THE USE OF LEAF ANALYSIS IN THE CONDUCT OF COCONUT FIELD FERTILIZER TRIALS IN THE PHILIPPINES[1]

S. S. Magat*

ABSTRACT

Ten fertilizer trials were initiated in 1975 on coastal and inland areas of Davao and Misamis Oriental provinces to determine the efficacy of leaf analysis in predicting fertilizer needs of the coconuts.

In trials where nitrogen and chlorine were present, nut/tree, copra/nut and copra/tree were considerably increased starting two years from initial fertilization. This positive response in coastal and inland areas was closely related to the improvement in leaf N and Cl levels but not in P, K, Ca and Mg, suggesting that the palms receive adequate supply of these nutrients, and the need for N and Cl fertilization in attaining high yields. Moreover, the early results of the work gave strong indication of leaf analysis as an effective tool in diagnosing fertilizer needs of the local talls, using the critical levels (leaf 14): 1.80% N; 0.12% P; 0.80% K; 0.30% Ca; 0.20% Mg; 0.50% Cl and 0.15% S.

INTRODUCTION

Like any other crop, coconut *(Cocos nucifera,* Linn.) needs fertilization to sustain high yields. In such activity proper rate of application should be determined otherwise it is going to be very costly. Along this line, three methods had been developed, namely: soil analysis, leaf analysis and field experiments/trials. Of these techniques, it is well accepted that field experiments is the most accurage one though expensive and time-consuming, two good reasons why workers and researchers resort the other two techniques.

Soil analysis has been practiced with some degree of success, but workers are not entirely solved with the reliability or usefulness of this method. This is attributed to the expectations that exceed the capability limits of the method. As an example, it does not always follow that the available soil nutrients are for crop utilization as the plant nutrient uptake is affected by the other soil conditions *i.e.* pH, soil available moisture, drainage, etc.

During the 50's, the interest in the use of leaf analysis as an index of crop nutrient status grew rapidly. The concept of foliar diagnosis (Prevot and Ollagnier, 1957) led to great expectations that it could be widely used as a means to predict fertilizer needs of two tropical oil crops, oil palm and coconut. This new approach was greeted with enthusiasm by agronomists and soil scientists because when fertilizer recommendations were based on soil analysis alone, unsatisfactory results were obtained. Moreover, it was strongly felt that plant analysis must have the advantage over soil analysis as the former reveals amounts of plant nutrients absorbed by the crop and interpretation is not dependent on soil nutrient "availability" or "exchange". Hence, on the assumption that nutrient level or concentration within the leaves of the plant is related to crop growth or yield, leaf analysis was developed into a diagnostic tool. Worldwide, a number of coconut research organizations and commercial coconut plantations have been using this technique extensively with considerable success. In the Philippines, the serious use of leaf analysis was pioneered in early 70's by the Philippine Coconut Research Institute now the Agricultural Research Branch of PCA. This led to the discovery of the essentiality of chlorine for coconut production (Uexkull, 1971; Mendoza & Prudente, 1972; Magat *et al.*, 1974).

Now, leaf analysis is widely used in the country to determine the nutritional development or effect of fertilizer application on coconuts. This report deals with the early results and progress on the use of foliar diagnosis in the conduct of fertilizer trials in the Philippines[2].

MATERIALS AND METHODS

Selection of sites

Out of the 20 possible fertilizer trial sites initially selected during the nutrition survey (leaf survey) conducted in 1975 in Mindanao, 8 sites were finally selected in August 1975 (Table 1). The guidelines or criteria used were as follows: (a) areas should be suitable for coconut considering soil conditions and rainfall; (b) bearing stage (10-40) years); (c) low nut production, not more than 50 nuts/tree/year; (d) strategic location, near or adjacent national roads; and (e) with a system of planting, not closer than 8 meter spacing.

The sites located near the national road have palms ranging from 11 to 30 years of age and nut production from 18 to 45 nuts/tree/year. All are suitable for coconut production.

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*Chief and Research Supervisor, Agronomy and Soils Division, Agricultural Research Branch, Philippine Coconut Authority, P.O. Box 295, Davao City, Philippines.

[2] In cooperation with the UNDP/FAO Coconut Research and Development Project, Philippines.

Selection of treatments

The fertilizer treatment combinations and rates of fertilization were based on the initial or benchmark leaf nutritional status (Tables 2 and 3). In the selection, the critical levels (the concentration of leaf nutrient of leaf 14 expressed as percentage of its dry matter, below which, an addition of appropriate fertilizer is likely to improve growth or increase crop yield) was used as reference. The critical levels in percent, used are: N, 1.80; P, 0.120; K, 0.80-1.00; Ca, 0.30; Mg, 0.20; Cl, 0.50-0.55 and S, 0.150.

Based on these levels, all sites are deficient in nitrogen and chloride, except fertilizer trial 1.1 in Oppus Farm, Bunawan, Davao City. As sulfur levels are apparently low, thus some fertilizer combinations involved sulfur-bearing fertilizers to confirm the suspected deficiency. Table 3 shows the rates or weights of fertilizers applied every 6 months as well as the total fertilizer applied from initial application up to April 1978. In fertilizer trials 3.1 (Untal farm), 4.1 (Mendoza farm) and 9.1 (Cagampang farm), additional fertilizers to correct other deficiencies were added as no noticeable increase in production was observed after 1½ years from initial application.

Design and field layout

The fertilizer trials are non-replicated studies and for the purposes of this work, the number of palms per treatment varies from 36 to 100, depending on the availability of area and number of trees.

The basic designs used were as follows:

Type I – trial with 3 treatments, with control of farmer's practice in-between the 2 fertilizer treatments.

Type II – trial with 2 treatments, the control and fertilizer treatment side by side.

Those belonging to type I are fertilizer trials at Catalunan Pequeno, Davao City (2.1); Pantukan, Davao Norte (4.1); Montevista, Davao Norte (5.1); Laguindingan, (6.1); Alubijid (7.1); Balingasag (8.1), all at Misamis Oriental. While those with type II layout are fertilizer trials at Bunawan (1.1 and 1.2); Angalan (3.1), Davao City and Pantukan, Davao Norte (4.2).

Gathering of yield data

Harvesting for each palm was done every 2 months. Copra weight per nut was estimated during the second, fourth, sixth harvest and succeeding even number harvests. Copra estimate was based on 20 nuts taken at random from the harvest of each plot or treatment. By multiplying nuts/tree and copra/nut, the mean copra yield/tree for each fertilizer treatment was obtained.

Leaf analysis

Aside from the initial leaf analysis, an annual foliar analysis was made to follow up to the nutritional development related to improvement and yield increase of the palms as influenced by fertilizer application.

The leaf samples collected from leaf 14 of bearing palms were submitted to the leaf analysis laboratory and analyzed for leaf nutrient levels (in percent) of N, P, K, Ca, Mg, Na, Cl and S. When deemed necessary, analyses for micro-nutrients such as B, Zn, Cu, Fe and Mn were also made.

Maintenance

Every 2 months or as necessary, circle-weeding the base of the palms (fertilizer zone) to a radius of 1.5-2.0 meters was done, except for the control. Likewise, other cultural management practices such as underbrushing (for non-covercropped areas) and crop protection controls were followed.

RESULTS AND DISCUSSION

1. Oppus/Bunawan, Davao City (coastal-flat)

In trial 1.1 of the area, the addition of $(NH4)2SO4$ increased nut production by only 7.1% over the control while copra/nut and copra/tree increased by 11.1% and 18.8%, respectively (Table 4). This slight improvement in yield was accompanied by an increase in leaf N, indicating moderate N deficiency of the palms exists in the area.

On the other hand, trial 1.2 in the same farm showed response to N and Cl application. In terms of nuts and copra production, an increase of 32.3% and 55.6% respectively, over the control was observed with the application of 0.62 kg NH_4Cl every 6 months. With this fertilization, leaf N and Cl increase from 1.38 to 1.66%, and from 0.45 to 0.73%, respectively.

2. Cuizon/Catalunan Pequeno, Davao City (inland-upland)

In this inland-upland area located about 3.5 km from the Davao Research Center of PCA, the application of both $(NH_4)_2SO_4$ + KCl and NH_4Cl improved nut and copra yields with the former giving a higher increase over the control. This is probably due to the beneficial effects of the K and S additions from the $(NH_4)_2SO_4$ + KCl combination. The leaf analysis clearly indicate considerable increase in leaf N and Cl with the addition of either $(NH_4)_2SO_4$ + KCl and NH_4Cl to the palms two years and 3 months after initial application. Also, leaf analysis revealed marked improvement in K and S in the leaves which supports the contention that the addition of these elements apparently helps in further increasing in yield in the area.

So far, under similar conditions in the Davao, accelerated growth and development and yield of palms have been reported with the application of $(NH_4)_2SO_4$ + KCl fertilizer combination (Prudente and Mendoza,

1976; Magat *et al.*, 1975; Margate *et al.*, 1978).

3. Untal/Angalan, Davao City (inland-upland)

In this inland-upland area with palms grown under a residual reddish brown soil developed from igneous rocks of Mt. Apo, the application of NH_4Cl + $(NH_4)_2SO_4$ combination resulted to an increase of 19.7% and 28.7% in nuts/tree and copra/tree, respectively. The improvement observed is apparently due to the correction of N, Cl and S deficiencies of the palms, indicated by the appreciable increases in leaf nutrient levels of these three elements.

4. Mendoza/Pantukan, Davao Norte (coastal-flat)

In Trial 4.1, both the $(NH_4)_2SO_4$ and $(NH_4)_2SO_4$ + drainage treatments did not result to appreciable increase in nut and copra production even after 2 years from initial application thus starting from the fifth fertilizer application, NaCl (common salt) was applied together with $(NH_4)_2SO_4$. This was done as Cl was clearly a limiting nutrient in the area. The leaf analysis which ascertained this Cl limitation was doubted initially because the area being just 350 m from the seacoast was expected to have adequate Cl.

Only 6 months from the addition of NaCl or 2½ years from initial fertilizer application, 17.7% and 32.5% increase over the control in nuts and copra yield per tree, respectively was observed.

In another area (Trial 4.2) where NH_4Cl have been applied since October 1975, marked increase in copra was observed, for instance, copra nut of NH_4Cl-treated palms was 318.5 grams as against 268.5 grams of the control. In terms of copra/tree, an increase of 34% over the control was noted with 1 kg NH_4Cl per tree application every 6 months. This fertilization considerably increased leaf N and Cl but not the other nutrients which were considered adequately supplied by the soil.

5. Ladores/Montevista, Davao del Norte (inland-upland)

The area is more than 50 km from the coastline, with initial leaf analysis clearly indicating that N and Cl are the major nutritional limiting factors. Thus, the fertilizer combinations formulated were NH_4Cl and $(NH_4)_2SO_4$ + NaCl which both supply N and Cl.

With the addition of NH4Cl, the percent yield increase over the control was noticeably high, 51.3 and 61.7, in terms of nuts/tree and copra/tree, respectively, 2 years and 6 months from the start of a regular semi-annual fertilization. While for the $(NH_4)_2SO_4$ + NaCl, yield of the palms was slightly higher. Leaf analysis strongly indicates that leaf N and Cl were both increased by the application of the two fertilizer combinations tested. This result confirms that N and Cl are deficient in the areas and the correction of these deficiencies through fertilization is the best cultural practice that can immediately increase production of unproductive inland coconuts having similar conditions.

6. Clarin/Laguindingan, Misamis Oriental (inland-upland)

The highest response to fertilization in terms of nuts and copra of 260% and 307% over control was obtained in this inland area of northern Mindanao with the application of $(NH_4)_2SO_4$ + NaCl. Likewise the addition of NH_4Cl resulted to 233.5% and 177.1% increase in nuts and copra/tree, respectively, 2 years from initial fertilization. It was noted also, that the application of both fertilizer combinations increased copra/nut by 13% over the control. A study conducted in an inland-upland area of Davao showed increased copra nut with the addition of increasing levels of KCl to bearing palms which was attributed to chlorine (Margate *et al.*, 1978).

Leaf analysis indicated that the leaf N and Cl which were apparently deficient were corrected by the application of both fertilizers, resulting to remarkable increase in yield.

7. Balacquit/Alubijid, Misamis Oriental (inland-flat)

With the application of both $(NH_4)_2SO_4$ + KCl and NH_4Cl, nut and copra yields were increased. This improvement in production was accompanied by increased leaf N and Cl, suggesting that the palms are deficient in this elements and the alluvial soil in the area lacks the capacity to supply the palms with N and Cl for sustained high yields.

8. Cagampang/Balingasag, Misamis Oriental (coastal-flat)

In this trial, no marked improvement in yield was observed even after 1½ years from initial application with $(NH_4)_2SO_4$ but with the addition of NH_4Cl, nut and copra yields were observed to increase. Hence, it was likely that Cl was deficient in the area despite nearness to the seacoast (300 meters), and leaf analysis had this confirmed. By November, 1977, NaCl was added to supply Cl to the palms.

Accumulated yield data indicated that with the addition of NH_4Cl, copra weight per nut increased by 42.7% over the control. At the same time nut and copra/tree considerably increased by 48.5% and 112.3% respectively also over the control. It is expected that by about a year from NaCl addition, nut and copra yields could be made comparable to NH_4Cl-treated palms.

Leaf analysis revealed that the very low production in the area was primarily due to N and Cl deficiencies which were corrected by the NH_4Cl application, resulting to the appreciable improvement in weight of copra/nut, nut and copra yields.

SUMMARY AND CONCLUSION

Ten fertilizer trials were started from August to December 1975 in Davao and Misamis Oriental provinces to determine if leaf analysis could be an effective tool in predicting fertilizer needs of the coconuts. Five trials

were set on coastal areas and the rest on inland areas or in coconuts planted more than 2 km from the seacoast. All the sites were suitable for coconut production based on climatic and soil factors. The trials vary in palm age and nut production (11-25 years, and 18-50 nuts/tree per year, respectively). In all the fertilizer trials, the local tall variety were planted under a monoculture farming system and with spacing of 8 to 9 meters.

Fertilizer treatments were formulated based on the results and interpretation of the initial leaf analysis. In both coastal and inland areas, the leaf analysis apparently indicated basic deficiencies in N and Cl, thus fertilizer treatments selected usually contain N and Cl.

Two years from initial fertilization, palms applied with both N and Cl in both coastal and inland trials increased in nut and copra yields, 20-260% and 18-307%, respectively. These yield increases were accompanied by corresponding increases in leaf N and Cl levels but not in leaf P, K, Ca and Mg, confirming the general deficiency in N and Cl as strongly indicated by leaf analysis.

These two-year results of the fertilizer trials clearly showed that to supply N and Cl for coastal and inland coconuts, the combination of $(NH_4)_2SO_4$ + NaCl and NH_4Cl fertilizer are effective fertilizers as an alternate to the commonly recommended $(NH_4)_2SO_4$ + KCl combination in the country.

Moreover, the critical levels (leaf 14) used in the present work as follows: N, 1.80%; P, 0.12; K, 0.80; Ca, 0.30; Mg, 0.20; Cl, 0.50-0.55; S, 0.15%, could be used as a guide for foliar diagnostic techniques on local talls under Philippine conditions.

This study gave strong indications that leaf analysis, if properly used, could be an effective tool in predicting the qualitative fertilizer needs of the coconut areas. Thus, conducting field experiments or trials which is expensive and time-consuming may be dispensed with.

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