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Effect of planting geometry and variety on growth attributes of sugarcane in Indian sub-tropics

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ABSTRACT

An experiment was conducted to study the effect of planting geometry and varieties on growth attributes of sugarcane (*Saccharum* spp. hybrid complex) at Pusa (Bihar) during spring season of 2012-13. The experiment was laid out in split plot design allocating main- plots to planting geometry (120 cm, 150 cm, 30:120 cm and 90 cm row to row distance) and sub- plots to sugarcane varieties ('BO 139', 'BO 153', 'CoP 9301', and 'CoLk 94184') replicated thrice. Experimental results indicated that the planting geometry treatments had significant differences in plant population counted at different stages of growth. Planting geometry of 30: 120 cm row spacing produced maximum plant population of 107.6, 161.5 and 170.2 x 10^3/ha at 60, 90 and 120 days after planting(DAP), respectively. However, 90 cm row spacing gave higher leaf area index and leaf area duration at all the stages of growth. The varieties exhibited variation on all the growth parameters. The final germination of 35.8 per cent was obtained with the variety 'CoP 9301'. The maximum plant population, Leaf Area Index (LAI) and, Leaf Area Duration (LAD) were recorded at all the stages of growth under the variety 'BO 153'. Though, 'BO 139' performed better in case of plant height at all the stages of growth.

Key words: Growth parameter, Planting geometry, Sugarcane variety

Sugarcane being a C_4 plant, considered to be the most efficient convertor of solar energy to stored energy in the form of carbohydrates. Efficient interception of radiant energy to crop surface requires adequate leaf area, uniformly distributed to give maximum ground cover. This can be achieved by manipulating planting geometry. Plant population are the most important determinants which governs the cane yield in subtropical India. It has been well established that row to row spacing is an important factor in adjustment of seed rate and also in performing cultural operations including plant protections measures and irrigations.

There is need to have higher initial population either by increasing seed rate or promoting germination or modifying geometry. It has been observed under wider spacing, tillering per clump is more and canes are thick, while in closer spacing tillering per clump is less and canes are thin. It has been observed that row to row spacing of 90 cm, results in higher yields at recommended planting methods in comparison to other spacing. Tillering starts from around 60 days after planting and may last upto 120 days in sub-tropical India. Tillering phase largely determine the productivity of sugarcane crop and number of tillers had positive association with number of millable canes at harvest (Roodagi *et al*. 2001). Planting geometry may influence the tillering pattern and other growth parameters of different varieties to a greater extent. Among the numerous technologies for increasing cane yield and recovery per cent, variety is the pivotal and main ingredient. The adoption of high yielding better quality variety is the Leaf better technology that the cane growers can easily afford. A variety with shy tillering and short stature needs to be planted closer, while a tall and profusely tillering one may require wider spacing to produce desired plant population per unit area. Hence, the present investigation was carried out to determine the effect of planting geometry and varieties on growth attributes of sugarcane.

MATERIALS AND METHODS

A field experiment was conducted during spring season of 2012 - 13 at Sugarcane Research Institute (Rajendra Agricultural University), Pusa, Bihar to study the effect of planting geometry on growth attributes of sugarcane varieties. It was laid out in split plot design with three replications. The treatments consisted of four planting geometry (120 cm, 150 cm, 30: 120 cm and 90 cm row to row distance) which were assigned to main plots and four varieties of sugarcane ('BO 139', 'BO 153', 'CoP 9301' and 'CoLk 94184') were allotted to subplots. The experimental soil was sandy loam in texture with pH 8.3, low in organic carbon (0.43%), available nitrogen (225 kg N/ha); medium in available phosphorus (11.9 kg/ha) and potassium (120 kg/ha). The total rainfall of 851.4 mm was received during the crop period. The recommended dose of fertilizer was 150 - 37.1 - 49.8 Kg N, P and K/ha, respectively. Half of total N and full dose of P and K were applied as basal and remaining N in two splits, after first irrigation and earthing up. Sugarcane was planted in last week of February and harvested in the following year in the last week of January. The planting was done in furrow at a different row distance using same seed rate of three budded sets in all the plots. Various growth parameters *viz.*, germination, plant population, LAI, LAD and plant height were recorded at the respective stages of crop growth.

RESULTS AND DISCUSSION

Percent germination

Germination counts were recorded at 30th and 45th days after planting of sugarcane. Experimental data presented in Table 1, indicated that the planting geometry failed to bring significant improvement in germination percentage of sugarcane. However, the germination ranged between 18.8 and 20.2 % at 30 DAP and 31.0 and 32.5 % at 45 DAP. Per cent germination differed among the varieties (Table 1). At 30 DAP, higher germination per cent was recorded with the variety 'BO 153' (23.7 %) which was followed in order by 'CoP 9301' and 'CoLk 94184'. However, at 45 DAP significantly higher germination percentage was recorded with 'CoP 9301' (35.8 %) which was almost similar to 'BO 153' (33.2 %). The varietal difference was mainly due to variation in temperature requirement, waxyness of rind, fibre ratio and glucose content etc. The remarkable improvement in germination percentage in the variety 'CoP 9301' at 45 DAP of sugarcane was mainly due to higher glucose content at the cellular level resulting from conversion of higher amount of sucrose to glucose with the rise of temperature in the subsequent month, which might have led to greater availability of glucose to the germinating buds which was the main reason behind higher germination percentage of high sugared variety ('CoP 9301') at later stage. Results obtained in the present study are in accordance with those of Vashishtha and Sinha (2004) and Singh *et al.* (2011).

Plant population

Table 1 Germination and plant population of sugarcane as affected by planting geometry and variety

Treatment	Germination (%)		Plant population ($x10^3$/ha)		
	30 DAP	45 DAP	60 DAP	90 DAP	120 DAP
Planting geometry					
120 cm	19.5	31.7	62.6	116.9	128.1
150 cm	18.8	31.9	50.7	81.1	93.1
30:120 cm	20.2	31.0	107.6	161.5	170.2
90 cm	19.7	32.5	101.5	153.8	162.5
SEm (±)	1.32	2.08	6.78	14.14	14.94
CD (P=0.05)	NS	NS	23.5	48.9	51.7
CV (%)	11.7	11.3	14.6	19.1	18.7
Variety					
BO 139	15.8	26.1	59.7	105.3	113.6
BO 153	23.7	33.2	112.5	160.6	172.4
CoP 9301	20.6	35.8	62.6	111.2	121.8
CoLk 94184	18.2	31.8	87.6	136.2	146.1
Mean	**19.6**	**31.7**	**80.6**	**128.3**	**138.5**
SEm (±)	0.51	1.05	2.46	4.88	5.27
CD (P=0.05)	1.5	3.1	7.2	14.2	15.4

The plant population was counted from 60 days after planting at monthly interval in which the significantly higher population counts of 107.6, 161.5 and 170.2 x 10^3/ha was recorded at 30:120 cm row spacing at 60, 90 and 120 days after planting, respectively which was statistically similar to 90 cm row spacing and both of them were significantly superior to 150 cm row spacing. The drastic reduction in plant population was noticed due to widening of row spacing from 30:120 and 90 cm to 120 and 150 cm. However, at all the stages there was no significant differences between 30:120 cm to 90 cm and 120 cm to 150 cm in respect of plant population (Table 1). To maintain the plant population, the seed rate used at lower and wider spacing was kept constant. It was surprisingly observed that in spite of uniform seed rate there was significant reduction in plant population at wider spacing. The increase in plant population at 30:120 cm and 90 cm row spacing may be due to availability of more rows per unit area as compared to 120 and 150 cm row spacing. Such increased trends were also reported by Raghu *et al.* (2006) and Devi *et al.* (2005).

Varieties differed significantly for observations recorded on plant population (Table 1). Plant population recorded with 'BO 153' was significantly higher among the varieties which followed in order by 'CoLk 94184', 'CoP 9301' and 'BO 139' at all the stages of growth. The significant variation in plant population count was due to chemical composition of soluble solids in juice as well as enzymes and hormones present in cell sap, which differs from variety to variety. Kumar *et al.* (2012) also noticed significant variation on plant population among different sugarcane varieties.

Leaf area index

It was evident from the data (Table 2) that leaf senescence increased towards maturity of the crop due to drying up of the older leaves and tiller mortality; hence leaf area indices were lowered down. The data clearly indicated that green leaf areas increased progressively from initial stage and reached the maximum at 210 DAP. The LAI was estimated at 4 stages starting from 120 to 210 DAP at monthly interval. The planting geometry had significant influence on LAI at 120 and 150 DAP. The maximum LAI of 2.19, 3.11, 3.78 and 4.22 was recorded at 90 cm row spacing at 120, 150,180 and 210 DAP, respectively. The higher values of LAI at 90 cm row spacing were due to higher number of millable canes and better retention of tillers. These results were in close agreement with those of Lopez-Bellido *et al.* (2000).

At all the stages of observation significant variation was observed among the varieties in terms of leaf area index, and the variety 'BO 153' recorded the highest value of LAI at 120 (2.17), 150 (3.08), 180 (3.72) and 210 (4.18) days after planting. The variety 'CoP 9301' recorded the minimum LAI at all the stages of growth. The higher value of LAI was mainly due to higher plant population under these varieties at all the stages of growth. These findings support the findings of Lopez-Bellido *et al.* (2000).

Table 2 Leaf area index and leaf area duration of sugarcane at different stages of crop growth as influenced by planting geometry and variety

Treatment	Leaf area index				Leaf area duration		
	120 DAP	150 DAP	180 DAP	210 DAP	120 - 150 DAP	150 - 180 DAP	180 - 210 DAP
Planting geometry							
120 cm	1.55	2.47	3.17	3.63	66.4	84.6	102.0
150 cm	1.33	2.24	2.97	3.46	53.5	78.1	96.5
30:120 cm	2.12	3.02	3.74	4.08	77.1	101.4	117.2
90 cm	2.19	3.11	3.78	4.22	79.5	103.2	120.0
SEm (±)	0.183	0.190	0.248	0.290	5.55	6.57	8.04
CD (P=0.05)	0.63	0.67	NS	NS	19.2	NS	NS
CV (%)	17.61	12.12	12.61	13.04	14.2	12.4	12.8
Variety							
BO 139	2.05	2.97	3.67	4.12	75.3	99.6	116.8
BO 153	2.17	3.08	3.72	4.18	78.7	101.9	118.4
CoP 9301	1.14	2.06	2.76	3.19	48.0	72.2	89.3
CoLk 94184	1.83	2.73	3.51	3.91	68.4	93.5	111.2
Mean	**1.80**	**2.71**	**3.42**	**3.85**	**67.6**	**91.8**	**108.9**
SEm (±)	0.069	0.090	0.113	0.113	2.163	3.06	3.34
CD (P=0.05)	0.20	0.26	0.33	0.33	6.31	9.73	9.74

Leaf area duration

An examination of the data indicates that 90 cm row spacing recorded the maximum LAD, whereas 150 cm row spacing had minimum LAD at all the stages of growth (Table 2). The effect of planting geometry on LAD was found to be significant during 120 – 150 days after planting, but failed to affect it significantly during advance stages of growth. The maximum LAD of 79.5 measured between 120 - 150 DAP at 90 cm row spacing was closely followed by 30: 120 cm (77.1) and both of them were significantly superior to 150 cm (53.5) row spacing.

The varieties differed significantly in terms of leaf area duration at all the stages of growth (Table 2). The variety 'BO 153' recorded the highest LAD values of 78.7, 101.9 and 118.4, respectively between 120 - 150, 150 - 180 and 180 - 240 days after planting closely followed by 'BO 139' and the lowest value was found in 'CoP 9301' between all the stages of observations. Maintenance of higher LAD in the variety 'BO 153' and 'BO 139' may be one of the reasons responsible for higher growth and development by way of maintenance of higher current photosynthate supply to developing parts of the plant.

Plant height

In the present investigation (Table 3) plant height recorded at four successive stages from 150 to 240 DAP at monthly interval. The increase in plant height of 2.45 cm per day was recorded from 150-180 DAP while it was 1.44 cm from 180 to 210 DAP and 0.98 cm from 210 to 240 DAP. The plant height under the study was comparatively higher at 150 cm row spacing, though the differences were non-significant. The extent of increase in plant height under 150 cm row spacing over 30:120 cm row spacing (lowest height) at 150, 180, 210 and 240 DAP was to the extent of 9.7, 4.2, 4.8 and 6.2 per cent, respectively. Comparatively, the higher values of plant height at wider row spacing might be attributed to rapid elongation and multiplication of cells by availability of more space in between cane rows and more sunlight interception, which led to comparatively taller plants. Singh *et al.* (2008) and Singh *et al.* (2006) observed higher cane length under 90 cm row spacing over other spacing.

Plant height was significantly differed among sugarcane varieties (Table 3) at all the stages of observations. The

Table 3 Plant height as influenced by planting geometry and variety at different stages of crop growth recorded at monthly interval

Treatment	Plant height (cm)			
	150 DAP	180 DAP	210 DAP	240 DAP
Planting geometry				
120 cm	152.4	225.1	265.5	299.8
150 cm	155.5	225.2	273.6	303.5
30:120 cm	141.7	216.2	261.1	285.8
90 cm	145.9	223.6	263.2	291.9
SEm (±)	12.91	19.62	23.61	25.92
CD (P=0.05)	NS	NS	NS	NS
CV (%)	15.00	15.3	15.4	15.2
Variety				
BO 139	167.8	247.5	290.8	312.7
BO 153	153.7	229.5	271.2	304.5
CoP 9301	136.4	201.2	235.3	262.2
CoLk 94184	137.6	212.0	266.1	301.6
Mean	**148.9**	**222.5**	**265.8**	**295.2**
SEm (±)	5.40	8.02	9.53	10.53
CD (P=0.05)	15.7	23.4	27.8	30.7

maximum value of plant height was found in 'BO 139' which was followed in order by 'BO 153' and 'CoLk 94184'. The minimum plant height at all the stages of growth was recorded with the variety 'CoP 9301'. The differences in plant height among the varieties might be due to variation in partitioning of photosynthates by different genotypes. The results confirm the findings of Kumar *et al.* (2012) and Yadav *et al.* (2012).

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