Coffee Nutrition—Part III. The Sampling of Coffee Leaves for Chemical Analysis.

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ABSTRACT.

A description is given of the method used in Papua and New Guinea for the collection of foliar samples for analysis of essential nutrients. It is stressed that comprehensive field information describing the sample area is essential for accurate interpretation of foliar analysis results and the type of information required is outlined in the paper.

MOST Arabica coffee plantations in New Guinea use considerable amounts of fertilizers each year in their coffee. In general compound fertilizers are used and rates of application vary from a few ounces per bush once a year, to 3 lb. per bush by means of monthly applications.

The preliminary survey of Highland Coffee plantations by Hart [1] showed that there was a great variation in the nutritional status of coffee and the fertility of plantation soils and consequently the requirement for fertilizers was also very variable. The use of fertilizers was seldom based on the requirements of coffee on the plantations; thus in many cases insufficient nutrients were applied, in others some nutrients were being added unnecessarily.

Hart used field data, soil, and foliar analysis for his survey and plantations have had the benefit of advice based on these methods of fertilizer assessment. However, since then conditions may have changed considerably on plantations and follow-up investigations are necessary. Moreover, the Department of Agriculture's chemical facilities have been improved so that a wider range of analyses, including trace element determinations, can now be carried out on a routine basis.

The analysis of representative samples of coffee leaves is the best available method at present for coffee plantation owners and managers to check on the current nutritional status of their coffee areas and to obtain advice on the use of fertilizers. This leaf analysis service is available from the Chemical Section, Department of Agriculture, Stock and Fisheries, Konedobu, Territory of Papua and New Guinea, which undertakes the analysis and the interpretation of results. At present each coffee leaf sample, if it has been collected according to a standardized technique and is in good condition, is analysed for the essential nutrients, nitrogen, phosphorus, potassium, calcium, magnesium, iron, manganese, zinc, copper and boron. It is hoped to extend the analytical work to sulphur and molybdenum in the near future.

The use of leaf analysis for determination of nutritional status and assessment of fertilizer requirements is discussed by Southern in this journal.[2] The limitations to the accurate interpretation of the results are fully realized and it is usually not possible to recommend precisely the most suitable fertilizer or the quantities required for application. However, it is usually possible to—

(*a*) Diagnose any serious deficiencies or toxicities.

(*b*) Indicate where applications of particular nutrients are unnecessary or too heavy.

(*c*) Recommend trial applications of subnormal nutrients.

It is obviously essential in such a comparative technique that leaf samples should be collected and treated in the standard approved manner and, if samples are forwarded for examination and analysis, the following method of sampling should be followed :—

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SELECTION OF AREAS.

The coffee plantation is first divided up into a number of areas representing good, moderate, or poor production, or healthy and unhealthy growth. Each area selected should be uniform with respect to soil type, age and condition of plants, variety grown, fertilizer, shade or management treatments. At least one area representing the best coffee on the plantation should be included. On plantations with very uneven growth, as many as twelve areas could be selected.

From these larger areas, representative smaller areas should be selected ; these should become permanent sampling areas and might be from one-half to one acre in size. These areas should not be situated close to a plantation road to avoid possible contamination with dust.

COLLECTION OF SAMPLES.

A leaf sample will only be representative of the trees from which it is collected and therefore these trees must be representative of the sampling area. To sample the areas as selected above it is necessary to select 30 to 50 trees well distributed throughout the sampling area. This can be carried out by sampling along the diagonals of the area in an X pattern, but any method which will ensure a random sampling is satisfactory. The minimum size of a leaf sample should be 120 leaves consisting of two pairs of leaves from the 30 randomly distributed trees but it is more satisfactory to collect from 50 trees, making a total of 200 leaves. The leaves selected are the third pairs from the apex or tip of lateral branches on opposite sides of the tree. Outside branches, midway between the ground and the top of the tree, are used. The first leaf pair, or end leaves, are only counted as leaves if they are more than 2in. long. New vertical shoots should not be sampled and branches carrying large numbers of berries should also be avoided. Samples should be collected before 11.00 a.m.

Normally the third leaf pairs are sampled ; however, if symptoms of chlorosis or yellowing are occurring on other leaves of the bushes, these leaves can be sampled (separately), providing another sample of leaves from an area without symptoms is also sampled. The leaves from this healthy area should be of the same age as those from the unhealthy area. It is often an advantage to collect a small sample of typically chlorotic leaves for visual diagnosis.

The separate leaf samples are air-dried to remove dew, rain or surface moisture and then placed in paper bags, or alternatively rolled in sheets of newspaper. Plastic bags should not be used.

CONSIGNMENT OF SAMPLES.

The leaf samples should be forwarded immediately to the Principal Chemist, D.A.S.F., Konedobu, and should be marked "URGENT—COFFEE LEAF SAMPLES". It is essential that they reach the laboratories within four days or the samples will start to deteriorate and lose weight. Telegraphic advice of despatch will ensure that there is no delay in receipt.

FIELD INFORMATION.

It is of the utmost importance to forward the fullest possible information on the areas sampled. The information required is as follows :—

(*a*) Name and address.
(*b*) Altitude of plantation.
(*c*) Date of sampling.
(*d*) Location and marks on container.
(*e*) Preceding type of land use (e.g., forest, grassland, gardens).
(*f*) Variety used.
(*g*) Age of trees (years).
(*h*) Approximate production per acre.
(*i*) Shade (type and approximate density).
(*j*) Ground cover (e.g., bare, mulch, weeds).
(*k*) Condition (e.g., flowering, fruiting, ripening crop, dormant, newly pruned).
(*l*) Pruning and spacing.
(*m*) Soil conditions (e.g., clay, loam, sandy, hard pan).
(*n*) Drainage (e.g., good, poor).
(*o*) Soil moisture (e.g., very wet, moist, dry).
(*p*) Topography (e.g., flat, hilly).
(*q*) General condition of trees (e.g., poor, mediocre, healthy).

FOLIAR ANALYSIS REPORT—ARABICA COFFEE, 3rd LEAVES

NAME..... ADDRESS..... DATE SAMPLED.....

NUTRIENT CONTENT		%N	%P	%K	%Ca	%Mg	p.p.m. S	p.p.m. Mn	p.p.m. Fe	p.p.m. Cu	p.p.m. Zn	p.p.m. B	p.p.m. Mo	RECOMMENDATIONS
Indicates a possible toxicity, or a high content of a nutrient due to another deficiency.	ABOVE NORMAL RANGE													Use of fertilizers containing above normal nutrients should be avoided
		3.4	0.19	2.6	1.6	0.7								
Normal range of leaf contents for adequate and balanced nutrition. Current nutritional status good.	NORMAL RANGE													Present fertilizer programme adequate. If fertilizer not used, no responses likely at this stage.
TENTATIVE CRITICAL LEVEL		2.6	0.13	1.8	0.6	0.4	200	50	70	4	8	40		**TENTATIVE CRITICAL LEVEL**
Indicates possibility of a deficiency. Analyses dependent to some extent on shade density, climate, etc., and condition of trees, e.g., flowering, ripening crop, dormant period.	SUB NORMAL RANGE													Fertilizers containing sub-normal nutrients likely to give responses in growth and yield, but dependent on growing conditions, e.g., shade, production. Trial applications recommended.
		2.2	0.10	1.4	0.4	0.3	100	25						
Indicates inadequate or unbalanced nutrition. Serious deficiencies likely. Symptoms often present.	DEFICIENT RANGE													Fertilizer containing deficient nutrients should be used. Treatment necessary and good responses likely.

ANALYSIS OF SUBMITTED SAMPLES	%N	%P	%K	%Ca	%Mg	p.p.m. S	p.p.m. Mn	p.p.m. Fe	p.p.m. Cu	p.p.m. Zn	p.p.m. B	p.p.m. Mo

No. Location lab. No.

1.
2.
3.
4.
5.
6.

Note.—1. The current nutritional status is indicated by analysis. Samples should be analysed at regular intervals to give more complete information.
2. Analyses are not likely to represent the true picture if other important limiting factors (e.g., drought, poor drainage, severe disease) are present.

CHECKED

Figure 1.—Foliar Analysis Report.

(*r*) Symptoms on leaves, defoliation, dieback, stunting, disease, insects attack. Performance of other crops. Any other pertinent information.

(*s*) Fertilizer used. Details of type, frequency, quantity, last application.

(*t*) Rainfall, annual.

(*u*) Rainfall, distribution in the two months prior to sampling.

This information is necessarily detailed to aid in accurate interpretation. Questionnaire forms are available which will enable these details to be conveniently recorded.

In addition to foliar analysis, soil analysis is often useful in the diagnosis of nutritional problems and in the determination of soil nutrient reserves. Instructions for sampling soils are also available from the Department.

RESULTS OF LEAF ANALYSES AND RECOMMENDATIONS.

Analytical determinations by modern and accurate methods are carried out for all essential nutrients except sulphur and molybdenum. The results of these analyses are usually available within six or eight weeks.

The results of the analysis are recorded on a printed form (*Figure* 1), which compares the analyses obtained with the classification of leaf analysis contents proposed by Southern [2] for New Guinea conditions. More detailed advice and recommendations accompany the foliar analysis report.

FOLLOW-UP INVESTIGATIONS.

The analysis will only indicate the current nutritional status and plantations are invited to submit regular samples from permanent sampling areas. Information gained from these foliar analyses and field data will provide the most useful information on nutritional status that it is possible to obtain at the present time.

While there is less information available on the use of leaf analysis in connection with lowland coffee (*Coffea canephora*), managers of plantations growing this crop may forward samples collected in exactly the same manner as above.

REFERENCES.

[1] HART, GAVIN. Coffee Nutrition. Part II. Plantation Survey. *Papua and New Guinea agric. J.*, 18 (2).

[2] SOUTHERN, P. J. Coffee Nutrition. Part I. The Determination of Nutritional Status and Fertilizer Requirements of Arabica Coffee in New Guinea. *Papua and New Guinea agric. J.*, 18 (2).