Some factors related to yield components of bananas, in relation to sampling to assess nutrient status.

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ALGUNOS FACTORES QUE GUARDAN RELACIÓN CON LA PRODUCCIÓN DE BANANAS EN RELACIÓN CON EL MUESTREO PARA LA EVALUACIÓN DEL ESTADO NUTRITIVO.

QUELQUES FACTEURS LIES AUX COMPOSANTES DU RENDEMENT DU BANANIER, EN RELATION AVEC L'ECHANTILLONNAGE POUR EVALUATION DE L'ETAT NUTRITIONNEL

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RESUME - Le stade mi-floral de la croissance de la plante (plante à l'état reproductif mais régime non encore émis) est suggéré comme physiologiquement le meilleur pour l'échantillonnage du bananier en vue de l'analyse foliaire. La surface des feuilles émergeant dans cette période s'est montrée corrélée positivement avec le nombre total de fruits par régime. Le produit surface x durée des trois dernières feuilles s'est montré lié au poids moyen du fruit. Le choix d'une feuille particulière dans la séquence ontogénétique n'est pas important car les concentrations en éléments nutritifs montrent de faibles variations pendant cette période de la croissance.

INTRODUCTION

When sampling for banana leaf analysis a particular stage of plant growth is usually chosen. Choice of a particular growth stage has been based on ease of identification (HEWITT, 1955) or on observed changes in concentrations of nutrients during plant growth (MARTIN-PRÉVEL, 1964 ; TWYFORD and COULTER, 1964 ; TURNER and BARKUS, 1974). A choice of plant growth stage with a more physiological base may be better if certain growth phases are more closely correlated with yield. SUMMERVILLE (1944) found that the time during the appearance of the three leaves before the bunch was important in determining yield and established a correlation between the area of the last three leaves, T_S (a crude measure of assimilation) and the number of fruit per bunch.

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The determination of critical periods during ontogeny would assist in the development of a sampling standard for leaf analysis and may provide a physiological basis for samples to be included in a «méthode d'échantillonnage internationale de référence» (MEIR) (MARTIN-PRÉVEL, 1974).

Yield in the banana is a function of the total number of fruit on the bunch (f_B) and the mean fresh weight of those fruit (w_f). f_B is determined by events before bunch emergence (SUMMERVILLE, 1944) while w_f would be related to the photosynthetic activity of the leaves nearest the bunch. Relationships between leaf areas and f_B could be expected during the pre-emergence phase of bunch growth while the w_f component would be influenced mainly by post bunch emergence events.

Data from two experiments conducted at the Tropical Fruit Research Station, Alstonville (Lat. 28°51'S) provide a base for the establishment of likely critical periods of growth using simple measurements of leaf area, yield and

potential evaporation.

MATERIALS AND METHODS

Leaf area and yield measurements were made in two experiments. Experiment 1 was a sand culture experiment described elsewhere (TURNER and BARKUS, 1980) and experiment 2 was carried out in a high yielding plantation described by TURNER and BARKUS (1974).

The area of each leaf (a) in the ontogenetic sequence was calculated from

$$a = 0.83\,1\,b$$

where l is the length of the lamina and b its width at the widest point (CHAMPION, 1967).

Yield was divided into a number of components - fruit number per hand (f_h), hand number per bunch (h_B) and mean fresh weight of individual fruit (w_f). Then the total number of fruit per bunch (f_B) and the total fresh weight of the bunch (w_B) are

$$f_B = f_h \times h_B$$

and $$w_B = f_B \times w_f$$

In experiment 1 measurements of a, f_B, h_B, f_h and w_B were made on 36 plants over 3 crop cycles. In experiment 2 similar measurements were made on 14 plants but the area of only the last ten leaves to emerge were measured. The longevity of the last three leaves to emerge before bunch emergence was measured on all three crops in experiment 1. The number of leaves produced by the ratoon crop at the bunch emergence of the parent estimated the stage of growth of the sucker. Potential evaporation (E_o) during bunch growth was estimated from meteorological data collected 150 m west of the site using the tables of Mc CULLOCH (1965).

Leaf area duration (A_d) was calculated from

$$A_d = t\,(a_1 + a_2 + a_3)$$

where t was the time from bunch emergence to harvest and a_1, a_2 and a_3 the area of the last three leaves.

The correlation between the area of individual leaves and f_B in both experiments was assessed using the least squares method. Using multiple regression techniques the correlation between potential evaporation, leaf area duration of the last three leaves, number of leaves on the sucker (L_s) and w_f in experiment 1 was determined.

RESULTS

In experiment 1 the area of the third last to the eighth last leaves was closely correlated with f_B (Fig. 1). In the plant crop the third, fourth and fifth last leaves were more closely correlated with f_B than any others. In ratoon crops the areas of leaves -6, -7, -8 and -9 (ratoon 1) and -5, -6 and -7 (ratoon 2) were more closely correlated with f_B than -3, -4 and -5 (Fig. 1).

Individual fruit weight, w_f, was correlated with A_d, E_o and L_S as follows ,

$$w_f = -12{,}38 + (0{,}327 \pm 0.026)A_d + (14.32 \pm 1.96)E_o - (1.612 \pm 0.207)L_S \qquad r^2 = 0.73\ **$$

The range and units of each of the variables were :

A_d	40 - 500	$m^2\ d$
E_o	1.5 - 4.9	$mm\ d^{-1}$
L_S	0 - 32	
w_f	6 - 185	g

A_d alone accounted for 36 percent of the variation in w_f. The inclusion of E_o increased it to 58 percent and L_S to 73 percent. When the area of the third, fourth and fifth last leaves and the data from experiment 2 were added about 92 percent of the variation in f_B was accounted for (Fig. 2).

DISCUSSION

The correlation between the areas of the third to eighth last leaves and total fruit number per bunch suggests that the mid-floral stage of growth is a critical stage in the determination of f_B, an important component of yield. The relationship may not be causal as both leaf areas and f_B may be affected by a common factor. The question of causality is unimportant in a sampling context.

In ratoon crops it would probably be best to select the sixth or seventh last leaves for sampling while in the plant crop the third, fourth or fifth last leaf would be more suitable.

The area and longevity of the last three leaves was closely correlated with the fresh weight of individual fruit. Because of the influence of potential evaporation (E_o) and the growth stage of the ratoon sucker (L_S) it is impossible to define a fixed growth stage which could be regarded as critical in the determination of yield (w_B). The most satisfactory time was the mid-floral stage because of its influence on f_B.

The selection of this stage of growth raises the problem of determining its occurrence since the total number of leaves produced by the plant varies (TURNER, 1970). Of the various methods reviewed by MARTIN-PRÉVEL (1974), that used in the Windward Is. and Lebanon (sampling one to two months before emergence) has the best physiological base. Since the concentrations of nutrients in the leaf dry matter do not vary greatly during this stage of growth

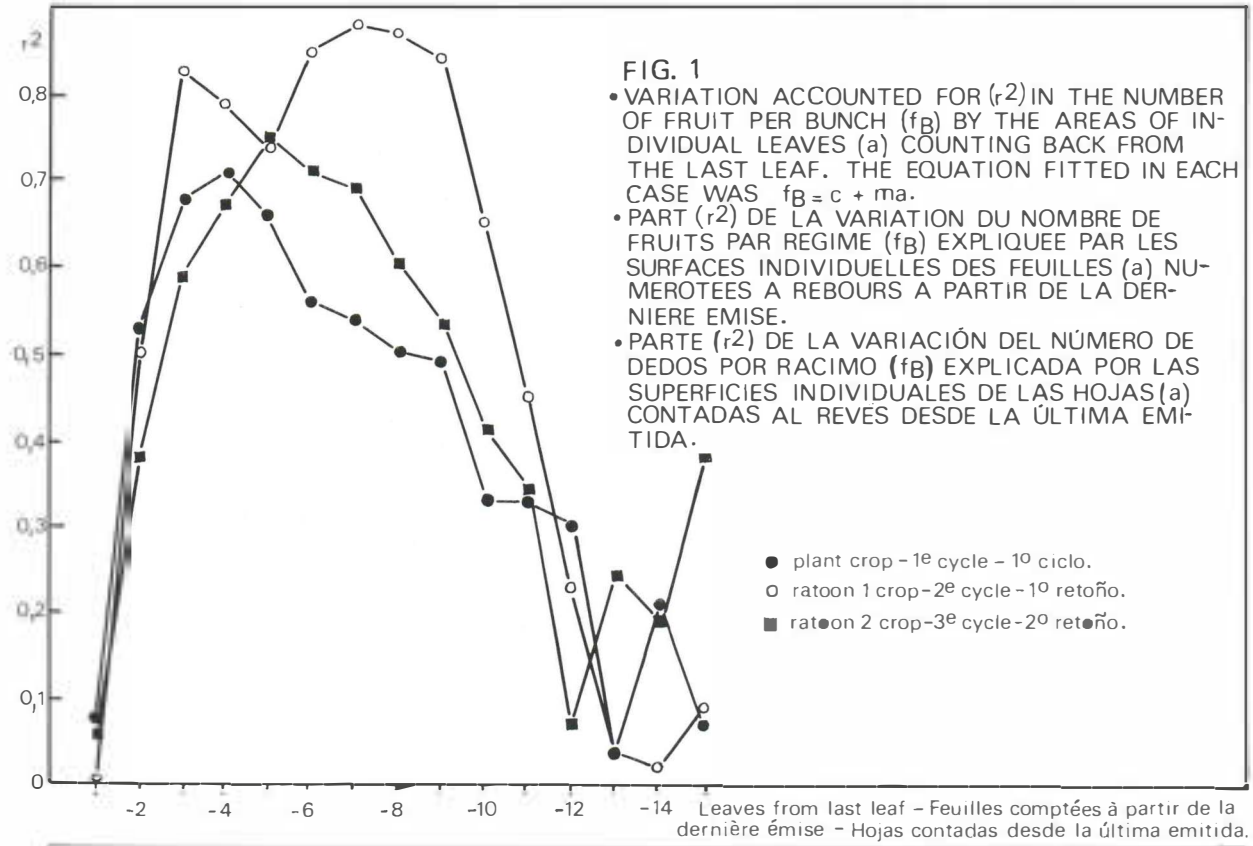

FIG. 1
- VARIATION ACCOUNTED FOR (r^2) IN THE NUMBER OF FRUIT PER BUNCH (f_B) BY THE AREAS OF INDIVIDUAL LEAVES (a) COUNTING BACK FROM THE LAST LEAF. THE EQUATION FITTED IN EACH CASE WAS $f_B = c + ma$.
- PART (r^2) DE LA VARIATION DU NOMBRE DE FRUITS PAR REGIME (f_B) EXPLIQUEE PAR LES SURFACES INDIVIDUELLES DES FEUILLES (a) NUMEROTEES A REBOURS A PARTIR DE LA DERNIERE EMISE.
- PARTE (r^2) DE LA VARIACIÓN DEL NÚMERO DE DEDOS POR RACIMO (f_B) EXPLICADA POR LAS SUPERFICIES INDIVIDUALES DE LAS HOJAS (a) CONTADAS AL REVES DESDE LA ÚLTIMA EMITIDA.

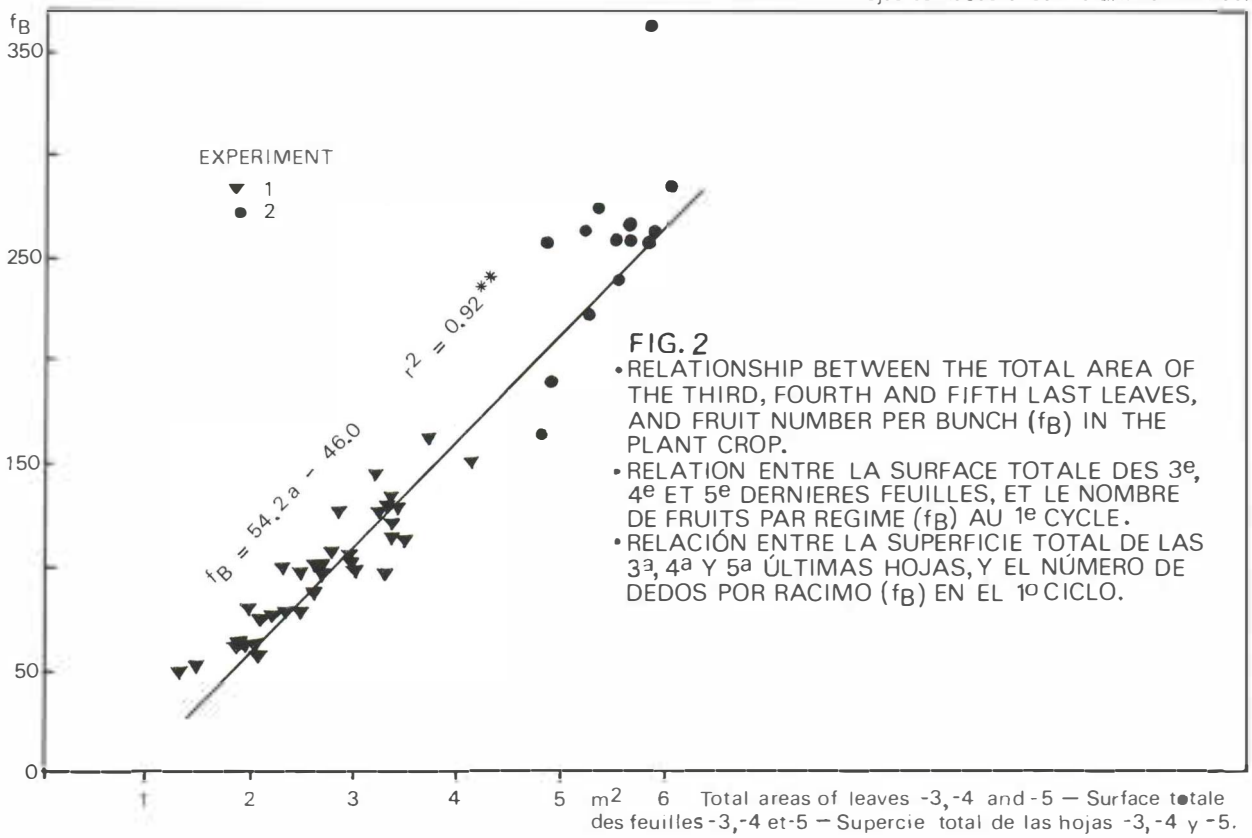

FIG. 2
- RELATIONSHIP BETWEEN THE TOTAL AREA OF THE THIRD, FOURTH AND FIFTH LAST LEAVES, AND FRUIT NUMBER PER BUNCH (f_B) IN THE PLANT CROP.
- RELATION ENTRE LA SURFACE TOTALE DES 3e, 4e ET 5e DERNIERES FEUILLES, ET LE NOMBRE DE FRUITS PAR REGIME (f_B) AU 1e CYCLE.
- RELACIÓN ENTRE LA SUPERFICIE TOTAL DE LAS 3a, 4a Y 5a ÚLTIMAS HOJAS, Y EL NÚMERO DE DEDOS POR RACIMO (f_B) EN EL 1o CICLO.

(TWYFORD and COULTER, 1964 ; TURNER and BARKUS, 1974) it would not be necessary to determine it accurately. In tropical areas leaves emerge at the rate of one leaf every 10 days while during winter in the subtropics it may take 30-40 days for a leaf to emerge (TURNER, 1971). Sampling over a range of 3-4 leaves allows plenty of flexibility as at least one month is available (the time period for 3-4 phyllochrons in the tropics).

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QUELQUES FACTEURS LIES AUX COMPOSANTES DU RENDEMENT DU BANANIER, EN RELATION AVEC L'ECHANTILLONNAGE POUR EVALUATION DE L'ETAT NUTRITIONNEL

L'échantillonnage du bananier pour l'analyse foliaire est habituellement effectué à un stade de croissance qui est, soit facilement reconnaissable, soit caractérisé par des concentrations stables en éléments nutritifs. Une autre solution serait de choisir dans la séquence ontogénétique un stade que l'on puisse démontrer comme étroitement corrélé avec le rendement.

Des expériences à la Station de Recherches des Fruits tropicaux d'Alstonville (Nouvelle Galles du Sud,lat.28°51'S) ont montré que la surface des troisième à huitième dernières feuilles à émerger était étroitement corrélée avec le nombre total de fruits par régime, en premier cycle et en rejeton. Une autre composante du rendement, le poids moyen frais du fruit, était corrélée avec le produit surface x durée des trois dernières feuilles, l'évaporation potentielle et le stade de croissance du rejet.

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El muestreo foliar del banano para el análisis foliar se hace habitualmente en un estado de crecimiento que sea fácilmente reconocible, o en un estado de concentraciones estables de los nutrientes. Otra solución sería la de elegir en la secuencia ontogénica un estadio en el que se demuestre que su estado nutritivo está relacionado con la producción.

Experiencias realizadas en la Estación de Investigación de Frutos Tropicales de Alstonville (Nuevas Gales del Sur, lat. 28°51'S) han mostrado que la superficie de la tercera a la octava últimas hojas estaba estrechamente relacionada con el número total de dedos por racimo, en primer ciclo y en retoño. Otro componente del rendimiento, el peso fresco del dedo, estaba correlacionado con el producto de la superficie por la duración de la vida de las tres últimas hojas, la evaporación potencial y el estado de crecimiento del hijo.

Ces données suggèrent que, à cause de ses relations avec le rendement, le stade mi-floral (plante à l'état reproductif mais régime non encore émis) pourrait être physiologiquement le meilleur moment pour échantillonner le bananier en vue de l'analyse foliaire. Toutefois, cette période est difficile à détecter avec précision, car le nombre total de feuilles produites par la plante est variable. Heureusement, les variations de concentration des éléments nutritifs sont faibles pendant cette période ; une détermination précise du stade n'est donc pas nécessaire.

Estos resultados sugieren que el estado antes de la floración («mid-floral» : planta en fase reproductiva pero racimo ya no emergido) podría ser fisiológicamente el mejor momento para el muestreo del banano para su análisis foliar. Sin embargo, este período es difícil de detectar con precisión pues el número total de hojas emitidas es variable. Felizmente, las variaciones de concentración de los elementos nutritivos son pequeñas durante este período ; no es necesario, pues, una determinación precisa del estadio de desarrollo.