RESPONSE OF INLAND COCONUTS TO INORGANIC FERTILIZATION FROM FIELD-PLANTING

Remus L. Prudente and Alfonso M.R. Mendoza*

ABSTRACT

A long-term study designed to investigate the effects of seven (7) inorganic fertilizer combinations on the vegetative growth, nutritional status and yield of inland coconuts was conducted at the Davao Research Center, Davao City. The experiment started from newly transplanted coconut seedlings up to the bearing stage.

Cumulative data for the first two years of bearing revealed that palms fertilized with KCl, either with N or NP, produced significantly more nuts which had thicker, heavier meat and more copra per tree than palms fertilized without KCl. On nut production, palms with $N+P+KCl_1$ treatment obtained an increase of 202%, 127% and 93% over the N, unfertilized and NP plots, respectively. Palms receiving KCl, either with N or NP, gave a mean yield of 23.1 kg copra/tree; on the other hand, only 6.6 kg/tree were produced from trees fertilized without KCl, a difference of 250% for the period under report.

Coefficients of correlation between leaf nutrient levels and production showed that inland coconuts grown on reddish-brown clay loam soil (Ultisol) of Davao apparently responded only to N and Cl. Nitrogen levels in the leaves are highly correlated with nut and copra production, while chlorine levels, with copra weight/nut, copra/tree and nuts/tree. The partial correlation analysis between copra production and chlorine, with nitrogen levels constant, was highly significant.

INTRODUCTION

The application of inorganic fertilizers to hasten the development of the palm has been consistently advocated by coconut workers. The major elements considered to be essential for coconut are N, P, K, and Mg, but lately chlorine or chloride has gained acceptance as a major nutritional requirement of the palm (von Uexkull, 1971; Ollagnier and Ochs, 1971; Mendoza and Prudente, 1972; Magat, *et al*, 1975 and Magat and Prudente, 1975). However, the role of chlorine is not well understood; hence further studies at the Davao Research Center of PCA-ARB were initiated with the object of shedding more information on the role of Cl.

Yield improvements through fertilization have been reported by many workers. Fremond and Gross (1968) reported marked increases in nut yield and weight of copra per nut with the application of potassium chloride (KCl) fertilizer. Similar results were obtained by John and Jacob (1959) where the application of balanced NPK fertilizer combined with green manure and timely intercultural operations gave 35% and 44% increases in nut and copra yields. With coconut seedlings, it was shown by Cooke (1954) that proper manuring promoted early bearing and high yields. Salgado (1947, 1952) claimed that potash accelerated flowering, from the eighth to the fifth year. Mendoza and Prudente (1972) initially demonstrated the role played by chlorine in the vegetative and reproductive growth of the palms. Trees receiving nitrogen with two different levels of potassium chloride produced significantly more leaves, were taller and had much stouter trunks than those trees fertilized with N, NP or none at all. These ordinary tall coconuts were likewise induced to flower in 3.5 years with the application of NK fertilizers and other cultural management practices, instead of the usual 7-8 years.

This paper deals with the progress and recent results of a long-term NPK study, particularly those involving the first 25 months of production of the Typica palms field-planted in 1968. Leaf analysis results, however, as well as correlation coefficients between elements, refer only to the second half of the period covered in this report. This study sought to determine the effects of inorganic fertilizers on the production of inland coconuts.

MATERIALS AND METHODS

Experimental Site and Materials

An area of 2.72 hectares in the Davao Research Center previously cropped with old coconuts was used in the experiment. The soil is classified as Tugbok clay loam (an Ultisol) with 2.4% organic matter, 48 ppm

* Science Research Associate and Deputy Administrator for Agricultural Research, Philippine Coconut Authority, Diliman, Quezon City.

available phosphorus, 300 ppm exchangeable potassium and 68% base saturation. Normally, this soil consists of brown to reddish-brown prismatic and slightly compact clay. It is hard when dry, friable when moist but very sticky when wet. Topography ranges from undulating to slightly rolling with fairly good surface and internal drainage.

The area has an almost even distribution of rainfall throughout the year. Its annual average for the past decade amounted to 2450 cm in 187 rainy days. Adequate sunshine prevails year-round and the relative humidity is ideal for coconuts.

The palms used belong to the variety typica (Laguna tall), typical all over the Philippines.

Methods

The experiment consisted of seven (7) treatments (N, N+P, N+KC1, N+KC1$_2$, N+P+KC1, N+P+KC1$_2$ and control) arranged in a completely randomized design with nine palms per experimental plot and replicated three times. A single guard row separated one experimental unit from the other. The fertilizers were applied semi-annually, broadcast and forked-in within the two-meter radius from the base of the palms after ring-weeding the area. The fertilizer nutrient rate per tree per year is shown in Table 1.

Fertilizers used were ammonium sulfate (21%N), ordinary superphosphate (20% P_2O_5) and muriate of potash (44% C1). The area was regularly ring-weeded, mowed and underbrushed. Harvesting was done at 45 days interval. The copra was prepared by sundrying. Leaf sampling for foliar diagnosis was done annually.

Table 1. Fertilizer nutrient rate per tree per year

FERTILIZER	FERTILIZER SYMBOL & LEVEL	YEAR AFTER FIELD-PLANTING 1 – 2	3 – 4	5 – 6	7 and up
a. Nitrogen (kg N)	N_0	None	None	None	None
	N_1	0.08	0.16	0.24	0.32
b. Phosphate (kg P_2O_5)	P_0	None	None	None	None
	P_1	0.06	0.12	0.18	0.24
c. Potash (kg K_20)	K_0	None	None	None	None
	K_1	0.09 (0.06)*	0.18 (0.13)	0.36 (0.26)	0.54 (0.39)
	K_2	0.18 (0.13)	0.36 (0.26)	0.72 (0.52)	1.08 (0.78)

* corresponding chlorine levels.

RESULTS AND DISCUSSION

Nut Production

Table 2 shows the cumulative nut yield per tree, copra weight per nut and copra production (per tree and per hectare basis) for the first two years of bearing. Highest nut yields were obtained from palms fertilized with N+P+KC1$_1$ and N+KC1$_1$, followed closely by the same combinations with higher KC1 rates. N+P+KC1$_1$ treatment resulted in an increase of 202%, 127% and 93% over the N, unfertilized and N+P plots, respectively, while N+KC1$_1$ obtained 198%, 124% and 91% over the three treatments respectively. No statistical difference was noted among the four treatments with potassium chloride fertilizer.

The response curves show that nut production and nutrients nitrogen and chlorine followed a curvilinear trend which were significantly correlated (Figs. 1a & 1b). K did not influence production (Fig. 2b) while Mg had a negative effect (Fig. 2a).

Copra Weight per Nut

The application of two higher KC1 levels significantly increased the copra weight per nut. Palms with N+P+KC1$_2$ treatment realized an increase of 68% over NP-treated palms and 63% over the control and N, while N+KC1$_2$ had 64% and 58% increase over the said three treatments, respectively. N+P+KC1$_1$ treatments also produced significantly heavier copra per nut over the palms without KC1 addition (Figs. 3a, 3b, 3c).

Table 2. – **Effects of Inorganic Fertilizer on Initial Production of Inland Coconuts**[1]

TREATMENT	NUTS PER TREE	COPRA PER NUT	COPRA PRODUCTION	
			Per Tree	Per Hectare[2]
	number	g	kg	ton
0-0-0	31.9	214.5	6.5	1.008
N-0-0	23.9	214.5	5.5	0.853
N-P-0	37.4	207.7	7.8	1.212
$N\text{-}0\text{-}K_1$	71.4**	302.6	21.8**	3.396*
$N\text{-}0\text{-}K_2$	67.0*	339.6**	22.8**	3.552**
$N\text{-}P\text{-}K_1$	72.3**	331.9*	24.1**	3.760**
$N\text{-}P\text{-}K_2$	68.6*	349.9**	23.8**	3.713**
HSD				
.05	36.8	104.4	10.0	2.062
.01	47.6	131.3	12.8	2.633
C.V. (%)	25.5	13.0	21.9	4.1
S.E.	7.84	21.08	2.01	416.64

1 Average of 3 replicates, accumulated production of 16 harvests (45-days interval).

2 Estimated at 156 trees per ha.

* Significant at 5% level.

** Highly significant at 1% level.

Copra per Tree

There appears to be marked differences in the copra yields of palms fertilized with the different fertilizer combinations. Palms receiving KC1 with N or N+P registered an average production of 23.1 kg copra per tree while those without KC1 had only 6.6 kg per tree, a difference of 250%.

Figs. 4a, 4b, 4c clearly show that the response of the palms to potassium chloride fertilizer in terms of copra yields are linear, indicating that the effect of such fertilizer is expressed more in terms of the weight of copra per nut. An estimate of the copra production per hectare showed that the control palms and N and N+P-treated palms produced only about a ton copra, while the trees fertilized with either N+KC1 or N+P+KC1 combinations yielded an average of 3.6 tons, a remarkable increase of 260%.

Nutrient Levels

Leaf analysis revealed that the likely factors which limit production are nitrogen and chlorine (Table 3). While no significant difference was noted on the other six nutrients analyzed, N and C1 levels in the leaves varied significantly. Palms with $N+KC1_2$ addition have higher nitrogen levels than control palms. Likewise, $N+P+KC1_1$ and $N+P+KC1_2$ had also significantly higher N levels than the control trees. On the other hand, the same combinations ($N+KC1_2$, $N+P+KC1_2$ and $N+P+KC1_1$) increased significantly the levels of chlorine over the treatments without KC1.

Relations between Nutrients and Production

As shown in Table 4, correlation coefficients between the different production indices and leaf nutrient levels revealed that nuts per tree, copra weight per nut and copra per tree are positively and strongly correlated with nitrogen and chlorine levels only. A close positive correlation existed also between N and C1 levels (Fig. 5). The r-value of P and K is positively significant (Fig. 6) but these two elements did not affect the production of the trees, while Mg levels appear to have a negative influence on nut and copra yields per tree (Figs. 2a and 4c). Apparently, Mg and K had an antagonistic interaction.

Undoubtedly, the application of potassium chloride fertilizer accelerated vegetative growth and improved the production of the palms in this study. Potassium has

Table 3. Nutrient levels as influenced by inorganic fertilizer[1]

TREATMENT	NUTRIENT (% of dry matter) N	P	K	Ca	Mg	Na	Cl	S
0-0-0	1.48	0.150	1.560	0.395	0.238	0.043	0.043	0.134
N-0-0	1.66	0.139	1.313	0.394	0.277	0.055	0.042	0.167
N-P-O	1.68	0.146	1.287	0.394	0.274	0.039	0.038	0.159
N-O-K_1	1.69	0.145	1.410	0.381	0.225	0.031	0.179	0.162
N-O-K_2	1.83**	0.152	1.444	0.350	0.224	0.032	0.403**	0.168
N-P-K_1	1.72*	0.153	1.452	0.395	0.251	0.045	0.224*	0.197
N-P-K_2	1.72*	0.151	1.362	0.372	0.261	0.043	0.390**	0.169
HSD .05	0.228	ns	ns	ns	ns	ns	0.149	ns
.01	0.291	ns	ns	ns	ns	ns	0.199	ns
C.V.	4.8	4.9	7.8	11.6	11.5	42.8	27.7	17.8
S.E.	0.046	0.004	0.063	0.025	0.017	0.01	0.03	0.0174

[1] Means of 3 replicates, analyzed at IRHO laboratory, Paris.

* Significant at 5% level.

** Highly significant at 1% level.

Table 4. Correlation coefficients (r) between nutrients and production of tall coconuts at the Davao Research Center, Davao City[1]

	NUTS/ TREE	COPRA/ NUT	COPRA/ TREE	N	P	K	Ca	Mg	Na	Cl
N	0.565**	0.511*	0.575**							
P	0.409	0.364	0.426	0.204						
K	0.239	−0.053	0.177	−0.291	0.532**					
Ca	−0.244	−0.268	−0.265	−0.162	0.055	−0.020				
Mg	−0.524*	−0.181	−0.456*	−0.188	−0.353	−0.696**	0.350			
Na	−0.365	−0.168	−0.300	−0.155	−0.314	−0.202	0.195	0.356		
Cl	0.582**	0.829**	0.681**	0.541*	0.432	−0.005	−0.334	−0.119	−0.111	
S	0.222	0.158	0.232	0.384	−0.048	−0.270	−0.018	0.087	−0.190	0.0295

[1] One year leaf analysis data as against the production record of the first 25 months.

* Significant at 5% level.

** Highly significant at 1% level.

always been cited as an important limiting factor in the nutrition of coconut. However, leaf analysis results showed that the addition of KC1 did not increase the levels of K. In fact, the control palms had higher K levels over the other treatments though the differences were not found statistically significant. The values of P and K were higher than established critical levels (0.12% and 0.8-10%, respectively), (Fremond, *et al.,* 1966), indicating that the Tugbok clay loam soil has enough reserves of these nutrients to sustain the normal growth, development and production of coconut palms.

Partial correlation analysis between chlorine (C1) and copra production (y) with nitrogen (N) constant was significant (ryC1. N=0.54). However, the correlation between nitrogen and copra production, with chlorine constant, was not significant (ryN.C1=0.33). This suggests that the marked increases in production are most likely influenced by chlorine leaf levels rather than by nitrogen. The significant correlation of nitrogen and nut production may also be due to high concentrations of chlorine in the leaves, which somehow brought up the nitrogen levels. This probably explains why a positive significant correlation existed between N and C1.

CONCLUSIONS

It is indicated that chlorine is the most likely factor that limits production of inland coconut areas, especially in Davao, followed by nitrogen. The addition of 1.6 kg ammonium sulfate plus 1.8 kg muriate of potash tremendously increased production by 191%, 58% and 314% in terms of nut yield, copra weight per nut and copra production per tree, respectively, over the trees with nitrogen fertilizer only.

Simple correlation analyses revealed that both nitrogen and chlorine played important roles in inducing coconut palms to produce more nuts with thicker, heavier copra. Only chlorine was positively observed to greatly influence nut and copra production.

Moreover, some salient findings of this work which have far-reaching benefit may be stated as follows: 1) the limiting nutritional factors (in the order of importance) of typica coconuts (Laguna tall) when grown inland on reddish brown clay loam soil are (a) chlorine and (b) nitrogen; 2) inorganic fertilizer, of the proper kind and at the appropriate rate, must be supplied to the palms from field-planting and regularly thereafter for early fruiting and high production; and 3) for inland upland coconut areas of Davao and similar areas in the country, nitrogen and chlorine should be applied together, rather than N being applied alone, in order to achieve higher fertilizer efficiency resulting in high coconut yields.

ACKNOWLEDGMENTS

The authors wish to convey their profound thanks and gratitude to: 1) Mr. Severino S. Magat, Science Research Chief, Agro-Soils Division, for his valuable suggestions and review of the paper; 2) Mr. Leon M. Alforja, Science Technologist, for the statistical analyses of the data; and 3) Mr. Virgilio V. Minoza, General Utility Worker, for his assistance in the gathering of field data.