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Growth, Yield and Quality of Sugarcane Influenced by Row Spacing and Plant Geometry under Sub Surface Drip Fertigation System

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A B S T R A C T

Sugar cane is one of the most important field crops in the tropics. Sugarcane is grown is not less than 105 countries and presently it covers a total acreage of about 19 million hectares for a world production of approximately 1.3 billion metric ton of cane and 127 million ton of sugar. Sub surface drip irrigation is the most advanced method of irrigation, which enables the application of small amounts of water to soil through the drippers placed below the soil surface with discharge rates. Row spacing has a direct effect on plant population. It plays a distinct role in the amount of solar radiation intercepted and density, hence, crop canopy development which in turn affects photosynthesis and ultimately the dry matter produced by plant. Based on this view, field experiment was carried out at Sugarcane Research Station, Cuddalore to optimize the row spacing and plant geometry for mechanized cane cultivation under sub surface drip fertigation system. Sugarcane variety viz., CoC 24 was in ten row spacing's of 120,135,150,and 180 cm with each in single side and double side planting treatments were applied. A Randomized block design with three replications was used. Results revealed that widening spaces between rows of sugarcane from 120 up to 180 cm resulted in a significant and gradual increase in bio metric observation and yield parameters. Row spacing at 120 cm with double side planting gave the highest values of cane yield, juice quality and commercial cane sugar. The double side planting registered more tiller population than single side planting. The double side planting registered more cane yield. Among the treatments, the maximum cane yield of 155.35 t/ha was observed in the treatments by the row spacing of 120+40 cm double side planting.

Introduction

Sugar cane is one of the most important field crops in the tropics. Sugarcane is grown is not less than 105 countries and presently it covers a total acreage of about 19 million hectares for a world production of approximately 1.3 billion metric ton of cane and 127 million ton of sugar. Fertigation has been described as the application of plant nutrients in irrigation water to accomplish fertilization. Many researchers indicated that the beneficial effect

of fertigation increasing the efficiency of nutrients utilization under drip fertigation system.

Sub surface drip irrigation Is the most advanced method of irrigation, which enables the application of small amounts of water to soil through the drippers placed below the soil surface with discharge rates (Risz. *et al.*, 2004). Row spacing has a direct effect on plant population. It plays a distinct role in the amount of solar radiation intercepted and density, hence, crop canopy development which in turn affects photosynthesis and ultimately the dry matter produced by plant. Also, it may affect cane diameter, length and weight which contribute to cane yields. Sugarcane planted at a row spacing of 75 cm gave significantly higher cane yield compared to 90 cm row spacing (Avtar *et al.*, 2001). Narrow row spacing (100 cm) produced higher number of millable canes, cane and sugar yields compared to 120 and 140 cm row spacing. Their results showed that the wider row spacing (140 cm) significantly recorded thicker stalks, compared with those of narrower spacing of 100 cm.Juice quality traits were not significantly affected by spacing. Cane girth and number of millable canes were significantly higher with a 90 cm intra-row spacing compared with 30 or 60 cm intra-row spacing. Millable cane height and average number of internodes/plant were not significantly affected by spacing. Sucrose was insignificantly affected by the studied row distances (100, 120 and 140 cm) (Rizk *et al.*, 2004). The widest row distance significantly gave the thickest stalks (Raskar *et al.*, 2003).

Growing sugarcane in rows of 80 cm apart attained a significant increase in stalk height, number of millable canes, cane and sugar yields. However, stalk diameter increased with 120 cm spacing (EL-Shafai and Ismail, 2006). Sucrose and sugar recovery percentages were insignificantly affected by row spacing. The highest number of millable canes (128000/ha) and cane yield (62.9 tons/ha) were recorded at 45 cm spacing followed by 60 cm (119400/ha and 58.2 tons/ha) and 75 cm (112300/ha and 55.0 tons/ha). Planting sugarcane in rows spaced at 80 cm attained significant increases in millable cane length, number of millable cane, cane and sugar yields, compared with 100 and 120 cm spacing (Singh *et al.*, 2001). The aim of the present work was to find out the best row spacing and effective planting geometry to obtain the highest yield and quality of sugarcane.

Materials and Methods

The experiment was conducted at sugarcane Research Station, Cuddalore during December 2009 using sub surface drip irrigation system. The soil of the experimental site was deep, sandy clay loam with neutral pH 7.6, EC 0.08 dS m^{-1} and organic carbon 0.09 %. The available nitrogen, P and K were 192, 13, 250 kg/ha respectively. The water holding capacity for corresponding depths was 25 %. Before cultivation, drip tubing was buried 10 cm deep directly under the soil beds. Sugarcane setts were planted in to soil beds in different row spacing. Water requirement was scheduled based on evaporation replenishment. (0.75 class pan evaporation) Irrigation frequency was running on alternate days for a period of two hours over the four month duration of experiment included 12 irrigation events with fertigation. The experiment was arranged in randomized block design consisting of ten row spacings with single side and double side plantings. The sets were planted on both sides of the furrows as well as in a single row. The seed rate adopted was 8 two budded sets per running meter and this was uniform for both double side and single side plantings. The 100 % water soluable fertilizers fertigation were applied on 15 days intervals. The fertilizer schedule was 275 : 65: 113. kg N, P_2O_5 and K_2 O /ha. All nitrogen and potassium fertilizers

were injected directly in to the irrigation water using injector.The yield were recorded along with the quality parameters.

Results and Discussion

The growth characters, yield and yield attributes characters were recorded and the results are presented in the Table 1.

Tiller population

In the 90th day tiller population, maximum of 2,26,765 tillers/ha was registered by the row spacing of 120 +40 cm DS followed by the row spacing of 135+40 cm DS with 2,21,461 tillers/ha. The double side planting registered more tiller population than single side planting. Among the single row planting, the spacing of 135 +30 cm produced the maximum of 1,65,993 tillers /ha. These results could be due to the competition among cane plants grown in narrower rows for growth elements, *i.e.*, nutrients, water and sun light. Chang (1974) explained that the proportion of invisible solar radiation is so much increased than the visible solar radiation due to dense sowing.

Millable cane population

Double side planting at the spacing of 120 +40 cm produced the maximum shoot population of 1,19,240 /ha followed by 135+40 cm with double side 103085 shoots /ha.

Cane yield

The double side planting registered more cane yield. Among the treatments, the maximum cane yield of 135.35 t/ha was observed in the treatments by the row spacing of 120+40 cm double side planting followed by the row spacing of 135+ 40 double side planting 129.33 t/ha. These results could be attributed to the increase in number of millable canes as row spacing decreased. These results are in agreement with those reported by El-Shafai (2002). The Higher cane yield at 120 cm spaced planting might be attributed to higher values of yield contributing parameters like cane length, cane weight and cane diameter. These results are in line with Bashir *et al.*, (2005) who reported that a row spacing of 120 cm was found optimum for higher cane yields.

Commercial cane sugar (%)

Double side planting at the spacing of 120+40 cm under double side planting registered the CCS of 13.22 % followed by 135+40 cm with double side planting of 13.20 %. This huge difference in sucrose content might be due to climatic changes, as high rainfall was noted during the growth period of the crop that resulted in high water contents in the cane juice and lesser sucrose content.

The plant crop was taken up with test variety CoC (SC) 24 with different row spacing from 120 cm to 180 cm. The sets were planted on both sides of the furrows as well as in a single row. A seed rate of 8 two budded sets per running meter was adopted and it was uniform for both double side and single side plantings. Regarding double side planting at the spacing of 120 +40 cm produced the maximum shoot population of 1, 19,240 /ha followed by 135+40 cm with double side 1, 03,085 shoots /ha. The double side planting at a spacing of 120 +40 cm produced the maximum mean cane yield of 155.35 t /ha followed by the lateral spacing of 135+40 cm (149.33 t/ha.). The CCS content ranged from 10.88 to 12.15 %.The CCS content was observed to be higher (12.15 %) in the treatment of 150 cm lateral spacing as double side planting.

The millable cane population, cane yield and CCS content were recorded for first ratoon crop. The results on yield and yield attributes are presented in Table 2.

Table.1 Treatment details

T_1 - Lateral spacing at 120 cm SSP
T_2 - Lateral spacing at 120 cm DSP
T_3 - Lateral spacing at 130 cm SSP
T_4 - Lateral spacing at 130 cm DSP
T_5 -Lateral spacing at 150 cm SSP
T_6 - Lateral spacing at 150 cm DSP
T_7- Lateral spacing at 165 cm SSP
T_8- Lateral spacing at 165 cm DSP
T_9- Lateral spacing at 180 cm SSP
T_{10}- Lateral spacing at 180 cm DSP

Design : Randomised Block Design SSP- Singe Side Planting
Replication :Three DSP- Double Side Planting

Table.2 Effect of row spacing on growth characters and yield attributes

Sl .No.	Treatments	Millable cane population (000 ‘s /ha)	Cane yield (t/ha)	C.C.S (%)
1.	Lateral spacing at 120 cm SSP	96.37	128.37	**11.17**
2.	Lateral spacing at 120 cm DSP	119.24	*155.35*	**11.62**
3.	Lateral spacing at 130 cm SSP	93.33	124.90	**11.48**
4.	Lateral spacing at 135 cm DSP	103.09	149.33	**11.58**
5.	Lateral spacing at 150 cm SSP	95.37	122.58	**11.68**
6.	Lateral spacing at 150 cm DSP	94.64	139.28	**12.15**
7.	Lateral spacing at 165 cm SSP	81.39	118.57	**11.85**
8.	Lateral spacing at 165 cm DSP	77.34	137.38	**12.03**
9.	Lateral spacing at 180 cm SSP	74.42	112.57	**11.73**
10.	Lateral spacing at 180 cm DSP	100.32	*145.29*	**11.78**
11.	Normal furrow at 120 + 40 cm DSP	73.38	102.67	**10.88**
SEd		9.29	11.27	**0.05**
CD		**21.93**	**23.23**	**0.12**

Table.3

Sl. No.	Treatments	Millable cane population (000 ‘s /ha)	Cane yield (t/ha)	C.C.S (%)
1.	Lateral spacing at 120 cm SSP	99.68	130.12	**11.29**
2.	Lateral spacing at 120 cm DSP	121.24	157.42	**11.75**
3.	Lateral spacing at 130 cm SSP	93.67	126.92	**11.54**
4.	Lateral spacing at 135 cm DSP	119.56	152.01	**11.62**
5.	Lateral spacing at 150 cm SSP	97.89	123.27	**11.75**
6.	Lateral spacing at 150 cm DSP	95.25	141.17	**12.23**
7.	Lateral spacing at 165 cm SSP	91.25	120.57	**11.92**
8.	Lateral spacing at 165 cm DSP	89.25	139.19	**12.15**
9.	Lateral spacing at 180 cm SSP	82.1	115.23	**11.82**
10.	Lateral spacing at 180 cm DSP	112.29	147.15	**11.91**
11.	Normal furrow at 120 + 40 cm DSP	79.52	104.67	**10.99**
	SEd	**2.84**	**0.64**	**0.004**
	CD	**5.93**	**1.38**	**0.0089**

The results showed that there was significant difference between row spacing and planting methods. The double side planting at the lateral spacing of 120 +40 cm produced the maximum millable cane population (1,21,242 /ha) followed by double side planting at the spacing of 135+40 cm (1,19,569 /ha). The double side planting at a spacing of 120 +40 cm produced the maximum mean cane yield of 157.42 t /ha followed by the lateral spacing of 135+40 cm (152.01 t/ha.) (Table 3). The CCS content ranged from 10.99 to 12.23 %.The CCS content was observed to be higher (12.23 %) in the treatment of 150 cm lateral spacing as double side planting.

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