Pyracantha coccinea 'Kasan' and 'Lalandei' Response to Uniconazole and Chlormequat Chloride

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Abstract. *Pyracantha coccinea* M.J. Roem. 'Kasan' and 'Lalandei' were treated with a soil drench of 30 mg a.i. chlormequat chloride per container or 0, 0.25, 0.50, or 1.00 mg a.i. uniconazole per container or with a foliar application of 3000 mg a.i. chlormequat chloride/liter or 0, 25, 50, or 100 mg a.i. uniconazole/liter. Chlormequat chloride applied as a drench did not affect growth of 'Kasan' or 'Lalandei' until 17 weeks after application, when 'Kasan' was taller and 'Lalandei' shorter than untreated plants. 'Kasan' plants drenched with chlormequat chloride had more leaves with greater total leaf area and higher leaf and stem dry weights than untreated plants. However, area per leaf, root dry weight, and root : shoot ratio were not affected by the chlormequat chloride drench. In 'Lalandei', the chlormequat chloride drench did not affect any of these criteria, except stem dry weight. Foliar applications of chlormequat chloride had little effect on either cultivar. Height of 'Kasan' and 'Lalandei' decreased with increasing uniconazole rates for both application methods. Area per leaf increased in 'Kasan' but decreased in 'Lalandei' receiving a drench applied to the medium. Foliar and drench applications of uniconazole both resulted in decreased stem dry weight of both cultivars. Chemical names used: 2-chloro-N,N,N-trimethylethanaminium chloride (chlormequat chloride); (E)-1-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-1-penten-3-ol (uniconazole).

Uniconazole and chlormequat chloride are plant growth regulators that reduce plant growth by inhibiting gibberellin biosynthesis (Henry, 1985). These chemicals have been used to restrict the height of floricultural crops such as chrysanthemum (Holcomb et al., 1983; Wilfret, 1986), poinsettia (Conover and Vines, 1972; White and Holcomb, 1974; Wilfret, 1986) and several bedding plant species (Barrett and Nell, 1986).

The use of growth regulators on woody ornamental plants is less widespread than in

the floriculture industry. The response of woody plants to uniconazole has been variable, depending on species and application rate. Extremely short internodes resulted when uniconazole was applied at 2.5 mg a.i. per container as a soil drench to ibolium privet and 'Wonderberry' pyracantha (Norcini and Knox, 1989). Uniconazole-treated hibiscus were shorter than untreated hibiscus, but foliar distortion reduced plant quality as application rate increased (Newman et al., 1989). In contrast, forsythia (Vaigro-Wolff and Warmund, 1987) and Fraser photinia (Norcini and Knox, 1989) treated with similar uniconazole rates were more compact, plant appearance was more desirable, and photinia flowers were showier than for controls. Although chlormequat chloride has not been as widely tested on woody plants, increased shoot lengths, plant diameters, and

plant heights have been observed in willows, forsythias, and roses but not spirea or weigela that were treated with this growth regulator (Grzesik and Rudnicki, 1985).

Pyracantha is used widely as an informal hedge and as espaliers. This species can, however, grow out of control if it is not properly pruned and maintained. The use of growth regulators to control the growth habit of pyracantha during production and after planting into the landscape could lead to wider use of this species and reduced maintenance costs. The objectives of this research were to determine uniconazole application rates that would decrease growth of two pyracantha cultivars while maintaining a desirable appearance, and to determine whether uniconazole controls the height of woody plants better than chlormequat chloride, a growth regulator currently used in the floriculture industry to reduce height of seasonal flowering plants.

One hundred 7.5-cm-long rooted cuttings of *Pyracantha coccinea* 'Kasan' and 'Lalandei' were planted in 3.8-liter containers of 3 pine bark : 1 peat : 1 sand (by volume) amended with 17N-3, 6P-10K slow release fertilizer at 8.3 g·m⁻³ (Osmocote, Sierra Chemical, Milpitas, Calif.), Micromax at 1.9 kg·m⁻³ (Sierra Chemical), and dolomite at 2.3 kg·m⁻³. Plants were grown in a greenhouse for 6 weeks at 30/15C day/night, then pruned to a 20-cm final shoot length. Plants then were treated with 30 mg chlormequat chloride per container or 0, 0.25, 0.50, or 1.00 mg uniconazole per container as a soil drench, or 3000 mg chlormequat chloride/liter or 0, 25, or 50 mg uniconazole/liter as a foliar spray and placed outside in full sun. Soil drenches were applied in 100 ml of solution to each container, and foliar applications were applied as a spray to runoff. The soil surface of plants receiving a foliar spray was covered with plastic before spraying to assure that no uniconazole would enter the growing medium. Plastic was removed when the foliage had dried.

Plant height from the medium surface to the top of the tallest shoot was measured periodically beginning 3 weeks after application. Plant widths were determined by measuring plant diameter at the widest point and perpendicular to this point and then averaging the values. Seventeen weeks after

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Table 1. Influence of medium drench or foliar applications of growth regulators on height and width of 'Kasan' pyracantha.

Treatment	Weeks after treatment									
	3		5		8		13		17	
	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)
<i>Medium drench (mg a.i./container)</i>										
Chlormequat chloride										
30	25.7	30.7	29.2	37.0	35.8	46.0	40.9	49.3	50.9	55.7
Uniconazole										
0	26.0	33.8	29.1	37.2	34.4	44.4	40.7	48.5	45.5*	53.9
0.25	25.4	33.8	25.7*	35.4	29.0**	43.7	31.5**	46.5	35.9**	54.1
0.50	25.5	34.4	26.7	35.7	30.6**	41.0*	32.0**	45.3	37.6**	49.0*
1.00	25.5	33.5	27.6	37.1	29.7**	43.6	31.2**	45.0	35.3**	49.0*
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	NS	NS
<i>Foliar application (mg a.i./liter)</i>										
Chlormequat chloride										
3000	27.2	34.2	28.1	36.5	32.3	43.7	34.5	47.3	40.9	50.3
Uniconazole										
0	26.0	33.8	29.1	37.2	34.4	44.4	40.7**	48.5	45.5	53.9
25	24.0*	32.2	24.6*	34.2	30.0	41.3	33.7	46.4	38.1	51.9
50	24.8	34.0	25.3	36.8	27.7*	42.5	31.6	46.5	38.0	53.7
100	24.9	32.5	26.2	34.2	27.8*	43.1	30.7	45.3	35.9	49.4
Linear	NS	NS	**	NS	**	NS	**	NS	**	NS
Quadratic	NS	NS	NS	NS	**	NS	**	NS	**	NS
Cubic	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS,*,**Nonsignificant or significant at $P = 0.05$ or 0.01 , respectively, relative to chlormequat chloride or in respect to linear, quadratic, or cubic responses.

Table 2. Plant growth characteristics of 'Kasan' pyracantha treated with medium drench or foliar applications of uniconazole or chlormequat chloride.

Treatment	Leaves/plant	Leaf area (cm ²)		Dry wt (g)			Root : shoot ratio
		Per leaf	Per plant	Leaf	Stem	Root	
Medium drench (mg a.i./container)							
Chlormequat chloride							
30	3530	0.71	2250	27.7	37.9	45.6	0.70
Uniconazole							
0	2760**	0.71	1810*	23.3*	33.0*	39.6	0.71
0.25	3440	0.60	2070	26.4	21.7**	36.0	0.80
0.50	2890*	0.68	1980	25.1	21.1**	29.9*	0.65
1.00	2710**	0.78	2080	28.3	21.6**	31.8*	0.65
Linear	NS	NS	NS	NS	**	NS	NS
Quadratic	NS	*	NS	NS	*	NS	NS
Cubic	NS	NS	NS	NS	NS	NS	NS
Foliar application (mg a.i./liter)							
Chlormequat chloride							
3000	2740	0.78	1950	24.3	34.1	37.8	0.65
Uniconazole							
0	2760	0.71	1810	23.3	33.0	39.6	0.71
25	2890	0.73	2120	26.8	32.4	33.7	0.58
50	2630	0.80	2120	24.2	27.7*	35.2	0.70
100	2660	0.83	2180	26.9	23.7**	39.6	0.78
Linear	NS	NS	NS	NS	NS	NS	NS
Quadratic	NS	NS	NS	NS	**	NS	NS
Cubic	NS	NS	NS	NS	NS	NS	NS

NS,*,**Nonsignificant or significant at $P = 0.05$ or 0.01 , respectively, relative to chlormequat chloride treatment or in respect to linear, quadratic, or cubic responses.

treatment, plants were harvested and leaves counted, leaf areas were measured with a LI-3100 area meter (LI-COR, Lincoln, Neb.), and leaves, shoots and roots were dried at 45°C for 7 days and weighed. Average area per leaf for each plant was calculated by dividing total leaf area by leaf number. Root : shoot ratios were calculated as (leaf dry weight + shoot dry weight)/root dry weight.

A randomized complete-block design with 10 single-plant replications and 10 treatments within each cultivar was used. Analy-

sis of variance procedures and paired t tests were used to determine differences among chlormequat chloride and uniconazole treatments within each application method. Orthogonal contrasts were used to determine linear, quadratic, and cubic relationships among uniconazole application rates.

'Kasan' plants treated with a chlormequat chloride medium drench did not differ significantly from controls in height or width until 17 weeks after application when treated plants were taller than controls (Table 1). These results agree with observations of in-

creased plant height in willow, forsythia, and roses treated with chlormequat chloride (Grzesik and Rudnicki, 1985). Plants receiving foliar treatments also did not differ except at week 13, when chlormequat chloride plants were shorter than control plants.

Chlormequat chloride applied as a drench resulted in more leaves, larger plant leaf areas, and higher leaf and stem dry weights in 'Kasan' than the control treatment (Table 2). The foliar application of chlormequat chloride did not affect these measurements.

'Lalandei' plants drenched with chlormequat

Table 3. Influence of medium drench or foliar applications of growth regulators on height and width of 'Lalandei' pyracantha.

Treatment	Weeks after treatment									
	3		5		8		13		17	
	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)	Height (cm)	Width (cm)
<i>Medium drench (mg a.i./container)</i>										
Chlormequat chloride										
30	26.9	34.4	29.0	37.7	31.8	44.4	36.6	50.9	38.4	56.1
Uniconazole										
0	26.7	33.7	28.7	37.7	34.7	45.6	38.5	47.8	45.0**	53.9
0.25	25.9	33.3	28.7	37.1	34.7	42.9	38.9	47.1	40.5	50.7
0.50	26.0	34.8	27.8	38.5	30.6	43.6	32.1	44.7**	34.9	47.0**
1.00	25.1	30.5	27.3	33.3*	28.7	38.7**	30.7*	40.3**	33.5	43.1**
Linear	NS	NS	NS	NS	NS	NS	*	NS	**	NS
Quadratic	NS	NS	NS	NS	**	*	**	**	**	**
Cubic	NS	NS	NS	*	NS	NS	NS	NS	NS	NS
<i>Foliar application (mg a.i./liter)</i>										
Chlormequat chloride										
3000	25.4	30.2	29.6	34.9	36.1	43.2	43.8	47.6	49.9	52.1
Uniconazole										
0	26.7	33.7*	28.7	37.7	34.7	45.6	38.5*	47.8	45.0	53.9
25	24.5	29.8	26.0*	34.7	31.1*	41.7	38.2*	48.6	41.7**	52.5
50	22.7	28.6	23.5**	30.5*	28.1**	37.6**	30.4**	42.2*	37.3**	46.9
100	23.9	31.1	26.4*	32.8	26.5**	38.4*	28.7**	42.2*	32.8**	46.2*
Linear	*	**	*	**	NS	*	NS	NS	NS	NS
Quadratic	*	NS	NS	**	**	**	**	**	*	**
Cubic	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS,*,**Nonsignificant or significant at $P = 0.05$ or 0.01 , respectively, relative to chlormequat chloride or in respect to linear, quadratic, or cubic responses.

Table 4. Plant growth characteristics of 'Lalandei' pyracantha treated with medium drench or foliar applications of uniconazole or chlormequat chloride.

Treatment	Leaves/plant	Leaf area (cm ²)		Dry wt (g)			Root : shoot ratio
		Per leaf	Per plant	Leaf	Stem	Root	
Soil drench (mg a.i./container)							
Chlormequat chloride							
30	2150	0.80	1660	23.5	23.6	34.9	0.74
Uniconazole							
0	2550	0.69	1690	24.3	27.8*	39.3	0.78
0.25	2060	0.78	1600	23.3	15.1	28.5	0.74
0.50	1900	0.82	1510	22.3	13.0*	29.0	0.84
1.00	1690	1.00	1670	24.2	12.3*	26.8	0.75
Linear	NS	NS	NS	NS	**	NS	NS
Quadratic	*	*	NS	NS	**	NS	NS
Cubic	NS	NS	NS	NS	NS	NS	NS
Foliar application (mg a.i./liter)							
Chlormequat chloride							
3000	1930	0.83	1600	23.8	25.6	32.8	0.66
Uniconazole							
0	2550	0.69	1690	24.3	27.8	39.3	0.78
25	2070	0.90	1710	24.1	22.6	29.0	0.62
50	1770	0.98	1720	24.4	15.4**	27.0	0.68
100	1520	1.23**	1910	26.7	16.3*	28.5	0.74
Linear	NS	NS	NS	NS	NS	**	NS
Quadratic	*	NS	NS	NS	**	*	NS
Cubic	NS	NS	NS	NS	NS	NS	NS

NS,*,**Nonsignificant or significant at $P = 0.05$ or 0.01 , respectively, relative to chlormequat chloride treatments or in respect to linear, quadratic, or cubic responses.

quat chloride were smaller than controls after 17 weeks (Table 3). The foliar chlormequat chloride application resulted in larger plants at week 13, but this difference was not significant at week 17. Application of chlormequat chloride as a medium drench to 'Lalandei' reduced stem dry weights, but foliar applications had no effect (Table 4).

'Kasan' height decreased as the uniconazole concentration increased for the medium drench and foliar applications (Table 1). The effect was curvilinear for foliar sprays, beginning 8 weeks after treatment and for me-

dium drenches beginning 13 weeks after treatment. Similar results were obtained by Norcini and Knox (1989), with ibolium privet, fraser photinia, and 'Wonderberry' pyracantha, all being shorter when treated with uniconazole, particularly when environmental conditions favored rapid growth.

Uniconazole did not affect the number of leaves per plant or plant leaf area, leaf and root dry weights, or the root : shoot ratio of 'Kasan' (Table 2). The medium drench resulted in a curvilinear increase in area per leaf, while both application methods curvi-

linearly decreased stem dry weights.

Decreased stem and leaf dry weight with uniconazole was also noted by Norcini and Knox (1989) on 'Wonderberry' pyracantha, fraser photinia, and ibolium privet. The increased individual leaf areas were in contrast to the decrease in total foliage areas observed in treated privet seedlings and American sycamore when uniconazole was injected into plants (Sterrett, 1988); however, individual leaf areas were not measured in that study.

Height and width of 'Lalandei' decreased beginning 8 weeks after drench applications

(Table 3). At this time, there was a curvilinear relationship between application rates and height and width. Foliar applications decreased plant height curvilinearly by 3 weeks after application. There was a linear relationship between foliar application rate and width at week 3, but it was curvilinear by week 5.

Both application methods decreased leaf count and stem dry weight curvilinearly in 'Lalandei' (Table 4). The drench resulted in a curvilinear decrease in area per leaf, while the foliar treatment resulted in a curvilinear decrease in root dry weight.

In this study, chlormequat chloride had little effect on plant growth and visual appearance of either *Pyracantha coccinea* 'Kasan' or 'Lalandei'. In contrast, uniconazole decreased height of both. 'Kasan' was most affected by the soil drench, while 'Lalandei' responded more to foliar applications. Uniconazole-treated plants of both cultivars had a desirably compact growth habit and darker

green foliage and were considered more desirable in appearance than those not treated with the growth regulator or with chlormequat chloride.

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