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Influence of Planting Geometry in Single Eye Bud Seedling Planting Technique on Sugarcane Productivity and Profitability under Drip Irrigation in Karnataka, India

S. S. Nooli[1*], S. C. Alagundagi, M. B. Patil, S. Y. Wali and S. N. O. Sadashivangouda

ACRP on Sugarcane, ARS, Sankeshwar, Karnataka, India

**Corresponding author*

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A B S T R A C T

A field experiment on single eye bud seedling planting technique was conducted on farmer's field during 2013-14 at Vijayapura, Karnataka, India and during 2014-15 at Agriculture Research Station, Almel, University of Agricultural Sciences, Dharwad, Karnataka, India, in a randomized complete block design. Treatments comprised of four row spacing and two intra row spacing compared with national check (150 X 60 cm) and conventional method of planting (90 cm row spacing) under drip irrigation. Two years pooled data indicated that, single eye bud sugarcane seedling planted at 180 X 60 cm recorded significantly higher cane yield of 162 t ha^{-1} which was on par with planting at 180 X 90 cm (154 t ha^{-1}) and national check of 150 X 60 cm (150 t ha^{-1}). Conventional method of planting with three budded setts recorded significantly lower cane yield (102 t ha^{-1}) compared to different planting geometry with single eye bud seedling planting technique. The yield attributes viz., number of millable cane per meter, number of inter nodes per cane, inter nodal length (cm), inter nodal girth (cm), single cane weight (kg) and quality parameters viz., commercial cane sugar (CCS %), CCS yield (t ha^{-1}) and sucrose content (%) followed the similar trend. Further, the economic analysis of the system revealed higher monetary advantage in term of net returns [₹ 202880 ($ 3121.23) ha^{-1}] and benefit cost ratio (2.68) with single eye bud seedling planted at 180 X 60 cm which was on par with single eye bud seedling planted at 180 X 90 cm and 150 X 60 cm compared to conventional method of planting [₹92528 ($ 1423.50) ha^{-1}] and 1.83 respectively). Besides, single eye bud seedling planting technique offers good scope in reducing water requirement for sugarcane cultivation. Water saving was to the extent of 35-55 per cent.

Introduction

In India, sugarcane is grown in two distinct agro-climatic regions i.e., the Tropical (Maharashtra, Karnataka, Gujarat and Tamil Nadu states) and the Sub-tropical (Uttar Pradesh, Punjab, Haryana and Bihar states). Among the states, Uttar Pradesh occupies half (2.25 m ha) of the total area followed by Maharashtra (1.04 m ha). Though UP

dominates in production with 134 m t followed by Maharashtra (79 m t), in terms of productivity, Tamil Nadu leads with 105 t ha^{-1} followed by Karnataka (88 t ha^{-1}) and Andhra Pradesh (82 t ha^{-1}) (Anon., 2014).

Despite its longer tradition and larger area in Karnataka, in terms of productivity, sugarcane yields are unimpressive, especially where the crop is grown under irrigated eco system, the average productivity of sugarcane is lower with reported yields as low as 40 t ha^{-1} only. Not only is the cane yield lower but also, the sugar yield is typically at less than 10 % of cane weight - is also less than satisfactory. The main reason for lower productivity is unpredictable water availability. The concern is not only the quantity of water required, but also the lack of proper water management practices. Due to this, water is either wasted or sometimes not available at the right time. Unpredictable climatic aberrations, improper cultivation practices, and imbalanced nutrient management often results in lower productivity. On one hand, there is an opportunity in terms of growing demand for sugar and other bi-products of sugarcane, and on the other, there is decline in production and productivity due to various reasons. The rising cost of farm chemicals, along with the increasing social and environmental costs of water use by the agricultural sector and the pollution accruing due to modern, input intensive production practices have begun to raise serious questions in the minds of policy makers, planners and farmers alike. Any problem affecting the sugar sector is a widespread problem, affecting a significant number of households and eco systems. The desirability of a widely replicable solution is therefore equally obvious.

Cane planting innovations and water saving practices that have great potential for not only meeting the growing demands of sugar sector players looking for increased revenues and profitability, but also for the bigger picture of improved natural resource management, reduced environmental foot prints and improved livelihoods by means of technologies that are appropriate and effective at household farm level. Keeping this in view, the study was carried out to know the influence of planting geometry in single eye bud seedling planting technique on the sugarcane yield under drip irrigation.

Materials and Methods

The study was conducted on farmer's field during 2013-14 at Vijayapura, Karnataka, India and during 2014-15 at Agriculture Research Station, Almel, University of Agricultural Sciences, Dharwad, Karnataka, India. Single eye bud seedling planting were carried out with four row spacing viz., 120, 180, 240 and 300 cm at two intra row spacing viz., 60 and 90 cm in a randomized complete block design and were compared with national check (150 X 60 cm) along with conventional method of planting under drip irrigation . The plot size was 100 m^2 for each treatment. The prime objective was to identify the biologically most efficient and sustainable planting technology in sugarcane cultivation for the farmers of the region. The soil of the trial sites was clay loam in texture with medium organic carbon content (0.52 %) having neutral (pH 7.4) reaction. The available N status of the soil was low (220 kg ha^{-1}), whereas, available P_2O_5 (11.2 kg ha^{-1}) and K_2O (324 kg ha^{-1}) were in medium and high range of soil fertility, respectively. The single eye buds were cut from the upper 2/3rd portion of the healthy and disease free canes using a locally made cutter. The single eye bud setts were placed in a porous gunny bag and immersed for 20 minutes in a solution of 50 ml of chlorpyriphos, 50 grams of urea and 50 ml of carbendazim mixed in 50 liters of water. The treated setts were taken out and

shade dried and used for planting in plastic trays containing 52 cones each. The cones were half filled with mixture of well-decomposed coco-pith and vermicompost. The single eye buds were placed in slightly slanting position in half-filled cavities of trays. Then the buds were completely covered with coco-pith and vermicompost mixture. After filling, the trays were placed one above the other and finally, an empty tray was placed upside down on the top of the stack. In this way the trays were arranged in eight sets and wrapped tightly with black polyethylene sheet and kept as such to create enough temperature and good humidity. The sprouted single eye buds (after six days) were removed from the polyethylene sheet and kept side by side on the ground to facilitate watering and other nursery management practices. Twenty-five to thirty day old seedlings were planted in the main field during August first and second fortnights at a spacing of 120, 180, 240 and 300 cm with intra row spacing of 60 and 90 cm. A mid late maturing (12-14 months) sugarcane variety Co 86032 was used for the study. The crop was harvested in December. All the recommended agronomic cultivation practices were followed to raise the crop. Biometric observations on sugarcane growth, yield attributes, quality parameters and water use were recorded at appropriate stages and compared accordingly after working out the economics.

Results and Discussion

Plant population

Percentage of seedling survival and bud germination in single eye bud seedling planting (SEBSP) technology and conventional method has been presented in Table 1. Higher plant population which is ultimately responsible for higher number of millable canes in SEBSP technology was observed compared to conventional method. The results revealed that the seedling survival rate was 92 % in SEBSP technology compared to 70.81 % bud germination in conventional method, providing scope for gap filling with nursery raised seedlings in SEBS planting technology which helped to ensure the initial plant stand in the field.

Yield attributes

Average number of millable canes m^{-1} was 18.0 in SEBSP at 180 X 60 cm planting geometry which was on par with 180 X 90 cm and 150 X 60 cm planting geometry compared to 9.0 m^{-1} in conventional method. This may be attributed to planting the sugarcane crop at higher spacing (180 X 60 or 90 cm) which facilitated better availability of air, water, sunlight and nutrition to the crop compared to the cane crop planted conventionally at lower row spacing (90-105 cm). Number of internodes $cane^{-1}$, inter nodal length (cm) and girth (cm), cane height (cm) and single cane weight (kg) were also significantly higher in seedlings planted crop at planting geometry of 180 X 60 or 90 cm and 150 X 60 cm compared to cane crop raised through planting of three budded setts. Length and girth of canes in SEBSP technology were 290, 295 and 12.8, 12.4 cm, respectively in seedlings planted at 180 X 60 or 90 cm compared to 284 and 9.4 cm in conventional method of planting. A higher initial stand establishment on account of uniform, wider spacing and also the good agronomic management practices must have attributed to higher yield attributing characters in SEBSP technology (Mohanty 2013 and Mohanty *et al.*, 2015).

Yield

As the number of millable canes per meter was also higher in SEBSP technology compared to conventionally grown crop, clearly endorses the results of higher number

of millable canes ha^{-1}. Average cane weight was 1.52 to 2.15 kg in seedling planting technology compared to 1.1 kg in conventional method of planting. Higher plant stand along with higher yield attributing characters showed that, single eye bud sugarcane seedling planted at geometry of 180 X 60 cm recorded significantly higher cane yield of 162 t ha^{-1} which was on par with 180 X 90 cm (154 t ha^{-1}) and national check of 150 X 60 cm (150 t ha^{-1}). Conventional method of planting with three budded setts recorded significantly lower cane yield (102 t ha^{-1}) compared to different planting geometry with single eye bud seedling planting technique (Table 1). Similar findings were also recorded by Mohanty *et al.*, (2015).

Table.1 Yield attributes and yield of sugarcane as influenced by single eye bud seedling planting technique with different planting geometry under drip irrigation (pooled data of 2013-15)

Treatment	No. of seedlings ha^{-1}	Percentage survival or germination	No. of millable cane m^{-1}	No. of inter node cane^{-1}	Inter nodal length (cm)	Inter nodal girth (cm)	Cane height (cm)	Single cane weight (kg)	Cane yield (t ha^{-1})
T_1:Single eye bud seedling (SEBS) planting at 120X60 cm	13889	92.0	12	23	9.8	10.9	245	1.52	140
T_2:SEBS planting at 120X90cm	9259		11	24	9.4	11.1	254	1.55	138
T_3:SEBS planting at 180X60cm	9259		18	32	11.5	12.8	290	2.15	162
T_4:SEBS planting at 180X90cm	6173		16	30	11.0	12.4	295	1.99	154
T_5:SEBS planting at 240 X60cm	6944		14	28	9.8	11.1	279	1.65	142
T_6:SEBS planting at 240 X90cm	4630		12	27	9.6	10.8	275	1.68	140
T_7:SEBS planting at 300 X60cm	5556		13	25	9.4	10.8	278	1.58	139
T_8:SEBS planting at 300 X90cm	3704		12	26	9.6	10.1	273	1.64	135
T_9:SEBS planting at 150X 60cm (National Check)	11111		16	30	11.3	12.6	284	1.98	150
T_{10}: Conventional planting with 90cm row	---	70.8	09	23	8.4	9.4	225	1.10	102
S. Em±			0.98	1.36	0.37	0.52	3.42	0.10	6.2
CD (P=0.05)			2.94	4.10	1.13	1.58	10.40	0.32	18.4

Table.2 Quality and economic parameters of sugarcane as influenced by single eye bud seedling planting technique with different planting geometry under drip irrigation **(**pooled data of 2013-15)

Treatment	Cane yield (t ha^{-1})	CCS (%)	CCS yield (t ha^{-1})	Sucrose content (%)	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net Returns (₹ ha^{-1})	BC ratio
T_1:Single eye bud seedling (SEBS) planting at 120 X 60 cm	140	11.5	16.10	14.6	134580 ($ 2070.5)*	280000 ($ 4307.7)	145420 ($ 2237.2)	2.08
T_2:SEBS planting at 120 X 90cm	138	11.8	16.28	14.9	121120 ($ 1863.4)	276000 ($ 4246.2)	154880 ($ 2382.8)	2.28
T_3:SEBS planting at 180 X 60cm	162	13.4	21.71	19.3	121120 ($ 1863.4)	324000 ($ 4984.6)	202880 ($ 3121.2)	2.68
T_4:SEBS planting at 180 X 90cm	154	13.6	20.94	19.4	112450 ($ 1730.0)	308000 ($ 4738.5)	195550 ($ 3008.5)	2.74
T_5:SEBS planting at 240 X 60cm	142	12.1	17.18	16.7	111750 ($ 1719.2)	284000 ($ 4369.2)	172250 ($ 2650.0)	2.54
T6:SEBS planting at 240 X 90cm	140	12.3	17.22	16.9	111450 ($ 1714.6)	280000 ($ 4307.7)	168550 ($ 2593.1)	2.51
T_7:SEBS planting at 300 X 60cm	139	11.9	16.54	17.1	109540 ($ 1685.2)	27800 ($ 4276.9)	168460 ($ 4130.2)	2.54
T_8:SEBS planting at 300 X 90cm	135	11.8	15.93	17.2	108450 ($ 1668.5)	270000 ($ 4153.9)	161550 ($ 2485.4)	2.49
T_9:SEBS planting at 150 X 60cm (National Check)	150	12.6	18.90	18.9	124282 ($ 1912.0)	300000 ($ 4615.4)	175718 ($ 2703.4)	2.41
T_{10}:Conventional planting with 90 cm row	102	11.8	12.04	15.3	111472 ($ 1715.0)	204000 ($ 3138.5)	92528 ($ 1423.5)	1.83
S. Em±	6.2	0.42	1.22	0.64			8180	0.04
CD (P=0.05)	18.4	1.21	3.60	2.12			24540	0.13

* The figures in the parentheses are calculated at ₹ 65 per Dollar

Table.3 Water use under drip irrigation and planting geometry of single eye bud seedling planting technique in sugarcane

Treatment	Total water applied (000 liters ha^{-1})	Water saving (%)
Single eye bud seedling (SEBS) planting at 120 cm row	9457	35
Single eye bud seedling (SEBS) planting at 150 cm row	8439	42
Single eye bud seedling (SEBS) planting at 180 cm row	8002	45
Single eye bud seedling (SEBS) planting at 240 cm row	7420	49
Single eye bud seedling (SEBS) planting at 300 cm row	6547	55
Conventional planting with 90 cm row	14550	---

Quality parameters

The results of pooled data have been presented in Table 2. Sucrose content was significantly higher with single eye bud sugarcane seedling planted at 180 X 60 or 90 cm geometry (19.3 to 19.4 %) which was on par with cane planted at 150 X 60 cm. Significantly lower sucrose percent was found with cane planted in conventional method. Similar trend was also recorded with respect to commercial cane sugar (%) and commercial cane sugar yield (t ha^{-1}).

Economics

Economics worked out for SEBSP technology with different planting geometry and conventional method of planting clearly indicated the higher monetary advantage in term of net returns [₹ 202880 ($ 3121.23) ha^{-1}] and benefit cost ratio (2.68) with single eye bud seedling planted at 180 X 60 cm planting geometry and was on par with single eye bud seedling planted at 180 X 90 cm and 150 X 60 cm compared to conventional method of planting [₹. 92528 ($ 1423.50) ha^{-1} and 1.83, respectively)]. The cane was sold @ ₹ 2000 ($ 30.77) t^{-1} which generated a gross returns of ₹ 324000 ($ 4984) to 270000 ($ 4153.8) ha^{-1} in SEBSP technology with different geometry of cane cultivation compared to ₹204000 ($ 3138.4) ha^{-1} the conventionally grown crop (Table 2).

Water use

Single eye bud seedling planting technique also offers good scope in reducing the water requirement for sugarcane cultivation (Table 3). SEBSP technique under drip saved the water to the extent of 39 - 55 per cent. Similar findings were also observed by Pandian and Ambumani (2013).

It can be concluded that under drip irrigation, the cane yield obtained under SEBSP technology with 180 X 60 or 90 cm or 150 X 60 cm planting geometry was higher by 50 % compared to conventional method of planting. The study thus suggests that the single eye bud seedling planting technology of sugarcane is worth recommending particularly to the small and marginal farmers in command areas of Karnataka state, since it is not only high yielding and cost effective in a sustainable manner but can also attract a large number of farmers due to its ease of planting operations.

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