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Effects of Sources and Levels of Phosphorus on Yield and Quality of Sugarcane in Southern Guinea Savanna Zone of Nigeria

Tsado P.A. [*1], Lawal B.A. [2], Igwe C.A. [3], Adeboye M.K.A. [4], Odofin A.J. [5], Adekambi A.A. [6]

[1] Department of Soil Science, Federal University of Technology, PMB 65, Minna, Nigeria.
[2] Department of Soil Science, Federal University of Technology, PMB 65, Minna, Nigeria.
[3] Department of Soil Science, University of Nigeria, Nsukka, Enugu State, Nigeria.
[4] Department of Soil Science, Federal University of Technology, PMB 65, Minna, Nigeria.
[5] Department of Soil Science, Federal University of Technology, PMB 65, Minna, Nigeria.
[6] Department of Soil Science, Federal University of Technology, PMB 65, Minna, Nigeria.

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ABSTRACT

This study was carried out on an Alfisol to investigate the effects of different sources and levels of phosphorus fertilizer on yield and quality of sugarcane. The treatments consisted of two sources of phosphorus: rock phosphate (RP) and single super phosphate (SSP) applied at three levels (50, 100 and 150 kg P_2O_5 ha^{-1}) arranged as a 2 x 4 factorial experiment fitted to a randomized complete block design (RCBD) with three replicates. Data collected were quantitative and qualitative traits of yield. The quantitative traits were: germination count, plant height, tiller count, millable cane and cane yield, while the qualitative traits were percentages of Brix, Pol, purity and fibre. P sources significantly influenced the tiller count, millable cane and cane yield (except germination %) of the cane with RP showing significant superiority over SSP. Also, application of P levels significantly increased the quantitative traits compared with control (0 Kg ha^{-1}). Effects of P sources and levels on the quality of sugarcane were not significant.

I. Introduction

Sugarcane (*Saccharum officinarum* L.) is a crop of a great agro – economic importance in Nigeria which is grown mostly by small scale farmers who contribute up to 90% of total production (Olomola, 2007). The importance of sugarcane especially sugar as its bi – product is still the most widely used as caloric food in all countries especially among those of lower income. (Alamazan *et al*, 2009) they further reported that sugarcane has one of the most efficient photosynthetic mechanisms among commercial crops and this allows to fix almost 2 – 3 percent of radiant solar energy and transform it into green biomass.

The cane yield and sugar recovery obtained in Nigeria is still less than other developed sugarcane growing countries in the world. This has adverse consequence for profitability and competiveness of the commodity. Many causal factors to the declining yield at the farm level have been documented, and one such cause could be attributed to declining level of soil nutrient especially the most limiting nitrogen (N) and phosphorus (P) which are the major nutrients required for higher and sustained sugarcane growth, yield and quality (Ogunleye and Adesoye, 1994; Omollo and Abayo, 2011). Punnu, *et al.* (1985) reported that P role in sugarcane is to stimulate early root formation and development. Application of P, especially on P deficient soils promotes root growth, stimulates tillering, and influences favorable better growth and thereby better yield and juice quality (Bokhtail and Sakurai, 2003). P deficiency leads to reduced metabolic rate and photosynthesis which then leads to cane yield and quality Also; small scale sugarcane farmers in Nigeria do not have bigger options regarding high yielding and high sucrose varieties as well as vitality of the use of chemical fertilizers for producing high yielding and sugar recovery in sugarcane. While most soils, contain a high proportion of reserves of total P, most of it remains relatively inert and less than 10 % of the soil P enters the plant – animal cycle (Pal and Allan, 1992). Coupled with continuous sugarcane monocropping with limited replenishment, the P in soil solution becomes inadequate for sugarcane establishment.

One of the remedial measures is the application of P fertilizer to supplement native supply in the soil (Bokhtail and Sakurai, 2003). Considering the importance of P nutrition in sugarcane performance, the present study was undertaken to investigate the growth, yield and quality of sugarcane as affected by sources and application of P fertilizer levels in the southern Guinea savanna agro ecological zone of Nigeria.

* Corresponding author.
Email address: tsadophilips@yahoo.com

2. Materials and methods

The field experiment was conducted at Wuyagi, Kilometer 16, Bida-Mokwa Road, Niger State, Nigeria. (latitude 9° 40° N and longitude 6° 30° E) during the period of May, 2009 to April, 2010. The experimental soil was classified at order level as Alfisol (Soil Survey Staff 2010) with a clay loam texture, pH (H_2O) 6.0, available P 4.12 mg kg^{-1}, organic matter 8.60 g kg^{-1} and cation exchange capacity (CEC) 4.20 cmol kg^{-1} soil. The treatments are P fertilizer source (rock phosphate (RP) and single super phosphate (SSP)) and P levels (0, 50, 100, 150 kg P ha^{-1}). The experimental design was 2 X 4 factorial experiment fitted to a randomized complete block design with three replications. The plot size was 10 m by 10 m. The cane cuttings (var. CO957) of 2-3 internodes from 7-month old seed canes were laid end to end in furrows opened on top of ridges spaced 1 m apart. The spacing between each plot was 2 m. P fertilizer was applied at the time of planting and covered along with sugarcane setts. Supplementary irrigation was given during the dry months of October to April.

Data collected were quantitative and qualitative traits of yield. The quantitative traits were germination count, plant height, tiller count, millable cane and cane yield, while the qualitative traits were percentages of Brix (with hydrometer after juice extraction from the cane), Pol (using polarimeter), purity and fibre. The data collected were subjected to statistical analysis of variance and LSD test was applied to separate the means (Gomez and Gomez, 1984).

3. Results and discussion

3.1. Sugarcane quantitative parameters

The data given in Table 1 indicated that the differences among various treatments for set germination were non-significant. Although the germination percentage is up to required which indicate the establishment of proper plant population maintained for getting a standard crop harvest. However, the highest (81.1%) and lowest (71.0%) germination was recorded in those plots treated with 150 kg SSP and 50 kg SSP respectively. Non-significant effect of fertilizers on germination was also observed by Aleem, *et al* (2009). These observations indicated good germination potential of cane sett. Seed canes of between 6 and 8 months usually have high viability.

Sources and levels of P significantly increased tiller number, amount of millable canes, plant height and cane yield (Table 1). The effect of RP on the quantitative parameters was significantly higher than that of SSP. Similar result had been reported by Omollo and Abayo (2011). They observed that the effect P sources on quantitative traits of sugarcane was in the order DAP>RP>TSP>SSP. Also, sugarcane being a long duration crop, its requirement for P is distributed over a longer period of time (about 12 months of growing period per cycle in Nigeria). For this reason, SSP will be less important than RP.

Tillers, millable cane and yield were significantly increased as the levels of these sources increases as compared to those plots that received no fertilizer (control). The highest cane yield of 102.5 t ha^{-1} was obtained from 150kg RP treated plots while the lowest of 62.5 t ha^{-1} was obtained from control plots. Toomsan and Limpinuntana (2005) suggested that higher cane yield could be attributed to the higher number of tillers and millable cane. Application of P fertilizer promote root growth, stimulate tillering, influences millable cane growth, and thereby sugarcane yield per ha (Bokhtair and Sakurai, 2003). Beside yield, adequate P nutrition is conducive for sugar accumulation in cane tissues. Kumar and Verma (1999) observed that application of 50 kg P_2O_5 ha^{-1} and above increased cane yield significantly over the control (37.2 – 56.4 t ha^{-1})

3.2. Sugarcane qualitative parameters

The effect of sources and levels of P on sugarcane quality is shown in Table 2. The result shows that the effects of P sources and levels on sugarcane juice were not significant. However, higher values were obtained for % Brix and Pol of 20.62 and 18.81 respectively at control plots compared to treated plots irrespective of the sources and levels of P. Omollo and Abayo (2011) suggested that fertilizer P sources can be applied to supply P and that P has a greater effect on yield parameters than on quality parameters. Treatment 3 recorded highest purity of 93.3% while treatment 4 recorded the least (91.7%). Cane juice from the P fertilized plots showed lower percentages of Brix, Pol and Purity. Pannu *et al* (1985) and Majeedamo, *et al*. (2003) reported adverse effect of high P on cane juice quality and sugar yield.

4. Conclusion

The result of the study shows that application of P fertilizers to these systems and soils resulted in very significant and profitable increases in plant crop. If P is omitted in a common farmer practice, crop yield and profit suffer. Because a yield threshold was not reached in plant crop (i.e. first cycle), further research and investigation continues in ratoon crops to determine the P and other nutrient requirements to achieve maximum economic yield.

Table 1. Sugarcane quantitative characters as affected by P sources and levels

Treatments (P_2O_5 ha^{-1})	Germination (%)	Tiller No. (*1000 ha^{-1})	Millable cane (*1000 ha^{-1})	Cane yield ($t\ ha^{-1}$)
Control	78.3	77.9	70.5	62.5
50kg RP	78.7	96.8	82.3	89.0
100kg RP	71.3	99.0	85.1	96.9
150kg RP	80.9	108.2	95.0	102.5
50kg SSP	71.0	94.1	83.4	81.8
100kg SSP	76.5	96.8	84.9	93.7
150kg SSP	81.1	101.2	87.2	96.2
LSD 5%	NS	9.13	7.16	10.31

Table 2. Sugarcane qualitative characters as affected by P sources and levels

Treatments (P_2O_5 ha^{-1})	Brix	Pol (%)	Purity
Control	20.62	18.81	93.0
50kg RP	20.52	18.63	92.6
100kg RP	20.49	18.57	93.3
150kg RP	20.33	18.43	91.7
50kg SSP	20.50	18.37	92.0
100kg SSP	20.21	18.32	92.8
150kg SSP	20.15	18.47	91.9
LSD 5%	NS	NS	NS

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