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INFLUENCE OF THE PART OF THE LEAF AND LEAF RANK OF PLANTAINS ON ITS NUTRIENT CONTENT

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INTRODUCTION

Fertilizer ranks as one of the largest direct cost a farmer has in growing high yielding crops. The correct recommendations of fertilizer for a given crop in a given soil can mean increased yields with no excessive fertilizer costs. The problem is one of determining a practical method of evaluating the fertilizer needs of the crop in the soils where it is growing.

Soil and plant analyses are used to evaluate the fertilizer requirements of the soil and its crop. Foliar analyses has become a valuable guide in this work, especially because of its value for nitrogen recommendations and its sensitivity to variables which effect the growth of the crop. Foliar diagnosis is being used as a practical guide to fertilizer usage for sugarcane (Samuels, 1969) and pineapples (Sanford, 1962).

Little information is available as to use of foliar analysis as a guide for fertilizing plantains (*Musa paradisiaca*) an important food crop in Puerto Rico. Research work has been initiated at the Agronomy and Soils Department, Agricultural Experiment Station to determine the fertilizer requirements of plantains and how best to evaluate these needs. This paper deals with the findings in the leaf tissue and its possible role in foliar diagnosis for plantains.

MATERIALS AND METHODS

A fertilizer experiment with plantains on a Corozal clay, a Ultisol, pH 5.2, in the humid mountain regions of Puerto Rico was utilized as a source for material in this work, and consisted of N and K_2O at 4 levels: 101, 202, 403, and 605 Kg/ha (90, 180, 360, and 540 lbs/A) and P_2O_5 at 2 levels: 0 and 112 kg/ha (100 lbs/A). When one element was varied, the other two fertilizer elements were held at constant level of N at 202 Kg/ha, P_2O_5 at 112 Kg/ha and K_2O at 404 Kg/ha. All treatments received 202 Kg/ha of MgO (180 lbs/A), and total fertilizer was applied in 3 applications: 1, 3, and 10 months after planting on June 6, 1973.

The experiment was replicated 6 times in rectangular-lattice design. The plot consisted of 9 trees total planted 1.82 m x 1.82 m in 3 rows with a 2.13 m space between plots. Leaf samples were taken at 4, 6, and 9 months after planting. Leaf No. 1 was designated as the first fully-opened leaf counting from the top.

RESULTS AND DISCUSSION

Part of Leaf

In very few cases is the entire plantain leaf taken at sampling used for chemical analyses. To save space and time in drying the leaf materials, and in grinding, only a portion of the plantain leaf is used. If the plaintain leaf were rather uniform in its nutrient composition along its long axis, there would be no particular concern about a little variation as to what part of the leaf was used. However, this is not so, for there is quite a large variation in nutrient composition for various sections of the leaf as shown in Table 1.

Both in leaf blade and midrib, the N and Ca content increased from base to tip of the leaf. Leaf K, however, decreased from base to leaf tip for both blade and midrib. Leaf P changed little from base to tip with a trend to increase for midrib-P only. There was no definite trend for change in leaf-Mg from base to tip. The variations found in leaf blade N P K and Mg for plantains were similar to those obtained by Twyford and Coulter (1964) for bananas in the Windward Islands; however, they found that leaf-blade Ca decreased from base to tip. The variation in leaf N P K composition in leaf lamina and midrib for plaintains was also similar to those for sugarcane (Samuels 1967).

The data indicates that plantain leaf does not have a uniform nutrient composition along its long axis. Therefore, to insure accuracy in foliar-diagnosis work it is necessary that the leaf sample be taken from the sameportion of the leaf each time. The use of visual estimates of the leaf center is not sufficiently accurate to ensure consistent and uniform sampling if a portion of the leaf is to be used. A simple measurement of folding the leaf in half is a rapid means of finding the center of the long axis of the leaf. A ruler or mark on the cutting table or board will ensure that the same length of section is taken from the leaf each time for analyses.

Aside from variations in nutrient composition along the long axis of the leaf, there is a difference in nutrient, composition between - leaf blade or lamina and the midrib. The differences are showing in table 2 under averages. The leaf blade has a higher N and P and lower K content than the midrib. The Ca and Mg content is rather similar in both leaf blade and midrib. The higher N and P in the leaf blade or lamina as compared to the midrib has also been found in the sugarcane leaf (Samuels 1967).

Leaf Rank

The influence of the leaf rank or number on the nutrient content of the plaintain leaf is shown in table 2. The leaf blade and midrib N and Ca increased from second to fifth leaf with the increase being more than double for Ca, but only about 12% for N. The variation in leaf K differed between blade and midrib with a decrease in K from second to fifth leaf in the blade and an increase in the midrib.

There was no appreciable change in leaf P for blade or midrib for leaves nos. 2 to 5. The same was true for leaf-blade Mg with a slight trend to increase in midrib Mg from second to fifth leaf.

Murray (1960) working in sand culture, found that the banana leaf-blade N increased from first to fourth leaf then a progressive fall with increasing age or leaf number. Leaf-blade P and Mg was rather constant for all leaf number, and leaf-blade K had only a little fall with increasing leaf number. Leaf blade-Ca increased rapidly from first to fifth leaf. These findings were quite similar to those found for the plantain leaf.

The leaf number containing the highest amount of the nutrient element being studied does not necessarily serve as the best criteria for foliar-diagnosis recommendations. The leaf rank or number most sensitive to changes in available nutrient level to the plantain will give a better picture of the fertilizer needs of the plant. Using the fertilizer treatments with low and high level of N P K as a guide, table 3 shows the differences in uptake of the nutrient in the leaf blade by leaf number.

For N, the largest differences between N fertilizer application was detected in leaf No. 2, and differences decreased thereafter to leaf No. 5. Differences in phosphate application was hardly detected, with only leaf No. 4 showing a slight difference in leaf P. Leaf No. 4 gave the greatest difference in leaf K with differential potash application to the soil.

Hewitt (1955) in his work with bananas in Jamaica suggested leaf No. 3 for the most general indication of the nutrition of the tree. However, his decision was based moreso on the fact that the third leaf had the highest N level and next to highest P and K levels as compared to leaves Nos. 1, 5, and 7. Table 2 indicates that for the leaf blade of plantains, using a criteria of highest level of the nutrient, the second leaf is best for N and Ca while any leaf from second to fifth was suitable for P and Mg. Yet, if we use the criteria of the leaf number showing greates sensitivity to differences in fertilizer levels (table 3), we obtain an entirely different picture with the second leaf best for N and the fifth for K.

CONCLUSIONS

For foliar diagnosis with plantains this study suggests that the third or fourth leaf gives the most general indication for N P K. The leaf blade or lamina is suggested as the most general indicator for N P K as compared to the leaf midrib. The use of a constant section near the center of the leaf is indicated to avoid variation in sampling along the long axis of the leaf. The preliminary findings of this study with plantains does not differ greatly with those obtained for bananas in choice of leaf-analysis tissue.

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Table 1. - The Distribution of Nutrient Elements in the Plaintain Leaf*

Element Determined	Distribution of element in leaf				% dry-weight basis			
	0- " Base	-12",	12-18",	18-24",	24-30",	30-36"	36-42"	42-48" Tip
				Leaf blade				
N	4.27	4.47	4.67	4.82	5.07	4.96	4.82	4.81
P	.32	.28	.27	.26	.25	.27	.26	.27
K	7.06	6.71	6.36	6.09	5.93	5.79	5.70	5.49
Ca	.64	.72	.81	.77	.89	.89	.84	.66
Mg	.28	.33	.28	.29	.24	.27	.28	.33
				Midrib				
N	1.33	1.35	1.39	1.53	1.66	1.75	1.95	2.03
P	.12	.12	.12	.11	.13	.15	.15	.1
K	12.96	13.09	12.23	12.33	11.79	11.68	11.66	-
Ca	.55	.68	. 7	72	.80	.81	.86	-
Mg	.18	.14	.13	.14	.15	.15	.16	-

Table 2. - The Influence of Leaf Rank or Number on the Distribution of Nutrient. Element in the Plaintain Leaf *

Leaf Number	Leaf nutrient content on a % dry-weight basis				
	N	P	K	Ca	Mg
			Blade		
2	4.33	0.27	5.72	0.39	0.31
3	4.57	.28	5.31	.58	.31
4	4.66	.27	5.00	.75	.31
5	4.76	.27	4.88	.84	.30
Average	4.58	.27	5.18	.64	.31
			Midrib		
2	1.25	0.12	9.34	0.35	0.29
3	1.31	.12	9.90	.49	.31
4	1.32	.13	9.93	.58	.32
5	1.42	.12	10.40	.84	.34
	1.33	.12	9.89	.75	.32

* Average of 3 samplings at 5, 6, and 8 months of age.

Table 3. - The Difference in Nutrient Uptake by Plaintain Leaves by Leaf Rank *

Fertilizer		Nutrient content, % dry-weight, for leaves blade No.			
Element	Lbs./acre	2	3	4	5
			Nitrogen (N)		
N	404	4.37	4.63	4.75	4.83
	101	3.91	4.33	4.58	4.68
Difference		.46	.30	.17	.16
			Phosphorous (P)		
P_2O_5	112	0.29	0.27	0.27	0.26
	0	.29	.27	.26	.26
Difference		0	0	.01	0
			Potassium (K)		
K_2O	404	6.68	6.20	5.96	5.92
	101	6.62	6.03	5.51	5.52
Difference		.06	.17	.45	.37

* Mean of leaf samplings at 6 and 9 months.