Some aspects of banana leaf analysis in Jamaica.

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QUELQUES ASPECTS DE L'ANALYSE FOLIAIRE DU BANANIER EN JAMAIQUE

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RESUME - On compare la technique d'échantillonnage utilisée en Jamaïque (section «milieu gauche» de la feuille II quand le «cigare» est à peine visible, sur plants non fleuris d'environ six mois) avec diverses suggestions formulées par MARTIN-PREVEL (1974) en vue d'une méthode de référence internationale. Des différences significatives se manifestent. Certains modes d'échantillonnage soulèvent des difficultés. L'établissement des fourchettes de teneurs doit tenir compte des influences saisonnières. L'auteur met en garde contre les dangers d'un excès de normalisation.

INTRODUCTION

For almost two decades, leaf analysis of 'non-fruiting' banana plants, aged approximately six months, has been used in Jamaica as a means of determining fertilizer requirements, detecting deficiencies and monitoring changes in nutrient levels.

There is almost total dependence on rainfall for supplying water to the crop. Since there is considerable fluctuation of some nutrients due to rainfall, a range of Adequacy Levels rather than a single critical level for each nutrient is used for interpretation of leaf analysis results. During each year, there are periods of very low rainfall. Within the last two years, these have become more severe and prolonged. Under this system, lack of rainfall affects nutrient levels in the leaves, retards application of fertilizer, affects development of the fruit and eventually causes reduction in yield.

Factors such as leaf age and plant age which influence nutrient levels in the leaves, have been reduced or eliminated by standardization. Other factors such as soil moisture, which could be controlled by irrigation, require greater overall change from the traditional method of growing bananas in Jamaica.

At the present time, the commercial varieties are 'Lacatan', 'Robusta' and 'Valery'. Fruit is harvested throughout the year but the peak of fruit production is usually between May and September. The fertilizer programme is geared to supply approximately 200 lbs (224 kg/ha) N, 80 lbs (90 kg/ha) P_2O_5 and 500 lbs (662 kg/ha) K_2O per acre per year to a population of 690 plants per acre. Planting of bananas is usually done in Spring and early Fall.

HEWITT (1955) developed a sampling technique for plants when the inflorescence had emerged («shot» plants) and the leaf in third position (first position or leaf I = youngest unfurled leaf) was used.

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Difficulty has been experienced in numbering leaves on «shot» plants because of the stage of development of the last emerged leaf (bracteolate leaf). The leaf blade of the bracteolate leaf develops to different degrees on different plants, and the effect this would exert on the nutrient composition of other leaves is still to be determined.

It became evident that there was the need to sample younger plants so that corrective measures could be applied early in the cycle to benefit the existing crop rather than the succeeding crop.

METHODS

The present leaf sampling technique is described and some of the rationale behind development of the technique. Some effects of rainfall on nutrient levels are also described. The term «non-fruiting» is used to describe plants in the vegetative phase of growth preceding emergence of the inflorescence.

Sampling techniques suggested by MARTIN-PREVEL (1974) for the M.E.I.R. (Méthode d'échantillonnage internationale de référence) study were compared with the technique used locally. Five nutrients were studied in two varieties, 'Valery' and 'Giant Cavendish', at two stages of growth.

LEAF SAMPLING TECHNIQUE

«Non-fruiting» plants are sampled. In the first crop, it is possible to use age to determine when plants should be sampled. Sampling is done 6 months (± 1 month) after germination of the suckers.

In «ratoon» crops, plants produce a certain number of leaves with underdeveloped leaf blades before producing leaves with fully developed lamina. Using a combination of stage of development and height as the criteria for choosing plants for sampling, the range is defined as follows :

- from the shedding of the last underdeveloped (juvenile) leaf to 2/3 grown in relation to «shot» or fruiting plants in the same field. These plants are equivalent to an approximate age of 6-7 months.

Samples are taken from plants on which the «heart leaf» or «cigar» in just barely visible or at a very early stage of development.

The collector stands below the leaf tip of leaf II, facing the pseudostem and removes a 60 cm middle portion of the left side of leaf II. A cutter or cocoa pruner attached to a stick of suitable length is used.

The stage of growth has been defined to cover plants which could be termed «young adults», as the stage of «floral differentiation» is not easily detected by outward visible signs. There are indications that nutrient levels in the youngest fully developed leaves differ when the «heart leaf» is at an early stage of development from those obtained when the «heart leaf» is in the late stages of unrolling (from the «funnel» stage onwards).

Some aspects of the present technique which have been influenced by local conditions are the preference for leaf II. Leaf II was as good as leaf III in detecting changes in nutrient levels. Leaf II had the added advantage of not being as badly torn by wind as older leaves and not wilting as early as the older leaves. If it becomes necessary to specify a special «time of day» for sampling, the selection of this leaf allows a longer period for collecting samples.

Collection of samples is not limited to any particular time of year but enquiries are made about rainfall conditions at sampling time and rainfall 1 month before sampling.

RAINFALL EFFECTS

At the time of sampling, weather conditions should be favourable so that leaf levels will truly reflect the nutritional status of the plants. Figure 1 shows leaf nitrogen and potash for plants receiving 4 x 8 oz (907 gm) and 4 x 14 oz (1587 gm) of NPK 12:8:30 fertilizer per plant per year. Rainfall in figure 1 is plotted one month ahead of the leaf nutrient levels.

It can be seen that leaf potash is very sensitive to rainfall and follows the rainfall pattern closely after a short time lag. Leaf nitrogen decreases in the dry season even at high levels of fertilizer application.

INTERPRETATION OF RESULTS

From a series of 3^3 NPK factorial experiments and by sampling sites of high and low productivity, nutrient levels which corresponded constantly with «high» productivity were chosen. The following are the levels used for interpreting leaf analysis results :

Levels of adequacy (% in dry matter).

N	2.80 - 3.00		
P_2O_5	0.40 - 0.55	P	0.17 - 0.24
K_2O	3.80 - 4.00	K	3.15 - 3.32
CaO	0.50 - 1.00	Ca	0.36 - 0.72
MgO	0.40 - 0.70	Mg	0.24 - 0.42

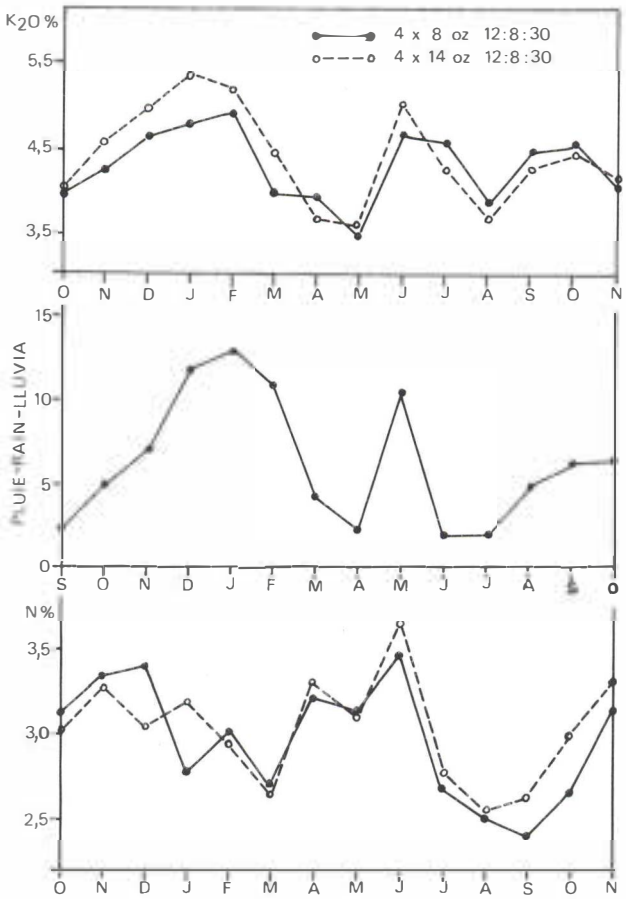

FIGURE 1
THE EFFECT OF RAINFALL OF LEAF NITROGEN AND POTASH LEVELS IN PLANTS RECEIVING TWO RATES OF FERTILIZER.
EFFET DE LA PLUVIOMETRIE SUR LES NIVEAUX FOLIAIRES EN AZOTE ET POTASSE DE BANANIERS RECEVANT DEUX DOSES D'ENGRAIS.
EFECTO DE LA PLUVIOSIDAD SOBRE LOS NIVELES NITROGENADO Y POTASICO EN HOJAS DE PLANTAS RECIBIENDO DOS DOSIS DE ABONO.

A recent study indicated that potash levels shown above may be slightly low as the levels associated with highest yields were between 4.00 and 4.50 % K_2O.

In the case of nutrient deficiencies of N, P, K, Ca and Mg, leaf II and the leaf showing the earliest symptoms are sampled from affected and unaffected plants in the same area. Deficiencies of N, K and Mg have been detected. Phosphorus and Calcium deficiencies are rare in banana fields in Jamaica. The banana plant tolerates a fairly wide range of soil pH levels and the level of leaf calcium has been found to be related to soil pH. With regard to phosphorus, the demand for this nutrient appears to be quite small.

COMPARISON OF SAMPLING TECHNIQUES

Sampling techniques suggested for the M.E.I.R. study were compared with the sampling technique used locally, i.e. leaf II «mid-left» section. Samples were collected from two varieties, 'Valery' and 'Giant Cavendish' plants aged approximately 6 months corresponding to the stage of «floral differenciation» and from «fruiting» plants after exposure of the first male hands of fruit. Samples of leaf blade from both sides of the midrib were put together, and halved to give «inner» sections nearest the midrib and «outer» sections. In the younger plants lamina and midribs from leaves I, II, III and the «last living leaf» were sampled. Petioles of leaf VII and the last living leaf were also sampled. In «fruiting» plants, the bracteolate leaf was not counted, and samples were taken from the lamina and midribs of leaves II and III.

Samples were analysed for Nitrogen (N), Phosphorus (P_2O_5), Potassium (K_2O), Calcium (CaO), Magnesium (MgO) and for as many trace elements as possible. The results for «inner» and «outer» sections of a particular leaf were averaged to give a value for the whole leaf. Statistical «t» tests were done to determine significant differences between nutrient levels of different leaves and sections of leaves with particular reference to comparing the present leaf sampling technique with others. Some attention has also been given to the «inner» sections since this was suggested as a means of sampling in very windy areas. The «t» values for each set of comparisons are shown in Table 1, and average values for leaf analysis results in Table 2.

Statistical results : of the five nutrient elements considered, no significant differences were found between the «left mid» portion of leaf II and the «whole mid» of leaf II. Higher levels of calcium in leaf III resulted in a significant difference between the «left mid» portion of leaf II and the «whole mid» portion of leaf III. This was due mainly to the increase in calcium levels with leaf age.

Comparisons of the «left mid» portion of leaf II with the «inner» sections of leaves II and III gave significant differences for leaf N and Ca, while comparison with the «inner» section of leaf I showed significant differences for N, K and Ca. The «inner» portions of leaves I, II and III were lower in N. «Inner» sections of leaves II and III were higher in calcium than the «left mid» section of leaf II, but the «inner» section of leaf I was lower. K was much higher in the «inner» section of leaf I than in the «mid left» portion of leaf II. Comparison of the nutrient levels for the «whole mid» section of leaf II with that of leaf III showed no significant differences for any of the five nutrients. In «fruiting» plants, leaf nitrogen was significantly lower in the «inner» section of leaf III than the «left mid» portion of leaf II. Potash (K_2O) was higher in the «inner» section of leaf II. Potash levels in leaf III were significantly lower

TABLE 1 - Statistical «t» values for comparisons of different leaf sampling techniques at two stages of growth.
Valeurs statistiques «t» pour la comparaison de différentes techniques d'échantillonnage foliaire à deux stades de croissance.
Valores estadísticos «t» para la comparación de distintas técnicas de muestreo foliar a dos estadios de crecimiento.

comparisons	N	P_2O_5	K_2O	CaO	MgO	possible causes
«Non-fruiting» plants - plantes non fleuries - plantas sin flor						
leaf II left mid/leaf II (av. inner & outer)	1.40	0.12	0.18	1.58	0.02	
" leaf III (av. inner & outer)	0.61	0.21	0.56	3.44^{++}	1.94	Ca levels increase with leaf age
" leaf I (inner)	3.68^{++}	1.11	6.62^{+++}	3.66^{++}	1.12	K very high in L_I. Lower N, higher Ca in «inner»
" leaf II (inner)	2.46^{+}	0.26	2.20	2.90^{+}	0.51	Lower N, higher Ca in «inner»
" leaf III (inner)	2.40^{+}	0.36	1.41	5.08^{+++}	0.32	Lower N, higher Ca in «inner»
leaf II (av. inner & outer)/leaf III (av. inner & outer)	0.56	0.08	0.66	2.03	1.04	
«Fruiting plants» plantes avec régime - plantas con racimo						
leaf II left mid/leaf II (av. inner & outer)	0.52	0.10	0.22	0.50	0.48	
" leaf III (av. inner & outer)	0.03	0.00	0.46	0.38	1.45	
" leaf II (inner)	0.94	0.04	2.65^{+}	0.04	1.13	K higher in «inner»
" leaf III (inner)	2.39^{+}	0.39	1.88	0.87	1.37	N lower in «inner»
leaf II (av. inner & outer)/leaf III (av. inner & outer)	0.67	1.10	2.75^{+}	0.48	0.87	K lower in leaf III

Significant levels : t 0.05 : $2,31^{+}$ 0.01 : 3.36^{++} 0.001 : 4.78^{+++}

TABLE 2 - Average values for 5 nutrients in leaves for «non-fruiting» and »fruiting» plants.
Taux moyens de cinq éléments dans les feuilles de plantes «non fleuries» et «avec régime».
Teores medias de 5 nutrientes en hojas de plantas «sin flor» y «con racimo».

% in dm	6 months - 6 mois - 6 meses						fruiting - avec régime - con racimo				
	leaf II mid left	leaf II (whole)	leaf III (whole)	leaf I (inner)	leaf II (inner)	leaf III (inner)	leaf II mid left	leaf II (whole)	leaf III (whole)	leaf II (inner)	leaf III (inner)
N	2.73	2.60	2.66	2.24	2.51	2.48	2.61	2.65	2.61	2.53	2.42
P_2O_5	0.59	0.58	0.57	0.66	0.57	0.56	0.53	0.53	0.53	0.52	0.51
K_2O	5.13	5.17	5.01	6.37	5.54	5.46	4.80	4.86	4.71	5.36	5.14
CaO	0.90	0.99	1.08	0.69	1.08	1.20	1.38	1.32	1.34	1.38	1.48
MgO	0.63	0.63	0.69	0.58	0.61	0.62	0.78	0.77	0.73	0.75	0.72

Each = average of 10 samples - chaque valeur = moyenne de 10 échantillons - cada valor = promedio de 10 muestras
whole : average of inner and outer mid sections
moyenne des sections interne et externe
promedio de las secciones interna y externa

than in leaf II.

COMMENTS AND CONCLUSIONS

More pronounced differences exist between the present sampling technique when compared with nutrient levels for the «inner» portions of leaves I, II and III, particularly leaf I. Some of these differences are due to nutrient gradients from the midrib to the leaf margin, while others were due to gradients due to leaf age. There were no significant differences between nutrient levels in leaf II and III in younger

plants but in «fruiting» plants there was a significant difference in potash levels.

During the collection of samples for testing various sampling methods the following were noted :

1. leaf number of the «last living leaf» varied from plant to plant. It is also likely to be removed in countries where leaf pruning is done to remove leaves likely to bruise or damage the developing bunch.
2. sampling of midribs requires removal of a substantial portion of the leaf blade. Sampling of petioles causes loss of the whole leaf. These techniques are likely to cause difficulties in experimental plots.

Some of the fluctuations in nutrient levels are due to other factors such as the practice of applying fertilizer 3 or 4 times per year. This causes more marked fluctuations than areas where smaller amounts of fertilizer are applied at more frequent intervals.

In the absence of irrigation, it may become necessary to determine the effects of various soil moisture contents on leaf nutrients so that some correction could be made to nutrient levels. Another alternative would be to collect samples at a time when soil moisture is neither a limiting factor or excessive because heavy prolonged rainfall also affects the levels of some nutrients.

In working towards an International Method of Sampling, some effort could be made to establish suitable «Levels of Adequacy» for plants at different stages of growth. This is useful in the first crop or in fields where plants are all at similar ages. The problem of over-standardization should be watched, as the technique may become too rigid and may not have the useful effect that it should. Even at the low level of standardization in Jamaica, (plant age, leaf number and «heart leaf» stage) there are sometimes complaints that it is difficult to find plants with all the stated criteria.

BIBLIOGRAPHY

HEWITT (C.W.). 1955.
Leaf analysis as a guide to the nutrition of bananas.
Emp. J. exp. Agr., vol. 23, n° 89, p. 11-16.

MARTIN-PREVEL (P.). 1974.
Les méthodes d'échantillonnage pour l'analyse foliaire du bananier. Résultats d'une enquête internationale et propositions en vue d'une référence commune.
Fruits, vol. 29, n° 9, p. 583-588.

QUELQUES ASPECTS DE L'ANALYSE FOLIAIRE DU BANANIER EN JAMAIQUE

La technique d'échantillonnage foliaire utilisée en Jamaïque s'adresse à des bananiers non fleuris, âgés d'environ six mois.On prélève la section médiane du demi-limbe «gauche» de la feuille II, à un moment où le «cigare» est tout juste visible. L'âge ou le stade de croissance auxquels les plantes sont échantillonnées, le rang de la feuille prélevée, la portion de feuille, et le stade de développement de la plus jeune feuille apparaissant («cigare») ont été définis par une normalisation.

Pour l'interprétation de l'analyse foliaire, on utilise une fourchette de niveaux adéquats pour chaque élément plutôt qu'un niveau critique unique, en raison des fluctuations prononcées de certains éléments, dues principalement à la pluviométrie. On suggère qu'une atténuation des effets des pluies pourrait être obtenue au moyen de l'irrigation. Autrement, les échantillons pourraient être prélevés seulement lorsque la pluviosité n'est pas un facteur limitant.

Des comparaisons ont été effectuées entre cette technique

ALGUNOS ASPECTOS DEL ANÁLISIS FOLIAR DEL BANANO EN JAMAICA

La técnica de muestreo foliar utilizada en Jamaica es como sigue : Bananos antes de la floración, de 6 meses de edad aproximadamente, tomándose la sección media del semilimbo izquierdo de la hoja II en el momento en que el cigarro es apenas visible. La edad o el estadio de crecimiento en las cuales las plantas son muestreadas, el rango de hoja elegida, la porción de hoja y el estado de desarrollo del cigarro fueron definidos por una normalización.

Para la interpretación del análisis, se utiliza para cada elemento un rango de niveles óptimos mejor que un único nivel crítico, debido a las fuertes fluctuaciones de ciertos elementos, debido en gran parte a la pluviometría. Se sugiere que para atenuar los efectos de las diferentes pluviosidades podría ser utilizada la irrigación. Por otra parte, podrían tomarse muestras solamente cuando la pluviosidad no es un factor limitante.

Las comparaciones se han efectuado entre la técnica descrita y algunos aspectos de las sugeridas por MARTIN-

actuelle d'échantillonnage et certaines de celles suggérées par MARTIN-PREVEL (1974) pour l'étude d'une Méthode d'Echantillonnage internationale de Référence (M.E.I.R.), en particulier les sections «internes» proches des nervures centrales, proposées en vue de surmonter les effets dus aux dégâts des vents. On a trouvé des différences plus prononcées entre la technique jamaïcaine actuelle et les sections «internes» des feuilles I, II et III qu'entre cette technique et la section «médiane entière» de la feuille III, sur plants non fleuris comme sur plants fleuris des variétés 'Giant Cavendish' et 'Valéry'.

Des difficultés ont été rencontrées pour la reconnaissance, extérieurement, du stade «différenciation florale». L'usage de la «dernière feuille vivante» dans une méthode d'échantillonnage pourrait poser des problèmes, en raison de pratiques culturales exigeant la suppression des plus vieilles feuilles, susceptibles de se briser ou de causer des dommages au régime en cours de développement. L'utilisation de nervures et pétioles comporte l'enlèvement de portions substantielles de feuilles ou de feuilles entières, et pourrait causer des difficultés dans les parcelles expérimentales.

On a besoin de fourchettes de teneurs adéquates pour des plants de différents âges ou stades de croissance, particulièrement pour le conseil de fertilisation sur les premiers cycles après plantation. Il faut prendre garde au danger d'une normalisation excessive, car l'adoption d'une technique trop rigide pourrait ne pas aboutir aux effets utiles qu'on attend d'elle, en raison des difficultés de son emploi.

PRÉVEL (1974) para el estudio de un Método de Muestreo internacional de Referencia (M.E.I.R.), en particular las secciones internas próximas al nervio central, propuesto para subsanar los efectos de rompimiento de las hojas debidos al viento. Se han encontrado diferencias más pronunciadas entre la técnica jamaicana actual y las secciones internas de las hojas I, II y III que entre esta técnica y la sección «media entera» de la hoja III tanto sobre plantas sin flor como con flor en las variedades 'Gran Cavendish' y 'Valery'.

Se encuentran dificultades en el reconocimiento externo de la diferenciación floral. El empleo de la «última hoja viva» en un método de muestreo podría traer problemas por motivos de las prácticas culturales tendentes a eliminar las hojas más viejas por causar daño al racimo durante su desarrollo. La utilización de nervios y pecíolos comporta la eliminación de partes substanciales de la hoja o de la hoja entera y podría causar dificultades en las parcelas experimentales.

Es necesario establecer un rango de niveles óptimos para las plantas de diferente edad o estadio de desarrollo, particularmente para las recomendaciones de fertilización en los primeros ciclos de una nueva plantación. Es necesario estar en guardia sobre los peligros de una normalización excesiva, pues la adopción de una técnica demasiado rígida podría ser poco útil por causa de sus dificultades de empleo.