

Possibility of Reducing Harvesting time in Sugarcane Using Bioactivators

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ABSTRACT: Over the last 50 years, the sugarcane yield at Wonji-Shoa Sugar Estate showed a declining trend. To mitigate the problem the use of bioactivators could play a role. Therefore, studies on the effect of three fertilizer rates (0, 100 and 200 kg ha⁻¹) and two types of bioactivators (Agrostemin applied in furrows at 30 gm ha⁻¹ and Crops[®] foliar applied at 30 ml ha⁻¹) as well as untreated (no bioactivator) treatments were investigated to determine the effect on early growth, yield and quality of sugarcane variety NCo334. The experiment was carried out at Wonji/Shoa on clay loam textured soil in a factorial RCBD design using four replications. Analysis of variance revealed that in sucrose percent cane, the sole application treatments 100 kg ha⁻¹ urea, 200 kg ha⁻¹ urea and the treatment that didn't receive either urea or bioactivator gave significantly ($p < 0.05$) the lowest percent sucrose cane. Sole application of agrostemin and crop resulted in a 13.56 and 12.86 % increase in sucrose percent cane against the check (200 kg ha⁻¹ urea). Furthermore, trend analysis of brix-ratio indicated the possibility of harvesting cane earlier at the age of 12 months if treated with bioactivators Agrostemin and Crops[®].

Key Words: bioactivators, Agrostemin, Crops[®], urea fertilizer, sugarcane, sucrose.

INTRODUCTION

Sugarcane (*Saccharum* spp.) is cultivated in different weather and management conditions which directly affect its ripening (Scarpari and Beauclair, 2004). Ripening of sugarcane is the accumulation of sucrose in the cane stalk (Van Dillewijn, 1952). According to Morgan et al. (2007) ripening in sugarcane refers to an increase in sugar content on a fresh weight basis before commercial harvest. Glover (1971) also asserted that ripening increases both fresh and dry mass of sucrose, expressed as stalk fresh and dry matter contents; respectively. In the process of ripening monosaccharide forms of sugars (glucose and fructose) are converted into disaccharide sugar sucrose, and this manifests the success of economical recovery of sucrose during milling (Culverwell, 1996).

Age of harvest is one of the most important factors affecting productivity, and varietal differences in growth and maturity rates (Donaldson et al., 2008) must be considered when harvesting decisions are made. Varieties are classified as early, mid and late maturing based on the time taken for maturity (Sundara, 2000; Verma, 2004). As sugarcane plant matures throughout the growing season, the amount of sucrose in the cane increases. Most of this sucrose production occurs when the plant is fully mature and begins to ripen (Alexander, 1973). Maturity of cane can be hastened artificially by withholding water (Singles et al., 2000; James, 2004) or use of chemical ripeners (SASRI, 2008). Apart from this, some biostimulators/bioactivators are claimed to have the capacity to induce ripening and reduce harvesting time (Anon, 1996; Agentra, ND). According to Castro and Pereira (2008), bioactivators are defined as a complex organic substance that can alter the growth, capable of acting on the DNA transcription into the plant, gene expression, membrane proteins, metabolic enzymes and mineral nutrition. Plissey (2003) reported that plant bioactivators enhances yield and yield components of crop. Among the bioactivators, Agrostemin and Crops are claimed to have effect on yield and quality of cane.

According to Anon (2010), all responses caused by Agrostemin consequentially result in a series of positive effects of the plant among which the following stand out: increased content of chlorophyll and band more intense photosynthesis, better root development, better developed above-ground plant parts. Furthermore, agrostemin is claimed to have the capacity to improve cane quality (Anon, 2010). Similarly, Crops[®] is another bioactivator which is known to boost immune system, induces chitanese enzymes and phytoalexine, acts as a biostimulant, increases chlorophyll production, reduce time of harvesting and in general enhances biostimulation

(Agentra, ND). Therefore, this proposal was initiated to evaluate the effect of bioactivators Agrostemin and Crops on sugarcane ripening.

MATERIALS AND METHODS

Site Description

Wonji-Shoa is located in the Rift Valley of Ethiopia at an altitude and longitude of 8°31'N and 39°12'E, respectively, with an elevation of 1550 masl. The area has a mean maximum and minimum temperature of 26.9°C and 15.3°C, respectively with annual rainfall of 800 mm.

Treatments and Design

The experiment was laid out in a randomized complete block design in factorial combination of rate of fertilizer and type of bio-activators using four replications. The treatments consisted of three rates of fertilizers (0, 100 and 200 kg ha⁻¹) and two types of bioactivators (Agrostemin applied in furrows at 30 gm ha⁻¹ and Crops[®] foliar applied at 30 ml ha⁻¹) as well as untreated (No bioactivator) plot. The control rate of nitrogen fertilizer at Wonji/Shoa is 200 kg ha⁻¹. The sugarcane variety was NCo334 which was selected based on its yielding potential and area coverage. The study was carried out on clay loam textured soil on plant cane crop.

The size of each experimental plot was 43.5 m² (six furrows of 5 m length and 1.45 m width). The net plot area used for data collection was 29 m² (four furrows of 5 m length and 1.45 m width). The distance between adjacent plots and replications were 1.50 and 2.90 meters, respectively. Healthy stalks of 10 months of age were used as seed cane source.

Two budded setts which were prepared from the same portion of seed cane, i.e., the middle of the stalk of 10 months of age were used for planting. In each row, 25 two budded setts were planted with ear-to-ear alignment. All cultural managements were conducted as per the norm of the estate except fertilization. Agrostemin was applied during planting into furrows on the setts (at a rate of 30 g ha⁻¹ in 1000 liter) prior to covering. Crops[®] application was performed by spraying (using knapsack sprayer) the solution on the leaf of the cane at 20, 35, 50 and 65 days after planting at a rate of 30 ml ha⁻¹.

Data Collections

Harvesting was made at 14th months of age after drying the cane as per recommended for the Estate. Cane yield per hectare basis was calculated from the yield obtained per plot. For cane quality analysis, juice was extracted from 10 stalk samples using a sample mill. Maturity test (brix ratio) was also performed using hand refractometer at 10, 12 and 14 months after planting.

Percent recoverable sucrose (rendiment) was calculated using Winter Carp indirect method of cane juice analysis (James and Chou, 1993). Then, commercial sugar yield per hectare was calculated as follows;

$$ESY (t / ha) = CYH (t / ha) \times ERS (\%)$$

Where;

ESY = estimated sugar yield

CYH = cane yield per hectare

ERS = estimated recoverable sucrose (%)

The cane and sugar yields were described as suggested by Sweet & Patel (1985) according to COTCHM method (Corrected Tones Cane per Hectare per Month).

Finally, the data collected were subjected to analysis of variance using SAS software (SAS Institute, 2002). Comparisons among treatment means with significant differences for the measured and counted parameters were done based on the Duncan Multiple Range Test (DMRT).

RESULT AND DISCUSSION

Effect of Urea N fertilizer and bioactivators on cane yield, sucrose (%) and Sugar Yield

Analysis of variance showed that sole application of Agrostemin gave statistically the same yield with other treatments except the sole application treatment of 100 kg ha⁻¹ urea and the treatment that didn't receive either urea or bioactivator (Table 3). All the treatments that received both the bioactivator and urea were superior to the

sole application treatments 100 kg ha⁻¹ urea, 200 kg ha⁻¹ urea and the treatment that didn't receive either urea or bioactivator (Table 3).

In sucrose percent cane, the sole application treatments 100 kg ha⁻¹ urea, 200 kg ha⁻¹ urea and the treatment that didn't receive either urea or bioactivator gave significantly (p<0.05) the lowest percent sucrose cane. Sole application of agrostemin and crop resulted in a 13.56 and 12.86 % increase in sucrose percent cane against the check (200 kg ha⁻¹ urea). In agreement with this, Anon (1996) and Agentra (ND), reported the increase in sucrose content and hastening maturity of cane by growth regulators agrostemin and crops, respectively.

Table 1. Effect of rates of urea nitrogen fertilizer rates and bioactivators on cane yield, sucrose (%) and sugar yields of sugarcane on plant crop at Wonji/Shoa from 2013-2014.

| Treatments | Cane Yield (t ha ⁻¹ m ⁻¹) | Sucrose (%) | Sugar Yield (t ha ⁻¹ m ⁻¹) |
|---|--|-------------|---|
| NF + NB (Untreated) | 12.21 c | 11.50 b | 1.41 d |
| Agrostemin (30 gm ha ⁻¹) alone | 16.19 a | 13.15 a | 2.13 a |
| Crops (30 ml ha ⁻¹) alone | 16.18 a | 13.07 a | 2.12 a |
| 200 kg ha ⁻¹ Urea alone (Check) | 14.58 ab | 11.58 b | 1.68 bc |
| 200 kg ha ⁻¹ Urea + Agrostemin (30 gm ha ⁻¹) | 15.60 a | 12.04 ab | 1.87 b |
| 200 kg ha ⁻¹ Urea + Crops (30 ml ha ⁻¹) | 15.09 a | 12.18 ab | 1.83 b |
| 100 kg ha ⁻¹ Urea alone | 12.97 bc | 11.70 b | 1.52 cd |
| 100 kg ha ⁻¹ Urea + Agrostemin (30 gm ha ⁻¹) | 14.95 a | 12.05 ab | 1.80 b |
| 100 kg ha ⁻¹ Urea + Crops (30 ml ha ⁻¹) | 14.65 a | 12.15 ab | 1.78 b |
| LSD (5%) | ** | * | ** |
| CV | 7.85 | 6.16 | 7.75 |

Means followed by the same letter in a column are not significantly different from each other; NF = without fertilizer application; NB= without bioactivator application; m = month; CV = Coefficient of Variation, LSD = Least significant Difference; t = tone; ha = hectare.

Brix ratio (top to bottom ratio) and bioregulators effect on maturity

Analysis of the top to bottom ratio of brix for the bioactivators agrostemin and crop treatments indicated that the maximum brix ratio was obtained at the age of 12 months of cane age (Figure 1).

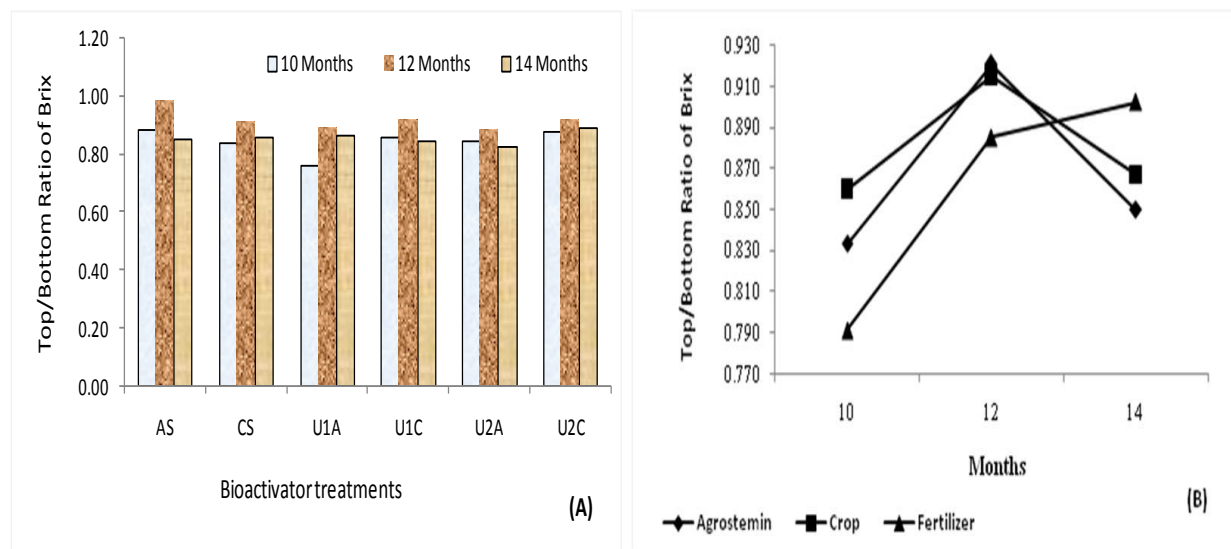


Figure 1. Brix ratio (top/bottom ratio) for the treatments taken for three ages (A) and average brix ratio value obtained for the applied treatments agrostemin, crop and fertilizers for the three ages (B). Note: AS= agrostemin solo; CS = crop solo; U1A= 200 kg ha⁻¹ urea + Agrostemin; U1C= 200 kg ha⁻¹ urea + crop; U2A= 100 kg ha⁻¹ urea + agrostemin and U2C= 200 kg ha⁻¹ urea + crop.

In general, sole application of agrostemin and crop was higher than all other combination treatments (Figure 2A). Average of the brix ratio values for agrostemin and crop containing treatments has showed a mean brix ratio of 0.921 and 0.915; respectively (Figure 2B). However, sole application of fertilizer has showed an increasing trend as age increased (Figure 2B). From the best practices identified at Wonji-Shoa Sugar Estate

based on long year harvest result, the harvest age ranges from 17-18 months for plant cane. However, the brix ratio value trend analysis indicated that at the age of 12 months a peak value obtained and at the age of 14 months declined (Figure 1B). This result indicates that bioregulators have the ability to hasten ripening of cane earlier than the time of natural maturity. According to Anon (2010) and Agentra (ND), bioactivators hasten maturity and reduce harvesting time. However, on fertilizer treated plots showed an increasing brix ratio trend indicating the peak value to be attained latter.

CONCLUSION AND RECOMMENDATIONS

The use of bioactivator has affected yield and yield components. Though there was difference among treatments for the parameters considered; however, estimated sugar yield was superior in the sole application of the bioactivators. Though harvesting was conducted at the age of 14 months, the brix ratio indicated the possibility of harvesting agrostemin and crop treated cane earlier than the natural ripening time. However, the time period the peak sucrose maintained should be evaluated at commercial scale, since practically can harvesting could be delayed after burning due to several reasons.

REFERENCES

- Agentra (ND). Crops, Introductory presentation. Northampton, United Kingdom.
- Alexander AG. 1973. Sugar Cane Physiology. Elsevier Scientific pub. Comp. Newyork.
- Anonymous, 1996. Evaluation of the performance and effects of BETASTAMIN bioregulator on the cultivation of sugar cane. Sugar mill "San Francisco Ameca", Municipality of Ameca, Jalisco, Mexico (1996).
- Anonymous, 2010. The influence and effects of application of agrostemin® on sugarcane (*Saccharum officinarum* L.). "Colonial" alcoholic beverages manufacturer plantations in the city Aquiraz – CE Brazil.
- Castro PRC, Pereira MA. 2008. Bioactivators in agriculture. Thiamethoxam: a revolution in the Brazilian agriculture, Gazzoni, D.L. (Ed.), p. 118-126.
- Culverwell TC. 1996. Joint session on cane quality: The Umfolozi experience. Proc. S. Afr. Sugar Technol. Ass. **70**, 265-286.
- Donaldson RA, Rdshaw KA, Rhodes R, Van Antwerpen R. 2008. Season Effects on Productivity of some commercial South African Sugarcane Cultivars. I: Biomass and Radiation use efficiency. Proc S Afr Sug Technol Ass. 81: 517-527.
- Glover J.1971. Changes in sucrose % cane and yield of sucrose per unit area associated with cold, drought and ripening. Proc. S. Af. Sugar Technol. Ass. 46, 158-164.
- James CPC, Chou CC. 1993. Cane Sugar Handbook, 12th ed. A manual for cane sugar manufacturers and their chemists. John Wiley and Sons, Inc. New York.
- James G (ed) .2004. Sugarcane. Blackwell Science Ltd. UK.
- Morgan T, Jackson P, McDonald L, Holtum J (2007). Chemical ripeners increase early-season sugar content in a range of sugarcane varieties. Aust. J. Agric. Res. **58**:233–241.
- Plissey ES. 2003. Applying crop stimulant technology to the potato crop. In: Lyons, T.P, Jacques, K.A. (eds) Nutritional Biotechnology in the Feed and Food Industries, Proceedings of Alltech's 19th Annual Symposium. Nottingham University Press, U.K, pp.415-421.
- SAS (Statistical Analysis System). 2002. Institute of Applied Statistics and SAS programming Language. Cary, North Carolina.
- SASRI.2008. South Africa Sugarcane Research Institute The Link. Volume 17, Number 1. South Africa.
- Scarpari MS, Beauclair EGF.2004. Sugarcane maturity estimation through edaphic-climatic parameters.
- Singles A, Kennedy AJ, Bezuidenhout CN.2000. The effect of water stress on sugarcane biomass accumulation and partitioning. Proc S Afr Sug Technol Ass. **74**:169-172.
- Sundara B.2000. Sugarcane cultivation. Vikas publishing house Pvt. Ltd., New Delhi.
- Sweet CPM, Patel R. 1985. Changes in cane yield of irrigated variety NCo376 due to season and their implications when evaluating field performance. Proceedings of the South African Sugar Technologists Association, **59**, 210–214.
- van Dillewijn C.1952. Botany of Sugarcane. Chronica Botanica, Waltham, MA.
- Verma RS.2004. Sugarcane Projection Technology in India. International Book Distributing Co. Lucknow. India.