

PERFORMANCE OF SUGARCANE SOMACLONES UNDER FIELD CONDITIONS AT NIA, TANDO JAM

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Abstract

Thousands of somaclones regenerated from six sugarcane clones were transferred in the field after acclimatization. All the clones showed varied response to the traits under study. Eight somaclones viz. 3 of BL4 (P36, P70 and P105) and one each of AEC81-0819 P5, AEC81-8415 P8, AEC82-1026 P5, AEC80-4725 P1 and AEC80-2046 P8 were selected and advanced to the preliminary yield trial for further evaluation. The data on components of cane yield and sugar yield were recorded. Somaclone AEC80-2046 P8 gave significantly higher cane yield than check L116 and was at par with BL4.

Introduction

Sugarcane (*Saccharum* spp.) is one of the most important cash crop of Pakistan. Natural viable seed production has been a problem in Pakistan, because of non- or sporadic flowering. Arrangements for hybridization under artificial conditions are scarce. Hence, alternative methods such as *in vitro* culture techniques in combination with induced mutations have been elaborated for creating the new genetic variability for the selection of desired clones / genotypes.

Realization of the full potential of somatic cell genetics in higher plants is predicted on the ability of induced desired development states (Orton, 1979). Callus has now been induced in a large number of species indicating that this phenomenon is not limiting (Liu & Chen, 1976). The fascinating feature of callus culture is that one can alter one or a few character (s) of the questioned genotype keeping the rest of genome intact. Ahloowalia (1982) reported that the development of desired genotypes are possible through somaclonal variation in case of vegetatively propagated plants. The ability to differentiate plantlets from callus tissue of *Saccharum* species was first demonstrated by Heinz & Mee (1969) while Liu & Chen (1976, 1978, 1984) have reported significant variation in somaclones (plants regenerated from tissue culture) in the important agronomic characters such as cane yield and its components, sugar contents and some morphological traits.

The objective of this study was to estimate the performance for yield and quality traits of the sugarcane somaclones under agroclimatic conditions of Tando Jam, Sindh, Pakistan.

Materials and Methods

Eight somaclones alongwith commercial varieties BL4, L116 and their respective parents were evaluated in preliminary yield trials for 3 consecutive years (1996-97, 1997-98 and 1998-1999). The experimental layout was RCB design with 3 replications. The

plot size was 4 x 5m. Four rows one metre apart from each clone were planted. The data on cane girth, cane length, number of tillers/stool, weight per stool, purity %, fibre%, Pol%, CCS% and sugar yield (t/ha) were recorded. Three stools were randomly taken from each plot to determine sugar contents (Pol % and CCS %) from November to January each year, according to Sugarcane Laboratory Manual for Queensland Sugar Mills (Anon., 1970), while three rows from each plot were harvested to record yield data. The data were analysed according to Eberhart & Russell (1966) methods.

Results and Discussion

Cane yield and yield components: Results regarding the mean performance of the genotypes for cane yield and its components showed significant ($P \leq 0.05$) differences amongst the clones (Table 1). Two clones AEC81-8415 and AEC82-1026 P5 produced significantly highest cane yield (146.3 t/ha and 146.1 t/ha, respectively) followed by AEC80-2046 P8 (138.8 t/ha), AEC81-8415 P8 (137.7 t/ha), BL4 P 70 (129.5 t/ha) and BL4 (125.7). The lowest cane yield was observed in commercial check variety L116 (98.45 t/ha). Highest plant height was observed in BL4 P36 (250 cm) followed by AEC80-2046 P8 (248 cm), AEC81-8415 P8 and AEC81-8415 (246.7 cm) and the lowest plant height was recorded in AEC80-4725 P1 (170 cm) and L116 (173.3 cm). As regard cane girth (cm), BL 4 (2.90) was at the top followed by AEC82-1026 P5 (2.86), AEC81-8415 P8 (2.73) and AEC81-8415 (2.68), while minimum girth was observed in AEC81-0819 (2.26). Weight per stool (kg) was highest in AEC81-8415 P8 (7.99) and AEC81-8415 (7.73), while minimum weight per stool was observed in L116 (6.25). Almost, non-significant differences were observed for number of tillers per plant. The maximum tillers were noted in AEC81-8415 P8 (7.63), whereas minimum in BL4 P36 (6.03).

Sugar content and sugar yield: Mean values of different clones for Pol %, CCS % and sugar yield t/ha were significantly different at ($P \leq 0.05$) (Table 1) . Significantly highest Pol % and CCS % were observed in AEC81-0819 (21.52 & 16.74) followed by AEC81-0819 P5 (21.35 & 16.28 respectively). Somaclones of BL4 (P36, P70 and P105), AEC82-1026-P5, AEC81-8415- P8, AEC81-4725-P1 and AEC80-2046-P8 showed less Pol % and CCS % as compared to local check L116, but it was at par with their respective parents. Maximum sugar yield (t/ha) was obtained from AEC81-0819 (20.69) followed by its somaclone, AEC81-0819-P5 (18.79) and AEC80-2046 P8 (18.37). BL4 P36 produced the lowest sugar yield (13.23 t/ha) and remaining somaclones were at par with check L116 and their respective parents. Maximum purity % was observed in AEC81-0819 (90.60) followed by its somaclone AEC81-0819 P5 (90.52) and minimum was observed in somaclone of BL4 P36 (84.98). Somaclones BL4 P36 and BL4 P105 exhibited higher fibre% as compared to BL4 control. Moreover, other somaclones except AEC82-1026 (C) were found at par in fibre% with (commercial varieties) BL4 and L116.

Month wise analysis of Pol%, Purity% and CCS% showed significant differences ($P \leq 0.05$) (Table 1a). Clone AEC81-0819 and AEC81-0819-P8 maintained its superiority among the clones in month wise analysis in all the three traits.

The correlation coefficient results indicated that the cane yield was correlated positively with cane girth ($r=0.776$ **), weight per stool ($r = 0.769$ **), sugar yield ($r = 0.524$ *), cane length ($r=0.486$ *) and non significantly correlated with tiller per plants and

Table 1. Pooled mean performance of somaclones in Preliminary Yield Trial at NIA, Tandojam for three years (1996-99).

Clones	Cane girth (cm)	Cane length (cm)	Wt./Stool	Tiller/plant (Nos)	Cane yield (t/ha)	Pol %	Purity %	CCS %	Fiber %	Sugar yield (t/ha)
BL4 P36	2.32 fgh	250.0 a	6.54 bcd	6.03 b	108.6 cd	16.54 d	84.98 b	11.87 d	14.75 a	13.23 c
BL4 P70	2.63 bcde	177.3 d	6.40cd	6.25 ab	129.5 abc	17.39 d	87.51 ab	12.77 d	14.13 ab	16.80abc
BL4 P105	2.45 defgh	180.0 d	7.26abcd	6.81 ab	118.9 bcd	17.77 d	85.85 b	13.01 d	14.48 a	16.94abc
BL4 Control	2.90 a	194.7 cd	6.74abcd	6.51 ab	125.7 abc	17.82 d	87.10 ab	13.41 cd	12.56 bc	16.92abc
AEC82-1026 P5	2.86 ab	215.7 bc	7.60abc	7.21 ab	146.1 a	16.38 d	85.07 b	11.93 d	13.73 ab	17.56abc
AEC82-1026 (C)	2.56 cdefg	207.3 bc	7.03abcd	6.47 ab	115.4 bcd	17.83 d	86.60 ab	13.52 cd	11.24 c	15.00bc
AEC81-8415 P8	2.73 abc	246.7 a	7.99a	7.63 a	137.7 ab	16.93 d	86.04 ab	12.58 d	13.32 ab	17.91abc
AEC81-8415 (C)	2.68 abcd	246.7 a	7.73ab	6.87 ab	146.3 a	16.41 d	84.59 b	11.80 d	14.04 ab	17.84abc
AEC81-0819 P5	2.45 defgh	230.0 ab	6.49bcd	6.97 ab	115.2 bcd	21.35 ab	90.52 a	16.28 ab	14.01 ab	18.79ab
AEC81-0819 (C)	2.26 h	213.3 bc	6.89abcd	7.19 ab	118.3 bcd	21.52 a	90.60 a	16.74 a	12.90abc	20.69a
AEC80-4725 P1	2.40 efgh	170.0 d	6.46bcd	7.10 ab	112.1 bcd	17.78 d	86.72 ab	13.29 cd	13.24 ab	15.85bc
AEC80-4725 (C)	2.37 efgh	195.7 cd	6.21d	6.72 ab	103.1 cd	18.27 cd	88.31 ab	13.62 cd	13.96 ab	14.67bc
AEC80-2046 P8	2.58 cdef	248.0 a	6.83abcd	6.30 ab	138.8 ab	16.91 d	85.84 b	12.51 d	14.16 ab	18.37ab
L 116	2.30 gh	173.3 d	6.25d	6.64 ab	98.45 d	19.74 bc	89.21 ab	14.92 bc	13.81 ab	15.44bc

DMR test (0.05): Means followed by the same letters are not significantly different from each other

Table 1a. Monthwise CCS% of selected somaclones in Preliminary Yield Trial at NIA, Tandojam.

Clones	Pol % (1996-97 to 1998-99)		Purity % (1996-97 to 1998-99)		CCS % (1996-97 to 1998-99)				
	Nov.	Dec.	Jan.	Nov.	Dec.	Jan.			
BL4 P36	16.03de	16.22bcd	17.36c	83.89b	84.82cd	86.24	11.57def	12.02cd	12.04c
BL4 P70	16.84cde	17.24bcd	18.07bc	85.99ab	88.56abc	87.97	12.34bcdef	12.82cd	13.14c
BL4 P105	17.14cde	17.64bc	18.53bc	84.75b	86.38bcd	86.43	12.35bcdef	12.99cd	13.68bc
BL4 Control	17.18cde	17.98bc	18.29bc	86.25ab	87.80abc	87.25	12.85bcde	13.69bc	13.80bc
AEC82-1026 P5	15.60e	16.05cd	17.48c	84.35b	84.40cd	86.46	11.13f	12.10cd	12.56c
AEC82-1026 (C)	17.55bcd	17.78bc	18.17bc	86.82ab	86.94abcd	86.03	13.39bc	13.55bc	13.62bc
AEC81-8415 P8	16.66cde	16.22bcd	17.91bc	86.73ab	84.32cd	87.09	12.02cdef	12.32cd	13.39bc
AEC81-8415 (C)	15.96de	15.57d	17.70c	84.20b	82.16d	87.40	11.40ef	11.46d	12.55c
AEC81-0819 P5	20.78a	21.45a	21.82a	90.11a	90.33ab	91.13	15.88a	16.44a	16.53a
AEC81-0819 (C)	20.85a	21.23a	22.48a	89.80a	91.27a	90.74	16.04a	16.51a	17.67a
AEC80-4725 P1	17.28cd	17.47bcd	18.61bc	85.15b	86.53abcd	88.48	12.42bcdef	13.00cd	14.28bc
AEC80-4725 (C)	17.93bc	18.05b	18.83bc	87.36ab	88.59abc	88.98	13.03bcd	13.49bc	14.29bc
AEC82-2046 P8	16.38cde	16.38bcd	17.96bc	84.75b	85.45bcd	87.31	11.55def	12.31cd	13.67bc
L 116	18.99b	19.82a	20.40ab	87.52ab	90.17ab	89.94	13.91b	15.12ab	15.74ab

DMR test (0.05): Means followed by the same letters are not significantly different from each other

Table 2. Correlation (r) analysis of sugarcane somaclones.

Traits	Cane girth	Cane length	Tillers/Plant	Weight/stool	Cane yield	Fibre %	Purity %	Pol %	CCS %
Cane length	0.189 ns								
Tillers/Plant	0.146 ns	0.051 ns							
Weight/stool	0.572 *	0.493 *	0.556 *						
Cane yield	0.776 **	0.486 *	0.208 ns	0.769 **					
Fibre %	-0.223 ns	0.171 ns	-0.174 ns	-0.117 ns	0.045 ns				
Purity %	-0.499 *	-0.329 ns	0.152 ns	-0.556 *	-0.548 *	-0.172 ns			
Pol %	-0.554 *	-0.241 ns	0.214 ns	-0.436 *	-0.525 *	-0.171 ns	0.957 **		
CCS %	-0.522 *	-0.246 ns	0.234 ns	-0.418 *	-0.510 *	-0.255 ns	0.958 **	0.995 **	
Sugar yield	0.196 ns	0.228 ns	0.534 *	0.390 ns	0.524 *	-0.060 ns	0.336 ns	0.412 *	0.426 *

* = Significance at 5 % level, ** = Significance at 1 % level, ns = non significant

Table 3. Mean cane and sugar yield and estimates of stability parameters for somaclones of sugarcane.

Clones	Cane yield (t/ha)		Sugar yield (t/ha)	
	Regression 'b'	Deviation from regression S ² d	Regression 'b'	Deviation from regression S ² d
BL4 P36	1.239	0.300	1.307	1.713
BL4 P70	1.733	2.770	1.602	3.567
BL4 P105	0.752	0.018	0.669	0.456
BL4 Control	1.001	0.003	1.084	1.193
AEC82-1026 P5	1.214	0.270	1.367	1.825
AEC82-1026 (C)	0.866	0.009	0.963	1.030
AEC81-8415 P8	0.743	0.180	0.794	0.620
AEC81-8415 (C)	1.005	0.040	1.077	1.156
AEC81-0819 P5	1.101	0.140	1.016	1.065
AEC81-0819 (C)	0.934	0.006	0.763	0.587
AEC80-4725 P1	0.752	0.016	0.696	0.522
AEC80-4725 (C)	0.987	0.010	0.975	0.932
AEC80-2046 P8	0.948	0.004	0.952	0.931
L 116	0.981	0.004	0.898	0.795

fibre % (Table 2). The Pol %, Purity% and CCS % were significantly negatively correlated with cane yield. The increase in cane yield might be due to maximum plant height, weight per stool and cane girth. Chaudhry (1982) concluded that the increase in cane yield was due to combined effect of stalks per stool, length of stalk and weight per stool. According to Raman *et al.*, (1985) number of stalks per stool was a major yield contributing factor followed by height and cane girth. Singh & Sherma (1983) concluded that cane yield exhibited phenotypic association with stalks per stool. Our results do not agree with these workers as far as contribution of stalks per stool to cane yield is concerned. Khan *et al.*, (1997) reported the same results as observed in the present study. Our findings exhibited non-significant correlation between stalk per stool and cane yield. However, highest number of tillers were observed in somaclone of AEC81-8415 P8 and its cane yield was also next to the maximum. The correlation of tillers per plant with weight per stool ($r = 0.556^*$) was significant, whereas purity %, pol % and CCS % showed negative correlation with cane yield (Table 2).

Sugar yield per hectare is mainly dependent on tillers per plant, cane yield, Pol % and CCS %. Sangwan & Singh (1983) reported positive and significant association of sugar yield with brix. The negative correlation of Pol % and CCS % with cane yield and positive correlation with sugar yield is one of the major constraints in the improvement of sugarcane. Fibre % is another obstinate character in sugarcane genome and it showed negative correlation with Pol%, CCS%, Purity%, sugar yield, weight per stool and cane girth but exhibits positive correlation with cane yield and cane length (Table 2).

Stability analyses results are presented in Table 3. Regression coefficient 'b' is a measure of stability in crop plants (Finlay & Wilkinson, 1963; Eberhart & Russell, 1966). Paroda & Hayes (1971) suggested that both regression coefficient 'b' and deviation from regression coefficient 'S²d' may be taken into consideration in identifying a stable genotype. A cultivar with 'b' value less than 1.0 has above average stability and is specially adapted to low-performing environments, a cultivar with 'b' value greater than 1.0 has below average stability and is specially adapted to high performing environments and a cultivar with 'b' value equal to 1.0 has average stability and is well or poorly adapted to all environments depending on having a high or low mean performance (Finlay & Wilkinson, 1963), but a cultivar with $b = 1.00$ and $S^2d = 0.00$ may be defined as stable (Eberhart & Russell, 1966; Javed *et al.*, 2002). Regression coefficient 'b' values for cane yield and sugar yield ranged from 0.743 to 1.733 and 0.669 to 1.602, respectively, while deviation from regression coefficient 'S²d' values ranged from 0.003 to 2.770 and 0.456 to 3.567, respectively in all genotypes, which suggests wide genetic variability among genotypes over environments (Table 3). AEC81-8415 produced the highest cane yield (146.3 t/ha) with unit regression $b = 1.005$ and low S^2d value (0.040) confirming wide adaptability for the cane yield. Clone AEC81-0819 gave maximum sugar yield (20.69 t/ha) with unit regression value ($b = 0.763$ and $S^2d = 0.587$). Lowest S^2d value in case of cane yield was recorded in L116 and AEC80-2046 P8 ($S^2d = 0.004$) proved to be the most stable genotypes according to stability determinations. In the present study, no clones showed good stability for sugar yield. The somaclone AEC80-2046 P8 showed comparatively better regression coefficient i.e. 0.948 and S^2d value (0.004) for cane yield showing better stability, but same genotype had $b = 0.952$ value with higher values of S^2d for its sugar yield. Somaclone BL4 P70 had the highest value of b and S^2d than the other clones included in the trial which indicates that this clone is less stable. However, check

varieties BL4 and L116 gave 1.001, 0.981 and 1.084, 0.898 'b' values respectively, while 'S²d' was 0.003, 0.004 and 1.193, 0.795 for cane yield and sugar yield respectively.

Clones AEC82-1026 P5, AEC81-8415 P8 and AEC80-2046 P8 showed promising performance for cane and sugar yield and these clones will be confirmed in the subsequent varietal trial. One of these somaclone may get its place in the varietal complex of sugarcane in Sindh.

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