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Response of Citrus (*Citrus* spp.) Rootstock Seedlings to Soil-Applied Herbicides[1]

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Abstract

A greenhouse study was conducted to evaluate the response of Carrizo citrange [*Citrus sinensis* (L.) Obs. × *Poncirus trifoliata* (L.) Raf.], Cleopatra mandarin (*C. reticulata* Blanco), sour orange (*C. aurantium* L.), and Swingle citrumelo [*C. paradisi* Macf. × *P. trifoliata* (L.) Raf.] citrus rootstock seedlings to multiple applications of Premier (fluometralin), Dual (metolachlor), Devrinol (napropamide), Solicam (norflurazon), Surflan (oryzalin), Prowl (pendimethalin), and Treflan trifluralin). The citrus rootstock responses ranged from a 11% reduction in shoot weight of sour orange with Treflan (trifluralin) to a 19% reduction in fibrous root weight of Swingle citrumelo with Surflan (oryzalin). Cleopatra mandarin was tolerant to all the seven herbicides. Dual (metolachlor), Devrinol (napropamide), Solicam (norflurazon), and Premier (fluometralin) were not phytotoxic to all four rootstocks.

Index words: Carrizo citrange, cleopatra mandarin, sour orange, Swingle citrumelo, tolerance, weed control

Species used in this study: Carrizo citrange [*Citrus sinensis* (L.) Obs. × *Poncirus trifoliata* (L.) Raf.]; Cleopatra mandarin (*C. reticulata* Blanco): sour orange (*C. aurantium* L.); and Swingle citrumelo [*C. paradisi* Macf. × *P. trifoliata* (L.) Raf.].

Herbicides used in this study: Premier (fluometralin), 2-chloro-*N*-[2,6-dinitro-4-(trifluoromethyl) phenyl]-*N*-ethyl-6-fluorobenzenemethanamine; Dual (metolachlor), 2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methlethyl) acetamide; Devrinol (napropamide), *N*,*N*-diethyl-2-(1-naphthalenyloxy)propanamide; Solicam (norflurazon), 4-chloro-5-(methylamino)-2-(3-(trifluoromethyl)phenyl)-3 (2*H*)-pyridazinone; Surflan (oryzalin), 4-(dipropylamino)-3,5-dinitrobenzenesulfonamide; Prowl (pendimethalin), *N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine; Treflan (trifluralin), 2,6-dinitro-*N*,*N*-dipropyl-4-(trifluroemethyl)benzenamine.

Significance to the Nursery Industry

The temperate to subtropical climate of Florida is favorable for year-round germination and growth of weeds. Weed control in citrus nurseries with herbicides is an acceptable alternative compared to labor intensive hand weeding. Multiple applications of herbicide can provide year-long weed control compared to a single application. Our study provides information on multiple applications of seven herbicides to four common citrus rootstocks. Data on fibrous root and shoot growth of rootstocks indicates possible injury with multiple applications of Surflan, Prowl, and Treflan. All the herbicides evaluated (except Premier) are currently registered for citrus. Dual and Prowl are only registered for non-bearing citrus.

Introduction

Florida citrus nurserymen produce trees both under field and container-grown conditions. Weed control is the most expensive cultural practice in the citrus nursery, with hand weeding being tedious and costly. Herbicides appear to be an acceptable alternative for weed control in citrus nurseries. Rapidly changing growth stages of rootstock seedlings and numerous rootstock/scion combinations often result in differential responses to herbicides. Differential cultivar response may be exhibited by various injury symptoms, reduction in growth, and effects on yield. Reduction in shoot and/or root weight is the best indicator of differential cultivar response. Differential cultivar response to herbicides has been reported for corn (4), soybean (8), potato (3), and tomato (7). In citrus, differential response of several citrus rootstocks to herbicides has been reported for both field (2, 6) and container-grown (5) seedlings or budded plants.

Multiple applications of a recommended rate of herbicides can provide season-long weed control with a minimum stress on citrus when compared to a single application. Continual exposure of citrus nursery trees to herbicides under multiple applications may promote greater uptake and accumulation of herbicides in plants. Shoot and fibrous root weights of Swingle citrumelo plants grown for 1 month in nutrient solutions containing 0.1 mM Solicam were reduced by more than one-third when compared to no herbicide control (1). Reduced growth of Swingle citrumelo, a tolerant rootstock, may be due to total exposure to Solicam in the six applications (6). Florida nurserymen may make as many as 10 herbicide applications in a year to achieve effective year-long weed control. The effects of such multiple applications of herbicides on growth of citrus nursery trees needs to be examined. The objective of this study was to examine the seedling response of four commercial citrus rootstocks to multiple applications of seven soil-applied herbicides.

Materials and Methods

Three-month-old seedlings of Carrizo citrange, Cleopatra mandarin, and Swingle citrumelo were obtained from a local nursery. Seedlings of uniform size were selected and their fresh weight recorded. One seedling was planted per styrofoam cup of 17 cm deep (6.8 in) and 11 cm diameter (4.4 in) containing Candler fine sand (hyperthermic, typic quartzipsamments). Plants were grown in a greenhouse at a 32/23°C (115/99°F) mean day/night temperature and natural

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Table 1. Effects of repeated herbicide application on fibrous root and shoot weight of citrus rootstocks. When applied six times at monthly intervals.[z]

Treatments		Cleopatra mandarin		Carrizo citrange		Swingle citrumelo		Sour orange	
		Fibrous roots	Shoot	Fibrous roots	Shoot	Fibrous roots	Shoot	Fibrous roots	Shoot
		% of control							
Rate kg/ha	*(lb/A)*								
0	0	100 a[x]	100 a	100 a	100 a	100 a	100 a	100 a	100 a
0.5	0.45	102 a	104 a	106 a	101 a	97 a	102 a	99 a	99 a
1.0	0.90	105 a	101 a	103 a	104 a	101 a	96 a	97 a	99 a
Herbicide[y]									
Premier (fluometralin)	*Rate*	109 a	110 a	107 a	107 a	105 a	102 a	95 ab	110 a
Dual (metolachlor)		101 a	100 a	101 a	100 ab	101 a	97 b	102 ab	98 ab
Devrinol (napropamide)		101 a	101 a	107 a	107 a	104 a	97 b	98 ab	100 ab
Solicam (norflurazon)		103 a	104 a	95 a	108 a	100 a	106 a	101 ab	101 ab
Surflan (oryzalin)		102 a	97 a	103 a	100 ab	81 b	109 a	106 a	99 ab
Prowl (pendimethalin)		104 a	101 a	106 a	92 b	106 a	91 b	90 b	99 ab
Treflan (trifluralin)		96 a	99 a	98 a	99 ab	102 a	92 b	97 ab	89 b
LSD (0.05) interaction		NS	NS	NS	NS	NS	NS	NS	NS

[z]Means within a column and rate or herbicide followed by the same letter are not significantly different at the 5% level as determined by Fisher's LSD test. NS = Nonsignificant at P = 0.05.

[y]Herbicides were applied six times at monthly intervals at rate indicated.

[x]Data are presented as percent of untreated check.

light. Plants were watered and fertilized as needed with 1% (w/v) Tracite (20-20-20(20N-8.6P-16.6K) with micronutrients. A measured amount of water (20 mL) was applied to each plant to minimize herbicide loss through leaching.

The treatments were seven herbicides at three (0.0, 0.5, and 1.0 kg/ha) application rates (Table 1). Commercial formulation of each herbicide was applied in 1 mL water to soil surface around the plant. Initial herbicide applications were made on August 28, 1991 and repeated five times at monthly intervals with the final application made on January 28, 1992.

Plants were harvested one month after the sixth application of herbicides. Shoots and fibrous root were separated, dried at 50°C for 72 hours, and weighed. Dry weights of treated plants were expressed as percent of untreated plants. The experiment was conducted in a split plot design with rates as main plots and herbicides as subplots. Treatments were replicated six times. Data were subjected to analysis of variance for each rootstock and means were separated at the 5% level of significance using Fisher's LSD test.

Results and Discussion

The rate of application of all the seven herbicides at 0.5 or 1.0 kg ai/ha (0.45 or 0.90 lb ai/A) had no adverse effect on fibrous root or shoot weight regardless of rootstock (Table 1). Only Cleopatra mandarin rootstocks, exhibited tolerance to each of the seven herbicides (Table 1). Herbicides had no adverse effect on fibrous root weight of Carrizo citrange, but shoot weight was reduced by 8% with Prowl. In Swingle citrumelo, Surflan reduced fibrous root weight by 19%, but Surflan had no adverse effect on the shoot weight. Prowl and Treflan reduced shoot weight of Swingle citrumelo by 8 to 9%. Prowl reduced fibrous root weight of sour orange by 10% but had no adverse effect on shoot weight. Treflan had no adverse effect on fibrous root weight but reduced shoot weight by 11%. There were no significant interactions between herbicide and rate regardless of rootstock (Table 1). The results of this study suggest that Cleopatra mandarin is tolerant to multiple applications of all the seven herbicides. The other three rootstocks exhibited some tolerance to the herbicides. Rootstock responses were independent of rates although total dose was 3 to 6 kg/ha (2.7 to 5.4 lb/A). Reduction in fibrous root weight in Swingle citrumelo with Surflan did not reduce shoot weight as expected. The fibrous root volume still present was probably enough to support normal growth of the seedling. Premier, an experimental herbicide, had no adverse effects on the four rootstocks. Multiple applications of these herbicides could be used by citrus nurserymen in Florida to obtain year round weed control.

(*Ed. note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities).

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