EFFECT OF PLANTING PATTERN AND NUTRIENT MANAGEMENT ON YIELD OF SPRING PLANTED SUGARCANE

MOHAMMAD SAJJAD¹, ABDUL BARI², MOHAMMAD NAWAZ² and SHAHID IQBAL¹

1 Sugar Crops Research Institute, Mardan - Pakistan
2 Cereal Crops Research Institute, Pirsabak, Noshera - Pakistan

ABSTRACT

Row spacing and nutrient management have a key role in maximizing sugarcane yield and improving its quality. A field experiment was conducted to investigate the performance of sugarcane variety, CP-77/400 to row spacing with different fertilizer levels at Sugar Crops Research Institute Mardan, Khyber Pakhtunkhwa, during 2005-06. The experiment was comprised of two row spacing (135 cm spaced single row, 75 cm spaced double row strips) and two fertilizer levels (recommended dose, 190-80-50 kg NPK ha⁻¹; 2-times recommended dose). The maximum cane length (203.00 cm) was achieved in dual row strips planting while minimum cane length (184.00 cm) was recorded at single row planting. The same cane length (193.5 cm) was obtained from both standard and double NPK fertilization. The maximum cane diameter (2.49 cm) was achieved from single rows while minimum cane diameter (2.31 cm) was recorded in dual row strips planting. Cane diameter did not differ between double NPK application and the standard application. The maximum number of millable canes m⁻² (8.48) was produced with dual row strips whereas the minimum number of millable canes m⁻² was recorded at single row plantation. Fertilization treatments did not differ for millable canes m⁻² or cane yield. The Maximum cane yield (57.84 t ha⁻¹) was recorded with dual row strips while minimum cane yield (32.77 t ha⁻¹) was obtained at single row plantation. The commercial cane sugar percentage was higher (13.45%) with dual row planting compared with single rows (12.84%). The NPK application had no effect on commercial cane sugar percentage. Dual row spacing effected maximum sugar yield (7.74 t ha⁻¹) while minimum sugar yield (4.21 t ha⁻¹) was obtained at single rows, however, NPK application had no effect on sugar yield.

Key words: Planting Pattern, nutrient management


INTRODUCTION

Sugarcane (Saccharum officinarum L.) is an important and highly valuable cash crop in Pakistan. It plays an important role in the economic success of growers and country. In Pakistan sugarcane is cultivated on an area of about 0.99 million hectares with total production of 55.31 million ton of cane with an average cane yield of 56.0 t ha⁻¹ (MINFAL, 2010-11). The average cane yield per hectare in our country is lower as compared to other sugarcane growing countries of the world (GOP, 2010).

Several factors are responsible for the yield gap. Poor agronomic management practices and imbalanced nutrition are the key factors. Quality parameters of cane juice are genetically controlled but these are also affected by agronomic practices and nutrient management (Ahmad et al., 2003). According to Thomas et al. (1977), narrow spacing significantly increased pol, brix, and purity of juice. Among the agronomic practices, lower cane yield are due to improper nutrient management and planting geometry (Suggu, 2010). Hence there is a need to develop an appropriate production technology of sugarcane particularly in relation to optimum row spacing and proper fertilizer application.

High density planting (HDP) is one of the practices being used to overcome low productivity. Increased yield due to high plant population; efficient use of land, inputs, sunlight; lower weeds infestation due to thick canopy; higher operational efficiencies like harvesting and trickle irrigation; lower harvesting losses; reduced stool damage and soil compaction, are the major advantages of HDP. While redesigning of existing machinery to cope with the new requirements and problems during operation in the hilly areas are some of the demerits of this new technology (Aitken, 1999).

Khandaga et al. (2005) found that the 120 cm row (dual row) spacing produced higher cane yield (123.4 tons ha⁻¹) than conventional 90 cm row (single row) spacing. Sing and Sing (1984) reported that sugarcane grown in 90 cm (single row) spaced rows had slightly higher sucrose content and available sugar than that grown in 60 cm (dual row) spaced rows. Hardwood and achieved 20-25% more yield than that from the conventional method (Lindale,
1998). Row spacing had no significant effect on commercial cane sugar percentage and total sugar yield of cane in work by Malik et al. (1999) and Ali et al. (1996). On the contrary, other scientists have reported higher sugar yield at narrow row spacing than wider rows (El Geddawy et al., 2002). As regards nutrient management, Ali et al. (2000) recorded the maximum sugar yield at 250-112-112 kg NPK ha\(^{-1}\) whereas Sarwer et al. (2000) did not observe any significant effect of different NPK levels on commercial cane sugar percentage.

The present study was conducted to measure the impact of different spatial arrangements and nutrient levels on the qualitative traits of sugarcane under the agro-climatic condition of Mardan, Pakistan.

MATERIALS AND METHODS

A field experiment was conducted to evaluate effects of dual row planting and different doses of NPK application on cane yield and juice quality of spring planted sugarcane cultivar, CP-77/400, at Sugar Crops Research Institute, Mardan, Khyber Pakhtunkhwa during 2005-06. The crop was planted in April, 2005 in a split plot design. Cropping pattern was treated as the major factor and assigned to main plots, while NPK was the minor factor, allotted to sub plots. The net plot size was 24m\(^2\) with four replications. The cropping pattern comprised single-row planting (conventional planting) and dual-row planting (new planting) while the NPK application was the recommended dose (190-80-50 kg NPK ha\(^{-1}\)) and two-times of the recommended dose. The crop was planted in 75 cm spaced double-row strips with 60 cm spacing within the strip and single rows 135 cm apart, during the 1st week of April 2005 and harvested in the second week of February, 2006. In the dual-row planting, three rows were accommodated in 135 cm (60 cm + 75 cm) space, compared with two rows within the same space in the single-row planting. The entire dose of P, half of N and K, were applied at the time of sowing in the form of diammonium phosphate (DAP), urea and potassium sulphate (SOP) respectively, while the remaining P and K were applied after earthing up - at the start of cane formation.

Uniform agronomic practices were carried out in all the treatments. Observations on desired traits viz, stalk length (cm), stalk diameter (cm), millable cane (no. ha\(^{-1}\)), CCS (%), sugar yield (t ha\(^{-1}\)), cane yield (t ha\(^{-1}\)). The data collected were statistically analyzed by using Fisher’s analysis of variance and the treatment means were compared by LSD test at 5 % probability level (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Stalk Length

Dual row planting had a significant effect on stalk length which averaged from 184 to 203 cm. These results are in agreement with those of Ehsanullah et al., (2011) who recorded maximum cane length (232 cm) in 90 cm spaced double row strips while minimum cane length was recorded in 60 cm spaced single rows. The application of NPK in different rates had no significant effect on this trait (Table 1). The interaction between row spacing and fertility treatments was significant. Comparatively high stalk lengths (208 and 198 cm) were recorded in dual row x normal fertilizer dose and dual row x double fertilizer interactions, respectively (Table 2).

Table 1. Yield and yield components of sugarcane variety CP-77/400 as affected by different planting patterns and nutrient management during 2005-06 at SCRI Mardan.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stalk length (cm)</th>
<th>Stalk diam (cm)</th>
<th>Millable cane /m(^2)</th>
<th>Stripped cane (t ha(^{-1}))</th>
<th>CCS (%)</th>
<th>Sugar Yield (t ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Row Spacing (S)</td>
<td>S1</td>
<td>184.00</td>
<td>2.49</td>
<td>5.20</td>
<td>32.77</td>
<td>12.84</td>
</tr>
<tr>
<td>S2</td>
<td>203.00</td>
<td>2.31</td>
<td>8.48</td>
<td>57.84</td>
<td>13.45</td>
<td>7.74</td>
</tr>
<tr>
<td>LSD at P ≤ 0.05 for S</td>
<td>18.38</td>
<td>0.10</td>
<td>3.02</td>
<td>5.90</td>
<td>0.56</td>
<td>0.88</td>
</tr>
<tr>
<td>B. Fertilizer Rate (F)</td>
<td>F1</td>
<td>193.50</td>
<td>2.39</td>
<td>6.73</td>
<td>44.89</td>
<td>13.06</td>
</tr>
<tr>
<td>F2</td>
<td>193.50</td>
<td>2.41</td>
<td>6.98</td>
<td>45.72</td>
<td>13.23</td>
<td>6.07</td>
</tr>
<tr>
<td>LSD at P ≤ 0.05 for F</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

S1= 135 cm spaced single row
S2= 75 cm spaced dual row strips
F1= Normal fertilizer dose (190-80-50 NPK kg ha\(^{-1}\))
F2= 2 times normal fertilizer dose

Stalk Diameter

Row spacing had significant effect on stalk diameter. Comparatively thicker stalks (2.50 cm) were observed in...
single rows while thinner stalks (2.31 cm) were recorded in the dual row strips (Table 1). On the contrary, Ehsanullah et al., (2011), reported maximum stalk diameter in double row strips (2.27 cm) while minimum stalk diameter (2.26 cm) was found in the single rows. The different trends can be attributed to difference in the genetic material and the environments where the studies were conducted. Application of NPK in different rates had no significant effect on stalk diameter. There was no significant difference among the means for stalk diameter.

Table 2. Row spacing x fertilizer interaction effect on yield and yield components of sugarcane variety CP-77/400 as affected by row spacing and nutrient management during 2005-06 at SCRI, Mardan.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Stalk length (cm)</th>
<th>Stalk diameter (cm)</th>
<th>Millable cane /m²</th>
<th>Stripped cane (t ha⁻¹)</th>
<th>CCS (%)</th>
<th>Sugar Yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 F1</td>
<td>179.00</td>
<td>2.45</td>
<td>5.19</td>
<td>32.67</td>
<td>12.62</td>
<td>4.13</td>
</tr>
<tr>
<td>S1 F2</td>
<td>189.00</td>
<td>2.53</td>
<td>5.22</td>
<td>32.87</td>
<td>13.05</td>
<td>4.30</td>
</tr>
<tr>
<td>S2 F1</td>
<td>208.00</td>
<td>2.34</td>
<td>8.22</td>
<td>57.11</td>
<td>13.49</td>
<td>7.62</td>
</tr>
<tr>
<td>S2 F2</td>
<td>198.00</td>
<td>2.28</td>
<td>8.74</td>
<td>58.57</td>
<td>13.41</td>
<td>7.85</td>
</tr>
</tbody>
</table>

S1F1=135 cm spaced single row + normal NPK kg ha⁻¹  
S1F2=135 cm spaced single row + 2 times normal NPK kg ha⁻¹  
S2F1=60/75 cm spaced dual rows + normal NPK kg ha⁻¹  
S2F2= 60/75 cm spaced dual rows + 2- times normal NPK kg ha⁻¹

**Millable Cane**

Data given in Table 1 revealed that number of millable canes m⁻² differed significantly between two row patterns under study. Higher number of millable canes m⁻² (8.48) was recorded in dual-row planting compared with conventional planting (5.20). Different number of millable canes per unit area at different planting patterns has also been reported by Nazir et al. (1988) and Bashir (1997).

Application of NPK in different rates had no significant effect on number of millable canes m⁻². Interactions dual row x normal fertilizer dose and dual row x double fertilizer gave higher number of millable canes compared with the rest of interactions (Table 2). These results are in agreement with those reported by Nazir et al. (1999) while evaluating influence of seeding density and nutrient management on morpho-qualitative traits of autumn planted sugarcane.

**Stripped Cane Yield (t ha⁻¹)**

Planting patterns significantly affected the stripped cane yield. Maximum cane yield (57.84 t ha⁻¹) was recorded from dual row strips (Table 1). Ehsanullah et al. (2011) also observed similar results while optimizing the row spacing and seeding density to improve yield and quality of sugarcane. Lindale (1998) reported 20-25% increase in cane yield by keeping row-to-row distance 0.5 m in dual-rows, and distance in the their centers, 1.8 m. Application of different doses of NPK had no significant effect on stripped cane yield (Table 1). This indicated that sugarcane variety CP-77/400 did not significantly respond to excessive fertilizer application than the recommended dose of NPK. These results are not in consonance with those reported by Nazir et al. (1987) and Afghan (1997). Maximum cane yield (57.11, 58.57 t ha⁻¹) were obtained from R2xN1 and R2xF2 interactions.

**Commercial Cane Sugar (CCS)**

The CCS percentage indicates the magnitude of sugar recovery and it is directly proportional to the sucrose content in cane juice. Planting patterns influenced the CCS% significantly which on average varied from 12.84 to 13.45 %. These results are in disagreement with those of Maqsood et al., (2005) while comparing productivity performance of sugarcane sown in different planting patterns at farmer’s field. Similarly, Bull et al. (1999) observed little or no impact of planting patterns on CCS% during the trial. There were no significant differences between different fertilizer rates. The non-significant differences between different fertilizer rates were probably attributed to almost uniform maturity of cane in all treatments.

**Sugar Yield (t ha⁻¹)**

Planting patterns significantly affected the sugar yield (Table 1). The maximum sugar yield (7.74 t ha⁻¹) was recorded from dual row strips. Similarly, Ehsanullah et al. (2011) reported significantly high sugar yield from 90 cm spaced dual row strips. Fertilizer doses did not affect sugar yield significantly. Dual row x normal fertilizer and dual row x double fertilizer interactions gave maximum sugar yield (7.62, 7.85 t ha⁻¹) as compared with rest of the interactions.
CONCLUSIONS AND RECOMMENDATION

Increase in yield was achieved with dual row planting. Besides, improvement in other agronomic traits was also recorded with this new technology. Maximum cane length, cane diameter, millable canes, stripped cane yield, commercial cane sugar percentage and sugar yield were recorded with dual row strips while maximum cane length was obtained from single rows. Moreover, close and thick crop canopy discouraged weed infestation which resulted into high yield and better quality. Though, improvement in all evaluated traits except cane length, was observed with double fertilizer dose, however, the differences were non-significant. It indicates that by manipulating row spacing, no extra inputs are required to the crop if the recommended NPK requirements are provided.

The overall performance achieved under dual row planting was encouraging and it must be attained importance in future while maximizing sugarcane production. Though yield achieved during the instant study (spring-planting) is comparatively lower than September-planting due to short growth period. However, 30-32% increase in cane yield is possible if planting is shifted to September from March.

REFERENCES


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