applied fertilization may not even be necessary for mature trees if they have received adequate fertilization in years prior to the freeze, or alternatively that only N should be applied to the soil with minor elements being applied as a foliar spray as currently recommended.

Literature Cited

1. Chapman H. D. 1968. The mineral nutrition of citrus. pp. 127-289. In: W. Reuther, L. D. Batchelor, and H. J. Webber (eds.) The Citrus Ind. Vol. 2, Univ. of Calif. Presses, Berkeley.
2. Davies, F. S. and L. K. Jackson. 1985. Methods of cold protection for young citrus trees. Fruit Crops Fact Sheet FC-75.
3. Division of Plant Industry Commercial Citrus Tree Inventory. 1990. Fla. Agr. Stat. Ser., Orlando, FL.
4. Koo, R.C.J. 1990. Summer fertilization and irrigation. The Citrus Ind. 71(5):62-63.
5. Koo, R.C.J., C. A. Anderson, I. Stewart, D.P.H. Tucker, D. V. Calvert, and H. K. Wutscher. 1984. Recommended fertilizers and nutritional sprays for citrus. Fla. Agr. Expt. Sta. Bul. 536-D.
6. Lawless, W. W. 1941. Effect of freeze damage on citrus trees and fruit in relation to grove practices. Proc. Fla. State Hort. Soc. 54:67-74.
7. Swietlik, D. and J. V. LaDuke. 1985. Nutritional status and growth responses of freeze-injured citrus trees to mineral foliar sprays in the first year of recovery. J. Rio Grande Valley Hort. Soc. 38:51-58.
8. Turrell, F. M. 1968. The science and technology of frost protection. pp. 338-446. In: W. Reuther, L. D. Batchelor and H. J. Webber (eds.) The Citrus Ind. Vol. 2, Univ. of Calif. Presses, Berkeley.

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YOUNG 'HAMLIN' ORANGE TREE FERTILIZER RESPONSE IN SOUTHWEST FLORIDA

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Abstract. **Southwest Florida has experienced a major expansion of citrus acreage, and fertilizer rates applied to young trees have generally been greater than present guidelines. Currently-recommended fertilizer rates were evaluated for young 'Hamlin' (*Citrus sinensis* (L.) Osb.) on Carrizo citrange (*C. sinensis (L.) Osb. x Poncirus trifoliata*) rootstock orange trees under this region typified by an extended growing season. Conventional water-soluble and controlled-release complete fertilizers were applied to newly-planted trees at N rates of 0, 0.06, 0.12, 0.24, and 0.48 lb/tree/yr. Water-soluble material was applied six times, while controlled-release materials [isobutylidene diurea (IBDU), methylene urea (MU), IBDU briquets, and Osmocote (OSM)] were applied one to three times. Twelve months after planting, trunk cross-sectional area increase and canopy volume were maximized at 0.12 lbs N/tree for Osmocote and 0.12-0.24 lbs N/tree for the other sources. Similar canopy volume was obtained for conventional, IBDU, and methylene urea sources at 0.24 lbs N/tree. Substantial growth measured on nonfertilized trees indicated that N may have been available from sources other than the fertilizer treatments.**

The expansion of citrus acreage in southwest Florida (Charlotte, Collier, Hendry, Glades, and Lee counties) has been substantial since the freezes of the early 1980s. Grove land within the region increased from 50,000 acres in 1980 to 126,000 acres by 1990 (3). Based on the amount of unplanted land which is currently permitted for citrus, southwest Florida could potentially have 150,000-200,000 acres of citrus by the year 2000.

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One concern associated with the expansion of citrus is the effect of agricultural practices on the environment. Because of the mobility of nitrogen fertilizer in sandy Florida soils, the potential for ground water contamination exists. Adoption of fertilizer management practices which increase fertilizer efficiency should minimize environmental effects and reduce costs. Two ways to increase nitrogen fertilizer efficiency are: using amounts close to the minimum amount required by the plant for maximum growth, and 2) using controlled-release N sources when multiple, small applications of water-soluble sources are not possible or practical.

Citrus growers in southwest Florida have recognized that the region's shorter winter (dormant) season relative to central Florida allows trees to grow for a longer time during the year. In an effort to accelerate fruit production of young trees, growers have attempted to "push" tree growth through the winter. Rates of fertilization in excess of current University of Florida/IFAS recommendations for young citrus trees are typically used. The current recommendations (6) do not differentiate between central and south Florida with respect to fertilizer rates.

Recent studies with young 'Hamlin' orange trees in central and east coast Florida have suggested that the current fertilizer recommendation for the first year of new plantings (0.40-0.60 lb N/tree) are above that which is required for maximum growth. Marler et al. (7) found no growth differences between N rates of 0.16, 0.32, and 0.48 lbs tree/yr for newly-planted trees grown at Gainesville. They also found no difference in growth between soluble and controlled-release fertilizers applied at 0.32 lb N/tree/yr. At Clermont and Fellsmere, Ferguson et al. (4) compared soluble fertilizer applied at 0.18 and 0.30 lb N/tree/yr to controlled-release materials applied at 0.04-0.13 lb N/tree/yr and found no differences in tree growth for the first year.

This study was designed in a similar manner as those mentioned to determine if there are any regional differences in fertilizer requirements for young, non-bearing citrus trees. The objectives were: 1) to determine the relationship between fertilizer rates and citrus tree growth in southwest Florida, and 2) to compare growth between trees fertilized frequently with a soluble N source and infrequently with controlled-release N sources.

Materials and Methods

This experiment was conducted within a large newly-developed commercial southwest Florida citrus grove. Land which had been in pasture for more than 25 yr was disked, laser-leveled, and formed into two-row beds during the summer and autumn of 1988. 'Hamlin' orange (*Citrus sinensis (L.) Osb.*) on Carrizo citrange (*C. sinensis (L.) Osb. x Poncirus trifoliata*) trees were planted in mid-March, 1989 at a spacing of 9 ft (in-row) x 25 ft (between-row). The irrigation method was seepage, where water was supplied to the trees through upward flux from a water table approximately 24-30 inches below the soil surface.

The experimental area consisted of four adjacent rows (two 2-row beds) each containing 128 trees. The area was separated into eight blocks, each four rows wide by 16 trees long. Each block contained 16 plots, consisting of four adjacent trees within a row. In each block, 16 fertilizer treatments were assigned to plots at random (Table 1).

In addition to the N-P-K content listed in Table 1, the conventional (CONV) fertilizer source contained all soluble N, 3.0% Mg, 0.3% Mn, and 0.05% Fe; the IBDU source contained half of its N in soluble form and half as slow-release isobutylidene diurea, with 2.4% Mg, 0.3% Mn, and 0.06% Fe; the MU source contained 60% of its N in soluble form and 40% in slow-release forms including methylene urea, sulfur-coated urea, and activated sludge, with 3.0% Mg, 0.5% Mn, and 0.03% Fe; the Osmocote (OSM) contained all slow-release N-P-K, with 1.5% Ca, 1.0% Mg, 4% S, 0.10% Mn, 0.40% Fe, 0.05% Cu, 0.05% Zn, 0.02% B, and 0.001% Mo; the Woodace Briquets (BRIQ) contained primarily slow-release N (from IBDU), P, and K, with 2.3% Ca, 1.2% Mg, 0.17% Mn, 1.12% Fe, 0.05% Cu, and 0.08% Zn.

Block soil samples and initial trunk diameter measurements were taken in mid-Apr. 1989. The two middle trees in each 4-tree plot were measured 6 inches above the bud union in both north-south and east-west directions. Assuming a circular trunk, the cross-sectional area (CSA) was calculated from the mean radius.

Initial fertilizer applications were made in April 1989. For the OSM and BRIQ treatments, a 3-inch deep, 4-ft long trench was dug on two sides of the tree approximately 18 inches from the trunk, the materials were laid in evenly, and the trench was filled. Fourteen briquets per tree were required to equal the rate in Table 1. The remaining treatments were applied under the trees in a 3-ft circle at planting and a wider circle as the trees grew. The CONV fertilizer was applied in Apr., Jun., Jul., Sep., Oct., and Dec.; the IBDU source was applied in Apr., Jul., and Nov.; the MU source was applied in Apr. and Sep.

Trunk CSA as measured in Sep. 1989 and Mar. 1990 (7 and 12 months after planting). Trunk growth was expressed as the increase in CSA from Apr. 1989 to Mar. 1990. Mean canopy width (measured in north-south and east-west directions) and height were measured at 12 months. Canopy volume was calculated based on the formula $(4/3)(3.14)(H/2)(W/2)^2$, where H = height and W = width (8).

Leaf tissue samples and soil samples were taken from each plot in mid-Mar. 1990. Leaves were 5 to 6-month-old autumn growth. Soil samples were taken to a depth of 6 inches at the dripline of the trees. Leaves were analyzed for N, P, K, Ca, Mg, Mn, Zn, Fe, and Cu. Soil samples were extracted with Mehlich 1 solution and analyzed for P, K, Ca, and Mg according to University of Florida/IFAS Extension Soil Testing Laboratory procedures (5).

Analysis of variance was used to determine fertilizer treatment and block effects on tree growth and leaf nutrient concentration. Where significant treatment effects were found, orthogonal contrasts were used to evaluate treatments. Contrasts evaluated the effect of fertilizer rate for each individual source. Duncan's multiple range test was used to evaluate the effect of fertilizer source at each rate. The response of leaf nutrient concentration was examined with respect to fertilizer rates across all sources.

Results and Discussion

Tree trunk CSA with respect to rate of N applied (regardless of source) at the three sampling dates is shown in Fig. 1. Approximately 60% of the total year's growth occurred between Oct. 1989 and Mar. 1990. Above-normal temperatures were most likely a contributing factor to the

Table 1. Fertilizer treatments applied to newly-planted 'Hamlin' orange trees.

No.	Fert. source[z]	Analysis (N-P-K)	Applic. rate (lb/tree)	Applic. freq. (no./yr)	Yearly application N	Yearly application P (lb/tree)	Yearly application K
1	CONV	8-1.8-6.6	0.125	6X	0.06	0.01	0.05
2	IBDU	8-1.8-6.6	0.25	3X	0.06	0.01	0.05
3	MU	9-2.2-6.6	0.33	2X	0.06	0.01	0.04
4	CONV	8-1.8-6.6	0.25	6X	0.12	0.03	0.10
5	IBDU	8-1.8-6.6	0.50	3X	0.12	0.03	0.10
6	MU	9-2.2-6.6	0.67	2X	0.12	0.03	0.09
7	CONV	8-1.8-6.6	0.50	6X	0.24	0.05	0.20
8	IBDU	8-1.8-6.6	1.00	3X	0.24	0.05	0.20
9	MU	9-2.8-6.6	1.33	2X	0.24	0.06	0.18
10	CONV	8-1.8-6.6	1.00	6X	0.48	0.11	0.40
11	IBDU	8-1.8-6.6	2.00	3X	0.48	0.11	0.40
12	MU	9-2.2-6.6	2.64	2X	0.48	0.12	0.35
13	OSM	17-2.6-7.5	0.35	1X	0.06	0.01	0.03
14	OSM	17-2.6-7.5	0.70	1X	0.12	0.02	0.05
15	BRIQ	14-1.3-2.5	0.43	1X	0.06	0.01	0.01
16	Control	-------	---	--	0.00	0.00	0.00

[z]CONV = Water-soluble N source; IBDU = Isobutylidene diurea N source; MU = Methylene urea N source; OSM = Osmocote; BRIQ = Woodace briquets.

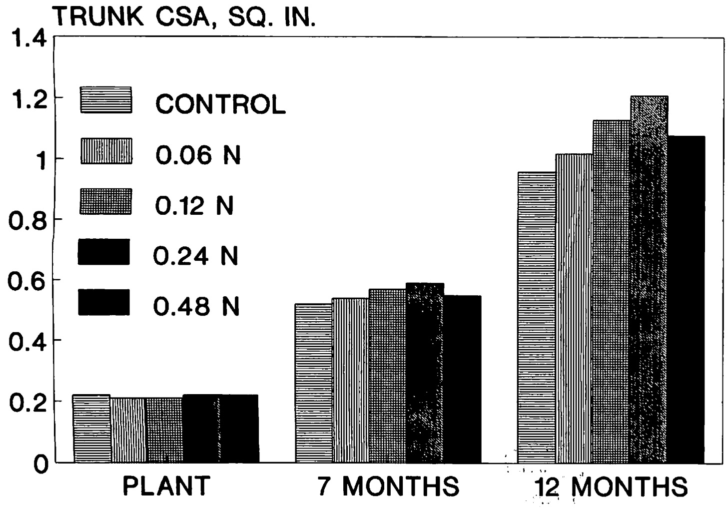

Fig. 1. 'Hamlin' orange tree trunk cross-sectional area at three sampling dates with respect to rate of N applied.

substantial growth observed during the autumn and winter, traditionally a "dormant" period for citrus trees. Fertilizer rate effects also became more obvious during this interval.

Effect of fertilizer source. CONV and OSM sources effected greater trunk CSA increase than IBDU or MU at 0.12 lb N/tree (Table 2). CONV was superior to MU at 0.24 lb N/tree. There was no difference among sources at 0.48 lb N/tree. Greater canopy volume was observed with OSM than with BRIQ at 0.06 lb N/tree. OSM was superior to CONV, IBDU, and MU at 0.12 lb N/tree. There was no difference among sources at either 0.24 or 0.48 lb N/tree.

Effect of fertilizer rate. Depending on the measurement method, the CONV, IBDU, and MU sources effected no further trunk CSA or canopy volume increase above a rate of either 0.12 or 0.24 lbs N/tree (Table 3). Trunk CSA increase and canopy volume showed a response to the OSM source up to its maximum rate of 0.12 lb N/tree. There was no response to the BRIQ treatment at 0.06 lb N/tree.

OSM proved to be a very effective fertilizer source in this experiment. Additional analysis of variance (not shown) indicated that growth response was similar between OSM at 0.12 lb N/tree and the CONV, IBDU, and MU sources at 0.24 lb N/tree. This is even more striking considering the single application of OSM versus multiple applications of the other sources.

No differences occurred in leaf P concentration among treatments (Table 4). Leaf N concentration was significantly higher at the 0.48 lb N/tree rate than at any other rate. Leaf K concentration significantly increased with each increment of K applied from 0 to 0.40 lb K/tree (for treatments 1-12 and 16 only). For any treatment, all leaf concentrations of N, P, and K were within the optimum range or higher according to current guidelines (6).

Soil test results. The effect of relative fertilizer rate on Mehlich 1-extractable P and K is shown in Fig. 2. (Relative fertilizer rate 1 equals the amounts applied in treatments 1-3.) The amounts of P and K extracted from the nonfertilized treatment after 12 months were very similar to the values seen at planting. As the fertilizer rate increased, the extractable P and K increased in a near-linear manner. High soil Ca most likely caused the retention of fertilizer P, while the cation exchange capacity from soil organic matter most likely held fertilizer K. The high soil Ca levels originated from calcareous subsurface material which was brought to the bed surface during land formation. Organic matter levels of 1.3-1.9% in the root zone soil originated from pasture grasses which had previously grown at the site.

Non-fertilizer sources of nitrogen. An interesting aspect of this study was the substantial growth achieved by the nonfertilized trees. Since N is the primary inorganic element affecting vegetative growth (2), these trees obtained N elsewhere. The most likely sources were the tissues of the newly-planted tree itself, and mineralization of soil organic matter. A less likely but possible source was irrigation water.

A recent survey of the mineral content of citrus nursery trees (1) provides evidence that most commercial nursery trees contain luxury levels of N. An excess N concentration at planting could serve as a reservoir for the initial growth in the field. In previous studies, nonfertilized trees grew comparably to fertilized trees for up to 7 months after planting (F. S. Davies, personal communication).

Table 2. Effect of fertilizer source on growth of 12-month-old 'Hamlin' orange trees.

Fert. Source	N applied, lb/tree/yr 0.06	0.12	0.24	0.48
	Trunk CSA[z] increase (in^2)			
CONV	0.79 a[y]	1.04 a	1.09 a	0.90 a
IBDU	0.77 a	0.83 b	1.00 ab	0.89 a
MU	0.85 a	0.88 b	0.89 b	0.79 a
OSM	0.85 a	1.02 a	----	----
BRIQ	0.74 a	----	----	----
	Canopy volume (ft^3)			
CONV	22.9 ab	30.7 b	37.8 a	30.7 a
IBDU	26.1 ab	30.3 b	28.9 a	30.0 a
MU	28.6 ab	26.8 b	33.9 a	27.9 a
OSM	30.0 a	40.2 a	----	----
BRIQ	20.5 b	----	----	----

Values for the control treatment were 0.75 in^2 and 21.2 ft^3 for trunk CSA increase and canopy volume respectively.
[z]CSA = cross-sectional area
[y]Means within columns followed by the same letter are not significantly different according to Duncan's multiple range test, $p < 0.05$.

Table 3. Analysis of variance for effects of fertilizer treatments and blocks on citrus tree growth, and contrasts of effects of nitrogen fertilizer rate on trunk cross-sectional area (CSA) increase and tree canopy volume.

Source	df	Trunk CSA increase	Canopy volume
		------mean squares------	
Blocks	7	15.49***	0.55***
Treatment	15	7.70***	0.36***
Error	232	1.83	0.11
Contrasts			
		------mean squares------	
CONV fertilizer *N rates, lb/tree/yr*			
0 vs. 0.06		0.61	0.02
0 vs. 0.12		27.76***	0.58***
0.12 vs. 0.24		1.00	0.33*
IBDU fertilizer *N rates, lb/tree/yr*			
0 vs. 0.06		0.20	0.16
0 vs. 0.12		2.10	0.53**
0 vs. 0.24		20.99***	----
0.12 vs. 0.24		----	0.01
MU fertilizer *N rates, lb/tree/yr*			
0 vs. 0.06		3.72	0.35**
0 vs. 0.12		5.98**	0.19
0.06 vs. 0.12		----	0.02
0.12 vs. 0.24		0.07	0.32**
OSM fertilizer *N rates, lb/tree/yr*			
0 vs. 0.06		3.36	0.47*
0 vs. 0.12		24.83***	----
0.06 vs. 0.12		----	0.68**
BRIQ fertilizer *N rates, lb/tree/yr*			
0 vs. 0.06		0.014	0.003

*, **, *** Response significant at probability levels of 0.10, 0.05, and 0.01, respectively.

In a preliminary 84-day laboratory incubation study (data not shown), the N mineralization rate from organic matter in the top 1 ft of grove soil averaged 0.2 lb N/acre/

Table 4. Effect of fertilizer application level on leaf tissue nutrient concentration of 12-month-old 'Hamlin' orange trees.

	Yearly application			Leaf tissue conc.[z]		
	N	P	K	N	P	K
Treatment no.		(lb/tree)			(%)	
16	0.00	0.00	0.00	3.19	0.18	1.68
1, 2, 3	0.06	0.01	0.05	3.11	0.15	1.72
4, 5, 6	0.12	0.03	0.10	3.10	0.15	1.98
7, 8, 9	0.24	0.05	0.20	3.17	0.16	2.27
10, 11, 12	0.48	0.11	0.40	3.38	0.15	2.61
13	0.06	0.01	0.03	2.91	0.13	1.34
14	0.12	0.02	0.05	2.89	0.16	1.50
15	0.06	0.01	0.01	3.14	0.16	1.27

[z]6-month-old autumn growth flush leaves sampled in March 1990.

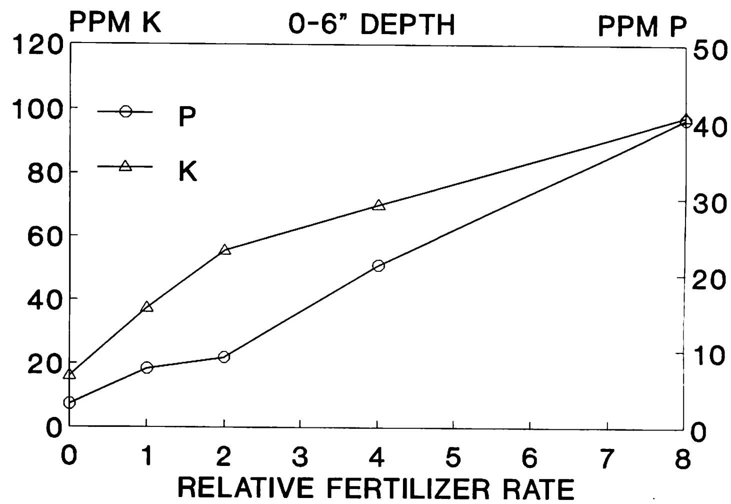

Fig. 2. Mehlich 1-extractable P and K from as a function of relative fertilizer rate at 12 months after planting. (Relative rate 1 equals treatments 1-3.)

day under favorable moisture and temperature conditions. If this rate was approached in the field, it could potentially provide a significant amount of N relative to the amount taken up by citrus trees during their first year in a grove. This aspect requires further quantification due to its importance with respect to groves planted on old pasture sites.

The seepage irrigation source was surface water ultimately originating from the Caloosahatchee River. This water was not tested for the presence of nitrate. Since the experimental site was located within a much larger expanse of young grove, there is the possibility that some fertilizer from the surrounding area reached the irrigation water. This effect is believed to be negligible because the commercial N fertilizer rate was 0.48 lb/tree for the first year, half of which was applied in controlled-release form (J. Hoffman, personal communication).

Summary. The results of this study generally agree with those recently conducted in other parts of Florida (4, 7) with regard to rates of N fertilizer required by newly-planted citrus trees. No tree growth response (trunk CSA increase or canopy volume) was seen above application rates of 0.12-0.24 lb N/tree/yr. This indicates that optimum fertilizer rates may be lower than those currently recommended. It does not appear that N fertilizer recommendations need to differ with respect to geographic area within the state.

Similar growth of young trees was obtained using controlled-release forms of fertilizer applied at lower frequency when compared to a water-soluble material applied at higher frequency. Greater fertilizer efficiency was obtained with Osmocote compared to the other sources used. Ferguson et al. (4) obtained similar results with Osmocote. Although controlled-release forms are more expensive, they may have a role in reset situations or circumstances where high-frequency fertilization with a soluble source is not convenient or practical (4). Environmental concerns may also favor controlled-release sources.

Substantial tree growth in the nonfertilized treatment indicated that newly-planted trees had access to N from sources other than the fertilizer applied in this experiment. The individual grove situation will dictate the magnitude of contribution from the nursery trees themselves and mineralization of soil organic matter. A soil test for organic matter content prior to planting a new grove could give an indication as to the potential contribution of N from this source.

Literature Cited

1. Castle, W. S., and R. E. Rouse. 1990. Total mineral content of Florida citrus nursery plants. Proc. Fla. State Hort. Soc. 103: In press.
2. Chapman, H. D. 1968. The mineral nutrition of citrus, p. 127-289. In: W. Reuther, L. D. Batchelor, and H. J. Webber (eds.) The citrus industry, vol. II. University of California, Berkely, CA
3. Florida Dept. of Agr. and Consumer Services. 1990. Commercial citrus inventory. Fla. Agr. Stat. Serv., Orlando, FL.
4. Ferguson, J. J., F. S. Davies, C. H. Matthews, and R. M. Davis. 1988. Controlled-release fertilizers and growth of young 'Hamlin' orange trees. Proc. Fla. State Hort. Soc. 101:17-20.
5. Hanlon, E. A., and J. M DeVore. 1989. IFAS extension soil testing laboratory chemical procedures and training manual. Univ. Fla. Coop. Ext. Serv. Cir. 812.
6. Koo, R. C. J., C. A. Anderson, I. Stewart, D. P. H. Tucker, D. V. Calvert, and H. K. Wutscher. 1984. Recommended fertilizers and nutritional sprays for citrus. Fla. Agr. Expt. Sta. Bul 536D.
7. Marler, T. E., J. J. Ferguson, and F. S. Davies. 1987. Growth of young 'Hamlin' orange trees using standard and controlled- release fertilizers. Proc. Fla. State Hort. Soc. 10061-64.
8. Westwood, M. N. 1978. Temperate zone pomology. W. H. Freeman & Co., New York.

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MULTIPLE APPLICATIONS OF PREEMERGENCE HERBICIDE TANK MIXTURES IN YOUNG CITRUS GROVES

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Abstract. **Young citrus grove sites were selected in Polk, Indian River, and Collier counties to evaluate preemergence herbicides for weed control and tree phytotoxicity. The studies were carried out for 2 yr starting in the spring of 1988. Herbicides evaluted included bromacil (Hyvar), diuron (Direx and Karmex), metolachlor (Dual), napropamide (Devrinol), norflurazon (Solicam), oryzalin (Surflan), oxadiazon (Ronstar), oxyfluorfen (Goal), pendimethalin (Prowl) and simazine (Princep). All herbicide treatments reduced weed populations compared with untreated controls and there were significant differences among weed control treatments. Better weed control was observed at 60 days after treatment (DAT) than at 120 DAT. Bromacil + diuron and all combinations with norflurazon provided the best weed control at all 3 locations. Variation in weed control was observed with frequency and time of herbicide application. None of the herbicides consistently produced any phytoxicity symptoms on trees. Occasional mild symptoms of bromacil appeared on foliage in weaker soil areas only at the Indian River County location.**

Prevention of weed infestation is the best strategy to minimize losses due to weeds, but is not practical in commercial citrus production. Some acceptable level of control is the goal of growers who utilize several weed control methods in an integrated control program.

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Weed control accounts for 20-25% of the production budget and losses from weeds can be substantial in young groves as they compete for nutrients and moisture and contribute to other undesirable effects (1, 2). Chemical control or suppression is the most common method of weed control utilized on over 90% of Florida citrus acreage. Preemergence herbicides are used alone or in combination with postemergence herbicides for the control of established weed cover. Preemergence herbicides currently registered for citrus include bromacil, diuron, EPTC, metolachlor, napropamide, norflurazon, oryzalin, oxyfluorfen, pendimethalin, simazine and trifluralin. These herbicides vary in efficacy, chemical properties, safety, and cost. Herbicide should be considered by growers based on weed species and density, variety and age of trees, soil type, and local environmental conditions. Mixtures of 2 or more herbicides at reduced rates may be used to maximize efficacy and minimize environmental impact.

Singh and Tucker (6) reported that frequent applications of low rates of preemergence herbicides will improve weed control consistency without any phytotoxicity to young trees in containers and in the field. Singh and Achhireddy (5) also demonstrated the safe use of preemergence herbicides on young citrus rootstock plants. Bromacil and diuron have been found to be effective against a wide range of grass and broadleaf wed species and generally safe for use around citrus trees (8, 9). Norflurazon is an effective herbicide for use in water rings (7), for application through irrigation systems, and for general weed control in groves. Simazine is effective against germinating annual grasses, broadleaf weeds, and vines (3, 4).

Objectives of these experiments were to examine the effectiveness of various preemergence herbicides against commonly found weed species under central Florida ridge, east coast, and southwest flatwoods growing conditions and to record phytotoxic effects if any.

Materials and Methods

Three young groves planted in 1987 located in Lake Alfred (Polk County), Vero Beach (Indian River County)