exportations ne représentent cependant qu'une partie, de loin la plus importante, des besoins totaux du cocotier. Les immobilisations à long terme dans le stipe et les racines, et à court terme dans les feuilles, sont en cours d'étude et viendront compléter très prochainement ces premiers résultats qui permettent déjà d'orienter les programmes de fumure à long terme de ce nouveau matériel végétal.

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### SUMMARY

**Mineral Exportations of the hybrid Coconut Port-Bouet 121.**

M. OUVRIER and R. OCHS, *Oléagineux*, 1978, **33**, N° 8-9, p. 437-443.

Mineral exportations of the hybrid coconut Port-Bouet 121 were measured in the Port-Bouet experimental station. Potassium and chlorine dominate, with 193 and 125 kg/ha/year respectively, followed by nitrogen (108 kg). Albumen, and consequently copra, the useful part of the harvested nuts, withdraw large quantities of nitrogen (74 p. 100 of the total exported), but on the other hand, it is the husk which is responsible for the greater part of the potassium exportations (60 p. 100). In conclusion, the authors propose formulae for calculating the exportations in function with the yield.

### RESUMEN

**Exportaciones minerales del cocotero híbrido Port-Bouet 121.**

M. OUVRIER y R. OCHS, *Oléagineux*, 1978, **33**, N° 8-9, p. 437-443.

En la estación experimental de Port-Bouet se midió las exportaciones minerales del cocotero híbrido Port-Bouet 121. Hay un predominio del potasio y del cloro, con 193 y 125 kg/ha/año respectivamente ; seguidamente viene el nitrógeno (108 kg). El albumen y por lo tanto la copra, que es la parte útil de los racimos cosechados, ocasionan una importante exportación de nitrógeno (74 % del total exportado), y en cambio conviene achacar a la borra la mayor parte de exportaciones de potasio del cocotero (60 %). Como conclusión los autores proponen fórmulas que permiten calcular las exportaciones con arreglo al rendimiento.


# Mineral Exportations by the hybrid Coconut « Port-Bouet 121 »


M. OUVRIER (1) and R. OCHS (2)


The Yellow Dwarf × West African Tall hybrid coconut palm known as PB-121 [M. de Nuce de Lamothe and F. Rognon, 1975] is capable of producing up to 6 t of copra/ha per year by 8 years old on the coastal sands of the Ivory Coast (Table I). Its productivity is thus much greater than that of the West African Tall, which cannot surpass 3.5 t/ha/year under the same conditions.

The spectacular rise in the potential of the new planting material obviously results in increased uptake of mineral elements from the soil, and consequently in greater fertilizer requirements, particularly in the very poor sandy soils of the off-shore bar where the first hybrids used in this study were planted (Table II).

The mineral elements absorbed by a plant have several destinies : some of them are exported definitively in the bunches ; some are immobilized for several decades in the stem and roots ; finally some are restored to the soil sooner or later in the fallen leaves. By far the graatest quantities are removed with the harvest, and thus it was necessary to measure them to find out the nutrient requirement as a basis for a new fertilizer policy adapted to the potential of the new planting material, which is incomparably more productive than the old.

The study of the immobilized elements is in progress, and will soon make it possible to complete and define the mineral needs of the hybrids.

## MATERIAL AND METHODS

This study was begun in November of 1974 on 10 trees chosen as representative of the whole of plot 31 in Port-Bouet, which was planted in 1963 in the first Yellow Dwarf × West African Tall hybrids. The production of these ten trees over the year of study averaged 217 nuts/tree (15 bunches), that is 49 kg of copra per tree, or 6.7 tonnes of copra per hectare. Fertilizer applications since planting are shown in table III.

The ripe bunches are cut each month, and each bunch treated as follows : the stalk, the spikelets and the nuts are weighed ; the nuts are stored in a warehouse for one month ; nuts are dehusked and weighed, the water is removed, and a second weighing is done, the difference between the two being the weight of the husk and water after storage ; the half-nuts are dried in Wanson ovens to simulate copra preparation, and the copra and shell are weighed ; the stalk, spikelets and sliced husk are dried for 36 hours in an infra-red oven to determine the dry weight (the shell being considered dry on removal from the Wanson oven) ; the residual humidity of the copra oven dried at 105 °C. is measured according to the international method.

The various components of the bunches harvested monthly from these ten trees are then ground up and mixed together to give a mean sample of stalk, spilelet, husk and shell. For the copra, 1/8 of each nut is retained. These monthly average samples are then sent to the mineral analysis laboratory for determination of N, P, K, Ca, Mg, Na, Cl and S.

## RESULTS

### 1. — Weighted average composition of the bunch.

During the year of observation, 155 bunches bearing 2 186 nuts were harvested from the 10 trees selected. The average composition of a bunch in fresh and dry weight is given in table IV. At harvesting, the nuts represent virtually all the weight of the bunch ; 94 p. 100 ; they lose between 10 and 20 p. 100 of their weight in moisture during storage (average 15.5 p. 100). The fresh albumen contains 88 p. 100 water on dry weight ; this humidity drops to 6 p. 100 on dry weight after oven drying to produce copra.

In dry weight, the dominant weight is that of the husk (42 p. 100), followed by that of the albumen (34 p. 100) and the shell (20 p. 100).

The individual variability of the relative composition of the bunches is not great (the coefficient of variation is 2.5 p. 100 for the shell, 6 p. 100 for the husk, 7.7 p. 100 for the copra), except for the stalk and spikelet (c. v. 30 p. 100) which represent, in fact, only 4. 5 p. 100 on the total dry weight of the bunch.


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**2. — Seasonal variations in the weighted composition of the bunch.**

The monthly production of bunches and nuts varies during the year, with a peak in February, March, and April, when 35 p. 100 of annual nut production occurs. This variation depends to a great extent on the number of nuts per bunch, which varied between 4 and 23 during the period of observation, the two peak periods being in March and August. The average nut weight varied widely inversely from 856 g in the low production periods to 496 g in the second peak period (August) (Fig. 1).

Although considerable in absolute value, these seasonal variations had but a very limited effect on the weighted composition of the bunch, but it was noted that the large nuts produced during the low yield period had much more husk than copra (45 p. 100 compared to 29 p. 100), while the smaller nuts produced during August had as much copra as husk (38 p. 100).

**3. — Mineral composition of the bunch.**

The mineral content of the plant material varies considerably from one organ to another ; the maximum content is in the spikelets (7.3 p. 100), the minimum in the shell (0.5 p. 100) (Table V). The various mineral elements are unequally represented, but potassium and chlorine alone account for more than 60 p. 100 of the total content in all the organs except the albumen, which is particularly rich nitrogen and phosphorus (proteins).

**4. — Seasonal variations in mineral composition.**

The monthly analyses showed that the seasonal variations in content are relatively small except for the elements present in the smallest quantities, whose effect on exportations was negligible. In other words, the monthly yield increases are not followed by a fall in the levels. Figure 2 gives an example of the monthly variations in potassium content in the various components of the nut ; the extreme variations from the mean value are :

- — 19 to + 15 p. 100 in the husk,
- — 30 to + 19 p. 100 in the albumen,
- — 21 to + 24 p. 100 in the shell.

They are not related to yield variations.

## INTERPRETATION

**1. — Annual exportations.**

The total quantities of elements exported by these 10 trees over the year are expressed in grams per tree in table VI and in kg per hectare in table VII. ***Potassium*** and ***chlorine*** dominate with 193 and 125 kg/ha/year respectively, which partly explains the importance of these elements in the mineral nutrition of the coconut. The poverty of lateritic soils in potassium and the high requirements of the plant explain easily why potassium is by far the dominant element in fertilizers [Ochs and Ollagnier, 1977]. This was the first time exports of chlorine had been measured, and they were found to be very high, which partly explains the deficiencies observed in certain regions in spite of the fact that this element is relatively abundant in nature [Ollagnier and Ochs, 1971 ; Magat S. S. *et al.*, 1975].

***Nitrogen*** comes third with 108 kg/ha/year, followed by sodium, phosphorus, magnesium, calcium, and sulphur, in that order, the quantities ranging from 20 to 9 kg/ha/year.

It is interesting to note that the fertilizers applied to the observation plot compensated potassium exports practically in proportion to the amount lost.

This abundant fertilization is justified by the extreme poverty of the coastal sands in exchangeable potassium (Table II). On the contrary, nitrogen applications were well below requirements without the slightest deficiency symptom appearing ; it must be admitted that the soil is capable of furnishing a large part of the need, in spite of its poverty in total nitrogen. Can it be suspected that the biological fixation of atmospheric nitrogen is responsible for this exploit ?

The albumen, and consequently the copra, the useful part of the harvest, is responsible for considerable removal of nitrogen (74 p. 100 of the total exported), phosphorus (87 p. 100), and sulphur (67 p. 100), but only 24 p. 100 of the potassium. It is the husk which removes most of the potassium (60 p. 100) ; it is sometimes used for making coil or for fuel, but however this may be, it costs a lot in potassium fertilizers, and efforts should be made to restore it to the soil, at least in the form of ashes. Indeed it can be imagined that in future geneticists will try to modify nut composition to the benefit of albumen and the detriment of the husk, even if the yield in copra remains the same, so as to reduce the mineral removal.

The quantities of elements exported by the hybrid PB-121 are considerable, but they correspond to an exceptional yield. If they are compared to the values obtained by Pillai and Davis [1963] for much less productive material, it is seen that they are about the same per tonne of copra.

These exports were measured in a plot which is well fertilized judging by the leaf contents, which are equal to if not slightly higher than the critical levels now being arrived at in the first fertilizer experiments at Port-Bouet on this new planting material. To find out whether they were slightly overestimated by « luxury » consumption, the same observations in simplified form were undertaken this year in a few experimental plots on a factorial experiment in Port-Bouet.

**2. — An attempt at extrapolation.**

The study of monthly variations indicates that the weighted composition of the bunch does not vary perceptibly between the peak and low yield periods. The same is true of mineral composition. If we now consider that the monthly yield variations are a valid reflection of geographic variations in potential, it is possible to calculate the annual removal for a larger or smaller production than those of the trees studied, taking it that the proportions of the bunch components and the mineral elements remain the same. This results in the following formulae, which give a quantity Y of exported elements in kg/ha in function of a yield X of copra, expressed in tonnes/ha :

— N ... $Y = 3.2 + 15.4\,X$
— P ... $Y = 0.5 + 2.1\,X$
— K ... $Y = 19.5 + 25.5\,X$
— Ca ... $Y = 1.6 + 1.1\,X$
— Mg... $Y = 2.8 + 1.8\,X$
— Na... $Y = 4.4 + 2.3\,X$
— Cl ... $Y = 15.6 + 16.0\,X$
— S ... $Y = 0.6 + 1.2\,X$.

These formulae must be utilized with caution when there is too great a variation from the average production of the plot studied (6 t of copra/ha/year), particularly in the low yield zones where there is probably a higher proportion of husk than of albumen, resulting in a greater uptake of potassium. Exports of N, K, P and Mg are shown in graphic form in figure 3.

To give an idea of the corresponding fertilizer consumption, the fertilizer equivalent of these exports can be calculated for several production hypotheses (Table VIII).

## CONCLUSIONS

The quantities of mineral elements removed by the high yields of the hybrid coconut PB-121 are obviously larger, in particular as regards potassium and nitrogen, than those admitted heretofore and observed in similar experiments conducted on the lower-yielding Talls. These exports, however, represent only a part of the total requirements of the tree, albeit the most important by far. Long-term immobilization in the trunk and roots, and short-term immobilization in the leaves are now being studied, and the results will very shortly complete those of the first experiments, which themselves already provide guidelines for long-term manuring of this new planting material.

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**Erratum**

Dans le résumé de l'article intitulé « Etude des facteurs d'amélioration de la production d'arachide dans la région de la N'Gounié au Gabon », paru dans *Oléagineux*, de juin dernier, page 291, à l'avant-dernière ligne à la place de : « trois herbicides... » il faut lire : « trois fongicides (Benlate, Bravo, Duter)... ».