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STUDIES ON THE RELATIONSHIP BETWEEN SOME SOIL PROPERTIES AND SUGARCANE PRODUCTION AT THE BACITA SUGAR ESTATE

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ABSTRACT

Field studies on the relationship between some soil properties and sugarcane yield was carried out in the production fields of the Nigerian Sugar Company, Bacita, Kwara State, Nigeria. The soils were found to be strongly acidic with medium organic matter while values obtained for total nitrogen and cation exchange capacity were low, potassium and other secondary nutrients were found to be present in adequatae quantities for good cane growth if other necessary production inputs are non-limiting. Relative yield was positively correlated with both macro and secondary nutrients while strong acidity was found to have adverse effect on sugarcane yield.

Key words: Sugarcane, productivity, soil properties, relationship.

INTRODUCTION

The soil of the Bacita Sugar Estate has been under intensive sugarcane production for about thirty years (Busari, 1980). For some time now sugarcane tonnage has been on the decline in the estate (Annon, 1990). The cane yield generally declines with each succeeding crop inspite of fertilizer application to the cane plants. This rapid decline in cane yields and the need to replant a large percentage of the land each year present serious economic problems to cane growers. Some of the factors reported to be responsible for this phenomenon include substandard cultural practices, varietal and soil management problems (Annon, 1990).

The standard recommended rates in most Nigerian sugar estates showed that NPK fertilizers are broadcast at 125kgNha^{-1} ; 56kg$K_2$0ha^{-1} . and 56$P_2$0$_5$ kgha^{-1} respectively. Secondary and micro-nutrients are seldom recommended because cane plants rarely show deficiency symptoms to these elements (George, 1983). However, supplementary application of the major nutrients are sometimes carried out in the cane fields at the Bacita Sugar Estate, (Annon, 1990).

Since inception there has been very few studies on the fertility status of the production fields while information on the soil characteristics and their relationship with yield is scanty. Obakin (1978) report on sugarcane nutrition at the Bacita Sugar Estate found high levels of sodium in the brung soils capable of depressing yields. Although the classification of the production fields was carried out by

Makanjuola (1980) it did not include soil analysis of major nutrients. Therefore an evaluation of the soil properties of the production fields might be necessary in order to increase the potentialities of the fields.

The study investigated the roles of some soil properties and their relationship with sugarcane yield in five major production fields with a view to obtaining information that will be of practical agronomic value in commercial sugarcane production in Nigeria.

MATERIALS AND METHODS

The experimental site had been planted with the following commercial sugarcane varieties for over twenty years: Co 957, B 61208 and Co 997. The experimental fields received NPK fertilization at 12kg N/ha, 60kgP_2O_5/ha and 60kgk_2O/ha, during the period of study. The rainfall at Bacita is erratic starting from May to July with a dry spell in August. The average annual rainfall is about 1434mm. The canes normally received supplementary irrigation during the dry months of the year.

The production fields were classified by Makanjuola (1980) as follows:

Egbungi:	Heavy black clays.
Oshin:	Silty loam.
Nebung:	Sandy clasy, underlain by structuraleess clay pan.
Sclle:	Brown clay loam, overlain by brown silt loam.
Shigo:	Coarsegrained,structurelcss quartz sands overlain by silty loam.

The above fields were sampled and analysed for soil pH, total N, available P, exchengeable K, Ca, Kg and cation exchange capacity (CEC). Soil pH was determined on pll meter using 0.1m Cacl . Total nitrogen was determined by the regular micro kjeldahl method, (Jackson, 1962) while available P was determined by the Bray P method of Bray and Kurtz (1945). Soil organic matter was determined by the wet oxidation method as described by Walkley and Black (1934). The CEC was determined by saturating the soil sample with sodium acetate and the adsorbed Na was displacsed with ammonium acetate (NH_4OAC). The displaced sodium was then determined on the flame photometer as a measure of CEC. The potassium, calcium, sodium and magnesium were analysed as described by Jackson (1962). Exchangeable acidity for N and Al was determined by titrating with 0.01N NaoH after leaching with 1N KCl. The sugarcane yield (TC/ha) dfor all the fields were collected for four successive cropping seasons and data obtained subjected to statistical analysis. The corellation coefficient was used to determine the relationship between soil properties and cane yield.

RESULTS AND DISCUSSION

The results showed that majority of the fields were acidic (Table 1). Although sugarcane is moderately acid tolerant (Boss and Wug You Choeng, 1974; Samuels, 1983), at high levels of acidity liming might become necessary in order to increase the soil prooducutivity. Investigation of soil acidity correction howsever showed that in the humid tropics, liming would be more effective and economical if it was aimed at climinating exchangeable Al and at supplying Ca as a nutrient to the plant rather than bringing soil pH to near neutrality (Pearson, 1975; Reeve and Summer, 1970). The fertilization policy in the estate might have contributed to the strong acidity observed in this study. A re-evaluation of the various forms of

nitrogen fertilizers currently being used is recommended.

A nutrient survey done by Sobulo and Adepetu (1987) in the guinea savanna zone of Nigeria indicated that there is every likelihood that crops will respond to any additional fertilization if available soil nutrients fall below 0.1% for total N, 8(ppm) for P, 2.0, 0.4 and 0.16 (C' Mol (±) kg^{-1} soil) for Ca, Mg and K respectivelly and 1.5% for organic matter. Judging from the nutrient status of these fields (Table 1), the total nitrogen is low for an intensive sugarcane cultivation. In the savanna region of Nigeria, N deficiency is the most serious crop nutritional problem followed by P (Sobulo and Adepetu, 1987). The recommended critical levels for total nitrogen in the tropics is 0.1% (Nelson, 1971; Pearson, 1975). The values of phosphorus obtained for Belle, Neburg and Shigo production fields were moderate for cane production while low values were recorded for Egbungi and Oshin (Table 1). Potassium, Magnesium and sodium are present in adequate quantities in all the fields sampled. Calcium is present in moderate quantities at Belle, Egbungi and Shigo but was low in Nebung and Oshin fields.

The CEC values suggest slightly favourable exchange sites for the available nutrients but these values are however low when compared with those obtained from other sugarcane growing regions in other parts of the world (Shegal *et al* 1980). The exchange complex is dominated by Ca and Mg. The organic matter content of the soils is moderate in Belle, Egbungi, Oshin and Shigo but low in Nebung field. Low organic matter suggests that the exchange sizes will be predominantly controlled by the clay content. The Ca; Mg ratio of 4:1 in Egungi, Belle and Shigo fields dropped to 3.5 in Nebung field suggesting the removal of Ca either as soluble carbonates or slightly soluble gypsum. The Mg: K ratio is high in Belle, Oshin and Nebung fields (Table 1) but moderate in Shigo and Egbungi. The Mg: K critical level in the Guinean Savanna is 2.0 according to the reports of Sobulo and Adepetu (1987). The results therefore suggest that Mg: K is adequate for good cane growth if other necessary production inputs are non-limiting.

Relatilonship between soil nutrients status and relative yield:

Relative yield is a measure of the yield response to a single nutrient when other nutrients are supplied in adequate but not in excessive amounts and is used to avoid difference due to location effects. Table 2 shows the relationship between soil nutrients and relative yield of sugarcane from five different production fields. The positive and significant correlation between relative yield and these nutrients therefore suggests that these elements play vital roles lin sugarcane production. Fertilizer recommendations in Sugar Estates seldom include secondary and micro-nutrients because deficiency symptoms of these elements are rare in production fields (Annon, 1990; George, 1983). Major fertilizer formulations also contain secondary/micro-nutrients. A pragmatic fertilization policy based on soil tests and foliar analysis would enhance cane productivity and bring reduction in the cost of fertilization as observed in this study.

The results of this study suggest that the conventional blanket NPK recommendation should be re-examined in these production fields to eliminate wastages in fertilizer use lin these fieldds. This was indicated by the adequacy of some of the major nutrient elements investigated

in this study.

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Table 1. The results of the chemical analysis of the soils of the production fields.

Site	pH	OM %	N	P (ppm)	Na C'	K mol (±)	Ca Kg^{-1} soil	EA	Mg:K	Ca:Mg
Belle	5.9	1.76	0.09	26.30	0.06	0.35	2.51	0.09	2.0	3.5
Egbungi	4.2	1.98	0.09	6.22	0.07	0.51	3.17	0.62	1.5	1.2
Nebung	4.3	1.02	0.09	16.50	0.08	0.22	1.43	0.22	2.6	2.5
Shigo	4.1	1.57	0.08	10.10	0.11	0.34	2.04	0.27	1.6	3.8
Oshin	4.5	1.50	0.08	8.10	0.07	0.21	1.70	0.25	2.5	3.2

Table 2: The relationship between soil properties and relative yield of sugarcane.

Soil properties	R
pH	0.68*
Om	0.84*
%N	0.98*
Exch. K	0.96*
Avail.P	0.79*
Exch. Na	0.95*
Exch. Ca	0.60*
CEC	0.54*
EA	

*Significant at 5%