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Comparative effect of polybag culture and conventional methods of planting at different dates on rapid multiplication of seed cane (*Saccharum* species complex) in sub-tropical India

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ABSTRACT

The conventional system of sugarcane planting is less efficient in rapidly multiplying the seed cane of newly released varieties due to higher seed rate (6 tonnes/ha) and low germination (35–40%) in sub-tropical climatic conditions of India. The present investigation was, therefore, carried out during 2005–06 and 2006–07 cropping seasons to assess the effect of poly-bag culture and conventional methods of planting at different dates on rapid multiplication of seed cane. One-month old single cane bud settlings grown in poly-bags were transplanted 45 cm apart in furrows of 90 cm spacing and the results compared with the usual practice of using three- bud seed pieces planted at the rate of 38 000/ha. Results showed that the poly-bag culture raised sugarcane produced significantly higher germination of cane buds (87.72%), number of shoots (19 8 000/ha) and millable canes (124 000/ha) as against the corresponding values of 35.95%, 186 000/ha and 116 000/ha, respectively under conventional sett method, which is an advantage for seed cane multiplication. The cane yield obtained under both the methods was statistically at par, however, conventional sett method produced significantly higher seed cane yield than that of poly-bag culture in February planting but, it was statistically at par in March and April, and for May plantings, the reverse trend was noticed where poly-bag culture raised crop significantly out-yielded conventionally planted crop. The results further indicated that poly-bag culture raised sugarcane multiplied seed cane by 36 times as against 11 times observed under conventional method. The cost of cultivation of poly-bag culture crop versus the conventional method was nearly equal.

Key words: Planting system, Polybag culture, Seed cane multiplication, Sugarcane

Sugarcane (*Saccharum* species complex) is an important agro-industrial crop grown primarily for sugar in tropical and sub-tropical parts of India under diverse agro-climatic conditions. It is cultivated commercially by planting portions of cane stalk known as seed pieces, cane setts or seed cane. In normal course, about 38,000 three-bud cane setts (6–7 tonnes/ha) are required per planting in 1 ha area. It ranges 20–25% of the total production cost as the use of such seed material in bulk is one of the major items of the expenditure in sugarcane cultivation. Due to non-availability of healthy seed material in desired quantity, farmers have no option but to grow the crop with old and degenerated varieties of sugarcane. As a result, farmers obtain low cane yield with the same cost of cultivation and even after performing all recommended package of practices. Availability of healthy seed material for distribution to the cane growers is an important pre-requisite for achieving the desired yield and quality improvement. Sugarcane, being a vegetatively propagated crop, has a low 1:6 to 1:9 seed multiplication rate. Hence, non-availability of quality seed material is one of the major problems faced by farmers. On account of these problems, it becomes imperative to develop an efficient method of agro-technique for availability of sufficient quantity coupled with optimum quality of healthy seed cane for planting of sugarcane. Therefore, it is an utmost need to rapidly multiply the newly released varieties of sugarcane to ensure availability of sufficient seed stock for distribution to the growers. In general, it takes more than 6–7 years to develop and release a new variety for commercial cultivation. It further takes about 7–8 years to spread the variety in remote areas if the seed production programme is devised simply by the conventional techniques. By this time, the varieties

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starts declining in yield and quality due to increasing load of different disease causing microbes and other environmental factors. Several techniques such as planting of single bud setts directly in the field, development of hydroponics' nursery, planting with pre-germinated buds, planting with tissue culture derived plantlets and spaced transplanting (STP) technique have been tried for multiplication of seed cane of promising varieties at a faster rate (Panje 1965, Srivastava *et al.* 1981, Yadav 1993). These techniques could not be transferred to the farmers' fields in the broader spectrum due to one or the other reasons. Sugarcane bud chips technique has also been tried for faster multiplication of seed cane of newly released varieties of sugarcane (Sugarcane Breeding Institute 2007). To find the solution of these problems, Singh *et al.* (1995) initiated the method of raising poly-bag nursery from young buds of spindle region of sugarcane plants and transplanted the plantlets in the field. In case of scarcity of planting material, buds from upper 2/3rd portion of sugarcane stalk having more reducing sugar content and even from the whole cane may also be tried for rapid multiplication. Planting single bud setts in poly-bags may provide an opportunity to express the genetic potential of a variety for tillering and yield. Keeping these constraints in view, the method of poly-bag culture was tried for seed cane production at the Indian Institute of Sugarcane Research, Lucknow, during 2005–06 and 2006–07.

MATERIALS AND METHODS

A field experiment was conducted for two crop cycles of sugarcane plant crop during 2005–06 and 2006–07 at the Indian Institute of Sugarcane Research, Lucknow, India located at 26°56'N, 80°52'E and 111 m above mean sea level with semi-arid sub-tropical climate having dry hot summers and cold winters. The soil of the experimental field was sandy loam (13.7, 24.6 and 62.5% clay, silt and sand, respectively) of Indo-Gangetic alluvial origin, very deep (>2 m), well drained, flat and classified as non-calcareous mixed *hyperthermic udic ustochrept*. The initial organic carbon, available N, P and K of the experimental soil were 14.3 Mg/ha and 177, 12.3 and 197.2 kg/ha, respectively.

Crop culture

Conventional sett planting: The crop was planted using 38 000 three-bud cane setts/ha in the first week of February, March, April and May during 2005 and 2006 at 90 cm row spacing. Before placing setts in furrows, half the dose of required nitrogen, i.e. 150 kg N/ha and full doses of P and K (60 and 60 kg/ha, respectively) applied in furrows beneath the cane setts using urea (46.4% N), single super phosphate (6.98% P) and potassium chloride (49.8% K). Insecticide, chlorpyriphos (20% EC) was sprayed over cane setts before covering them to safeguard against termite and early shoot borer. The crop received four pre-monsoon irrigations with a view to have optimum soil moisture for cane growth. Remaining dose of 75 kg N/ha through urea was top-dressed uniformly in the first week of June.

Preparation of soil mixture

Field soil, compost and sand were taken in equal proportions, mixed thoroughly and sieved through 4 mm sieve. The soil mixture was treated with chlorpyriphos 20 EC @ 100 ml/tonne. The mixture was filled in perforated poly-bags (size 12.5 × 12.5 cm). The filled bags were arranged in small plots (1.20 m × 10 m).

Seed preparation

About 6.0 cm long pieces, each containing one healthy undamaged bud, were cut from the freshly harvested sugarcane variety CoSe 92423 for raising the nursery. The pieces were taken from upper two-third portion of canes using a sharp cutter. About 23 500 single bud pieces were required for raising the nursery to transplant in 1 ha area. The pieces were soaked in water for 6–8 hrs before planting.

Seed treatment

100 g of fungicide bavistin (0.2%) along with 2.5 g of each (for 50 ppm concentration) of two growth regulators gibberallic acid (GA_3) and naphthalene acetic acid (NAA) were mixed in 50 liters of water and mixed thoroughly. The single bud pieces, soaked for 6–8 hrs in water were treated with this solution for 10 min.

Implanting in polybags

After seed treatment, the pieces were planted in polybags containing soil mixture on the same dates of conventional sett planting, in such a way that the buds remained about 2.5 cm below the surface of soil mixture. A light irrigation was given to the plots where the polybags were kept, so that the water absorbed by the soil mixture through the perforations reaches up to the soil surface. Nursery was covered with dry leaves of sugarcane to maintain the humidity. After every 4–5 days, water was sprinkled over the nursery to maintain the proper moisture level till the completion of germination.

Field transplantation

About one-month old plantlets each bearing 4–5 leaves and attaining heights of 15–25 cm were transplanted into the field after proper nipping of leaves (2–3 cm from tips). Transplanting was carried out one month later from the scheduled date of conventional planting in well prepared field at a distance of about 45 cm between the plants in 20–24 cm deep furrows 90 cm apart. During transplanting the poly-bags were removed, the plants were placed in furrows and the root zone along with the ball of soil mixture was covered with the neighboring field soil. Basal dose of fertilizers was given as per conventional method of planting and placed at the base of every transplant in the furrows. Field was immediately

irrigated after transplanting. The other agronomic practices followed were same as in the case of conventional planting.

Observations

The experimental crop of sugarcane raised from poly-bag cultured seed nursery (M_1) and conventional sett planting (M_2) at different planting dates from February through May was assessed for growth, yield and quality of sugarcane under factorial randomized block design with three replications. Germination per cent, number of shoots, number of millable canes and seed cane yield of different treatments were studied at appropriate stages. At harvest, ten canes were randomly selected from each plot for estimation of juice quality parameters following standard methods. Sucrose (%) in juice was determined as per the method described by Meade and Chen (1977). Sugar yield was calculated after multiplying CCS (%) and seed cane yield.

Statistical analysis of data

The data of each crop season were statistically analyzed separately. The homogeneity of error variance was tested using Bartlett's χ^2 test. As the error variance was homogenous, pooled analysis was done according to Cochran and Cox (1957). Since the variation between the two seasons was not significant, the mean data of two crop seasons were considered for results and discussion. Some treatments were compared under factorial randomized block design. The critical difference (CD) was computed to determine statistically significant treatment differences.

RESULTS AND DISCUSSION

Germination of cane buds

Experimental data presented in Table 1 revealed that the mean germination of cane buds, recorded over different dates of planting from February through May, was significantly higher (87.72%) under poly-bag culture than that of conventional planting by three bud setts (35.95%) in field. Results of field experiments particularly in sub-tropical India have amply proved that 33% germination is generally obtained from three-bud cane setts planting due to apical dominance in young and terminal buds. Thus, terminal (youngest) bud will germinate rapidly and at the same time it retards or even inhibits the development of lower buds, with a result that the average germination percentage will be less as compared to the shorter cuttings. In poly-bag culture, the setts were pre-soaked in water to dilute the growth retarding substances and afterwards treated with NAA for root development and GA_3 to induce precocious bud break for quick germination. In poly-bag culture, it is possible to select healthy single bud cane setts for nursery raising in a protected environment particularly due to less quantity of seed material used. Horizontal placement of well treated setts in perforated poly-bags facing buds upward, keeping them to 2–3 cm below the pulverized soil mixture and ambient humidity on account of frequent but light irrigation, accelerated the process of cane buds germination, which under these circumstances required less energy to reach to the soil surface.

Significant difference was observed in the germination percentage of cane buds under poly-bag culture at different dates of planting from February through May. The mean germination being 29.71, 63.47, 78.09 and 87.72% at 10, 20, 30 and 40 days after planting (DAP), respectively whereas, under conventional method the corresponding values were 0, 12.61, 32.14 and 35.9%. Germination recorded at 30 DAP and 40 DAP under poly-bag culture were statistically at par except for February and March plantings at 30 DAP. The germination per cent of cane buds planted during April and May was significantly higher as compared to February and March both at 10 DAP and 20 DAP. It thus, indicates that implanting sugarcane buds in poly-bag during April and May months give appreciably higher germination

Table 1 Effect of methods and dates of planting on germination of cane buds in polybag culture and conventional methods

Treatment	Germination (%) of cane buds				Mean	CD (P=0.05)
	10 DAP	20 DAP	30 DAP	40 DAP		
Polybag culture method						
February	15.18	38.52	64.42	83.20	50.33	Planting dates = 4.67
March	26.31	54.80	75.16	86.34	60.65	Days of planting = 4.67
April	34.62	78.47	84.27	88.18	71.39	Dates × days = 9.35
May	42.73	82.08	88.51	93.17	76.62	
Mean	29.71	63.47	78.09	87.72		
Conventional sett method						
February	0	9.32	28.31	34.61	24.08	Planting dates = 3.16
March	0	11.40	30.62	36.44	26.15	Days of planting = 3.16
April	0	13.26	34.55	35.58	24.13	Dates × days = 6.32
May	0	16.86	35.08	37.18	29.71	
Mean		12.61	32.14	35.95		

DAP, Days after planting

than that of earlier months implanting (Table 1). It was basically due to increase in atmospheric temperature from February onwards in sub-tropical India, which is a pre-requisite for better germination.

Growth and yield of seed cane

A perusal of data (Table 2) revealed that the sugarcane crop raised through poly-bag culture method under different dates of planting from February through May produced significantly higher number of shoots and millable canes as compared to conventionally grown crop. However, the yield of seed cane and commercial cane sugar (%) did not alter significantly between the two methods. The higher number of shoots and millable canes under poly-bag culture method was primarily due to ample but equal space provided to all the transplanted settlings, which is necessary for penetration of sufficient sunlight to the plants. Suryavanshi *et al.* (2010) and Rahman *et al.* (2004) also reported similar findings. In conventional system, the setts were grown in rows of 90 cm spacing and were arranged in a series which results into uncontrolled germination and gaps. This adversely affects the number of shoots and millable canes per unit area and for each sett planted.

Planting dates from February through May under both the methods had significant effect on the number of shoots, millable canes and the yield of seed cane (Table 2). Significantly higher number of shoots, millable canes and cane yield were observed when transplanting/planting was carried out in February as compared to March, April and May. The decreasing trend was primarily due to restricted time span for tillering and growth of the plants. Increasing atmospheric temperature, severe dry winds, rapid loss of moisture from soil and cane setts and limited water resources for irrigation adversely affect the growth and development of cane plants in subtropical India. Commercial cane sugar (%) followed almost the similar trend as the seed cane yield obtained under different treatments.

The interaction effect between methods and dates of planting was found significant for cane yield. Results indicated that conventionally grown sugarcane by sett method in February produced significantly higher cane yield than that of 1-month old poly-bag raised settlings transplanted in the field in the month of March. The differences in cane yield under both the methods were statistically at par in March. This indicates that transplanting of one-month-old settlings of poly-bag method in April gave cane yield at par to that obtained from conventional crop of March. Further, it was found that when transplanting of one-month-old settlings raised through poly-bag culture was done in the month of May and June, it produced significantly higher cane yield than that obtained from conventional crop planted in April and May. This indicates that sugarcane crop raised through poly-bag culture method, during the later part of the spring season (i.e. after harvest of wheat in April/May) may be better for obtaining higher cane yield as compared with conventional method of planting. Higher seed cane yield as observed under poly-bag culture method raised sugarcane crop in later part of the spring season was clearly due to quick germination of single cane bud setts in poly-bags. Quick germination triggered early growth of cane plants resulting into the better overall growth and development of cane plants.

Seed cane multiplication and cost of cultivation

The seed multiplication ratio was computed on the basis of average number of millable canes per clump and germination of cane buds obtained from the planting of 100 healthy buds in each method, separately. The results indicated that poly-bag culture raised sugarcane multiplied seed cane by 36 times as against 11 times observed under conventional

Table 2 Effect of methods and dates of planting on number of shoots, millable canes, seed cane yield and commercial cane sugar

Treatment	Number of shoots ('000/ha)	Number of millable canes ('000/ha)	Seed cane yield ('000/ha)	Commercial cane sugar (%)
Methods of planting				
Polybag culture	198	124	77.71	11.45
Conventional	186	116	76.42	11.40
CD (*P*=0.05)	8.58	6.38	NS	NS
Dates of planting				
February	217	136	89.50	11.52
March	201	128	82.25	11.48
April	181	115	71.76	11.44
May	170	102	63.95	11.25
CD (*P*=0.05)	8.06	6.04	4.54	NS

Table 3 Seed cane multiplication ratio through polybag culture and conventional methods*

Particulars	Conventional	Polybag culture
Number of canes taken for multiplication	10	10
Number of healthy buds obtained from 10 canes	100	100
Number of plants obtained after germination	36 (at 35.95% germination)	88 (at 87.72% germination)
Average number of millable canes/clump	03	04
Total number of canes produced from initial 10 canes	108	352
Approximate multiplication ration	108/10 = 11 times	352/10 = 36 times

*on the basis of observations recorded on average number of canes/clump and germination per cent

Table 4 Economics of polybag culture and conventional methods of planting (₹/ha)

Operation/item	Polybag culture	Conventional
Field preparation	2 816	2 816
Seed and seed preparation		6 924
conventional method at 6 tonnes/ha		
Polybag culture method at 1.2 tonnes/ha	1 794	
Cost of polybags (25 kg)	1 750	
Cost of soil mixture	475	
Cost of fungicide and growth hormones	500	55
Filling of polybags	3 000	
Nursery maintenance + irrigation	600	
Furrow opening for planting	692	692
Planting	825	544
Fertilizers and their application	3 444	3 444
Irrigation	6 254	5 138
Inter-culture operations	6 862	6 862
Plant protection measures		
At planting		2 586
During growth period	3 000	3 000
Harvesting	6 225	5 858
Supervision etc.	1 000	1 000
Total cost of cultivation	39 237	38 919

sett method of planting (Table 3). Higher multiplication ratio of seed cane under poly-bag culture raised crop was obtained primarily due to higher germination (87.72%) of cane buds and more number of millable canes/clump (04) as compared to corresponding values of 35.95% germination and 03 millable canes under conventional method. The results also exhibited that with higher seed cane multiplication ratio and reduced quantity of seed material (1.2 tonnes/ha) required for planting as against 6.0 tonnes/ha under conventional method, the polybag culture technique may be worth adopting by cane growers in general for multiplying the seed of newly released varieties of sugarcane. Kapur *et al.* (2011) also stressed for efficient methods of seed cane multiplication of newly released varieties for prolonging their commercial life and better realize their genetic potential for yield and quality, without wasting time and energy in conventional methods of sugarcane planting by 3-bud setts.

Table 4 represents the cost of cultivation for raising one ha crop from polybag culture in comparison to conventional crop. It also indicates that with the slightly higher cost of cultivation, planting of sugarcane by poly-bag culture method can be adopted by small and marginal farmers as well.

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