Interpretation and Management of Oil Palm Leaf Analysis Data

By T.H. Fairhurst and E. Mutert

Fertilizer recommendations are effective when planters combine the interpretation of leaf analysis with field knowledge and common sense.

Five zones have been identified in terms of the relationship between leaf nutrient content and yield response (**Figure 1**), although it has been suggested that luxury uptake (Zone D) does not occur in oil palm.

Differences in leaf nutrient concentration may be due to a wide range of factors (**Figure 2**), which underlines the importance of strict adherence to proper procedures for leaf sampling. They also result in difficulties involved in the interpretation of the results of leaf analysis. Critical leaf nutrient concentrations, considered to have wide applicability, are given in **Table 1**. However, these values should only be used with the greatest caution. 'Optimum', or 'critical', values for individual nutrients can vary over a considerable range, depending on such factors as the age of palms, soil moisture regime, ratio to other nutrient concentrations, type of planting material, spacing, and inter-palm competition. These factors do not act in isolation, but should be considered in sum (**Figure 2**). It is therefore advisable to refer to optimal 'ranges' rather than to critical or optimal 'values'. Suggested nutrient ranges associated with optimum, deficient, and excessive nutrition are given in **Tables 2** and **3** for young and mature palms, respectively.

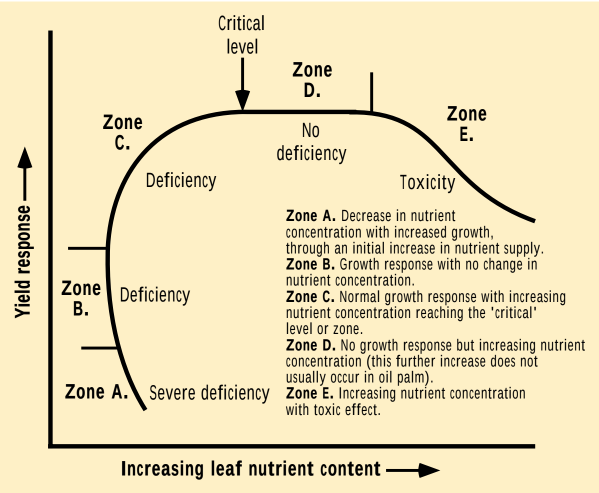

Figure 1. Diagram of deficiency and toxicity in relation to leaf nutrient concentration, growth, and yield (after Hartley, 1988).

Because of the synergism between nitrogen (N) and phosphorus (P) uptake, leaf P concentration must be assessed in relation to leaf N concentration (Ollagnier and Ochs, 1981). This is due to the constant ratio between N and P in protein compounds found in plant tissue. A

Table 1. Critical nutrient levels for oil palm leaves 9 and 17 (Ochs and Olvin, 1977).

Leaf #	N	P	K	Mg	Ca	Cl	S
17	2.50	0.15	1.00	0.24	0.60	0.55	0.22
9	2.75	0.16	1.25	0.24	0.60	–	–

‘critical curve’ has been developed where:

Critical Leaf P Concentration = 0.0487 x Leaf N Concentration + 0.039.

In the end, critical leaf nutrient concentrations must be determined for each agroecological environment, taking into account local soil and climate conditions, and this can only be achieved by means of factorial fertilizer experiments. Some workers have suggested larger critical nutrient concentrations where the number of effective sunshine hours is very high.

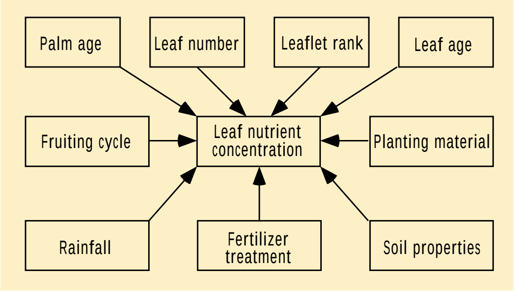

Figure 2. A large number of factors affect leaf nutrient concentration.

A different approach to determine whether potassium (K) and magnesium (Mg) are deficient involves taking into account the relative concentrations of leaf cations...K, Mg and calcium (Ca). First, the total amount of bases in the leaf (TLB) is calculated (see formula below) and K and Mg assessed as a percentage of TLB (Foster, 1999).

TLB (cmol/kg) = (Percent leaf K/39.1 + Percent leaf Mg/12.14 + Percent leaf Ca/20.04) x 1000

Very approximately, K and Mg deficiency can then be individually assessed, based on their percentage of TLB, as follows:

(X/TLB) x 100	Deficiency rating
<25	Deficient
25-30	Low
>30	Sufficient

Note:
X = partial TLB
of K, Mg and Ca

For example, if K = 0.91, Mg = 0.23, and Ca = 0.56, TLB = 70.16 and X = 23.27 for leaf K and 18.94 for leaf Mg, then X/TLB = 33 percent for leaf K and 27 percent for leaf Mg. With this method we would conclude that K is sufficient and Mg moderately deficient.

Leaf analysis may be used to determine whether differences in nutrient status explain the abnormal appearance of a particular selection of palms (e.g., where some palms exhibit particular deficiency symptoms, but the cause is not clear). A bulk sample based on 20 to 30 sampled palms should be prepared in the normal way for both affected and unaffected palms. Leaves should be analysed for micronutrient content if symptoms are not obviously related to one of the macro-nutrients. Affected palms should also be photographed to assist with leaf analysis interpretation at a later date.

The estate profits from properly implemented leaf sampling and analysis only when the results are correctly interpreted and transformed into a fertilizer program. Leaf analysis data begin to provide more useful information when a series of data has accumulated over a number of years. Formerly, data storage and retrieval were difficult tasks and required the use of clip card systems of the kind developed by PT London Sumatra in the 1960s. However, personal computers equipped with database software now provide powerful tools allowing much more thorough and detailed analysis of leaf data.

A suitable system, 'Oil Palm Monitoring Program (OMP7)', is available from PPI/PPIC. Provided the necessary background information has been collected and entered, a suitable monitoring program can be used to run queries on sets of data. Examples are given below:

- Show all fields where leaf N and K concentration is below critical levels.
- Calculate mean leaf P concentration in all Ultisol fields.
- Select blocks with above critical leaf N concentration and show yield.
- Calculate mean leaf N concentration in fields affected by caterpillars.
- Calculate mean N concentration in similarly aged palms (averaged over several planting years).
- Calculate mean leaf K level in a particular planting material.

After two to three years, booklets may be printed for each block showing yield, leaf analysis, and past fertilizer applications for each year. When such information is available, a discussion in the field between different levels of staff is based on actual data rather than guesswork and memory.

Table 2. Nutrient concentration in leaf 17 associated with deficiency, optimum and excess in young palms, less than 6 years from planting (von Uexküll and Fairhurst, 1991).

Nutrient	Units	Deficiency	Optimum		Excess
N	% DM	<2.50	2.60	2.90	>3.10
P	% DM	<0.15	0.16	0.19	>0.25
K	% DM	<1.00	1.10	1.30	>1.80
Mg	% DM	<0.20	0.30	0.45	>0.70
Ca	% DM	<0.30	0.50	0.70	>0.70
S	% DM	<0.20	0.25	0.40	>0.60
Cl	% DM	<0.25	0.50	0.70	>1.00
B	mg/kg	<8	15	25	>35
Cu	mg/kg	<3	5	7	>15
Zn	mg/kg	<10	15	20	>50

Table 3. Nutrient concentration in leaf 17 associated with deficiency, optimum and excess in mature palms, more than 6 years from planting (von Uexküll and Fairhurst, 1991).

Nutrient	Units	Deficiency	Optimum		Excess
N	% DM	<2.3	2.40	2.80	>3.00
P	% DM	<0.14	0.15	0.18	>0.25
K	% DM	<0.75	0.90	1.20	>1.60
Mg	% DM	<0.20	0.25	0.40	>0.70
Ca	% DM	<0.25	0.50	0.75	>1.00
S	% DM	<0.20	0.25	0.35	>0.60
Cl	% DM	<0.25	0.50	0.70	>1.00
B	mg/kg	<8	15	25	>40
Cu	mg/kg	<3	5	8	>15
Zn	mg/kg	<10	12	18	>80

Conclusions

Because of the importance of fertilizer in the production and maintenance of large and sustainable yields of fruit bunches, considerable efforts have been made to develop methods providing a scientific basis for estimating fertilizer requirements of oil palm. However, while soil and leaf analysis may provide the basis for decisions on fertilizer use, the final crop is the result of the interaction of so many different factors, some of which cannot be controlled or predicted. Hence, exact 'prescriptions' are not possible. Effective fertilizer recommendations are usually the result of combining the results of leaf analysis with field knowledge and common sense. Fertilizer recommendations should not rely on prescriptions based on leaf analysis data, determined in an analytical laboratory without recourse to field inspections. For example, applying large amounts of N fertilizer based on low leaf N status will be ineffective where the underlying constraint to palm productivity is over-pruning and poor drainage. However, under good management, the oil palm is so responsive to fertilizer that it almost always pays to use rates that are close to the agronomic maximum, which in turn will depend on the prevailing soil and climate conditions.

The underlying cause of small leaf nutrient concentrations and observed deficiency symptoms may be careless and incorrect application rather than insufficient amounts of fertilizer. Indeed, attention to application technique (e.g., spreading, use of calibrated measures) may often eliminate the need to increase application rates. Field inspections are thus an integral part of leaf analysis data interpretation, and professional consultants will always insist on walking all the fields for which they provide recommendations. **BCI**

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