Full Length Research Paper

Effect of Planting Density on Yield and Yield Components of Sugarcane at Wonji-Shoa

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An experiment was conducted at Whonji-Shoa Sugar Estate plantation from 2005-2008 to determine the effect of four intra-row sett spacing [10 cm between setts, 5 cm between setts, setts placed end-to-end, and setts placed ear-to-ear (5 cm overlapping)] on the performance of three sugarcane varieties (B52298, NCo334 and N14). The experiment was carried out on clay loam textured soil on plant cane and first ratoon crops in a split plot design. Analysis of variance revealed that the parameters stalk weight, number of millable canes, cane yield, sucrose percent cane and estimated sugar yield were significantly (p<0.01) affected only by the main effect of variety in both the plant and ratoon crops, however, the main effects of spacing as well as the interaction of variety and intra-row spacing were not significant. Therefore, 10 cm intra-row spacing between setts was found to be best to use since it economizes planting material of all three sugarcane varieties without compromising both cane and sugar yields.

Keywords: Ear-to-ear; intra-row; plant cane crop; ratoon; sett spacing and Wonji.

INTRODUCTION

Sugarcane (Saccharum officinarum L.) is a vegetatively propagated crop. The yield of sugarcane is greatly affected by different factors. Among these, lack of study based planting population is the important one (Muhammad, 2007). Establishing an optimum plant population in any crop is vital for achieving maximum production and sugarcane is not an exception. The yield of sugarcane partly depends on the initial stand density of primary shoots and their tillers onwards. These, in turn, are influenced by the number and quality of setts planted (Kakde, 1985). According to Collins (2002), plant density is a function of inter and intra-row spacings.

Using a large number of setts per furrow results in a very strong competition among the main shoots, which in turn, reduces the number of tillers per each planting material (Verma, 2004). Moreover, the use of large number of planting materials impose high cost to the sugar estates resulting in shortage of planting materials to cover annually planted commercial fields. The use of large number of planting material also forces the estates to allocate large area of land for seed cane production, which competes for fertile land that would have been used for production of crop for milling.

Currently, Wonji-Shoa Sugar Estates use ear-to-ear (5 cm overlapping) alignment of two budded setts within furrow at the time of planting and even more denser in fear of sprouting failure due to limited research in this area. However, setts can be placed in furrows in either end-to-end (but-to-but) or ear-to-ear alignment (Onwueme and Sinah, 1991). Furthermore, setts can be aligned within furrow by leaving a space of some centimeters (Tsehay, 1993; Worku, 2001). According to Girma (1997), a trial conducted at Finchaa with the objective to study the effect of different planting densities (5 cm overlapping, end-to-end, double and double + end-to-end alternatively) for the varieties B41-227, B52-298, Co449 and NCo334 in plant cane indicated that the four planting densities showed non-significant differences on the main sugarcane yield parameters and the ultimate sugar yield. Furthermore, the study indicated the possibility of reducing the amount of seed cane from 21-33%, by shifting from the 5 cm overlapping to end to end (but-to-but) alignment.

An experiment conducted on plant cane crop on two...
soil types at Wonji-Shoa using three varieties (B52298, B41227 and NCo334) and five different sett spacings (10 cm overlapping, 5 cm overlapping, end-to-end, 5 and 10 cm spacing between setts) indicated that there was significant differences among the varieties in most of the characters studied although none of the intra-row spacings of setts resulted in significant difference in cane and sugar yield (Tsehay, 1993). However, this study didn’t show the repercussion of low density planting on the next crop.

Sugarcane has a high compensating ability to maintain potential yield under different cases of spacing and population density (Netsanet et al, 2014). It is an established fact that the ultimate objective of cane cultivation is to achieve high yield of sugar with a minimal cost of production, as a result cost effective crop management requires implementation of sound cultural practices. Among these, optimization of planting material is the most essential one. Therefore, this proposal was initiated to determine optimum intra-row setts spacing for three sugarcane varieties at Wonji-Shoa Sugar Estate.

MATERIALS AND METHODS

Site Description

Wonji-Shoa is located in the Rift Valley of Ethiopia at an altitude and longitude of 8º31’N and 39º12’E, respectively, with an elevation of 1550 masl. The area has a mean maximum and minimum temperature of 26.9 and 15.3°C, respectively with annual rainfall of 800 mm.

Treatments and Design

The treatments consisted of five intra-row spacings [10 cm between setts, 5 cm between setts, setts placed end to end, setts placed ear-to-ear (5 cm overlapping) and setts placed ear-to-ear (10 cm overlapping)]. The penultimate spacing mentioned here was used as a check. The sugarcane varieties used were B52298, NCo334, and N14. The study was carried out on clay loam textured soil on plant cane and first ratoon crops. The sugarcane varieties were selected based on their yielding potential and area coverage.

The experimental design was split-plot with three replications. The main plots and sub plots were sugarcane varieties and intra-row spacings of setts, respectively. Area of each experimental plot 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 for planting. The setts were planted in furrows at 30 cm depth. UREA was applied for the plant cane manually at 2.5 months after planting at a rate of 200 kg ha⁻¹.

Data collection

Millable canes in each plot were counted before harvesting from the net plot area and then converted to the hectare bases. Cane weight measurement was taken from 50 sample stalks randomly from the middle two rows. Measurement was made using suspension balance. Cane yield per hectare was determined from the cane yield obtained from the middle rows.

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, data were 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 Studentized Range (HSD) Test.

RESULTS AND DISCUSSION

Anova for the effect of intra-row spacing on yield and yield components of sugarcane

Analysis of variance revealed that stalk weight, cane yield, sucrose percent cane and estimated sugar yield were significantly (p<0.01) affected only by the main effect of variety in both the plant cane and first ratoon; however, millable cane was affected by variety main effect in plant cane (Table 1, 2 and 3). However, for all the parameters, the main effect intra-row spacing as well as the interaction of variety and intra-row spacing were not significant in plant cane as well as in the first ratoon (Table 1, 2 and 3).

The difference among varieties in the parameters considered except for millable canes in the first ratoon indicates the presence of genotypic variation. In agreement with this different studies reported the presence of variation among genotypes in stalk weight, number of millable canes, cane yield, sucrose percent cane and estimated sugar yield (Orgeron et al., 2007; Tsehay, 1993; Worku and Chinawong, 2006; Yousaf et al., 2002).
Table 1. Analysis of variance for the main and interaction effects of variety and intra-row spacings at Wonji-Shoa from 2005-2010.

<table>
<thead>
<tr>
<th>Variety (V)</th>
<th>Spacing (S)</th>
<th>V x S</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>**</td>
<td>ns</td>
<td>ns</td>
<td>6.61</td>
</tr>
</tbody>
</table>

** = significant at p < 0.01; * = significant at p< 0.05; ns = non-significant. PC = Plant crop; RI= First ratoon; m = month; V = Variety; S = spacing.

Table 2. Analysis of variance for the effect of variety and sett spacing on stalk weight, millable canes, cane yield, sucrose (%) and estimated sugar yield on plant crop at Wonji on light soil from 2005-2007

<table>
<thead>
<tr>
<th>Variety</th>
<th>Stalk Weight (kg)</th>
<th>Millable canes (000 ha(^{-1}))</th>
<th>Cane yield (t ha(^{-1}) m(^{-1}))</th>
<th>Sucrose (%)</th>
<th>ESY (t ha(^{-1}) m(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>B52-298</td>
<td>1.82 a</td>
<td>152.89 a</td>
<td>13.01 a</td>
<td>15.05 a</td>
<td>1.96 a</td>
</tr>
<tr>
<td>NCo334</td>
<td>1.46 c</td>
<td>162.64 a</td>
<td>11.13 b</td>
<td>14.57 a</td>
<td>1.62 b</td>
</tr>
<tr>
<td>N14</td>
<td>1.57 b</td>
<td>137.10 b</td>
<td>10.06 b</td>
<td>14.35 b</td>
<td>1.34 c</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>0.096</td>
<td>13.73</td>
<td>1.16</td>
<td>0.891</td>
<td>0.199</td>
</tr>
</tbody>
</table>

Means followed by the same letter in a column are not significantly different from each other; ESY= estimated sugar yield.


<table>
<thead>
<tr>
<th>Variety</th>
<th>Stalk Weight (kg)</th>
<th>Millable canes (000 ha(^{-1}))</th>
<th>Cane yield (t ha(^{-1}) m(^{-1}))</th>
<th>Sucrose (%)</th>
<th>ESY (t ha(^{-1}) m(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>B52-298</td>
<td>0.854 a</td>
<td>116.05</td>
<td>7.86 a</td>
<td>15.25 a</td>
<td>1.153 a</td>
</tr>
<tr>
<td>NCo334</td>
<td>0.707 b</td>
<td>118.41</td>
<td>6.39 b</td>
<td>14.61 ab</td>
<td>0.931 b</td>
</tr>
<tr>
<td>N14</td>
<td>0.793 a</td>
<td>117.02</td>
<td>7.07 ab</td>
<td>14.05 b</td>
<td>0.993 b</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>0.078</td>
<td>ns</td>
<td>0.913</td>
<td>1.054</td>
<td>0.150</td>
</tr>
</tbody>
</table>

Means followed by the same letter in a column are not significantly different from each other; ESY= estimated sugar yield.

The effect of intra-row spacing on stalk weight was not significant in both crops (plant cane and first ratoon) (Table 1 and 2). Similar to this finding, Tsehay (1993) reported the absence of difference among five intra-row spacings (10 cm overlapping, 5 cm overlapping, end-to-end, 5 and 10 cm spacing between setts) in cane weight.
Millable canes was not significantly affected by the effect of intra-row spacing in both crops (plant cane and first ratoon) (Table 1, 2 and 3). Contrary to the current finding, Netsanet et al. (2014) reported that intra-row spacing influenced number of millable canes formed in plant cane crop at Finchaa. This might have been due to the presence of moulding operation at Wonji-Shoa which diminished the tiller produced in the early period consequently, the effect reflected in the formation of more or less similar population. According to Sundara (2000), moulding (earthing up) checks formation of further tillers.

In general, the cane yields obtained from the widely and densely spaced planting were in statistical parity (Table 3). Previous studies conducted at the Wonji-Shoa and Finchaa Sugar Estates in Ethiopia revealed a similar result (Tsehay, 1993; Worku, 2001; Netsanet et al, 2012; Netsanet et al, 2014). This means a widely-spaced planting compensates for the low stalk population. The presence of sufficient incident sunlight might have resulted in high photoassimilate production and partitioning of dry matter during the heavy tillering and root proliferation in the wider spaced planting, thereby avoiding diversion of carbohydrate away from the stalks. This may be attributed to the phenomenon that where sunlight quality and intensity are limiting, cane yield reductions arise due to the diversion of photosynthate away from the primary stalks. It is for this reason that high density planting is practiced in some countries (Amolo and Abayo, ND; Nayamuth and Koonjah, 2003).

Similarly, sucrose percent cane was affected only by the main effect of variety (Tables 1, 2 and 3). This result corroborates that of Sundara (2003) who reported that sett spacing did not affect sucrose content. Corroborating the results of this study, previous experiments conducted at the Wonji-Shoa Sugar Estate also indicated that can sucrose percent was not affected by sett spacing (Tsehay, 1993).

CONCLUSION

The results of this study revealed that sett spacing influenced neither cane yield nor sugar yield. Therefore, it is recommended that Wonji-Shoa Sugar Estate should use the intra-row spacing of 10 cm between sets for all three varieties instead of the conventional ear-to-ear 5 cm overlapping intra-row sett spacing that the Estate is currently using. This is because the spacing of 10 cm between sets ensures economy of planting material without sacrificing both cane and sugar yields.

REFERENCES


