Propazine Has Little Effect on Growth of Several Containerized Woody Plant Species

Janet C. Cole

ADDITIONAL INDEX WORDS. *Buddleia davidii* var. *veitchiana*, *Buxus microphylla*, *Euonymus fortunei* var. *acutis*, *Forsythia* × *intermedia*, herbicide, *Hibiscus syriacus*, *Juniperus chinensis*, *Lagerstroemia indica*, ornamentals, phytotoxicity, *Pyracantha angustifolia*, shrubs, *Spiraea japonica*

SUMMARY. Woody plant species were treated in 1995 and 1996 with 0, 1, 2, or 4 lb/acre (0, 1.1, 2.3, or 4.5 kg·ha⁻¹) propazine (a.i.). Species studied in 1995 included rose-of-sharon (*Hibiscus syriacus* L. 'Double Purple'), japanese boxwood (*Buxus microphylla* Sieb. & Zucc. 'Green Mountain'), butterfly bush (*Buddleia davidii* var. *Veitchiana* Rehd. 'Nanho Purple'), euonymus (*Euonymus fortunei* var. *acutis* Hand-Mazz. 'Emerald n' Gold'), forsythia (*Forsythia* × *intermedia* Zab. 'Lynnwood Gold'), fire thorn (*Pyracantha angustifolia* Roem. 'Gnome'), and japanese spiraea (*Spiraea japonica* L.f. 'Goldflame'). Crape myrtle (*Lagerstroemia indica* L. 'Acoma' and 'Zuni') and juniper (*Juniperus chinensis* L. 'Pfitzeriana') were added and euonymus and japanese spiraea were omitted in 1996. In both years, statistical analyses revealed differences in height and visual quality between plants exposed to propazine and

control plants of some species; however, differences were inconsistent in that some plants treated with propazine were larger or rated better than control plants while other plants were smaller or of lower quality than their corresponding control plants. In all cases, differences among propazine treatments within each species were <1.2 inches (3 cm) in height while decreases in visual quality compared to control plants were most evident in plants receiving four times the recommended rate of propazine. The horticultural significance of these differences was, therefore, considered small, suggesting that all of the species tested are tolerant to propazine applied at the recommended rate of 1 lb/acre (1.1 kg·ha⁻¹). Chemical names used: 6-chloro-*N,N*-bis(1-methylethyl)-1,3,5-triazine-2,4-diamine (propazine).

Chemical weed control in nursery and landscape settings can be risky because of the large number of plant species grown in a limited area, and potential herbicidal effects on nontarget species. Despite the risks involved, chemical weed control is important to the nursery and landscape industries because the alternative is hand weeding. Hand weeding is tedious and the labor costs can be prohibitive.

Another problem faced by the nursery and landscape industries is the loss of labelling for chemicals used for ornamental purposes. These industries are high value, but relatively low acreage. Chemical companies are reluctant to invest the large amount of money required to relabel products for limited uses.

Propazine was labelled for preemergent control of broadleaf and grass weeds common in sorghum (Boettger, 1989; Humburg, 1989) until 1988, at which time manufacturers chose not to relabel the product. It is not currently labelled for use in any crop. However, data have been collected and applications for registration have been filed with the U.S. Environmental Protection Agency to use the product on containerized ornamental plant species, and approval is anticipated (V. White, personal communication).

Propazine can be applied pre- or postplant without affecting tree mortality of field-grown mountain ash (*Eucalyptus regnans* F. Muell.) (Fagg, 1988). Havis (1966) tested propazine

for control of several annual weeds in *Rhododendron* L. 'Roseum Elegans' and *Euonymus fortunei* (Turcz.) Hand.-Mazz. 'Vegetus'. He found no injury on the rhododendron and only slight injury on euonymus. At 2 lb/acre (2.3 kg·ha⁻¹), Scudder (1961) found no damage to caladiums [*Caladium bicolor* (Ait.) Vent.], while Taylor (1963) observed slight to moderate injury on japanese boxwood and no injury to slight injury on pineapple guava (*Feijoa sellowiana* O. Berg.), wax privet (*Ligustrum japonicum* Thunb.), pittosporum (*Pittosporum tobira* Ait.), sweet viburnum (*Viburnum odoratissimum* Ker.-Gawl.), and *Viburnum suspensum* Lindl. At the higher rate of 4 lb/acre (4.5 kg·ha⁻¹), no damage occurred on caladiums (Scudder, 1961), but slight to moderate damage occurred on these other species (Taylor, 1963). While relatively few studies have tested propazine for weed control in ornamental crops, simazine, a herbicide from the same chemical family, is currently labelled for use on a number of field-grown ornamental plants (Ahrens, 1994). The purpose of this study was to determine the effect of propazine on several containerized woody plant species.

Materials and methods

1995. Rooted cuttings of eight woody ornamental species—rose-of-sharon, japanese boxwood, butterfly bush, euonymus, forsythia, fire thorn, and japanese spiraea—were planted on 8 May 1995 in 1-gal (3.8-L) containers in composted 3 pine bark : 1 peat : 1 sand (by volume) amended with 3 lb/yd³ (1.8 kg·m⁻³) N as 17N-3.1P-10K controlled-release fertilizer (Osmocote 17-7-12, Scotts Co., Marysville, Ohio), 1.5 lb/yd³ (0.9 kg·m⁻³) Micromax (Scotts Co.), and 4 lb/yd³ (2.3 kg·m⁻³) each of gypsum and dolomite.

Plants were irrigated immediately after planting and treated with 0, 1, 2, or 4 lb/acre (0, 1.1, 2.3, or 4.5 kg·ha⁻¹) propazine (a.i.) 14 h later. Propazine was applied with a CO₂ pressurized backpack sprayer with an output of 213.4 gal/acre (0.2 L·m⁻²). Plants were not irrigated for 24 h after herbicide application to expose plants to the herbicide for an extended time, similar to what they might receive in a nursery or landscape application. Plants were maintained outdoors throughout the growing season and irrigated with 0.5

Professor, Department of Horticulture and Landscape Architecture, Oklahoma State University, Stillwater, OK 74078-6027.

Approved for publication by the director of the Oklahoma Agricultural Experiment Station. This research was supported under project H-2066 and by a grant from Griffin Corp., Valdosta, Ga. Plants and pine bark were supplied by Greenleaf Nursery Co., Park Hill, Okla., and propazine was supplied by Griffin Corp. The technical assistance of Clydette Alsop, LeAnn Prater, Steve Owens, Paula Craig, and Michael Frost is greatly appreciated. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

inch (1.3 cm) water daily. Pots of all treatments were kept weed free throughout the study. Plant heights

and widths were measured and plant quality was visually rated by three independent evaluators monthly, begin-

ning 1 week following herbicide application. Plants were harvested between 30 Aug. and 22 Sept. 1995. While the

Table 1. Height and visual quality rating of plants from several woody species exposed to various concentrations of propazine. The rating scale ranged from 1 to 5, with 1 being a dead plant and 5 being a high-quality plant (1995).

Species	Rate ^z (lb/acre)	May		June		July		August	
		Ht ^y (inches)	Visual rating	Ht (inches)	Visual rating	Ht (inches)	Visual rating	Ht (inches)	Visual rating
Rose-of-sharon	0	5.5	3.6	9.4	4.2	11.6	4.0	12.7	3.2
	1	5.0	3.1	8.1	3.9	9.7	3.3	10.6	2.8
	2	4.6	3.1	8.9	4.5	14.3	3.9	14.4	2.9
	4	5.2	3.2	8.9	4.1	11.9	3.7	12.8	3.2
Linear		NS	NS	NS	NS	NS	NS	NS	NS
Quadratic		NS	NS	NS	NS	NS	NS	NS	NS
Cubic		NS	NS	NS	*	*	*	NS	NS
Japanese boxwood	0	4.4	4.7	5.2	4.6	5.6	4.4	5.6	4.4
	1	3.7	4.8	4.1	4.7	4.6	4.4	4.8	4.5
	2	5.0	4.8	5.3	4.6	5.4	4.4	5.4	4.5
	4	3.9	4.4	4.9	4.5	5.4	4.5	5.4	4.4
Linear		**	***	***	NS	*	NS	NS	NS
Quadratic		**	**	***	NS	NS	NS	NS	NS
Cubic		***	NS	***	NS	NS	NS	NS	NS
Butterfly bush	0	5.2	2.1	10.6	4.2	11.4	4.0	10.7	4.0
	1	5.3	1.8	11.0	4.1	11.5	3.9	10.6	3.6
	2	5.0	2.5	11.9	4.3	12.5	4.2	11.1	4.0
	4	4.8	2.0	10.6	2.9	11.6	3.0	10.3	2.9
Linear		NS	NS	NS	***	NS	**	NS	**
Quadratic		NS	NS	NS	*	NS	*	NS	NS
Cubic		NS	**	NS	NS	NS	NS	NS	NS
Euonymus	0	3.1	4.7	4.3	4.2	5.0	2.6	5.8	2.7
	1	3.2	4.8	4.3	4.2	5.2	3.1	5.7	3.0
	2	3.1	4.7	3.9	4.0	4.3	2.5	4.3	2.2
	4	3.1	4.6	3.7	4.1	4.1	2.1	4.7	2.0
Linear		NS	NS	NS	NS	NS	*	NS	**
Quadratic		NS	NS	NS	NS	NS	NS	NS	NS
Cubic		NS	NS	NS	NS	NS	NS	NS	NS
Forsythia	0	5.4	3.0	10.6	2.5	14.5	2.6	13.8	2.4
	1	5.9	3.4	9.0	4.2	14.1	4.0	19.7	3.6
	2	5.7	3.3	7.8	3.8	12.3	4.4	16.0	4.4
	4	5.6	3.2	8.3	3.9	14.1	3.9	17.0	4.3
Linear		NS	NS	NS	**	NS	***	NS	***
Quadratic		NS	*	NS	***	NS	***	NS	***
Cubic		NS	NS	NS	**	NS	NS	NS	NS
Fire thorn	0	5.3	2.9	6.3	4.6	7.2	3.7	8.4	3.8
	1	5.1	3.7	5.4	3.4	6.6	3.6	8.3	3.8
	2	5.1	2.9	5.7	3.6	6.9	3.9	8.0	4.1
	4	5.7	3.7	6.5	2.6	7.0	2.8	7.3	3.0
Linear		NS	NS	NS	*	NS	*	NS	**
Quadratic		NS	NS	NS	NS	NS	NS	NS	*
Cubic		NS	NS	NS	NS	NS	NS	NS	NS
Japanese spiraea	0	3.7	4.3	6.5	4.8	7.8	1.7	7.4	1.8
	1	3.7	3.6	5.7	4.7	6.7	1.8	6.8	2.0
	2	3.7	3.4	5.6	4.5	6.5	2.6	6.1	3.2
	4	3.9	2.9	3.9	2.0	4.8	1.7	5.0	1.7
Linear		NS	***	NS	***	NS	NS	NS	NS
Quadratic		NS	NS	NS	***	NS	**	NS	***
Cubic		NS	NS	NS	NS	NS	*	NS	**

^z1 lb/acre = 1.1 kg-ha⁻¹.

^y1 inch = 2.54 cm.

NS,*,**,*NSignificant or significant at $P = 0.05$, 0.01 , or 0.001 , respectively.

final harvest took several days, all plants of each species were harvested within a 24-h period. Shoots and washed roots were separated and dried at 113 °F (45 °C) for 7 d.

A completely randomized design was used within each species, with 13 plants per species and herbicide application rate. Trend analysis was used to determine treatment differences through linear, quadratic and cubic relationships among propazine application rates.

1996. The study described above was repeated with the following adjustments. Two cultivars of crape myrtle ('Acoma' and 'Zuni') and 'Pfitzer' juniper were included while euonymus and japanese spiraea were omitted from the previously listed plants in the study. Plants were planted in a randomized complete-block design on 3 May 1996 and harvested 6 and 7 Aug. 1996.

Results and discussion

1995. Plant widths were not affected by propazine in any species tested (data not shown). Plant heights were similar among herbicide application rates in all species and at all measurement dates with two exceptions. There was a curvilinear relationship between height and propazine rate such that the rose-of-sharon control plants were taller than those receiving 1 lb/acre but shorter than those receiving 2 or 4 lb/acre in July. The heights of japanese boxwood in May and June were smaller than those of control plants at 1 and 4 lb/acre and larger than control plants at 2 lb/acre (Table 1). In July, japanese boxwood plant heights increased as propazine rate increased, but all plants treated with propazine were smaller than the control plants.

The visual quality ratings among the propazine treatments varied with species and date (Table 1). There were no differences in visual quality in rose-of-sharon among the various propazine application rates in May or August. In June and July, however, there was a curvilinear relationship between visual quality and propazine application rate on rose-of-sharon such that plants treated with 1 lb/acre were rated lower than control plants. Rose-of-sharon plants receiving 2 lb/acre were rated higher in June and lower in July than untreated controls, and those plants receiving 4 lb/acre were rated lower than control plants during June and July. Japanese boxwoods showed a

curvilinear relationship between visual quality and application rate such that, at 1 and 2 lb/acre, plants were rated higher and, at 4 lb/acre, plants were rated lower in quality than control plants during May. In June and July, there was a negative curvilinear relationship in which visual quality of butterfly bush plants receiving 1 lb/acre was rated slightly lower, but those receiving 4 lb/acre were rated much lower than control plants. In those same months, butterfly bush plants receiving 2 lb/acre were rated slightly higher in visual quality than control plants. A negative linear relationship in which visual quality tended to decline as propazine rate increased occurred in August for butterfly bush. A similar negative linear relationship between propazine rate and visual quality rating occurred in euonymus during July and August. Propazine rate and visual quality were curvilinearly related in forsythia on all dates that the plants were rated. In forsythia, this curvilinear relationship was characterized by a general increase in visual quality as propazine application rate increased until the 4 lb/acre rate where quality generally declined. There was a negative linear relationship such that visual quality generally declined as propazine application rate increased on fire thorn in June and July, but in August, the relationship was curvilinear indicating that the decline was more pronounced as application rate increased. In trends similar to fire thorn, japanese spiraea showed a negative linear relationship between propazine application rate and visual quality rating during May, but the relationship became curvilinear during June, July, and August. Plants of euonymus and japanese spiraea appear to have been adversely affected by high temperatures in July and August as evidenced by the decline in visual ratings for these species from June to July regardless of propazine application. Propazine did not adversely affect shoot or root dry weight of any species (data not shown).

1996. Propazine did not affect any of the parameters measured in any species during May or in japanese boxwood during June, July or August (data not shown). Visual quality of rose-of-sharon decreased curvilinearly so that visual quality of propazine-treated plants was lower regardless of rate than visual quality of control plants in June. In July and August, however,

there was a curvilinear increase such that plants treated with propazine had greater visual ratings than control plants suggesting a recovery from propazine phytotoxicity (Table 2). Plant width of 'Acoma' crape myrtle decreased in June but increased in August (linear relationships during both months) as propazine application rate increased. In June, visual quality of 'Acoma' crape myrtle was lower (4.6) at the 4 lb/acre rate than at any other application rate (5.0 visual rating), but by July there were no significant trends in visual ratings. In contrast, height of 'Zuni' crape myrtle decreased in July as propazine application rate increased (linear trend), but plant width and visual quality were not significantly affected at any measurement time. Forsythia visual rating decreased in June as propazine application rate increased (linear trend), but in July and August there were no differences in any parameter measured. Visual rating of fire thorn generally decreased in June (linear trend) as propazine rate increased. In August, there was a curvilinear relationship between propazine rate and visual rating such that plants receiving 1 and 2 lb/acre were rated lowest (2.4), control plants were rated highest (3.3), and plants receiving 4 lb/acre were intermediate (2.9) in visual rating. Height of fire thorn decreased quadratically as propazine rate increased in July such that plants treated with propazine at any rate were smaller than control plants, but plant height of propazine-treated plants increased with increased rates of propazine. There were no differences in shoot or root dry weight regardless of propazine application rate in any species tested (data not shown).

Results of this study agree with those of Havis (1966) in which only slight effects of propazine were noted on some species and there was no propazine affect on other species. In 1995, all plants were exposed to a short but severe drought stress period soon after planting. In 1996, all plants received daytime temperatures as high as 117 °F (47.2 °C) for several days during early July, which may have caused plant quality in most species to decline during July and August regardless of propazine treatment. Symptoms of phytotoxicity are often more severe during and after periods of environmental stress. Despite the adverse conditions encountered during

Table 2. Height, width and visual quality rating of plants treated with various rates of propazine. The rating scale ranged from 1 to 5, with 1 being a dead plant and 5 being a high quality plant (1996).

Species	Rate ^z (lb/acre)	June			July			August		
		Ht ^y (inches)	Width (inches)	Visual rating	Ht (inches)	Width (inches)	Visual rating	Ht (inches)	Width (inches)	Visual rating
Rose-of-sharon	0	12.3	9.3	4.8	12.2	8.5	2.3	14.8	10.3	3.5
	1	12.0	8.4	4.1	12.2	9.1	3.1	15.1	9.8	4.7
	2	11.9	8.5	4.1	11.7	8.3	2.6	14.0	9.0	4.7
	4	11.4	8.4	3.9	11.7	8.7	2.6	13.1	8.5	4.1
Linear		NS	NS	***	NS	NS	NS	NS	*	NS
Quadratic		NS	NS	***	NS	NS	NS	NS	NS	***
Cubic		NS	NS	**	NS	NS	**	NS	NS	NS
Butterfly bush	0	10.0	13.3	4.8	10.3	22.9	3.1	12.2	23.7	4.7
	1	10.6	13.4	4.4	9.8	23.8	3.1	10.8	23.3	4.2
	2	10.2	14.0	4.5	9.2	22.8	3.0	10.8	23.5	4.4
	4	10.6	12.8	4.4	9.7	23.1	3.5	10.8	24.2	4.4
Linear		NS	NS	NS	NS	NS	*	NS	NS	NS
Quadratic		NS	NS	NS	NS	NS	NS	NS	NS	NS
Cubic		NS	NS	NS	NS	NS	NS	NS	NS	NS
Crape myrtle 'Acoma'	0	7.0	16.4	5.0	8.2	18.3	3.9	8.6	19.9	4.1
	1	7.7	16.2	5.0	7.9	17.7	4.0	8.1	19.8	4.3
	2	7.6	15.6	5.0	8.0	19.3	3.9	9.1	20.6	4.2
	4	6.5	11.3	4.6	7.3	18.9	4.2	7.9	21.9	4.1
Linear		NS	**	***	NS	NS	NS	NS	*	NS
Quadratic		NS	NS	*	NS	NS	NS	NS	NS	NS
Cubic		NS	NS	NS	NS	NS	NS	NS	NS	NS
'Zuni'	0	12.6	9.7	5.0	12.8	11.3	4.8	13.9	12.2	4.7
	1	12.2	10.1	5.0	12.5	11.5	4.9	13.0	12.4	4.7
	2	10.7	9.4	5.0	11.3	10.4	4.8	12.4	12.9	4.5
	4	11.2	9.4	4.9	11.5	11.0	4.6	12.5	12.4	4.5
Linear		NS	NS	NS	*	NS	NS	NS	NS	NS
Quadratic		NS	NS	NS	NS	NS	NS	NS	NS	NS
Cubic		NS	NS	NS	NS	NS	NS	NS	NS	NS
Forsythia	0	10.9	10.4	4.9	14.2	20.4	4.2	13.8	24.1	4.2
	1	10.2	10.4	5.0	11.9	21.9	3.8	11.7	25.0	3.8
	2	9.6	9.6	4.8	13.3	21.3	4.2	11.1	25.2	4.2
	4	11.6	10.1	4.6	14.8	22.8	4.1	11.5	28.9	4.0
Linear		NS	NS	*	NS	NS	NS	NS	NS	NS
Quadratic		NS	NS	NS	NS	NS	NS	NS	NS	NS
Cubic		NS	NS	NS	NS	NS	NS	NS	NS	NS
Juniper	0	7.4	6.6	4.5	8.6	7.5	4.8	10.5	10.2	4.8
	1	7.5	6.5	4.4	8.7	7.8	4.6	10.1	10.1	4.5
	2	7.7	6.4	4.5	8.8	7.6	4.7	10.7	10.3	4.7
	4	7.5	6.3	4.2	8.7	7.0	4.7	10.1	8.7	4.8
Linear		NS	NS	NS	NS	NS	NS	NS	NS	NS
Quadratic		NS	NS	NS	NS	NS	NS	NS	NS	NS
Cubic		NS	NS	NS	NS	NS	NS	NS	NS	*
Fire thorn	0	9.5	10.8	4.9	12.3	15.4	3.2	13.5	17.5	3.3
	1	9.4	11.8	5.0	10.0	16.4	2.7	11.3	17.3	2.4
	2	9.0	10.2	4.5	10.8	14.8	2.7	12.4	18.1	2.4
	4	8.9	9.6	4.0	11.4	14.0	2.6	12.7	16.4	2.9
Linear		NS	NS	***	NS	NS	NS	NS	NS	NS
Quadratic		NS	NS	NS	*	NS	NS	NS	NS	**
Cubic		NS	NS	NS	NS	NS	NS	NS	NS	NS

^z1 lb/acre = 1.1 kg·ha⁻¹.

^y1 inch = 2.54 cm.

NS, *, **, *** Nonsignificant or significant at $P = 0.05$, 0.01 , or 0.001 , respectively.

this study, plants within each species that received propazine treatments generally differed from the control

plants by <1.2 inches (3 cm) in height while differences in visual quality ratings were most evident at the highest

propazine rate tested which was four times the recommended rate. Though there were statistical differences in the

plant parameters measured in some months and for some species, those differences would probably not be apparent to the consumer, supporting the hypothesis that all of the species tested appear to tolerate propazine when it is applied at the recommended rate.

Literature cited

Ahrens, W.A. (ed.). 1994. Herbicide handbook. Weed Sci. Soc. Amer., Champaign, Ill.

Boettger, M.S. (ed.). 1989. Weed control manual. Meister Publishing, Willoughby, Ohio.

Fagg, P.C. 1988. Weed control techniques for the establishment of *Eucalyptus regnans* plantations on pasture sites. Aust. For. 51:28-38.

Havis, J.R. 1966. Progress report on weed control in nursery crops. Proc. N.E. Weed Control Conf. 15:137-145.

Humburg, N.E. (ed.). 1989. Herbicide handbook. Weed Sci. Soc. Amer., Champaign, Ill.

Scudder, W.T. 1961. Controlling annual weeds in caladiums on Florida peat soil. Proc. South. Weed Conf. 14:164-174.

Taylor, J.L. 1963. Preemergence weed control in field grown woody ornamental plants. Proc. South. Weed Conf. 16:145-155.