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Research Note

Comparison of Three N Fertilizer Materials on Growth of Young Citrus Trees

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ABSTRACT

Calcium nitrate, ammonium sulfate and slow release encapsulated fertilizer (SREF, a sulfur-coated urea) were applied to navel orange trees (*Citrus sinensis* L. Osbeck) to determine relative growth effects during the first three years of orchard establishment. SREF resulted in larger trunk cross-sectional area and canopy volume than ammonium sulfate and calcium nitrate produced a final canopy volume that was superior to that of ammonium sulfate.

RESUMEN

Se aplicó nitrato de calcio, sulfato de amonio y fertilizante encapsulado de liberación lenta (SREF, urea cubierta de azufre) en árboles de naranjo ombligón [*Citrus sinesis* (L.) Osbeck] para determinar los efectos en el crecimiento relativo durante los primeros tres años del establecimiento de la huerta. La aplicación del SREF produjo áreas transversales del tronco y volúmenes de la canopia más grandes que el sulfato de amonio, mientras que el nitrato de calcio produjo un volumen de la canopia final que fué superior al producido por el sulfato de amonio.

The standard fertilizer recommendation for the establishment of young citrus trees in Texas is 57, 113 and 226 g (2, 4 and 8 ounces) of nitrogen per tree in years 1, 2 and 3, respectively (Sauls, 1991). The most common form of fertilizer used is ammonium sulfate, although other nitrogen sources are available and are used to a limited extent. Since the 1983 freeze in the Lower Rio Grande Valley, there has been an increase in the number of trees planted per acre (Texas Agr. Stat. Serv., 1989); however, there has been no fertilizer materials research reported in Texas for higher tree densities. This work was conducted to compare the efficacy of three N fertilizer materials at higher than recommended rates on high density navel orange orchards.

MATERIALS AND METHODS

Container-grown trees of N33E navel oranges on sour orange rootstock (*Citrus aurantium* L.) were planted in October, 1985, on Hidalgo sandy clay loam soil near Santa Rosa, Cameron County, Texas. Orchard spacing was 2.44 x 7.31 m, (8 x 24 feet), for a population of 560 trees per hectare (227 per acre). In February, 1986, nine adjacent rows of 30 trees each were selected for this study; there were three blocks of three randomized whole-row treatments with five subsamples (trees number 5, 10, 15, 20 and 25) in each row designated and marked for data collection.

Complete weed control was accomplished by a trunk-to-trunk herbicide program typical of Texas orchards. Irrigation was by flood, with permanent borders every three rows and semi-permanent borders in all other row middles. Irrigation was supplied six to 10 times annually, depending upon rainfall. Because the irrigation runs were short [75 m (250 feet)], water accumulated to an approximate depth of 10 to 15 cm (4.0 to 6.0 in.) down the entire row, and required 12 to 15 hours to soak into the soil following valve closure.

Treatments included ammonium sulfate (21-0-0), calcium nitrate (15.5-0-0) and SREF (sulfur coated urea, 30-0-0, O.M. Scott, Inc.) applied at 113,226 and 340 g (4, 8 and 12 ounces) of nitrogen per tree during 1986, 1987 and 1988, respectively. Applications in the first year were placed in a ring around the tree, approximately 45 cm (1.5 feet) from the trunk. Subsequent applications were tossed into the air above the canopy during dry, windy conditions to obtain a fairly uniform distribution on the soil after the fertilizer filtered down through the canopy. The two soluble materials were split into four equal applications annually during February, April, June and August; SREF was split into two equal annual applications in February and June. Flood irrigation was applied immediately following fertilization.

Trunk circumference was measured at 20 cm (8.0 inches) above ground, initially in February, 1986, and thereafter in April of the following three years. Tree height and in-row and cross-row diameters were measured each April beginning in 1987. Trunk cross-sectional area was calculated from a standard mensuration formula for the area of a circle ($0.07958C^2$) (Gaboury, 1949); canopy volume was calculated using the formula for oblate spheroids (0.5236 height x in-row diameter x cross-row diameter) (Turrell, 1946).

The data were subjected to one-way analysis of variance and means were separated by Duncan's multiple range analysis.

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RESULTS AND DISCUSSION

Trunk cross-sectional area in 1986 indicates that the trees were essentially equal in size at the start of this test (Table 1). However, differences between SREF and ammonium sulfate were apparent after one year of treatment, and this relationship was maintained throughout the succeeding two years. Canopy volume differences between SREF and ammonium sulfate were also apparent throughout (Table 1). The response to calcium nitrate was equal to the other fertilizers in all cases except that canopy volume at the end of the test was superior to that of ammonium sulfate.

Because trees receiving ammonium sulfate did not grow as rapidly as those receiving SREF (or calcium nitrate in final canopy volume) it is possible that ammonium sulfate may have suffered greater loss to leaching. Potential loss to volatilization should have been minimized by immediate irrigation. It is unlikely that nitrification could have delayed growth response over the term of this test. The relative solubility of calcium nitrate could result in greater loss to leaching than should occure with SREF, particularly when application was followed by irrigation.

Table 1. The effect of fertilizer material on cumulative growth of young navel orange trees, 1986-1989.

	Trunk cross-sectional area (cm^2)[z]			
Fertilizer	1986	1987	1988	1989
SREF	0.80[y] a	3.22 a	15.28 a	33.77 a
Calcium nitrate	0.76 a	2.98 ab	13.58 ab	28.30 ab
Ammonium sulfate	0.73 a	2.43 b	11.02 b	24.07 b
	Canopy volume (m^3)[z]			
Fertilizer	1986[x]	1987	1988	1989
SREF	—	0.41 a	1.81 a	4.37 a
Calcium nitrate	—	0.34 ab	1.78 ab	4.24 a
Ammonium sulfate	—	0.25 b	1.33 b	3.09 b

[z] 6.45 cm^2 = 1.0 in^2, 1.0 m^3 = 1.3 yd^3 = 35.3 ft^3.
[y] Mean separation within columns by Duncan's multiple range test, $p = 0.05$.
[x] Canopy volume was not measured in 1986 because of small tree size.

Because the growth response relationship among fertilizer treatments in the first year persisted throughout the course of this study, it is apparent that the initial year of establishment is more critical than the succeeding two years. That initially larger trees continue to be larger in size for several years after planting was also reported by Maxwell and Rouse (1980, 1984) in comparisons between container-grown and field-grown grapefruit trees. In their work, differences in trunk cross-sectional area were maintained for at least six years, whereas canopy volume differences persisted for at least 10 years.

Leaf annalyses in mid-1988 offer limited insight into possible reasons for observed growth differences (Table 2). Leaf N reflects the same relationship as growth responses to the fertilizer materials, but leaf N was not limiting in any case. Leaf Mg under ammonium sulfate was low by Florida standards (Koo, 1984) which are the standards used by the Texas A&M University System (Sauls and Pennington, 1988).

Table 2. Leaf nutrient content of 3-year-old navel orange trees under three fertilizer treatments[z].

	% Dry Weight					ppm				
Treatment	N	P	K	Ca	Mg	Zn	Fe	Mn	Cu	Na
SREF	2.82	0.13	1.81	3.78	0.32	23	196	36	4.7	367
Calcium nitrate	2.67	0.14	1.78	4.20	0.32	12	120	35	5.0	366
Ammonium sulfate	2.50	0.13	1.73	4.16	0.26	14	165	35	4.8	447

[z] Analysis was conducted on a composite 75-leaf sample (five spring-flush leaves per sub-sample) from each treatment, collected in August, 1988.

Mild foliar symtoms of zinc deficiency were observed in trees under both soluble fertilizers in the summer of 1988, but symptoms were absent under SREF. Leaf analyses confirmed the visual symptomology of zinc deficiency (Table 2). Composite soil analyses for each treatment taken to the 15-cm (6-in) depth directly beneath the canopy were essentially identical except for soil reaction: pH in the SREF treatment was near neutral (7.3) as compared to 7.7 and 7.8 in the ammonium sulfate and calcium nitrate treatments, respectively. According to the orchard manager, soil pH in this orchard traditionally runs 7.6 to 7.8. Obviously, SREF fertilizer induced greater soil acidification in the limited area beneath the tree by virtue of its elemental sulfur coating, as free sulfur applied over three years would have a greater effect than the oxidized sulfate form of ammonium sulfate.

Because young trees are normally fertilized several times during the season, the use of slow release fertilizers less frequently should result in sufficient savings in application costs to partly offset the relatively higher cost of such fertilizers, irrespective of any positive benefits on growth.

Similar work in Florida (Obreza, 1990) revealed little difference among N sources or rates after one year's use on young 'Hamlin' oranges. However, substantial growth on non-fertilized control trees suggested ample supplies of residual N from prior cropping. Zekri and Koo (1991a, 1991b), however, reported better growth in young 'Valencia' orange trees from slow release N and K sources than from soluble fertilizers. High N rates in a fertigation study (Ferguson et al., 1990) failed to produce growth differences in 'Sunburst' tangerine. The N rate used in the current work was exclusive, so no comparison to the standard N rate is possible. Swietlek (1992) reported that growth of 'Ray Ruby' grapefruit trees was unaffected by N treatment in a four-year study. However, the highest N rate used by Swietlek was only 70% of the standard recommendation and resulted in barely optimal foliar N levels after 14 months, with lower rates resulting in below optimal foliar N levels at that time.

The experimental plots produced some fruit in 1988, but there were no statistical differences between treatments (data not shown). Production averaged 3.9, 2.8 and 2.1 kg (8.6, 6.1 and 4.7 lbs.) per tree for SREF, calcium nitrate and ammonium sulfate, respectively. The parallels between production, leaf N and growth response to the different fertilizer materials indicate the need to further evaluate citricultural practices during the critical years of orchard establishment. Additional research is planned to further explore the response of young citrus trees to higher rates of different N fertilizer materials under Texas conditions.

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