ject to severe iron deficiency in the Rockdale soils in southern Florida.

To achieve high yields in the early years of an orchard's development it has become customary in Florida to plant the trees relatively close together, with plantings of 150 to 250 trees per acre instead of the 100 to 150 of the past. Such plantings have the important disadvantage that after a few years the trees grow together and some sort of periodic pruning is necessary to maintain production and permit the passage of people and machinery through the orchard. Some means of limiting tree size would be highly desirable, and dwarfing rootstocks are one obvious solution to the problem. Unfortunately, none of the rootstocks used in this experiment appears so far to have good possibility for dwarfing trees, because yield of fruit is directly related to tree size.

This experiment will be continued and hopefully will give further useful information on new rootstocks for 'Tahiti' lime.

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EFFECTS OF MAGNESIUM NITRATE SPRAYS ON MAGNESIUM DEFICIENT LIME TREES ON CALCAREOUS SOIL

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Abstract. **On 'Persian' lime (Citrus latifolia Tanaka) trees on calcareous soil, with a history of severe Mg deficiency, the deficiency was readily corrected with foliar sprays of magnesium nitrate at concentrations supplying as low as 1.75 pounds of MgO/100 gallons of dilute spray. Two sprays a year at this concentration gave satisfactory commercial control over a 4-year period. Magnesium in leaves increased significantly with increasing Mg in spray from 1.75 to 5.25 pounds of MgO/100 gallons. Juice and acid content of fruit increased with higher Mg level in the tree. There was a definite trend for yields to increase with increased Mg level in the tree and by the fourth year the difference was significant. Soluble solids, juice and acid contents were generally higher and peel thinner for fruit under spray treatment than for fruit from nearby trees receiving Mg only on the soil from magnesium sulfate.**

Foliar sprays containing magnesium nitrate at a rate supplying 1.1 pounds of MgO per 100 gallons of water have been used to control Mg deficiency symptoms on oranges in California (2) and in Florida (1). Magnesium fertilizers have failed to give satisfactory control of Mg deficiency on 'Persian' ('Tahiti') lime trees in Florida on Rockdale soil, especially on marcot trees. Spraying with magnesium nitrate at concentrations somewhat higher than 1.1 pounds of MgO per 100 gallons corrected severe deficiency within 3 months for a period of 15 to 24 months, depending upon concentration used (4). Magnesium level in the trees increased as the spray concentration increased. These sprays not only prevented Mg deficiency symptoms from developing in new leaves but corrected some chlorosis in old leaves as well and reduced leaf shed. Where the soil was fertilized with magnesium sulfate most of the old chlorotic leaves

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The authors are indebted to Mr. Wm. H. Krome for withholding magnesium fertilizer from trees in this experiment, for supplying fruit for quality studies and picking labor for yield records. It was his excellent cooperation that made this study possible. Thanks and appreciation are extended to Drs. C. W. Campbell and P. G. Orth for data on magnesium sulfate fertilizer, which were obtained from a nearby experiment they were conducting.

shed without any regreening, and correction of deficiency symptoms was through preventing their development in subsequent new leaves. Yield and soluble solids in juice of 'Washington' navel oranges in California increased the fourth year the trees were sprayed with magnesium nitrate at least twice annually (3).

Having corrected Mg deficiency of limes on calcareous soil with magnesium nitrate sprays (4), the study was continued to determine if Mg in the trees could be raised to levels above that necessary for correcting deficiency sumptoms and, if so, to examine effects of these levels on fruit quality and production. This paper reports results obtained.

Materials and Methods

The trees, planted on scarified and trenched Rockdale soil at a spacing of 12½ X 21¼ feet, were 6-year old certified disease-free marcots. They were hedged and topped each season in late summer after the experiment was started. They were irrigated and in good condition except for Mg and Fe deficiencies. The latter deficiency was controlled satisfactorily throughout the grove by the third year of the test. Although the trees had been well fertilized with mixed fertilizer containing 10% MgO, about 30% of the leaves were showing Mg deficiency symptoms throughout the experimental area. After the magnesium nitrate treatments were started, no Mg was used in the fertilizer.

The experimental design has been described (4). Briefly, treatments were sprays with magnesium nitrate equivalent to zero (control), 1.75 (low rate), 3.50 (medium rate) and 5.25 (high rate) pounds of MgO per 100 gallons of water at 5 gallons per tree. This is equivalent to about 15, 30 and 45 pounds, respectively, of MgO per acre.

Dates of application of the sprays were:

Date	Lbs. MgO/100 gal.		
	1.75	3.50	5.25
3/14/67	X	X	X
6/ 8/67	X	X	X
9/ 7/67	X	X	X
4/ 3/69	X		
8/ 6/69		X	X
12/18/69		X	X
4/ 1/70	X	X	X
7/ 1/70	X	X	X
12/17/70	X	X	X
3/10/71	X	X	X

The 4 treatments were replicated 4 times on 3-tree plots arranged in randomized blocks with guard trees on all sides. Leaf Mg content and visible deficiency symptoms in leaves were used as guides for Mg spraying.

Thus, for the 4 years of the experiment, the low rate trees were sprayed 8 times, the medium and high rate trees 9 times. Except for the spray on July 1, 1970, when about one-half inch of rain fell 4 hours after application, the sprays were on the trees at least 3 days before rain or irrigation on the experimental block. This was sufficient time for maximum absorption (4).

Trees were rated for Mg deficiency symptoms several times each year between 1967 and 1971. Yields were obtained at each harvest from May 22, 1968, through September 18, 1971, except for one occasion in 1969 and another in 1970 when some salvage picking was done just preceeding hedging and topping without opportunity to record yields. Leaf and fruit samples were collected at least once each year, usually in June. Also, leaf and fruit samples were collected from a magnesium sulfate fertilizer experiment in the same block of trees for comparison.

Results and Discussion

A noticeable decrease in Mg chlorosis on trees sprayed with magnesium nitrate was observed a month after the initial treatment, as compared with controls. By November, 1967, about 2 months after the third spraying, Mg deficiency symptoms virtually had disappeared from foliage of trees at the 2 higher rates of magnesium nitrate, and only a few chlorotic leaves were found on trees at the low rate. Some of this decrease was due to the prevention of chlorosis in new leaves, some to partial correction of chlorosis in old leaves, and some to shedding of chlorotic leaves.

No Mg spray was applied in 1968 because no Mg deficiency symptoms were observed on treated trees. Sprays were resumed in 1969 to determine effect on fruit quality and production of Mg levels in the trees above that necessary for correction of Mg deficiency. A total of 6 sprays were applied to the medium and high rate plots and 5 sprays to the low rate plots between 1969 and 1971.

In general, leaf content of Mg increased with Mg concentration in the spray. There was a significant correlation between deficiency symptoms and Mg content of leaves (Fig. 1), and between leaf Mg and treatment.

Leaf N also generally increased with increased concentration of magnesium nitrate in the spray,

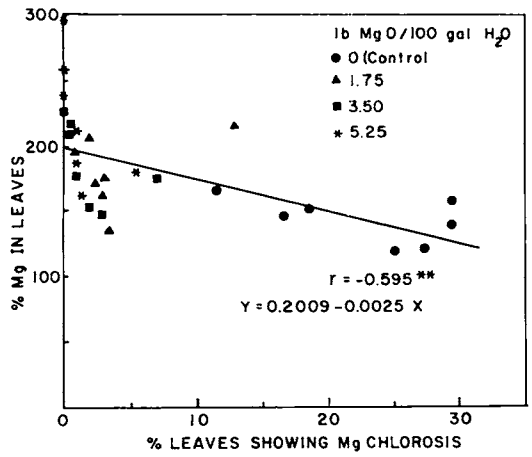

Fig. 1. Relationship between percent Mg in leaves and percent leaves showing Mg chlorosis.

but with less consistency than for Mg. Such exceptions are to be expected since N is readily absorbed from fertilizer applied from time to time.

Fruit quality measurements showed definite trends toward increased juice content, acid and fruit production with increased leaf Mg content (Table 1). These differences were more apparent in 1970 and 1971 when the range in leaf Mg content was wider. The increased acid is highly important since the processing market value of acid citrus fruits (limes and lemons) is dependent on acid content.

Table 1. Effects of magnesium nitrate sprays on fruit quality and yield of 'Persian' limes.

Year	Rate lbs. MgO per 100 gal	Leaf Mg %	Juice by wt. %	Acid %	Acid /bu lbs.	Yield /tree bu	Acid /tree lbs.
1968	0	0.166	47.4	5.58	1.19	3.50	4.21
	1.75	0.178	48.3	5.64	1.22	3.38	4.07
	3.50	0.173	47.2	5.70	1.21	4.20	5.09
	5.25	0.188	48.1	5.86	1.27	3.87	4.97
	Significance	*	n.s.	*	n.s.	n.s.	n.s.
1969	0	0.157	54.6	6.90	1.17	3.47	4.09
	1.75	0.215	55.5	6.82	1.19	3.47	4.10
	3.50	0.177	56.8	6.84	1.20	3.47	3.87
	5.25	0.180	56.4	6.69	1.16	3.60	4.22
	Significance	**	n.s.	n.s.	n.s.	n.s.	n.s.
1970	0	0.138	50.7	6.22	1.41	3.27	4.64
	1.75	0.206	53.6	6.22	1.50	3.23	4.81
	3.50	0.211	51.9	6.22	1.45	3.20	4.67
	5.25	0.237	53.9	6.26	1.52	3.50	5.26
	Significance	**	**	n.s.	*	n.s.	n.s.
1971	0	0.123	45.6	6.67	1.26	2.70	3.43
	1.75	0.174	45.9	6.84	1.30	2.87	3.92
	3.50	0.210	45.8	6.84	1.30	2.67	3.42
	5.25	0.259	46.7	6.89	1.35	3.43	4.62
	Significance	**	n.s.	*	*	*	**

Statistical significance:

n.s. not significant.
* significant at 5% level.
** significant at 1% level.

No difference in fruit quality was found in 1969. This is consistent with the fact that no Mg spray was applied in 1968. At the time leaf and fruit samples were taken in 1969, only the low rate treatment had been sprayed recently. This was reflected in the higher leaf Mg content in the low rate (1.75) treatment than in leaves from the medium or high rate treatments (Table 1). The trend towards increased yield with increased Mg level in the tree was apparent each year, but because of wide variation in yield within treatment, the difference was statistically significant only in 1971. This was due at least partly to a scattered decline of trees in the plots which was not associated with treatments, and which became severe by the third year of the experiment. Cause of the decline was unknown, but since the trees were certified disease-free, a recognized disease was eliminated as cause of the decline. It probably was a combination of circumstances, including close planting which caused die-back from shading. It is possible that Fe deficiency may have contributed to the decline. With correction of Fe deficiency by the third year, the efficiency of the trees may have been increased so as to partly offset effects of the decline. Thus, the yield response to correction of Mg deficiency may have been enhanced late in the experiment, and the increase became statistically significant in 1971. The wider range in the Mg content of the trees in 1970 and 1971 may also partly account for the significant increase in yield in 1971.

There were some interesting comparisons on quality between fruit from magnesium nitrate and magnesium sulfate experiments in the same block of grove.. The trees in the 2 experiments were the same age and on the same soil and received identical cultural treatments except source of Mg and method of application (Table 2). On the aver-

Table 2. Comparison of fruit quality from trees sprayed with magnesium nitrate with that from trees receiving Mg only from magnesium sulfate fertilizer.

Measurement	Magnesium nitrate	Magnesium sulfate	No. of years showed significant difference
MgO applied/tree/yr	0.35 lbs.	2.0 lbs.	--
Method of application	foliar	soil	--
Leaf Mg content	0.201%	0.192%	4/4[z]
Peel thickness	2.41 mm	2.52 mm	2/3
Juice by weight	47.2%	46.7%	1/4
Soluble solids (Brix)	9.22%	8.89%	4/4
Acid	6.15%	6.01%	2/4
Acid/bushel	1.31 lbs.	1.26 lbs.	2/4

[z] 4 years out of 4, etc.

age, fruit from trees sprayed with magnesium nitrate had thinner peel, higher soluble solids, higher juice and acid content. The higher juice and acid content with higher leaf Mg are consistent with data in Table 1.

Data collected in this study show conclusively that magnesium nitrate sprays produced a high Mg level in the tree and invariably readily corrected Mg deficiency symptoms on marcot lime trees on Rockdale soil. With the higher Mg level in the tree, fruit with higher soluble solids, juice and acid contents was produced on the average. It has been difficult to obtain these higher levels of Mg under these circumstances with soil applications of Mg. Whether or not magnesium nitrate sprays should replace soil application of Mg in any particular case would depend on economics.

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QUALITY OF 'BOOTH 8' AND 'LULA' AVOCADOS STORED IN A CONTROLLED ATMOSPHERE

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Abstract. **Storage of 'Booth 8' and 'Lula' avocados in a controlled atmosphere (CA) of 2% O_2 and 10% CO_2 at 40°, 45°, and 50° F. for 20, 40, and 60 days resulted in more acceptable fruit than comparable storage in air. All 'Lula' and 63% of 'Booth 8' avocados were acceptable after 60 days in CA at 45°. No significant differences in quality were detected between 'Lula' or 'Booth 8' avocados stored in CA at 40° and those at 45°. 'Booth 8' fruit had less anthracnose decay at 40° but more internal chilling injury than at 45°. The development of anthracnose and chilling injury was severe in avocados stored in air and none were acceptable after 40 days. Slight internal chilling injury developed in 'Booth 8' avocados, but none in 'Lula,' stored in CA for 60 days at 40°. External chilling injury of avocados was slight after 60 days in CA.**

A controlled atmosphere (CA) of 1 to 2% O_2 and 10% CO_2 is superior to air for prolonged storage of 'Lula' avocados (3, 4, 5, 8). Storage life is increased by removal of ethylene from the storage chamber (5). Concentrations of O_2 greater than 2% are increasingly less beneficial for CA storage of avocados (3, 4). Experience in CA work at the U. S. Department of Agriculture laboratory in Miami, Florida, has shown that avocados are damaged when the O_2 concentration is less than 1% for several days. The use of 2% O_2 provides a margin of safety against low-O_2 injury and is more feasible commercially to maintain than a lower concentration. The use of 7% (3) and 9% (4), but not 5%, CO_2 in conjunction with 1% O_2 was beneficial to the avocados. In recent studies a CA of 2% O_2 and 10% CO_2 has been used (5, 8).

Materials and Methods

Mature 'Booth 8' avocados were obtained on day of harvest from packinghouses in the Homestead, Florida area on October 28, 1970 and October 18, 1971. Mature 'Lula' avocados were harvested on January 25, 1972. Fruits for each test were randomized and divided into samples of 10 fruits each in 1970 and 20 fruits each in 1971 and 1972. One sample was placed at 70° F. in air to determine softening time, to the nearest day, and quality before storage. Fruits were considered ripe when they attained uniform edibility and softness as indicated by slight finger pressure (6). The other samples were placed in 30-gal. chambers and stored in air or CA at 40°, 45°, or 50° F. Three samples were placed in each chamber. A tray of water was placed in each chamber to maintain a relative humidity of 95 to 100% as measured with

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