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Ornamental Tree Growth with Basin-applied Herbicides

Clyde L. Elmore[1], Lawrence R. Costello[2], and W. Douglas Hamilton[3]
Department of Botany, University of California, Davis, CA 95616

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Abstract. **Cider gum *(Eucalyptus gunnii* Hook. F.), Monterey pine *(Pinus radiata* D. Don), and camphor tree *[Cinnamonium camphora* (L.) J. Presl] were evaluated in a field study comparing the effects of herbicides on tree growth. Trees were planted on 13 May 1983 and treated on 20 May 1983, 10 Apr. 1984, and 4 Oct. 1984 with simazine, oryzalin, napropamide, and oxyfluorfen. Glyphosate was applied as a postemergence treatment in all basins on 20 Mar. 1984. None of the herbicides injured the trees. Trunk circumferencesin treated plots increased as much as 553% over untreated plots. All species showed a positive response to increasing weed control. Chemical names used: 6-chloro-N,N'-diethyl-1,3,5-triazine-2,4-diamine (simazine); 3,5-dinitro-N^4,N^4-dipropylsulfanilamide (oryzalin); N,N-diethyl-2-(1-naphthalenyloxy)-propanamide (napropamide); 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene (oxyfluorfen); N-(phosphonomethyl)glycine (glyphosate).**

Appropriate staking, pruning, watering, and pest control practices are important considerations to ensure successful establishment and development of trees. One aspect of pest control that affects the early development of trees is weed management.

Trees in landscape plantings in irrigated areas are planted either on the flat or with basins for irrigation. In some landscaped areas, weeds or turfgrasses are often allowed to grow to the base of the tree (Harris, 1969). Vegetation control may be attempted with a mechanical device or with preemergence herbicides (Nazer and Clark, 1984). Welker and Glenn (1985) demonstrated a positive response in trunk circumference and canopy of peach trees when grass was removed from the base of the tree. Eucalyptus planted without basins grew more when turf was removed (Harris, 1969). Glyphosate has been used without phytotoxicity to young honeylocust trees (Prochaska and Fretz, 1976).

If preemergence herbicides could be used in the planting basins without injury to the young trees, improved growth and tree vigor might be obtained. Since we found no studies where preemergence herbicides were used on young trees in planting basins, we determined the effects of four preemergence herbicides on three ornamental tree species when applied in the planting basin.

Monterey pine (4-liter container), cider gum (9-liter container), and camphor tree (5 × 5 cm liners) were planted at the Univ. of California, Santa Clara Field Station. The soil was a Zamora gravelly clay loam, Mollic haploxeralf (77% sand, 15% clay, 8% silt, and 3.2% organic matter) that was disked and leveled before planting.

After planting, the trees were watered by hand in the l-m basin around each tree. The top of the root ball was left exposed at planting. Herbicides were applied 20 May 1983 and followed with a 13-mm irrigation using solid-set sprinklers. On 23 May 1983, Italian ryegrass *(Lolium multiflorum* Lam.) seed was broadcast with a rotary spreader between the tree rows at the rate of 0.49 kg/100 m^2 and sprinkler-irrigated to establish a uniform weed population. A resident population of common sowthistle *(Sonchus arvensis* L.), rough pigweed *(Amaranthus retroflexus* L.), common purslane *(Portulaca oleracea* L.), lambsquarters *(Chenopodium album* L.), knotweed *(Polygonum aviculare* L.), and field bindweed *(Convolvulus arvensis* L.) were also present.

Each tree species was planted as a single tree per experimental unit on a 3 × 3 m spacing and replicated four times in a randomized complete-block design. The preemergence herbicide treatments (all kg-ha-r) were simazine (2.2), oryzalin (4.5 and 6.7), napropamide (4.5 and 9.0), and oxyfluorfen (1.1 and 2.2). Each replication included an untreated control. The untreated control was mowed as needed at 7-cm height to reduce weed growth. Herbicides were applied as a broadcast spray in 339 liters·ha^{-1} with a CO_2 pressurized sprayer using two 8004 nozzles (Teejet; Spraying Systems Co., San Bruno, Calif.) at 207 kPa pressure.

A 1.8-m band was sprayed under each tree leaving the remaining area between the rows to be mowed. Plant residue was left on the soil. All herbicides were reapplied 10 Apr. and 4 Oct. 1984.

Glyphosate [1.5% solution (v/v)] was applied on 20 Mar. 1984 as a directed spray, so the trunk was not contacted, for control of winter annual weed seedlings in all treatment basins, except the untreated control,

Weed control was visually evaluated by rating for individual weed species and by a general rating for all annual weeds 2 months after the first and second applications and 7 and 13 months after the third application. To determine the influence of weed control on tree growth, data for each weed control evaluation and an average of five evaluations were each regressed against the change in trunk circumference over the duration of the study (Little and Hills, 1978). Growth was measured by taking the difference in trunk circumference between the initial and 3-year measurement; weed control data taken 2

Table 1. Mean visual weed control rating for annual weeds at several intervals after treatment in planting basins using preemergence herbicides.

Herbicide	Rate (kg·ha^{-1})	Visual rating[z,y] Months after treatment[x] 2 (1)	2 (2)	7 (3)	13 (3)
Simazine	2.2	7.8 a	8.9 a	8.8 a	5.2 b
Oryzalin	4.5	8.9 a	8.4 b	7.8 b	4.8 b
	6.7	8.7 a	9.3 a	9.3 a	7.9 a
Napropamide	4.5	6.0 c	5.9 c	3.3 d	1.4 cd
	9.0	5.9 c	6.6 c	4.0 d	1.5 cd
Oxyfluorfen	1.1	8.2 b	8.0 b	5.8 c	2.4 c
	2.2	9.0 a	9.2 a	7.5 b	4.2 b
None	---	1.0d	1.0d	1.2e	1.0d

[z]A rating scale was used with 1 = no control and 10 = complete control.
[y]Mean separation in columns by Duncan's multiple range test, $P = 0.05$.
[x]In parentheses, time of application: (1) 20 May 1983, (2) 10 Apr. 1984, (3) 4 Oct. 1984.

Table 2. Visual control rating of specific weeds with preemergence herbicides in planting basins.[z,y]

Herbicide	Rate (kg·ha^{-1})	Barnyardgrass	Field bindweed	Italian ryegrass	Common sowthistle	All annual species
Simazine	2.2	7.8 cd	3.9 c	7.3 bc	9.9 a	6.2 c
Oryzalin	4.5	10.0 a	8.3 a	9.9 a	5.7 c	7.4 b
	6.7	10.0 a	8.8 a	10.0 a	8.0 b	8.9 a
Napropamide	4.5	7.9 cd	1.6 d	6.8 c	5.6 c	4.3 d
	9.0	9.2 ab	2.2 d	6.8 c	5.9 c	4.3 d
Oxyfluorfen	1.1	7.4 d	4.1 c	7.1 bc	6.8 bc	5.1 d
	2.2	8.8 bc	5.8 b	8.5 b	8.4 ab	6.2 c
Untreated		2.1 e	1.8 d	2.4 d	3.4 d	1.0 e

[z]Mean separation in columns by Duncan's multiple range test, $P = 0.05$.
[y]A rating scale was used with 1 = no control and 10 = complete control 6 months after second herbicide treatment.

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[1]Extension Weed Scientist.
[2]Extension Farm Advisor, San Mateo/San Francisco Counties, Univ. of California Cooperative Extension, Half Moon Bay, CA 94019.
[3]Former Extension Farm Advisor, Alameda/Santa Clara Counties, Univ. of California Cooperative Extension, Hayward, CA 94544.

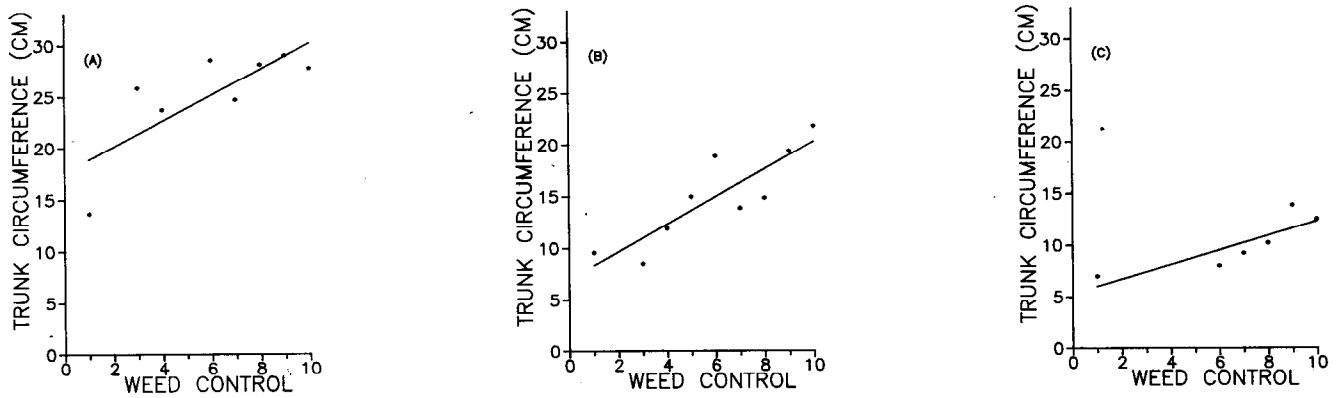

Fig. 1. Trunk circumference difference (1983-85) as a function of mean weed control 2 months after the first herbicide application of **(A)** *E. gunnii* ($y = 0.817 + 0.620X + 0.346X^2$, $R^2 = 0.51$), **(B)** *P. radiata* ($y = 1.238 + 0.156X + 0.005X^2$, $R^2 = 0.84$), and **(C)** *C. camphora* ($y = 0.943 + 0.009X + 0.009^2$, $R^2 = 0.90$).

Table 3. Change in trunk circumference of three tree species over 3 years as a function of weed control using preemergence herbicides in planting basins.

Herbicide	Rate ($kg \cdot ha^{-1}$)	Trunk circumference difference (cm)		
		Cider gum	Monterey pine	Camphor tree
Simazine	2.2	25.6 a	15.2 cd	12.7 ab
Oryzalin	4.5	29.3 a	22.4 ab	11.2 ab
	6.7	30.9 a	22.9 a	15.2 a
Napropamide	4.5	23.9 a	12.7 de	7.1 b
	9.0	26.1 a	11.9 cde	9.7 b
Oxyfluorfen	1.1	31.1 a	15.2 cd	8.9 b
	2.2	27.9 a	17.5 bc	8.9 b
Untreated		13.7 b	9.7 e	2.3 c

[z]Mean separation in columns by Duncan's multiple range test, $P = 0.05$.

months after the first herbicide application were selected for presentation. Phytotoxicity was evaluated visually to determine the effects of the various herbicide treatments on the tree species.

All trees were individually measured for height and trunk circumference at 15 cm above the soil after planting and at the termination of the study. The *E. gunnii* trees were staked for 1 year after planting. At planting, the Monterey pine trees were pruned to a central leader, and the suckers were removed from the camphor trees. All trees were sprinkler-irrigated to maintain vigorous growth (every 2 to 3 weeks in summer).

Weed control. Simazine at 2.2 $kg \cdot ha^{-1}$, oryzalin at 4.5 and 6.7 $kg \cdot ha^{-1}$, and oxyfluorfen at 2.2 $kg \cdot ha^{-1}$ gave excellent control of annual weeds for the duration of the study (Table 1). Oxyfluorfen at 1.1 $kg \cdot ha^{-1}$ controlled weeds 2 months after treatment, but did not give residual control at 7 months. When control of annual weeds was evaluated 13 months after the last application, only oryzalin at 6.7 $kg \cdot ha^{-1}$ provided significant residual control. Oryzalin at 4.5 $kg \cdot ha^{-1}$, simazine at 2.2 $kg \cdot ha^{-1}$, and oxyfluorfen at 2.2 $kg \cdot ha^{-1}$ gave some residual control, but were not as effective as oryzalin at 6.7 $kg \cdot ha^{-1}$. Napropamide at 4.5 and 9.0 $kg \cdot ha^{-1}$ controlled barnyardgrass, but did not adequately control (< 7.0 rating) common sowthistle, Italian ryegrass, or rough pigweed.

Preemergence weed control with simazine at 2.2 $kg \cdot ha^{-1}$ was excellent for control of common sowthistle, rough pigweed, common purslane, lambsquarters, and knotweed (Table 2). Italian ryegrass was only partially controlled and field bindweed was not controlled.

Oryzalin controlled most annual weeds, including field bindweed seedlings, but did not control common sowthistle and shepherdspurse. There was suppression of the perennial field bindweed plants with both 4.5 and 6.7 $kg \cdot ha^{-1}$. Oxyfluorfen at 1.1 $kg \cdot ha^{-1}$ controlled barnyardgrass and Italian ryegrass, but did not affectively control common sowthistle. Rough pigweed, cheeseweed *(Malva parviflora* L.), field bindweed, and knotweed were not controlled with either rate of napropamide. Oxyfluorfen controlled annuals at 2.2 $kg \cdot ha^{-1}$ and suppressed field bindweed, although it recovered.

Phytotoxicity. No visual phytotoxicity symptoms were observed on any of the three species from the preemergence herbicides or from glyphosate (data not presented).

Trunk circumference. Trunk circumference significantly increased with all tree species in treated plots relative to the control trees, except Monterey pine (Table 3) in the napropamide-treated plots. Applications of oryzalin (both rates) and oxyfluorfen (2.2 $kg \cdot ha^{-1}$) resulted in the largest increase in trunk circumference in Monterey pine, with the 6.7 $kg \cdot ha^{-1}$ rate of oryzalin being significantly better than oxyfluorfen at 2.2 $kg \cdot ha^{-1}$. Trunk circumference of cider gum trees did not differ among herbicide treatments, but it was significantly larger than for control trees.

Camphor trees in plots treated with oryzalin at 6.7 $kg \cdot ha^{-1}$ had a greater trunk circumference than any trees in plots treated with any rate of napropamide or oxyfluorfen. The results with simazine were not significantly different from oryzalin at 6.7 or 4.5 $kg \cdot ha^{-1}$. There was a consistent and significant increase in the trunk circumference of camphor trees in herbicide-treated plots compared to the trees in untreated plots.

All Monterey pine trees, except those in napropamide plots (4.5 and 9.0 $kg \cdot ha^{-1}$), had significantly greater trunk circumference than trees in control plots. Napropamide treatments were equal to the control. Oryzalin at 6.7 $kg \cdot ha^{-1}$ gave better results than the control and most other treatments (Table 3). The different responses to weed control by the tree species may have been due to the inherent difference in vigor of the species or, more possibly, to the tree size at planting.

Tree height. Tree height has been reported by Nazer and Clark (1984) to be more variable than a more reliable indicator of tree growth, trunk circumference.

In this study, tree height varied substantially within each tree species (data not shown); however, it generally responded positively to weed control.

Growth response compared to weed control. There was a positive response between weed control and trunk circumference increases for all three species (coefficient of determination: cider gum, $R^2 = 0.67$; Monterey pine, $R^2 = 0.85$; camphor tree, $R^2 = 0.76$) (Fig. 1 A-C). When comparing maximum growth increase with weed control, some variability existed among species. Cider gum showed a maximum of 553% increase at a control rating of 8, while Monterey pine and camphor tree increased 157% and 201%, respectively, at a rating of 10 (100% weed control).

These values generally agree with those of Meskimen (1970), who found increases in trunk circumference of *Eucalyptus camuldulensis* Dehnh. after 1 year to be 267% greater in trees that had vegetation-free areas around their base, and those of Harris (1969), where *Magnolia grandiflora* L. trunk diameter increase 2 years after planting was 500% greater in vegetation-free plots than in

tall fescue *(Festuca arundinacea* L.) turfgrass plots.

Notable increases in growth were found in cider gum with small increments of weed control (Fig. 1A). Trunk circumference increased 174% with a weed control rating change from 2 to 6. Monterey pine (Fig. 1B) and camphor tree (Fig. 1C) showed more gradual increases in growth as weed control improved. This difference in rate of growth response among species to weed control may be a consequence of differences in initial plant size, plant form, and inherent growth rate potential. Cider gum plants used were larger (9-liter pots), had a more upright growth habit, and a higher observed growth rate than Monterey pine and camphor tree. These characteristics of cider gum may have contributed to its rapid growth increase associated with small increments in weed control.

Control of annual weeds was satisfactory for the duration of the study with oryzalin at 4.5 and 6.7 $kg \cdot ha^{-1}$, simazine at 2.2 $kg \cdot ha^{-1}$, and oxyfluorfen at 2.2 $kg \cdot ha^{-1}$. Residual control was also observed with these same materials 13 months after the last application of herbicide. Oryzalin was the only herbicide to give significant control of field bindweed. Weed species that were controlled varied among herbicides.

Weed control in planting basins can be accomplished safely using preemergence herbicides. No phytotoxicity was observed either visually or using tree height or trunk circumference measurements' with any herbicide evaluated in this study. This result, however, has not been the experience with simazine in some field observations.

Although weed control using premergence herbicides was found to have a positive effect on tree growth, nonchemical methods of weed control (hand pulling, mulches, etc.) would be presumed to have a similar positive effect on tree growth.

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