Assessment of Exchangeable Bases of Different Fertilizer Management Practiced in Coconut (Cocos *nucifera)* Growing Soils of Sri Lanka in Gampaha District

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ABSTRACT

A laboratory experiment was conducted to find the availability of soil exchangeable bases in two different soil types of Boralu and Pallama series with at two different depths of 0-10 cm and 10 cm-20 cm, which are top soil, and the sub soil respectively, under three different management practices of Organic fertilized, Inorganic fertilized and non fertilized soils in Gampaha district. Here mentioned as exchangeable bases are Sodium, Potassium, Calcium, and Magnesium cations. One hundred and twelve samples were collected from selected areas. Out of which thirty four samples from Organic fertilized areas another thirty eight samples from Inorganic fertilized soil and the rest from non fertilized soil. Out of hundred and twelve samples, ten soil samples were collected to compare with leaf exchangeable bases. Exchangeable Sodium and Potassium were determined by using 1M ammonium acetate (pH=7.0) as well as Calcium and Magnesium were determined by using Lanthanum chloride stock solution (50,000 ppm La). GLM procedure was done to find out the soil sample and compare the soil with leaf sample, CORR, REG procedures were done. Soil was collected from manure square and center square for this comparison

KEYWORDS: Cations, Exchangeable Bases, Stock Solution.

INTRODUCTION

Coconut is the main plantation crop in Sri Lanka. Introduction of coconut to Sri Lanka dates back to well over 2500 years; it is popularly known as tree of life because of its innumerable uses to the people. Sri Lanka is the fourth largest coconut producing country in the world Furthermore coconut is the major source of edible oils and fats in the daily diet providing about 22% calories intake of an average person, second only to rice(Jayasekara,2002) and coconut occupies 439,000ha (Anon, 2004), which amount to 20% of the total cultivable land area. The coconut industry plays an important role in sustaining the national economy and food security of the people. It contributes about 2.0% to the Gross Domestic Products (GDP) giving a foreign exchange earning of 11,967 million rupees. Out of total extent under coconut in Sri Lanka and the average annual production of Coconut was an around 2557 million nut (Anon, 2004).The "Coconut Triangle" refers to the main Coconut growing areas in the North western province (Kurunegala & Puttalam districts) and part of western province (Gampaha district) represent 75% of the country's coconut growing lands. A small area is situated in the Kegalle district. (Liyanage,1999).Wet top soil is dark grayish brown to brown and the wet sub soil is brown to light brown in Gampaha district. pH rang of both top and sub soil is 4.5-5.0, and top soil has content more than 2.3% organic carbon. Calcium is the highly available cation than other cations. (Mapa, Somasiri, Nagaraja.2003)

In addition to the removal by palms soil nutrients can be lost by run off, leaching, erosion and uptake by weeds etc. The above process lead to depletion of essential plant nutrients in the soil, which cause a gradual decline of nut yield. Therefore soils in coconut plantation should be enriched with Nitrogen, Phosphorus, Potassium and Magnesium by regular fertilizer application. Coconut palms can be manure with either inorganic fertilizer or organic manures. The nutrient requirement of young coconut palms (before flowering) is different from that of adult Coconut palms (after flowering). Separate fertilizer recommendation are made for young palms and bearing palms. Continuous organic manure application tends to increase the humus content in the soil, and supply of plant nutrients. High humus content improves the water holding capacity, aeration, structure, micro organic density, micro biological activities and nutrient retention of soils. It also maintains the soil pH and temperature at favorable levels to coconut. Therefore organic manures are important sources of plant nutrients, which help in sustaining soil fertility and productivity especially for perennial crops such as coconut. Application of organic manure could results in an increase of 15-20% in terms of nut yield and 20-25% in terms of copra yield per year. If organic manures that are produced in the estate itself, example dairy or poultry farming of compost etc are applied, the income will be very much greater as the cost of fertilizer can be reduced. (Anon, 2004.CRI) Generally, deficiency symptoms occur unless nutrients removed by the palm are replenished by regular application of inorganic fertilizer and/or organic manure. (Liyanage, 1999).

Table 1. Sufficiency ranges / Critical levels of nutrients for coconut soil

Exchangeable bases	Range (mg / kg)
Sodium	69 -230
Potassium	78 – 234
Calcium	800 – 2000
Magnesium	60 - 480

Soil fertility assessment involves an estimation of available major & micronutrients present in a particular soil. It is necessary to estimate the "available" nutrient of a soil.

Sodium content in the earth's crust is about 2.8%. While soils contain 0.1 to 1 % exchangeable Sodium ion varies greatly among soils. Sodium ion can be utilized by crops.

Potassium is present among the exchangeable bases, in the soils are ranging 20 mg/kg – 130 mg/kg.In many laboratories, neutral ammonium acetate solution is the standard extractant for exchangeable potassium in soils. Usually less than 1% of the total potassium in soils occurs in this form. Determination of exchangeable potassium is the universal measure for predicting potassium availability and fertilizer requirements. Exchangeable potassium in sub soil can vary with the soil type.

Calcium is commonly the major cation in the soil solution and on the exchange complex. Calcium concentration in the soil higher than necessary for proper plant growth will normally have little effect of Calcium ion uptake, because the Calcium ion uptake is mainly genetically controlled. Although the Calcium ion concentration of the soil solution is about 10 times greater than that of Potassium ion.

Magnesium is absorbed by plants as Magnesium ion from the soil solution, like Calcium ion. The occurrence of Magnesium deficiency can be brought on by climate factors. Magnesium deficiencies are not widespread.

Calcium and Magnesium, which are some what similar in their behavior in soils, are held as exchangeable ions by electrostatic attraction around negatively charged soil colloids.

Potassium uptake would be reduced as Calcium ion and Magnesium ion [Ca^{2+}, $Mg2^{+}$] are increased. Potassium leaching losses are small.

The total Nitrogen, available Phosphorus exchangeable Calcium, Magnesium and organic matter contents were higher in the good than in the poor soil. The Magnesium content was higher in poor soil, pH values were similar. Coconut water from high yielding trees had higher potassium content than that from low-yielding trees. The Potassium content of Coconut water increased with the corresponding increased in the amount of available Potassium in the soil. When acid soils are limed, there is usually a substantial increase in pH dependent cation exchange capacity.

MATERIALS AND METHODS

The appropriate needed for soil samplings are soil augers, spades, Aluminium or Plastic trays, tugs, Polythene Bags, etc.

a)Sampling position

Sampling position could be either the manure circle or the centre of the square. Here two samples were taken from the manure circle and two samples were taken from four sides.

Composite samples was made according to the two depths 0—10 cm; 10 cm—20 cm separately. The collected soil sample is mixed thoroughly in a tray covered with a clean piece of polythene sheet. And also soil samples from the centre of squares formed by four Coconut palms was collected at 2 depths (0 --10cm and 10 cm –20 cm) at four points in each site and bulked to form the samples representing the site. Accordingly 40 soil samples from Coconut growing soils in Gampaha District. Where fertilizer had been not applied for a long time period and 40 soil samples from fertilized Coconut stands with organic manure were collected for this study. Accordingly 40 soil samples from fertilized Coconut land with inorganic fertilizer also were collected from 120 locations representing 30 sites of all Coconut growing areas of Boralu series and Pallama series of Coconut growing soils in Gampaha District.

b) Soil sample preparation

The soil samples brought to the laboratory were first being registered. The soil samples were brought to the glass house, removed from their container and spread out to dry on flat trays. When the soil got air dried, roots and other residues were removed by hand. The air-dried soil samples are crushed gently by hand and sieved through a 2mm sieve and mixed well and sieved. Chemical analysis, such as pH determination, electrical conductivity and exchangeable bases (Sodium ion, Potassium ion, Magnesium ion, Calcium ion) were carried out.

c) Determination of Electrical conductivity.

The electrical conductivity of the soil samples were determined by making a 1:5 suspension. The suspension was prepared as follows.10 g of dried soil sample was weighed in to a 100ml plastic container. 50 cm^3 of distilled water was added into the container with a 0— 100 cm^3 dispenser and stirred thoroughly with a glass rod. It was stand for 30minutes to equilibrate. Then measured electrical conductivity of soil samples without disturbing the soil samples. By using Orion Research Model 145 A plus EC meter.

d) pH determination

After measuring the electrical conductivity, soil samples were stirred and their pH values were measured. Before measuring the pH values the instrument was calibrated with standard buffer solution of pH 4.0 and 7.0.Before measuring the next sample, the electrode was rinsed with distilled water and wiped with tissue paper.

e) Determination of total exchangeable bases

Available exchangeable bases were determined by using atomic absorption spectrophotometer. Orbital shaker was used to get the clear supernatant solution. 1M ammonium acetate and Lanthium Chloride stock solution were used for extracting solution.

A) Can calculate available Sodium and Potassium ions.

m.eq per 100g of soil $= (S-B)/1000 * 50 * 100/W * X/M$

$= [5(S-B) X] / (W*M)$

mg per kg of soil $= (S-B)/1000 * 50 * 1000/W$

$= 50(S-B) / W$

Where,
S = Cation concentration in the sample in ppm.
B = Cation concentration in the blank in ppm.
X = Valency of the cation (for sodium and Potassium ions, X = 1)
W = weight of the soil sample.
M = Atomic weight of the cation.

B) Calcium and Magnesium ions

m.eq per 100g of soil = (S-B)/1000 * 25/1 * 50 * 100/W * X/M
=125(S-B)X/(W * M)

mg. per kg of soil = (S-B)/1000 * 25/1 * 50 * 1000/W
=1250(S-B)/W

Where;
W = Weight of the soil sample.
M = Atomic weight of the cation.
S = Cation concentration in the sample in ppm.
B = Cation concentration in the blank in ppm.
X =Valency of the cation (for Magnesium and Calcium ions, X = 2)

RESULTS AND DISCUSSION

Table 2. Probability Values of exchangeable bases.

Exchangeable bases	Pr > F.
Sodium cation.	0.0096
Potassium cation	0.1538
Calcium cation	0.2259
Magnesium cation	<0.001

Table 3. Mean values of Sodium ion in soil (mg/kg)

Level of treatment	Number of samples	Mean value.
Non fertilized soil	34	2.186
Inorganic fertilized soil	38	3.076
Organic fertilized soil	30	0.018

According to the analysis, no significant different in soil Sodium content was found between the non fertilized soils and inorganic fertilized soil (P=0.05). The average Sodium content was 2.186 mg per kg of soil and 3.076 mg per kg of soil respectively. But organic fertilized soil had significantly low Sodium content of 0.018 mg per kg of soil, When compare to the non fertilized and inorganic fertilized soils (P=0.05).

It also found the interaction effect between treatment and the soil type and there are higher amount of Sodium was found in inorganic fertilized Boralu soil series and low amount of Sodium was found in organic fertilized Pallama soil series. (P=0.05). The average Sodium content of those interactions was 4.354 mg per kg of soil and 0.011 mg/kg respectively. And also according to the leaf analysis, leaf Sodium content had significantly less than soil sodium content. (P=0.05).

No significance difference in Potassium content were found between the application of fertilizer management practice and the non fertilized soil (P=0.05). However there was significance difference in Potassium content was found between the soil type as well as position of soil. The potassium content in the Boralu series is significantly greater than in Pallama series and the average Potassium content were 1.46 mg/kg and 1.01 mg/kg respectively (P=0.05). It also found the Potassium content in manure square is significantly greater than in centre square and the Potassium content were 1.05mg/kg and 1.45 mg/kg respectively (P=0.05), and not a single interaction effect was found among these factors. Leaf Potassium content had significantly greater than manure square soil potassium content as well as less than center square soil (P=0.05).

Table 4. Mean values of Potassium ion in content soil (mg/kg)

		Number of samples	Mean value.
Level of soil type	Boralu	54	1.46
	Pallama	40	1.01
Level of position	Centre square	44	1.05
	Manure square	50	1.45

Table 5. Mean values of Calcium ion in soil (mg/kg)

		Number of samples	Mean value.
Level of treatment	Non fertilized soil	36	69.39
	Inorganic fertilized soil	34	136.65
	Organic fertilized soil	30	124.18
Level of depth	Top soil	50	131.92
	Sub soil	50	85.46

No significance difference in soil Calcium content was found between the organic fertilized and inorganic fertilized soils and the average Calcium content were 136.65mg/kg and 124.18 mg/kg respectively. (P=0.05). But non fertilized soil had significantly low Calcium content was 69.39 mg/kg, when compare to the fertilized soils (P=0.05). It also found the Calcium content in the top soil is significantly greater than in the sub soil (P=0.05) and the average calcium content were 131.92 mg/kg and 85.46 mg/kg. There are not a single interaction effect was found among these factors. Leaf Calcium content had significantly greater than manure square soil potassium content as well as less than center square soil (P=0.05)

Table 6. Mean vales of Magnesium ion (mg/kg)

		Number of samples	Mean value.
Level of treatment	Non fertilized soil	38	40.46
	Inorganic fertilized soil	34	45.14
	Organic fertilized soil	24	59.89
Level of soil type	Boralu	52	53.12
	Pallama	44	39.72
Level of position	Centre square	48	37.60
	Manure square	48	56.35
Level of depth	Top soil	48	54.32
	Sub soil	48	39.64

No significant difference in soil Magnesium content was found between the non fertilized soils and inorganic fertilized soils. The average Magnesium content were 40.46 mg /kg and 45.14 mg/kg respectively (P=0.05). But organic fertilized soil had significantly high Magnesium content of 59.89 mg/kg when compare to the non fertilized and inorganic fertilized soils. (P=0.05). It was also found the Magnesium content in the Boralu series is significantly greater than in the Pallama series. The average Magnesium content was 53.12 mg/kg and 39.72mg/kg respectively. (P=0.05). It was also found the Magnesium content in the manure square is significantly greater than in the centre square. The average content was 56.35 kg/mg and 37.6 mg/kg respectively. (P=0.05). It was also found the Magnesium content in the top soil is significantly greater than in the sub soil and the average Magnesium content were 54.32 mg/kg and 39.64 mg/kg respectively.(P=0.05).It also found the interaction effect between soil type and position of the fertilizer with the fertilizer management practice. It is also high amount Magnesium content was fount in manure circle organic fertilized Boralu series soil and low amount of Magnesium was found in centre square inorganic fertilized Pallama series soil (P = 0.05) and the average Magnesium content were 79.68 mg/kg and 25.50 mg/kg respectively.

CONCLUSIONS

The mean exchangeable bases content not enough in Gampaha district soil except Magnesium. They might be remove by run off, leaching, erosion, and uptake by weeds etc.Comparatively Boralu soil series have higher amount of soil exchangeable bases than Pallama soil series. Top soil have high amount of exchangeable bases than sub soil. Inorganic fertilized soil has higher amount of Sodium and Calcium as well as organic fertilized soil has higher amount of Potassium and Magnesium. If we want to get enough production of coconut from this area, we need apply fertilizer at correct rate.

ACKNOWLEDGMENTS

Authors are grateful to Prof. S.J.B.A. Jayasekera, Dean, Faculty of Agriculture and Plantation Management and Prof. N.E.M. Jayasekera, Head, Department of Plantation Management Wayamba University of Sri Lanka, for their valuable suggestions and encouragement. Authors would also like to thank Dr. N.A. Tennakoon, Head, Soil and Plant Nutrition Division, senior technicians, technicians, Labors and all staff members of biometry Division of Coconut Research Institute, Lunuwila, for the assistance and guidance in statistical analysis. A special thank goes to Dr. W.J.S.K. Weerakkody and the staff of the computer unit of Wayamba University of Sri Lanka, for assisting and giving computer facilities.

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