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MINERAL COMPOSITION OF FLORIDA MANGO LEAVES

T. W. YOUNG

Sub-Tropical Experiment Station
Homestead

ROBERT C. J. KOO

Florida Citrus Experiment Station
Lake Alfred

ABSTRACT

Results of analyses of 274 mango leaf samples for N, P, K, Ca and Mg are given. The leaves were collected between 1958 and 1968 from 'Kent', 'Parvin', 'Haden' and 'Zill' variety trees on Lakewood sand and from 'Kent' and 'Haden' trees on Rockdale soil. The trees were fertilized during the collection period with as wide a range in levels of these 5 elements as likely ever would be used in commercial practice. The desirable range in level in the leaf for each element for satisfactory performance is suggested tentatively.

INTRODUCTION

The use of leaf analysis as an aid in planning an efficient fertilizer program for crop plants is increasing. The value of this approach has been emphasized recently for potassium on citrus (3). For some tree crops, apples and some types of citrus for example, the acceptable concentration ranges of various mineral elements in the leaf for desirable results have been fairly well established (1, 7). Such standards have not been set for mango (*Mangifera indica* L.), although the wide range in levels of fertilizer elements, especially of N and K_2O, used under the same conditions by the Florida mango grower points to the need.

Pertinent information on nutritional requirements of the mango in Florida is scarce. Zinc deficiency has been described and recommendations for correction made (6). The levels at which deficiency symptoms of N, P. K. Mg, Mn and S appeared in leaves of young mango trees grown in sand culture have been reported (9). Some results of leaf analyses made in connection with field fertilizer experiments on mangos in Florida have been published (11, 12, 13). These data, combined with unpublished results from similar experiments, serve as a foundation for tentative mineral nutritional standards for mangos in Florida. Although these data are not as ultimate or comprehensive as they woulud be if combined with yield data and data from an extensive survey study, the fertilizer treatments included in the experiments were such that they bracketed all levels of N, P_2O_5, K_2O, CaO and MgO likely to be used in normal commercial practice. This paper is a summarization and interpretation of these analytical results.

MATERIALS AND METHODS

The leaf samples were taken between 1958 and 1968 from trees in fertilizer experiments with 'Kent', 'Parvin', 'Haden' and 'Zill' variety mangos on the acid Lakewood sand and from 'Kent' and 'Haden' varieties on th alkaline Rockdale soil. The range in fertilizer levels used on these trees for the 5 elements examined are given for both soils in Table 1. A total of 274 samples were collected and analyzed, with the majority being from the 'Kent' variety.

For valid comparison of mineral content, leaf samples should be near the same physiological age. Mango trees are inclined to have growth flushes at different times on different trees and on different parts of the same tree. By collecting leaf samples after bloom from shoots with bloom panicles, leaves taken were of the same physiological age. It generally has been considered advisable to take leaves from non-bearing shoots for mineral analysis (2, 4, 5, 7. 8. 10). But many of these shoots bore fruit and it was felt

Florida Agricultural Experiment Station Journal Series No. 3368.

Table 1. Range in fertilizer levels on Lakewood sand and Rockdale soil.

Soil Type	Pounds per tree per year									
	N		P_2O_5		K_2O		CaO		MgO	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Lakewood	0.2	5.4	0.6	7.5	0.6	9.4	0	400.0	0.3	5.3
Rockdale	1.2	16.0	0	2.0	0.8	10.6	0	0	0.3	3.1

that the mineral status of the trees at that particular time would be represented better by leaves from both fruiting and non-fruiting shoots. Consequently, the leaf samples were taken in May, June and July equally from shoots with and without fruit. Generally, the samples were composites of leaves taken uniformly from all trees within a given fertilizer treatment, but a few samples were from individual trees. Each sample consisted of 60 leaves taken at the second or third position back from the base of the bloom panicle and distributed uniformly about the tree at a height of about 4 to 8 feet.

The method of handling leaves after collection and analytical procedures used are described elsewhere (5).

Results and Discussion

The minimum, maximum and mean leaf concentration of N, P, K, Ca and Mg found for each variety on the respective soils, together with the number of samples represented by each mean, is given in Table 2. The mean and range in level of these elements in the leaf of the 'Kent' variety each year from 1958 through 1968 on both Lakewood and Rockdale soil are shown graphically in Fig. 1-A to E.

The data in Table 2 show a wide range between minimum and maximum levels of the 5 elements examined. This variation was greater within than between varieties for all 5 elements. N and K showed less variation between varieties than P, Ca or Mg. Variations due to soil differences were most apparent in the Ca and Mg contents of leaves. The mean values of N and K did not vary greatly among varieties or between soil types. P was lower on calcareous Rockdale soil than on acid Lakewood sand. Among the varieties studied on Lakewood sand, and receiving the same amounts of P_2O_5 in the fertilizer, the mean P levels in leaves of 'Haden' and 'Zill'

Table 2. Mineral composition of leaves from 4 varieties of Florida mangos.

Variety		PERCENT DRY WEIGHT									
		N		P		K		Ca		Mg	
		Lakewood	Rockdale	Lakewood	Rockdale	Lakewood	Rockdale	Lakewood	Rockdale	Lakewood	Rockdale
'Kent'	Min.	0.70	0.79	0.068	0.088	0.11	0.15	1.00	3.03	0.190	0.033
	Max.	1.82	1.52	0.840	0.148	1.25	1.01	5.75	5.38	0.550	0.332
	Mean	1.20	1.26	0.126	0.109	0.50	0.59	2.62	4.31	0.316	0.146
		(171)	(31)	(171)	(31)	(171)	(31)	(171)	(31)	(154)	(27)
'Haden'	Min.	1.15	0.90	0.130	0.073	0.54	0.21	1.13	3.00	0.345	0.040
	Max.	1.70	1.42	0.343	0.175	0.85	0.88	1.31	5.53	0.408	0.474
	Mean	1.33	1.20	0.193	0.106	0.68	0.54	1.24	4.00	0.375	0.179
		(6)	(23)	(6)	(23)	(6)	(23)	(6)	(23)	(6)	(21)
'Parvin'	Min.	1.01		0.070		0.29		1.45		0.240	
	Max.	1.50		0.145		0.77		2.94		0.440	
	Mean	1.23		0.095		0.47		2.18		0.340	
		(33)		(33)		(33)		(33)		(27)	
'Zill'	Min.	1.21		0.160		0.44		1.00		0.230	
	Max.	1.44		0.182		1.13		2.88		0.328	
	Mean	1.30		0.171		0.73		1.93		0.281	
		(10)		(10)		(10)		(10)		(10)	

Numbers in parentheses = number of samples.

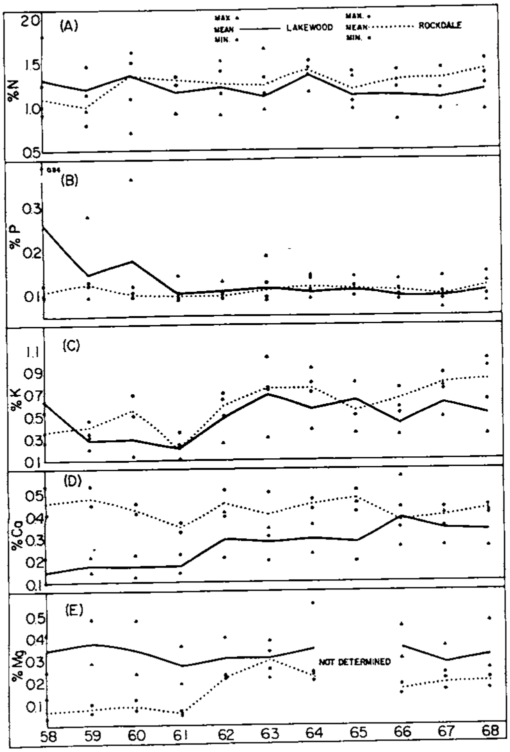

Fig. 1.—Mineral composition of 'Kent' mango leaves from trees on Lakewood sand and Rockdale soil.

were considerably higher than in 'Parvin' leaves. The mean level of Ca was higher on Rockdale than on Lakewood soil for the 2 varieties ('Kent' and 'Haden') compared. The reverse was true for Mg.

The wide variations observed in the minimum and maximum values for the 5 elements were mostly due to variation in fertilizer levels. The level of a given element in the fertilizer usually was reflected by the concentration of that element in the leaf. An excption was found with N on Rockdale soil in 1959-60 on some 'Kent' and 'Haden' trees that received 16 pounds each of N in the fertilizer during the season. Leaf N for both varieties that season was 1.5% as compared with about 1% in leaves of control trees that received only 1 pound of N. The low efficiency of N here probably was due to shallow rooting, which is common on Rockdale soil. But mango trees appear to be less responsive to N and K_2O fertilization than is citrus. This is indicated by the inability to raise the N and K levels in leaves appreciably with heavy applications of these elements.

Repeated heavy applications of calcitic limestone or gypsum brought the Ca content of 'Kent' leaves higher than that found on Rockdale soil. This indicated that mango is responsive to Ca fertilization. Among the elements studied, Mg had the poorest correlation between fertilization and leaf content of the element.

Mango trees appeared to be quite sensitive to P_2O_5 fertilization, and recognizable symptoms of any deficiency or toxicity were observed only in leaves with a very high P content. This was in 'Kent' leaves from trees on Lakewood sand that received a total of 7.5 pounds of P_2O_5 from triple superphosphate in 4 applications during the 1957-58 season. This was 8 to 10 times the amount of P_2O_5 that normally would be considered adequate for these trees. The P level of these leaves reached 0.84% (Fig. 1-B) in th summer of 1958. By fall that year a spotting of mature leaves occurred on these trees which somewhat resembled greasy-spot lesions on citrus leaves. These spots appeared first on the lower surface, but in time on the upper surface also. Necrotic areas developed on the margins of some leaves (Fig. 2). Leaves became chlorotic and there was a heavy leaf shed, with some dying of shoots. After the 1957-58 season phosphatic fertilization of these trees was reduced to 0.72 pound of P_2O_5 per tree per year, and there was a gradual recovery from the trouble (apparently P toxicity). The P level in leaves from these trees remained relatively high, however, through 1959 and 1960 (0.275 and 0.359%, resp.).

The year to year variation in mineral content of mango leaves is best illustrated by data from the 'Kent' variety (Fig. 1-A to E) because of the greater number of different fertilizer treatments included and the greater number of samples analyzed than for other varieties. In addition to fertilizer treatments, meteorological factors and crop size may also influence the mineral composition of leaves. The interrelations among meteorological conditions, yield and mineral absorption by mango are little understood. The scope of this paper does not permit speculation on these interrelations or their possible effects on the mineral content of the leaves collected.

Nitrogen levels in leaves (Fig. 1-A) were relatively constant as compared with the other 4 elements examined. Although N fertilization

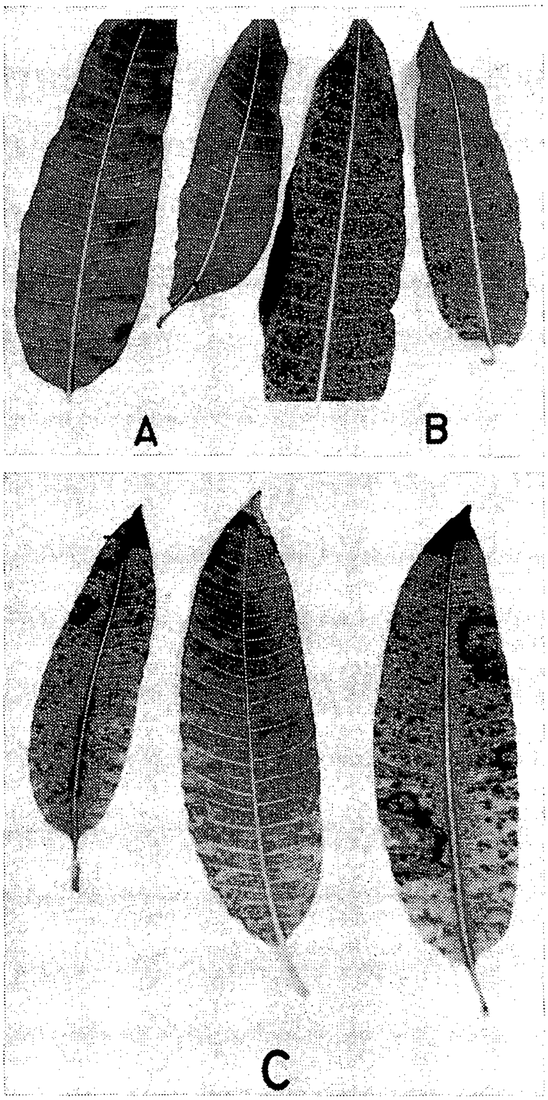

Fig. 2.—Lesions on 'Kent' mango leaves resulting from very heavy phosphate fertilization. (A) Normal leaves. (B) Moderate damage. (C) Severe damage.

ranged from as low as 0.2 to as high as 5.0 pounds of N per tree per year on Lakewood sand, and from about 1.0 to 16.0 pounds per tree per year on Rockdale soil, the levels in leaves ranged only from 0.7 to 1.82% on Lakewood and from 0.79 to 1.52% on Rockdale soil.

Except for the high P level in leaves from 1958 through 1960 from trees on Lakewood sand that received the extremely heavy phosphatic fertilization, the P level in 'Kent' leaves was rather constant (Fig. 1-B). After 1960, the levels of P in leaves from Lakewood sand were comparable to those in leaves from Rockdale soil.

The abrupt drop between 1958 and 1959 in the mean K level in leaves from Lakewood sand (Fig. 1-C) was caused by discontinuing some high rate potash treatments in 1958. The drop to even lower levels in 1961 in leaves from both Lakewood and Rockdale soil may have resulted from leaching losses during a wet hurricane in September 1960 and dry weather in 1961 which reduced absorption. Heavy applications of Ca (both as high calcitic limestone and as gypsum) for 4 consecutive years, beginning in 1961, to some of the trees on Lakewood sand had no marked effect on K absorption. Beginning in 1962, potash fertilization of the trees on Rockdale soil was increased sharply. This is reflected in the upward trend of th leaf K curve for this soil (Fig. 1-C).

The mean Ca level in leaves from Rockdale soil remained relatively stable (Fig. 1-D). No liming material was applied on this soil. The low Ca level reached in leaves from Rockdale soil in 1961 was probably due to reduced absorption because of dry weather of that season. On the Lakewood sand liming of the trees was with dolomitic limstone at the rate of around 1 ton per acre at intervals of several years, except for some experimental heavy liming. Starting in 1961, and continuing through 1964, some of the trees on Lakewood sand received high calcic limestone at the rate of 5 tons per acre each year. Others received gypsum at the rate of 10 tons per acre each year for 4 years. This increase in Ca fertilization caused a sharp increase in leaf Ca, starting in 1962 (Fig. 1-D). The drop in leaf Ca in 1967 and 1968 on this soil may have resulted from partial depletion of Ca in the soil.

The mean Mg level (Fig. 1-E) in leaves from Lakewood sand remained fairly constant, but there were broad unexplainable differences between minimum and maximum levels. Differential Mg treatments were made only in the 1957-58 and 1958-59 seasons on some of the trees on Lakewood sand. These treatments appear as a peak in 1959 on the mean Mg curve (Fig. 1-E) for this soil. As with K and Ca, the lowest mean level of leaf Mg, which occurred in 1961 for both Lakewood and Rockdale soils, was probably due to dry weather. Starting about 1961-62, the MgO content of fertilizers applied

Table 3. Desirable ranges of 5 mineral elements in mango leaves in Florida. (Tentative standards)

Element	Chem. symbol	Desirable range
Nitrogen	N	1.0 to 1.5%
Phosphorus	P	0.08 to 0.175%
Potassium	K	0.3 to 0.8%
Calcium	Ca	2.0 to 3.5% (acid soil)
		3.0 to 5.0+ % (alkaline soil)
Magnesium	Mg	0.15 to 0.4%

to the trees on Rockdale soil was increased considerably. This was reflected by an increase in leaf Mg starting in 1962.

Desirable ranges of N, P, K, Ca and Mg in mango leaves in Florida for satisfactory results are given tentatively in Table 3. These standards are based on the recorded performance of trees in the several experiments involved, but may be changed with time as more data are accumulated from various fertilizer experiments and surveys.

The Ca standard for acid soil is set somewhat above the level generally found under present liming practices. Leaf Ca levels of 2.5% or above are suggested because of the decrease in incidence of soft-nose with high Ca levels, particularly where N levels are relatively high. This is especially important on varieties such as 'Kent' which shed large numbers of seeded fruits, apparently because of heavy utilization of minerals by the large crop of seedy fruit. Increased yields of marketable fruits have been secured with the 'Kent' variety on Lakewood soil through increased N and Ca fertilization. With varieties such as 'Haden', which produce large numbers of seedless fruits that soon shed, regardless of fertilization, neither heavy N nor Ca fertilization is justified. For such varieties, a Ca level in leaves of around 2% may be ample.

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RESPONSE OF IRON CHLOROTIC AVOCADO TREES ON ROCKDALE SOIL TO CERTAIN IRON TREATMENTS

T. W. YOUNG

Sub-Tropical Experiment Station

Homestead

ABSTRACT

Iron chlorosis of avocado trees on Rockdale soil can be corrected by soil surface applications of NaFeEDDHA, but treatment is relatively expensive. In a search for a more economical treatment, several iron compounds were tested. One of these, $Na_2FeEDTA$, when used in combination with aluminum sulfate, corrected the chlorosis satisfactorily in about 80% of the trees treated with sufficient of the mixture to supply 0.2 pound of Fe per tree. However, there were unexplainable exceptions where there was little improvement. Perhaps it would be feasible

Florida Agricultural Experiment Station Journal Series No. 3365.