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Early Growth, Yield and Quality of Sugarcane as Affected by Number of Buds per Sett at Wonji/Shoa Sugar Estate

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Abstract

Owing to the high cost associated with planting, planting materials deserves attention in a sugar industry thriving to be competitive in the world market and also to enhance profitability. Accordingly, an experiment was conducted in a randomized complete block design with three replications to determine the effect of number of buds per sett (one bud, two buds (control), three buds, four buds, randomly chopped setts (containing variable buds per sett) and whole stalks) on the early growth, yield and quality of two sugarcane varieties (NCo334 and B52/298) at Wonji/Shoa Sugar Estates on the plant and first ratoon crops. The analysis of variance indicated that sprouting was significantly ($p<0.05$) affected by the main effects of variety and type of planting material. Number of tillers and millable canes were affected by the main effect of variety and the interaction of variety with the type of planting materials in the plantcane, however, none of the main effects and their interaction had significant effect in the first ratoon crop. Cane yield was not affected by the main effects or their interaction in both the plant and first ratoon crops. Similarly, sucrose percent cane and estimated sugar yield in the plant crop were not affected by the main effects and their interaction, however, in the first ratoon crop the main effect of the variety were found to be significant. Therefore, it can be concluded that there is no significant difference among the type of planting materials utilized in this study.

Keywords: Plant crop; Ratoon crop; Bud; Sett; Whole stalk

Introduction

Sugarcane (*Saccharum officinarum* L.) is the main industrial crop of the world [1] and it is also the leading crop of the world in terms of production [2]. Owing to its multifarious advantages coupled with the immense potential available for its cultivation, Ethiopia has given due focused for the crop to boost production and export for world market [3]. Competitiveness is characterized by the cost of production of sugar. Among the cost incurred in sugarcane management practices, the type of planting material used is the important one. The type of planting material used confers its own advantages in terms of economic benefits [4,5].

The most common practice today is to use setts of sugarcane stalk which may have 2 to 3 buds [6], but longer setts with 4 to 6 buds or smaller single budded setts are also being used for planting sugarcane. Since, the commencement of sugar production at Wonji/Shoa, it has been a common norm to use two budded setts as a planting material, irrespective of the variety, soil type and growing condition. On the other hand, whole stalk or longer stalk pieces are planted in countries where sugarcane plantings are carried out by means of machineries for commercial cane establishment. [7], in his classical work indicated that in regions with favorable conditions, cuttings containing one to two buds can be used, while, for less favorable conditions the length of cuttings has to be increased accordingly. In line with this, at Formosa, to deter the effect of severe growing conditions cuttings having 4 and 6 buds are used.

The success of the establishment of a sugarcane crop affects the yield of that field for the whole crop cycle, which in turn depends upon number of setts and number of viable eyes per setts Among the various sugarcane management costs, planting is the most expensive operation which involves huge number of labourers in seed cane preparation, transportation and planting. Among the costlier inputs, seed is the most important one, which accounts for nearly 25% of the total operational cost [8].

Accordingly, economization of seed by altering the type of seed material (sett size) without compromising yield should be an inevitable venture for a competitive sugar industry. Therefore, present investigation was proposed to study the effect of bud number per set on early growth, yield and quality of sugarcane, under agro-ecological conditions of Wonji/Shoa sugar estate.

Materials and Methods

Site description

Wonji-Shoa is located in the Rift Valley of Ethiopia at latitude and longitude of 8°31'N and 39°12'E, respectively, with at an elevation of 1550 msl. The region has a mean maximum and minimum temperature of 26.9 °C and 15.3 °C, respectively with an annual rainfall of 800 mm. The soil of experimental field was clay in texture, moderately alkaline in reaction (7.8), low in available organic carbon (2.2%) and low in exchangeable cation (0.61meq/100 g).

Experimental design and treatments

The experiment was conducted at Wonji/Shoa sugar estate plantation fields on plant and first ratoon crops in a randomized complete block design with three replications. The experiment consisted of six types of planting materials such as single budded sett, double budded sett, three budded sett, four budded sett, randomly chopped sett (each stalk chopped into 3 pieces) and whole stalk and the sugarcane varieties (B52-298) and (NCo334). The varieties were selected based on their area coverage and yield potential. The size of

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each plot was 29 m^2 (4 furrows of 5 meters length and 1.45 meters width) and the net plot area of data collection was 14.5 m^2 (2 furrows of 5 meters length and 1.45 meters width).

Healthy stalks of 10 months of age were used for planting. End to End type of planting was used for the single bud, randomly chopped and whole stalk planting while the rest were planted in overlapping (ear-to-ear) way. The planting material were properly chopped as per the treatments and treated manually with a fungicide, Noble 250 EC (bupirimate), then placed in the planting furrow in ear to ear alignment at 30 cm depth. Urea fertilizer was applied in side dressing method at 200 kg ha^{-1} (92 kg N) for plant crop at age of two and half months after planting and at 400 kg ha^{-1} (184 kg N) rate for first ratoon crop at age of one month after ratooning. The field was irrigated fortnightly starting from planting date. All other agronomic practices were kept uniform for all treatments in the course of the experiments. The first crop (plant cane) was planted on December 1, 2009 and harvested on April 11, 2011. Then the first ratoon crop experiment continued and harvested on June 12, 2012.

Data collection and Measurements

Data were collected for all agronomic parameters from the middle two rows. Number of planting material as setts and counting of buds was conducted at planting from the middle furrows. The number of buds present in each planting material and the total planting material utilized in the two middle furrows were counted. Sprouting percentage was determined as the ratio of number of buds sprouted to the total number of buds planted multiplied by 100. Number of tillers per plot was recorded at four months of cane age from the middle two furrows and the values obtained were converted to hectare basis.

Number of millable canes in each experimental unit was counted at harvest from the middle two furrows and the values obtained were converted to hectare basis. Average stalk height was determined at harvest from twenty randomly selected stalks from the middle furrow by measuring the distance from the bottom end to the top visible dewlap (TVD) and then the average stalk height value was determined. Stalk girth was determined at harvest by measuring the cane thickness of each stalk drawn for stalk height measurement at the top, middle and bottom part using Vernier Calliper, and then the average value of the top, middle and bottom values were taken.

Cane yield was determined at harvest from the middle two rows and weighed using balance and then converted to per hectare basis. Sugarcane quality parameters (Brix%, Pol% and Purity %) was determined from the juice extracted from 10 stalk samples using a Jeffco mill. Percent recoverable sucrose was calculated using Winter Carp indirect method of cane juice analysis as described by Kassa [9]. Estimated commercial sugar yield (ECS) was calculated as the product of the sucrose percent cane and cane yield per hectare.

Data analysis

Data was analyzed using SAS General Linear Model (GLM) procedure (SAS Institute, 2002). Comparisons among treatments with significant differences for the measured and counted parameters were based on Tukey's Test.

Results and Discussion

Weather condition during the study period

A total rainfall of 958.6 and 779.7 mm were recorded during the study periods of the plant and first ratoon crops, respectively. In both the study periods the distribution was not even and maximum rainfall of 185.9 and 206.5 mm was recorded in July 2010 and September 2011, in the plant and first ratoon crops study periods; respectively. The mean maximum temperatures were 27.9 and 28.4°C, while the mean minimum temperatures were 13.3 and 13.5°C, in the plant and first ratoon crops study periods, respectively Figure 1.

Effect of variety and number of buds per sett on sprouting, tillering and millable stalks and weight per stalk

The analysis of variance for sprouting revealed that it was significantly ($p<0.05$) affected by the main effects of variety and number of buds, however, their interaction was not significant (Table 1). The variety B52-298 was significantly ($p<0.05$) superior for sprouting percentage than that of NCo334 (Table 2).

The difference in sprouting was due to the innate genetic difference between the varieties. In line with this, [10] also reported difference in sprouting among these varieties. The types of setts also differed significantly in sprouting (Table 2) and three budded sett was found to give a significantly ($p<0.05$) higher sprouting than randomly chopped setts, while it was statistically on par with the rest (Table 2). Several workers have reported that the size of planting material (having varied number of buds) influence the sprouting of cane [11,12].

Number of tillers and millable canes were affected by the main

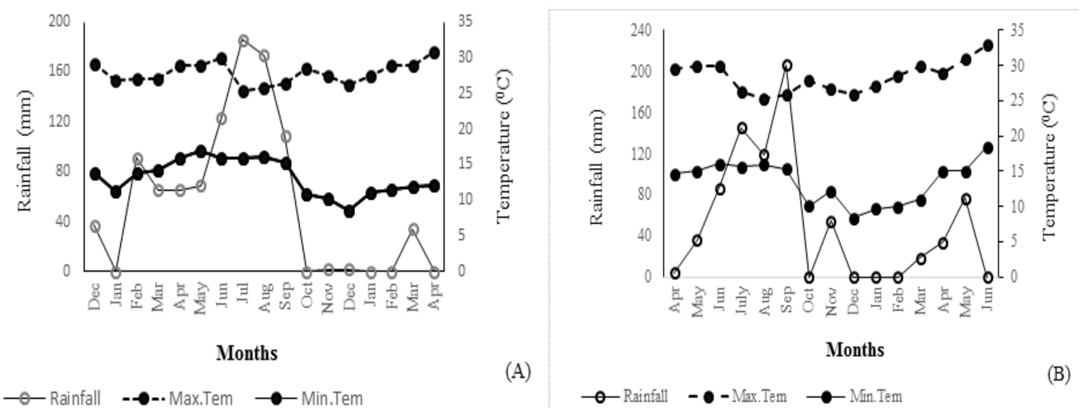

Figure 1: Monthly total rainfall distribution and the mean maximum and minimum temperature variations during the study period of plant cane crop from December 2009-April 2011 (A) and first ratoon crop from April 2011 to June 2012 (B) at Wonji/Shoa, Ethiopia.

effect of variety and the interaction of variety with number of buds in the plant crop (Table 1). However, in the first ratoon none of the main effects as well as their interactions was significant (Table 1). The varieties were significantly different from each other for number of tillers NCo334 had the highest tiller while B52-298 had the lowest (Table 3). B52-298 had maximum number of tillers (289.9) from two budded setts planting material though it was not statistically different from three budded sett and whole stalk planting. However, planting of single bud, four bud sett and randomly chopped setts gave a significantly lower number of tillers than two and three bud sett planting, but they were statistically on par with whole stalk planting (Table 3). The variety NCo334, recorded significantly highest number of tillers from randomly four bud sett planting (293.1) which did not differ statistically from all type of planting material except two buds set planting (Table 3).

Weight per stalk was significantly affected by variety but not by bud number of setts and the interaction of the treatments in both plant and first ratoon crops. There was a highly significant ($P<0.01$) difference among the two varieties in weight per stalk (Table 1). The highest weight per stalk was recorded from B52-298 while the lowest was recorded from NCO-334 (Table 2). Similarly, [4] found significant difference among different sugarcane genotypes in weight per stalk. The present finding is in conformity with results reported by Abiy et al. [13].

The mean number of millable canes recorded for NCo334 was superior to B52 298 (Table 4). The varieties differed in response to the number of buds per sett and number of buds per sett didn't affect number of millable canes in the case of B52 298.

On the other hand, for NCo334, the number of millable canes formed across the different types of planting material was significant and planting of three bud set planting resulted in a significantly highest number of millable canes than all except one bud sett planting which was not statistically different (Table 4).

In general, varieties differed in response to the number of buds per sett used. Contrary to this [5] in a study conducted at Metahara reported that sett type didn't affect the number of millable canes of the variety NCo334 across the four sett types (2 bud, 3 bud, 4 bud and 5 bud) considered.

Effect of variety and number of buds per sett on cane yield, sucrose percent and estimated sugar yield

Cane yield and sucrose (%) were not affected by the main effects as well as by their interaction in both the plant and first ratoon crop. Similarly, estimated sugar yield in the plant cane was not affected by the main effects and their interaction, however, in the first ratoon crop the main effect variety was found to be significant (Tables 1 and 5).

Though there was conspicuous difference in number of millable canes formed across number of bud types used in the variety NCo334 (Table 4), it was not reflected on yield. This might have been due to the fact that sugarcane compensated by efficient utilization of the space in the less populated cane through increased weight [14].

	Sprouting (%)	Number of tillers (000 ha^{-1})		Number of millable canes (000 ha^{-1})		Weight per stalk (Kg)		Cane Yield (t ha^{-1})		Sucrose (%)		ESY (t ha^{-1})	
	PC	PC	RI	PC	RI	PC	RI	PC	RI	PC	RI	PC	RI
Variety (V)	*	**	ns	**	ns	**	**	ns	ns	ns	**	ns	**
Number of buds (B)	*	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
V x B	ns	*	ns	*	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV	17.4	14.7	9.6	7.9	14.1	16.77	22.9	13.4	12.4	3.5	4.14	15.5	13.0

PC=plantcane RI = first ratoon

Table 1: Analysis of variance for the main and interaction effects of variety and number of buds on sprouting , number of tillers, number of millable canes, weight per stalk, Cane yield, Sucrose (%) and estimated sugar yiedof Plant cane and First Ratoon experiments at Wonji-Shoa from 2009-2012.

Treatment	Sprouting (%)	Number of tillers (000 ha^{-1})	Number of millable canes (000 ha^{-1})	Weight per stalk (Kg)	
	PC	RI	RI	PC	RI
Variety					
B52-298	69.4 a	268.8	123.4	1.72a	1.58 a
NCo334	60.4 b	285.6	129.8	1.15b	0.86 b
LSD (5%)	7.81	ns	ns	0.17	0.19
SE (±)	2.66	26.7	17.9	0.06	0.08
Number of buds					
One budded	70.55 ab	270.0	130.2	1.41	1.27
Two Budded	60.70 ab	274.5	128.4	1.42	1.17
Three Budded	73.67 a	286.1	132.9	1.57	1.35
Four Budded	66.90 ab	277.7	115.1	1.39	1.17
RCS	51.77 b	282.9	121.0	1.42	1.08
Whole Stalk	65.65 ab	272.0	132.0	1.38	1.30
LSD (5%)	20.32	ns	ns	ns	ns
SE (±)	4.61	26.7	17.9	0.06	0.08
CV (%)	17.4	9.6	14.1	16.77	22.9

Note: RCS = randomly chopped sett PC=plantcane RI = first ratoon

Table 2: Effects of sugarcane varieties and number of buds per sett on the sprouting, number of tillers, millable canes and weight per stalk at Wonji/Shoa in 2009 to 2011.

Varieties (V)	Number of buds (B)						Mean
	One Bud	Two Bud	Three Bud	Four Bud	RCS	Whole Stalk	
B52298	223.7 c	289.9ab	249.0abc	206.4 c	210.4 c	245.0 bc	237.4 b
NCo334	283.7 ab	222.1 c	281.8 ab	293.1 a	283.2 ab	269.7 ab	272.3 a
Mean	253.7	256.0	265.4	249.8	246.8	257.4	
LSD ($p<0.05$): **V** = 25.83; **B** = 20.32; **V x B** = 45.86 **SE** (±) = 21.57 **CV** (%) = 14.7							

Note: RCS = randomly chopped sett.

Table 3: Interaction effects of sugarcane varieties and number of buds per sett on number of tillers (000/ha) formed in plant cane of sugarcane at Wonji/Shoa in 2009-2011.

Varieties (V)	Number of buds (B)						Mean
	One Bud	Two Bud	Three Bud	Four Bud	RCS	Whole Stalk	
B52298	115.9 e	120.0 e	112.0 e	116.3 e	113.0 e	116.7 e	115.6 b
NCo334	180.4 ab	147.5 d	182.3 a	167.2 bc	147.9 d	156.4 cd	163.6 a
Mean	148.1 a	133.8 a	147.1 a	141.7 a	130.5 a	136.5 a	
LSD ($p<0.05$): **V** = 7.6; **B** = 19.76; **V x B** = 13.40 **SE** (±) = 6.34 **CV** (%) = 7.9							

Note: RCS = randomly chopped sett.

Table 4: Interaction effects of sugarcane varieties and number of buds on number of millable of plant canes of sugarcane at Wonji/Shoa in 2009-2011.

Treatment	Cane Yield (t/m/ ha^{-1})		Sucrose (%)		ESY (t/m/ ha^{-1})	
	PC	RI	PC	RI	PC	RI
Variety						
B52-298	14.96	17.7	12.0	11.2	1.79	2.11 a
NCo334	14.48	16.4	12.2	10.7	1.77	1.87 b
LSD (5%)	ns	ns	ns	ns	ns	0.18
SE (±)	1.97	2.11	0.43	0.46	0.28	0.26
Number of buds						
One budded	13.55	16.46	11.80	11.15	1.60	1.94
Two Budded	15.15	17.49	12.20	10.99	1.85	2.04
Three Budded	15.55	18.24	12.31	11.15	1.92	2.16
Four Budded	15.15	16.11	12.28	10.96	1.86	1.88
RCS	14.41	16.89	11.80	10.67	1.72	1.91
Whole Stalk	14.50	17.00	12.11	11.00	1.76	1.94
LSD (5%)	ns	ns	ns	ns	ns	ns
SE (±)	1.97	2.11	0.43	0.46	0.28	0.26
CV (%)	13.4	12.4	3.5	4.17	15.5	13.0

Note: ESY = estimated sugar yield; RCS = randomly chopped sett.

Table 5: Effects of sugarcane varieties and number of buds per sett on the cane yield, sucrose% and estimated sugar yield (ESY) at Wonji/Shoa in 2009 to 2012.

Conclusion

The current result indicated that there is no significant difference among the type of plant material used in the study. The current results illustrated that there is no additional advantage by the use of chopped canes as planting material in terms of cane and sugar yield. Practically, it is two or three budded setts used as a planting material at Wonji. Based on this result, it is vital to verify the planting materials (Four buds, randomly chopped cane and whole stalk) as a planting material in the plantation. The use of single budded sett planted in end to end method in this study, though resulted in a similar yield to the control (two budded overlapping planting) and the rest the of treatments, practically it is valuable to evaluate the rest planting materials under field condition for their economic advantages against the present two budded set planting. This study was conducted on heavy (clay) soil only; therefore, future work is envisaged to evaluate the performance of these planting materials in other soil types of the plantation area to understand the varietal response and plant material.

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