INFLUENCE OF FERTILITY RATES AND CHEMICAL WEED CONTROL ON THE STALK YIELD (TON/HA) AND JUICE QUALITY OF CHEWING SUGARCANE AT BADEGGI, NIGERIA

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Abstract

Field trials were conducted in 2004–2005, 2005–2006 and 2006–2007 wet and dry seasons at the upland sugarcane experimental field of National Cereals Research Institute (NCRI) Badeggi, to evaluate the influence of fertility rates and chemical weed control on the stalk yield (ton/ha) and juice quality of chewing sugarcane. From the results obtained in the three trials, the application of combined fertility rates of air dried cowdung with inorganic N, P and K fertilizer produced significantly greater values of stalk yield to/ha, percent reducing sugar, percent polarity (pol) and percent nitrogen (N) in juice than at separate application of cow dung and inorganic N, P & K fertilizer. However the effect of the fertility rates on laboratory percent brix and percent purity was not significant. The percent fibre content increased as the fertility rates decreased with the highest values been obtained from the control where neither cow dung nor inorganic fertilizer was added. No yield was obtained from the weedy check through out the period of experimentation. How ever, there was no significant difference among the values of stalk yield (ton/ha) and juice quality parameters obtained from chewing sugarcane treated with herbicides, and that of the hoe – weeded plots.

Key word: fertility rates, chemical weed control, stalk yield, sugar quality parameters

INTRODUCTION

Chewing sugarcane is an important cash crop in Nigeria, which is normally chewed as a ready made source of energy (Sucrose). The sucrose can be processed into "Mazarkwaila" and "Alewa" for drinking "Akamu" and "Gari" (Busari, 2004). However, the production of this crop in Nigeria is presently in the hands of local farmers with low average yields of between 20–60 tonnes per hectare compared to over 100 tonnes per hectare obtained in the United States and Cuba (Fadayomi, 1996). According to Rao and Sharma (1981), poor stalk yield of sugarcane is mostly due to poor weed control and crop nutrition. Poor soil nutrition and heavy weed in the early life of a crop tends to result in stalk yield loss at harvest time by causing reduced cane weight, high in fibre content and poor juice quality (Allison and Haslam, 1985). According to Fadayomi, uncontrolled weed interference coupled with poor soil nutrition in the crop caused about 12–99% reduction in stalk yield.
Fertility affects the composition of crops in several ways. A nutrient may increase or decrease the concentration of other nutrients, alter the course of constituents like protein, and carbohydrates. For sugarcane, the quality of the crop is particularly assessed by the sugar produced per tonnage, and of the major elements essential for cane growth, nitrogen has the greatest influence on cane growth, the ripening and the juice quality (Hussaini *et al*.1990). Rao and Sharma (1981) reported that the presence of phosphoric acid and potash in cow dung helps in promoting sucrose syntheses. However, the interaction between inorganic and cowdung have been proved to increase yield significantly (Rayer, 1986).
Yanami *et al.* (1997) reported the use of NPK and cow dung not to have any significant effect on juice quality, parameters such as percent brix, and purity. While a significant effect on stalk yield and percent sucrose and pol was observed. According to them juice quality (brix% and purity%) mainly depends upon genetic nature of the variety. Neman *et al.* (1995) recorded increased juice cation, chlorine and nitrogen content at application of nitrogen. However, when applied in excess or late in growth period impaired juice quality and the recoverable sucrose percentage was reduced. High application of nitrogen fertilizers generally results in luxurious growth and high percentages of reducing sugars but as the crop ages and close maturity, it is expected that nitrogen content reduces and there is an increasing conversion of the reducing sugars to sucrose (Hussain *et al*., 1990). Macalinta (1990) observed decreased sucrose concentration in potassium deficient soil. Therefore, the objective of this research study was to determine the influence of fertility rates and chemical weed control on stalk yield and juice quality of chewing sugarcane under an overmined sandy upland ecology.

MATERIALS AND METHODS

Field experiments were conducted at the upland sugarcane experimental field of National Cereals Research Institute, Badeggi (Lat 9°45^{l} N. Long. 06°07^{l} E, 70.5 metres above sea level) in the Guinea Savanna ecological zone of Nigeria in 2004–2005, 2005–2006 and 2006–2007 wet and dry seasons. The soil of

experimental site has been classified as ultisol and sandy loam in texture with a bulk density of 1.489 m^{-1} (Ayotade and Fagade, 1993). It has an average annual rainfall of 1124 mm and mean temperature 23°C–33°C respectively. Details of the physico-chemical properties of the soil and analysis result of the cow dung during the periods of experimentation are presented in Tables 1 and 2.

Tab. 1: Physico-chemical characteristics of soil taken from experimental site before the establishment of the trial

Soil properties 0–25cm depth	Badeggi 2004
Physical properties	
Sand (%)	91.00
Silt (%)	8.00
Clay (%)	1.00
Textural class	Sandy
Chemical properties	
pH in water	6.2
Organic carbon (%)	0.50
Organic matter (%)	1.10
Total nitrogen (%)	0.039
Available phosphorus (ppm)	8.95
Exchangeable cation (cmol/kg)	
K	0.35
Mg	0.29
Ca	1.00
Na	0.16
CEC (cmol/kg)	5.85

Tab. 2: Laboratory analysis of cow dung component

	Percent (%) 2004–2007
Nitrogen	0.315
Phosphorus	0.26
Potassium	0.35
Organic	16

Source: Cow dung from the cow market behind Gwadebe New Market – Bida

The treatments tested consisted of seven fertility rates and four weed control measures. The treatments were fertility (F). F_0 = Control (no cow dung, no inorganic fertilizer), F_1 = 120N – $60P_2O_5$ – $90K_2O$ kg/ha alone (NCRI recommended rate), F_2 = 10 tonnes/ha of air dried cow dung (NCRI recommended rate), F_3 = 10 tonnes/ha of air dried cow dung + 120N – $60P_2O_5$ – $90K_2O$ kg/ha, F_4 = 10 tonnes/ha of air dried cow dung + 60N – $30P_2O_5$ – $45K_2O$ kg/ha, F_5 = 5 tonnes/ha of air dried cow dung + 120N – $60P_2O_5$ – $90K_2O$ kg/ha, and F_6 = 5 tonnes/ha of air dried cow dung + 60N – $30P_2O_5$ – $45K_2O$ kg/ha. Straight fertilizer were used to work out the various rates of N, P and K using Urea for N, Sungle super phosphate for P and Muriate of potash for K. The weed control measures were W_0 = Weedy check, W_1 = Hoe – weeding at 1, 2, 3, 4, 5, 6 and 9 MAP, W_2 = Atrazine 2.0 kg a.i./ha (P.E.) + dimethametryne 3.0 kg a.i./ha (Post.E) + Supplementry hoe – weeding 2, 4, 5, 6 and 9 MAP and ment from the net plot using Jeffco cutter/Grind (Busari, 2004).

Laboratory percent brix
This was determined by using hand refractometer graduated in percentage.

Percent fibre
After the dry water = Insoluble fibrous material in cane product. It was determined using Bag washing method.

$$\text{Percent fibre} = \frac{\text{Weight of dried sample}}{\text{Weight of sample + Loss during preparation}} \times 100$$

Percent reducing sugar
The reducing value of a sugar product calculated as invert sugar.

$$\text{Invert sugar} = \frac{\text{Weight of dried sample}}{\text{Titration} \times \text{ml sample per 100 ml of final solution} \times \text{d (density)}}$$

Percent polarity (pol)
The value determined by single polarization weight of a sugar product made up to a total volume of 100 ml at 20°C. It was read using the Bates Jackson Saccharimeter Scale (Payne, 1968).

Pol% bagasses = Saccharimeter reading × 2.73

Percent purity
Expected final mosses. A theoretically attainable refractometer sucrose. Purity as indicated by the reducing substances – ash or the reducing conductivity (Payne, 1968).

$$\text{A. Purity} = \frac{\text{reduce substance}}{\text{ash (carbonate)}}$$

$$\text{B. Purity} = \frac{\text{Reducing substance \% refractometer solid}}{\text{Specific conductance} \times 1000}$$

Nitrogen (N) in sugar
This was determined by using micro-kjeldah method (Payne, 1968).

$\%N = (t - b) \times N \times 1400$

T = Sample titration (ml)
B = Blank titration (ml) (Blank determination include one cigarette paper)
N = Normality of HS_2o_4 (to 3 decimal places)
S = Sample weight

Analysis of data
All data determined during the experiment were subjected to statistical analysis to test treatment effects for significance using 'F' test as described by Snedecor and Cochran (1969). Where the 'F' test showed

significance, the means were compared using Duncan's multiple range test (DMRT).

RESULTS AND DISCUSION

Throughout the period of experimentation, the effect of fertility rates on the stalk yield (ton/ha) and the following juice quality parameters: percent fibre, percent reducing sugar, percent pol and percent nitrogen (N) in juice was significant (Tables 3 and 4). This result shows these parameters to be fertility dependant and therefore their performance could be improved by increasing the fertility rates in this ecology. As being shown on Tables 3 and 4, the application of combined fertility rates of cow dung with inorganic fertilizer led to increase in chewing sugarcane stalk yield, and higher percentage values of reducing sugar, pol and nitrogen in juice than at separate application of cow dung and inorganic N, P and K Fertilizer. According to Hussain *et al*. (1990) higher combined application rates of cow dung and inorganic NPK fertilizer at the right stage, time and on the right soil results in luxurious growth and high percentages of reducing sugars, pol and nitrogen in juice. According to them, fertility affect the composition of crops in several ways and for sugarcane, the quality of

Tab. 3: Effect of fertility rates and chemical weed control on the stalk yield (ton/ha), laboratory percent brix and percent fibre of chewing sugarcane at Badeggi, 2004–2005, 2005–2006 and 2006–2007 wet and dry seasons

Treatments	Yield (ton/ha)			Laboratory brix%			Fibre %		
	2004 ↓ 2005	2005 ↓ 2006	2006 ↓ 2007	2004 ↓ 2005	2005 ↓ 2006	2006 ↓ 2007	2004 ↓ 2005	2005 ↓ 2006	2006 ↓ 2007
Fertility rates (F)									
0 (Control no cow dung and inorganic fertilizer)	14.82d	10.70e	8.25d	18.92	18.92	18.92	13.98a	15.00a	16.31a
120N-60P_2O_5-90K_2O kg/ha (NCRI recommended rate)	27.86b	36.75c	41.00b	18.92	18.92	18.92	12.67b	11.92b	11.63b
10 ton/ha air dried cow dung (NCRI recommended rate)	18.83c	28.19d	31.21c	18.92	18.92	18.92	11.11c	10.56c	10.41c
10 ton/ha air dried cow dung +120N-60P_2O_5-90K_2O kg/ha	70.63a	72.64a	76.23a	18.91	18.91	18.91	9.01e	8.22e	8.30d
10 ton/ha air dried cow dung +60N-30P_2O_5-45K_2O kg/ha	68.63a	70.81a	74.40a	18.92	18.92	18.92	9.75d	8.85d	8.48d
5 ton/ha air dried cow dung +120N-60P_2O_5-90K_2O kg/ha	68.18a	71.82a	75.90a	18.91	18.91	18.91	9.72d	8.79d	8.39d
5 ton/ha air dried cow dung +60N-30P_2O_5-45K_2Okg/ha	67.61a	70.00a	74.98a	18.92	18.92	18.92	9.79d	8.90d	8.69d
SE±	0.60	2.29	2.01	0.16	0.13	0.64	0.91	0.18	0.17
	*	**	**	NS	NS	NS	**	**	**
Chemical weed control									
Atrazine 2.0 kg a.i/ha (P.E) + dimethametryne 3.0 kg a.i/ha (P.O.E) + supplementary weeding at 2, 4, 5, 6 and 9MAP	62.00a	62.13a	62.89a	17.36a	17.37a	17.3a	11.39a	11.38a	11.36
Diuron 2.0 kg a.i/ha (P.E) + dimethametryne 3.0 kg a.1/ha (P.O.E) + supplementary weeding at 2, 4, 5, 6 and 9MAP	62.51a	62.71a	62.98a	17.36a	17.38a	17.39a	11.37a	11.36a	11.36a
Hoe weeding 1, 2, 3, 4, 5, 6 and 9MAP	62.61a	62.98a	63.21a	17.37a	17.39a	17.39a	11.36a	11.35a	11.35a
Weedy check	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b
SE±	0.21	1.29	1.59	0.11	0.10	0.48	0.11	0.13	0.13
	**	**	**	**	**	*	**	**	**

MAP → Months after planting 2. PE → Pre-emergence herbicide, 3. P.O.E. → Post emergence herbicide
4. N.S. → Nonsignidicant, 5. * → Significant at 5%, 6. ** → Highly significant at 1%

Means followed by the same letter(s) in both columns are not significantly different at 5% level of probability using DMRT (Duncan's multiple range tests).

Tab. 4: Effect of fertility rates and chemical weed control on the percent reducing sugar, percent polarity, percent purity and percent nitrogen in juice of chewing sugarcane at Badeggi, 2004–2005, 2005–2006 and 2006–2007 wet and dry seasons

Treatments	Reducing sugar %			Pol%			Purity %			N % in sugar		
	2004 ↓ 2005	2005 ↓ 2006	2006 ↓ 2007	2004 ↓ 2005	2005 ↓ 2006	2006 ↓ 2007	2004 ↓ 2005	2005 ↓ 2006	2006 ↓ 2007	2004 ↓ 2005	2005 ↓ 2006	2006 ↓ 2007
Fertility rates (F)												
0 (Control no cow dung and inorganic fertilizer)	0.53c	0.46c	0.34c	6.97b	6.37c	6.35c	72.81	73.84	74.70	0.15c	0.10c	0.00c
120N-60P_2O_5-90K_2O kg/ha (NCRI recommended rate)	0.70b	0.75b	0.87b	7.05b	7.08b	7.18b	72.91	73.99	74.80	0.28b	0.30b	0.40b
10 ton/ha air dried cow dung (NCRI recommended rate)	0.70b	0.72b	0.89b	6.97b	7.05b	7.11b	73.67	74.69	75.20	0.24	0.40b	0.59b
10 ton/ha air dried cow dung +120N-60P_2O_5-90K_2O kg/ha	1.05a	1.07a	1.09a	7.52a	7.63a	8.80a	73.89	74.71	75.92	0.59a	0.59a	0.79a
10 ton/ha air dried cow dung +60N-30P_2O_5-45K_2O kg/ha	1.05a	1.05a	1.07a	7.48a	7.57a	8.69a	73.77	74.68	75.90	0.49a	0.59a	0.71a
5 ton/ha air dried cow dung +120N-60P_2O_5-90K_2O kg/ha	1.04a	1.07a	1.08a	7.50a	7.60a	8.79a	73.82	74.71	75.90	0.58a	0.63a	0.75a
5 ton/ha air dried cow dung +60N-30P_2O_5-45K_2O kg/ha	1.02a	1.03a	1.04a	7.46a	7.55a	8.61a	73.81	74.62	75.81	0.48a	0.50a	0.69a
SE±	0.84 **	0.47 **	0.64 **	0.13 **	0.11 **	0.13 **	1.56 NS	0.80 NS	0.64 NS	0.44 **	0.24 **	0.35 *
Chemical weed control (H)												
Atrazine 2.0 kg a.i/ha(P.E)+dimetha metryn 3.0 kg a.1/ha (P.O.E) + supplementary weeding at 2, 4, 5, 6 and 9MAP	0.89a	0.89a	0.92a	8.13a	8.16a	8.18a	72.30 a	72.55 a	72.68 a	0.34a	0.37a	0.38a
Diuron 2.0 kg a.i/ha(P.E)+dimetha metryn 3.0 kg a.1/ha (P.O.E) + supplementary weeding at 2, 4, 5, 6 and 9MAP	0.90a	0.91a	0.93a	8.14a	8.16a	8.19a	72.33 a	72.55 a	72.69 a	0.35a	0.38a	0.39a
Hoe weeding 1, 2, 3, 4, 5, 6 and 9MAP	0.91a	0.91a	0.93a	8.15a	8.17a	8.19a	72.32 a	72.56 a	72.69 a	0.35a	0.38a	0.39a
Weedy check	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b	0.00b
SE(±)	2.14 **	0.353 **	0.41 **	0.62 **	0.290 **	0.33 **	1.67 **	0.61 **	0.51 **	0.33 **	0.31 **	0.18 **

MAP → Months after planting 2. PE → Pre-emergence herbicide, 3. P.O.E. → Post emergence herbicide
4. N.S. → Nonsignidicant, 5. * → Significant at 5%, 6. ** → Highly significant at 1%
Means followed by the same letter(s) in both column are not significantly different at 5% level of probability using DMRT (Duncan's multiple range test)

the crop is particularly assessed by the sugar produced per tonnage. And of the major elements essential for cane growth, nitrogen has the greatest effect on cane growth, the ripening and juice quality. The nonsignificant effect of the fertility rates on the laboratory percent brix and percent purity in 2004–2005, 2005–2006 and 2006–2007 wet and dry seasons agrees with Neman *et al*. (1995) who earlier reported nonsignificant effect of inorganic NPK Fertilizer with cow dung on laboratory percent brix and percent purity of sugarcane (Tables 3 and 4). The percent fibre increased as the fertility rates deceases with the highest value of fibre content being obtained from the control where neither cow dung nor inorganic fertilizer was applied.

No stalk yield ton/ha (100% loss) was obtained from the weedy check as a result, high incidence of weeds and therefore, no sucrose or juice was obtained for quality analysis. This result agrees with Grivasatva and Chauhan (2002) who earlier reported 100% reduction in stalk yield of sugarcane due to weed infestation throughout the crop growth. According to Fadayomi (1996), poor soil nutrition and heavy weed in the early life of a crop tends to stalk yield loss, high in fibre content and low in juice quality. However, there was no significant difference among the values of stalk yield ton/ha, laboratory percent brix, percent fibre, reducing sugar, pol, purity and N in sugar obtained from chewing sugarcane treated with herbicides, and that of the hoe-weeded (Tables 3 and 4).

CONCLUSION

From this study it is clearly determined that better stalk yield ton/ha and juice quality were obtained from the application combined fertility rates of cow dung with inorganic fertilizer. And the application of herbicides throughout the periods of the experiment did not affect both the stalk yield and juice quality negatively. Therefore, application of the lowest rate of combined fertility of 5 tonnes/ha of air dried cow dung + 60N – $30P_2O_5$ – $45K_2O$kg/ha with any of the herbicides either diuroun or atrazine each supplemented with dimethametryne 3.0 kg a.i./ha (post emergence) + hoe – weeding at 2, 4, 5, 6 and 9MAP can be recommended for this type of ecology with sandy soil.

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