Bangladesh J. Sugarcane, 17: 36-40

July. 1995

Response of Sugarcane to Phosphorus Fertilization in an Alfisol

S. S. Afolabi
Sugar Research Institute,
University of Ilorin,
P.M.B. 1515,
Ilorin - Kwara State,
Nigeria.

Received on 25.6.94

ABSTRACT

Field studies on the effects of different P levels and placement methods on the yield and juice quality of a commercial sugarcane cultivar was carried out in the Unilorin Sugar Research Institute Experimentation Farm at Ilorin. The soil series is an alfisol. The tiller population decreased with increase in P fertilizer levels at both 8 and 16 weeks after planting thus indicating on adverse effect of fertilizer P application on tillering ability of the canes. Optimum cane yield was obtained at 40 kg P_2O_5/ha in the plant cane while the control was significantly better than other treatments in the first ratoon. Interaction between placement and P levels was not significant.

INTRODUCTION

Phosphorus is one of the most important macroelements in sugarcane production. P plays vital roles in maturity of crop plants and encourages early development of vigorus root system (Chowdhury and Rahman, 1986). The effects of P fertilizer on sugarcane productivity has been reported by several workers (Stevens, 1943; Pan, 1974; Oseni, 1978). Isobe *et al* (1968) reported a higher uptake of P by sugarcane when amonium polyphosphate (APP) and Triple Superphosphate (TSP) were subsurface applied than surface application. Kadian *et al* (1981) observed that application of 50 kg P_2O_5/ha increased yield significantly over the control.

An important agronomic practice in the efficient use of P fertilizer is that of placement in relation to the plant. Phosphorus applied to tropical acid soils is rendered unavailable to plants in most cases because of the high-P-fixing of these soils according to reports of Udo and Uzu (1972). Water soluble phosphates gives best results on these acid soils when they are granulated and applied in bands (Tisdale and Nelson, 1970).

In Nigeria, although P has been recognised as one of the most essential elements to be supplied to sugarcane under intensive commercial cultivation, greater emphasis have often been placed on nitrogen (Obakin, 1980; Afolabi, 1987). Also the use of acid containing fertilizers over the years in Nigerian Sugar Estates without a pragmatic liming programme had resulted into increase in soil acidity in these fields and decreased P uptake. This may be one of the factors responsible for the declining yield in these estates.

The objectives of this study is therefore to evaluate the effects of different P levels and placement methods on the yield and juice quality of a commercial variety.

MATERIALS AND METHODS

The experiment was conducted in the Unilorin Sugar Research Institute Farm at Bolorunduro Village, Ilorin in 1984/85 and 1985/86 cropping seasons. Prior to cropping, soil of the experimental site was sampled for both physical and chemical analysis (Black, 1965). Co 957 presently a standard commercial variety was used for the study. The canes were planted in May 1984 when the rain was fully established. The plot size is 60 m^2. The experimental design is a 2 x 4 factorial in a randomised block with four replications. Four levels of P fertilizers 0KgP_2O_5/ha, 40kgP_2O_5/ha, 60kgP_2O_5/ha and 100kgP_2O_5/ha were applied as band and furrow application using single superphosphate (SSP) at planting and at two months after harvesting. Smut was controlled by uprooting affected stools while weed control measures were done mannually until leaf canopy was formed. Nitrogen and potassium fertilizers were applied basal at recommended rates of 120kgN/ha and 60kgK_2O/ha respectively at 4 weeks after planting. The experimental plots received irrigation using sprinklers during dry months of the year.

Tiller population was counted at 8 and 16 WAP (weeks after planting). The canes were harvested at 10 months after planting (Feb. 1985) for the plant cane and 12 months after harvesting (March, 1986) for the first ratoon crop. The canes were then weighed for individual plots and converted into tonnes cane/ha. Representative samples were taken for total soluble solids analysis by standard methods (Meade and Chen, 1977). The data obtained for the plant cane and first ratoon were then subjected to statistical analsysis.

RESULTS AND DISCUSSION

The results of physical and physical-chemical analysis of soils of the experimental site are presented in the Table 1. The soil reaction is acid (pH 4.5) while organic matter is equally low (1.4%). Phosphorus might be rendered unavailable to canes at low pH levels (Tisdale and Nelson, 1970). The CEC value is low (8.5 meq/100g of soil) when compared with values obtained from other sugarcane regions (Wood, 1989). The available P and other exchangeable cations in the experimental site suggests that they are not optimum for intensive sugarcane production (Nelson, 1970).

Table 1. Results of soil chemical and physical analysis before first cropping.

Location	USRI Farm
pH	4.5
Organic matter (%)	1.4
Sand (%)	80.4
Silt (%)	14.0
Clay (%)	5.6
Textural class	Loamy sand
Avail. P (ppm)	8.30
Exch. K (meq/100g of soil)	0.42
Total N (%)	0.10
CEC (meq/100g of soil)	8.82

For growth characteristics, a significantly lower difference was observed for tiller population between the control (0kgP_2O_5/ha) and other treatments taken at 8 weeks after planting (Table 2). The tiller population decreased with increase in P levels. The highest tiller population was obtained in the control while the least tillers were obtained at 100kgP_2O_5/ha. The adverse effect of P on tillering is difficult to explain.

Table 2. Effects of P levels and placement methods on the tiller population of sugarcane (Var Co 957).

	TILLER POPULATION '000/ha					
	8 WAP Methods of Placement			16 WAP Methods of Placement		
Fertilizer Rate						
kgP_2O_5/ha	Banded	Furrow	*Mean	Banded	Furrow	*Mean
0	685.0	684.3	684.7a	1057.0	1050.5	1053.4a
40	614.0	520.0	567.0b	914.7	1100.0	1007.4a
60	587.3	511.0	549.2c	970.0	1032.0	1001.0a
100	587.6	749.0	533.3d	970.7	1125.3	1047.8a
Placement Mean	618.5	548.5	583.6	978.1	1076.6	1027.4

*Means followed by the same letter(s) in a given column are not significantly different from each other by Duncan Multiple Range Test. (P = 0.05).

It might however be suggested that the cane variety C0 957 was unable to utilize phosphate ions at an early age which might induce tillering. The effects of drought could also have had negative effect on tillering since supplementary irrigation was not available until November 1984. Majority of P fertilizers might have also been fixed. The P fertilizer had little effects on tiller population obtained at 16 WAP (Table 2). This lack of variation might be that the cane variety have already achieved its maximum genetic pontentiality. It may then be suggested that adequate attention be directed at improving this important yield component at breeding stage.

The reports of Van Dillewijn (1952) showed that tillering in sugarcane is affected by variety, fertilization, cultural and environmental factors. Oworu (1988) also reported lack of variation on some yield components of sugarcane in rain forest zone of Nigeria. The observations in this study is consistent with these reports.

The P levels and methods of placement did not affect brix % (Total Soluble Solids) and NPK content in sugarcane leaf (Table 5). Obakin (1978) reports on the effects of P fertilization on sugarcane juice quality showed that an application of upto $56kgP_2O_5$/ha had no effect on cane juice quality in derived Savannah Zone of Nigeria. This study agrees with this report. The lack of variation in the brix values showed that even at high P levels there was no detrimental to juice quality since brix values obtained compared favourably with recommended minimum brix values (Anonymous, 1990).

The result of cane yield in plant and first ratoon crops are presented in the Table 3. In the plant crop, the highest mean yield was obtained at $40kgP_2O_5$/ha. The least mean yield obtained at $100kgP_2O_5$/ha was however not significantly different from the control (Table 3). The cane yield increased to an optimum with increase in P and declined thus justifying the application of phosphate fertilizers.

In the first ratoon the mean yield obtained at 40, 60 and $100kgP_2O_5$/ha were significantly lower than control. This negative effect showed that P ratoon crop did not benefit from additional fertilization following plant cane. This observation thus indicated that the residual effect of P fertilizer from previous season was adequate for succeeding first ratoon crop. It can therefore be suggested that adequate soil/foliar tests should always be conducted before application of P fertilizers in subsequent ratoon crops, since this might lead to reduction in cost of P fertilization.

Table 3. Effects of P levels and placement methods on the yield of sugarcane (Var Co 957).

Fertilizer Rate (kgP_2O_5/ha)	Cane Yield (TC/H)					
	Banded	Furrow	*Mean (Plant cane)	Banded	Furrow	*Mean (1st ratoon)
0	26.9	23.7	25.3c	37.0	33.6	35.3a
40	30.9	36.3	33.6a	25.1	26.4	25.8b
60	32.0	23.5	27.8b	30.4	24.5	27.5b
100	20.8	28.0	24.4c	26.4	26.5	26.5b
Placement Mean	27.6	27.9	27.8	29.7	27.8	28.8

*Means followed by the same letter(s) in a given column are not significantly different from each other by the Duncan Multiple Range Test. (P = 0.05).

Table 4. Effects of P levels and placement methods on the % Brix of sugarcane (Var Co 957).

Fertilizer Rate	Plant Crop			First Ratoon		
kgP_2O_5/ha	Banded	Furrow	*Mean	Banded	Furrow	*Mean
0	21.0	20.8	20.9a	21.8	20.3	21.1a
40	20.5	20.9	20.7a	20.3	21.5	20.9a
60	21.5	21.0	21.3a	23.0	22.1	22.9a
100	22.0	21.2	21.6a	20.7	22.2	21.5a
Placement Mean	21.3	21.0		21.5	21.5	

(SE = 2.4) *Means followed by the same letter in any column are not significantly different by the DMRT at P = 0.05.

Table 5. Effects of P levels and placement methods on the NPK content of sugarcane leaf.

Fertilizer Rate (kgP_2O_5/ha)	% N			% P			% K		
	Banded	Furrow	*Mean	Banded	Furrow	*Mean	Banded	Furrow	*Mean
0	2.33	2.30	2.31a	0.11	0.14	0.13a	1.43	1.66	1.55a
40	2.10	2.20	2.16a	0.13	0.13	0.13a	1.55	1.53	1.54a
60	2.10	2.10	2.10a	0.14	0.13	0.14a	1.85	1.72	1.78a
100	2.10	2.10	2.10a	0.13	0.12	0.13a	1.07	1.59	1.33a
Placement Mean	2.20	2.18	2.20	0.13	0.13	0.13	1.48	1.63	1.58

(SE = 0.2) *Means followed by the same letter in any column is not significantly different by the DMRT at P = 0.05

Response of cane yield to P fertilization have been reported by several workers (Paris, 1962; Davis and Vlitos, 1968). A survey of 2000 fields done by Humbert (1968) showed that only about 13% of fields sampled required additional P fertilizer for ratoon cane while 42% required additional P at time of planting thus indicating that in many areas of industry substantial reductions in P fertilizer costs could be achieved without detrimental to yield.

Wood (1989) also showed that fertilizer P is not irretrievably lost due to P retention by soil. At least 20% of applied P mainly in Al-bound form are used efficiently by succeeding crops and upto 35% phosphate fertilizer was made available even in moderately phosphorus fixing soils for succeeding sugarcane crops in South Africa. These reports are consistent with this study. An investigation of P fertilization in subsequent ratoon crops is recommended for further study.

REFERENCES

Anonymous. 1990. The Nigerian Sugar Company. Field Tech Reports. 42p.

Afolabi, S.S. 1987. Fertilizer Management in Sugarcane. A paper presented at the annual meeting/workshop of sugarcane technologists. 11th - 13th May, 1987. University of Ilorin.

Black, C.E. 1965. Methods of soil analysis. No. 9 Part II American Society of Agronomy, Madison, Winsconsin. pp. 1149-1176.

Chowdhury, M.K.A. and Rahman, M.H. 1986. Effect of NPKSZn Fertilization on sugarcane in calcareous soils. *Bangladesh J. Sugarcane*, 8: 31-35.

Davis, W.N.L. and Vlitos, A.J. 1968. Fertilization of sugarcane. *Proc. ISSCT*, **13:** 68-83.

Humbert, R.P. 1968. In the growing of sugarcane. Rev. ed. Elsevier Publishing company, New York. 779p.

Ferratis, I.P. and Cacson, M.V. 1964. Effect of system and rate of planting on yields. Proc. PHILSULTECH, Manilla, **12**: 467-476.

Isabe, M.; Lai T.M. and Yamasaki, Y. 1968. Comparison of surface and subsurface application of phosphorous fertilizers. Hawalian Sugar Planters Record, pp. 24-25.

Kadian, V.S.; Srivastava, S.N.L and Singh V.R. 1981. Effect of P Fertilization on the quality of sugarcane. *Indian Sugar*, **31** (16): 405-408.

Meade, G.P. and Clean, J.C.P. 1977. Cane Sugar Handbook 10 ed. Wiley interscience publications. John Wiley and Sons. New York, pp. 640-645.

Metson, A.J. 1971. Methods of clinical analysis for soil samples. Longman, U.K. 115p.

Oseni, L.B. 1978: Response of sugarcane to source, level and placement of phosphorus in a Histosol. A paper presented at an International Symposium on sugarcane research and production. NCRI. Ibadan, Nigeria.

Obakin, F.O. 1980. A summary of research findings in sugarcane nutrition. In the sugarcane Industry in Nigeria. The Unilorin Sugar Research Institute, University of Ilorin. 24-25 June. 1980.

Obakin, F.O. 1978. The effect of N Fertilization on sugarcane juice quality. In Proceedings International symposium on sugarcane Research and production. National Cereal Research Institute, Ibadan, Nigeria.

Pan, Y.C. and Eow, K.L. 1974. The response of sugarcane to three forms of P fertilizer in three successive cultivation. Proc Inter. Soc. Sugarcane Technol. 15th Caongress Durban S. Africa. **2**: 576-585.

Parish, D.H. 1962. Fertilizers and the sugar industry in Mauritius. *Proc. ISSCT*, **11**: 77-83.

Prasad, R. and Rajale, G.B. 1970. Effect of time and method of application of fertilizer on sugarcane. *J. Agnc. Sci.* Cambridge, **10**: 430-441.

Stevens, F.O. 1943. Agronomic studies with sugarcane. University of Florida Expt. Station, Ann. Report . 180p.

Tisdale, M.L. and Nelson W.L. 1970. Soil Fertility and Fertilizers. 2nd ed. The Macmillan Company. London. 694p.

Thakur, K.; Bose, P.K. and Raysharma, R.P. 1979. Response of sugarcane to nitrogen and phosphate in calcareous soils. *Indian Sugar*, **29** (5): 227-280.

Udo, E.J. and Uzu, F.O. 1972. Characteristics of phosphorus absorption by some Nigerian soils. Soil. Sci. Sco. Amer. Proc. **26**: 879-883.

Van Dilewijn, C. 1952. Botany of Sugarcane Chronica. Botanica Co. Walthman Ma.

Wood, R.A. 1989. Sugarcane nutrition and Fertilizer use in South Africa. *Proc. ISSCT*, **2**: 495-503.