# COCONUT LEAF NUTRIENT LEVELS OF BEARING DWARF VARIETIES AND PHYSIOLOGICAL CRITICAL AND ADEQUACY LEVELS IN CROP NUTRITION MANAGEMENT

**By**

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## Abstract

*An analysis of the leaf nutrient concentrations data of bearing palms (grown in a suitable coastal ecosystem) of three coconut dwarf varieties [Malayan yellow dwarf(MLYD), Catigan green dwarf(CATGD) and Tacunan green dwarf(TACGD)] planted at the designed-genetic blocks of the Zamboanga Research Center, San Ramon, Zamboanga City (Western Mindanao, Philippines), covering the period 1995-1999, was conducted . The variability and trend of each leaf nutrient (N, P, K, Ca, Mg, Na, Cl, S and B) over the years was determined.*

*The critical levels of leaf nutrients are estimated based on the average or normal values of the historical data. An initial general reference guide on the physiological leaf critical levels of dwarfs is presented, as follows (leaf #14, dry matter): 1.70% N: 0.125% P; 0.90% K; 0.38% Ca; 0.26% Mg; ; 0.12% Na, 0.37% Cl; 0.15% S; and 11 ppm B.*

*The implications of knowing the adequacy and critical levels in leaves as an indicator of crop nutrition to optimize the yield potential of dwarf varieties of coconut are discussed.*

## 1. INTRODUCTION

In recent years, globally, there have been increasing concerns to improve the plantings, young tender nut supply, and productivity of dwarf varieties for commercial purposes - largely intended for food, nutritional and medicinal purposes (Eyzaguirre,1996; Naka, 1996; Thampan, 1996; Wazir and Othman, 1996; Ovasuru,1996). In the varietal improvement (development of improved planting materials and production of hybrids of the dwarf x tall crosses), dwarf varieties have been collected, conserved, managed and utilized for new planting, and replanting and rehabilitation objectives (Thampan, 1996; Peries, 1996; Novarianto and Santos, 1996; Ovasuru, 1996).

Generally, dwarf coconut varieties are characteristically: shorter and slow in growth; with slender stem; having smaller leaves, inflorescences and fruit (with exception of some green dwarfs); precocious and rapid succession of inflorescences; and with high degree of self-pollination (Ohler and Magat, 2001). Dwarfs are differentiated based also on the color of the leaf petiole (normally same as the skin color of immature nuts). For instance, in most coconut-producing countries, there are green dwarfs, yellow dwarfs and red dwarfs (or orange dwarfs). Among the green dwarfs, ones popular in the Philippines are the Catigan green dwarf (CATGD); Tacunan green dwarf (TACGD) and Aromatic green dwarf (AROGD), claimed to have originated from Thailand.

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In the Philippines and rest of coconut-producing countries, to optimize the productivity (yield) and production volume from these varieties, crop nutrition management is essential, as most coconut areas now have nutritionally-deficient, degraded and marginal soils.

To determine the crop and location-specific fertilizer needs of the dwarf varieties of coconut, the physiological critical nutrient levels of the leaves collected at different stages of crop development should be identified to be able to diagnose the nutrient status of the coconut trees thru the leaf analysis. For mature or bearing palms, leaf rank # 14 has been the accepted as the reference leaf, thus usually sampled annually - preferably during dry periods and submitted to analytical laboratories for the analysis of leaf nutrient concentrations (N, P,K, Ca, Mg, Na, Cl, S and B). As practical and needed, other micronutrients (Zn, Mn, Fe and Cu) other than B are also included in the analysis.

## 2. DATA OF SELECTED DWARF VARIETIES

Three dwarf varieties of coconut grown in genetic blocks at the Zamboanga Research Center (Philippine Coconut Authority, Department of Agriculture), at San Ramon Zamboanga City, Western Mindanao) was used in this study. The important features of the three dwarfs are as follows:

a. **Malayan yellow dwarf (MLYD) -** produces larger number of nuts under excellent ecological conditions; nuts contains around 150 g copra; petiole and young nut yellowish (Balingasa and Santos, 1978);

b. **Catigan green dwarf (CATGD) -** produces round medium-size nut, about 210 g copra/nut, flowering could start 20 months from field-planting; full-bearing palms with copra yield of 3 t/ha/yr, but may be followed by lower yield cropping year (Santos, 1989);

c. **Tacunan green dwarf (TACGD) -** easily recognized with its short spikelets; shrunken spathes; medium-size nuts with long stigmatic end and bulbous base; average of 230 g copra per nut; claimed to be resistant to very strong winds, likely due to a strong root system (Santos, 1989)

Leaf analyses and yield data (1995 - 1999) of three selected dwarf varieties in some experimental blocks at the Zamboanga Research Center were reviewed. Relevant data are indicated in table 1.1. The rainfed center, situated in a coastal area has fair to above average soil conditions and suitable climatic conditions for coconut production. Fertilizer application mainly based on annual leaf analysis had been an annual practice, following a modern and high-yield farming production system, but rainfed (no irrigation), even during the extended dry periods (El Niño years).

Data on yield of coconut was requested from the files of the Breeding and Genetics Division of PCA-ZRC. Leaf samples submitted by the ZRC was analyzed by the Plant Tissue Analysis Laboratory, Plant and Soils Division, based at the central office of PCA, Diliman, Quezon City, Metro Manila.

| TABLE 1.1. YIELD AND LEAF NUTRIENT STATUS OF THREE DWARF VARIETIES, PCA-ZAMBOANGA RESEARCH CENTER (LEAF RANK #14, 1995-1999)* | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **VAR(1)** | **YEAR** | **YIELD/year** | | **LEAF NUTRIENT CONTENT (%, dry matter. leaf rank #14)** | | | | | | | | | |
| | | **Nut/ Tree** | **Copra/ Tree(kg)** | **N** | **P** | **K** | **Ca** | **Mg** | **Na** | **Cl** | **S** | **B (ppm)** |
| *MLYD* | 1995 | 91 | 14.2 | 2.02 | 0.165 | 0.94 | 0.37 | 0.35 | 0.22 | 0.35 | 0.21 | 11.2 |
| | 1996 | 148 | 29.1 | 2.01 | 0.138 | 0.75 | 0.38 | 0.36 | 0.20 | 0.19 | 0.17 | 10.4 |
| | 1998 | 118 | 23.1 | 1.55 | 0.124 | 0.95 | 0.35 | 0.29 | 0.19 | 0.29 | 0.17 | 12.7 |
| | 1999 | 166 | 30.7 | 1.72 | 0.127 | 0.62 | 0.47 | 0.34 | 0.12 | 0.38 | 0.17 | 17.1 |
| | **Ave.** | **130** | **24.3** | **1.82** | **0.138** | **0.81** | **0.39** | **0.33** | **0.18** | **0.30** | **0.18** | **13.0** |
| **CATGD** | 1995 | 76 | 15.3 | 1.70 | 0.145 | 1.25 | 0.34 | 0.25 | 0.13 | 0.39 | 0.14 | 10.6 |
| | 1996 | 61 | 14.4 | 2.34 | 0.166 | 0.89 | 0.50 | 0.26 | 0.10 | 0.58 | 0.18 | 12.3 |
| | 1998 | 91 | 21.6 | 1.78 | 0.142 | 1.46 | 0.38 | 0.27 | 0.12 | 0.44 | 0.17 | 11.4 |
| | 1999 | 62 | 12.6 | 1.69 | 0.139 | 0.92 | 0.64 | 0.30 | 0.11 | 0.70 | 0.20 | 13.8 |
| | **Ave.** | **72** | **15.9** | **1.88** | **0.148** | **1.10** | **0.46** | **0.27** | **0.11** | **0.52** | **0.17** | **12.0** |
| **TACGD** | 1995 | 64 | 15.7 | 1.83 | 0.138 | 1.21 | 0.32 | 0.21 | 0.10 | 0.29 | 0.15 | 11.7 |
| | 1996 | 116 | 24.9 | 1.93 | 0.142 | 1.03 | 0.39 | 0.25 | 0.07 | 0.32 | 0.16 | 12.9 |
| | 1998 | 68 | 12.2 | 1.86 | 0.123 | 1.32 | 0.41 | 0.27 | 0.08 | 0.45 | 0.17 | 12.4 |
| | 1999 | 93 | 23.3 | 1.66 | 0.123 | 0.81 | 0.54 | 0.27 | 0.03 | 0.57 | 0.19 | 16.1 |
| | **Ave.** | **85** | **19.0** | **1.82** | **0.131** | **1.09** | **0.41** | **0.25** | **0.07** | **0.41** | **0.17** | **13.2** |
| ***Mean – Dwarf Varieties*** | | ***96*** | ***19.7*** | ***1.84*** | ***0.139*** | ***1.00*** | ***0.42*** | ***0.28*** | ***0.12*** | ***0.41*** | ***0.17*** | ***12.7*** |

NOTE:

***** all leaf analyses done by the Plant Tissue Analysis Laboratory, PCA Central Office, Diliman, Quezon City

(1) MLYD - Malayan yellow dwarf variety; CATGD - Catigan green dwarf; TACGD - Tacunan green dwarf variety

## 3. RESULTS AND DISCUSSION

### 3.1 Yield

In table 1.1, it is shown that the productivity (or yield) of dwarf varieties varied or fluctuated over the years, with nut and copra yields of the yellow dwarf (MLYD) generally higher than the two green dwarfs (TACGD and CATGD). Between the two green dwarfs, The TACGD achieved higher average yields during the evaluated cropping period of 1995 - 1999.

Looking at the fertilizer use efficiency in terms of the crop fertilizer use index (CFE), measured by coconut yield per kg fertilizer applied(Magat, 1966), i.e. CFEn (nut yield/tree/ year) and CFEc (copra yield/tree/yr), this is presented in table 1.2. It shows that the MLYD achieved the highest (both in nut and copra yields) at 29.5 nuts and 5.52 kg copra per kg fertilizer applied, followed by the TACD with 19.5 CFEn and 4.35 CFEc and that of CATGD with 16.6 CFEn and 3.66 CFEc.

Earlier, the CFE index was tested in the country, using the performance of several hybrids and local talls in a nationwide coconut multilocation tests which revealed clearly that CFEs (CFEn and CFEc) of dwarf x tall hybrids generally higher than tall varieties over a period of 9 years from field-planting (Magat, 1966).

### 3.2 Leaf Nutrient Levels

The data presented in table 1.1 appears adequate enough to initially generate some relevant information on the physiological leaf nutrient levels as: (1) normal or adequacy levels; (2) critical levels, of dwarf varieties of coconuts as guide-reference in the nutritional (foliar) diagnosis of the crop. In many cases, critical levels of growth or yield-limiting nutrient(s) of coconut are determined using field data on yield and leaf nutrients, either from an extensive survey or fertilizer/nutrient response studies (usually at increasing rates of a limiting or deficient nutrient (s) in representatives coconut areas. Statistical or biometrical analysis of data as ANOVA, correlation and regression analysis, and trend analysis are used to identify critical levels leaf nutrient in relation with growth and yield data obtained from designed long-term experiments (Magat, 1998).

**Table 1.2 Average Crop Fertilizer Use Efficiency index (CFE) of three dwarf varieties of coconut grown at the PCA - Zamboanga Research Center ((period 1995-99)**

| Dwarf Variety | Nut/tree/yr | Copra/tree/yr (kg) | Average Total fertilizer/yr (kg)[1] | CFEn (nuts/ Kg fertilizer Applied | CFEc (kg copra/ kg fertilizer applied |
|---|---|---|---|---|---|
| | | | | | |
| MLYD | 130 | 24.3 | 4.40 | 29.5 | 5.52 |
| CATGD | 72 | 15.9 | 4.34 | 16.6 | 3.66 |
| TACGD | 85 | 19.0 | 4.36 | 19.5 | 4.34 |
| | | | | | |

[1] *average fertilizers applied (kg/tree/year)*:

***MLYD*** - 1.3 kg Ammo. sulfate + 1.62 kg NaCl + 0.30 kg KCl + 1.10 kg dolomite + 40 g borax; ***CATGD*** - 1.40 kg Ammo. sulfate + 1.48 kg NaCl + 0.25 kg KCl + 1.20 kg dolomite + 40 g borax; ***TACGD*** – 1.39 kg Ammo.sulfate + 1.47 kg NaCl + 0.30 kg KCl + 1.20 dolomite + 42 g borax.

Clearly, the average (or adequacy levels) leaf nutrient concentrations of dwarf varieties: (1) Catigan green dwarf (CATGD) and (2) Tacunan green dwarf (TACGD) are higher (slight to moderate degree) compared to that of Malayan yellow dwarf (MLYD), except in leaf Mg and S.

Table 2 indicates that the average (1995 -1999) leaf nutrient concentrations (levels) of sampled leaf No.14 of dwarfs were not statistically different in terms of leaf nutrients N, P, Ca, S, and B. In contrast, these significantly vary in leaf K (green dwarfs > MLYD); leaf Mg (MLYD > green dwarfs); leaf Na (green dwarfs> MLYD); and Leaf Cl ( CATGD similar to TACGD but > MLGD). This suggests that uptakes or concentrations of leaf nutrients K, Mg, Na and Cl are likely variety-sensitive, while the rest (leaf N, P, Ca, S and B) are not.

Looking closely on the trends (1995–1999, with values in 1997 not included) of leaf nutrient contents as indicated in figures 1-99), the following are noted. For leaf K, the trend is almost consistent, except for year 1996 (TACGD had the highest content), while in most years CATGD had the highest leaf K level. For leaf Mg and Na, the trend were consistent in almost all years, with the highest levels in MLGD. Moreover, leaf Cl trends showed clear consistency, with CATGD having the highest level in all years, except in 1998.

### 3.3 Adequacy (normal) and Critical Levels of Leaf Nutrients

Table 3 below shows an estimate or approximation of the normal or average levels of leaf nutrients for the adequacy levels and the critical levels of mature and bearing dwarf coconut variety. The estimation of adequacy levels is based from the mean of the three varieties evaluated, while the leaf nutrient critical levels was derived by assuming that critical level is very likely about 10% lower in nutrient concentration than that of the adequacy level of nutrients in leaves of coconut. Generally, the leaf nutrient critical level refers to the concentration in plant tissues as in a particular leaf position in the plant (leaf rank #14 for mature coconuts), of which a positive growth or economic yield response to fertilizer application (to supply one or more plant nutrients) is very likely, as critical concentration of nutrient(s) is considered growth- or yield-limiting.

**TABLE 2. LEAF NUTRIENT LEVELS OF 3 DWARF VARIETIES AT PCA-ZRC, ZAMBOANGA CITY (LEAF RANK #14, 1995-1999).**

| Variety | Leaf Nutrient (% dry matter, leaf rank # 14) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | K | Ca | Mg | Na | Cl | S | Bppm |
| MLYD | 1.82 | 0.138 | 0.81 b | 0.39 | 0.33 a | 0.18 a | 0.30 b | 0.18 | 13.0 |
| CATGD | 1.88 | 0.148 | 1.10 a | 0.46 | 0.27 b | 0.11 b | 0.52 a | 0.17 | 12.0 |
| TACGD | 1.82 | 0.131 | 1.09 a | 0.42 | 0.25 b | 0.12 b | 0.41 ab | 0.17 | 13.2 |
| Stat. Sign. | ns | Ns | ** | Ns | * | ** | * | ns | ns |
| C.V. (%) | 9.7 | 7.9 | 8.5 | 12.0 | 9.9 | 16.7 | 22.3 | 13.4 | 8.8 |

ns - Not significant

* Significant at 5% level

** Highly significant at 1% level

*Treatment means with the same letter are not significantly different from each other (LSD test)*

To optimize growth and yield of coconuts (talls, hybrids and dwarfs), crop nutrients should not be yield-limiting or the crop must have adequate and balanced nutrition (macro and micro-nutrients) in timely and sustained manner. Hence, the importance of at least an annual crop nutrition monitoring to check the undesirable inadequate and imbalanced nutrition of palms.

In bearing palms (based on leaf rank #14), the average leaf nutrient critical levels of dwarfs strongly appears slightly higher than talls, except for leaf nitrogen (dwarfs, 1.70% vs talls, 1.80%). However, leaf nutrient critical levels of hybrids (earlier presented by the author in 1988) are generally slightly higher than that of dwarf variety, indicated by the author for the first time in this paper.

**TABLE 3. ADEQUACY AND CRITICAL LEVELS OF LEAF NUTRIENTS IN SELECTED DWARF VARIETIES, PHILIPPINES**

| Variety | Leaf nutrient content (% dry matter, leaf rank # 14, bearing palms) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **N** | **P** | **K** | **Ca** | **Mg** | **Na** | **Cl** | **S** | **B (ppm)** |
| **Dwarfs:** *Adequacy level* | 1.84 | 0.139 | 1.00 | 0.42 | 0.28 | 0.12 | 0.41 | 0.17 | 12.7 |
| *Critical level* | 1.70 | 0.125 | 0.90 | 0.38 | 0.26 | 0.11 | 0.37 | 0.15 | 11.0 |
| **Talls** (1) Critical *Level* | 1.80 | 0.120 | 0.80 | 0.32 | 0.20 | 0.10 | 0.35 | 0.12 | 11-12 |
| *Hybrids* ***(2)*** *Critical level* | 1.80 | 0.13 | 0.90 | 0.35 | 0.30 | 0.15 | 0.40 | 0.15 | 12 |

*(1) Magat (1979); (2) Magat (1988)*

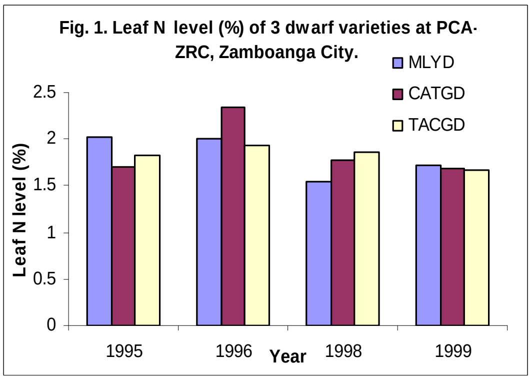


Fig. 1. Leaf N level (%) of 3 dwarf varieties at PCA-ZRC, Zamboanga City.
Leaf N level (%)
Year
1995
1996
1998
1999
MLYD
CATGD
TACGD

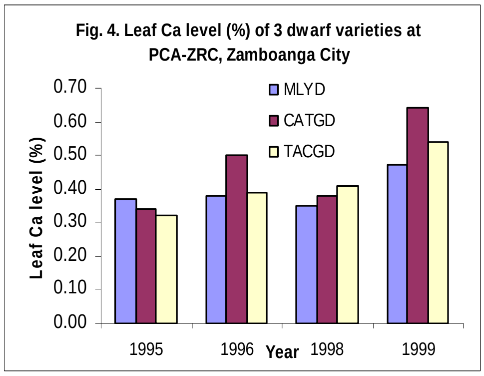


Fig. 4. Leaf Ca level (%) of 3 dwarf varieties at PCA-ZRC, Zamboanga City
Leaf Ca level (%)
Year
1995
1996
1998
1999
MLYD
CATGD
TACGD

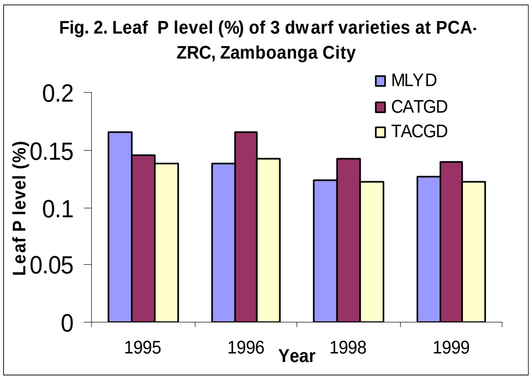


Fig. 2. Leaf P level (%) of 3 dwarf varieties at PCA-ZRC, Zamboanga City
Leaf P level (%)
Year
1995
1996
1998
1999
MLYD
CATGD
TACGD

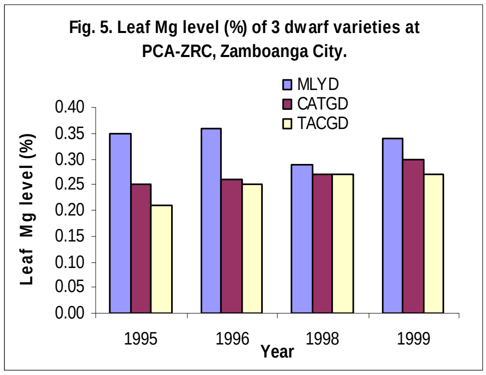


Fig. 5. Leaf Mg level (%) of 3 dwarf varieties at PCA-ZRC, Zamboanga City.
Leaf Mg level (%)
Year
1995
1996
1998
1999
MLYD
CATGD
TACGD

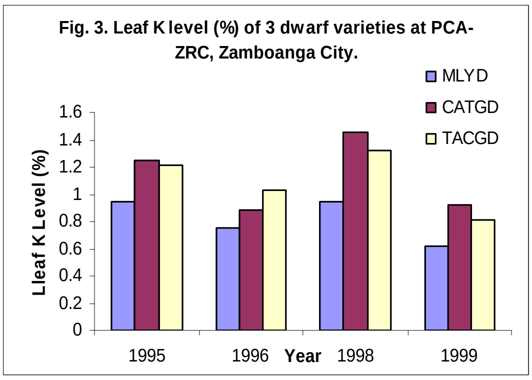


Fig. 3. Leaf K level (%) of 3 dwarf varieties at PCA-ZRC, Zamboanga City.
Lleaf K Level (%)
Year
1995
1996
1998
1999
MLYD
CATGD
TACGD

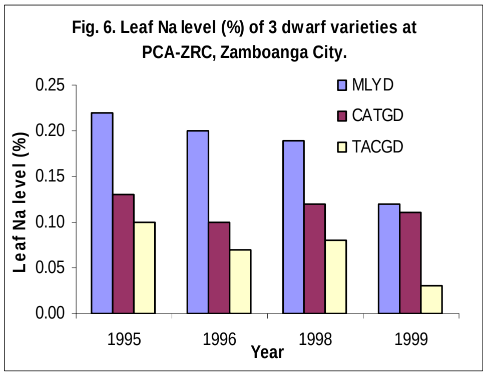
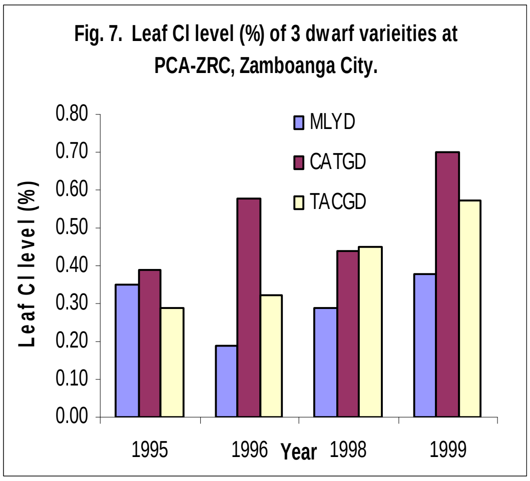
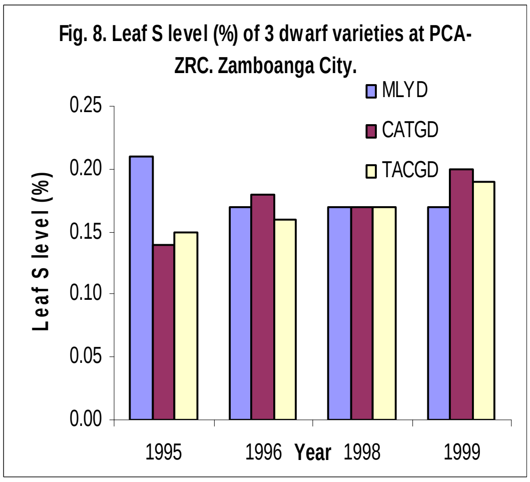
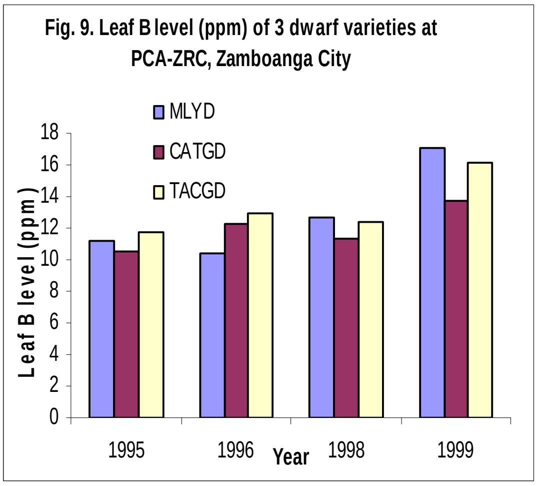


Fig. 6. Leaf Na level (%) of 3 dwarf varieties at PCA-ZRC, Zamboanga City.
Leaf Na level (%)
Year
1995
1996
1998
1999
MLYD
CATGD
TACGD




## 4. CONCLUSION

In the absence of extensive field data on yield and associated leaf nutrient contents of dwarf coconut varieties or designed field experiments (testing one or more deficient nutrients) in identified nutrient-deficient area(s), an available historical record (at least three years) of the leaf nutrient concentrations of productive plantings or experimental blocks may be used to determine an average or normal (adequacy) levels leaf nutrients as N, P, K, Ca, Mg. Na, Cl, S and B. The critical levels, values of which are likely 10-20 % lower than the adequacy level of leaf nutrients (leaf rank#14, bearing palms) may be estimated.

Using the substantial data gathered from the dwarf varieties (particularly MLYD, CATGD and TACGD) at the PCA-ZRC (1995 – 1999), a simple averaging (to explore practical tendencies of data) revealed: it appears that the physiological adequacy and critical leaf nutrient levels of the yellow dwarf and green dwarf varieties differs (slightly to moderately) in most nutrients. Generally, leaf nutrient levels of dwarfs are slightly higher than that of talls, but lower than hybrid coconuts.

For bearing dwarfs in general, a reference or guide on leaf nutrient critical levels (leaf rank #14) as derived in this study is presented, as follows: 1.70 % N, 0.125% P, 0.90%K, 0.38% Ca, 0.26% Mg, 0.12%Na, 0.37 % Cl, 0.15% S and 11ppm boron (B).

Nevertheless, with the initial findings that the normal or adequacy levels of some leaf nutrients of dwarf varieties tend to differ, particularly leaf K, Mg, Na, and Cl, future refinements of physiological leaf critical levels should be considered specific to the different dwarf varieties.

With the availability of leaf analysis results of highly productive dwarf varieties of coconut for several cropping years, it is possible to determine the acceptable adequate levels of leaf nutrients to derive the average physiological critical levels The estimated critical levels of leaf nutrients of dwarf varieties of coconut may be based on the estimated adequacy or average values of leaf nutrient levels as presented in this work. To confirm or validate the critical levels indicated in this work, further works on dwarf varieties of coconuts - particularly on salient aspects of crop mineral nutrition cum experimentally - designed fertilization response studies under different cases of soil mineral nutrient deficiencies in coconut areas should be actively pursued at different stages of the growth and development dwarfs.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