Mineralisation of the bunch in the hybrid coconut PB-121, from the flower to maturity

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I. — INTRODUCTION

The hybrid coconut PB-121, better known in the Far east as the « Mawa », is now very widely used in coconut development programmes in Africa, South America and Asia.

This is due to its hardiness, its precocity and its excellent yield characteristics, confirmed in very different environments [Vanialingam, Khoo, Chew, 1978 (1) ; Chan, 1979 (2) ; Sangaré and Rognon, 1980 (3)].

Because of its widespread use, the fertilization of the PB-121 is the subject of numerous studies. Most often, the problem is approached in standard fashion by mineral nutrition experiments, of which certain results have been published [Coomans, 1977 (4) ; Rosenquist, 1980 (5)].

Simultaneously, research is pursued on the Marc Delorme Station to gain greater knowledge of the plant's physiology :

— development of dry and mineral matter in the PB-121 from planting to maturity ;
— mineral balance of yield exports [Ouvrier and Ochs, 1978 (6)] ;
— influence of manuring on exports by the harvest ;
— study of mineralisation of bunch from flower to maturity.

This last point is important *a priori* for a better approach to the development in time of the plant's mineral element needs. It is known, in fact, that yield can vary considerably from one year to the next according to the climatic factors in particular.

The present article recapitulates the main results obtained in this domain.

II. — MATERIAL

The observations were made in January 1978 on 10 trees chosen for the study of mineral exports [6] ; they were PB-121 hybrids growing on plot S 31 at the Marc Delorme Station in the Ivory Coast, planted in 1963 at a density of 143 trees/ha. The yield of this plot during the 1977/78 season was 4.4 tons of copra/ha, equivalent to a harvest of 151 nuts/tree/year with an average copra of 217 g/nut.

III. — METHODS

1. — Sampling.

All the bunches from the unopened spathe (conventionally Frond 9) to the bunches which have dropped to the ground were taken at the rate of one tree per day.

The different bunch components (stalk, spikelets, husk shell and albumen) were separated for the determination of the fresh and dry weight.

On young fruit it was accepted that there would only be husk ; as soon as possible, the shell and husk were separated. The water was drained off in all cases ; the albumen was sampled as soon as the solid phase started.

For the stalks and spikelets, the dry weight is determined on all the fresh matter, and the same applies to the nuts of fronds 9 to 13. Then it is calculated for each nut on sub-samples by the following method :

— for shell and albumen, on about 1/8th. in volume,
— for husk, a whole slice about 2 cm thick is removed.

2. — Preparation of samples and analysis.

All the samples are chopped into pieces and oven-dried at 105 °C for 36 hours. After that, the dry weight is determined.

The samples of the 10 coconuts are regrouped for each bunch and each component. Except for the albumen, they are ground in a Gondard hammer mill so that they are well homogeneized. An aliquot part is taken and sent to the Mineral Analysis Laboratory (GERDAT, Montpellier) for titration of the major elements (N, P, K, Ca, Mg, Na, Cl and S).

For each component corresponding to a sample sent for analysis the dry weight is determined for the 10 coconuts ; the results serve for the calculation of the mineral masses.

IV. — RESULTS - DISCUSSION

1. — Number of nuts per bunch (Fig. 1).

Variations from bunch rank 14 onwards are not very large and cannot induce « dilution effects » on mineral element levels.

2. — Development of total dry matter (Fig. 2).

There is a large increase in dry matter between bunches rank 14 and 18, mainly due to husk and corresponding to the nut growth phase.

The start of this phase and the differentiation between husk and shell coincide, both components growing rapidly and then stabilizing. The end of the phase leads into the formation of albumen, which increases regularly thereafter.

It should be noted that pollination occurred on bunch rank 11, whereas harvesting is usually done from rank 26 on.

3. — Evolution of mineral element levels (Figs 3-9).

In the stalk and spikelets the contents vary little with bunch rank for any element.

In the shell and albumen they are very high at the time of formation ; they decline regularly up to bunches rank 18-20, and are stable after that.

The same applies to the husk, except for **chlorine** and **potassium,** levels of which vary little around a mean (a sine curve with a descending phase from 9-16, an ascending one from 17-22, descending again beyond rank 23).

4. — Evolution of the total quantity of each element.

a) In the whole bunch (Figs 10-12).

For all elements, the total amount immobilized in the bunch increases considerably between ranks 14 and 18, a period of rapid nut growth linked to high mineralisation. Stabilization follows and lasts until maturity for certain elements (nitrogen, phosphorus, sodium and sulphur), or is followed by a reduction in the total quantity (potassium, chlorine, magnesium and calcium).

It will be seen that the most important elements are potassium, chlorine and nitrogen. The annual export by the bunch (husk, shell and albumen) per ha planted is shown in Table I.

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(1) I.R.H.O. ATS Marc-Delorme Coconut Station, 07 B.P. 13 Abidjan 07 (Ivory Coast).

b) For each bunch component (Figs 13-19).

The relative proportion of each component varies according to the element and can be modified during ripening, the overall development being the result of reshuffling between the components.

To be noted is the increase in nitrogen, phosphorus and sulphur in the albumen in the course of its development (bunches rank 17-22), partially compensated by a reduction in the same elements in the husk. Much the same thing occurs for magnesium, but to a lesser extent.

The husk is always preponderant for potassium, calcium and chlorine.

5. — Discussion.

Unfortunately there is no analysis of the leaves supporting the bunches. Such analyses might have provided an explanation of the evolution in the quantities of elements in function of bunch rank or from one component to another within the same bunch.

The absence of replications over a period of time makes it tricky to interpret certain results. For example, it could be advanced that the increase of total potassium and chlorine in bunches 18-22 corresponds to an active absorption phase following fertilizer application. Nonetheless, this is not very likely, as manuring is split each year, April and August, and there should therefore be two peaks on the curves.

CONCLUSIONS

The stalk and spikelets reach their final development just after the spathe opens, and their mineral matter is constant thereafter.

For the nuts, the interval between bunches 12 and 18 corresponds to a period of very substantial increase in dry matter consequent on **strong mineralisation**, and that, even though the contents (p. 100 dry matter) diminish during this time.

Beyond bunch 18, the quantity of mineral matter immobilized increases no more overall, although there is a certain reshuffling between the various components (deposit of albumen). The practical implication of this observation is important, because it must be admitted that any further fertilizer dressing will have **no incidence** on bunches of ranks above 18 ; now, they represent about 65 p. 100 of the harvest for the coming year. To calculate manuring according to the uncut crop, with simple restitution of exports, therefore turns out to be a bad method.

On the contrary, manuring recommendations should be aimed at the maintenance of the tree's mineral status at an **optimum** level or its correction to that level, so that it is able to cover its needs for its production in the following years. Precisely, leaf analysis enables this status to be appraised, and is therefore a good approach to the problem.

In bunches of ranks above 18, there is a considerable change in balance between the two main components which interest the planter : husk and albumen. The albumen continues to fix nitrogen, phosphorus and sulphur ; simultaneously, the husk becomes poorer in these elements.

It would be risky to affirm that there is a transfer of husk towards the albumen, as we have no data on the mineral evolution of the corresponding leaf. Nevertheless, this does draw attention to the husk as a regulating organ of the mineral matter.

Finally, let us mention that the drop of unripe nuts because of climatic accidents (drought, cyclones) or pest attacks (rats) leads to the export (at least temporarily) of large quantities of potassium, chlorine and magnesium. In the same way, to exploit a coconut grove solely for ' comestible nuts ' is equivalent to exporting larger quantities of these elements.