of irradiation is very important. The authors recommend that future research on the effects of low dosage irradiation on seeds should be done with high intensity sources. Treatments should be of very short duration.

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Evaluation of Herbicides for Container-grown Citrus[1]

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Abstract. **Three applications granular formulations of herbicides were applied broadcast over a 7-month period to budded citrus trees growing in 7.6 liters (4-gal) containers with a soil mix containing equal parts of peat, bark, and sand. Materials and rates at each application were alachlor + simazine 4.48 + 2.24 and 8.96 + 2.24 kg/ha; oryzalin 5.60 and 11.20 kg/ha; trifluralin 5.60, 11.20 and 22.40 kg/ha; oxadiazon 4.48 and 8.96 kg/ha; napropamide 11.20 and 22.40 kg/ha; and alachlor 11.20, 22.40 and 44.80. Good to excellent weed control was obtained at all rates of all herbicides used with no phytotoxicity to citrus trees observed.**

Of the 2.5 million citrus nursery trees produced annually in Florida, about 150,000 are container-grown with an estimated wholesale value of about $700,000 and a retail value of $1,200,000. Demand is expected to double in 5 years. Production techniques and conditions for container-grown citrus are similar to container-grown woody ornamentals and some nurseries produce both types of plants. Many of these citrus trees are marketed through retail garden centers as home landscape plants and contribute to the expected increase in demand. Weed control is considered a major production problem and the competitive effects of weeds growing with container-grown plants have been shown (1). In the woody ornamental industry the cost of weed control has been said to account for 20% of the total wholesale dollar volume of sales each year (3). Currey (unpublished data) has estimated that the cost of hand-weeding in container-grown plants may exceed $8,800/ha per year in Florida where no herbicides are used. Although a few herbicides are used on container-grown woody ornamentals and citrus, information on their use is limited. Product registration is difficult to obtain due to the high dollar value per unit area of the crop in relation to the potential low product sales and high risk.

Although a number of herbicides have been evaluated for use in field-grown citrus nursery stock, such results should not be transferred to container-grown stock because of the differences in conditions which affect herbicide activity and plant growth. Container media differs in composition and structure from field soil. Roots are confined within containers and much higher volumes of irrigation water are applied per unit area. Based on previous work in Florida ornamentals (2 and 4) we evaluated granular formulations of 2-chloro-2^1, 6^1-diethyl-N-(methoxymethyl) acetanilide + 2-chloro-4, 6-bis (ethylamino)s-triazine (alachlor + simazine); 3,5-dinitro N^4, N^4-dirpopylsulfanilamide (oryzalin); α,α,α-trifluoro-2, 6-dinitro-N, N-dipropyl-p-toluidine (trifluralin); 2-tert-butyl-4-(2,4-dichloro-5-isopropoxyphenyl) -Δ^2-1,3,4-oxadiazolin-5-one(oxadiazon); 2-(α-napthoxy)-N-N-diethylpropionamide (napropamide); and 2-chloro-2^1, 6^1diethyl-N-(methoxymethyl) acetanilide (alachlor) for weed control in container-grown citrus nursery stock. The experiment was conducted in full sun at a large commercial citrus nursery in Central Florida and initial treatments were applied in May 1975 under climatic conditions favoring active growth. Objectives of the experiment were to determine: 1) efficacy of several herbicides in controlling weeds which commonly compete with citrus trees, 2) satisfactory application rates, and 3) phytotoxicity of the herbicides to citrus.

Nursery plant material used was 'Hamlin' orange [*Citrus sinensis* (L.) Osbeck] on sour orange (*Citrus aurantium* L.) rootstock which had been transplanted from field to 7.6 liters (4-gal) containers with a 1 peat:1 bark:1 sand (v/v) mix.

Initial treatments were applied 1 month after transplanting from the field at which time trees had become established. A Casoron-type cyclone granular applicator, which gave uniform coverage of herbicides on container surfaces was used. Each of the 16 granular herbicide treatments was applied on May 7, 1975, to 30 single tree replicates in a completely randomized experimental design at application rates shown in Table 1. Containers were weed-free at the time of application. Irrigation was provided immediately after herbicide application and 2-3 times per week by a permanent overhead sprinkler system at the rate of 1.27

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Table 1. Evaluation of herbicides in reducing weed cover in container-grown citrus trees.[z]

Herbicide	Rate (kg/ha)	Weed cover (%) June 5	Aug. 28	Oct. 20
Alachlor + simazine	4.4 + 1.1	1.3 efgh[y]	0.4e	0.0b
Alachlor + simazine	8.9 + 2.2	0.3h	0.3e	0.0b
Oryzalin	5.6	5.0b	5.0d	0.0b
Oryzalin	11.2	3.0cde	0.0e	0.6b
Trifluralin	5.6	2.6def	20.0b	0.3b
Trifluralin	11.2	2.0fgh	0.0e	0.0b
Trifluralin	22.4	1.0gh	0.0e	0.0b
Oxadiazon	4.4	10.0a	10.0c	1.1b
Oxadiazon	8.9	3.6bcd	9.6c	0.0b
Oxadiazon	17.9	0.6h	0.0e	0.0b
Napropamide	11.2	2.3defg	10.0c	0.6b
Napropamide	22.4	3.0cde	7.5c	0.0b
Alachlor	11.2	0.3h	0.0e	3.0b
Alachlor	22.4	1.0gh	0.0e	0.0b
Alachlor	44.8	0.3h	0.0e	0.0b
Control	–	4.3bc	25.0a	43.3a

[z]Herbicide application dates May 7 and September 5, 1976.

[y]Mean separation in columns by Duncan's multiple range test, 5% level after arc sine transformation.

Fig. 1. Alachlor at 11.20 kg/ha 3 months after application (top), untreated control (bottom).

cm per application. Weed control was evaluated on the basis of % weed cover observed in each container and ratings were made 1, 3 and 5 months following the initial treatment and 2 months after the second application. Predominant summer annual weed species included relatively uniform populations of spotted spurge (*Euphorbia maculata* L.), common purslane (*Portulaca oleracea* L.), and crabgrass (*Digitaria sanguinalis* (L.) Scop.). Nutsedge did not occur with sufficient uniformity to provide valid control data.

One month after treatment, weed growth was significantly reduced in all treated containers, compared to the untreated controls, with the exception of oryzalin at both rates, oxadiazon at the low and intermediate rate and napropamide at the higher rate (Table 1). The best weed control resulted from alachlor + simazine at 8.96 + 2.24 kg/ha and alachlor at all rates. Three months after application, weed growth in all containers was significantly less than in the controls. Excellent control of annual weeds was observed from alachlor + simazine at both rates, oryzalin at 11.20 kg/ha, oxadiazon at 17.92 kg/ha and alachlor at all rates. On Sept. 5, 1975, all containers were weeded and a second application of herbicides was made. Weed control at 2 months following the second application was good to excellent for all treatments, with some limited weed cover present including spurge and common purslane. A comparison of weed control at 3 months with alachlor at 11.20 kg/ha and the control is shown in Fig. 1.

On Nov. 20, 1975, all pots were weeded by hand with as little disturbance of the container surface as possible and the treatments reapplied. One month later, the experimental trees were needed for sale and a final evaluation was made. No weed growth was present in any of the treated containers or the controls. Trees were examined for signs of phytotoxicity throughout the period of the experiment and no symptoms were observed. No differences in tree growth were noted and an examination of the root systems showed no differences in density or quality.

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