FERTILIZER RECOMMENDATION IN BASED ON SOIL AND LEAF ANALYSIS

By Severino S. Magat

In soil analysis, the following data are required:

1. the chemical properties (physical properties sometimes needed) as determined by capable laboratories following acceptable methods;
2. a guide on suggested critical levels or satisfactory levels of soil properties for coconut; and
3. a guide on the average nutrient and fertilizer needs based on nutrient uptake and extensive mineral nutrition and fertilization research.

Items 2 and 3 which are presented in Tables 1 and 2 to 7, may be used as references for determining the qualitative needs and estimating the fertilizer rates for a particular farm(s) or area(s) under study or evaluation.

The rates of fertilization in Tables 2, 3, 4, 5, 6 and 7 may be considered as the ones recommended under moderate levels of nutrients, that is, those slightly above the critical levels. When levels of nutrients are about equal or lower than the critical level, rates of nutrient and fertilizer application should be increased to at least 20-50% of values in the reference tables, while when levels of nutrients are higher than the critical, the rates of nutrients and corresponding fertilizers should be lower by at least 20-50% of reference values (Tables 2 to 7). Under high levels of soil fertility, fertilization is not usually required except for periodic maintenance.

Table 1 A Guide on Soil Fertility Levels in Coconut Production (PCA 1991)

Property	Level/Concentration		
	Low/Deficient	Med/Adequate	High/Excessive
pH (1:5 soil H_2O)	<5	5-7.5	>7.5
EC (mmhos/cm)	<20	20-40	>40
Organic C (%)	<1	1-2	>2
Total N (ppm)	<1000	1000-2000	>2000
CEC (meq/100 g soil)	<10	10-25	>25
Exch. K	<0.3	0.3-0.6	>0.6
Exch. Ca	<10	10-20	>20
Exch. Mg	<5	5-8	>8
Exch. Na	<0.2	0.2-0.5	>0.5
Total K (ppm)	<200	200-300	>300
Avail. P (ppm)	<5	5-20	>20
Avail. S (ppm)	<20	20-40	>40
Avail. Cl (ppm)	<20	20-40	>40
Micronutrients (ppm):			
Avail. Mn	<15	100	>100
Avail. Fe	<5	75	>75
Avail. Zn	2	4	>4
Avail. Cu	<4	4-8	>8
Avail. B	<0.5	2	>2

The best estimate depends to a great extent on the user's (for example, Agronomist) strong background, experience and understanding of the field conditions and agro-economic considerations as well.

For instance, the chemical analysis of the soil samples collected from a 25 year old bearing coconut plantation shows the following results:

Soil pH 6.0; organic matter, 1.8%; available P, 25 ppm; exchangeable Mg, 2.5 m.e./100g.

Table 2 Recommended Rate of Nitrogen Fertilization (Tree/Year) at Different Ages of Coconut

AGE	N rate (per tree)	FERTILIZERS (TREE/YEAR) [a]			
		Ammonium sulfate[b] (21-0-0) (A)	Ammonium chloride (25-0-0) (B)	Urea (45-0-0) (C)	Complete (14-14-14) (D)
Field-planting	30 g	150 g	120 g	66 g	200 g
6-months	40 g	200 g	160 g	88 g	266 g
1 year	0.10 kg	0.50 kg	0.40 kg	0.22 kg	0.67 kg
2 years	0.15 kg	0.75 kg	0.60 kg	0.33 kg	1.00 kg
3 years	0.20 kg	1 0 kg	0.80 kg	0.44 kg	1.33 kg
4 years	0.30 kg	1.5 kg	1.20 kg	0.66 kg	2.00 kg
5 years or older	0.40 kg	2.0 kg	1.60 kg	0 89 kg	2.67 kg

(Magat, 1991)

* Percentage of N: A, 21%; B, 25%,; C, 45%; D, 14%.
[a] Most common N source for coconut.

Table 3 Recommended Rate of Phosphorus Fertilization (Tree/Year) at Different Ages of Coconut

AGE	P rate (per tree)	FERTILIZERS (TREE/YEAR)[a] Solophos (0-20-0)[b] (A)	Amophos (16-20-0) (B)	Complete (10-5-20) (C)	Complete (14-14-14) (D)
Field-planting	13 g	150 g	120 g	590 g	209 g
6-months	22 g	250 g	250 g	1.00 kg	355 g
1 year	44 g	0.50 kg	0.50 kg	2.00 kg	0.70 kg
2 years	63 g	0.70 kg	0.70 kg	2.86 kg	1.01 kg
3 years	72 g	0.80 kg	0.80 kg	3.27 kg	1.16 kg
4 years	87 g	1 00 kg	0 kg	3.95 kg	1.40 kg
5 years or older	131 g	1 50 kg	1.50 kg	5.95 kg	2.11 kg

(Magat, 1991)

[a] Percentage of P: A, 9%; B, 9%,; C, 2.2%; D, 6.2%.
[b] Most common P source for coconut.

Table 4 Recommended Rate of Potassium Fertilization (Tree/Year) at Different Ages of Coconut

AGE	K rate (per tree)	FERTILIZERS (TREE/YEAR)[a] Potassium chloride (0-0-60)[b] (A)	Potassium sulfate (0-0-50) (B)	Complete (10-5-20) (C)	Complete (14-14-14) (D)
Field-planting	75 g	150 g	182 g	468 g	536 g
6-months	125 g	250 g	304 g	781 g	1.13 kg
1 year	0.30 kg	0.60 kg	730 g	1.87 kg	2.72 kg
2 years	0.45 kg	0.90 kg	1 09 kg	2.81 kg	4.09 kg
3 years	0.60 kg	1 20 kg	1.46 kg	3.75 kg	5.45 kg
4 years	0.80 kg	1.60 kg	1.95 kg	5.00 kg	7.27 kg
5 years or older	1.00 kg	2 00 kg	2.43 kg	6.25 kg	9.09 kg

(Magat, 1991)

[a] Percentage of K: A, 50%; B, 41%,; C, 16%; D, 11%.
[b] Most common K source for coconut.

Table 5 Recommended Rate of Chlorine Fertilization (Tree/Year) at Different Ages of Coconut

AGE	Cl rate (per tree)	FERTILIZERS (TREE/YEAR)[a] Potassium chloride (0-0-60)[b] (A)	Sodium chloride (Common salt)[b] (B)	Ammonium chloride (25-0-0) (C)	Complete (10-5-20) (D)	Complete (14-14-14) (E)
Field-planting	66 g	150 g	132 g	110 g	412 g	600 g
6-months	111 g	250 g	222 g	185 g	693 g	1.00 kg
1 year	260 g	0.60 kg	0.52 kg	0 43 kg	1.62 kg	2.36 kg
2 years	400 g	0.90 kg	0.80 kg	0.67 kg	2.50 kg	3.64 kg
3 years	530 g	1 20 kg	1.60 kg	0.88 kg	3.31 kg	4.82 kg
4 years	700 g	1 60 kg	1.40 kg	1.17 kg	4.37 kg	6.36 kg
5 years or older	800 g	2.00 kg	1.80 kg	1 50 kg	5.62 kg	6.18 kg

(Magat, 1991)

[a] Percentage of Cl: A, 44%; B, 50%,, C, 60%; D, 16%.
[b] Common sources of chloride for coconut.

Table 6 Recommended Rate of Magnesium Fertilization (Tree/Year) at Different Ages of Coconut

AGE	Mg rate (per tree)	FERTILIZERS (TREE/YEAR)[a] Dolomite—ub (A)	Kieserite[b] (B)	Epsom Salt (C)
Field-planting	30 g	300 g	172 g	315 g
6-months	50 g	500 g	294 g	526 g
1 year	75 g	0.75 kg	0.44 kg	0.79 kg
2 years	150 g	1.50 kg	0.88 kg	1.58 kg
3 years	0.20 kg	2.00 kg	1.17 kg	2.10 kg
4 years	0.25 kg	2.50 kg	1.47 kg	2.63 kg
5 years or older	0.30 kg	3.00 kg	1.76 kg	3.15 kg

(Magat, 1991)

[a] Percentage of Mg: A, 10%; B, 17%,; C, 9.5%; D.
[b] Common source of Mg for coconut.

Table 7 Recommended Rate of Sulfur Fertilization (Tree/Year) at Different Ages of Coconut

AGE	S rate (gram per tree)	FERTILIZERS (TREE/YEAR)[a]				
		Ammonium sulfate (21-0-0)[b] (A)	Calcium sulfate[b] (gypsum) (B)	Potassium sulfate (gymsum) (C)	Magnesium sulfate (epsom salt) (D)	Complete (14-14-14) (E)
Field-planting	36	150 g	200 g	200 g	276 g	327 g
6-months	49	250 g	266 g	266 g	369 g	436 g
1 year	120	0.50 kg	0.67 kg	0.67 kg	0.92 kg	1.09 kg
2 years	180	0.75 kg	1.00 kg	1.00 kg	1.38 kg	1.64 kg
3 years	240	1.00 kg	1.33 kg	1.33 kg	1.85 kg	2 18 kg
4 years	360	1.50 kg	2.00 kg	2.00 kg	2.77 kg	3.27 kg
5 years or older	480	2.00 kg	2.67 kg	2.67 kg	3.69 kg	4 36 kg

(Magat, 1991)

[a] Percentage of S: A, 24%; B, C, 18%; D, 13%, E, 11%.
[b] Common sources of sulfur for coconut.

Comparing these values with the suggested levels (Table 1), referenced to PCA, the former indicate satisfactory levels of soil acidity, available P, exchangeable K, Mg, while both N (organic matter as basis) and K are likely at low to moderate levels. This suggests the need to apply both N and K, and using Table 2 (N fertilization) and Table 4 (K fertilization), the suggested rates of K and N are 0.40 kg and 1 kg, respectively. These required nutrients can be satisfied by 2 kg 21-0-0 or 0.90 kg urea plus 2.0 kg 0-0-60. In cases where information on soil Cl and S levels are not known, the use of 21-0-0 and 0-0-60 are recommended as coconut usually needs these nutrients widely in the country.

Based on Leaf Analysis

In leaf analysis or foliar diagnosis, the following data are required:

1) the results of chemical analysis of the concentration of nutrients (N, P, K, Ca, Mg, Na, Cl, S, B and micronutrients) of a particular leaf reference, such as leaf 14 for bearing palms, analyzed by a qualified laboratory. The PCA has a specialized

Table 8 Guide on Coconut Leaf Critical Levels (% of Dry Matter) for Tall (Typica) Variety

Nutrient/Leaf No.	Reference			
	IRHO	Unilever (1)	Kanapathy (2)	PCA (3)
MACRONUTRIENT				
Nitrogen (%)				
Leaf 1	1.70	1.60	-	-
4	2.20	1.80	-	-
9	2.20	1.95	-	-
14	1.8-2.0	2.00	1.80	1.80
Phosphorus (%)				
Leaf 1	0.160	0.17	-	-
4	0.138	0.16	-	-
9	0.130	0.15	-	-
14	0.120	0.14	0.12	0 12
Potassium (%)				
Leaf 1	2.20	2.00	-	-
4	1.75	1.70	-	-
9	1.15	1.30	-	-
14	0.8-1.00	1.00	0 8-1.10	0.80
Calcium (%)				
Leaf 1	-	0.30	-	-
4	-	0.34	-	-
9	-	0.44	-	-
14	0.50	0.55	0 15-0.30	0.30
Magnesium (%)				
Leaf 1	0 20	0.22	-	-
4	0.22	0.23	-	-
9	0.24	0.25	-	-
14	0 24-0.28	0.26	0.30	0.20
Sodium (%)				
Leaf 1	-	0.10	-	-
4	-	0.12	-	-
9	-	0.17	-	-
14	0.40	0 20	-	-
Chloride (%)				
Leaf 1	-	-	-	-
4	-	-	-	0.40-0.70
9	-	-	-	0.30-0 55
14	0.50	-	-	0.30-0.40

Table 8 Continuation ...				
	Reference			
Nutrient/Leaf No.	IRHO	Unilever (1)	Kanapathy (2)	PCA (3)
Sulfur (%)				
Leaf 1	-	-	-	-
4	-	-	-	-
9	-	-	-	-
14	0.15-0.20	-	-	0.12
MICRONUTRIENT				
Boron (ppm)				
Leaf 1	-	12	-	-
4	-	13	-	9.13
9	-	14	-	-
14	-	14	-	9.11
Manganese (ppm)				
Leaf 1	-	100	-	-
4	-	130	-	-
9	-	165	-	-
14	60	185	60	-
Iron (ppm)				
Leaf 1	-	80	-	-
4	-	90	-	-
9	-	100	-	-
14	50	115	50	-
Zinc (ppm)				
Leaf 1	-	20	-	-
4	-	18	-	-
9	-	15	-	-
14	60	15	60	-
Copper (ppm)				
Leaf 1	-	13.5	-	-
4	-	18.5	-	-
9	-	13	-	-
14	-	12.5	-	-

(1) Friend (1975) The Solomon Islands and Levers Pacific Plantations Proprietory Limited Joint Coconut Research Scheme, 1971-74
(2) Kanapathy (1971) Preliminary work on foliar analysis as a guide to the manuring of coconut. Conference on Cocoa and Coconuts, (Incorporated Society of Planters) Kuala Lumpur, Malaysia
(3) Magat (1979) The use of leaf analysis in the conduct of field fertilizer trials in the Philippines. Plant nutrition 1978. New Zealand DSIR Info Series 134:299-311 Also in Phil J Coconut Studies 4(1):32-39.

Table 9 A Guide on Coconut Leaf Critical Levels (% of Dry Matter) for Hybrids			
	REFERENCE		
Nutrient/Leaf No.	IRHO (1) Critical level	PCA (2) Critical level	PCA (2) Optimum level
MACRONUTRIENT			
Nitrogen			
Leaf 1	1.7	-	-
4	2.2	1.95	2.2
9	2.2	1.80	2.0
14	2.2	1.80	2.0
Phosphorus			
Leaf 1	0.16	-	-
4	0.14	0.13	0.15
9	0.13	0.12	0.13
14	0.12	0.12	0.13
Potassium			
Leaf 1	3.0	-	-
4	2.0	1.70	1.90
9	1.7	1.00	1.17
14	1.4	0.90	1.10
Calcium			
Leaf 1	-	-	-
4	-	0.35	0.41
9	-	0.34	0.38
14	-	0.32	0.35
Magnesium			
Leaf 1	0.27	-	-
4	0.24	0.25	0.29
9	0.23	0.30	0.33
14	0.20	0.30	0.33
Sodium			
Leaf 1	-	-	-
4	-	0.30	0.37
9	-	0.20	0.25
14	-	0.15	0.17
Chloride			
Leaf 1	-	-	-
4	-	0.65	0.74
9	-	0.55	0.60
14	-	0.45	0.52
Sulfur			
Leaf 1	-	-	-
4	-	0.17	0.19
9	-	0.15	0.17
14	-	0.15	0.16

(Magat, 1991)

(1) Manciot et al. (1979)
(2) First Approximation (Magat 1988).

laboratory, the Tissue Analysis Laboratory (TAL) based at the Head Office, Diliman, Quezon City;

2) a guide on the suggested critical levels and optimum levels of leaf nutrients (if available);
3) a guide on the average nutrient and corresponding fertilizer needs based on average nutrient uptake and substantial mineral nutrition and fertilization research (Tables 2a-2f).

For item 2, Table 8 may be used as reference for tall varieties, and Table 9 for coconut hybrids, particularly the dwarf x tall types, using the 'MAWA' or Port Bouet 121 as a guide.

As in the soil analysis technique in diagnosing fertilizer recommendations, the rates of fertilization in Tables 2, 3, 4, 5, 6, and 7 could be considered as the ones recommended under moderate levels of nutrients (N, P, K, Cl, Mg, and S), slightly above the critical levels. When levels of nutrients are about equal to or lower than the critical levels, rates of nutrient and fertilizer application should be increased to at least 20%-50% of the values in the reference tables. On the contrary, when levels of nutrients are higher that the critical concentrations, the rates of nutrients and corresponding fertilizer sources should be decreased by at least 20%-50% of the reference values (Tables 2 to 7). Under very high levels of soil fertility, regular fertilizer application is not normally practiced except for periodic maintenance.

In fertilizer management, the maintenance fertilization rate corresponds to the fertilizer amounts necessary to maintain the available reserves at constant level, while corrective fertilization rate is the difference between optimum fertilization and maintenance fertilization. The optimum level depends on economic conditions, as well as the response obtained under field experimentation in particular soil type or area.

The degree of accuracy and reliability of recommending the best fertilizer amounts (as close to the optimum rates) for the maximum economic yield (MEY) depends much on the knowledge and experience of the one using foliar diagnosis. This means historical records and agronomic data and information available help improve the reliability of the method.

For instance, the leaf sample (leaf 14) from a 30 year old coconut (local tall variety) has the chemical analysis below as reported by the laboratory:

N,1.65%; P, 0.13%; Ca, 0.55%; Mg, 0.35%; Na, 0.15%; Cl, 0.10%; S, 0.11%; B, 11

By comparing the values with the guide on critical levels (PCA as reference), the coconut area represented by this sample is likely suffering from moderate deficiencies in N and S, and strong deficiencies in K and Cl, while P, Ca, Mg, Na, and B are well above satisfactory levels or very adequate for the palms. The nutritional needs (per tree per year) are very likely 0.40 kg N, 1.3 kg K, 1.2-1.3 kg Cl, and 0.48 kg S. These can be supplied by 2 kg 21-0-0 and 2.5 kg KCl per palm per year.

In cases where K and S are adequate, NaCl and NH_4Cl(25-0-0) have been found to be very effective and are cheaper sources of chloride, a macronutrient for coconut. ❐

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available in the markets. Likewise, spray dried coconut milk shows good shelf life over longer periods of storage in polyester/foil/polylaminated packs. Similarly, quick method of vinegar production from coconut water was developed which is now being utilised by entrepreneurs on commercial scale. Coir pith, coconut bunch waste and leaf stalk were shown as good substrates for producing oyster mushroom. Higher biological efficiency was achieved when prefermented coir pith and other wastes as well as bunch waste and paddy straw in 1:1 proportion each were used as substrates.

A cost effective technology for the recovery of commercially valuable resources like tannins, lignins and other natural colouring compounds from coconut husk was developed and transferred to entrepreneurs. The colouring material derived is a precursor in the manufacture of chemicals like vanillin, furfural and tannins. Similarly, technology for the conversion of tender coconut waste into paper pulp is now available for pilot testing.

Technoeconomic viability of producing coir fibreboard as a substitute for timber could be established. The product is cost effective and ecofriendly and is suitable for paneling, cladding, surfacing and partitioning for interior use. The possibility of using coir fibre for making cheap, but efficient country boat was also successfully demonstrated. The coir fibre based boat is stronger than wood based one with comparatively low capital expenditure as well as maintenance cost.

Technology for the production of coir geotextiles and their use for specific purposes was rationalised and translated into field practice for erosion control on slopy terrain and for supporting surface vegetation including woody species.

A new product called polycoir was developed from brown coir fiber in different densities. These boards which are termite resistant, moisture resistant, fire retardant and having a good finish, can be molded to size for different end uses such as indoor paneling and doors among others. Likewise, a technology for the production of coir-cement composite panel for diverse applications was also perfected. ❐

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