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Effects of Urea Fertilizer and Placement Methods on Yield and Yield Components of Sugarcane

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ABSTRACT

A field experiment was set up at the Unilorin Sugar Research Institute farm, to study the effects of different nitrogen levels and placement methods on yield and yield components of sugarcane in the cropping seasons 1990-1991. The experiment was conducted in both plant cane and first ratoon crop. The soil analysis revealed a loamy sand characterised by low soil organic matter and cation exchange capacity. The soil reaction is strongly acid. A significant difference was obtained for percentage germination, cane population, stalk length and cane yield. The effects of the different nitrogen levels and placement methods on stalk thickness was not significant. Highest sugarcane yield obtained at 160kg/ha, although this was not statistically better than values obtained at 80kg/ha

INTRODUCTION

Various efforts directed at improving yield include the application of chemical fertilizers. Many factors affect germination and growth of sugarcane. Besides, external factors such as temperature, soil moisture and fertilisation, internal factors such as reducing sugar contents of sugarcane stalks are also very important for germination and development of buds (Matin *et al.* 1988; Mukerji, 1979). High percent germination cannot be over-emphasized as desirable agronomic practice in commercial sugarcane production considering their effects in ensuring adequate crop stands and yield.

Low cane population resulting from missing gaps in cane fields may lead to reduced yields (Anonymous, 1990). This might be part of the factors responsible for low yields in the Nigerian Sugar estates.

The effects of fertilizers on germination, growth and ripening have been widely reported (Obakin, 1978; James, 1983; Wood, 1989; Afolabi, 1988). In Nigeria, very few studies have been carried out on growth and development aspects of sugarcane plant under different nitrogen levels and placement methods. This study was therefore set up to investigate the roles of different nitrogen fertilizer levels and placement methods on growth characteristics and yield of sugarcane variety Co 957, with a view to obtaining information that will be of practical agronomic value in sugarcane production in Nigeria.

MATERIALS AND METHODS

The experiment was conducted in the Unilorin Sugar Research Institute farm at Bolorunduro village, Ilorin in 1989-90 and 1990-91 cropping seasons. Prior to first cropping, soil of experimental site was sampled to determine physical - chemical soil properties. Mechanical analysis was done by the hydrometer method (Bouyoucos, 1951)

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and soil pH was determined on pH meter using 1:1 water to soil ratio and 0.01m $CaCl_2$ methods. Total nitrogen was determined by microkjeldahl method as described by Jackson (1962) while available phosphorus was determined by the Bray P method as described by Bray and Kurtz (1945). The exchangeable cations were determined by leaching the soil with neutral normal Ammonium acetate (NH_40Ac) and potassium and calcium were read on flame analyser. Magnesium was determined as described by Jackson (1962) while organic matter was determined by wet-oxidation method of Walkley and Black. Cation exchange capacity (CEC) was taken as the summation of the exchangeable bases as described by Jackson (1962).

The experiment was laid in 2 x 4 factorial randomised complete block design with four relication. Four levels of nitrogen fertilizers (0,80,160 and 240kg/ha) were applied as surface (broadcast) and furrow applications (buried at 15cm). The methods of application constitute the main plots and different nitrogen levels the sub plots. The plot size was 12 x 5m and urea was the source of nitrogen fertilizer.

Weeds were controlled manually until leaf canopy was formed (4 months after planting) while single superphosphate (SSP) and muriate of potash (MP) were applied basal at standard estate recommendations of 60kgP_2O_5/ha and 60kgK_2O/ha respectively. The experimental plots received irrigation during the dry months of the year. For germination the total number of sprouts (buds) were counted at four week after planting and expressed as a percentage of total canes planted (75,000 three budded setts/ha) while cane population (tillers) were counted at 8, 16 weeks after planting and at harvest. Cane weight was determined by harvesting from six middle rows/plot and converted to tons/ha. For growth characteristics average stalk diameter and stalk length were determined from ten stalks randomly selected from the plots. The experiment was harvested at ten months after planting for plant cane and repeated in the first ratoon and data collected statistically analysed.

RESULTS AND DISCUSSION

Table 1 shows the results of soil chemical and physical analysis before first cropping. The soil was loamy sand and had pH value of 5.6 which is acidic. Although sugarcane tolerates very moderately low pH values, several nutrients such as P, Fe, Mn and Zn tend to become less available if the soil is strongly acid according to the reports of Reeve and Summer (1970).

Table 1. Results of soil physical and chemical analysis before planting.

Soil Properties		
Sand (%)	-	80.4
Silt (%)	-	11.4
Clay (%)	-	5.2
Textural class	-	Loamy sand
pH	-	5.6
Organic matter (%)	-	1.4
CEC (meq/100g of soil)	-	8.5
Total N (%)	-	0.1
Exch. Na (meq/100g of soil)	-	0.18
" Mg "	-	0.56
" Ca (ppm)	-	3.0
" K (ppm)	-	0.29
Avail. P (ppm)	-	8.20

Table 2 shows the results of effects of nitrogen rates and placement methods on germination stalk length and stalk diameter of sugarcane. A significant difference was observed for percent germination at different nitrogen levels. The highest percent germination was obtained at 240kg/ha while the lowest value was obtained in control. This indicated positive effect of urea fertilisation on sugarcane germination. This observation agrees with the report of Chen *et al* (1980). They showed that germination is positively correlated with nitrogen rates. The reports of Nickel (1984) showed that percent germination lower than 60% was detrimental to good cane yield. The percent germination obtained in this study ranges between 66 and 85%, and therefore consistent with these reports. Matin *et al.* (1988) and shown that high germination is important towards obtaining a good crop stand and early rapid growth in sugarcane.

Table 2. Effects of different levels of urea and placement methods on percent germination, stalk diameter and stalk length of Co 957.

	METHODS OF PLACEMENT								
Fetilizer rate	Germination count at 4 WAP (%)			Stalk length at 16WAP (cm)			Stalk diameter at 16 WAP (cm)		
kg N/ha	Broad-cast	Furrow	Mean	Broad-cast	Furrow	Mean	Broad-cast	Furrow	Mean
0	67.8	66.5	67.2d	85.0	85.0	85.0c	6.0	6.3	6.2a
80	72.0	69.0	70.5c	83.8	83.8	83.8d	6.8	7.4	7.1a
160	70.8	85.0	77.9b	115.0	115.0	115.0a	6.8	6.8	6.8a
240	78.3	82.0	80.3a	107.5	107.5	107.5b	7.5	7.5	7.5a
Placement Mean	72.2	75.6		97.8	97.8		6.8	7.0	

Mean followed by the same letter in a given column are not significantly different from each other by the Duncan Multiple Range test (P = 0.05)

Response of sugarcane to tillering (cane population) has been reported by many workers (Yadav *et al.* 1990; Rahman *et. al.* 1987). Of the many variable involved in the production of sugar from the cane plant, probably the most significantly related factors is the number of stalks (Nickel, 1984). A significantly lower difference was observed in the control plots at all periods of sampling for plant population. The highest cane population was obtained at 160kg/ha applied as subsurface. The cane population increased with time of sampling to a maximum and then gradually declined due to tiller mortality and reduced the final yield (Table 3). This might be due to competition, unfavourable fertilisation, pests and diseases. Van Dillewijn (1952) had shown that tiller mortality vary with sugarcane genotypes.

The effects of nitrogen rates and placement methods on stalk length and stalk diameter at 16 WAP are presented in Table 2. A significant difference was observed for stalk length at different nitrogen levels (0, 80, 160, 240 kgN ha^{-1}), the tallest stalk was obtained at 160kg/ha while the shortest was recorded in the control plot. Stalk length increased to an optimum with increase in nitrogen level and declined. A study by Sweet and Patel (1985) had shown that a high correlation exists between stalk length and cane yield. It has also been reported that nitrogen deficient canes had retarded growth and slender stalks (Clements, 1981). This study showed that nitrogen fertilizers boosted cane growth and therefore consistent with these reports. The nitrogen rates and placement

had no effect on stalk diameter (Table 2). This is consistent with the findings of Afolabi (1988).

Table 3. Effects of different levels of urea and placement methods on cane population and yield of sugarcane (Co 957).

Fertilizer rate (KgN/ha)	Method of Placement / Plant population x 10^3/ha											
	8 WAP			16 WAP			32 WAP			Yield (Tons/ha)		
	Broad-cast	Furrow	Mean	Broad-cast	Furrow	Mean	Broad-cast	Furrow	Mean	Broad-cast	Furrow	Mean
0	274.5	275.0	274.5c	432.0	412.5	422.0d	358.8	372.0	365.4c	40.0	43.2	41.6b
80	354.5	380.0	367.3b	516.0	489.8	502.9c	469.0	482.0	475.5b	45.2	45.0	45.1a
160	393.3	419.8	406.4a	485.3	663.8	574.6b	594.0	570.0	582.3a	49.1	42.0	45.2a
240	353.0	385.0	369.6b	594.8	651.5	623.1a	539.5	366.0	452.8b	43.2	37.0	40.1b
Placement Mean	343.8A	364.9A	507.0	554.2A	447.5A	490.5A	490.1A	447.5A		44.4A	41.8A	

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

One of the criteria for determining commercial acceptability of sugarcane is the yield per hectare. Cane yield is primarily an aggregate of stalk diameter, stalk length and number of millable stalks (Olaoye and Agbana, 1987). A significant difference was observed for cane yield in this study (Table 3). Although the highest yield was obtained at 160kg/ha, this was not statistically better than those obtained at 80kg/ha. The cane yield increased to an optimum and gradually declined with increase in nitrogen levels (Table 3). The yield obtained at 240kg/ha was not significantly better than the control indicating no beneficial effect beyond 160kg/ha. 80kg/ha appear adequate for optimum cane yield in this study. Since interaction between placement methods and different nitrogen levels was not significant broadcast application may be recommended because it is a relatively cheaper operation than subsurface application. The reports of nitrogen application in sugarcane growing regions vary. Obakin (1978) had obtained higher yields using 240kg/ha in the guinea savannah region of Nigeria using Sulphate of Ammonia while (Clements, 1981; Wood, 1989 and Yadav, 1990) had shown that nitrogen deficiency in sugarcane might cause retarded growth, production of slender stems and reduced yield. Odofin (1980) had recommended 120kg/ha as adequate for good cane commercial production in the Nigerian sugar estates, Bacita (Lat 90N). This finding however differs from these reports. This observation showed that an assessment of the fertilizer requirements of commercial sugarcane should be carried out periodically with suitable soil tests and/or foliar analysis.

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