Costa, A. S. and T. J. Grant. 1951. Studies on transmission of the tristeza virus by the vector, *Aphis citricidus*. Phytopathology 41:105-113.
Garnsey, S. M., R. F. Lee, C. O. Youtsey, R. H. Brlansky and H. C. Burnett. 1980. A survey for citrus tristeza virus in registered budwood sources commercially propagated on sour orange rootstock in Florida. *Proc. Fla. State Hortic. Soc*. 93:7-9.
Grant, T. J. 1952. Evidence of tristeza, or quick decline, virus in Florida. *Proc. Fla. State Hort. Soc.* 65:28-31.
Hooker, M. E., C. A. Powell, R. F. Lee, R. H. Brlansky and S. M. Garnsey. 1993. Development of monoclonal antibodies to citrus tristeza virus. Phytopathology 83:1378.
LeClerg, E. L., W. H. Leonard and A. G. Clark. *Field Plot Technique*. 1939. Burgess Publishing Co., Minneapolis, Minn. pp. 76-79, 85, 144.
Norman, P. A. and T. J. Grant. 1954. Preliminary studies of aphid transmission of tristeza virus in Florida. Proc. Fla. State Hortic. Soc. 6:89-92.
Norman, P. A. and T. J. Grant. 1956. Transmission of tristeza virus by aphids in Florida. Proc. Fla. State Hortic. Soc. 69:38-42.
Oldfield, G. N. and R. K. Yokomi. 1990. Seasonal fluctuations of alate aphid activity in California citrus groves. Proc. Conf. Int. Organ. Citrus Virol. 11th. 17:53:05.
Powell, C. A., R. R. Pelosi and M. Cohen. 1992. Superinfection of orange trees containing mild isolates of citrus tristeza virus with severe Florida isolates of citrus tristeza virus. Plant Disease 76:141-144.
Powell, C. A. and R. R. Pelosi. 1993. Prevalence of severe strains of citrus tristeza virus in Florida citrus nurseries. HortScience 28(7):699-700.
Powell, C. A., R. R. Pelosi and R. C. Bullock. 1996. Natural field spread of mild and severe isolates of citrus tristeza virus in Florida. Plant Dis. (in press).
Simanton, W. A. and L. C. Knorr. 1969. Aphid Populations in Relation to Tristeza in Florida Citrus. Florida Entomologist 52(1):21-27.
Yokomi, R. K. and S. M. Garnsey. 1987. Transmission of citrus tristeza virus by *Aphis gossypii* and *Aphis citricola* in Florida. Phytophylactica 19:169-172.
Yokomi, R. K., S. M. Garnsey, R. F. Lee and M. Cohen. 1987. Use of vectors for screening protecting effects of mild citrus tristeza isolates in Florida. Phytophylactica 19:183-185.
Yokomi, R. K. and Y. Q. Tang. 1996. A survey of parasitoids of the brown citrus aphid (Homoptera: Aphididae) in Puerto Rico. Biological Control (in press).
Yokomi, R. K. 1996. Personal communication.

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PREPLANT LEAF NITROGEN EFFECTS ON GROWTH AND FERTILIZER REQUIREMENT OF YOUNG 'HAMLIN' ORANGE TREES

LAURA GUAZZELLI, JAMES J. FERGUSON
AND FREDERICK S. DAVIES
Horticultural Sciences Department
University of Florida
Gainesville, FL 32611-0690

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Abstract. **Fertilization rate and growth response of young trees vary both in citrus nurseries and in new plantings. Experiments were conducted with 'Hamlin' orange trees [*Citrus sinensis* (L.) Osb.] on 'Swingle' citrumelo rootstock [*C. paradisi* Macf. × *Poncirus trifoliata* (L.) Raf.] rootstock to determine the optimum N rate for greenhouse nursery trees and the effect of N nutrition of greenhouse nursery trees on growth and fertilization response of trees in the field. Greenhouse nursery trees received 12, 50, 100 or 200 ppm N weekly via drip irrigation for one year. Optimum tree growth occurred at the two highest rates, while trees that received 12 or 50 ppm N were stunted and chlorotic. In another experiment from 0 - 0.75 lb N/tree/year were applied for 2 years to young field trees with initial leaf N levels of 1.4 - 4.1% when planted. Preplant leaf N level had no effect on trunk diameter, height, shoot growth and number or dry weight of trees for year one and two in the field. Fertilizer rate in the field did not affect tree growth in year one but did in year two, with maximum growth occurring at 0.37 lb N/tree/ year.**

Nutrition of citrus is one of the most important aspects of nursery tree production. Fertilization programs for young trees are highly variable in Florida. Different fertilizer formulations (dry or liquid), frequencies, and rates are used for seedlings and budded, container-grown, and field-grown trees. High N rates are commonly used in Florida greenhouse and field citrus nurseries, ranging from 1,058 to 2,903 lbs/acre. Despite use of such high rates, only 5 to 20% of the N applied could be found in the leaves of 'Valencia' orange trees grown in container nurseries (Castle and Rouse, 1990).

Nitrogen nutrition for young trees is highly variable, as reflected by the optimum N fertilization rates reported for the first year in the field which range from 2 (Rasmussen and Smith, 1961) to 2.4 (Marler et al., 1987) to 3.8 (Obreza and Rouse, 1993) to 8 oz/tree/ year (Willis et al., 1990). Moreover, some studies suggest that fertilization rate has no effect on tree growth for the first (Rasmussen and Smith, 1961; Obreza and Rouse, 1993) and second years in the field (Calvert, 1969 and Rasmussen and Smith, 1961). In other studies, Obreza and Rouse (1993) found that tree growth increased with increasing N rate.

Factors that may contribute to different fertilization responses by young citrus trees include soil type (Obreza and Rouse 1993), tree age and size (Calvert, 1969), rootstock (Wustcher, 1989), amount of stored reserves (Legaz et al., 1995) or type of nursery trees (bareroot or container grown) (Davies unpublished).

The objectives of these studies were to determine the N rate that produced the greatest tree growth in the greenhouse using 'Hamlin' orange on 'Swingle' citrumelo rootstock and to determine if there is a residual effect of greenhouse nutrition on subsequent growth and fertilization response of young citrus trees planted in the field.

Materials and Methods

Nursery studies. Experiment 1: Four hundred bare-root 'Swingle' citrumelo liners were purchased from a commercial nursery and planted on 25 Feb. 1992 in citripots containing a commercial medium composed of 1 perlite:1 peatmoss (v/v), 14.6 lbs of limestone and 0.13 lb of superphosphate/yard^3. Liners were budded with Hamlin orange on 3 Mar., 7 and 11 Apr., and 3 and 6 May

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1992. Average height of liners after budding was 12-inches. Budbreak was forced by looping and tying the rootstock to the base of the tree.

Liquid fertilizer (8N-0P-8K; 4% NH_4+, 4% NO_3-, 8% KCl) was applied at rates of 12, 50, 100, and 200 ppm N/quart/tree/week (12, 50, 100 and 200 mg N/liter/tree/week) to groups of 100 plants per treatment from 27 Apr. 1992 until trees were harvested on 21 Jan. 1993. In addition, trees were irrigated every 2 days to replace water lost via transpiration. Twenty five trees from each treatment were selected at random for final measurements and data analysis. Tree scion length and trunk diameter were measured one inch above the bud union. At harvest the trees were separated into leaves, scion stems, rootstock stems, lateral roots, and tap roots. Fresh and dry weights were collected. Data from 25 single-tree replications per treatment were evaluated by regression analysis.

Experiment 2: One hundred 'Swingle' rootstock plants obtained from a commercial nursery on 15 Feb. 1993 were planted in the same type of medium and container as described in Expt. 1 and budded with Hamlin' orange on 13 Apr. 1993. The same fertilizer rates as in Expt. 1 were applied from 13 Apr. to 22 Sept. 1993. Scion trunk diameter was measured one inch above the bud union and tree height was measured from the planting surface to the tip of the scion stem. Trees were harvested on 22 Sept. 1993 and separated into scion leaves and stems (by growth flushes), rootstock stem, lateral roots, and tap roots. Dry weight was determined as described in Expt 1. Regression analysis was used to evaluate data and optimum N rate was calculated using critical-level analysis (Maust and Williamson, 1991).

Young tree field studies. Experiment 3: One hundred 'Hamlin' orange trees on 'Swingle' citrumelo rootstock were obtained from a commercial nursery on 9 March, 1992. Average leaf N concentration was 2.8%. The trees were divided into three groups, each of which received 0, 12 or 100 ppm of N/quart/tree/week, (0, 12 or 100 mg N/liter/tree/week) respectively, from 27 Apr 1992 until trees were transplanted to the field in Oct. at a 10 × 20-foot spacing within and between rows, respectively. Leaf N was determined by sampling 3-to4-month old leaves.Groups of 18 trees were formed according to leaf N concentrations: low(1.4-1.6% N), medium (1.7-1.9% N), and high (2.0-2.2% N). For this field study trees receiving three preplant N concentrations and six postplant fertilizer rates were arranged in a randomized complete block design with three blocks and three individual tree replicates/treatment (54 trees total). Trees were planted on 14 Oct. 1992 at the Fifield Farm in Gainesville, Fla. Granular fertilizer (8N-2.6P-6.6K-2Mg-0.2Mn-0.12Cu-0.27Zn-1.78Fe) was broadcast within the dripline at 0.12, 0.24, 0.37, 0.51, 0.62, and 0.75 lbs N/tree split into six applications per calendaryear(31 Oct. 1992, 14 Feb., 27 March, 1 May, 12 June, 24 July, and 4 Sept. 1993). Soil type was an Arredondo loamy fine sand. Monthly trunk diameter and tree height measurements were made from 10 April until 10 Sept. 1993. Ten leaves per tree were collected on 23 Aug. for nutrient analysis (N-P-K-Ca-Mg-Fe-Mn-Zn-Cu) (Maurer and Davies, 1993). Trees were harvested above the soil line between 1 and 4 Oct., 1993. Shoot length was determined by measuring four shoots per growth flush per tree at harvest time. Shoot number per flush and fresh and dry weights were also determined for each tree. Trees were irrigated at 30% soil water depletion (SWD) for 1.5-h as described previously (Marler and Davies, 1990) using 90° 10-gallon/hour microsprinklers located 3.3-feet northwest of the trunk. Soil water deficit was determined at a 1-foot depth twice per week if no rain occurred, using a Troxler model 4300 neutron probe (Troxler Inc., Research Triangle Park, NC). Fruit were removed from trees after the initial fruit set period.

Experiment 4: One hundred 'Hamlin' orange trees on 'Swingle' citrumelo rootstock were obtained from a commercial nursery on 13 Jan. 1993 and placed in the greenhouse. Initial N concentration averaged 4.6%.The plants were divided into three groups, each of which received 0, 50, or 100 ppm N/quart/week (0, 50 or 100 mg N/liter/tree/week), respectively, beginning 21 Jan. 1993. The same liquid fertilizer formulation was used as in Expt. 1. Leaf samples were taken on 17 April and trees were separated into three groups based on the N concentration in the leaves: low (3.1%), medium (3.6%), and high (3.84.1%). Eighteen uniform trees from each N level (54 trees total) were planted on 14 Apr. 1993 at the Fifield Farm at a 12 × 20-foot spacing within and between rows, respectively. The same experimental and plot designs were used as in Expt. 3.

Tree height, trunk diameter and leaf number were measured monthly for two growing seasons from 14 Apr. 1993 until 10 Dec. 1994. Trunk diameters were measured 1-inch above the bud union. Shoot growth was measured by tagging three randomly selected shoots per tree at the beginning of the growth flush and measuring final length. Granular fertilizer (same formula as Expt. 1) was applied 4 times/year at 0, 0.24, 0.37 0.51 0.62 or 0.75 lb of N/tree on 18 May, 29 June, 10 Aug., 21 Sept. 1993 and 17 Mar., 28 Apr., 9 June and 21 July 1994.

Soil analysis (Expt. 4): Soil samples were taken to determine nitrate-N concentration for the 0.24, 0.51 and 0.75 lb N rates using four randomly selected single-tree replicates per treatment. Samples were taken at 0-6 and 6-12 inch depths within the dripline for a total of two samples/tree. To follow the movement of nutrients over time, soil samples were collected 1, 3, and 5 weeks after each of the four fertilizer applications. Soil samples were placed in paper bags and dried at 105° F until they reached a constant weight. Filtrates from soil samples were analyzed for NO_3-N on an air-segmented spectrophotometer (rapid flow analyzer model RDF300; Alpken Corp., Silver Spring, Md.). Samples were collected on 25 May; 8 and 22 June; 6 and 20 July; 3, 17 and 31 Aug.; 14 and 28 Sept.; and 12 Oct. in 1993 and on 24 Mar.; 7 and 21 Apr.; 5, 12 and 26 May; 16 and 30 June; 14 and 28 July; and 25 Aug. in 1994.

Statistical Analysis: Data from expts. 3 and 4 were analyzed separately from each other, using ANOVA and regression analysis by time, fertilizer rate, preplant leaf N concentration and appropriate interactions.

Results and Discussion

Nursery studies. Tree growth (trunk diameter, shoot growth and shoot and stem dry weight) generally increased linearly with increasing N rates (Tables 1-2). A sharp increase in growth occurred between the 100 and 200 ppm N rates in Expt. 1 (Table 1), while in Expt 2, the increase was generally linear (Table 2). N rates had a positive effect on the number of growth flushes: four flushes at 100 or 200 ppm, three at 50 ppm, and two at 12 ppm. Critical-level regression analysis resulted in optimum N rates between 155 and 165 ppm per application (0.12 to 0.13 oz N/tree/year). Leaf N concentrations were increased by higher N rate. Therefore, trees that received 100 or 200 ppm had higher leaf N concentrations than those that received 12 or 50 ppm for both experiments (data not shown). Levels of all other nutrients were similar. These data suggested higher optimum N rates than those of previous studies (Chapman and Liebig, 1937); Lea-Cox, 1989; Maust and Williamson, 1991), probably due to differences in planting medium and rootstock. he fertilizer requirements by plants grown in sand culture (Chapman and Liebig and Maust and Williamson) or pine bark (Lea-Cox) may be lower than those grown in commercial medium.

[1]Table 1. Effects of N fertilizer rates in the nursery on dry weight of leaves, stems and roots of containerized 'Hamlin' orange trees on 'Swingle' citrumelo rootstock (Expt. 1)[z].

	Dry wt. (g)					
	Scion[x]		Rootstock			
N (ppm)	Leaf	Stem	Stem	Lateral roots[y]	Tap roots	Total
12	1.21	0.32	4.03	4.03	3.28	12.88
50	1.06	0.25	3.72	3.18	3.10	11.31
100	1.10	0.31	4.94	4.18	3.69	14.21
200	2.45	1.52	4.56	4.12	3.53	16.19
Regression	L***	L***	C*	C*	NS	L**

[1]Guazzelli et al., 1995.
NS, *, **, *** nonsignificant or significant at P ð 0.05, 0.01 or 0.001, respectively; L = linear, C = cubic.
[z]Means of 25 trees/treatment.
[y]Includes all except tap roots.
[x]Data analysis was performed on log of the original values of scion leaf and stem dry weights.

While optimum growth of trees in sand culture may occur at less than 50 ppm N, higher rates are needed for optimum growth in a commonly used commercial planting medium of peatmoss and perlite. Nutrients are more strongly complexed in commercial medium than in sand, and therefore less available to the tree.

Rootstocks are known to affect leaf N levels (Wustcher, 1974), and previous studies by Maust and Williamson and Lea-Cox were done using 'Cleopatra' mandarin, 'Carrizo' citrange, or rough lemon rootstocks. 'Swingle' citrumelo rootstock may have higher nutrient requirements than other rootstocks because it is more likely to have nutrient deficiency problems. In addition, 'Swingle' stops growing earlier and at higher temperatures than these other rootstocks. Citrus nurserymen who use commercial planting medium can increase tree height, trunk diameter, and dry weight by fertigating once a week with a fertilizer solution containing 155 to 165 ppm N, enough solution being applied at each application to wet the medium thoroughly. Although, higher rates will increase growth further, they may not be cost-effective. Another important factor in nursery management is water management to prevent salt accumulation and associated leaf damage. Heavy irrigation may be needed for nurseries with water high in salts. N rates currently used in many nurseries in Florida (200-400 ppm) are higher than the optimum rates found in this study, suggesting that current rates may be reduced without decreasing tree growth. There is considerable interest in Florida in reducing N rates to decrease the potential for nitrate pollution of groundwater.

Young tree field studies. Expt 3: No significant effect of preplant leaf N concentration was observed on tree fresh weight, dry weight, flush number or length, or trunk diameter in 1993 (year 1) (data not shown). No visual differences in tree vigor or appearance were observed at the end of the first year. Similar leaf N concentration occurred in all treatments (2.6-2.8%), except at the 0.056 N rate (2.2%). Trees with initially low N concentration (1.4%) increased in N leaf levels and it remained the same for those with initially high leaf N (2.2%).

Expt. 4. There was no significant effect of preplant N concentration on tree trunk diameter, height, shoot length (data not shown) or shoot number (Table 3) for the growing seasons of 1993 and 1994. In 1993 trunk diameter, tree height, or shoot number or length was not consistently affected by N rates in the field. However, in 1994 N fertilizer rate had a significant quadratic effect on trunk diameter for all three preplant N levels (Fig. 1). When data were combined for the three preplant N concentration, trunk diameter was greatest at the 0.24 to 0.37 lb N/tree/year rates and least at the 0 and 0.75 lb N rates (Fig. 1). The 0 and 0.75 lb rates resulted in lower number of second growth flushes than with the intermediate rates (Table 3). Most of the nonfertilized trees had no second growth flush (when preplant N treatments were combined). The effects of lack of fertilization was not noticed until the end of the second season. Although our findings agree with those of Obreza and

[2]Table 2. Effects of N fertilizer rates in the nursery on dry weight of leaves, stems and roots of containerized 'Hamlin' orange trees on 'Swingle' citrumelo rootstock (Exp. 2)[z].

	Scion		Rootstock (g)			
N (ppm)	Leaf	Stem	Stem	Lateral roots[y]	Tap roots	Total
12	1.72	0.57	3.94	4.63	2.99	13.86
50	2.49	1.00	4.69	4.89	4.02	17.10
100	4.23	2.19	4.74	4.74	4.30	19.86
200	4.91	1.99	4.72	4.72	4.71	21.37
Regression	L***	L***	L**	NS	L***	L***

[2]Guazzelli et al., 1995.
NS, *, **, *** nonsignificant or significant at P ð 0.05, 0.01 or 0.001, respectively; L = linear.
[z]Means of 25 trees/treatment.
[y]Includes all except tap roots.

[3]Table 3. Shoot number of young 'Hamlin'/Swingle orange trees related to flush, fertilizer rate and preplant leaf N concentration (Exp. 4)[z].

	Preplant leaf N (%)[z]					
	Low (3.1)		Medium (3.6)		High (3.8-4.1)	
	Shoot number					
N(lb/tree/year)	Flush 1	Flush 2	Flush 1	Flush 2	Flush 1	Flush 2
0.0	152	18	117	3	91	0
0.24	133	25	118	7	115	15
0.37	131	7	141	19	114	12
0.51	146	7	110	8	98	24
0.62	102	1	98	16	66	30
0.75	57	4	128	4	103	1
	*	*	*	*	*	*

AOV	
Shoot number	**
Block	NS
Preplant leaf N%	NS
N Rate	0
Preplant leaf N% × N Rate	NS

[3]Guazzelli et al., 1996.
Note: NS, *, nonsignificant or significant at P ð 0.05, respectively.
[z]Means of 4 shoots/tree for 3 individual tree replicates/treatment.

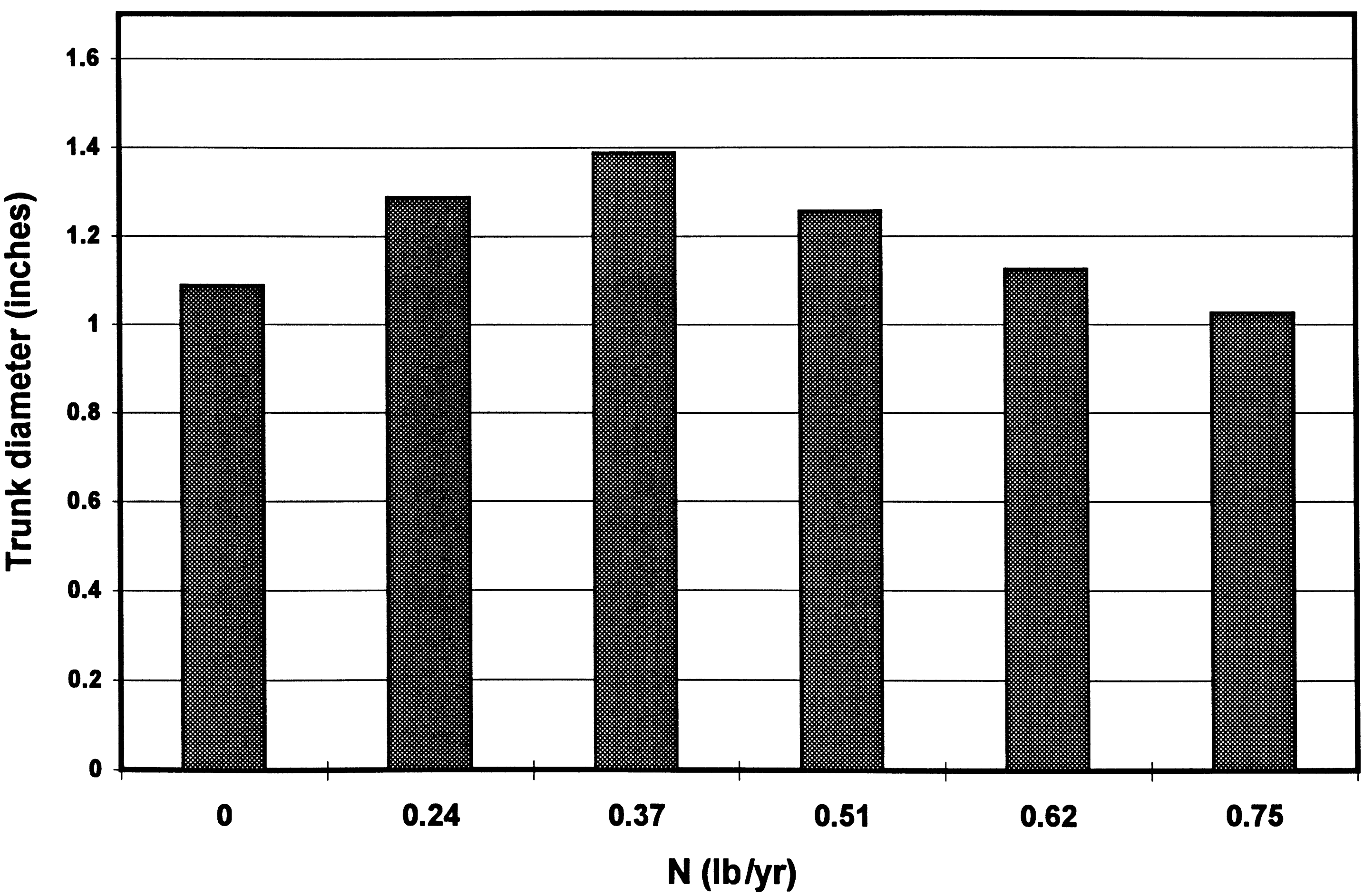

Figure 1. Effect of fertilizer rate on trunk diameter of 2-year old orange trees (Experiment 4). Adapted from Guazzelli et al., 1996.

Rouse (1993) they may not apply for every soil type as found by Marler et al. (1987). These data also demonstrate the disadvantages of using high fertilization rates or of not fertilizing over a 2-year period.

Leaf N concentration was similar for all fertilization rates and averaged 3.4% with the exception of the nonfertilized treatment which was 2.8%. While low preplant treatments increased the N leaf concentration (3.1%), the intermediate preplant level (3.6%) remained the same, and the high preplant level (3.8-4.1%) decreased. Trees with low initial leaf N may increase N uptake and those with high initial leaf N decrease uptake as suggested by Lea-Cox and Syvertsen (1995). Higher leaf N concentrations were found in young trees than those found in mature trees and these values were similar to those reported by Willis et al. (1990) and Maurer and Davies (1993)

Soil nitrate-N (Expt. 4). Higher N fertilizer rates resulted in higher soil nitrate-N levels for the first month after application with the highest rate (0.75 lb). Peak levels were obtained within 1 week of fertilization with 0.8-1.6 ounces N/1000 lbs of soil at the 0.5 foot depth. The 0.51 and 0.24 rates had peak nitrate-N concentrations of 0.4-1.2 oz/1000 lbs. With all three N rates the nitrate-N levels decreased to within 2 weeks of fertilization to 0.16 oz/1000 lbs. at both depths. However, at the 0.6-1.0 foot depth lower N levels were found than at the 0.5 foot depth. Heavy rainfall periods decreased nitrate-N levels at both depths in June and July, strongly suggesting leaching of N occurred below the root zone. Soil nitrate-N patterns for 1994 were similar to those in 1993 (data not shown). Soil nitrate-N levels decreased rapidly within 2-3 weeks of fertilization and after heavy rainfall as observed in June-July 22 (8.2 inches) in 1993, and May 5-June 10 (5.3 inches) in 1994. The use of reduced N rates for fertilization of young trees was also suggested by Willis et al. (1990), due to relatively rapid uptake or losses (volatilization, denitrification, leaching) of soil nitrate-N within the root zone. It has been suggested that 27 to 51% of applied N is taken up by citrus seedlings within 7 days of application (Lea-Cox and Syvertsen, 1995) which accounts for a portion of the rapid decrease in nitrate-N within 2 weeks of application. Other factors that affect nitrate-N levels are volatilization, leaching and denitrification as indicated by the large pulses of nitrate-N in groundwater following fertilization of mature citrus (McNeal et al. 1994).

The hypothesis concerning effects of preplant leaf N concentrations on subsequent tree growth was not supported in Expt. 3 or 4 using a wide range of preplant N levels (1.4-4.6%). Citrus trees seem to adjust leaf N concentrations to relatively stable levels either by increasing uptake (Lea-Cox and Syvertsen, 1995) or by reallocating N reserves (Legaz et al., 1995). Data strongly suggest, at least in the soil types tested that fertilizer rates in Florida can be reduced as currently recommended (Tucker et al., 1995) to reduce nitrate-N. Moreover, nitrate-N levels decrease rapidly following fertilization and use of recommended rates of 0.24 to 0.37 lb N/tree/year for 2-year-old trees will not produce excessively high nitrate-N levels. Frequent applications of fertilizer combined with lower rates will further decrease nitrate-N in the soil (Willis et al., 1990).

Literature Cited

Calvert, D. V. 1969. Effects of the rate and frequency of fertilizer application on growth yield and quality factors of young citrus trees. Proc. Fla. State. Hort. Soc. 82:1-7.

Castle, W. S. and R. E. Rouse. 1990. Total mineral content of Florida citrus nursery plants. Proc. Fla. State Hort. Soc. 103:42-44.

Chapman, H. D. and G. F. Liebig. 1937. The effects of various nitrate concentrations on the growth and composition of sweet orange seedlings. Proc. Soil. Sci. Soc. Amer. 2:359-365.

Chapman, H. D. and G. F. Liebig. 1940. Nitrate concentration and ion balance in relation to citrus nutrition. Hilgardia. 13:141-173.

Guazzelli, L., F. S. Davies, J. J. Ferguson and W. S. Castle. 1995. Nitrogen nutrition and growth of Hamlin orange nursery trees on ‘Swingle’ citrumelo rootstock. HortTechnology 5:147-149.

Guazzelli, L., F. S. Davies and J. J. Ferguson. 1996. Fertilization rate and growth of ‘Hamlin’ orange trees related to preplant leaf nitrogen levels in the nursery. HortTechnology 6:383-387.

Lea-Cox, J. D. A. 1989. Macroelement nutrition of container-grown citrus nursery stock in pine bark substrates. MS thesis. Univ. of Natal, Pietermaritzburoz, South Africa.

Lea-Cox, J. and J. P. Syvertsen. 1995. Nitrogen uptake efficiency and leaching losses from lysimeter-grown citrus trees fertilized at three nitrogen rates. J. Amer. Soc. Hort. Sci. 121:57-62.

Legaz, F., M. D. Serna and E. Primo-Millo. 1995. Mobilization of the reserve N in citrus. Plant and Soil 173:205-210.

Marler, T. A. and F. S. Davies. 1990. Microsplinkler irrigation and growth of young ‘Hamlin’ orange trees. J. Amer. Soc. Hort. Sci. 115:45-51.

Marler, T. A., 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. 100:61-64.

Maust, B. E. and J. Oz. Williamson. 1991. Nitrogen rate effect on growth of containerized citrus nursery plants. Proc. Fla. State Hort. Soc. 104:191-195.

McNeal, B. L., C. D. Stanley, L. A. Espinosa and L. A. Schipper. 1994. Nitrogen management for vegetables and citrus some environmental considerations. Proc. Soil and Crop Sci. Soc. Fla. 53:45-51.

Obreza, T. A. and R. E. Rouse. 1993. Fertilizer effects on early growth and yield of ‘Hamlin’ orange trees. HortScience 28:111-114.

Rasmussen, G. K. and P. F. Smith. 1961. Evaluation of fertilizer practices for young orange trees. Proc. Fla. State Hort. Soc. 74:90-95.

Tucker, D. P. H., A. K. Alva, L. K. Jackson and T. A. Wheaton. 1995. Nutrition of Florida citrus trees. Univ. of Fla. Coop. Ext. Serv., Gainesville.

Willis, L. E., F. S. Davies and D. A. Graetz. 1990. Fertilization nitrogen leaching and growth of young ‘Hamlin’ orange trees on two rootstocks. Proc. Fla. State Hort. Soc. 103:30-37.

Wustcher, H. K. 1974. Rootstocks and mineral nutrition of citrus p. 97-113. In: L. K. Jackson, A. H. Krezdorn and J. Soule (eds.). Proc. 1st Intl. Citrus Short Course, 24-29 Sept. 1973. Univ. of Fla., Gainesville.

Wustcher, H. K. 1989. Alteration of fruit tree nutrition through rootstocks. HortScience 24:578-584.