Nutrient removal by Valencia orange fruit from citrus orchards in California

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These data show that relatively small amounts of nutrients applied to the soil are removed by citrus fruit. The larger amounts of these nutrients tied up in plant parts, particularly those in the leaf tissue, are eventually returned to the soil. For the most part, phosphorus, calcium, magnesium, zinc, manganese, copper, and iron will be adsorbed by the soil particles and are not easily displaced 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 concentration. Nitrogen compounds, being water soluble, move readily in the soil and are quite easily leached out, usually in the form of nitrates, although in some instances leaching losses of ammonium have been reported. It is imperative that nutrients be applied only as needed, since larger applications may be considered as "soil-polluting," and may find their way into underground water supplies used for human consumption.

AN IMPORTANT FACTOR in efficient citrus production is the maintenance of an adequate nutrient balance in the plant. Leaf chlorosis, premature defoliation, fruit drop, and twig die-back may be due to nutrient deficiencies. These physical abnormalities, any or all of which may result from nutrient deficiencies in the plant, may contribute to a subsequent reduction in both fruit yield and quality. Citrus growers, as a preventative measure, tend to maintain their groves under fertility programs which are excessive.

Many papers have been published concerning nutritional requirements of producing citrus trees, and from this work leaf tissue analysis has gained wide acceptance in determining an orchard's nutritional status. Several papers show the amounts of nutrients removed from an orchard by citrus fruit, but the results presented are averages of many cultivars and different locations. They show that potassium, calcium, nitrogen, and phosphorus are elements removed in greatest quantity from the soil by citrus fruit. A highly productive orange grove in Florida may annually remove as much as 28.6 kg (60.2 lb) of potassium, 36.3 kg (80 lb) of nitrogen, 11.4 kg (25.0 lb) of calcium, 4.6 kg (10.3 lb) of magnesium, and 2.3 kg (5.0 lb) of phosphorus per metric ton.

No published information is available showing the amounts of nutrients removed from California orchards by Valencia orange fruit. Such data have a significant potential for guidance in nutrient management of citrus groves everywhere. Indiscriminate use (or oversupply) of fertilizers may be thought to be of benefit to the plant, but it involves the risk of soil and water pollution.

An experiment was established in Ventura County on a 20-year-old Valencia orange orchard, half on sweet orange and half on rough lemon rootstocks, using 64 four-tree plots per year during a three-year period. In June, 1960, 1961, and 1962, 100 random fruits per tree were measured for size. Eight outside fruits per tree from four trees per plot were picked—two fruits from each quadrant—using a sizing ring to provide an annually representative size common to all trees in the eight differential treatment experiment. Fruits from each of the four trees in each plot were composited to make a sample of 32 fruit. The primary objective in this experiment was the evaluation of effects of factorial foliar applications of manganese, zinc, and urea on yield and fruit quality of Valencia oranges—and on nutrient concentrations in the leaves, peel, and juice. The physical and chemical measurements of the fruit were used to quantitate the nutrients removed by the fruit from the soil. These data are presented in tables 1 and 2.

Under the specified field conditions at this location, nitrogen, potassium, calcium, phosphorus, and magnesium, were the elements removed in greatest quantity (in that order) from the soil by Valencia fruit Only small amounts of mi-

TABLE 1. EFFECTS OF ROOTSTOCK ON ANNUAL YIELD AND PHYSICAL MEASUREMENTS OF VALENCIA ORANGES

	Rootstocks*		
Components	Sweet orange	Rough lemon	Mean for† both rootstocks
Wt of oranges/tree‡ (kg)	98.4	96.0	97.2
Number of fruit/tree	647.0	649.0	648.0
Weight/fruit (g)	152.0	148.0	150.0
Equatorial diameter (cm)	6.4	6.3	6.4
Juice per fruit (ml)	85.0	77.0	81.0
Dry weight of peel/fruit (g)	17.0	18.0	17.5

* Each value is a mean of 96 individual measurements.
† Each value is a mean of 192 individual measurements for 3 years, 1960, 1961, 1962.
‡ Field box of oranges weighs 24 kg.

TABLE 2. NUTRIENTS REMOVED BY VALENCIA ORANGE FRUIT

	Nutrient removed									
Rootstock	N	P	K	Ca	Mg	Zn	Mn	Cu	B	Fe
	Mg/fruit‡									
Sweet orange*	268	27	286	114	25	0.19	0.10	0.08	1.10	0.39
Rough lemon*	287	24	251	120	25	0.20	0.10	0.09	1.11	0.41
Avg†	277	25	268	117	25	0.19	0.10	0.08	1.10	0.39
	Kg/metric ton fresh fruit‡									
Sweet orange*	1.76	0.18	1.88	0.75	0.16	0.0013	0.0007	0.0005	0.0072	0.0025
Rough lemon*	1.94	0.16	1.70	0.81	0.17	0.0013	0.0007	0.0006	0.0074	0.0028
Avg†	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†)		4.00	42.90	18.72	4.00	0.030	0.016	0.005	0.176	0.062

* Each value based on 96 determinations.
† Each value based on 192 determinations for 1960, 1961, 1962; 250 trees/ha.
‡ Conversion factors, metric to avoir.: mg to oz = 3.53×10^{-5}; kg/metric ton to lb/ton = 2.0; kg/ha to lb/acre = 0.89.

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cronutrients were removed. The concentrations of nutrients in the fruit from this area were about the same magnitude as macro- and micro-nutrients found in the peel and juice of fruit harvested from many other citrus-producing areas in California. Based on fresh weight of fruit, comparison of these values with those obtained in Florida show that higher amounts of nitrogen, calcium, and boron, and lower amounts of zinc and manganese were removed by fruit in California. The amounts of phosphorus, potassium, magnesium, copper, and iron were about the same in California as those reported in Florida.

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Control of PYTHIUM ROOT ROT IN CARNATIONS

TABLE 1. CONTROL OF PYTHIUM VEXANS ON CARNATION PLANTS AS MEASURED BY PLANT GROWTH

Treatment	Rate of Active concentration	Equivalent concentration	Tops		Roots
			Net wt	Dry wt	Dry wt
			gr	gr	gr
Infested mix	PPM	per cu yd†	45	6.7	1.00
Infested mix + ethazol	50	4⅓ oz*	64	8.6	.91
Infested + diazoben	25	1⅞ oz‡	64.5	9.1	1.55
Infested mix + diazoben + PCNB	25 + 25	1⅞ oz ⅞ oz	72.5	10.8	1.71
Non-infested mix			68	9.8	1.26

* 30% material.
† Based on weight of moist planting mix at 60 lb/cu ft.
‡ 35% material.

TABLE 2. EFFECT AND CONTROL OF PYTHIUM VEXANS ON CARNATION PLANTS

Treatment	Rate of concentration	Equivalent concentration	Tops		Roots	
			Height	Dry wt	Dry wt	Net wt
			inches	gr	gr	gr
Infested mix			46.1	27.33	5.96	.76
Infested mix + diazoben weekly	100 ppm	4 oz/100 gal	61.5	63.53	10.16	.74
Infested mix + ethazol	50 ppm	4⅓ oz/cu yd	53.6	51.55	9.92	.79
Infested mix + propylene oxide			58.7	60.17	12.21	.88
Non-infested mix			60.1	61.26	12.49	.95

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These tests showed that when Pythium vexans (isolated from carnation roots) was introduced into soil mixes, it reduced the top growth and yield of Red Sim carnations. No other symptoms were visible on the plants. Control measures using ethazol as a preplant at 50 ppm, diazoben as a preplant at 25 ppm, or diazoben as a drench at 100 ppm at weekly or biweekly intervals also gave control. The ethazol preplant and diazoben drenches at weekly or biweekly intervals may be slightly toxic. Additional experiments on control are in progress.

THE WATER MOLD FUNGI (*Pythium* and *Phytophthora* sp.) are known to attack many plants and cause damage ranging from slight injury to death of the plants. *Phytophthora* sp. have been reported as damaging carnations but little has been reported regarding the effects of infection of these plants by *Pythium* sp. Since *Pythium vexans* has been isolated from roots of carnation plants not appearing to be adversely affected, this study was initiated to determine the effect of this fungus on the growth of carnation plants.

U.C. mix was infested with fungus grown in pure culture on autoclaved millet seed. Prior to use, some of the infested mix was treated with ethazol [5-ethoxy-3-trichloromethyl - 1,2,4-thiadiazole] at 50 parts per million (ppm) active ingredient, some was treated with diazoben [p-(dimethylamino) benzene-diazo sodium sulfonate] at 25 ppm active and some was treated with diazoben plus PCNB (pentachloronitro benzene) each at 25 ppm active. The mixes were put in pots and 10 pots of each treatment were planted with Red Sim carnation plants. In addition, 10 plants were planted in infested mix to which no fungicide had been added, and 10 plants were planted in non-infested U.C. mix. Approximately three months later, the plants were harvested and the weights of the tops were determined. The tops and the roots were oven-dried and weighed. The results are given in table 1.

In this experiment it was found that all treated plants grew better tops than those grown in the infested mix. All of the root systems except the ethazol treatment were larger than those from the infested mix. The tops of the plants grown in the mix treated with ethazol weighed more than the the tops from the infested mix, indicating the disease was controlled. A decrease in the size of the root system was interpreted as the result of a slight toxicity from a high rate of application. Soil treated with diazoben and diazoben plus PCNB produced better plants than the non-infested mix, suggesting that there may have been some contamination of the non-infested mix after planting. The fact that treatments with PCNB added to diazoben resulted in better plants than treatments with diazoben alone suggests that *Rhizoctonia* might also have been introduced as a contaminant.

Another experiment was then started using similarly infested U.C. mix. Some of the infested mix was treated with ethazol at 50 ppm active. Some was fumigated with propylene oxide to kill the fungus and in this way check the effect of the millet seed in the mix. Fifteen plants each of Peterson's Red Sim were planted in pots for each treatment. In addition, 30 plants were planted in infested mix and 15 of these were drenched with ethazol weekly at the rate of 100 ppm active. Fifteen were also grown in the infested mix, and 15 were grown in non-infested mix. After two months, no differences could be detected between the plants growing in treated and non-treated mixes, except the plants in the latter were shorter and did not have as many side branches (see photo 1). At this time the heights