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Field Performance of Several Morphological Characters of Six Sugarcane Genotypes and Their Somaclones

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ABSTRACT

The experiment was conducted at Biotechnology Laboratory and research field of Bangladesh Sugarcane Research Institute (BSRI), Ishurdi, Pabna, during the period of 2004-2008 for the improvement and understanding the biochemical and molecular basis of inheritance of sugarcane. Five somaclones from each of four genotypes viz. Isd 18, Isd 28, BSRI Akh 41 and Misrimala, four somaclones from Co 1158 and three somaclones from BS 96 were selected from R_0 plants. Setts of selected somaclones were planted in the second year as R_1 plants. The six donor sugarcane varieties were also planted in the field to compare with the somaclones. Field evaluation of somaclones and their respective parents were performed based on analysis of quantitative agro-morphological traits. Some variability was found from all four characters (leaf length and width, bud length and width). The highest leaf length was observed in variety Isd 28 (136.50 ± 0.83 cm) and (3.30 ± 0.15 cm) from the somaclone Co 1158 SC-3. The highest bud length (7.40 ± 0.22 mm) and width (5.00 ± 0.15 mm)were found in variety Isd 18. So it be concluded that a large number of plants could be raised through callus culture in sugarcane and the plants regenerated could be successfully established in the field for study of somaclonal variation.

Key words: Leaf, bud, node, genotypes, sugarcane, somaclones.

INTRODUCTION

Genetic variability is an essential component of any breeding program designed to improve the characteristics of crop plants. In recent years, plant cell culture has been hailed as one of the potential sources of useful genetic variation. The variability generated by the use of a tissue culture cycle has been termed somaclonal variation by Larkin and Scowcroft (1981). They defined a tissue culture cycle as a process that involves the establishment of a dedifferentiated cell or tissue culture under defined conditions, proliferation for a number of generations and the subsequent regeneration of plants. In other words, one imposes a period of callus proliferation between an explant and the regeneration of plant. The initiating explant for a tissue culture cycle may come virtually from any plant organ or cell type including embryos, microspores, roots, leaves, and protoplasts. It is argued that this variation already is proving to be of significance for plant improvement. Plant variant obtained from tissue culture is called somaclones. Evans *et al.* (1984) coined the term gametoclonal variation for variants clones specifically raised from gametic or gametophytic cells.

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Genetic variation appears during or after culture *in vitro*. It may occur in undifferentiated cells, isolated protoplasts, calli, tissues and morphological traits of regenerated plants. Variants selected in tissue cultures have been referred as calliclones (from callus culture), or protoclones (from protoplast culture). Somaclonal variation causes problem for plant propagationists, since their objective is to reserve a specific plant genotype. While for plant geneticists somaclonal variation is a valuable source of new genetic information. It leads to crop plant improvement and a deeper understanding of the biochemical and molecular basis of inheritance.

MATERIALS AND METHODS

The experiment was conducted both at Biotechnology Laboratory and field of Bangladesh Sugarcane Research Institute (BSRI), Ishurdi, Pabna, Bangladesh during the period of 2004-2008. Six sugarcane genotypes developed by BSRI, Bangladesh were used as experimental material. These were Isd 18, SC-1, SC-2, SC-3, SC-4 and SC-5. The field experiment was laid out following Randomized Complete Block Design with three replications. The regenerated plantlets obtained from leaf sheath derived calli of six sugarcane varieties, 30-50 somaclones from each of varieties were transferred to field after the acclimatization process and planted 15 October 2004. These plants were maintained properly and considered as R_0 plants. From R_0 plants five somaclones from Isd 18, five from Isd 28, five from BSRI Akh 41 and five from Misrimala, four from Co 1158 and three from BS 96 were selected. Setts from these selected somaclones were planted in the next year as R_1 plants and data on leaf, bud and node characters of somaclones and donor parent were recorded and analyzed. For each somaclone at least 50 R_1 plants were raised in the field and data were collected from 10 randomly selected plants. For convenience the results of evaluation of somaclonal variation were deals with quantitative characters. Data on quantitative characters were recorded from different selected somaclones and their donor parents. All agronomical practices like irrigation, weeding, fertilization, mulching, earthing up and insect and disease management were done when and where necessary for proper cane cultivation. Data were recorded at 7-8 months after planting and other characters were noted at 10-12 months after planting. These data were analyzed to show variation between different somaclones and their donor parents.

RESULTS AND DISCUSSION

Leaf length of six sugarcane varieties and their somaclones

The mean performance of leaf length of sugarcane variety Isd 18 and its somaclones is shown in Table 1. The highest length of leaf was recorded in the variety Isd 18 (129.20± 0.95 cm) and the lowest length of leaf was recorded in somaclones Isd 18 SC-4 (96.50 ± 5.22 cm).

The length of leaf of variety Isd 28 and it somaclone showed significant variation as shown in Table 2. The highest length of leaf was observed in variety Isd 28 (136.50 ±

0.83 cm) and the lowest length of leaf was observed in somaclone Isd 28 SC-2 (117.90 ± 1.86 cm). Somaclones Isd 28 SC-3 and Isd 28 SC-4 were statistically identical.

The length of leaf of variety BS 96 and its somaclones is presented in Table 3.The highest length of leaf was recorded in somaclone BS 96 SC-1 (123.30 ± 1.02 cm) and the lowest length of leaf was recorded in somaclone BS 96 SC-2 (119.70 ± 0.85 cm). Donor parent BS 96 and somaclone BS 96 SC-1 were statistically similar.

The length of leaf of variety Co 1158 and its somaclones is presented in Table 4. The highest length of leaf was obtained from Co 1158 SC-1 (128.60 ± 1.44 cm) and the lowest length of leaf was recorded in somaclone Co 1158 SC-4 (118.50 ± 2.48 cm). Parent Co 1158 and somaclone Co 1158 SC-3 were statistically similar.

The leaf length of BSRI Akh 41 and its somaclones is presented in Table 5. The highest length of leaf was observed in donor parent BSRI Akh 41 (147.80 ± 1.54 cm) and the lowest length of leaf was observed in somaclone BSRI Akh 41 SC-4 (122.80 ± 0.74 cm). Somaclones BSRI Akh 41 SC-1 and BSRI Akh 41 SC-4 were statistically similar. Somaclones BSRI Akh 41 SC-2 and BSRI Akh 41 SC-3 were also statistically identical.

The length of leaf of variety Misrimala and its somaclones showed highly significant variation are presented in Table 6. The highest length of leaf was obtained in somaclone Misrimala SC-2 (146.80 ± 0.97 cm) and the lowest length of leaf was observed in somaclone Misrimala SC-5 (115.50 ± 1.02 cm). Somaclones Misrimala SC-3 and Misrimala SC-4 were statistically similar to Misrimala and Misrimala SC-1 was also statistically similar to Misrimala SC-2.

Field evaluation of six sugarcane varieties and their somaclones was performed based on analysis of quantitative agro-morphological traits. The highest length of leaf was recorded in variety BSRI Akh 41 (147.80 ± 1.54 cm) and the lowest length of leaf was recorded in Co 1158 (122.50 ± 1.28 cm). The highest length of leaf was recorded in somaclone BSRI Akh 41 (147.80 ± 1.54 cm) and the lowest length of leaf was recorded in somaclone Isd 18 SC-4 (96.50 ± 5.22 cm). Chaudhary *et al.* (1982) studied variability, heritability and expected genetic gain for number of millable canes per clump. They found highly significant variability for all seven characters like cane thickness, leaf length and width, internodes length, cane height and cane yield per plant for 21 genotypes of sugarcane. They concluded that for selection of high yielding genotypes, attention be paid to number of millable canes per clump and cane height.

Leaf width of six sugarcane varieties and their somaclones

The mean performance of leaf width of sugarcane variety Isd 18 and its somaclones is shown in Table 1. The highest width of leaf was recorded in somaclone Isd 18 SC-5 (3.50 ± 0.16 cm), which was statisticallyidentical with its donor parent isd-18. The lowest width of leaf were recorded in somaclones Isd 18 SC-2 and Isd 18 SC-4 (2.50 ± 0.16 cm). Somaclones Isd 18 SC-2 and Isd 18 SC-4 (2.50 ± 0.16 cm) were statistically similar to Isd 18 SC-1 and Isd 18 SC-3.

The width of leaf of variety Isd 28 and its somaclones showed highly significant variation as shown in Table 2. The highest width of leaf was observed in variety Isd 28 (4.04 ± 0.04 cm) and the lowest width of leaf was recorded in somaclone Isd 28 SC-1 (2.80 ± 0.08 cm). Somaclone Isd 28 SC-1was statistically similar to Isd 28 SC-2, Isd 28 SC-3 and Isd 28 SC-4.

The width of leaf of variety BS 96 and its somaclones are presented in Table 3. The highest width of leaf was recorded in somaclone BS 96 SC-1 (2.92 ± 0.05 cm) and the lowest width of leaf in variety BS 96 (2.55 ± 0.14 cm). Somaclones BS 96 SC-2 and BS 96 SC-3 were statistically identical.

The leaf width of variety Co 1158 and its somaclones is presented in Table 4. The highest width of leaf was recorded in somaclone Co 1158 SC-3 (3.30 ± 0.15 cm). The lowest width of leaf was recorded in somaclone Co 1158 SC-1 (3.00 ± 0.21 cm). Donor parent Co 1158 and all of its somaclones were statistically identical.

The width of leaf of variety BSRI Akh 41 and its somaclones is presented in Table 5.The highest width of leaf was recorded in variety BSRI Akh 41 (3.50 ± 0.15 cm) and the lowest width of leaf was recorded in somaclone BSRI Akh 41 SC-5 (2.63 ± 0.11 cm). Somaclones BSRI Akh 41 SC-2 was statistically similar to somaclones BSRI Akh 41 SC-3 and BSRI Akh 41 SC-4.

The width of leaf of variety Misrimala and its somaclones showed highly significant variation (Table 6). The highest width of leaf was recorded in variety Misrimala (3.93 ± 0.08 cm) and the lowest width of leaf was recorded in somaclone Misrimala SC-5 (2.20 ± 0.08 cm). Donor parent Misrimala and somaclone Misrimala SC-1 were statistically identical.

The width of leaf among the six sugarcane varieties and their 27 somaclones were also compared and the mean performances and the results of ANOVA are presented in Table 7.The highest width of leaf was recorded in somaclone Isd 28 (4.04 ± 0.04 cm) and the lowest width of leaf was recorded in somaclone Misrimala SC-5 (2.20 ± 0.08 cm). Somaclones Co 1158 SC-1 and Isd 28 SC-4 (3.00 ± 0.21 cm) were statistically similar to Isd 28 SC-2, BSRI Akh 41 SC-1, Isd 18 SC-4 and was also statistically similar to Isd 18 SC-2.

Bud length of six sugarcane varieties and their somaclones

The mean performance of bud length of sugarcane variety Isd 18 and its somaclones is shown in Table 1. The highest bud length was recorded in variety Isd 18 (7.40 ± 0.22 mm). The lowest bud length was found in somaclones Isd 18 SC-2 and Isd 18 SC-3 (4.50 ± 0.17 mm). Somaclones Isd 18 SC-1, Isd 18 SC-4 and Isd 18 SC-5 were statistically similar. Somaclones Isd 18 SC-2 and Isd 18 SC-3 (4.50 ± 0.17 mm) were also statistically identical.

The bud length of variety Isd 28 and its somaclones is shown in Table 2. The highest bud length was observed in somaclone Isd 28 SC-5 (8.00 ± 0.30 mm). The lowest

bud length was observed in somaclones Isd 28 SC-1 and Isd 28 SC-3 (7.40 ± 0.30 mm). Donor parent Isd 28 and somaclones Isd 28 SC-2 & Isd 28 SC-4 (7.50 ± 0.17 mm) were statistically similar.

The bud length of variety BS 96 and its somaclones are presented in Table 3. The highest bud length were recorded in variety BS 96 and somaclones BS 96 SC-1 & BS 96 SC-2 (6.5 ± 0.17 mm). The lowest bud length was recorded in somaclone BS 96 SC-3 (5.4 ± 0.22 mm). Donor parent BS 96 and somaclones BS 96 SC-1 were statistically similar to BS 96 SC-2.

The bud length of variety Co 1158 and its somaclones are presented in Table 4. The highest bud length were recorded in donor parent Co 1158, somaclones Co 1158 SC-2, Co 1158 SC-3 and Co 1158 SC-4 (6.50 ± 0.17 mm). The lowest bud length was recorded in somaclone Co 1158 SC-1 (6.00 ± 0.15 mm). Donor parent Co 1158 and rest of the somaclones were statistically similar.

The bud length of variety BSRI Akh 41 and its somaclones are presented in Table 5. The highest bud length was recorded in variety BSRI Akh 41 (7.50 ± 0.16 mm). The lowest bud length was recorded in somaclone BSRI Akh 41 SC-5 (6.30 ± 0.15 mm). Somaclones BSRI Akh 41 SC-1, BSRI Akh 41 SC-2, BSRI Akh 41 SC-3 and BSRI Akh 41 SC-4 were statistically similar.

The bud length of variety Misrimala and its somaclones showed highly significant variation (Table 6). The highest bud length was observed in somaclone Misrimala SC-2 (8.40 ± 0.16 mm) followed by Misrimala SC-1 (7.50 ± 0.22 mm). The lowest bud length was observed in somaclone Misrimala SC-3 (6.50 ± 0.17 mm). Donor parent Misrimala and Misrimala SC-3 were statistically similar to Misrimala SC-4 and Misrimala SC-5.

Field evaluation of six sugarcane varieties and their somaclones was performed based on analysis of quantitative agro-morphological traits. In case of bud length, the highest bud length was recorded in Isd 28 (7.50 ± 0.16 mm) and BSRI Akh 41 (7.50 ± 0.16 mm) and the lowest bud length was recorded in BS 96 and Co 1158 (6.50 ± 0.16 mm). The highest length of bud was observed in somaclone Misrimala SC-2 (8.40 ± 0.16 mm) and the lowest length of bud was observed in somaclones Isd 18 SC-2 and Isd 18 SC-3 (4.50 ± 0.16 mm) (Table 1). Khan *et al.* (2004) reported that the somaclones were found better in the characters of tillers/plant, bud length, number of nodes/stem and root band width but they found no differences in the length of internodes of somaclones and source plants.

Bud width of six sugarcane varieties and their somaclones

The mean performance of bud width of sugarcane variety Isd 18 and its somaclones is shown in Table 1. The highest width of bud was observed in variety Isd 18 (5.00 ± 0.15 mm). The lowest width of bud was recorded in somaclone Isd 18 SC-2 (2.80 ± 0.13 mm). Somaclones Isd 18 SC-1was statistically similar to, Isd 18 SC-3, Isd 18 SC-4 and Isd 18 SC-5 respectively.

The bud width of variety Isd 28 and its somaclones showed significant variation (Table 2). The highest width of bud was observed in variety Isd 28 (5.70 ± 0.21 mm) The lowest width of bud was recorded in somaclone Isd 28 SC-2 (4.80 ± 0.20 mm). Somaclones Isd 28 SC-1 was statistically similar to Isd 28 SC-3 and was also statistically similar to Isd 28 SC-5.

The bud width of variety BS 96 and its somaclones is shown in Table 3. The highest width of bud was observed in variety BS 96 (4.6 ± 0.16 mm) followed by BS 96 SC-1 (4.5 ± 0.17 mm) and BS 96 SC-2 (4.4 ± 0.16 mm). The lowest width of bud was recorded in somaclone BS 96 SC-3 (4.3 ± 0.39 mm). Donor parent BS 96 and rest of the somaclones were statistically similar.

The bud width of variety Co 1158 and its somaclones is presented in Table 4. The highest width of bud was observed in somaclone Co 1158 SC-2 (4.70 ± 0.21 mm). The lowest width of bud was recorded in somaclone Co 1158 SC-1 (4.40 ± 0.16 mm). Donor parent Co 1158 and all of its somaclones were statistically identical.

The bud width of variety BSRI Akh 41 and its somaclones is presented in Table 5. The highest width of bud was observed in variety BSRI Akh 41 (5.50 ± 0.17 mm). The lowest width of bud was recorded in somaclones BSRI Akh 41 SC-5(4.90 ± 0.23 mm). Somaclones BSRI Akh 41 SC-1, SC-2, SC-3 and SC-3 were statistically identical.

The bud width of variety Misrimala and its somaclones showed highly significant variation (Table 6). The highest width of bud was observed in somaclone Misrimala SC-2 (6.10 ± 0.23 mm). The lowest width of bud were recorded in parent Misrimala (4.50 ± 0.17 mm). Donor parent Misrimala and all its somaclones were statistically identical except somaclone Misrimala SC-2.

Field evaluation of six sugarcane varieties and their somaclones was performed based on analysis of quantitative agro-morphological traits. Among the donor parents, the highest width of bud was observed in variety Isd 28 (5.70 ± 0.21 mm) and the lowest width of bud was recorded in BS 96 (4.6 ± 0.16 mm). The highest width of bud was recorded in somaclone Misrimala SC-2 (6.10 ± 0.23 mm) and the lowest width of bud was recorded in somaclone Isd 18 SC-2 (2.80 ± 0.13 mm). The highest width of node was obtained in somaclone BSRI Akh 41 (8.4 ± 0.16 mm) and the lowest width of node was recorded in BS 96 (5.5 ± 0.16 mm). The highest width of node was observed in somaclone BSRI Akh 41 (8.4 ± 0.16 mm) and the lowest width of node was observed in somaclone Isd 18 SC-4 (4.30 ± 0.21 mm). In case of node diameter, the highest diameter of node was observed in BSRI Akh 41 (3.15 ± 0.07 mm) and the lowest diameter of node was recorded in Isd 28 (2.17 ± 0.06 mm). The highest diameter of node was observed in somaclone Misrimala SC-2 (3.27 ± 0.10 mm) and the lowest diameter of node was observed in somaclone Isd 18 SC-4 (1.50 ± 0.16 mm) (Table 1). Hapase and Hapase (1990), Sahi *et al.*(1987), who reported that genotypic variance was the largest component for most of the characters. The contribution of environment on the phenotypic variance however was remarkable in their study indicating the major influence of environment on the quantitative characters. High values of phenotypic and genotypic components were noted for stalk volume, leaf area, cane length, bud width and node width. However, some characters like number of millable cane, single stalk weight, yield per clump showed intermediate variability.

Table 1. Field performance of leaf, bud and node characters of somaclones and comparison with its respective Isd 18 parent

Varieties/ Somaclones	Leaf length (cm) (Mean ± SE)	Leaf width (cm) (Mean ± SE)	Bud length (mm) (Mean ± SE)	Bud width (mm) (Mean ± SE)	Node width (mm) (Mean ± SE)	Node diameter (mm) (Mean ± SE)	Growth Ring width (mm) (Mean ± SE)
Isd 18	129.20 ± 0.95a*	3.05 ± 0.05a	7.40 ± 0.22a	5.00 ± 0.15a	6.50 ± 0.17a	2.90 ± 0.06a	1.45 ± 0.16a
Isd 18 SC-1	98.00 ± 3.26b	2.65 ± 0.13bc	5.40 ± 0.16b	3.50 ± 0.17b	5.50 ± 0.17b	3.00 ± 0.12a	1.00 ± 0.06b
Isd 18 SC-2	103.00 ± 2.80b	2.50 ± 0.22c	4.50 ± 0.17c	2.80 ± 0.13c	4.60 ± 0.16c	2.05 ± 0.05c	1.00 ± 0.06b
Isd 18 SC-3	100.00 ± 3.65b	2.70 ± 0.15bc	4.50 ± 0.17c	3.40 ± 0.16b	4.50 ± 0.17c	2.50 ± 0.16b	1.00 ± 0.06b
Isd 18 SC-4	96.50 ± 5.22b	2.50 ± 0.16c	5.30 ± 0.21b	3.80 ± 0.20b	4.30 ± 0.21c	1.50 ± 0.16d	1.00 ± 0.06b
Isd 18 SC-5	101.60 ± 2.49b	3.50 ± 0.16a	5.50 ± 0.17b	3.50 ± 0.17b	5.50 ± 0.17b	2.30 ± 0.13bc	1.00 ± 0.06b
LSD Value	9.423	0.4474	0.5236	0.4659	0.4960	0.3609	0.1815
CV(%)	10.04	17.71	10.74	14.18	10.73	16.92	18.88
Level of significance	*	*	*	*	*	*	*

In a column, figure having same letter(s) do not differ significantly by DMRT at 5% level
* = Significant at 5 % level

Table 2. Field performance of leaf, bud and node characters of somaclones and comparison with its respective lsd 28 parent

Varieties/ Somaclones	Leaf length (cm) (Mean ± SE)	Leaf width (cm) (Mean ± SE)	Bud length (mm) (Mean ± SE)	Bud width (mm) (Mean ± SE)	Node width (mm) (Mean ± SE)	Node diameter (mm) (Mean ± SE)	Growth Ring width (mm) (Mean ± SE)
lsd 28	136.50 ± 0.83a*	4.04 ± 0.04a	7.50 ± 0.16a	5.70 ± 0.21a	6.50 ± 0.17b	2.17 ± 0.06c	1.86 ± 0.05ab
lsd 28 SC-1	124.00 ±1.04c	2.80 ± 0.08c	7.40 ± 0.22a	5.10 ± 0.23ab	6.50 ± 0.17b	2.85 ± 0.13ab	1.90 ± 0.10ab
lsd 28 SC-2	117.90 ±1.86d	3.10 ± 0.12bc	7.50 ± 0.27a	4.80 ± 0.20b	6.50 ± 0.26b	2.50 ± 0.17bc	2.00 ± 0.12a
lsd 28 SC-3	128.20 ± 0.80b	3.20 ± 0.13bc	7.40 ± 0.30a	5.20 ± 0.25ab	7.50 ± 0.17a	3.20 ± 0.20a	1.70 ± 0.15ab
lsd 28 SC-4	129.10 ±1.61b	3.00 ± 0.21bc	7.50 ± 0.17a	4.90 ± 0.23b	6.50 ± 0.17b	3.10 ± 0.18a	1.80 ± 0.13ab
lsd 28 SC-5	123.10 ±1.00c	3.30 ± 0.21b	8.00 ± 0.30a	5.10 ± 0.31ab	7.00 ± 0.26ab	2.95 ± 0.22ab	1.60 ± 0.16b
LSD Value	3.567	0.4205	0.6934	0.6904	0.5790	0.4753	0.3282
CV(%)	3.15	14.49	10.24	15.00	9.56	18.98	20.21
Level of significance	*	*	NS	*	*	*	*

In a column, figure having same letter(s) do not differ significantly by DMRT at 5% level
* =Significant at 5 % level

Table 3. Field performance of leaf, bud and node characters of somaclones and comparison with its respective BS 96 parent

Varieties/ Somaclones	Leaf length (cm) (Mean ± SE)	Leaf width (cm) (Mean ± SE)	Bud length (mm) (Mean ± SE)	Bud width (mm) (Mean ± SE)	Node width (mm) (Mean ± SE)	Node diameter (mm) (Mean ± SE)	Growth Ring width (mm) (Mean ± SE)
BS 96	123.10 ±1.13a*	2.55 ± 0.14b	6.5 ± 0.17a	4.6 ± 0.16a	5.50 ± 0.16b	2.68 ± 0.14a	1.94 ± 0.03a
BS 96 SC-1	123.30 ±1.02a	2.92 ± 0.05a	6.5 ± 0.17a	4.5 ± 0.17a	4.50 ± 0.16c	2.60 ± 0.15a	1.68 ± 0.15a
BS 96 SC-2	119.70 ± 0.85b	2.75 ± 0.11ab	6.5 ± 0.17a	4.4 ± 0.16a	6.50 ± 0.16a	2.68 ± 0.14a	1.60 ± 0.16a
BS 96 SC-3	121.90 ±1.13ab	2.82 ± 0.12ab	5.4 ± 0.22b	4.3 ± 0.39a	6.30 ± 0.15a	2.81 ± 0.14a	1.80 ± 0.13a
LSD Value	2.985	0.3142	0.6997	0.9373	0.6284	0.4026	0.3729
CV(%)	2.70	12.52	9.24	17.33	9.06	16.50	23.46
Level of significance	*	*	**	NS	**	NS	NS

In a column, figure having same letter(s) do not differ significantly by DMRT at 5% level
* =Significant at 5 % level
** =Significant at 1 % level

Table 4. Field performance of leaf, bud and node characters of somaclones and comparison with its respective Co 1158 parent

Varieties/ Somaclones	Leaf length (cm) (Mean ± SE)	Leaf width (cm) (Mean ± SE)	Bud length (mm) (Mean ± SE)	Bud width (mm) (Mean ± SE)	Node width (mm) (Mean ± SE)	Node diameter (mm) (Mean ± SE)	Growth Ring width (mm) (Mean ± SE)
Co 1158	122.50 ±1.28ab	3.10 ± 0.06a	6.50 ± 0.17a	4.50 ± 0.17a	6.40 ± 0.16a	2.55 ± 0.16a	1.70 ± 0.15a
Co 1158 SC-1	128.60 ±1.44a	3.00 ± 0.21a	6.00 ± 0.15a	4.40 ± 0.16a	5.50 ± 0.17b	2.19 ± 0.14a	1.70 ± 0.15a
Co 1158 SC-2	128.00 ±1.33a	3.15 ± 0.21a	6.50 ± 0.17a	4.70 ± 0.21a	6.40 ± 0.22a	2.55 ± 0.14a	1.60 ± 0.16a
Co 1158 SC-3	124.00 ±1.94ab	3.30 ± 0.15a	6.50 ± 0.17a	4.50 ± 0.17a	6.90 ± 0.28a	2.55 ± 0.14a	1.80 ± 0.13a
Co 1158 SC-4	118.50 ± 2.48b	3.15 ± 0.20a	6.50 ± 0.17a	4.50 ± 0.17a	6.40 ± 0.16a	2.53 ± 0.15a	1.60 ± 0.16a
LSD Value	6.684	0.5031	0.4654	0.5023	0.7730	0.4147	0.4376
CV(%)	4.47	17.80	8.07	12.34	10.17	18.60	28.89
Level of significance	**	NS	NS	0.05	**	NS	NS

In a column, figure having same letter(s) do not differ significantly by DMRT at 5% level

** = Significant at 1 % level

Table 5. Field performance of leaf, bud and node characters of somaclones and comparison with its respective BSRI Akh 41 parent

Varieties/ Somaclones	Leaf length (cm) (Mean ± SE)	Leaf width (cm) (Mean ± SE)	Bud length (mm) (Mean ± SE)	Bud width (mm) (Mean ± SE)	Node width (mm) (Mean ± SE)	Node diameter (mm) (Mean ± SE)	Growth Ring width (mm) (Mean ± SE)
BSRI Akh 41	147.80 ± 1.54a*	3.50 ± 0.15a	7.50 ± 0.16a	5.50 ± 0.17a	8.40 ± 0.16a	3.15 ± 0.07a	2.01 ± 0.009a
BSRI Akh 41 SC-1	123.00 ± 0.74d	3.10 ± 0.06b	6.50 ± 0.16b	4.50 ± 0.17b	6.50 ± 0.17b	2.66 ± 0.12b	1.66 ± 0.14b
BSRI Akh 41 SC-2	133.90 ± 0.73b	2.82 ± 0.09bc	6.50 ± 0.16b	4.50 ± 0.17b	5.90 ± 0.31b	2.13 ± 0.07c	2.00 ± 0.06a
BSRI Akh 41 SC-3	132.50 ± 0.82b	2.75 ± 0.08bc	6.50 ± 0.16b	4.50 ± 0.17b	5.70 ± 0.30b	2.22 ± 0.07c	2.00 ± 0.06a
BSRI Akh 41 SC-4	122.80 ± 0.74d	2.85 ± 0.07bc	6.50 ± 0.16b	4.60 ± 0.16ab	6.20 ± 0.25b	2.30 ± 0.10bc	1.96 ± 0.03a
BSRI Akh 41 SC-5	127.60 ±1.26c	2.63 ± 0.11c	6.30 ± 0.15b	4.90 ± 0.23c	5.80 ± 0.20b	2.63 ± 0.13b	2.00 ± 0.06a
LSD Value	3.862	0.3776	0.6204	0.6755	0.9062	0.3719	0.2297
CV(%)	2.46	10.78	7.84	11.92	11.83	12.37	9.92
Level of significance	**	**	**	**	**	**	**

In a column, figure having same letter(s) do not differ significantly by DMRT at 5% level
** = Significant at 0.1 % level

Table 6. Field performance of leaf, bud and node characters of somaclones and comparison with its respective Misrimala parent

Varieties/ Somaclones	Leaf length (cm) (Mean ± SE)	Leaf width (cm) (Mean ± SE)	Bud length (mm) (Mean ± SE)	Bud width (mm) (Mean ± SE)	Node width (mm) (Mean ± SE)	Node diameter (mm) (Mean ± SE)	Growth Ring width (mm) (Mean ± SE)
Mishrimala	145.30 ± 0.66a*	3.93 ± 0.08a	6.80 ± 0.25b	4.50 ± 0.17b	7.50 ± 0.16a	2.99 ± 0.07ab	1.95 ± 0.03a
Mishrimala SC-1	143.90 ± 1.10a	3.67 ± 0.14a	7.50 ± 0.22ab	4.50 ± 0.17b	7.50 ± 0.16a	3.14 ± 0.07a	1.98 ± 0.01a
Mishrimala SC-2	146.80 ± 0.97a	3.20 ± 0.11b	8.40 ± 0.16a	6.10 ± 0.23a	8.10 ± 0.23a	3.27 ± 0.10a	2.05 ± 0.02a
Mishrimala SC-3	128.50 ± 0.61b	2.89 ± 0.08bc	6.50 ± 0.17b	4.50 ± 0.17b	6.60 ± 0.16b	2.62 ± 0.12b	1.56 ± 0.15b
Mishrimala SC-4	129.70 ± 1.63b	2.50 ± 0.14cd	6.70 ± 0.36b	4.90 ± 0.23b	6.50 ± 0.17b	2.20 ± 0.11c	1.20 ± 0.13b
Mishrimala SC-5	115.50 ± 1.02c	2.20 ± 0.08d	7.15 ± 0.36b	4.80 ± 0.29b	6.00 ± 0.21b	2.18 ± 0.10c	1.20 ± 0.13b
LSD Value	3.992	0.4289	1.016	0.8107	0.7044	0.3814	0.3832
CV (%)	2.48	11.72	11.90	13.91	8.39	11.68	19.35
Level of significance	**	**	**	**	**	**	**

In a column, figure having same letter(s) do not differ significantly by DMRT at 5% level

** =Significant at 0.1 % level

Table 7. Field performance of leaf, bud and node characters of somaclones and comparison with their respective six sugarcane parents

Varieties/ Somaclones	Leaf length (cm) (Mean ± SE)	Leaf width (cm) (Mean ± SE)	Bud length (mm) (Mean ± SE)	Bud width (mm) (Mean ± SE)	Node width (mm) (Mean ± SE)	Node Diameter (mm) (Mean ± SE)	Growth Ring width (mm) (Mean ± SE)
Isd18	129.20 ± 0.95cd*	3.05 ± 0.05d-h	7.40 ± 0.22bcd	5.00 ± 0.14bcd	6.5 ± 0.16def	2.90 ± 0.06a-e	1.45 ± 0.15cd
Isd18 SC-1	98.00 ± 3.26g	2.65 ± 0.12f-i	5.40 ± 0.16g	3.50 ± 0.16gh	5.5 ± 0.16g	3.00 ± 0.12a-e	1.00 ± 0.11e
Isd18 SC-2	103.00 ± 2.80g	2.50 ± 0.22hi	4.50 ± 0.16h	2.80 ± 0.13h	4.6 ± 0.16h	2.05 ± 0.05h	1.00 ± 0.11e
Isd18 SC-3	100.00 ± 3.65g	2.70 ± 0.15e-i	4.50 ± 0.16h	3.40 ± 0.16gh	4.5 ± 0.16h	2.50 ± 0.16e-h	1.00 ± 0.11e
Isd18 SC-4	96.50 ± 5.22g	2.50 ± 0.16hi	5.30 ± 0.21g	3.80 ± 0.19efg	4.3 ± 0.21h	1.50 ± 0.16i	1.00 ± 0.11e
Isd18 SC-5	101.60 ± 2.49g	3.50 ± 0.16bcd	5.50 ± 0.16g	3.50 ± 0.16fgh	5.5 ± 0.16g	2.30 ± 0.13fgh	1.00 ± 0.11e
Isd28	136.50 ± 0.83b	4.04 ± 0.04a	7.50 ± 0.16bc	5.70 ± 0.21ab	6.5 ± 0.16def	2.17 ± 0.06gh	1.86 ± 0.05abc
Isd28 SC-1	124.00 ± 1.04de	2.80 ± 0.08e-h	7.40 ± 0.22bcd	5.10 ± 0.23bcd	6.5 ± 0.16def	2.85 ± 0.12a-f	1.90 ± 0.10abc
Isd28 SC-2	117.90 ± 1.85ef	3.10 ± 0.12cd-h	7.50 ± 0.26bc	4.80 ± 0.19cd	6.5 ± 0.26def	2.50 ± 0.16e-h	2.00 ± 0.11ab
Isd28 SC-3	128.20 ± 0.80cd	3.20 ± 0.13c-f	7.40 ± 0.30bcd	5.20 ± 0.24bcd	7.5 ± 0.16bc	3.20 ± 0.19ab	1.70 ± 0.15abc
Isd28 SC-4	129.10 ± 1.61cd	3.00 ± 0.21d-h	7.50 ± 0.16bc	4.90 ± 0.23bcd	6.5 ± 0.16def	3.10 ± 0.18a-d	1.80 ± 0.13abc
Isd28 SC-5	123.10 ± 1.00def	3.30 ± 0.21cde	8.00 ± 0.29ab	5.10 ± 0.31bcd	7.0 ± 0.25cd	2.95 ± 0.21a-e	1.60 ± 0.16a-d
BS 96	123.10 ± 1.12def	2.55 ± 0.13ghi	6.50 ± 0.16def	4.60 ± 0.16de	5.5 ± 0.16g	2.68 ± 0.13b-g	1.94 ± 0.03ab
BS 96 SC-1	123.30 ± 1.02de	2.92 ± 0.05d-h	6.50 ± 0.16ef	4.50 ± 0.16de	4.5 ± 0.16h	2.60 ± 0.14c-h	1.68 ± 0.14abc
BS 96 SC-2	119.70 ± 0.85ef	2.75 ± 0.11e-i	6.50 ± 0.16ef	4.40 ± 0.16de	6.5 ± 0.16def	2.68 ± 0.13b-g	1.60 ± 0.16a-d
BS 96 SC-3	121.90 ± 1.12def	2.82 ± 0.11e-h	5.40 ± 0.22g	4.30 ± 0.39def	6.3 ± 0.15d-g	2.81 ± 0.13a-f	1.80 ± 0.13abc
Co1158	122.50 ± 1.28def	3.10 ± 0.06cd-h	6.50 ± 0.16def	4.50 ± 0.16de	6.4 ± 0.16def	2.55 ± 0.15d-h	1.70 ± 0.15abc
Co1158 SC-1	128.60 ± 1.44cd	3.00 ± 0.21d-h	6.00 ± 0.14fg	4.40 ± 0.16de	5.5 ± 0.16g	2.19 ± 0.13gh	1.70 ± 0.15abc
Co 1158 SC-2	128.00 ± 1.33cd	3.15 ± 0.21c-g	6.50 ± 0.16ef	4.70 ± 0.21cd	6.4 ± 0.22def	2.55 ± 0.13d-h	1.60 ± 0.16a-d
Co 1158 SC-3	124.00 ± 1.94de	3.30 ± 0.15cde	6.50 ± 0.16ef	4.50 ± 0.16de	6.9 ± 0.27cd	2.55 ± 0.13d-h	1.80 ± 0.13abc
Co 1158 SC-4	118.50 ± 2.47ef	3.15 ± 0.19c-g	6.50 ± 0.16ef	4.50 ± 0.16de	6.4 ± 0.16def	2.53 ± 0.15d-h	1.60 ± 0.16a-d
BSRI Akh 41	147.80 ± 1.54a	3.50 ± 0.14a-d	7.50 ± 0.16bc	5.50 ± 0.16abc	8.4 ± 0.16a	3.15 ± 0.07abc	2.01 ± 0.009ab
BSRI Akh 41 SC-1	123.00 ± 0.74def	3.10 ± 0.06c-h	6.50 ± 0.16ef	4.50 ± 0.16 de	6.5 ± 0.16def	2.66 ± 0.12b-g	1.66 ± 0.14abc
BSRI Akh 41 SC-2	133.90 ± 0.73bc	2.82 ± 0.09e-h	6.50 ± 0.16def	4.50 ± 0.16de	5.9 ± 0.31efg	2.13 ± 0.06gh	2.00 ± 0.11ab
BSRI Akh 41 SC-3	132.50 ± 0.81bc	2.75 ± 0.08e-i	6.50 ± 0.16def	4.50 ± 0.16de	5.7 ± 0.30fg	2.22 ± 0.06gh	2.00 ± 0.11ab
BSRI Akh 41 SC-4	122.80 ± 0.74def	2.85 ± 0.07e-h	6.50 ± 0.16ef	4.60 ± 0.16de	6.2 ± 0.24d-g	2.30 ± 0.10fgh	1.96 ± 0.02ab
BSRI Akh 41 SC-5	127.60 ± 1.25cd	2.63 ± 0.11f-i	6.30 ± 0.15ef	4.90 ± 0.23bcd	5.8 ± 0.19efg	2.63 ± 0.13c-g	2.00 ± 0.11ab
Mishnmala	145.30 ± 0.66a	3.93 ± 0.08ab	6.80 ± 0.24c-f	4.50 ± 0.16de	7.5 ± 0.16bc	2.99 ± 0.07a-e	1.95 ± 0.03ab
Mishnmala SC-1	143.90 ± 1.10a	3.67 ± 0.14abc	7.50 ± 0.22bc	4.50 ± 0.16de	7.5 ± 0.16bc	3.14 ± 0.07abc	1.98 ± 0.01ab
Mishnmala SC-2	146.80 ± 0.97a	3.20 ± 0.11c-f	8.40 ± 0.16a	6.10 ± 0.23a	8.1 ± 0.23ab	3.27 ± 0.10a	2.05 ± 0.02a
Mishnmala SC-3	128.50 ± 0.61cd	2.89 ± 0.08e-h	6.50 ± 0.16def	4.50 ± 0.16de	6.6 ± 0.16de	2.62 ± 0.12c-h	1.56 ± 0.15bcd
Mishnmala SC-4	129.70 ± 1.63bcd	2.50 ± 0.14hi	6.70 ± 0.36c-f	4.90 ± 0.23bcd	6.5 ± 0.16def	2.20 ± 0.11gh	1.20 ± 0.13de
Mishnmala SC-5	115.50 ± 1.02f	2.20 ± 0.08i	7.00 ± 0.36cde	4.80 ± 0.29cd	6.0 ± 0.21efg	2.18 ± 0.10gh	1.20 ± 0.13de
LSD Value	**6.649**	**0.5040**	**0.7620**	**0.7496**	**0.7277**	**0.4822**	**0.3897**
CV(%)	4.62	14.47	9.97	14.13	10.03	16.01	20.47
Level of significance	**	**	**	**	**	**	**

In a column, figure having same letter(s) do not differ significantly by DMRT at 5% level ** =Significant at 0.1 % level

Growth ring width of six sugarcane varieties and their somaclones

The mean performance of growth ring of sugarcane variety Isd 18 and its somaclones is shown in Table 1. The highest width of growth ring was recorded in variety Isd 18 (1.45 ± 0.16 mm). Rest of other somaclones were statistically similar.

The width of growth ring of variety Isd 28 and its somaclones showed significant variation as shown in Table 2. The highest width of growth ring was recorded in somaclone Isd 28 SC-2 (2.00 ± 0.12 mm) followed by Isd 28 SC-1 (1.90 ± 0.10 mm), Isd 28 (1.86 ± 0.05 mm), Isd 28 SC-4 (1.80 ± 0.13 mm), Isd 28 SC-3 (1.70 ± 0.15 mm). The lowest width of growth ring was recorded in somaclone Isd 28 SC-5 (1.60 ± 0.16 mm). Donor parent Isd 28 and somaclones Isd 28 SC-1 were statistically similar to Isd 28 SC-3 and Isd 28 SC-4.

The width of growth ring of variety BS 96 and its somaclones is presented in Table 3. The highest width of growth ring was recorded in variety BS 96 (1.94 ± 0.03 mm) followed by BS 96 SC-3 (1.80 ± 0.13 mm), BS 96 SC-1 (1.68 ± 0.15 mm). The lowest width of growth was recorded in somaclone BS 96 SC-2 (1.60 ± 0.16 mm). Donor parent BS 96 and its all somaclones were statistically similar.

The width of growth ring of variety Co 1158 and its somaclones is presented in Table 4. The highest width of growth ring was recorded in somaclone Co 1158 SC-3 (1.80 ± 0.13 mm). The lowest width of growth ring were recorded in somaclones Co 1158 SC-2 and Co 1158 SC-4 (1.60 ± 0.16 mm). Donor parent Co 1158 and rest of the somaclones were statistically similar.

The width of growth ring of variety BSRI Akh 41 and its somaclones is presented in Table 5. The highest width of growth ring was recorded in Variety BSRI Akh 41 (2.01 ± 0.009 mm). The lowest width of growth ring was recorded in somaclone BSRI Akh 41 SC-1(1.66 ± 0.14 mm). Donor parent BSRI Akh 41 and somaclones BSRI Akh 41 SC-2 was statistically similar to BSRI Akh 41 SC-3 and were also statistically similar to BSRI Akh 41 SC-4 and BSRI Akh 41 SC-5.

The width of growth ring of variety Misrimala and its somaclones showed highly significant variation is presented in Table 6. The highest width of growth ring was recorded in somaclone Misrimala SC-2 (2.05 ± 0.02 mm). The lowest width of growth ring were recorded in somaclones Misrimala SC-4 and Misrimala SC-5 (1.20 ± 0.13 mm). Donor parent Misrimala and Misrimala SC-1 and Misrimala SC-2 were statistically similar to Misrimala SC-3 and were also statistically similar to Misrimala SC-4 and Misrimala SC-5.

Field evaluation of six sugarcane varieties and their somaclones were performed based on analysis of quantitative agro-morphological traits. In case of growth ring, the highest width of growth ring was recorded in variety BSRI Akh 41 (2.01 ± 0.009 mm) and the lowest width of growth ring was noted in Isd 18 (1.45 ± 0.15 mm). The highest width of growth ring was observed in somaclone Misrimala SC-2 (2.05 ± 0.02 mm) and the lowest width of growth ring was observed in somaclones Isd 18 SC-1, Isd 18 SC-2, Isd 18 SC-3, Isd 18 SC-4 and Isd 18 SC-5 (1.00 ± 0.11 mm) (Table 1). Pandey (1989) found that

coefficient of variations were fairly high in number of millable cane per clump and cane weight. High to moderate associated with high to moderate genetic advance were recorded for the characters plant height, number of millable cane, growth ring of stalk and sucrose percent in juice.

In case of leaf length, the highest length of leaf (147.80 ± 1.54 cm) was recorded in variety BSRI Akh 41 and lowest length of leaf (96.50 ± 5.22 cm) was recorded in somaclone Isd 18 SC-4 (Table 7). The highest width of leaf (4.04 ± 0.04 cm) was recorded in variety Isd 28 and the lowest width of leaf (2.20 ± 0.08 cm) was recorded in somaclone Misrimala SC-5.

For bud length trait, the maximum bud length (8.40 ± 0.16 mm) was recorded in somaclone Misrimala SC-2 and the minimum bud length (4.50 ± 0.16 mm) was obtained in somaclones Isd 18 SC-2 and Isd 18 SC-3. The highest bud width (6.10 ± 0.23 mm) was recorded in Somacone Misrimala SC-2 and the lowest width of bud (2.80 ± 0.13 mm) was recorded in somaclone Isd 18 SC-2. In case of node width, the highest node width (8.4 ± 0.16 mm) was recorded in variety BSRI Akh 41 and the lowest node width (4.30 ± 0.21 mm) was recorded in somaclone Isd 18 SC-4. The highest diameter of node (3.27 ± 0.10 mm) was observed in somaclone Misrimala SC-2 and the lowest diameter of node (1.50 ± 0.16 mm) was recorded in somaclone Isd 18 SC-4. The highest width of growth ring (2.05 ± 0.02 mm) was obtained in somaclone Misrimala SC-2 and the lowest width of growth ring (1.00 ± 0.11 mm) was recorded in somaclones Isd 18 SC-1, Isd 18 SC-2, Isd 18 SC-3, Isd 18 SC-4 and Isd 18 SC-5.

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