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Full Length Research Paper

The effect of seed rates on performance of newly selected sugarcane in western Kenya

George Omoto*, Victor Otieno and Anne Omututi

Kenya Agricultural and Livestock Research Organization, Sugar Research Institute, P.O. Box 44-40100, Kisumu, Kenya.

*Corresponding author. E-mail: georgeomoto@ymail.com, george.omoto@kalro.org

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Seed rate in the Kenya sugar industry ranges from 5-12 tha^{-1} or 25,000-35,000 three budded setts ha^{-1}. A study was conducted to determine the most economic seed rate for newly selected sugarcane cultivars at Sugar Research Institute, Kibos in March 2011. Sugarcane cultivars CO 421, KEN82-62, KEN82-247 and KEN85-53 were each planted at the rates of 3, 5, 7 and 9 tha^{-1}. Diammonium phosphate (DAP) fertilizer was used across all treatment combinations at the rate of 80 kg P_2O_5 ha^{-1} at planting, while urea was used to top dress at 100 kg N ha^{-1} five months after planting (MAP). The trial was harvested at 20 MAP plant crop for yields and milling. The results showed that germination percent differed significantly among the treatments with KEN82-247 showing the highest germination (68.8%) and KEN85-53 showing the lowest (30.6%). Tiller numbers differed among the cultivars at the 5th and 7th MAP. Similarly, KEN82-247 showed the highest tillers number and KEN85-53 the lowest. There were no significant differences among the seed rates. Significant difference in yield components and yield among the cultivars were noticed with KEN82-247 out yielding the other three cultivars. The seed rates minimum cost analysis was adopted, which shows that the lowest cost (3-5 tha^{-1}) is hereby recommended as the most cost effective seed rate for cane growers in Kibos sugar zone.

Key words: Seed rate, cultivar, setts and minimum cost analysis.

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INTRODUCTION

Sugarcane (*Saccharum spp hybrids)* is one of the main cash crops grown in Western Kenya. Sugarcane growing covers a total of 202,400 ha spread in 14 Counties namely Kakamega, Busia, Bungoma, Kisumu, Kericho, Migori, Transmara, Homabay, Narok, Siaya, Nandi, Uasin Gishu, Trans Nzoia and Kwale (Statistics year book AFA-SD, 2018). It plays a significant role in the agricultural and social economic development in Kenya. It contributes 4.1% to the value of agricultural marketed production and 5.9% of all crops marketed value, thereby supporting over 6 million Kenyans (approximately 13% of the entire Kenyan population) that depends directly or indirectly on the industry and provides employment to 500,000 workers along the entire value chain (Statistics year book AFA-SD, 2018).

Sugarcane is usually grown at low altitude in most countries from sea level to 1000 m above sea level (asl) or more. In Kenya, most sugarcane is grown at high altitude of 1100-1600 m asl (KESREF, 2012). Commercial sugar cane cultivation in Kenya falls into three broad agro-climatic zones of Western sugar belt rising to 1,300-1,700 m asl and receiving 1,400-2,000 mm of rainfall annually, as well as having loam to sandy soils. Nyanza (Nyando) has altitude of 1,100-1,300 m asl and receives 1,000-1400 mm of rainfall annually. The soils are clay loam with poor drainage. Coastal region includes areas below 700 m asl and receives rainfall of about 1000 mm.

Seedcane is the most cost efficient means of increasing sugarcane production and productivity. Improved seedcane sugarcane varieties and correct seed rate have special place amongst all inputs required for sugarcane production. High seedrate increases the cost of sugarcane production. The overlapping planting method, where sugarcane setts are placed a few centimeters, overlaps another, and more seedcanes are used unlike the end-to-end method, where cane setts are placed a few centimeters away from one another, thus allowing the most economic use of seedcane. Seed rate used across the zones in Kenya sugar industry is not consistent. For example, Western and Awendo sugar zones use the seed rates of 6-9 tha^{-1}, Chemilil, Kibos sugar allies and Muhoroni sugar zones use seed rates of 9-10 tha^{-1}. This indicates that each sugarcane growing zone in the region uses different seed rates for planting sugarcane.

The seed rate issue has not been documented adequately, therefore the use of blanket rates ranging from 5-12 tha^{-1} are used. Seedcane alone contributes to about 20% of the total cost of production of sugarcane in Kenya sugar industry (KESREF, 2012). West Kenya sugar Company (2009) reported that the farmers in their zone use seed rate of 10-12 tha^{-1}. Similarly, the Kenya Sugar Research Foundation [KESREF] (2010) reported that the seed rate ranges between 6-12 tha^{-1} in western sugar zones. In Nzoia sugar company zone (2011), the seed rates ranges from 7.5 -8 tha^{-1}. Robert Antoine Sugar Industry Training College (2009) found that the optimum number of cuttings between 25,000 and 30,000 three budded setts ha^{-1} had been used as seed rate in Mauritius. Tang (1977) reported no significant difference on sugarcane yield when 18, 000, 20,000 and 30,000 three budded setts ha^{-1} were used in Taiwan. Nadeem (1989) reported seed rates of 6-7 tha^{-1} of medium to thin cultivars being used in Cuba. El-sogheir and Mohamed (2003) found that 16,800 three budded setts ha^{-1} is the optimum seed rate. In India, Zibair (2003) reported that 3.2 - 4 tha^{-1} was the optimum seed rate. Therefore, the aim of this study was to determine the most economic seed rate for newly selected sugarcane in Western Kenya.

MATERIALS AND METHODS

Experimental sites

This study was conducted at the Sugar Research Institute, Kibos. Kibos is located 15 km North East of Kisumu City along Kisumu- Miwani road, at a longitude of 0° 24' North and Latitude of 34° 48' East at altitude of 1185 m asl. The mean maximum monthly temperature ranges from 28 to 32° and the annual rainfall is 1490 mm. The minimum temperature ranges from 14-17°C (KESREF, 2010). There are two main rain seasons viz, a long rain season from March to June and the second season from August to October. The intervening months are expected to be slightly drier, and the dry season starts in November up to the end of January; however, the effect of climate change has changed the pattern of rainy seasons. The daily evaporation varies throughout the year with means of Kibos (5.1 mm/day). The mean relative humidity at Kibos is 70.4% (KESREF, 2012).

Experimental design

The trial was planted in field 13 in March 2011 at the Sugar Research Institute, Kibos with 4 sugarcane cultivars namely CO421, KEN82-62, KEN 82-472 and KEN 85-53. All the cultivars were high yielding and recommended for Western, Nyando and Awendo sugar zones. Clean seedcane aged 12 months of each cane cultivar was harvested manually and their stalks cut into three bud setts. The three budded setts were then dipped into confidor* SL 200 insecticide solution at the rate of 200 mm ha^{-1} to control termites attacks on setts. Seed rates were determined by the use of salter weighing balance. The plots were 6.0 x 10 m, with a 2 m path separating them. The treatments consisted of 4 sugarcane cultivars planted using four seed rates namely 3, 5, 7 and 9 tha^{-1} and arranged in a 4 x 4 factorial in a randomized complete block design.

The averaged setts of each treatment was then laid in 25 cm deep furrows of 10 m long and laid in an end-to-end method of planting, thereby covering with soil of 3 inches depth. The spacing between rows was 120 cm wide. The treatments were replicated three times. Diammonium phosphate (DAP) (46% P and 18% N) fertilizer was used at the rate of 80 kgP_2O_5 ha^{-1} at planting, while urea 46% N was used to top dress the crop (100 kg N ha^{-1}) five months after planting. The best crop management practice was applied as per SRI recommendations.

Data collection

Data on germination, tiller count, stalk population ha^{-1}, plant height (cm) at harvest, girth (mm) and cane weight tha^{-1} were collected. The trial was harvested at 20 months after planting. Sugarcane yield components and yield were measured from the three inner-most rows of each plot. Twelve stalks were randomly taken from each plot for sugarcane quality analysis at harvest. These data were analyzed by standard analysis of variance (ANOVA) using Statistical Analysis Systems (SAS) vs 8.0.

Economic analysis

Economic analysis was conducted by the minimum cost analysis, where major assumptions were:

Seedcane price ton^{-1} = Kshs 4000
Transport cost for zone area studied = Kshs 425 x 1.5 = Kshs 637.50 (1.5 – factor for seedcane transport)
Labour cost/ man day (md) = Kshs 365

Table 1. Germination percent of different cultivars of sugarcane.

Cultivar	Germination percent (%)
CO421	43.4
KEN82-62	47.1
KEN82-247	68.8
KEN85-53	30.6
Mean	**47.48**
LSD $_{0.05}$	16.4
CV%	30.4

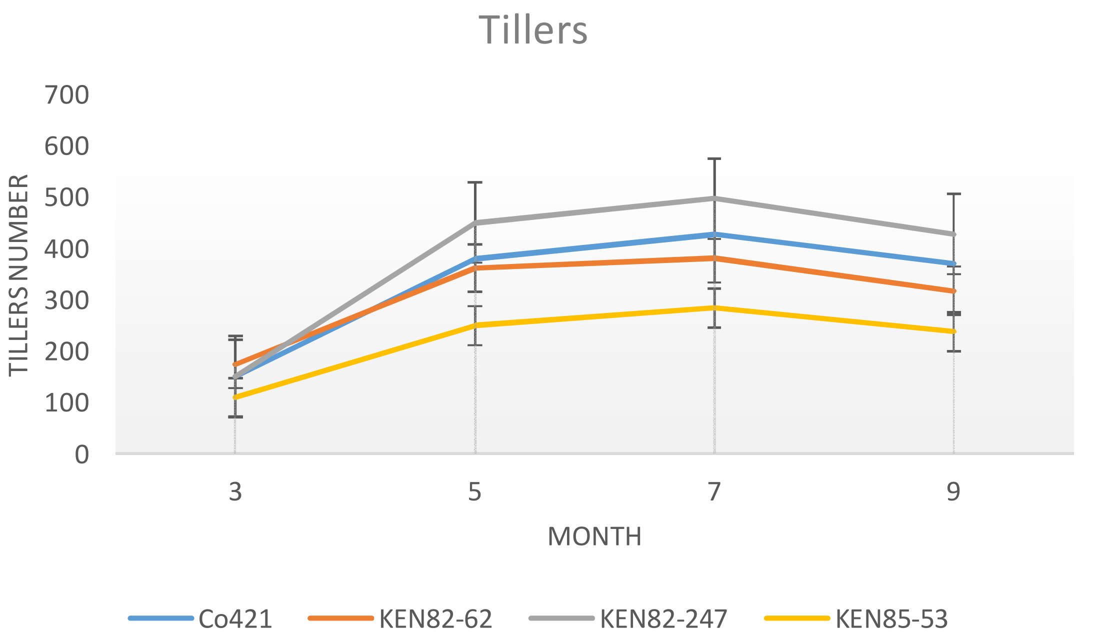

Figure 1. The effect of treatments on tillers number

Field price = Factory price – (Harvesting Cost + Loading + Transport)

RESULTS

Effect of different seed rates on germination and tiller count

There were significant differences among the cultivars (Table 1). Cultivar KEN82-247 showed the highest germination percentage, while cultivar KEN85-53 showd the lowest. Significant differences were noticed in both seedrates and cultivars at months five, and seen with cultivar KEN82-247 showing the highest tiller numbers and KEN85-53 showing the least (Figure 1). Tiller numbers rised drastically from the 3rd to 5th month, then gradual where they peaked at 7th MAP, thereafter declined for all cultivars.

Effect of different seed rates on yield components and yield

Appropriate seed rate by sugarcane growers often result into optimum plant population, which is the key factor in sugarcane production. Seed rates differ amongst sugarcane cultivars. Thick sugarcane cultivars require higher seed rate than thin and medium cultivars.

The result on the effect of different seed rates on cane yield components and yield (Table 2) showed that there were no significant differences noticed amongst the four seed rates. However, girth (mm), stalk population ha^{-1}and sugarcane yield differed among the cultivars. Cultivar KEN82-247 showed the thickest girth, while KEN82-62 showed the thinnest. The highest stalk population was

Table 2. Effect of seed rates on sugarcane yield components and yield.

Treatment (seedrate tha^{-1})	Stalk pop (ha^{-1})	Height (cm)	Girth (mm)	Ton of cane per ha (TCH)
3	91,167	281.3	23.4	130.9
5	88,611	269.8	23.3	122.3
7	93,333	270.6	24.3	135.6
9	93,166	261.4	24.2	123.4
Mean	**91,569.25**	**270.78**	**23.80**	**128.05**
LSD ≤ 0.05	Ns	Ns	Ns	Ns
CV%	29.2	10.3	8.3	30.7
Cultivar				
CO421	99,111	274.2	25.4	152.2
KEN 82-62	104,992	267.3	21.0	126.1
KEN82-247	79,750	282.3	26.0	126.9
KEN85-53	82,416	259.4	23.`1	107.0
Mean	**91,567.25**	**270.80**	**23.89**	**128.05**
LSD ≤ 0.05	S	Ns	S	S
CV%	29.2	10.3	8.3	30.7

Note: Ns, Not significant; S, Significant ($P \leq 0.05$)

Table 3. Effect of seed rates on cane quality.

Treatment (seedrate tha^{-1})	Pol% cane	Brix (%)	Purity (%)	Fibre content
3	14.8	18.2	81.3	14.4
5	15.1	18.3	82.5	14.2
7	15.4	19.1	80.6	14.1
9	14.9	18.3	81.4	13.9
Mean	15.05	18.48	81.45	14.15
LSD ≤ 0.05	Ns	Ns	Ns	Ns
CV%	5.6	3.4	2.8	8.9

Ns, Not significant

Table 4. Minimum cost analysis for seed rates**.**

Treatment	Cost of seedcane (Kshs)		Labour cost	Total variable cost
Seed rate (tha^{-1})	Purchase cost	Transport cost		
3	12,000	1,912.50	4,102.5	18,015.00
5	20,000	3,187.50	6,837.50	30,025.00
7	28,000	4,462.50	9,572.50	42,035.00
9	36,000	5,737.50	12,307.50	54,045.00

seen in cultivar KEN82-62 and the lowest in KEN85-53. Cultivar CO421 had the highest cane yield and KEN85-53 the lowest (Table 2).

Cane quality

Cane quality (Table 3) determined included Pol% cane, brix% cane, purity % and fibre content. No significant difference was observed among the seed rates (Table 3).

Minimum cost analysis

Since there was no significant difference in sugarcane among seed rate treatments, then the minimum cost analysis was adopted (Table 4).

DISCUSSION

Germination and tillers number

There were significant differences in germination among the cultivars. Cultivar KEN82-247 showed the best germination percentage among the four cultivars. This might be attributed to cultivar characteristics. Similarly, the tillers number differed among the cultivars at 5^{th} and 7^{th} months, with all of them being peaked at the 7^{th} MAP.

Effect of treatments on cane yield components and yield

There were no significant differences ($p \leq 0.05$) amongst the four seed rates (Table 2). This is in agreement with other researchers (Tang, 1977; Omoto et al., 2008) who reported that there was no significant difference on cane yield, when seed rates of 18,000, 20,000 and 30,000 setts ha^{-1} and seed rates of 5, 6, 7, 8, 9, 10, 11 and 12 tha^{-1} seedcane were used in Taiwan and Kenya respectively. This might be partly attributed to high mortality rates of tillers' number at higher seed rate due to lower seed rates. In addition, at lower seed rates, there might have been compensatory tillers that increased the cane tiller numbers. Tillers mortality could have been higher at high seed rate because of competition for nutrients, moisture and physiological weakness, such as weak stalks roots. This finding is in agreement with that reported by Gupta (1984). Furthermore, slanting growth of the newly emerging tillers impedes the normal functions of terminal buds and consequently the mechanism of translocation of auxins (Kanwar and Sharma, 1974). These findings concurs with those of Glazious (2001) who reported that physiological weakness, such as lack of stalk roots and poor elongation growth cause tiller mortality. Tiller mortality reduced the number of millable stalks at higher seed rate. Thus, cane yield is positively correlated with stalk number, stalk diameter and stalk length in these cultivars, Co421, KEN 82-62, KEN82-247 and KEN85-53. .This concurs with Zhou et al. (2003).

Stalk population did not differ significantly with the seed rates. This could be associated with newly emerged tillers that impeded the normal functions of the terminal buds for the establishment of sugarcane stalks at the higher seed rate. The significance was noticed among the cultivars that might be attributed to varietal traits.

Girth at harvest differed significantly among the cultivars irrespective of the seed rate (Table 2). The difference might be probably because of differences in genetic characteristics.

Conclusion and Recommendation

Since there was no significant difference between the seed rates, the minimum cost analysis was adopted. In this case, the lowest cost of 3-5 tha^{-1} was found to be most economic rates, hence recommended for sugarcane in the growth of CO421, KEN82-247, KEN82-62 and KEN85-53 in Kibos zone

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