

# **EFFECTS OF ORGANIC AND INORGANIC NITROGEN ON THE PRODUCTIVITY OF COCONUT GROWN ON THREE IMPORTANT SOIL TYPES IN LEYTE, PHILIPPINES**

M.E. Baliad<sup>1</sup>

## **ABSTRACT**

Severe nitrogen-deficiency in unfertilized plots resulted in low bearing percentage (19.62%) of the palms. Highest bearing percentage of 68.82% was observed on palms applied with 1.5 kg ammonium sulfate per palm per year.

Application of 2 kg ammonium sulfate/palm/year resulted in most number of harvested nuts. The yields of palms applied with 1.5 kg ammonium sulfate or 0.66 kg/urea/palm/year were, however, not statistically different from the former. Similar trends in fresh meat and copra yields were observed. Copra yields were significantly higher in plots applied with inorganic N fertilizers.

Palms growing on Maasin clay had higher nut, tresh meat, and copra yields than those planted on Mandaue clay and Palo clay loam.

Leaf nitrogen significantly increased in palms applied with 2 kg KCL plus kudzu mixed with calopogonium or 2 kg KCL plus inorganic N fertilizer. Phosphorus slightly decreased with increasing level of inorganic nitrogen fertilizer. Unfertilized palms and those applied with 2 kg KCL obtained the highest K values. Calcium and magnesium were not influenced by the different sources of nitrogen fertilizer. Palms growing on Maasin clay had higher leaf nitrogen content than those planted on Mandaue clay Palo clay loam. No trend between years of study was distinguishable from the observed values of the leaf elements.

Application of inorganic fertilizers could give better income to coconut farmers especially in N-deficient areas. Highest net profits were obtained from palms growing on Maasin and Mandaue clays and fertilized with 2.0 kg ammonium sulfate plus 2 kg KCL per palm per year applied twice in equal splits. On the other hand, the application of 1.5 kg ammonium sulfate plus 2 kg KCL per year was enough to obtain highest net profit from palms grown on Palo clay loam.

## **INTRODUCTION**

Coconut grows in diverse soil types. Although it can survive under adverse conclitions, its productivity varies with soil and climate. Like other crops, coconut requires certain stanclards for optimum growth and productivity.

Nitrogen, an element needed by coconut in greatest quantity, and chlorine are cleficient in Philippine soils planted to coconut. This was confirmed through leaf analyses conclucted by Prudente et al. (1979). Deficiency of such elements has been partially solved by fertilizer application, although the following setbacks have been' observed: a) fertilizer recommencations are usually general in nature and their accuracy has not been tesied in different soils; and b) majority of small coconut farmers are either unaware of the benefits of fertilizers or discouraged from following fertilizer recommencations because of copra price fluctuation, high cost of fertilizer, and inaccessibility of fertilizer source clue to the remote location of their farms or the lack of infra-structure and transportation facilities.

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<sup>1</sup> Instructor, Regional Coconut Research Center, Visayas State College of Agriculture, Leyte, Philippines.

Fertilizer from organic sources had been widely used in soil fertility programs of developing countries. But consumption of mineral fertilizer progressively increased as traditional forms of farming had to give way to more intensive systems. As a result, interest in the use of organic fertilizers waned. With the present price of inorganic fertilizer reaching unaffordable levels, organic fertilizer application is making a comeback.

Organic fertilizers enhance the microbial activity of the soil, help improve its physical and chemical conditions and provide a gradual and longterm source of nutrient elements. Fresh herbage of leguminous crops adds more nitrogen and organic matter to the soil when allowed to decompose on the ground.

Against the aforementioned background, a study was conducted to verify the following: 1) effects of ipil-ipil, kudzu mixed with calopogonium covercrops, and  $(\text{NH}_4)_2\text{SO}_4$  on copra yield of coconut; 2) extent of substitutions of inorganic N by the above leguminous crops; and 3) input-output relationship of different methods and levels of N fertilization. The study was also conducted to demonstrate to coconut farmers the economic advantage of applying fertilizer to coconut.

## **MATERIALS AND METHODS**

### **Site Selection**

Three coconut farms representing the three important soil types in Leyte, Philippines, i. e. Maasin clay, Palo clay loam, and Mandaue clay were identified based on the following criteria: coconuts at maximum bearing stage (20 years old and above); low nut production (50 nuts/tree/ yr); nitrogen-deficient soil; strategic location (near to or accessible from the national road); and planting distance of not closer than 8 meters between trees.

These soil types are described in Data Series on Coconut Statistics in the Philippines, Census Year: 1970-1971.

### **Treatments**

A randomized complete block design was used in the study. The coconut palms in each farm were subjected to 7 treatments, as follows:

T1 - check or control, underbrushed only once a year;

T2 - 2 kg KCL/palm/year, applied in equal splits every 6 months;

T3 - 2 kg KCL/palm/year plus ipil-ipil planted at 2 m x 2 m in between coconut rows and pruned every 6 months with herbage allowed to rot at the base of the palms.

T4 - 2 kg KCL/palm/year plus kudzu mixed with calopogonium at 50:50 ratio at 1.0 kg of each kind of seed per hectare;

T5 - 2 kg KCL plus 0.66 kg urea/palm/year applied in equal splits every 6 months;

T6 - 2 kg KCL plus 1.5 kg ammonium sulfate/palm/year applied in equal splits every 6 months; and

T7 - 2 kg KCL plus 2 kg ammonium sulfate/palm/year applied in equal splits every 6 months.

All treatments except T1 (control) were ringweeded and underbrushed twice a year before every fertilizer application.

## **Data Collection**

Twenty one sample palms were randomly selected per treatment. The data taken during every harvest at an interval of four months were: percentage of bearing palms, nut yield per hectare, fresh meat yield (kg/ ha) and copra yield (kg/ha). Other pertinent data include cost and return and tissue analyses.

One nut for every 5 mature nuts harvested was sampled for fresh meat weight. A 20-gram meat samples from each sample nut was oven dried at 6% moisture. Dried sample were weighed to determine copra yield.

Whenever applicable, the data gathered were converted to hectare basis.

Tissue analysis was done from leaf samples taken from 5 randomly selected palms per treatment collected every 6 months prior to fertilizer application. The 10-cm leaf samples were taken from the middle portion of 24 leaflets at the middle part of leaf 14.

## **Statistical Analysis**

The measurement-over-time analysis was used to analyze the data on the different sets of treatments throughout the duration of the study. While the treatment means were compared using the Duncan's Multiple range Test.

# **RESULTS AND DISCUSSION**

## **General Observation**

At the start of the experiment, the leaves of the coconuts were tapered and exhibited yellowing. In the second year of study, however, appreciable improvements in both vegetative and reproductive developments were observed among coconuts fertilized with varying amounts of inorganic N fertilizer. A slight change in leaf color from yellow to green, was noted in palms applied with organic nitrogen source such as ipil-ipil or kudzu mixed with calopogonium. Unfertilized palms remained yellow throughout the duration of the study.

## **Percentage of Bearing Palm**

Due to severe nitrogen deficiency, only 19.62% of the palms bore nuts in the unfertilized plots (Table 1). More than one-third (38.5%) of the palms treated with 2 kg KCL per palm year plus ipil-ipil were able to bear nuts. This figure is similar to that of palms applied with either 2 kg KCL plus a 50:50 mixture of kudzu and calopogonium or only 2 kg KCL. The effect of the organic fertilizers, however, were generally inferior to that of the inorganic fertilizers. Highest percentage of bearing palms (68.82%) was noted on those fertilized with 1.5 kg ammonium sulfate in combination with 2 kg KCL per palm per year. This, however, did not differ significantly from that of palms fertilized with either 0.66 kg urea or 2 kg of ammonium sulfate in addition to 2 kg KCL per palm per year.

Low percentages of bearing palms were noted in the first two years of the study and increased significantly in the succeeding years.

Effect of soil type likewise differed in between years of observation. Highest and lowest bearing percentages were observed from palms growing on Mandaue clay and Palo clay loam, respectively.

## **Nut Yield**

Significant differences in nut yield per hectare were noted among the treatments. Palms fertilized with 2 kg ammonium sulfate in combination with 2 kg KCL per palm per year obtained the highest nut yield, although not statistically different from those applied with either 1.5 kg ammonium sulfate or 0.66 kg urea. plus 2 kg KCL per palm per year. The unfertilized palms and those applied with 2 kg KCL plus organic fertilizer showed inferior results.

Almost all treatments showed increase in nut production in the years after initial implementation of the study. There was, however, no consistent trend in the yearly increases.

Average number of harvested nuts was highest among palms growing in Maasin clay and lower among those growing on Palo clay loam. Coconuts that had high bearing percentage did not, however, show superiority in nut peld. There were palms which, although showing high bearing percentages had fewer nut per inflorescence. Thus, percentage of bearing palms is not always an indication of nut productivity.

Differences in nut production between soil types were affected by the characteristics of the soil including its inherent fertility. There was also a strong relationship between nut yield and amount of nitrogen present.in leaves of palms (Table 2). Palms growing on Maasin clay which had the highest nut yield also had high leaf nitrogen content.

Number of harvested nuts increased significantly when inorganic N fertilizer was used. The application of 2 kg ammonium sulfate plus 2 kg KCL obtained significant results, although comparable with those observed with lower level of inorganic fertilizer application. The control had lowest nut yield, however, its yield did not generally differ from those applied with organic N fertilizer.

## **Fresh Meat Yield**

The unfertilized treatment had very low meat yield, although comparable with treatments utilizing only 2 kg KCL per palm per year or 2 kg KCL plus organic N fertilizer.

Heaviest fresh meat was taken from palms fertilized with 2 kg ammonium sulfate combined with 2 kg KCL per palm per year. This result, however, is not significantly different from those taken from plots applied with 0.66 kg urea or 1.5 kg ammonium sulfate plus 2 kg KCL.

Significantly higher fresh meat yield was realized from palms applied with inorganic source of nitrogen. These palms also yielded more nuts than the other treatments. It was also observed that meat of the nuts from these treatments was thicker that those of the control and to the treatments which used either 2 kg KCL or 2 kg KCL plus organic N.

The measurement over time analysis showed low fresh meat yield in the first two years of the study. This is because there were only few bearing palms which al'so gave low nut and meat yields. Fresh meat yield, however, tended to increase in the succeeding years.

Of the three soil types used, Maasin clay gave the heaviest fresh meat, although there were comparable yields among all soll types.

## **Copra Yield**

Copra yield followed the same trend as the fresh meat yield. The highest yield was obtained when each palm was fertilized with 2 kg ammonium sulfate added to 2 kg KCL, although this did not differ significantly from the yields of palms applied with lower levels of inorganic nitrogen.

Lowest copra yield was observed in the unfertilized palms. Yearly application of either 2 kg KCL only per palm per year or 2 kg KCL plus organic N source (ipil-ipil or kudzu mixed with calopogonium) resulted in a slight increase in copra yield over the control.

Under experimental conditions, copra yield of palms applied with 2 kg KCL could be improved by about four times with the addition of inorganic nitrogen (1.5 kg ammonium sulfate). Application of 0.66 kg urea was deemed as efficient as using 1.5 to 2 kg ammonium sulfate plus 2 kg KCL per palm per year. This finding is similar to that of Magat (1978) who observed that palms fertilized with 2 kg ammonium sulfate and KCL yielded the highest copra every year.

Lowest copra yield was observed in the first few years of the study where, there were very few bearing palms. Copra yield increased in the succeeding years with the highest yield observed in 1985. The yields observed in the years followed were comparable, although slight variation from year to year may have been influenced by environmental conditions.

Although palms growing on Maasin clay gave the highest copra yield, the yields in ail soil types were not significantly different from each other.

## **Tissue Analysis**

Of the five elements measured from, leaf number 14 of the coconut palms, nitrogen (N) calcium (Ca), and magnesium (Mg) were far below that the critical level, while phosphorus (P) and potassium (K) were above it (Table 2).

The effect of nitrogen fertilizer did not show any trend and was not significant in ail the treatments for P, Ca and Mg. Nitrogen level, however, was generally higher in palms applied with inorganic nitrogen. The same palms had lower levels of P and K.

The trend of the yearly leaf tissue analysis, however, was not consistent. The palms on Maasin clay contained slightly higher leaf nitrogen and less of the other elements.

Results of leaf tissue analysis further explained the yield data of the coconut paims.

## **Cost and Return Analysis**

Ail the organic and inorganic sources of nitrogen were profitable except in some treatments in Palo clay loam (Table 3). Comparing the two sources, the inorganic fertilizer gave higher profit inasmuch as it increased copra yield.

The highest profit was obtained from palms growing on Maasin and Mandaue clays and fertilized with 2 kg KCL plus 2 kg ammonium sulfate. Application of 1.5 kg ammonium sulfate plus 2 kg KCL resulted in the highest profit for palms growing on Palo clay loam.

Although increasing the N level of the soil through inorganic fertilization was more expensive, it resulted in higher yields than when organic fertilizer sources were used.

The palms applied with organic N fertilizers gave the lowest profits despite turning in high gross income. The high production expense incurred in utilizing organic fertilizers made this method less profitable than non-application of fertilizer.

The breakdown of the production cost is shown in Table 4.

#### **REFERENCES**

Magat, S. S. 1978. Why fertilize coconut? *Greenfields* 8(12):92-96.

Prudente, R. L., S. S. Magat and J. N. Maravilla. 1979. Properly fertilizing coconut trees. *Greenfields* 9( 12): 74-79.

**Table 1. Summary result of the measurement over time analysis on percentage of coconut palms with harvested nuts, nut yield, fresh meat yield, and copra yield as affected by different sources of N fertilizer, year, and soil type.\***

Treatment	Palms with harvested nuts per year (%)	Nut yield (nuts/ha/yr)	Fresh meat yield (kg/ha/yr)	Copra yield (kg/ha/yr)
<b>N Fertilizer</b>				
T1	19.62 c	662 b	271.3 b	130.3 b
T2	31.41 bc	1,218 b	497.5 b	240.8 b
T3	38.50 b	1,408 b	608.4 b	302.2 b
T4	38.88 b	1,551 b	661.2 b	328.4 b
T5	62.26 a	3,331 a	1,734.4 a	902.8 a
T6	68.82 a	3,724 a	1,910.5 a	998.9 a
T7	67.90 a	3,839 a	1,996.1 a	1,037.9 a
<b>Year **</b>				
1983	34.77 c	803 b	310.5 b	154.0 c
1984	23.80 d	844 b	447.0 b	234.6 c
1985	49.32 b	2,848 a	1,458.0 a	787.9 a
1986	48.23 b	2,864 a	1,352.2 a	678.6 ab
1987	45.52 b	2,662 a	1,337.7 a	667.1 ab
1988	62.42 a	2,278 a	1,139.0 a	589.2 b
<b>Soil Type</b>				
Palo clay loam	34.03 b	1,790 b	978.7 a	504.4 a
Maasin clay	2,861 a	54.51 a	1,333.0 a	694.1 a
Mandaue clay	2,285 ab	60.75 a	1,048.4 a	519.5 a

\* In a column within a set of treatments, means having common letter are not significantly different from each other at 5% level (DMRT).

\*\*Average of 3 harvests per year.

**Table 2. Summary result of the measurement over time on the leaf analysis of coconut as affected by N fertilizer, year, and soil type.\***

STAT DIR	Element (%)				
	N	P	K	Ca	Mg
N Fertilizer					
T1	1.41 d	.18 a	1.58 a	.06 a	.21 a
T2	1.58 bc	.18 a	1.43 ab	.06 a	.20 a
T3	1.53 c	.17 a	1.37 b	.06 a	.22 a
T4	1.72 a	.18 a	1.30 b	.06 a	.19 a
T5	1.64 ab	.18 a	1.39 b	.06 a	.20 b
T6	1.74 a	.17 a	1.28 b	.07 a	.21 a
T7	1.66 ab	.17 a	1.26 b	.07 a	.21 a
Year **					
1983	1.72 a	.16 c	1.33 ab	.07 b	.26 a
1984	1.55 b	.14 d	1.39 a	.05 c	.22 b
1985	1.53 b	.23 a	1.27 b	.05 c	.17 c
1986	1.54 b	.20 b	1.43 a	.06 b	.17 c
1987	1.75 a	.16 c	1.42 a	.09 a	.22 b
Soil Type					
Palo clay loam	1.65 a	.19 a	1.68 a	.06 a	.14 c
Maasin clay	1.69 a	.16 b	.96 c	.05 a	.29 a
Mandaue clay	1.46 b	.19 a	1.49 b	.07 a	.17 b

\* In a column within a set of treatments, means having a common letter are not significantly different from each other at 5% level (DMRT).

\*\*Average of 2 analyses per year.



**Table 3. Cost and return analysis of coconut as affected by organic and inorganic sources of nitrogen  
Fertilizer within each soil type.**

Treatment	Palo Clay Loam (Buraen, Leyte)				Maasin Clay (Sogod, So. Leyte)				Mandaue City (Hilongos, Leyte)			
	Copra Yield (Kg/ha/yr)	Income (P5.00/ kilo)	Expense* (P)	Profit (P)	Copra Yield (Kg/ha/yr)	Income (P5.00/ kilo)	Expense* (P)	Profit (P)	Copra Yield (Kg/ha/yr)	Income (P5.00/ kilo)	Expense* (P)	Profit (P)
T1 (control)	83.45	417.25	243.45	173.80	227.76	1,138.80	387.76	751.04	49.00	245.00	209.00	36.00
T2 (kg KCL)	43.29	216.45	1,306.89	-1,090.44	404.11	2,020.55	1,667.71	352.84	455.29	2,276.45	1,718.89	557.56
T3 (T2 + ipil ipil)	148.90	744.50	-1,090.44	-788.00	361.09	1,805.45	1,744.69	60.76	589.93	2,949.65	1,973.53	976.12
T4 (T2 + Kudzu + caopogonium)	110.72	533.60	-788.00	-820.72	395.64	1,978.20	1,659.24	318.96	622.58	3,112.90	1,886.18	1,226.72
T5 (T2 + .66kg urea)	865.90	4,329.50	2,589.70	1,739.80	1,144.00	5,720.00	2,867.80	2,852.20	847.10	4,235.50	2,570.90	1,664.60
T6 (T2 + 1.5 kg ammonium sulfate)	1,059.34	5,296.70	2,994.74	2,301.96	1,218.80	6,094.00	3154.2	2,939.80	857.83	4,289.15	2,793.23	1,495.92
T7 (T2 + 2.0 kg ammonium sulfate)	1,036.41	5,182.05	3,222.41	1,959.64	1,301.31	6,506.55	3,487.31	3,019.24	1,057.00	5,285.00	3,243.00	2,042.00

\* Cost of production is shown in Table 4.

**Table 4. Cost of coconut production per hectare per year as affected by organic and inorganic N fertilizer.**

Items	TREATMENT						
	T1	T2	T3	T4	T5	T6	T7
Fertilizer 1/ Underbrushing 2/ Ringweeding and canal making 2/ Transportation fee of fertilizer 3/ Fertilizer application 2/ Pruning and hauling 2/ Planting kudzu and calopogonium 2/	160	873.60 160.00 120.00 30.00 80.00	873.60 160.00 120.00 30.00 80.00 120.00	873.60 80.00 120.00 30.00 80.00	1,223.80 160.00 120.00 40.00 100.00	1,482.00 160.00 120.00 53.40 120.00	1,684.80 160.00 120.00 61.20 160.00
Sub-total	160	1,263.60	1,383.60	1,263.60	1,643.80	1,935.40	2,186.00
Harvesting and copra making 4/							

1/ P 140.00/sack of KCL (6.24 sacks/ha for all treatments except T1)

170.00/sack of urea (2.06 sacks for T5)

130.00/sack of ammonium sulfate (4.68 sacks/ha for T6) 6.24 sacks for T7)

2/ P 40.00/man-day

3/ P 5.00/sack

4/ 20% of copra cost