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A PRESENTATION OF LEAF ANALYTICAL DATA OF CACAO, OBTAINED FROM A FERTILIZER TRIAL IN NETHERLANDS NEW GUINEA[1])

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SUMMARY

An account is given of preliminary results obtained from a fertilizer experiment with young cacao, which was laid out as the first one of a series field trials in Netherlands New Guinea.

A comparison was attempted between the knowledge obtained from soil analyses and the information derived from leaf analyses with regard to the nutritional demands of cacao on a certain soil type.

It appeared that the soil analytical prognosis was confirmed and supplemented by the leaf analytical data. Particularly, both methods provided strong evidence that the phosphate and magnesium status of soil and crop needed correction.

Although of simple design, the experiment confirms the point that leaf-analysis should not be seen as an alternative to soil-analysis but as a complementary method.

INTRODUCTION

In Netherlands New Guinea the planting of Cacao is still in an initial stage of development. The trees have been planted on various soil types. It is intended to have the most important of these soil types tested on their fertilizer requirements for cacao by means of properly controlled, permanent field experiments. The outcomes of these trials will also provide a check on the validity of soil analytical prognosis which is carried out at the beginning. Simultaneously, a study will be made of the use of leaf analysis for diagnosing the nutrient requirements of the trees and the effect of fertilizers.

From extensive research work carried out elsewhere in the world, it has become quite clear that the relationship between fertilizer requirements of the cacao tree and the analyzed nutrient statuts of its leaves, at any time of sampling, is by no means a simple one. Therefore, the experimental lay-out, the observational field procedure and the sampling technique of the intended experimental series will have to be designed according to the findings of previous workers, when testing leaf analytical procedures under New Guinea conditions.

At present, the realisation of this cacao research scheme in Netherlands New Guinea awaits the necessary completion of the still understaffed agricultural research organisation. In the meantime, some preliminary observations and leaf analyses were carried out at an existing experimental site in the neighbourhood of Manokwari on the north coast. The results of this orientative work are recorded underneath.

1) Received for publication January 4, 1960.

EXPERIMENTAL DATA

The experiment used, was previously laid down as an observational trial consisting of four fertilizer treatments, three times replicated. Unfortunately, the treatments were not arranged in a factorial pattern but, being the only available experimental site planted with homogeneous material it had to be accepted in its present form.

The 3 x 4 plots were planted with clonal cacao in Januari 1957, each plot containing 8 rows of 4 trees. The planting distance used was 4 x 4 metres whereby in between the rows *Leucena glauca* was planted as a shade tree. The plots were separated by guard rows.

Soil conditions all over the experimental area proved to be quite homogeneous, as was proved by auger inspection and laboratory analyses. The soil type involved was the Mangoapi sandy loam of the following *analytical features* (top 6 inches):

Table 1

Texture (sandy loam)	64,5 % sand;	29,5 % silt;	6,0 % clay
Soil reaction	pH = 6.1		
Available kat-ions	CaO = 840 ppm;	MgO = 80 ppm;	K_2O = 230 ppm
(in 3 % acetic ac. extr. 10 : 400)	(low)	(low)	(high)
Available phosphate (Truog)	P_2O_5 = 5 ppm (very low)		
Total phosphate	P_2O_5 = 630 ppm (low)		
Total nitrogen	N ≙ 0.14 % (med. low)		

At the first of April 1958 the four fertilizer treatments were *applied:*

P treatment = 200 gr. Double Super 45 % per tree
K treatment = 100 gr. Potassium sulphate per tree
PK treatment = 200 gr. DS + 100 gr. PS per tree
O treatment = no fertilizer applied.

The fertilizers were broadcasted in a circular strip of loosened soil around each tree.

According to the soil analytical data, a positive response to the P-treatment could be expected whereas the potash treatment might show itself in leaf-analysis by luxury consumption and/or interactions with the uptake of calcium and magnesium.

At this time of fertilizer application a first leaf sampling was carried out in the three O-plots. In each plot the 2nd and 6th row were arbitrarily chosen for the sampling. Each sample represented four trees in one row and was composed of 16 leaves: from each tree two fan shoots were selected at random and from these the 2nd and 3rd fully green leaves near the apex were taken.

After sampling the samples were air-dried, petioles discarded, the laminae finely cut-up in small pieces and finally oven-dried at a temperature of 90° C before storing away for further analysis.

On the 29th of July 1959 all 12 plots were sampled in the same way yielding two individual leaf samples per plot or six leaf samples per treatment. At this time it was observed that trees flowered best in the P-plots and second best in the PK-plots.

From the 3 x 4 x 8 = 96 trees per treatment, the following percentages of trees flowering were computed for the four treatments:
O-plots: 20 %; K.-plots: 19 %; P-plots: 50 %; PK-plots: 40 %.

It should be mentioned that rainfall was normal and quite adequate during the months previous to the fertilizer application and afterwards up till the the time of leaf sampling: (see table 2).

Table 2

1958-months	Jan.	Febr.	March	April	May	June	July
Total rainfall mm	409	236	221	699	151	210	260
Total rainy days	15	11	17	14	13	10	9

LEAF ANALYTICAL DATA AND DISCUSSION

The results of the leaf analyses, which were carried out by the Royal Institute for the Tropics in Amsterdam, are presented in table 3 and are expressed as percentages of oven-dry material.

Comparison of the results from the first and second sampling is made in table 4.

Table 4

	O-plots (17/5)	O-plots (29/7)	O-plots (average)	K-plots	P-plots	PK-plots
	1	2	3	4	5	6
Ash	7.5	7.1	7.3 ± 0.50	7.3	7.4	7.9
Ca	0.96	1.10	1.03 ± 0.10	*1.54*	*1.58*	*1.63*
Mg	0.35	0.34	0.35 ± 0.05	0.34	0.35	0.37
K	1.82	2.04	1.93 ± 0.16	2.14	2.12	2.10
P	0.06	0.07	0.07 ± 0.01	0.09	*0.14*	*0.15*
N	1.67	1.63	1.65 ± 0.07	1.80	1.81	*1.89*
K/Ca			1.8	1.4	1.3	1.3
K/Mg			5.6	6.3	6.1	6.0
Ca/Mg ...			3.0	4.5	4.5	4.5
N/K			0.85	0.84	0.85	0.90
N/P			23.6	20.0	*13.0*	12.6
K/P			27.6	23.8	*15.0*	*14.0*

From table 4 it appears that there exists no significant difference between the nutrient status of leaves from O-plots sampled in May and of those which were sampled 10 weeks later. Therefore, it seems justified to put both batches together for the computation of the average nutrient status of the zero plots (column 3). These figures provide a standard or control against which we may gauge the nutrient status of the other, fertilized, plots.

Ash. The ash contents show fluctuations from one sample to the other of approx. 7 per cent. There is a vague indication that the ash content of leaves from PK-plots is increased.

Table 3 Data of the analysis of the first and second sampling.

Percentages	Replicates :						
O-plots (sampling 17/5)	1a	1b	2a	2b	3a	3b	Mean
Ash	7.3	8.2	8.4	6.9	7.1	7.1	7.5
Ca	1.10	0.91	0.94	0.90	0.80	1.10	0.96
Mg	0.35	0.40	0.39	0.27	0.33	0.35	0.35
K	1.80	1.54	1.73	1.86	2.10	1.90	1.82
P	0.06	0.05	0.06	0.07	0.06	0.06	0.06
N	1.65	1.59	1.65	1.85	1.67	1.62	1.67
O-plots (sampling 29/7)							
Ash	7.6	7.6	6.8	7.0	7.2	6.6	7.1
Ca	1.10	1.20	1.00	1.10	1.10	1.10	1.10
Mg	0.40	0.37	0.31	0.34	0.36	0.28	0.34
K	1.84	2.06	2.29	2.05	2.05	2.00	2.04
P	0.07	0.07	0.08	0.07	0.07	0.07	0.07
N	1.63	1.53	1.65	1.60	1.74	1.67	1.63
K-plots (sampling 29/7)							
Ash	8.0	7.6	6.9	7.3	7.1	6.9	7.3
Ca	1.50	1.50	1.82	1.43	1.10	0.90	1.54
Mg	0.33	0.39	0.36	0.31	0.36	0.31	0.34
K	2.14	2.01	2.30	2.42	1.94	2.04	2.14
P	0.08	0.08	0.11	0.13	0.07	0.08	0.09
N	1.82	1.99	1.73	1.63	1.73	1.91	1.80
P-plots (sampling 29/7)							
Ash	7.1	7.3	8.0	7.5	7.3	7.1	7.4
Ca	1.94	2.05	1.70	1.81	1.10	0.90	1.58
Mg	0.27	0.40	0.38	0.36	0.35	0.36	0.35
K	2.50	2.10	1.93	1.92	2.09	2.18	2.12
P	0.16	0.15	0.13	0.16	0.13	0.13	0.14
N	2.08	1.83	1.93	1.90	1.82	2.09	1.81
PK-plots (sampling 29/7)							
Ash	8.2	7.8	7.3	7.9	7.9	9.0	7.9
Ca	2.11	1.82	1.29	1.31	1.59	1.69	1.63
Mg	0.35	0.30	0.38	0.34	0.43	0.39	0.37
K	2.50	2.40	1.98	2.21	1.80	1.72	2.10
P	0.12	0.14	0.17	0.18	0.14	0.13	0.15
N	1.99	1.82	2.20	1.60	1.88	1.89	1.89

Calcium. The Ca-contents of all fertilized plots is definitely higher than the standard, which is believed to be somewhat on the low side. The Calcium, contained in the Double Super may account for this deviation as far as the P-plots are concerned. However, also the K-plots seem to show a higher Ca-intake which is not easily explained.

Magnesium. The intake of Magnesium, which element is in low supply on this soil type, does not show any deviation from the standard a as result of any of the fertilizer treatments. According to standards set up by A. Loué (Centre des Recherches à Bingerville, Côte d'Ivoire),a Mg-content of 0.35 % must be considered to be very low and should be twice to three times as high in fully green mature cacao leaves. It seems that here the leaf analysis provides a clear indication that the availability of Magnesium for cacao on this soil type needs correction.

Potassium. The intake of Potassium is considered to be high already in the O-plots and it looks as if the K-treatment has failed to induce a luxury consumption of this element by the plant. It is not unlikely that the adverse K/Mg ration is hampering the further intake of Potassium.

Phosphorus. The P-treatments are very markedly reflected by a 100 per cent higher P-level in the leaves. This finding confirms the soil-analytical recommendation.

There is a faint indication that the K-treatment has stimulated the intake of phosphate to a slight degree.

Nitrogen. The intake of Nitrogen, which is believed to be of medium level in the standard plots, is somewhat stimulated in the fertilized plots, though not very convincingly.