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SHORT COMMUNICATION

Studies on feasibility of sett planting through single eye bud technique for rapid multiplication of existing and new varieties in Saraswati sugar mills command area, Haryana, India

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Abstract
The conventional system of sugarcane (*Saccharum sp.*) planting is inefficient for rapidly multiplying the seed cane of newly released varieties due to a higher seed rate (7.5-8.0 t ha^{-1}) and low germination rate (40-50%). The present study was conducted at 8 sites in Saraswati Sugar Mill zone area of Haryana, India area during planting season 2017-18 and its subsequent ratoon 2018-19. The effect of planting methods on the multiplication rate of seed cane, yield potential and economics of sugarcane was calculated. Forty day old plantlets grown in polythene bags/trays/seedbed nursery using 19000 single-bud cane setts per ha area were transplanted at row to row and plant to plant distance of 120 x 45 cm. The results were compared with those obtained by the conventional practice of planting the three and two budded cane setts at the rate of 33600 and 50250 setts per ha, respectively. It was found that seedlings raised through bed nursery method recorded 46.39% higher cane yield (102.50 t ha^{-1}) than farmers' practice of conventional 3-budded method. The same also produced higher millable cane/ha (97620). The improved practices also recorded the higher gross return of Rs. 3, 48,500 ha^{-1}, B:C ratio (2.17) with additional net return of Rs.1,30,215 ha^{-1} over local check of conventional three eye budded method which can effectively be replaced in the existing farming situation for higher productivity. The results further indicated that the rate of seed cane multiplication was about 51.37 times by the bed nursery method and 7.99 times by the conventional planting method. The results of study showed that farmers could increase the sugarcane productivity significantly by switching over to improved technology.

Keywords: Single eye bud; Sett Planting; Planting Methods; New Varieties; Multiplication; Seedling; Cost of cultivation; Sugarcane seed; Haryana

Sugarcane is perennial, tropical or sub-tropical grass grown as a crop throughout the world at latitudes of 30ºN and 30ºS of the equator. Auxiliary buds present on its stem or stalk cuttings are used for the vegetative propagation of the crop (Mall et al. 2018; The crop reaches maturity in 10 to 12 months after planting.

At present, the total cultivable area of Saraswati Sugar Mills, Haryana, India is about 3.20 lakh acres. Out of this, the cane area under ratoon and plant crop is around 85000 acres. The existing varieties are Co 0118, Co 0239, CoH 160, Co 0238 and CoJ 85. In addition to these varieties, new varieties in pipeline namely Co 15023 and Co 15027 are also under seed multiplication in mill zone area.

One of the main expenditure in sugarcane production is the huge planting material which ranges from 22 to 25% of the total cost of cultivation (Srivastava et al. 1981). In case of newly released varieties, it becomes still expensive because cane growers may have to pay even due to scarcity of quality seed cane.

Therefore, it becomes important to develop an appropriate agro-technology for producing quality seed cane for planting sugarcane under such conditions. Number of techniques have been developed for rapid multiplication of seed cane of new promising varieties but could not be practical due to numerous problems. To sort out these problems, the sugar mill had adopted the Sett Planting techniques through single eye bud

developed by ICAR - Sugarcane Breeding Institute. Planting of single eye bud setts in polythene bags, trays and bed nurseries offer an opportunity for faster multiplication of newly released varieties of sugarcane since the conventional system with the average germination rate of 35- 40-% from 37,000 three eye bud cane setts (7.5-8.0 t ha^{-1}) wastes the valuable cane which otherwise could be used for crushing.

Materials and Methods

Experimental Site

Saraswati Sugar Mills, one of the private sugar factories in Haryana, India had conducted 8 field experiments in the mill zone area (two demonstration in each zone as total area of mill is divided in four zones) on sugarcane single bud sett transplanting method during season 2017-18 and its subsequent ratoon 2018-19. The average normal rainfall of this region is 1302.4 mm and more than 75% of the precipitation is received over five months i.e. June- October. The annual average maximum and minimum temperature of this region is 32.89^{0}C and 19.56^{0}C respectively.

Crop Culture:

1. Conventional planting

The sugarcane variety Co 0238 was planted using 33,600 and 50,250 three and two budded setts each at 8 and 7.5 t ha^{-1}, respectively in the first week of March at 120 cm row to row spacing. Before planting the setts, full doses of P_2O_5 (60 kg ha^{-1}), K_2O (50 kg $ha^{-1)}$ and $ZnSO_4$ (25 kg ha^{-1}) were applied in furrows. Soil and seed treatment with recommended fungicide and insecticide were done at the time of planting, while the 150 kg N ha^{-1} was top-dressed uniformly in the three split doses before rains i.e. July-August. Accordingly, all recommended package of practices were followed to raise the crop.

2. Direct Single eye bud (Full size) planting method

The sugarcane variety Co 0238 was planted using 30000 single bud cane setts ha^{-1}(each at 2.0 t ha^{-1}) during the month of March, 2017 at 120 x 30 cm spacing. Before planting the setts in the furrows, application of fertilizers was done similar to the conventional method and all recommended package of practices were followed to raise the crop.

3. Agro-technique for Polythene bag Method/ Tray Techniques

For the large scale production per unit area and rapid multiplication of seed material, use of polythene bag/trays for raising the settlings were adopted. It has been found from the past experience that using this method for faster seed multiplication involves almost same cost as conventional three budded method but improved rate of multiplication in contrast to the normal practice of planting.

Method: A mixture of 1:1:2 of soil, sand and decomposed FYM/press mud/coco peat was filled in polythene bags and trays having size of 10 x 15 cm and 60 x 30 x 6 cm, respectively. For the purpose of proper aeration and drainage of excessive water, small holes were made at certain places in polythene bags/trays. Healthy seed cane setts were dipped in 0.2 percent mixture of carbendazim plus imidacloprid solution for 20 minutes after which the setts had been planted in the soil mixture contained in polythene bags/trays. After that poly-bags/trays were placed on properly levelled ground. Irrigation was given either daily or at alternate days as per the requirement so as to avoid the water stagnation. After 30-45 days, emergence of four to five leaves indicating that the settlings are ready for transplanting. In total, 20,000 settlings prepared from 1.5 t of cane seed and transplanted in one hectare area by

Table 1. Soil Texture of Command Area (% area)

Sandy	Loam	Sandy Loam	Loamy Sand	Clay	Clay Loam
8.27	54.90	6.62	18.30	2.40	9.51

Table 2. Soil pH of Command Area (% area)

pH	Acidic	Normal	Alkaline
	0.42	97.38	2.20

Table 3. Macro-Nutrient Status of Command Area Soil (% area)

Parameters	Low	Medium	High
Organic Carbon	31.00	62.00	7.00
Phosphorus	28.25	39.66	32.09
Potassium	44.40	46.79	8.81

Table 4. Micro-nutrient status of command area Soil (% area)

Nutrient	Low	Sufficient
Zn	13	87
Fe	19	81
Mn	15	85
Cu	3	97

adopting crop geometry of 120 cm x 45 cm. For transplanting the settlings, normal transplanting method was adopted.

4. Raising settlings nurseries on beds

In case of late planting such as planting sugarcane after wheat, this method is very useful as this provides the extra time to the farmer to grow the crop. Nearly a month before transplanting, this procedure is to be followed. Nurseries are raised in small area of 5 x 10 m by using 1.5 t cane seed ha^{-1}. Upper half portion of the cane stalk is favoured for single bud setts which are cut 4-5 cm below and above the bud. Setts thereafter are soaked in a suspension of 0.2% Carbendazim 50 % WP + Imidacloprid 17.8 % SL solution. Normal irrigation is applied for proper germination. Most of the buds get sprouted after 4-5 weeks and produce four to five leaves. This time is considered the right time for transplanting the settling.

5. Settling transplanting method

Preparation of land was done as per the normal conventional method. About forty days old plantlets each bearing 4-5 leaves and a height of 20-25 cm were de-topped. Before transplanting, roots of settlings were dipped in 0.2 percent suspension of Carbendazim 50 % WP + Imidacloprid 17.8 % SL for 30 minutes. About 20000 Settlings were transplanted per hectare in rows at 120 x 45 cm spacing. Settlings were transplanted in the soil leaving at least 5 cm of the shoot above the soil surface. Irrigation in furrows before the transplanting was preferred for easy establishment of settlings. Light irrigation in

furrows after transplanting is also very important as per the requirement.

Observations related to different parameters such as cane yield were recorded and economic analysis was done by calculating cost of cultivation, gross return, net return and B: C ratio. Final cane yield was multiplied with the prevailing mill price of the produce to get the gross returns.

Results and Discussion

1. Germination percentage

Observation on mean germination percentage of cane buds at 45 and 60 days after planting (DAP) revealed that polythene bag/tray culture method recorded higher germination percentage (84.26 and 88.41%,) as compared to conventional method followed by bed nursery method (75.32 and 85.74%). The lowest germination rate was observed in conventional method of planting i.e. 45.20 and 48.22%, at 45 and 60 days after planting (DAP) respectively. The improved rate of germination in case of the polythene bag culture method may be attributed to continuous application of water in the nursery.

2. Growth, multiplication ratio and yield of sugarcane

As shown in Table 5, highest number of tillers was produced by the polythene/tray method. The lowest no. of tillers was in conventional three budded sett planting method (T1) and number of millable cane and yield in this treatment was also significantly lower than other treatments due to highest mortality rate among all the treatments. Table 5 shows that highest number of millable canes (97,620) was produced in bed nursery method followed by direct single bud planting (96,250), polythene/tray nursery (95,360), conventional two budded sett planting (86,570) and conventional three budded sett planting (80,490). Highest cane yield was obtained in bed nursery method. Yield of bed nursery, direct single bud planting and Polythene/tray method was also higher as compared to conventional methods. The per cent increase in yield over conventional three budded sett planting was 46.39% in bed nursery followed by 32.10% in direct single bud planting, 24.96% in polythene/tray nursery method and 17.46% in conventional two budded sett planting method. Moreover, the transplanting method also saved valuable seed material by necessitating only 1.5 t ha^{-1} seed cane for planting as compared to 7.5-8.0 t ha^{-1} by the conventional method. The higher number of tillers and millable canes by the bed nursery, direct single bud and polythene/ tray method resulted in a higher seed cane yield and it was principally due to plentiful and equal space provided to the transplanted setts, which is necessary for penetration of sufficient light to the plants. In the conventional system, low germination percentage and high mortality rate resulted in gaps and low yield.

The seed multiplication ratio in bed nursery and polythene method was 51.37 and 50.18 times as compared with that of 32.08, 8.61 and 7.99 times in direct single bud planting, conventional two budded sett planting and conventional three budded sett planting, respectively (Table 5). A higher multiplication rate of seed cane was obtained by the bed nursery and direct single bud planting possibly due to higher rate of germination (85-90%) in cane buds and more millable canes coupled with the corresponding values of germination.

3. Economic efficiency and cost of cultivation

As depicted in Table 6, the results of economic analysis of different method of planting of sugarcane revealed that for rapid multiplication of seed of new variety as well as for existing varieties, cost of seed material was reduced significantly by the use of bed and direct single eye bud planting

Table 5. Outcome of method of planting on germination, growth, multiplication ratio and sugarcane yield (Co - 0238)

Treatments	Germination of Buds (%)		No. of buds used for planting ha^{-1} (a)	No. of tillers (000 ha^{-1})	No. of millable canes (000 ha^{-1})	Total no. of buds obtained(@10 viable buds per cane) (b)	Multiplication ratio (b/a)	Cane Yield (t ha^{-1})	% increase in yield over conventional 3 budded	Mortality (%)
	45 DAP	60 DAP								
T1: Conventional 3 budded sett planting	45.20	48.22	1,00,800	114.20	80.49	8,04,900	7.99	70.02	-	29.52
T2: Conventional 2 budded sett Planting	52.30	63.25	1,00,500	115.5	86.57	8,65,700	8.61	82.25	17.46	25.05
T3: Direct Single Bud Planting`	60.85	75.70	30,000	122.70	96.25	9,62,500	32.08	92.5	32.10	21.56
T4: Polythene/Tray nursery	84.26	88.41	19,000	129.80	95.36	9,53,600	50.18	87.5	24.96	26.53
T5: Bed Nursery	75.32	85.74	19,000	126.70	97.62	9,76,200	51.37	102.5	46.39	22.95

method. The cost of cultivation was less and net return increased by the bed method (Rs 1,30,215/ ha) as compared to conventional 3 budded method. It was also found that bed system of planting recorded higher gross returns (Rs 3,48,500 / ha) and net returns(Rs 2,38,583 /ha) whereas in conventional 3 budded method, the gross returns (Rs 2,38,748/ha) and net returns(Rs1,08,368 / ha.) was lowest. The benefit cost ratio of bed nursery method (2.17) was also more than the conventional method (0.89) due to higher net return. The variation in net return and benefit-cost ratio may attribute to the variation in the price of agri inputs and produce (Mohanty et al. 2014).

Seedling programme in Mill command area

Based on the result of field experiment on different methods of sugarcane planting, Saraswati sugar mills had taken up the seedling programme on large scale in mill zone area and achieved great success. Bed nursery method has been promoted by the mill over the other methods of planting because of low mortality rate and higher yield. The data related to area and no. of seedling prepared in the planting season 2019-20 has been given in the Table 7 and 8.

The study indicated that planting of single eye bud of sugarcane or preparation of sugarcane nurseries in polythene/tray or bed could be a viable technique in reducing the cost of sugarcane production, if necessary precautions are taken in handling of seed material and their subsequent multiplication in the field. This saves several thousand tons of valuable raw materials that could be used for extracting sugar. Additionally, raising of settlings in small area of land of individual farmers would significantly decrease its cost and also help in propagation of new and improved cane varieties. Seedlings raised in bed nurseries are recommended strongly as compared to polythene/tray nurseries due to their higher survival percentage in the field with healthy crop stand. The reason of high mortality in tray method could be due to very small size of single bud sett and limited quantity of soil media with very low nutrient availability to the plant at initial stage of growth and establishment. The use of single bud seedlings raised in nursery saves 60-70% of the seed cost apart from better growth and yield. The per cent increment in yield of sugarcane to the extent of 46.39% in bed nursery method

Table 6. Effect of different method of planting on economics

Methods	Cost of cultivation (Rs/ha)	Gross Return (Rs/ ha)	Net Return (Rs/ha)	B:C ratio
Conventional (3 budded)	1,30,382	2,38,748	1,08,368	0.89
Conventional (2 Budded)	1,30,892	2,79,650	1,48,758	1.13
Direct Single eye bud planting	1,13,892	3,14,500	2,00,608	1.76
Polythene/Tray method	1,28,880	2,97,500	1,68,620	1.31
Bed Nursery	1,09,917	3,48,500	2,38,583	2.17

Table 7. Variety- wise area (acres) and seedling (no.) raised through polythene/tray techniques

Sr. No.	Varieties	Autumn Planting		Spring Planting		Total	
		Area	Seedling	Area	Seedling	Area	Seedling
1	Co 0118	6.00	50,500	3.75	31,300	9.75	81,800
2	Co 0239	18.00	1,46,700	9.50	76,000	27.5	2,22,700
3	CoH 160	2.50	20,000	3.00	24,000	5.50	44,000
4	CoJ 85	-	-	0.75	6,300	0.75	6,300
5	Co 0238	22.50	1,83,000	38.50	3,09,200	61.00	4,92,200
6	Co 15023	0.25	1800	19.00	1,52,000	19.25	1,53,800
7	Co 15027	-	-	10.75	87,000	10.75	87,000
Total		49.25	4,02,000	85.25	31,300	134.50	1,08,7800

over the conventional 3 budded method was due to high germination percentage less mortality. It also created awareness and encouraged other farmers to take up the improved method of sugarcane cultivation. The on hand farmer's practice of conventional method can successfully be replaced by bed or direct single eye bud planting method in the existing farming situation for higher productivity and profitability. It could be concluded that single bud planting programme is an effective tool for increasing the production and productivity of sugarcane. Bed nursery and polythene bag method is a cost-effective approach for rapidly multiplying newly released varieties of sugarcane and seed rejuvenation of existing varieties for sustainability of these varieties in command area of sugar mills.

Table 8. Variety- wise area (acres) planted through direct single eye bud (no.) technique

Sr. No.	Varieties	Autumn Planting		Spring Planting		Total	
		Area	Single bud	Area	Single bud	Area	Single bud
1	Co 0118	8.00	96,000	4.50	54,000	12.50	1,50,000
2	Co 0239	13.50	1,62,000	9.75	1,17,000	23.25	2,79,000
3	CoH 160	1.250	15,000	3.50	42,000	4.75	57,000
5	Co 0238	12.50	1,50,000	33.50	4,02,000	46.00	5,52,000
6	Co 15023	-	-	23.50	2,82,000	23.50	2,82,000
7	Co 15027	-	-	14.25	1,71,000	14.25	1,71,000
Total		35.25	4,23,000	89.00	10,68,000	124.25	14,91,000

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