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Yield Comparisons: Tissue Culture Seedlings versus Single Bud Setts

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A B S T R A C T

Four sugarcane varieties and three explants derived seedlings were utilized to assess the yield with respect to single bud setts and observed *In vitro* grown plants showed better response for certain characters.

Introduction

Sugarcane (*Saccharum officinarum* L.) is a monocotyledonous plant belongs to tribe Panicoideae, sub-tribe Andropogoneae of the family Gramineae (poaceae) and supposed to have originated in New Guinea. Importance of sugarcane has increased in recent years because it provides juice for making sugar, molasses which is used in the production of ethanol, bagasse is burned to provide heat and electricity for sugar mills, cane tops used as fuel wood and animal feed (Tolera and Shimelis, 2016).

India is the second largest producer of sugar in the world after Brazil occupying 5.0 million hectare area with average cane yield of about 69.4 tonnes per hectare while the production is around 3.4 lakh tonnes. Whereas, in Andhra Pradesh sugarcane is grown in 1.57 million hectares area with production of 1.2 lakh tonnes and productivity of 79.42 tonnes per hectare during 2015-2016 (*Cooperative sugar*, 2017).

Tissue culture raised sugarcane plantlets were reported to be superior in cane height, stalk girth, number of millable canes per clump, more sugar recovery percent, cane yield per hectare with broader and green leaves as compared to their donors (Ramanand *et al.*, 2005). Stalk diameter and stalk weight were lower and stalk population was higher for

plants derived from leaf roll callus compared to bud propagated cane in the study conducted by Jeffrey *et al.,* (2003). Thus response of varieties and explants to tissue culture protocols vary prohibiting direct supply of tissue culture seedlings to farmers for commercial cultivation. Assertion of performance of varieties propagated through micropropagation techniques thus assumed importance.

Materials and Methods

In the present research work, Sugarcane clones; 87A298, Co86032, CoT8201 and 2003V46 which are still popular occupying larger area in Andhra Pradesh were chosen for the source of three explants (shoot tip, leaf roll and apical meristem) for each clone. The plantlets which were regenerated through micropropagation of four varieties and their respective controls were taken as the planting material for evaluation under field condition.

Micropropagated plants (12 treatments) along with respective controls (4) were planted in Randomized Block Design (RBD) with two replications. Spacing adopted was 120 cm between furrows 60 cm between plants at Agricultural Research Station, Perumallapelle, Tirupati. Data were collected on five randomly selected clones in each treatment in each replication. Observations were recorded in terms of Seedling establishment percentage, Number of tillers at 120 days, Cane length (cm), Cane girth (cm), Number of internodes, Internode length (cm), Number of millable canes (t ha^{-1}), Single cane weight (kg), Cane yield (t ha^{-1}).

Seedling establishment percentage was recorded after 12-15 DAP. It was calculated by the number of plants established to the total number of plants. Number of tillers was counted manually at 120 DAP. Tillers population per plot was arrived by taking the cumulative total of all rows and expressed as 000' ha^{-1}.

Length of cane was measured using measuring tape from the base to last transverse mark and mean data was expressed in centimetres (cm). Cane girth was measured perpendicular to bud at the mid-point of cane half way between two nodes with the help of Vernier caliper and the mean data was expressed in centimeters (cm). Number of internodes per stalk was recorded by counting total internodes from the surface of the soil to the top of most visible internode of the stalk at 12 months after transplanting. The length of internode was noted by measuring length in centimeters between two nodes from three portions *i.e.* bottom, middle and top portion of the stalk and averaged to get the mean length of internode at 10 months after transplanting. Total number of canes in each treatment were counted at 300 DAP and expressed as NMC per plot. Fully developed cane with a minimum height of one meter shall be considered as millable cane. Single cane weight was derived by averaging the weight of five canes harvested randomly from each treatment at the time of maturity. The weight of canes in net plot after detrashing and detopping just below the spindle was recorded utilizing the very platform balance. The value was converted to tons per hectare.

Results and Discussion

Seedling establishment per cent ranged from 59 per cent to 87 per cent (Table 1). High seedling establishment per cent (87 per cent) was recorded in T_2 (87A298 from leaf roll) and T_4 (87A298 control). Among four varieties, mean number of seedling establishment per cent was high in 87A298. Among all the treatments, controls recorded high seedling establishment per cent than the tissue culture raised plants. Single bud sett seedlings used for controls established better than tissue culture seedlings.

Maximum number of tillers per hectare (111) was recorded in T_{13} (2003V46 shoot tip) (Table 2). Among four varieties, mean number of tillers per hectare was recorded in 2003V46. All the treatments of 87A298 produced maximum number of tillers per hectare than control. Among 87A298, T_2 (87A298 from leaf roll) recorded maximum number of tillers. In both the treatments of Co86032 and CoT8201, controls recorded maximum number of tillers than the tissue culture plants. All the treatments of 2003V46 recorded maximum number of tillers than the control. T_{13} (2003V46 from shoot tip) recorded maximum number of tillers (111) than other treatment of 2003V46. Similar findings were in agreement with (Sood *et al.,* 2006) for tillering.

Significant variation among 16 treatments was observed (Table 1) for this character which was ranged from 39.9 to 76.2. Maximum number of millable canes (76.2) was recorded in T_{13} (2003V46 from shoot tip). Among four varieties, mean number of millable cane was high in 2003V46. All the treatments of 87A298 produced more number of millable canes than control. T_1 (87A298 from shoot tip) recorded higher number of millable canes (64.6) than the other explants of 87A298. T_7 (Co86032 from apical meristem) recorded higher number of millable canes (65.3) than control. Among all treatments of CoT8201, T_{11} (CoT8201 from apical meristem) and T_{12} (CoT8201 control) recorded higher number of millable canes (49.0). All the treatments of 2003V46 produced more number of millable canes than control. T_{13} (2003V46 from shoot tip) recorded higher number of millable canes (72.0) than the other explants of 2003V46. Similar findings were in agreement with Saksena *et al.,* (2015) for number of millable canes.

Significant variation among 16 treatments was observed (Table 1) for this character which ranged from 239.1 cm to 264.9 cm. Maximum cane length (264.9 cm) was recorded in T_1 (87A298 from shoot tip). Among four varieties, mean cane length was higher in 87A298 when compared with all the varieties. All the treatments of 87A298 produced higher cane length than control. T_1 (87A298 from shoot tip) recorded higher cane length (264.9 cm) than the other explants of 87A298. All the treatments of Co86032 and CoT8201 produced lower cane length than control. All the treatments of 2003V46 produced higher cane length than control. T_{13} (2003V46 from shoot tip) recorded higher cane length (246.7 cm) than the other explants of 2003V46. Similar findings were in agreement with Saksena *et al.,* (2015) for cane length.

Cane girth showed variation among the treatments (Table 1). The range of cane girth was 2 cm to 3.98 cm. Maximum cane girth (3.98 cm) was recorded in T_1 (87A298 from shoot tip). Among four varieties, mean cane girth was higher in 87A298. Within 87A298, T_1 (87A298 from shoot tip) recorded higher cane girth (3.98 cm) than the other explants of 87A298. All the treatments of Co86032 and CoT8201 produced lower cane girth than control. All the treatments of 2003V46 produced higher cane girth than control.

T_{13} (2003V46 from shoot tip) recorded higher cane girth (3.28 cm) than the other explants of 2003V46. Similar results of lower cane girth in tissue culture derived plants were reported by Saksena *et al.,* (2015) and Tolera and Shimelis (2016)

Significant variation among 16 treatments was observed (Table 1) for this character which ranged from 20.1 to 26.7. Maximum number of internodes (26.7) was recorded in T_1 (87A298 from shoot tip). Among four varieties, mean number of internodes was higher in 87A298 when compared with all the explants.

Table.1 Comparative performance of tissue culture raised plants for yield traits

Treatments	Variety/Explant	Seedling establishment (%)	Tillers at 120 DAP ('000/ha)	NMC ('000/ha)	Cane length (cm)	Cane girth (cm)	No. of internodes	Internode length (cm)	Single cane weight (Kg)	Cane yield (t/ha)
T_1	87A298 ST	66	90	64.6	264.9	3.98	26.7	13.0	1.74	112.7
T_2	87A298 LR	87	91	64.4	262.9	3.79	26.5	13.2	1.76	113.9
T_3	87A298 M	63	66	43.2	259.8	3.70	25.4	12.9	1.80	77.3
T_4	87A298 Control	87	60	39.9	246.5	3.44	23.1	12.1	1.71	69.1
	Mean	75.7	76.7	53.0	258.5	3.73	25.4	12.8	1.75	93.2
T_5	Co 86032 ST	74	88	64.3	240.3	2.30	20.8	13.4	1.32	85.1
T_6	Co 86032 LR	69	74	54.3	241.8	2.14	21.0	13.1	1.28	69.7
T_7	Co 86032 M	62	96	65.3	239.3	2.00	20.6	12.9	1.38	89.5
T_8	Co 86032 Control	87	98	61.5	243.5	2.88	22.6	13.9	1.42	86.9
	Mean	73.0	89.0	61.4	241.2	2.3	21.3	13.3	1.4	82.8
T_9	CoT8201 ST	67	62	45.9	240.0	2.93	21.9	13.4	1.69	77.6
T_{10}	CoT8201LR	61	59	44.3	241.4	3.03	21.2	13.9	1.62	71.3
T_{11}	CoT8201 M	62	70	49.0	240.1	3.09	20.3	14.0	1.65	80.9
T_{12}	CoT8201 Control	76	70	49.0	249.4	3.37	22.9	14.4	1.81	88.2
	Mean	66.5	65.3	47.1	242.7	3.1	21.6	13.9	1.7	79.5
T_{13}	2003V46 ST	60	111	76.2	246.7	3.28	21.9	15.3	1.56	118.0
T_{14}	2003V46 LR	61	89	57.4	241.4	3.20	20.8	15.7	1.50	85.9
T_{15}	2003V46 M	59	93	68.8	241.0	3.25	20.7	15.2	1.53	104.7
T_{16}	2003V46 Control	64	70	51.7	239.1	3.18	20.1	14.9	1.47	76.3
	Mean	61.0	90.8	63.5	242.1	3.2	20.9	15.3	1.5	96.2
General mean		**69.0**	**80.4**	**56.2**	**246.1**	**3.10**	**22.28**	**13.83**	**1.58**	**87.94**
C.D at 5%		8.9	9.6	8.62	12.03	0.44	1.98	0.90	0.29	22.5
SE(m)		2.9	3.1	2.83	3.95	0.14	0.65	0.29	0.09	7.40
SE(d)		4.1	4.4	4.01	5.59	0.20	0.92	0.42	0.13	10.47
CV		6.0	5.5	7.13	2.27	6.73	4.13	3.06	8.69	11.90

Note: ST-Shoot tip, LR-Leaf roll, M-Apical Meristem

All the treatments of 87A298 produced maximum number of internodes than control. T_1 (87A298 from shoot tip) recorded maximum number of internodes (26.7) than the other explants of 87A298. All the treatments of Co86032 and CoT8201 produced minimum number of internodes than control. All the treatments of 2003V46 produced maximum number of internodes than control. T_{13} (2003V46 from shoot tip) recorded maximum number of internodes (21.9) than the other explants of 2003V46. Similar findings were in agreement with Devarumath (2007) for number of internodes

Significant variation among 16 treatments was observed (Table 1) for this character which ranged from 12.1 cm to 15.7 cm. Maximum internode length (15.7 cm) was recorded in T_{14} (2003V46 from leaf roll). Among four varieties, mean internode length was maximum in 2003V46. All the treatments of 87A298 produced internode length than control. T_2 (87A298 from leaf roll) recorded maximum internode length (13.2 cm) than the other explants of 87A298. All the treatments of Co86032 and CoT8201 produced minimum internode length than control. All the treatments of 2003V46 produced maximum internode length than control. T_{14} (2003V46 from leaf roll) recorded maximum internode length (15.7 cm) than the other explants of 2003V46. Similar findings were in agreement with Saksena *et al.,* (2015) for internode length

Single cane weight showed significant variation among the treatments (Table 1). The range of single cane weight was 1.28 kg to 1.81 kg. The highest single cane weight (1.81 kg) was recorded in T_{12} (CoT8201 control). Among four varieties, average single cane weight was the highest in 87A298. Among all treatments of 87A298, T_2 and T_3 (87A298 from leaf roll and apical meristem) recorded the highest single cane weight (1.8 kg) than the other explants of 87A298. All the treatments of Co86032 and CoT8201 produced lower single cane weight than control. All the treatments of 2003V46 produced higher single cane weight than control. T_{13} (2003V46 from shoot tip) recorded higher single cane weight (1.56 kg) than the other explants of 2003V46. Similar findings were in agreement with Tolera and Shimelis (2016) for single cane weight.

Significant variation among 16 treatments was observed (Table 1) for this character which ranged from 69.1 to 118 t ha^{-1}. Higher cane yield (118 t ha^{-1}) was recorded in T_{13} (2003V46 from shoot tip). Among four varieties, average cane yield was higher in 2003V46. All the treatments of 87A298 produced higher cane yield than control. T_2 (87A298 from leaf roll) recorded higher cane yield (113.9 kg ha^{-1}) than the other explants of 87A298. Among all treatments of Co86032, T_7 (Co86032 from apical meristem) recorded higher cane yield (89.5 t ha^{-1}) than the other explants of Co86032 including control. However the other two treatments T_5 (Co86032 from shoot tip) and T_6 (Co86032 from leaf roll) inferior to control with respect to cane yield. All the treatments of CoT8201 recorded lower cane yield than the control. All the treatments of 2003V46 recorded higher cane yield than the control. T_{13} (2003V46 from shoot tip) recorded higher cane yield (118 t ha^{-1}) than the other explants of 2003V46. Similar findings were in agreement with Saksena *et al.,* (2015) and Ibrahim *et al.,* (2016) for cane yield.

Though the establishment of control treatment of 87A298 was good, tissue cultured seedlings of all the three explants performed better for yield attributes. Leaf roll explants of 87A298 showed consistent performance all through their growth commencing from establishment of seedlings. All the three explants produced higher cane yield than

control. Yield traits of Co86032 (control) were better than its explants except apical meristem derived plants where number of millable canes per hectare contributed more towards improvement in cane yield per hectare. Similarly the performance of control in CoT8201 was superior to all its explants with respect to yield traits including cane yield. All the treatments of 2003V46 recorded higher values than control for cane yield and yield traits. Shoot tip derived plants were superior to other treatments with respect to cane yield, cane length, number of internodes and single cane weight. Hence direct supply of tissue culture seedlings of Co86032 and CoT8201 is not advisable for commercial cultivation. Performance of tissue culture seedlings of early varieties *viz.,* 87A298 and 2003V46 was superior to the performance of mid late varieties; Co86032 and CoT8201.

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