Amounts of Nutrients Removed by 'Valencia' Orange Fruit in a California Grove[1]

C. K. Labanauskas and M. F. Handy[2]
University of California, Riverside

Abstract. **Major nutrients removed by 'Valencia' orange fruit were N, K, Ca, P, and Mg. Amounts of N, Ca, and B were higher; Zn and Mn were lower than those reported for Florida oranges. Relatively small amounts of applied nutrients were found to be removed by the fruit. P, K, Ca, Mg, Zn, Mn, Cu, and Fe tended to be immobilized in the soil (either by direct application or decay of leaves and other plant parts), availability depending on soil pH. Leaching of N, largely as NO_3, should always be minimized.**

An important factor in efficient citrus production is maintenance of an adequate nutrient balance in the plant; serious problems occurring when any of the plant's essential nutrients become deficient. Leaf chlorosis, premature defoliation, fruit drop, twig die-back, any or all of which may result in subsequent reductions in both fruit yield and quality, may be due to nutrient deficiencies. Consequently, many citrus growers tend to maintain their groves under fairly high fertility programs (2, 7, 9).

Many papers have been published concerning nutritional requirements of a producing citrus grove (3, 6, 7, 8, 10). Leaf tissue analysis has gained wide acceptance in determining a grove's nutritional status (2). A few of these papers show the amounts of nutrients removed by citrus fruit from a grove (1, 11), but the results presented are averages of many cultivars and different locations. They show that K, Ca, N, and P are elements removed in greatest quantity from the soil by citrus fruit (11). Reitz (9), in Florida, showed that a highly productive orange grove may remove annually as much as 65.8 kg (145 lb.) of K, 36.3 kg (80 lb.) of N, 15.9 kg (35 lb.) of Ca, 7.7 kg (17 lb.) of Mg, and 10.4 kg (23 lb.) of P per 500 field boxes each of 40.8 kg (90 lb.).

No published information is available showing the amounts of nutrients removed by 'Valencia' orange fruit from California groves. Such data may provide significant guidance in nutrient management for citrus growers everywhere. An indiscriminate or oversupply of fertilizers may be thought to be of benefit to the plant, but at a risk of soil and water pollution.

A 20-year-old 'Valencia' orange grove, half on sweet orange and half on rough lemon rootstocks, was used. The experimental design has been previously described in detail and results have been published elsewhere (4, 5).

In June, 1960 – 1970, 100 random fruits per tree were measured for size. Eight outside fruits per tree from 4 trees were picked – 2 fruits from each quadrant – using a sizing ring to provide an annually representative size common to all trees under the experiment's 8 differential treatments (5). Fruits from each of the 4 trees in each plot were composited to make one sample of 32 fruit. The experiment encompassed 64 four-tree plots over a 3 year period. The primary objective in this experiment was the evaluation of effects of factorial foliar applications of Mn, Zn, and urea on yield and fruit quality of 'Valencia' oranges, and on nutrient concn in the leaves, peel, and juice (4, 5). Since all of the physical and chemical measurements of the fruit were at hand, quantitative determination could be made of nutrients removed by the fruit from the soil. These data are presented in Tables 1 and 2. Under the specified field conditions representing 1 location in Ventura County, California, N, K, Ca, P, and Mg, respectively, are the elements shown to be removed in greatest quantity by 'Valencia' fruit from an orchard soil; very small amounts of nicronutrients were removed. The concn of nutrients in the fruit from this area, however, are similar to macro- and micro-nutrients found in the peel and juice of fruit harvested from many other citrus-producing areas in California. Based on fresh wt of fruit, comparison of these values with those obtained in Florida (10) show that higher amount of N, Ca, and B, and lower amounts of Zn and Mn were removed by fruit in California. The amounts of P, K, Mg, Cu, and Fe were about the same in California as those reported in Florida (11).

These data (Table 2) and others (1) show that relatively small amounts of the nutrients applied to the soil are removed by fruit. Naturally, the larger amounts of these nutrients are tied up in the soil. Mineral nutrients tied up in plant parts, particularly those in the leaf

Table 1. Effects of rootstock on annual yield and physical measurements of 'Valencia' oranges.

Components	Rootstocks[z] Sweet orange	Rough lemon	Mean for[y] both rootstocks
Wt of oranges/tree[x] (kg)	98.4	96.0	97.2
No. of fruit/tree	647.0	649.0	648.0
Wt/fruit (g)	152.0	148.0	150.0
Equatorial diam (cm)	6.4	6.3	6.4
Juice per fruit (ml)	85.0	77.0	81.0
Dry wt of peel/fruit (g)	17.0	18.0	17.5

[z]Each value is a mean of 96 individual measurements.
[y]Each value is a mean of 192 individual measurements for 3 years, 1960, 1961, 1962.
[x]Field box of oranges weighs 24 kg.

Table 2. Nutrients removed by 'Valencia' orange fruit

Rootstock	Nutrient removed N	P	K	Ca	Mg	Zn	Mn	Cu	B	Fe
						mg/fruit				
Sweet orange[z]	268	27	286	114	25	0.19	0.10	0.08	1.10	0.38
Rough lemon[z]	287	24	251	120	25	0.20	0.10	0.09	1.11	0.41
Avg[y]	277	25	268	117	25	0.19	0.10	0.08	1.10	0.39
						kg/metric ton fresh fruit				
Sweet orange[z]	1.76	0.18	1.88	0.75	0.16	0.0013	0.0007	0.0005	0.0072	0.0025
Rough lemon[z]	1.94	0.16	1.70	0.81	0.17	0.0013	0.0007	0.0006	0.0074	0.0028
Avg[y]	1.85	0.17	1.79	0.78	0.17	0.0013	0.0007	0.0005	0.0073	0.0026
						kg/ha				
Avg (both rootstocks)[y]	44.34	4.00	42.90	18.72	4.00	0.030	0.016	0.005	0.176	0.062

[z]Each value based on 96 determinations.
[y]Each value based on 192 determinations for 1960, 1961, 1972; 250 trees/ha.

[1]Received for publication June 12, 1972.
[2]Professor of Horticultural Sciences and Research Associate, respectively. Department of Plant Sciences, College of Biological and Agricultural Sciences.

tissue, are eventually returned to the soil. For the most part P, K, Ca, Mg, Zn, Mn, Cu, and Fe will be adsorbed by the soil particles and not easily lost from the soil. Conversely, these elements may not always be readily available to the plant. Availability of most of these cations to a plant is highly dependent upon soil hydrogen ion concn. Nitrogen compounds, being water soluble, move readily in the soil and are quite easily leached out, generally in the form of NO_3, although in some instances leaching losses of NH_4 had been reported. Thus, the soil must be replenished regularly for normal plant growth and development, but to what extent is still being questioned and new evaluations are being made constantly. It is imperative that only adequate amounts of nutrients be applied as needed (8), since larger amounts may pollute the soil and, subsequently, the underground water, widely used for human consumption.

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Antitranspirants for Conservation of Leaf Water Potential of Transplanted Citrus Trees[1]

D. C. Davenport, P. E. Martin, and R. M. Hagan[2]
University of California, Davis

Abstract. **Spraying 7-year-old citrus trees with film-forming antitranspirants before transplanting increased leaf water potential, thereby reducing "transplant shock." Leaf water potential decreased rapidly after transplanting, by as much as 21 atm in unsprayed, and as little as 6 atm in sprayed trees. There was little benefit from transplanting in late afternoon rather than the morning.**

"Transplant shock" occurs when water loss from leaves exceeds uptake through a damaged root system. Plant survival should increase if transpiration is reduced by antitranspirant application to the foliage before transplanting. Gale and Hagan (4) reviewed literature on the use of antitranspirants in transplantation. Most reported experiments deal with transplanted seedlings of perennials, such as pines for reforestation (2, 5), or annuals such as commercially transplanted vegetables (3). We have shown that an antitranspirant significantly increased plant water potential of fruit trees (1). This paper reports the effects of film-forming antitranspirants on leaf water potential (ψL) of 7-year-old transplanted navel orange trees (*Citrus sinesis* Osbeck), just before and after transplanting.

Trees were originally close planted 3.4 x 6.7 m to maximize yield early. After 7 years, however, the grower decided to transplant every other tree and thereby produce an "instant orchard." The trees were first topped by about 20% to reduce transpiration and the risk of being blown over. Vermier Tree Diggers were used to dig a conical earth ball (about 1.2 m diam at the top and 1 m deep) around the base of the tree. This involved cutting through as many as 15 major roots and numerous minor roots (Fig. 1). The uprooted tree was transplanted into a conical hole half filled with water. A basin was then built around the tree and filled with water. Thereafter, soil moisture was provided by drip irrigation.

Leaf water potential was measured with a pressure chamber (6), and treatment comparisons were made only between leaves of similar age and exposure. One day before transplanting, the antitranspirants were sprayed with a mist blower (6-8 liters of diluted material per tree), ensuring that the lower (stomata-bearing) surfaces of the leaves were covered by the spray.

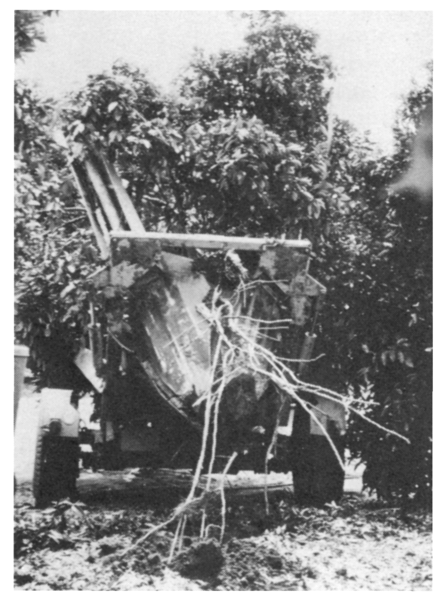

Fig. 1. Tree digger lifting a 7-year-old citrus tree. All the roots hanging outside of the shovels will be cut off before planting.

Effects of antitranspirants. One of 3 different film-forming antitranspirants (designated by code numbers D1, D5, and D6)[3] was sprayed on 4 replicate

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[2]Assistant Research Water Scientist, Research Associate, and Professor of Water Science, respectively, Department of Water Science and Engineering.

[3]D1: Vapor Gard (1:40, v/v) - a polyterpene mfg. by Miller Fertilizer & Chemical Co., Hanover, Pa.
D5: Mobileaf (1:6, v/v) - a wax emulsion mfg. by Mobil Chemical Co., Richmond, Va.
D6: CS-6432 (2%, ai) - a wax-latex emulsion mfg. by Chevron Chemical Co., Richmond, Ca.
Note: Optimum antitranspirant products and concn for citrus transplants have not been established, nor is it the intent of this paper to make product or concn recommendations.