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RESPONSE OF SUGARCANE VARIETY CO 997 PLANT CANE AND RATOONS TO NITROGEN FERTILIZER AT GUNEID SUGAR SCHEME, SUDAN

SALAHELDIN A. MUKHTAR* AND MOHAMED ABDELHALEEM
Sugarcane Research Center-Guneid, Sudan P.O.Box 511
e-mail: salahamukhtar@hotmail.com

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***Corresponding author**

ABSTRACT
Four experiments were conducted during the period 2010 to 2014 at the Sugarcane Research Center-Guneid farm, Sudan. The objective was to investigate the response of sugarcane variety Co 997 plant cane and ratoon crops to different rates of nitrogen application as urea. Treatments consisted of zero, 100, 150, 200 and 250 kg urea/ feddan (feddan, f = 4200 m^2) for each crop category. Urea rates were applied at two months age for the plant cane crop and at 20 days after harvest for the ratoons. Results revealed that sugarcane variety Co 997 showed weak response to N in the plant cane crop. For ratoons, generally, yield parameters increased with the increase of the urea rate up to 200 kg/f. Quality attributes; brix, pol and estimated recoverable sugar, decreased with the increase of urea rates. However, the cane variety Co 997 maintained viability and gave satisfactory yield throughout the crop cycle. The results emphasized that the rate of 150 kg urea/f, previously adopted for the plant cane of the variety Co 6806, is sufficient for the Co 997 plant crop. Ratoon crops of the variety Co 997 should be given 200 kg urea /f according to the come out in this study.

INTRODUCTION

Sugarcane is grown in Sudan as a cash crop and plays a pivotal role in agricultural and industrial economy of the country. Currently more than 600 thousand tons of sugar is produced, However, the production is mostly depending upon variety Co 6806 which is occupying over 90% of the commercial cane area. Attempts to introduce new varieties continue unabated. The variety Co 997 occupies considerable area especially in areas formerly cultivated with sorghum which is affected by *Striga spp* which is very harmful to the standard variety Co 6806.

Sugarcane is grown mainly in the central clay plain of Sudan (Vertisols) which is characterized by moderate chemical fertility, high contents of smectitic clays, high pH values, low N and organic carbon contents. Nitrogen content of these soils ranges from 0.03 to 0.045% (Idris, 2001).

The management of nitrogen (N) is vital for profitable and sustainable sugarcane production. Yield limitations due to inadequate N supply can have a large negative impact on profitability. Conversely, N application in excess of crop requirement may have potential deleterious off-farm impacts on the environment and can also reduce sugar quality and profitability (Muchow, 1997). It is well known that increase in N fertilizer increases the number of millable stalks, plant height, cane and sugar yields until an optimum level is reached beyond which all these parameters will be negatively affected (Dillewijn, 1952). Moreover, Rathroe *et al*. (2014) by using different rates and treatments of N, reported that significant improvement of yield attributes and yield in terms of tillers, plant height, millable canes, cane yield and sugar yield were recorded with application of 100% RDN through chemical fertilizer + 25% RDN (recommended dose of nitrogen) through pressmud over lower treatments of N. They reported that there was no interaction between genotypes (varieties) and N fertilizer rates. However, many workers have pointed out the poor or lack of response of the plant cane (PC) to N application (Wiedenfeld, 1997; Ali, 2003 and Mukhtar *et al*., 2009). Inversely, it is reported that ratoons response to N application in terms of yield was more common and relatively high (Mukhtar, 2015). Wiedenfeld (1995) concluded that the initial lack of N response of the plant cane indicates that adequate N to meet the needs of the crop was available initially in the soil and that N application was only required in the first and second ratoon crops. Franco *et al*. (2011) conducting field experiments in Brazil, has reported that sugarcane absorbs around 40% of N from fertilizer in ratoon cycle and only 5% in plant cane cycle which explains that why the ratoon crop shows a more consistent response to N fertilization than plant cane. Moreover, Gana (2008) established that for application of more than 120 kg N ha^{-1}, there was no significant difference between sugarcane yields. On the other hand, Rattey and Hogarth (2001) reported that sugarcane quality will be reduced with increasing levels of N.

Humbert (1968) reported that some sugarcane varieties are able to absorb higher levels of nitrogen, others adversely affected on juice quality while others suffers to a lesser degree. This was also confirmed by Stevenson *et al*. (1992) who stated

that with an imported variety, bred in exceptionally fertile conditions, the increased fertilization resulted in a considerable increase in yield, with little decline in quality.

MATERIALS AND METHODS

The study was carried out in the Sugarcane Research Center-Guneid farm during the seasons 2010/11, 2011/12, 2012/13 and 2013/14 for the plant cane, first, second and third ratoon, respectively. The farm lies within the Guneid Sugar Scheme (latitude 14º52' N and longitude 33º19' E). The soils belong to Remaitab soil series, (Vertisols). They were classified as Haplusterts, fine, smectitic, isohyperthermic (Soil Survey Staff, 1999). The land suitability subclass of the studied soils is S2v, *i.e.*, moderately suitable with vertisolic limitations.

Cane was planted in January 2010. For the crop husbandry, the land preparation of the sugarcane included deep ploughing, harrowing, leveling and ridging. A 100 kg/ f of triple superphosphate (TSP) was applied as a basal dose in all treatments. Then overlapping good 3-eyed cane setts were planted. The cane husbandry which was carried out throughout the growing seasons included application of herbicides, insecticides (to combat termites), irrigation and weeding. Harvest was done in March 2011. All the husbandry practices were done according to the Agricultural Guide. (2015) for commercial cane fields in the Sudanese Sugar company.

Ratoon cane was established quickly after cut of the previous crop and harvested in around 12 months for the first, second and the third ratoon. Ratoon husbandry included removing of trashes, ripping, application of herbicides, irrigation and weeding.

Treatments consisted of urea (46% N) rates were; zero, 100, 150, 200 and 250 kg/feddan (feddan, f = 0.42 ha) for all the cycles from the plant cane to the third ratoon. Treatments were arranged in a Randomized Complete Block Design with four replications. Urea fertilizer was applied by spreading the appropriate amount of urea on the shoulder of the bed at two months of cane age for the plant cane. For all the ratoons urea was applied at 20 days after the first irrigation as practiced in the commercial cane fields.

Measurements were taken from the two inner rows of each plot to avoid the marginal effects. Readings of millable stalk population, stalk height and cane yield were taken at harvest. Those measurements were done according to Clements (1980). Quality attributes were determined at harvest also by taking a random sample of 10 cane stalks from which brix (total soluble solids), pol (sucrose content of cane), fiber and ERS (estimated recoverable sugar) percentages were determined. Sugar yield was a product of ERS*cane yield. Determination of quality parameters were done according to ICUMSA(1979).

RESULTS AND DISCUSSION

Tables from 1 to 4 show yield components and quality attributes of the harvested cane. Generally, compared to the standard variety Co 6806, the variety Co 997 has showed less population and relatively lower cane yield but a bigger stalk height. In the plant cane crop of the variety Co 997 (Table 1), no significant or consistent differences were shown in millable stalk height, millable stalk population or cane yield in response to the different rates of urea though surprisingly, a zero rate (no urea) was included. The results are in agreements with Wiedenfeld (1995, 1997), Ali (2003) and Mukhtar *et al*. (2009). The former authors have stated the weak or lack of response of the plant cane crop to N in general. This may be due to that the plant cane usually comes after a rest period. Also land preparation preceding the plant cane is heavy and well done.

Table 1: Effect of urea rates on some yield and quality components of sugarcane variety Co 997, PC at Guneid, season 2010/2011.

Character	Urea rates (kg/f)					S. E. (±)	C. V. (%)
	0.0	100	150	200	250		
Stalk height (cm)	257.6	261.7	253.3	260.7	262.9	6.74	14.1
No. of millable stalks (1000)	3.27	3.24	3.65	3.33	3.48	0.711	8.9
Yield (ton cane /f)	49.2	54.2	47.1	46.4	49.1	1.28	11.6
Brix % cane	17. 8 a	18.0 a	17.6 a	17.0 b	16.9 b	0.12	1.7
Pol % cane	15.0 a	14.8 a	14.4 ab	13.7 b	13.6 b	0.16	3.6
Fiber % cane	17.3	16.3	16.7	17.3	16.7	0.18	5.1
ERS (%)	12.0 a	11.8 a	11.3 ab	10.7 b	10.6 b	0.16	4.5
Sugar yield (ton/f)	5.9 ab	6.4 a	5.4 ab	5.0 b	5.2 b	0.18	13.0

Means followed by the same letter(s) are not significantly different according to Duncan's MRT.

Table 2: Effect of urea rates on yield and quality components of sugarcane variety Co 997 at Guneid, 1st ratoon, season 2011/2012.

Character	Urea rates (Kg/fed.)					S.E.(±)	C.V.
	0.0	100	150	200	250		
Stalk height (cm)	217.5 b	242.4 ab	245.2 ab	250.5 ab	259.6 a	10.46	8.61
No. of millable stalks (1000)	34.9 a	33.6 a	35.3 a	33.1 a	35.3 a	1592	9.25
Cane yield (tons/f)	34.3 c	40.2 bc	45.0 ab	49.3 a	49.3 a	2.24	10.25
Brix %cane	18.5 a	18.8 a	18.5 a	18.7 a	18.2 a	0.27	2.90
Pol %cane	15.6 a	15.4 a	15.1 a	15.5 a	15.0 a	0.22	2.84
ERS %cane	12.6 a	12.4 a	12.1 a	12.5 a	12.0 a	0.22	3.53
Fiber %cane	15.8 a	15.2 a	15.2 a	16.0 a	16.2 a	0.73	9.28
Sugar yield (tons/f)	4.3 c	5.0 bc	5.4 ab	6.2 a	5.9 ab	0.28	10.30

Means followed by the same letter(s) are not significantly different according to Duncan's MRT.

Table 3: Effect of urea rates on yield and quality components of sugarcane variety Co 997 at Guneid; 2nd ratoon, season 2012/2013.

Character	Urea rates (Kg/fed.)					S.E.(±)	C.V.
	0.0	100	150	200	250		
Stalk height (cm)	241.1 a	226.9 a	241.2 a	257.8 a	258.3 a	11.5	9.4
No. of millable stalks(1000)	37.8 c	42.0 bc	46.8 ab	48.5 a	46.6 ab	1505	6.8
Cane yield (tons/f)	22.4 c	40.5 b	45.9 ab	49.0 a	51.2 a	1.8	8.7
Brix %cane	16.7	17.5	18.0	17.6	17.1	0.42	4.9
Pol %cane	14.4	15.2	15.0	14.6	14.8	0.29	4.0
ERS %cane	11.4	12.2	12.0	11.6	11.8	0.29	5.0
Fiber %cane	17.5	17.3	15.9	15.5	17.5	0.86	10.2
Sugar yield (tons/f)	2.5 c	4.9 bc	5.5 ab	5.7 ab	6.01 a	0.27	10.8

Means followed by the same letter(s) are not significantly different according to Duncan's MRT

Table 4: Effect of urea rates on yield and quality components of sugarcane variety Co 997 at Guneid, 3rd ratoon, season 2013/2014.

Character	Urea rates (Kg/fed.)					S.E.(±)	C.V.
	0.0	100	150	200	250		
Stalk height (cm)	162.7	196.6	187.1	183.4	188	10.7	11.3
No. of millable stalks(1000)	39.0	45.0	44.6	51.3	49.6	3945	16.7
Cane yield (tons/f)	37.1c	43.0 bc	52.1ab	53.0 a	44.6abc	3.3	14.2
Brix %cane	17.5	18.4	17.9	17.6	17.7	0.37	4.0
Pol %cane	14.5	14.3	14.7	14.2	14.2	0.47	6.3
ERS %cane	11.5	11.3	11.7	11.2	11.2	0.47	8.0
Fiber %cane	15.2	14.1	14.4	15.9	15.1	0.63	8.3
Sugar yield (tons/f)	4.3	4.9	6.1	5.9	5.0	0.37	14.1

Means followed by the same letter(s) are not significantly different according to Duncan's MRT

Differently, data in Table (2) shows that the first ratoon crop showed more obvious response to N, also similar to the variety Co 6806. Stalk height increased with the increase of urea rate from 0.0 upto 250 kg/f. However, the increase was significant between the rates 0.0 and 250 kg/f only. Millable stalks population showed no trend between all urea rates. Cane yield increased significantly as response to N from 0.0 upto 150 kg urea/f and no significant increase was shown after that. The results are in accordance with the findings of Mukhtar (2015). Also, Gana (2008) has reported that with application of more than 120 kg N ha^{-1}, no significant increase in sugarcane yields has happened.

In the second ratoon crop (Table 3), all urea rates showed similar stalk height values. Stalk population increased significantly as the rate of urea increased up to 150 kg /f. Similar to the results gained in the first ratoon cycle, cane yields scored by the 150, 200 and 250 kg urea /f were the highest and they were significantly higher than those of the lower rates of zero and 100 kg urea/f. Same results were obtained by Dillewijn (1952) and Mukhtar (2015).

The third ratoon crop kept more or less the same trend of previous ratoons (Table 4). Millable stalk height was lower than that observed in the previous crops in the cycle and no significant differences was seen between the treatments. Millable stalk population increased with the increase of urea rates up to 250 kg/f, however, without significant differences. Cane yield also increased with the increase of urea rates, but significantly in favour of 150 and 200 kg urea /f over zero and 100 kg urea /f. Generally, sugarcane yields decline with later ratoons, here variety Co 997 maintained a good yield in the 3rd ratoon though it is a later ratoon crop.

Quality attributes, especially, brix, pol and ERS percentages showed reverse effects to cane yield parameters. Confirming the fact that nitrogen in excess affects sugar content negatively, quality attributes decreased with the increase of urea rate. However, no significant differences were detected in brix, pol and ERS percentages as response to the rates of zero, 100 and 150 kg/f, but, they exceeded the response to the rates of 200 and 250 kg urea/f significantly. Consequently, Sugar yield , which was a product of both cane yield and ERS percent, followed the same trend, *i.e.* decreased with the higher rate of urea in the plant cane crop (Table 1). This was also confirmed by Stevenson *et al*. (1992) and Franco *et al*. (2011) who stated that the increased fertilization resulted in a considerable increase in yield, with little decline in quality. However, the reverse of that occurred in the ratoon crops (Tables 2, 3 and 4). This corroborates the results reported by Rattey and Hogarth (2001). It is worth mentioning that results of quality parameters of the variety Co 997 showed typical behavior of the known response of sugarcane to N fertilizers.

REFERENCES

Ali, O. A. 2003. Irrigated sugarcane response to applied nitrogen under fallow land. *Proceedings of the Crop Husbandry Committee, Agricultural Research Corporation*, Wad Medani, Sudan.

Clements, H. F. 1980. Sugarcane Crop logging and Crop Control: Principles and Practices. The University Press of Hawaii, Honolulu.

Dillewijn, C. V. 1952. Botany of Sugarcane. Waltham Mass, U.S.A., the Chronica Botanica Co: Book Department, pp. 196-270.

Franco, H. C. J., Otto, R., Faroni, C.E., Vitti, A.C., Oliveira, E.C.A. and Trivelin, P. C. O. 2011. Nitrogen in Sugarcane Derived from Fertilizer under Brazilian Field Conditions. *Field Crops Research*. 29-41. http://dx.doi.org/10.1016/j.fcr.2010.11.011. **121(1):**

Gana, A. K. 2008. Determination of optimal rate of nitrogen for chewing sugarcane production in the Southern Guinea Savanna of Nigeria. *Sugar. Tech.* **10:** 278-279.

Humbert, R. P. 1968. The Growing of Sugarcane. Elsevier Publications Co., Amsterdam, Netherlands, pp.133-301.

ICUMSA. 1979. International Commission for Uniform Methods of Sugar Analysis. In: Cane Sugar Handbook. *Pub. British Sugar Corporation, London*

Idris, M. A. M. 2001. Chemical fertility status of some soil series in irrigated schemes in the Sudan. Workshop on Diversified Fertilization for Yield Promotion in Sudan. *Friendship Hall, Khartoum, Sudan.*

Muchow, R. C., Robertson, M. J. Wood, A. W. and Keating, B. A. 1997. Effect of nitrogen on the time-course of sucrose accumulation in sugarcane. *Field Crops Research.* **47:** 143-153.

Mukhtar, S. A., Adam, A. I. and Ibrahim, A. S. 2009. Response of sugarcane (*Saccharum spp*) to nitrogen and methods of application in some soils of the Central Clay Plain of Sudan. *U of K J. Agric. Sci.* **17(2):** 167-182.

Mukhtar, S. A. 2015. Response of sugarcane ratoons to nitrogen rates and method of application in Guneid Sugar Scheme, Sudan. *Gezira J. Agric. Sci. Sudan.* **13(2):** 18-34.

Rathroe, A. K., Singh, H. and Jain R. 2014. Growth, yield and quality of sugarcane (*Saccharum spp*. Hybrid complex) as influenced by integrated nutrient management and genotypes.(supplement of genetics and plant breeding). www.thebioscan.in. *The Bioscan*. **9(2):** 727-730

Rattey, A. R. and Hogarth, D. M. 2001. The effect of different nitrogen rates on CCS accumulation over time. *Proc. Int. Soc. Sugar Cane Technol.* **24:** 168-170.

Soil Survey Staff. 1999. Soil Taxonomy, a Basic system of soil classification for making and interpreting soil surveys. U.S.D.A. Natural Resources Conservation Service. Handbook No. 436 2nd edition. *Printing Office, Washington D.C. 20402, U.S.A.*

Stevenson, D. W. A., Van Der Merwe, A., Benninga, W. and Allison, J. C. S. 1992. Response of different sugarcane varieties to greater than normal applications of nitrogen. *Proceedings of The South African Sugar Technologists' Association.*

The Agricultural Guide. 2015. A hand out by the Sugarcane Research Center-Guneid Staff, Sudan.

Wiedenfeld, R. P. 1995. Effects of irrigation and N fertilizer application on sugarcane yield and quality. *Field Crops Research.* **43:** 101-108

Wiedenfeld, R. 1997. Sugarcane responses to N fertilizer application on clay soils. *J. the American Society of Sugarcane Technologists.* **17:** 14-27.