Weed roots were able to penetrate all of the tested materials marketed for landscape weed control. Similar root penetration has been reported by Cook for grass roots (no species given) (3), Derr and Appleton for large crabgrass (4), and Klett (no species given) (6). If weed roots penetrate a fabric or film, rapid weed growth develops due to the favorable environment for root growth which occurs under landscape fabrics and films (5). Though brown polyethylene stopped most root penetration because it is nonporous, it creates a barrier to oxygen and water exchange, two factors important for the root growth of desired plants in landscapes.

The landscape fabrics and films differ as to the extent of root penetration. Examination of the ratio of open to closed areas for the various materials may provide insight as to why these materials differ in root penetration. For example, Weed-X, which significantly reduced grass shoot growth due to very limited root penetration, is 3% open—97% closed. By comparison, Duon, which had significantly less grass shoot reduction and far greater root penetration, is 60% open—40% closed (calculations provided by Dalen Products).

Fabrics such as Weed-X, which limit root penetration, should therefore be expected to provide superior weed control over fabrics and films that permit greater root penetration. Fabrics and films with limited root penetration should approximate the weed control provided by solid polyethylene, yet allow for gas and water exchange between the soil and air above the soil covering.

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Effect of Pruning on the Growth Inhibiting Activity of Sumagic (Uniconazole)[1]

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Abstract

Pruning date was investigated as a possible factor influencing the inhibitory activity of Sumagic (uniconazole) on growth of 6 container grown woody landscape plants. Plants were pruned 1 or 10 days before uniconazole was applied as a foliar spray or medium drench on June 22, 1988. Plant height and width were recorded weekly through November 30, 1988. Pruning date influenced the pattern of growth and/or the final size of plants treated with foliar-applied uniconazole. It also influenced uniconazole's inhibitory activity the first 2 to 3 weeks after application. Uniconazole was most effective on *Pyracantha* and *Ligustrum lucidum* the first 2 to 3 weeks after treatment if applied 1 day after pruning. Drench applications resulted in greater growth inhibition than foliar sprays; however, drench treatments caused unacceptable reduction in plant size.

Index words: chemical pruning agent, growth retardant, growth regulation

Species Used In This Study: gold spot euonymus (*Euonymus japonica* 'Aureo Marginata'); Nellie R. Stevens holly (*Ilex aquifolium* L. × *Ilex cornuta* Lindl. & Paxt. 'Nellie R. Stevens'; glossy privet (*Ligustrum lucidum* Ait.); variegated Chinese privet (*Ligustrum sinense* Lour. 'Variegatum'); Fraser photinia (*Photinia* × *fraseri* Dress); Wonderberry pyracantha (*Pyracantha koidzumii* [Hayata] Rehd. 'Wonderberry')

Growth Regulators Used In This Study: Sumagic, uniconazole, (E)-(p-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-1-penten-3-ol

Significance to the Nursery Industry

One of the major reasons growers seem reluctant to utilize growth retardants is that they, at least initially, do not seem to fit into a production scheme which emphasizes obtaining the desired size plant as fast as possible. We have demonstrated though, that short-term control of growth is possible with little to no reduction in final size. Temporary suppression of growth by Sumagic (uniconazole) could be useful when desiring to hold saleable-size plants (including those in fabric containers) until sale or shipment without

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further pruning or allowing plants to become pot bound. Also, plants previously treated with Sumagic may be less susceptible to water stress because of lower whole-plant transpiration rates (2).

Longer term control of growth could be obtained at the higher Sumagic rates. For example, a foliar spray above 50 ppm was considered excessive for short-term control of *Photinia* growth. But, if *Photinia* were to be potted into 11.4 liter (#3) containers for another season's growth, the plants treated at the lower rates would require pruning whereas those treated with 75 or 100 ppm rate would require little or no pruning. In a previous experiment (7), *Photinia* grown in 3.8-liter (#1) containers treated with a relatively high Sumagic rate in September 1986 required very little pruning the following May. One year later, these *Photinia* were very desirable 11.4 liter (#3) plants.

Introduction

Sumagic (uniconazole), an experimental plant growth regulator (PGR), has shown promise for reducing pruning frequency of woody plants in nursery and landscape situations. It inhibits the growth of *Forsythia* (14), *Ligustrum* spp. (5, 7, 13), *Liriodendron* (13), *Malus* (13), *Photinia* (5, 7), *Platanus* (13), and *Pyracantha* (7).

While Sumagic (uniconazole) exhibits excellent potential for reducing pruning frequency, the time of application in relation to growth flushes and pruning date has not been addressed. Effective utilization of labelled growth retardants for nursery and landscape use is highly dependent upon proper timing. Borden and Campbell (1) noted that Atrimmec (dikegulac) most effectively controlled *Ilex* growth when applied at the beginning of the growth flush rather than 3 weeks later. Similarly, maleic hydrazide (MH; Royal Slo-Gro) (9) and daminozide (B-Nine SP) (10) are most effective when applied at bud break. Results of a preliminary study (5) indicate that the effectiveness of Sumagic (uniconazole) and Cutless (flurprimidol) may be influenced by date of application after pruning. *Photinia* × *fraseri* treated with a 100 ppm foliar spray of Sumagic (uniconazole) 2 days after pruning were smaller than nontreated plants; however, final size of plants treated 9 days after pruning was the same as nontreated plants even though growth was temporarily inhibited after treatment.

The purpose of this study was to determine if the growth retarding activity of Sumagic (uniconazole) on several species of woody landscape plants is affected by the time of application after pruning.

Materials and Methods

Rooted liners of 6 species (see Table 1 for species and treatments) were obtained in May 1988 from local nurseries and potted in pine bark:sphagnum peat:sand (3:1:1 by vol) in 3.8 liter (#1) or 11.4 liter (#3; *Pyracantha* only) containers. Plants were grown in full sun with overhead irrigation, except for the first 2 weeks after transplanting, when they grown under 30% shade. A top dressing of Osmocote 18N:2.64P:9.96K was applied every 3 months starting at the time of transplanting. Plants were pruned (1-3 cm) to a uniform size 1 or 10 days before uniconazole (Sumagic Liquid formulated at 500 ppm; Valent USA, Walnut Creek, CA) was applied as a foliar spray (coverage to just short of drip point) or drench (100 ml—*Photinia*; 300 ml—*Pyracantha*) in early to mid-morning of June 22, 1988. Foliar-treated plants were temporarily transferred to a plexiglass-covered (20% shade) open-sided shed so as not to receive any overhead irrigation for 24 hr; drench-treated plants were irrigated 6 hr after application. Nonpruned nontreated plants and pruned plants sprayed with water served as controls. Plant height and width (cm), recorded weekly, were used to compute a growth index ([height + width]/2).

Table 1. Uniconazole (Sumagic) treatments applied to 6 species of woody landscape plants 1 or 10 days after pruning.

Species	Uniconazole Application		
	Day After Pruning	Foliar Spray (ppm)[z]	Drench (mg ai)
Euonymus japonica 'Aureo Marginata'	1	0,25, 50, 100	1, 2.5, 5.0
Ilex × 'Nellie R. Stevens'	1, 10	0, 25, 50, 75, 100	—
Ligustrum lucidum	1	0, 25, 50, 100	—
	10	0, 25, 50	—
Ligustrum sinense 'Variegatum'	1, 10	0, 25, 50, 100	—
Photinia × fraseri	1, 10	0, 25, 50, 75, 100	1, 2.5, 5.0
Pyracantha koidzumii 'Wonderberry'	1, 10	0, 25, 50, 75, 100	3, 7.5, 15

[z]Approximately 17 ml was required for thorough coverage of plants grown in 3.8-liter (#1) containers (50 ml for coverage of *Pyracantha*).

Treatments were completely randomized within each species with 5 replications per treatment. Height, width, and growth index data were subjected to analysis of variance. LSD values (5% level) were computed for comparing growth index differences within a treatment (within species).

Results and Discussion

Effect of pruning date. Pruning date influenced uniconazole activity on *Ligustrum lucidum* and *Pyracantha* primarily during the first few weeks after foliar application. Rate of height increase of *Pyracantha* sprayed with 25 to 100 ppm uniconazole 1 day after pruning (DAP) was about 50% or less than the plants sprayed with water 1 DAP, and 75% less than plants sprayed with water 10 DAP. The more vigorously growing *Pyracantha* (Table 2) sprayed 10 DAP required 100 ppm uniconazole for a comparable decline in rate of height increase. Similarly, *Ligustrum lucidum* needed a higher rate of uniconazole 10 DAP to elicit the same reduction in rate of height increase as occurred in plants treated 1 DAP.

The apparent influence of vigor on uniconazole activity is not surprising since the activity of other growth retardants are affected by plant vigor. Rapidly growing peach and apple seedlings readily metabolize paclobutrazol (3, 11). Older, less active apple trees do not metabolize either paclobutrazol (12) or uniconazole (13) as fast. Plant vigor also affects the activity of the growth retardants dikegulac (Atrimmec) and chlorflurenol (Maintain CF125) when used to reduce pruning frequency of woody landscape plants. Generally, the faster the plant is growing the shorter the period of growth control with these retardants.

The interval between pruning and the time uniconazole was applied also influenced the growth pattern for the remainder of the growing season and/or final size of all species except *Ligustrum lucidum*. *Photinia* treated 1 DAP with 75

Table 2. Growth rate (per week) of *Ligustrum lucidum* and *Pyracantha koidzumii* 'Wonderberry' after application of foliar-applied 0, 25, 50, 75, or 100 ppm uniconazole (Sumagic) 1 or 10 days after pruning (DAP); uniconazole applied June 22, 1988.

Uniconazole Application		*Ligustrum lucidum* Mean Growth Increase/Wk June 22 to July 6	*Pyracantha koidzumii* 'Wonderberry' Mean Growth Increase Per Week June 22 to July 13		
Spray Rate (ppm)	Day After Pruning	Growth Index[z] (cm)	Height (cm)	Width (cm)	Growth Index (cm)
0	Not Pruned[y]	1.0 ± 0.4[x]	3.5 ± 0.3	4.0 ± 0.3	3.8 ± 0.2
0	1	2.0 ± 0.6	1.7 ± 0.4	2.3 ± 0.5	2.0 ± 0.5
0	10	4.6 ± 0.6	3.1 ± 0.4	4.1 ± 0.7	3.6 ± 0.3
25	1	0.5 ± 0.1	0.8 ± 0.3	1.8 ± 0.2	1.3 ± 0.1
25	10	2.7 ± 0.5	2.6 ± 0.4	3.1 ± 1.0	2.8 ± 0.5
50	1	0.8 ± 0.3	0.8 ± 0.1	2.2 ± 0.2	1.5 ± 0.1
50	10	1.9 ± 0.3	2.9 ± 0.6	3.0 ± 0.6	3.0 ± 0.4
75	1	—	0.5 ± 0.2	1.4 ± 0.4	1.0 ± 0.2
75	10	—	1.8 ± 0.3	2.4 ± 0.2	2.1 ± 0.2
100	1	0.8 ± 0.3	0.3 ± 0.1	2.2 ± 1.0	1.3 ± 0.5
100	10	—	1.1 ± 0.4	1.9 ± 0.2	1.5 ± 0.3
Significance[w]					
Rate		*	***	NS	**
Rep (Rate)		*	NS	NS	NS
DAP		***	***	*	***
Rate × DAP		*	NS	NS	NS

[z]Growth Index = (Height + Width)/2.

[y]This treatment included only for comparison and was not included in the analysis of variance.

[x]Values represent the mean ± the standard error.

[w]NS, *, **, *** Nonsignificant at the 5%, 1%, or .1% level, resp.

or 100 ppm uniconazole had more distinct flushes of growth than those treated 10 DAP (Fig. 2ab). Different growth patterns occurred with *Ilex* treated with 25 ppm uniconazole 1 and 10 DAP, yet these plants were of equal size by November 30 (Fig. 1). *Pyracantha* (Table 3) sprayed with 50 ppm uniconazole 1 DAP were smaller than the pruned controls whereas those sprayed 10 DAP were not. This difference occurred because 50 ppm uniconazole did not retard growth when applied 10 DAP but slightly diminished the rate of growth when applied 1 DAP. Similar results occurred with *Ligustrum sinense* 'Variegatum' sprayed with 100 ppm uniconazole (Table 3).

Effect of uniconazole. Uniconazole inhibited overall growth of all 6 species (Table 3; final height and width results not shown). Increase in height and width of both *Ligustrum* species and *Ilex* were suppressed, while only height increase of *Euonymus, Photinia*, and *Pyracantha* was inhibited by uniconazole. We previously reported that uniconazole retarded height of *Ligustrum × ibolium, Photinia × fraseri*, and *Pyracantha koidzumii* 'Wonderberry' when it was applied as a medium drench immediately after pruning (7). Differences in growth habits could account for the discrepancy among the 3 *Ligustrum* species. *Ligustrum × ibolium* is more upright than the other 2 species and height inhibition might be expected.

Uniconazole drenches inhibited growth of *Photinia* and *Pyracantha* as much as or more than spray applications (results shown for *Photinia* in Fig. 2) but all drench rates caused unacceptable reduction in plant size. Over a longer growth period both the 1 and 2.5 mg rate may result in *Photinia* of acceptable appearance with little or no pruning required. Previous work (7) showed that *Photinia* treated with a medium drench of between 2.5 and 5.0 mg uniconazole immediately after pruning in early autumn resulted in plants 19 months later that were more desirable than pruned nontreated plants. The uniconazole-treated *Photinia* had a more compact habit, deeper green foliage and improved flowering (6, 7). All the drench treatments, as well as the 75 and 100 ppm spray, resulted in pendulous branches on *Pyracantha* by November 30. This effect of uniconazole on growth habit was noted on *Pyracantha* treated at a lower rate (7), as well as *Hibiscus* (15). Wang and Gregg (15) showed that the branches of *Hibiscus* were pendulous because of changes in shoot anatomy. Similar changes in stem anatomy may have also occurred in uniconazole-treated *Pyracantha*.

Maximum rate for foliar-applied uniconazole that retarded growth to an acceptable level (i.e., threshold level) for short term production use (6 to 8 weeks or less) was 50 ppm for *Photinia* (Fig. 2ab) and between 25 and 50 ppm for *Pyracantha* depending on the date of pruning (Tables 2 and 3).

Growth of *Euonymus* treated with a medium drench or a 100 ppm spray was retarded similarly, but was deemed excessive and inappropriate for short term use during production (Table 3; drench results not shown). Foliar-applied uniconazole at a rate between 50 (no growth inhibition) and 100 ppm would seem more desirable because temporary growth control could be achieved with no reduction in size by the end of the season.

Drench treatments may have suppressed growth more than sprays possibly because uniconazole in the medium would directly inhibit the growth of roots and shoots whereas only shoot growth would be directly affected by foliar sprays. Oshio and Izumi (8) demonstrated that ^{14}[C]uniconazole

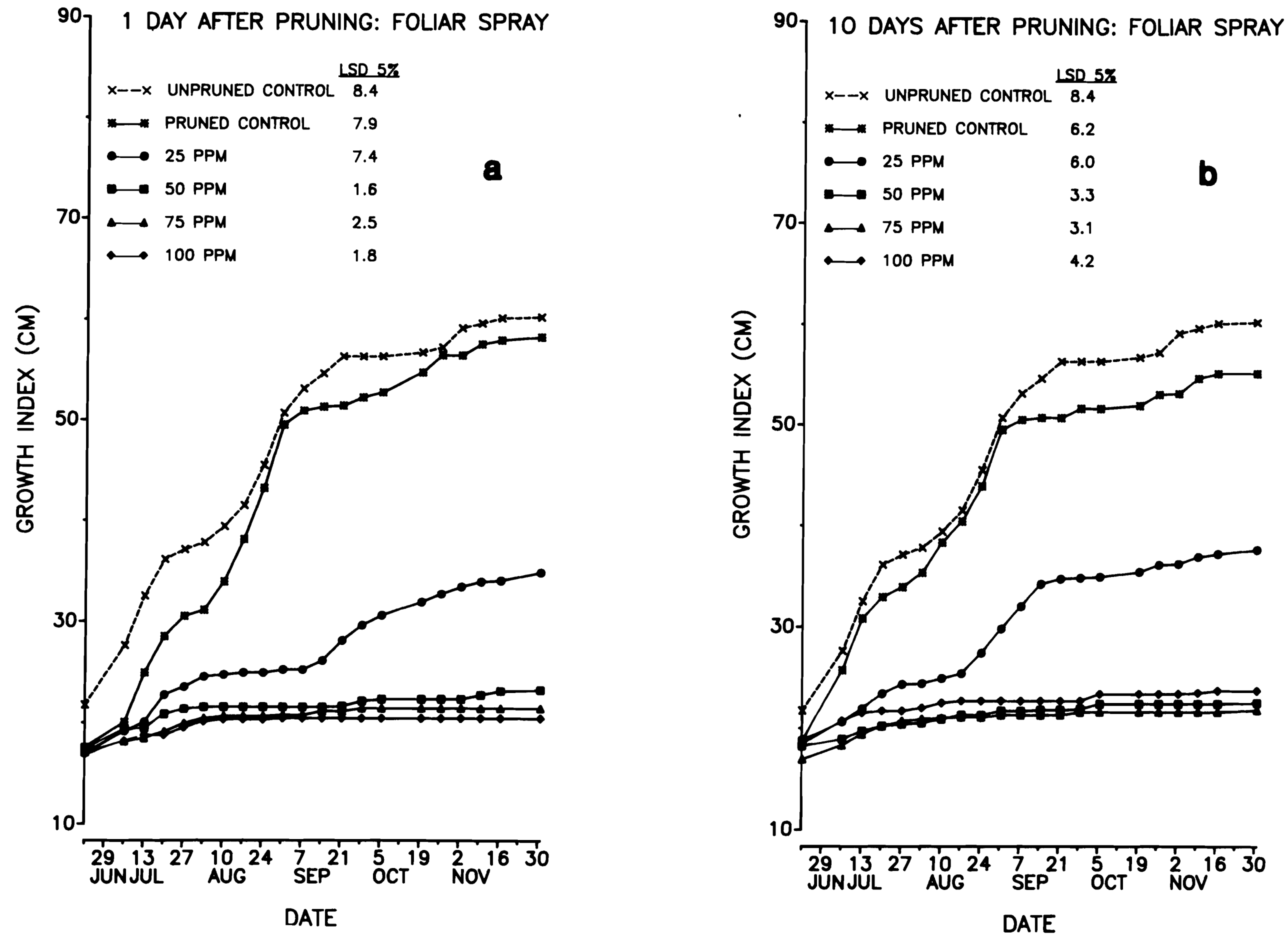

Fig. 1. Growth of *Ilex* × 'Nellie R. Stevens' from June 22 to November 30, 1988 when 0, 25, 50, 75, or 100 ppm uniconazole (Sumagic) was applied as a foliar spray 1 (a) or 10 (b) days after pruning. Nonpruned nontreated and pruned nontreated controls received only water. Growth index = (height + width)/2.

Table 3. Final size (Growth Index[z]) of *Pyracantha koidzumii* 'Wonderberry', *Photinia* × *fraseri*, *Euonymus japonica* 'Aureo marginata', *Ilex* × 'Nellie R. Stevens', *Ligustrum lucidum*, and *Ligustrum sinense* 'Variegatum' after applying uniconazole (Sumagic) on June 22, 1988 as a foliar spray 1 or 10 days after pruning (DAP); final size recorded November 30, 1988.

Uniconazole Application		Species					
Spray Rate (ppm)	Day After Pruning	Pyracantha	Photinia	Euonymus	Ilex	L. lucidum	L. sinense
0	Not[y]	149.0 ± 2.9	76.9 ± 2.3	38.9 ± 1.3	61.9 ± 3.1	72.8 ± 4.4	65.2 ± 1.1
0	1	119.6 ± 4.7	66.8 ± 2.3	38.4 ± 4.4	59.5 ± 3.2	67.8 ± 4.1	72.3 ± 6.7
0	10	125.5 ± 2.7	72.4 ± 2.6	—	58.1 ± 1.7	71.0 ± 4.4	66.8 ± 4.5
25	1	114.2 ± 8.4	64.2 ± 2.0	34.4 ± 2.9	35.3 ± 2.1	63.4 ± 4.8	68.1 ± 8.0
25	10	123.0 ± 4.2	73.8 ± 5.9	—	38.4 ± 2.4	71.8 ± 2.8	75.0 ± 4.5
50	1	92.5 ± 6.9	70.2 ± 3.0	39.7 ± 2.5	23.9 ± 0.6	49.6 ± 3.5	60.6 ± 8.0
50	10	120.2 ± 5.0	77.2 ± 5.9	—	23.2 ± 1.0	59.3 ± 2.7	67.9 ± 1.9
75	1	98.8 ± 6.6	57.7 ± 2.6	—	22.2 ± 1.0	—	—
75	10	108.0 ± 7.9	59.6 ± 4.7	—	22.6 ± 1.2	—	—
100	1	83.4 ± 5.7	59.6 ± 2.8	27.3 ± 1.1	20.7 ± 0.5	55.0 ± 4.6	47.2 ± 6.1
100	10	81.9 ± 3.8	59.8 ± 6.0	—	24.2 ± 1.5	—	60.2 ± 3.6
Significance[x]							
Rate		***	*	NS	NS	NS	NS
Rep (Rate)		NS	NS	—	NS	NS	NS
DAP		*	*	—	NS	NS	NS
Rate × DAP		NS	NS	—	NS	NS	NS

[z]Growth Index = (Height + Width)/2; values represent mean ± standard error.

[y]This treatment included only for comparison and was not included in the analysis of variance.

[x]NS, *, **, *** Nonsignificant, or significant at the 5%, 1%, or .1% level, resp.

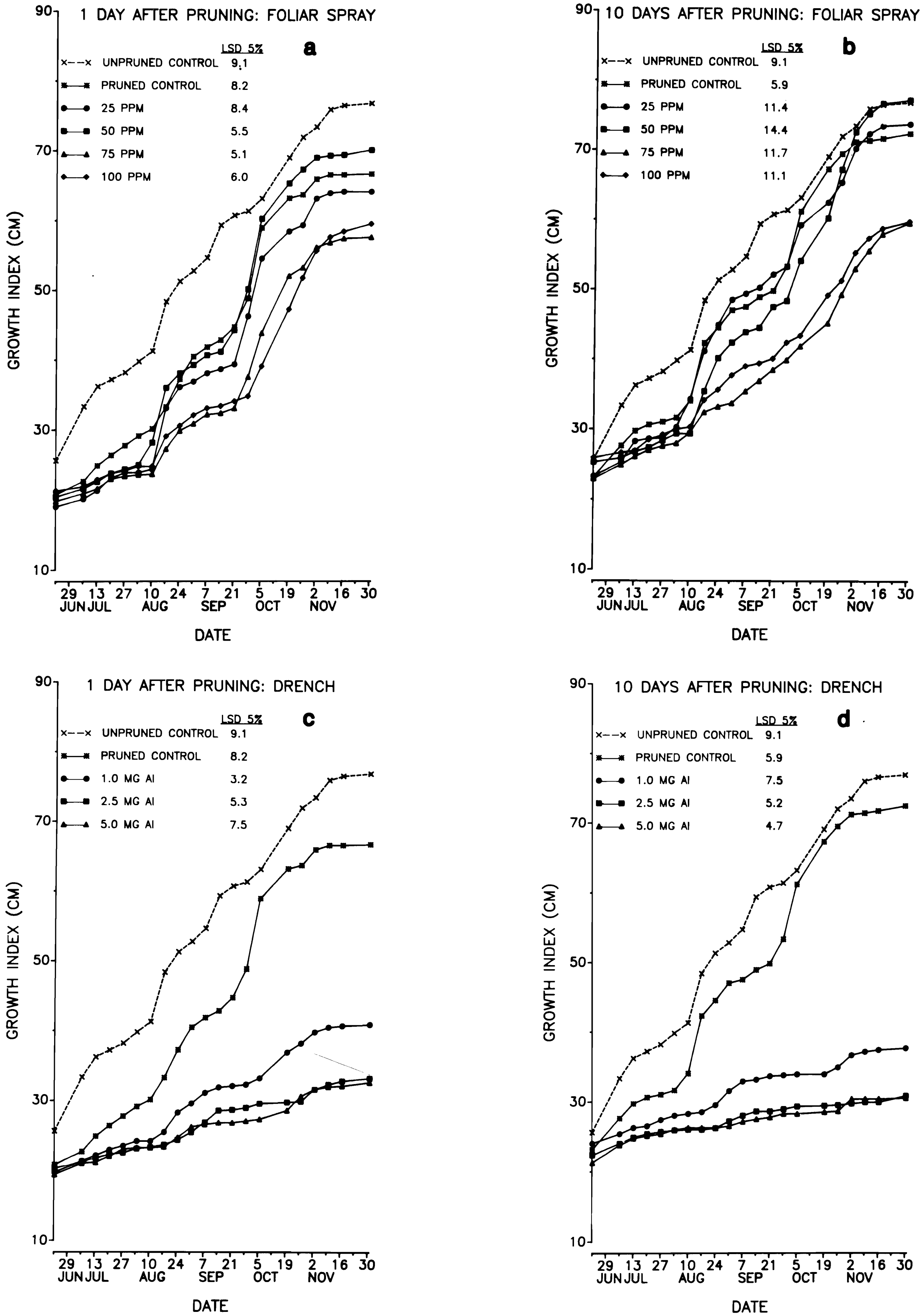

Fig. 2. Growth of *Photinia × fraseri* from June 22 to November 30, 1988 after uniconazole (Sumagic) was applied: 0, 25, 50, 75, or 100 ppm foliar spray 1 (a) or 10 (b) days after pruning; 2.5, 5.0, or 7.5 mg ai medium drench 1 (c) or 10 (d) days after pruning. Nonpruned nontreated and pruned nontreated controls received only water. Growth index = (height + width)/2.

applied to the roots was translocated to the entire plant but leaf-applied ^{14}[C]uniconazole remained in the leaf. Similarly, Sterrett (13) did not detect any basipetal movement of ^{14}[C]uniconazole in one-year-old apple trees. It is also possible that the uniconazole in the leaves degraded faster than that in the soil. Paclobutrazol, structurally similar to uniconazole, was shown to break down rapidly in the leaves of peach seedlings (8). The half-life of uniconazole in a mineral soil was more than four months (4).

Liqustrum sinense 'Variegatum' was the least sensitive to uniconazole because only a 100 ppm spray retarded growth (Table 3). The growth rate of plants treated with 100 ppm 1 DAP was slightly inhibited for about 8 weeks, resulting in plants smaller than than pruned nontreated plants by November 30. However, if applied 10 DAP, growth was suppressed for 4 weeks with no reduction in final size, a response that would seem ideal for use in production because growth is inhibited for only a brief time. However, *Ligustrum* of this size (3.8 liter container; #1) may not be marketable. The growth habit of the lower part of these plants was dense and compact as a result of the uniconazole treatment, whereas the post-inhibitory growth was open and airy. A rate of between 50 and 100 ppm 10 DAP, or possibly 1 DAP, would seem to be optimum.

A foliar spray of 25 to 50 ppm proved best for *Ligustrum lucidum*, depending on the pruning date (Table 3). Growth was suppressed during the first 2 weeks after application and/or during August with little or no reduction in final size.

Ilex was the species most sensitive to uniconazole because a rate of only 25 ppm excessively retarded growth (Fig. 1).

Uniconazole was not phytotoxic (cupping, necrosis, chlorosis) to any species, except *Ilex*, even at rates that severely retarded growth. Foliar-applied uniconazole at a rate of 50 ppm or more caused cupping of *Ilex* foliage.

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