

**1997 ANNUAL REPORT  
YEAR TWO OF FIVE YEAR PROJECT**

**SLOW RELEASE NITROGEN FOR FOLIAR FEEDING  
OF BEARING CITRUS TREES**

by

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## DESCRIPTION OF THE PROBLEM

Foliar applied urea has been used successfully as a source of fertilizer nitrogen (N) in many crops. Interest in foliar feeding of urea in citrus production originated over 20 years ago in California. The application of N to leaves was beneficial since high rates of ground application of N fertilizer appeared to contribute to salinity problems (Embleton et al., 1986) and to pollute groundwater with nitrate (Pratt et al., 1972; Embleton and Jones, 1978; Embleton et al., 1980; Dasberg et al., 1984).

There may be other advantages of foliar urea application, such as increased floral intensity and fruit set (Lovatt, 1990). This was apparently due to manipulation of  $\text{NH}_3\text{-NH}_4^+$  in leaves and buds which, in turn, may be an important factor affecting flowering and fruit set in citrus. Low biuret urea (containing 1.87 lb N/gal) was sprayed on citrus leaves as a single application at 15 gal/acre; i.e., equivalent to 28 lb N/acre (Citrograph, 1991; Richardson, 1993). The maximum benefit in terms of increased fruit yield (452 cartons/acre) and net return (\$1372/acre) was achieved when the foliar urea was applied in January (Ali and Lovatt, unpublished). One potential problem with foliar applied N materials is volatile losses to the air. There have been studies attempting to quantify volatilization losses from N fertilizers (Kissel and Cabrera, 1988) but not from citrus leaves.

## FLORIDA CITRUS RESEARCH ON FOLIAR N FEEDING

Biuret can be a contaminant in urea, and foliar application of urea containing biuret has resulted in biuret toxicity in citrus (Oberbacher, 1954). Spraying young flush of 2-year-old Pineapple orange trees with 1% urea solution containing only 0.01% biuret resulted in biuret toxicity and leaf loss. However, biuret toxicity is not necessarily a concern at present because urea filtration technology can produce urea with biuret concentration less than 500 ppb. Not all spray grade formulations of urea are equal however.

Leonard et al. (1961) observed evidence of biuret toxicity on trees sprayed with urea during the initial years. Subsequently, they used urea containing less than 0.25% biuret which overcame the biuret toxicity problems. They also made some general remarks about the potential problems in foliar feeding of N for citrus based on unpublished earlier research (Leonard et al., 1961). Repeated applications of urea sprays for a period of 8 weeks were required for urea to "green up" leaves. Therefore, they concluded that foliar application of urea was not an effective approach to supply the N requirement of citrus trees. They thought absorption of urea by leaves was insignificant and urea uptake only occurred through the roots when the foliar applied urea was washed off to the soil.

Recent studies have directed an interest in evaluation of urea to penetration into citrus leaves without causing phytotoxicity. Using mature grapefruit leaves dipped into labelled urea, the results have shown that 24% of applied urea was recovered from within leaves after 1 hr and 57% after 48 hr (Lea-Cox, 1993; Lea-Cox and Syvertsen, 1994). Thus, urea can readily penetrate citrus leaves but we have yet to develop maximum safe application rates and frequencies.

#### RECENT ADVANCES IN FOLIAR N FORMULATIONS

Interest in foliar fertilization increased with the introduction of liquid slow release nitrogen (SRN) products, i.e., methylol and methylene urea in the mid-1980s. These products have the same agronomic characteristics as the slow release granular products such as urea formaldehyde and IBDU granular fertilizer blends. The liquid formulations for foliar application also have the convenience of application, since they can be applied along with other pesticides required routinely.

In this study, a liquid SRN solution containing predominantly methylene urea (developed by Growth Products Company) will be evaluated for bearing citrus trees on vulnerable soils. Field evaluations of this product over a number of years, on several crops other than citrus, have shown that it is a safe, reliable product which is stable over a long shelf life. It has low biuret content, thus can be safely used for citrus, which is highly sensitive to biuret toxicity. We also used liquid

formulation for foliar application of N, P, and K. P and K are derived from mono-ammonium phosphate and potassium nitrate, respectively. The role of foliar application of P and/or K, as compared to ground application, for citrus trees has not been understood.

### OBJECTIVES

The objectives of this study are: (i) to evaluate the tree growth, leaf nutritional composition, and fruit yield and fruit quality under foliar application of N, P, and K vs. either total soil applications or 50/50 soil/foliar application and (ii) to evaluate the role of SRN for foliar application of bearing citrus trees.

This is a long-term study expected to continue for 5 to 10 years.

### MATERIALS AND METHODS

This field experiment began in Spring 1996 using 10-year-old Hamlin orange trees on either rough lemon, sour orange, or Carrizo citrange rootstock. The soil type is Candler fine sand which is a typical deep sandy soil along the ridge classified as vulnerable soil for soil applied agrichemicals. The trees were planted in paired rows at 25 ft apart with 50 ft middle between the pair of rows. Spacing between the trees within the row is 12 ft. Plot size is 12 trees with two rows of six trees each. Each row of six trees represents two trees each of rough lemon, sour orange, and Carrizo citrange rootstock.

Prior to this experiment, the grove was on a uniform fertility program at a moderate N rate, i.e., 120 lb N/acre/year dry granular broadcast, applied uniformly across the entire block. The irrigation system was overhead sprinkler, but changed in early 1996 to under-the-tree sprinkler system to represent the current industry practice. The following treatments are included for the study:

1. Soil application only: Dry granular broadcast (four equal doses/year) with a target N rate of 120 lb N/acre/year, using 13-5-16-1.3 Mg, derived from ammonium nitrate, triple super phosphate, and muriate of potash.
2. Total foliar application: Using 10-10-10 liquid fertilizer containing 40% SRN, derived from urea (4.5% N), methylene urea (4% N), nitrate N (1%), ammoniacal N (0.5%), phosphoric acid, and potassium nitrate. Five sprays were needed per year to deliver the annual dose of N, P, and K.
3. Combination of soil (50% NPK) and foliar (50% NPK) application. This was achieved by application of 1/2 dose of dry granular products used in treatment 1 and 1/2 dose of liquid product, used in treatment 2, applied as foliar spray.
4. Foliar application of N, and soil application of P and K. Nitro-30 [30-0-0; derived from polymethylene urea (19.5% N), polymethylol urea (5.7% N), and low biuret urea (4.8% N); 85% SRN] were applied in five equal doses as foliar applications to target 120 lb N/acre/year. P and K were applied to the soil as triple super phosphate and polymer coated sulfate of potash in single application per year.

All foliar applications were done using a commercial speed sprayer calibrated to apply 160 gal/acre.

#### PARAMETERS TO BE MEASURED

1. Five-month-old spring and summer flush leaves were sampled once a year to measure the concentrations of macro- and micro-elements to evaluate the nutritional status of the trees.
2. Fruit size and juice quality measurements.
3. Fruit yield.

### POTENTIAL BENEFITS

1. This study will evaluate the efficacy of foliar application of N, P, and K for citrus as compared to the soil application.
2. Increased efficacy of nutrient uptake of foliar applied nutrients may decrease the quantity of nutrients required, thus could offset the increased cost of foliar nutrition materials.

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Table 1. Concentration of mineral elements in 6-month-old spring flush leaves of Hamlin orange trees under total soil, total foliar, 50/50 soil/foliar, and slow release N only as foliar (ground application of P and K) fertilization programs, 1997.

Treatments	Concentration in 6-month-old spring flush leaves										
	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu	Al
	-----% on DW basis -----						----- mg/kg on DW basis-----				
1. Total N, P, and K soil	2.95	0.13	1.52	3.01	0.26	0.07	54	21	19	25	101
2. Total N, P, and K foliar	2.58	0.15	2.62	2.78	0.12	0.08	44	21	18	21	91
3. 50/50 of treatment 1/2	2.90	0.13	1.66	3.34	0.25	0.06	49	16	22	24	115
4. SRN foliar soil P and K application	2.67	0.18	2.81	2.51	0.17	0.07	50	13	17	22	90

Table 2. Fruit production and juice quality of Hamlin orange trees under total soil, total foliar, 50/50 soil/foliar, and slow release N foliar + soil P and K fertilization programs, 1997.

Treatments	Fruit		Percent juice (%)	Acid	Brix	Brix/Acid ratio	lb solid per box
	yield lb/tree	weight g/fruit					
1. Total N, P, and K soil	458	160	56.46	0.66	10.81	16.61	6.09
2. Total N, P, and K foliar	390	190	52.44	0.57	9.63	17.04	5.06
3. 50/50 of treatment 1/2	399	162	56.09	0.62	10.46	17.06	5.86
4. SRN foliar soil P and K application	392	198	53.52	0.66	10.36	15.71	5.56

1 box = 90 lb

Table 3. Chlorophyll meter (SPAD) reading of leaves of the Hamlin orange trees under total soil, total foliar, 50/50 soil/foliar, and slow release N foliar + soil P and K fertilization programs, 1997.

Treatments	Chlorophyll meter readings <sup>†</sup>
1. Total N, P, and K soil	76.2
2. Total N, P, and K foliar	63.0
3. 50/50 of treatment 1/2	73.0
4. SRN foliar soil P and K application	60.5

<sup>†</sup>The greater the value the greater the intensity of leaf green color.

TRACTS (Block 5 Experiment): Foliar Nutritional Spray - March 1996.

PLOT SIZE = 12 trees (spacing): 5 replicates - 60 trees/plot).

N rate is 120 lb N/Ac/year for all treatments 1 to 6.

YEAR II: 1997

Treat No.	Description	DRY Soil application	P & K CORRECTIONS	MAIN Treatments Soil / FOLIAR
1	Complete soil application of N, P, K $\frac{3.25}{13-5-16-3.25}$ Mg $\frac{0.0415}{}$	ALL N, P, K soil - Apply uniform under the canopy	Soil applied 120 lb N 46 lb P <sub>2</sub> O <sub>5</sub> 148 lb K <sub>2</sub> O per Ac/yr <b>NONE</b>	1.6 lbs of VIGORO MIX 13-5-16-3.25- per tree/application 4 appl/yr. with Ammonium $\frac{0.0415}{}$ Dates of appl:
2	Foliar N, P, K No soil appl. 10-10-10 with 40% SRN as MU.	ALL N, P, K FOLIAR	120 lb N 117 lb P <sub>2</sub> O <sub>5</sub> 117 K <sub>2</sub> O 0.5 lb MOP (60% K <sub>2</sub> O)/tree/year.	Five applications/yr at the rate of <u>22 gal/Ac/application</u> : List dates of appl:
3	50% N as Soil (as in treat 1) 50% Foliar (as in treat 2)	1/2 of total N as Foliar + 1/2 N, full P and K SOIL	<b>NONE</b>	Five applications/year at the rate of <u>11 gal/Ac/application</u> : List dates of appl: Four appl/year of dry blend to soil: List date of appl:
4	ALL N Foliar as UNOCAL PLUS (P & K soil appl.)	ALL N FOLIAR Soil P & K	0.7 lb TSP (46% P <sub>2</sub> O <sub>5</sub> )/tree/year. 1.7 lb MOP (60% K <sub>2</sub> O)/tree/year.	Five applications/year at the rate of <u>13 gal/Ac/application</u> . Dates of Appl:
5	ALL N Foliar as DYNARONE (P & K soil appl.)	ALL N FOLIAR Soil P & K	0.7 lb TSP (46% P <sub>2</sub> O <sub>5</sub> )/tree/year 1.7 lb MOP (60% K <sub>2</sub> O)/tree/year.	Five applications/year at the rate of <u>8 gal/Ac/application</u> . Dates of appl:
6	ALL N Foliar as NITRO-30 with SRN as MU. (P & K Soil appl.)	ALL N FOLIAR Soil P & K	0.7 lb TSP (46% P <sub>2</sub> O <sub>5</sub> )/tree/year 1.7 lb MOP (60% K <sub>2</sub> O)/tree/year.	Five applications/year at the rate of <u>8 gal/Ac/application</u> . Dates of appl:

TSP = Tripple Super phosphate.  
MOP = Murriate of Potash or use Slow release Potash (4-

Sampling numbers are in increment of 8 samples per plot.

EXP: **T5B5-96**

Block-5 (Tract 5)

Samples 1 to 4: No cu row (North)

depth 0-6,  
6-12  
12-18  
18-24 inch.

5 to 8: plus cu row (S)

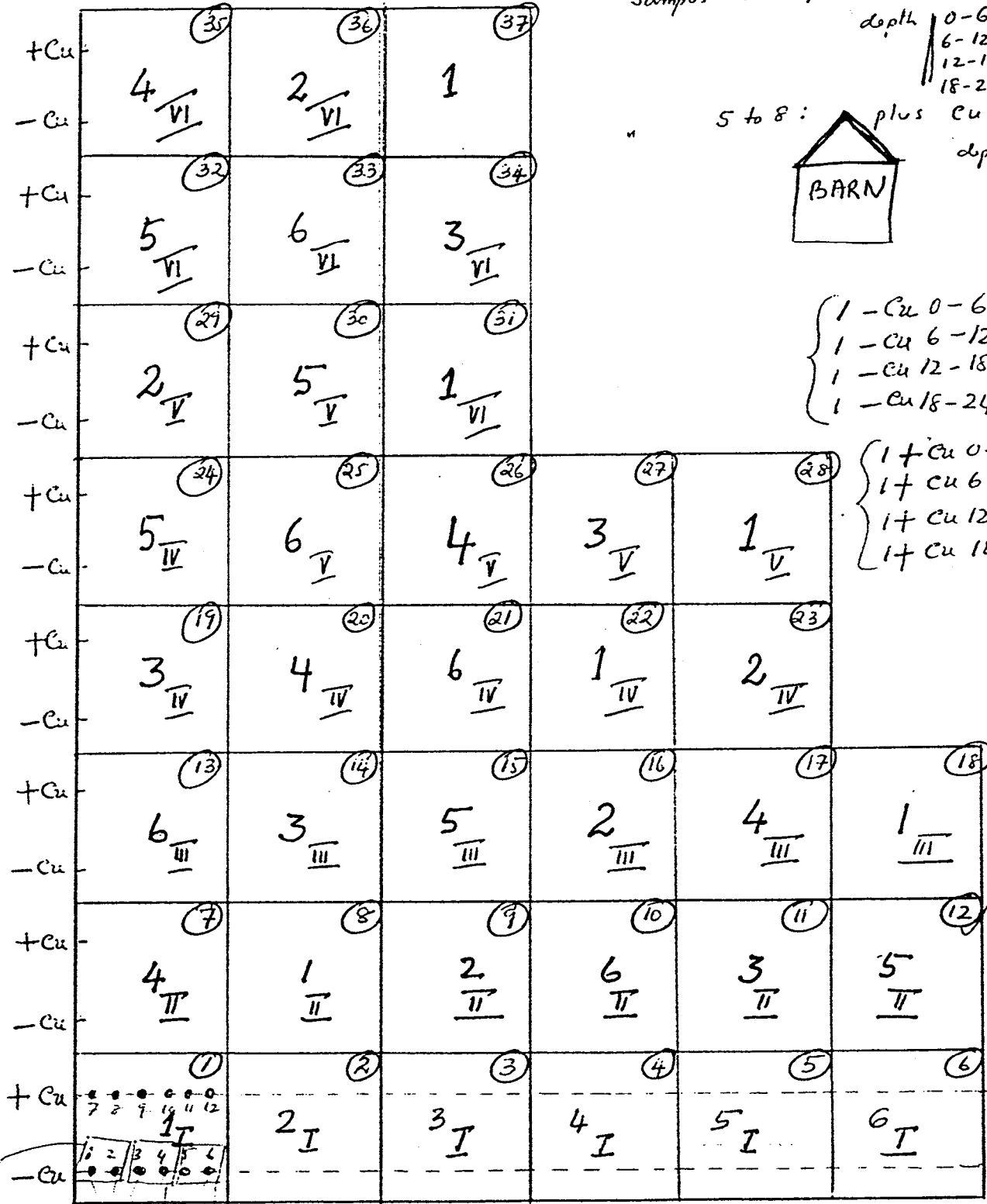


depth 0-6  
6-12  
12-18  
18-24

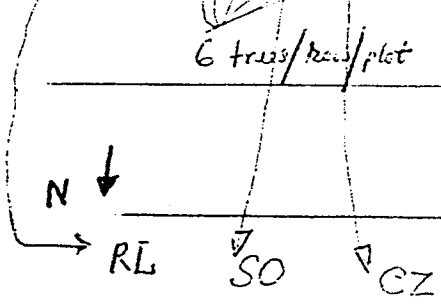
- 1 - Cu 0-6
- 1 - Cu 6-12
- 1 - Cu 12-18
- 1 - Cu 18-24

- 1 + Cu 0-6
- 1 + Cu 6-12
- 1 + Cu 12-18
- 1 + Cu 18-24

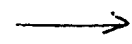
BLOCK-5 old (closed) trees



PLOT A



ROAD



Concentrations of mineral elements in 6 month old spring flush of Hamlin orange trees which received various foliar fertilizer programs. Leaf samples taken August 26, 1996. Year 1 of 5 years (Mean of 6 replications).

Concentrations in leaves

Treatment	C	N	P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu	Al
	% dry weight basis											
	mg Kg <sup>-1</sup>											
1. N,P,K- Soil	43.72	3.25	0.17	2.06	3.23	0.34	0.15	83	25	24	68	127
2. N,P,K-Foliar	43.67	2.94	0.17	2.19	3.02	0.27	0.16	67	18	24	67	154
3. 50/50 tr.1&2	43.83	3.39	0.18	2.16	2.69	0.34	0.12	63	24	21	50	100
4. Foliar N-Unocal	43.86	2.96	0.17	2.12	2.95	0.25	0.15	71	16	20	71	121
5. Foliar N-Dynazone	44.14	2.93	0.17	2.18	2.67	0.26	0.18	73	31	23	67	131
6. Foliar N-Nitro 30	44.07	2.87	0.17	2.23	2.63	0.29	0.15	78	25	19	59	115

File: a:/1996/data-out/MEAN96T5.dat  
 Disk: TRACT 5 Foliar N Disk #1