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Response of Fourth Ratooning of Sugarcane to Different Patterns of Plantation and Seeding Densities

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Abstract: Planting pattern and density effects on various agronomic traits of the fourth ratoon of sugarcane genotype SPSG-394 were determined during 1998-99 at the University of Agriculture, Faisalabad (Pakistan). Plant crop was raised during 1993-94 in three planting patterns, i.e. 100-cm spaced 100 × 100 squarish pits, 100-cm spaced circular pits with a diameter of 1 m and 90-cm spaced 2-row strips (30/90 cm) flat sowing at seeding densities of 10, 15, 20 and 25 buds m^{-2}, using randomized complete block design. Ratoon of the crop planted in 90-cm spaced double-row strips (30/90 cm) gave significantly higher cane yield ha^{-1} than pit plantation while the converse was true for the sucrose content. Planting densities used for the plant crop had little effect on stripped cane yield but had significant effect on sucrose content. Ratoon of the crop planted at the lowest seeding density (10 buds m^{-2}) produced juice with the maximum sucrose content against the minimum with a seeding density of 25 buds m^{-2}. Interactive effect of planting pattern and seeding density on stripped cane yield, sucrose content and purity of juice was non-significant. The results suggest that sugarcane should be planted in 90-cm spaced double row strips at a seeding density of 25 buds m^{-2} in order to maximize can yield ha^{-1} of the ratoon crop while pit plantation be preferred for improving sucrose content and purity of cane juice.

Key words: Seeding densities, ratooning of sugarcane

Introduction

Sugarcane (*Saccharum officinarum* L.) provides raw material for sugar industry which is second to the textile in Pakistan. It is cultivated on an area of 1056 thousand hectares with total annual production of 53104 thousand tonnes and average stripped *cane* yield of 50.3 t ha^{-1} (Anonymous, 1999). However, this average yield is much lower compared to the production potential of the existing cane varieties. Ratoon crop occupies more than 50% of the total acreage under sugarcane in the Punjab, Pakistan (personal communication with Director, Sugarcane Research Institute, AARI, Faisalabad). However, production of ratoon crop is 6-30% less than the plant crop of sugarcane (Anonymous, 1991) because of low and different ratooning potential of cultivars and sub-optimal crop management. Thus it is imperative to evolve cane varieties with higher ratooning potential and develop appropriate agro-technology for raising of successful ratoon crop in order to optimize use of the land pre-occupied by ratoon of sugarcane. Since there is paucity of information pertaining to the effect of seeding density and planting pattern on the agro-biological performance of the ratoon sugarcane, the objective of this study was to determine the effects of different seeding densities and planting patterns on agrobiological performance of the ratoon crop of sugarcane genotype SPSG-394.

Materials and Methods

The research study was conducted at the agronomic research area, University of Agriculture, Faisalabad, on a sandy-clay loam soil during the year 1998-99. The experiment already laid out according to the randomized complete block design with split-plot arrangement for plant crop and subsequent three ratoons of sugarcane was selected. Fourth ratoon of sugarcane genotype SPSG-394 was used as the test crop. Treatments for the plant crop and subsequent ratoon crops comprised three planting techniques, i.e., 100-cm spaced 100 cm × 100 cm squarish pits, 100-cm spaced circular pits with a diameter of 1 m, 90-cm spaced 2-row strips (30/90 cm) and four planting densities, i.e., 10 buds m^{-2}, 15 buds m^{-2}, 20 buds m^{-2} and 25 buds m^{-2}.

Third ratoon of sugarcane genotype SPSG-394 was harvested at the end of February 1998. The test crop (4th ratoon) was fertilized at 200-170-170 kg N, P and K ha^{-1}. Weeds were removed manually and irrigation was applied when needed. Observations on millable canes m^{-2}, cane yield ha^{-1}, weight per cane, cane length, cane diameter, sucrose content and cane juice purity were recorded by using the standard procedures. The data obtained were analysed statistically by using the Fisher's Analysis of Variance technique and treatment means were compared using the LSD test at 0.05 probability level (Steel and Torrie, 1984).

Results and Discussion

There were significant differences in cane yield ha^{-1} (Table 1) among the various planting techniques and seeding densities. The maximum cane yield (69.76 t ha^{-1}) was produced by ratoon of the crop planted on flat at 90-cm spaced double row strips (T_3), while the minimum (55.19 t ha^{-1}) by that in the squarish pits which, in turn, did not differ significantly from the circular pit plantation. These results are contrary to those of Urgel (1966) and Irvine *et al.* (1980) who stated that pit plantation was significantly more productive than flat plantation at 2-row strips. This difference in ours and others findings may be due to: (a) we are reporting results of the fourth ratoon crop while they worked on the plant crops and (b) different climatic conditions of the experiments. Treatment combinations did not differ significantly with one another but gave cane yield between 54.17 and 74.54 t ha^{-1}. Planting technique and seeding density had significant effect on millable canes m^{-2} (Table 1). The maximum millable canes m^{-2} (12.47) were recorded in 90-cm spaced double-row strip plantation while the minimum (10.28) in 100-cm spaced 100 × 100 cm circular pits which was, however, statistically equal to 100-cm spaced 100 × 100 cm squarish pits

Table 1: Cane yield and quality parameters as affected by planting pattern and seeding densities

Treatment	Stripped cane yield (t ha^{-1})	Minable canes m^{-2}	Weight per cane (kg)	Cane length (m)	Cane diameter (cm)	Sucrose content (%)	Cane juice purity (%)
Plating technique (T)							
	55.19b	10.49b	0.568	1.718	2.161	16.32a	89.04
T2	56.77b	10.28b	0.561	1.702	2.037	15.53ab	86.42
T3	69.76a	12.47a	0.566	1.663	2.011	14.49b	84.07
LSD (0.05)	5.91	1.12	NS	NS	NS	1.317	NS
Planting density (D)							
D_l	61.67	10.97ab	0.584a	1.688	2.061	16.16a	87.38
	60.60	10.48b	0.599a	1.702	2.115	15.83ab	87.22
D_3	59.71	11.59a	0.538b	1.746	2.071	15.29bc	86.85
D,	60.33	11.36a	0.529b	1.630	2.032	14.53c	84.58
LSD (0.05)	NS	0.76	0.031	NS	NS	0.849	NS
Interaction (T × D)							
T_1D_1	54.11	9.85de	0.583abc	1.833ab	2.157abc	16.55	90.79
T_1D_2	54.17	9.40e	0.637a	1.790abc	2.158cbc	17.15	89.54
T_1D_3	56.67	10.81cd	0.581abc	1.640bcd	2.157abc	16.45	90.49
T_1D_4	55.82	9.69de	0.467e	1.610cd	2.173ab	15.14	85.33
T_2D_1	63.75	11.33bc	0.590abc	1.583	1.953bcd	16.05	86.66
T_2D_2	54.38	9.29e	0.560bcd	1.663bad	2.020abcd	15.82	87.38
T_2D_3	58.33	10.28b	0.517de	1.893a	2.240a	15.27	85.41
T_2D_4	50.63	12.23ab	0.580bc	1 .670bcd	1.937cd	15.00	86.22
T_3D_1	67.13	12.13abc	0.580bc	1.650bcd	2.073abc	15.89	84.68
T_3D_2	73.26	12.62ab	0.600ab	1.683bcd	2.167ab	14.51	84.74
T_3D_3	64.12	12.89a	0.150de	1.710abcd	1.817d	14.14	84.65
T_3D_4	74.54	12.47a	0.577bc	1.610cd	1.987bcd	13.44	82.20
LSD (0.05)	NS	1.31	0.054	0.196	0.224	NS	NS

NS = Non-significant at $p = 0.05$

T_1 = 100-cm spaced 100 cm × 100 cm squarish pits. T_2 = 100·cm spaced circular pits with a diameter of 1 m, T_3 = 90-cm spaced 2-row strips (30/90 cm).

D_1 = 10 buds m^{-2}, D_2 = 15 buds m^{-2}, D_3 = 20 buds m^{-2}, D_4 = 25 buds m^{-2}

(10.49 canes m^{-2}). Different number of canes under various spatial arrangements have been reported by Kanwar and Sharma (1974). As regards seeding density, the maximum millable canes m^{-2} (11.59) were recorded in 20 buds m^{-2} which was, however, statistically on a par with D_4 and D_1. While the minimum canes m^{-2} (10.48) were recorded at a seeding density of 15 buds m^{-2} which was statistically equal to 10 buds m^{-2}. Greater number of millable canes m^{-2} at higher seeding density might be due to greater number of total tillers formed at higher seeding densities. Ahmad *et al*. (1995) also reported an increase in millable canes per unit area with an increase in planting density. Treatment combinations also differed significantly. The greatest number of millable canes m^{-2} was produced by ratoon of the crop planted at 25 buds m^{-2} in double-row strips (T_3D_4) that, however, did not differ significantly from T_3D_3, T_3D_2, T_3D_1 and T_1D_4. On the contrary, the lowest number of millable canes m^{-2} (9.29) was observed in ratoon of the crop planted in circular pits at 25 buds m^{-2} (T_2D_4) which was statistically on a par with the treatment combinations T_1D_2, T_1D_1 and T_2D_2.

Planting technique did not significantly affect the weight per cane that varied from 0.561 to 0.566 kg (Table 1). The results concur with the findings of Irvine *et al*. (1980).

As regards planting density, the maximum weight per cane (0.599 kg) was found in ratoon of the crop planted at 15 buds m^{-2} (D_2), which was, however, statistically on a par with the planting density of 10 buds m^{-2} (D_1). While the Minimum weight per cane (0.467 kg) was produced by ratoon of the crop planted at 25 buds m^{-2} in squarish pits. Main effects of planting technique and planting density on cane length were non-significant while their interaction was significant. The maximum cane length (1.89 m) was produced by ratoon of the crop planted at 20 buds m^{-2} in circular pits (T_2D_3) which was, however, statistically on a par with the treatment combinations T_1D_1, T_1D_2 and T_3D_3 (Table 1). On the contrary, the shortest cane length (1.58 m) was recorded in ratoon of the crop planted at 10 buds m^{-2} (T_2D_1) which did not differ significantly from T_3D_4, T_1D_1 and T_1D_3. More cane length at higher seeding density was probably because of less light penetration as light has been reported to suppress plant height (Agrawal and Srivastava, 1984). Main effects of planting density and planting technique on cane diameter were non-significant, while their interaction was significant. The maximum cane diameter (2.24 cm) was recorded in ratoon of the crop planted at 20 buds m^{-2} in 100-cm spaced 100 × 100 cm circular pits (T_2D_3), which, however, did not differ significantly from treatment combinations of T_1D_4, T_3D_2, T_1D_3, T_1D_1, T_1D_2 and T_2D_2 (Table 1). On the contrary, the minimum cane diameter (1.81 cm) was produced by ratoon of the crop planted at 20 buds m^{-2} in 90-cm spaced 2-row strips (30/90 cm) on flat (T_3D_3) which was, however, statistically on a par with T_2D_4, T_2D_1, T_3D_2 and T_2D_2. Variability in cane diameter of ratoon of the crop planted in pits and on flat may be attributed to better cane growth in pits because of adequate supply of various agricultural inputs, i.e., water, fertilizer, etc. which were applied directly to the pits instead of mixing with the surface soil over the entire cropped area as is done in flat plantation. Main effects of planting technique and seeding density on sucrose content of the cane juice were significant while interactive effect was non-significant. The maximum sucrose content (16.32%) was found in ratoon of the crop raised in 100-cm spaced 100 cm × 100 cm squarish pits which, however, did not differ significantly from that in circular pits (Table 1). On the contrary, the minimum sucrose content (14.49%) was recorded in ratoon of the crop at 90-cm spaced 2-row strips but was statistically on a par with the circular pit plantation. As regards seeding density, the maximum sucrose content (16.16%) was produced by ratoon of the crop planted at 10 buds m^{-2} which, in turn, was statistically equal to that planted at 15 buds m^{-2} (Table 1). Contrarily, the minimum sucrose content (14.53%) was found in ratoon of the crop planted at 25 buds m^{-2} which, however, did not differ significantly from the D_3. Crop at lower seeding density exhibited lower lodging that might have resulted in higher cane sucrose content than at high seeding density. These results conform to the findings of Kathiresan and Narayanasamy (1991) who observed that sugarcane seeded at 0.15 million buds ha^{-1} gave the maximum poi per cent (14.11), while that at 0.2 million buds ha^{-1} exhibited the minimum (13.82). In case of cane juice purity, both the main and interactive effects of planting technique and planting density on cane juice purity were not significant. However, among treatment combinations cane juice purity varied from 82.20 to 90.79% (Table 1).

Above results suggests that sugarcane should be planted in 90-cm spaced double-row strips at a seeding density of 25 buds m^{-2} to maximize cane yield ha^{-1} of the ratoon crop while pit plantation be preferred for improving sucrose content and purity of cane juice.

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