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Effects of season of ratooning and field position of seedling ratoon clumps on selection in sugarcane (*Saccharum officinarum*)

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ABSTRACT

Field experiments were conducted during 2000–06 to study the position of seedlings in the field (border and interior) and seasons of ratooning in the ground nursery using 12 crosses of sugarcane (*Saccharum officinarum*). Two hundred sixty two seedlings in each cross were ratooned during winter (December) and spring (March). Seedling ratooned clumps were scored for number of millable canes (NMC), stalk diameter, stalk height and hand refractometer Brix (HR Brix) during next October. Selected clones were evaluated at different stages of selection (C1 to C4). Ratooning during winter season resulted in reduction in NMC and stalk length, whereas increase in HR Brix of the population in comparison to spring ratooning. There was no effect of ratooning season on stalk diameter. Border effects on winter ratooned clumps resulted in increase in mean performance of all the traits except HR Brix. In spring ratooned clumps border effect resulted in improvement in all traits except stalk length. Results indicated that selection was more effective in spring ratooned and from interior field positioned seedlings. Sugarcane breeders should not be tempted to select vigorous border field positioned seedlings.

Key words: Border effect, Clones, Ratoon, Season effect

Improvement in genetic potential for stalk and sugar yields is obviously the most important objective in sugarcane (*Saccharum officinarum* L.) breeding programme since the first artificial hybrid plant was raised. The main difficulty in improvement of sugarcane is the selection at seedling stage. Further, it is a vital stage of selection because it provides the base population for remaining and more effective stages of selection. When a breeder selects the most attractive clumps found in the field border or fertile field spot or in a less competitive place, he not only selects good genotypes but also good environments. Seedlings planted at border positions (two ends of a row) are expected to get better environments than those planted at interior positions in each row. In general, breeders are tempted to select vigorous seedlings at border positions and from border rows. However, the fate of clones selected from border positions, in later selection stages, is not known.

At present seedlings are ratooned during spring (March) and selection is done during next October. To identify clones with better ratoonability during winter, seedlings were ratooned during winter (December). In the present investigation, effects of seasons of ratooning and positions of seedlings in field at single stool seedling ratoon stage were studied on selection of clones during subsequent stages of selection.

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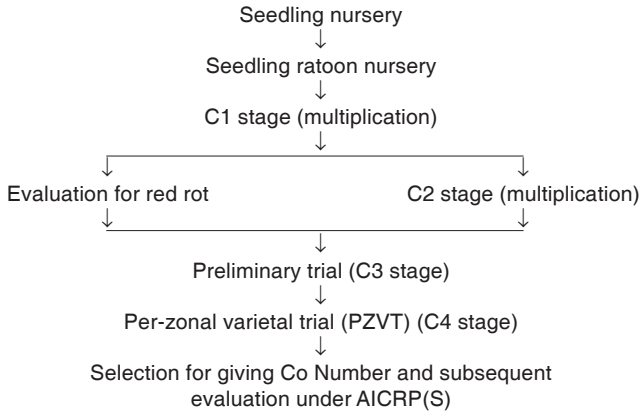
MATERIALS AND METHODS

The experimental material consisted of 6 300 seedlings from 12 crosses of sugarcane and selected clones at subsequent stages of selections. Three-month-old seedlings were transplanted during July in the ground nursery. Ten seedlings were transplanted at an equal distance of 60 cm between the seedlings in each of a 6 m row length, spaced at 75 cm. The seedlings at positions 1 and 10 in each row were designated as border positioned seedlings, whereas seedlings at 2, 3, 4, 5, 6, 7, 8 and 9 positions in each row were designated as interior positioned seedlings. Two hundred sixty two seedlings in each of 12 crosses were ratooned during last week of December (winter), whereas remaining seedlings were ratooned during March (spring). Seedling ratooned clumps were scored for number of millable canes (NMC), stalk diameter, stalk length and hand refractometer Brix (HR Brix) during next October.

On the basis of these observations and clump stand, lack of spines and splits, a total of 332 and 424 clones were selected from winter and spring ratooned seedling clumps, respectively. These clones were evaluated at different stages of selection (2000–06) as indicated below:



Effects of season of ratooning and positions of seedlings in ground nursery were studied to ascertain appropriate selection strategies.

RESULTS AND DISCUSSION

Effect of seasons

Effect of seasons and field positions of seedlings on number of clones selected at seedling ratoon stage and number of clones rejected at subsequent selection stages are presented in Table 1. The maximum rejection of clones was at C1 stage, irrespective of the season in the population of 12 crosses. This indicated the lack of correlation between performances of sugarcane clones at single stool seedling ratoon and clonal stages as also reported by Rao and Ethirajan (1985) and Reddy and Reddy (1988). None of the 332 clones from winter ratooned nursery were given co number. However, 3 clones (from 2 crosses) were given co numbers from 424 clones selected from spring ratooned seedlings. These results suggested that selection exercised in winter ratooned nursery was not effective to isolate elite clones suitable for giving Co number. However, these preliminary results need to be confirmed with more number of crosses. Similar trend (for rejection of clones), as that of population, was observed in 2 crosses, which yielded 3 elite clones for giving Co numbers. Comparatively lesser percentage of rejection at C1 stage and higher percentage of rejection at C2 stage due to red rot susceptibility were observed in selected crosses than in the population.

Effect of field position

Effect of field position of seedlings in a row of 6 m length was also studied (Table 1). In the whole population 26.3% selections were from border positions (seedlings at position 1 and 10), whereas 73.7% selections were from interior positions (seedlings at position 2, 3, 4, 5, 6, 7, 8 and 9). The rejection of clones at C1 stage (76.4 and 76.3%, respectively) and due to red rot susceptibility (16.6 and 16.7, respectively) was similar in border and interior field positioned seedlings. In other words, the proportion of rejection of seedlings at C1 stage and susceptibility due to red rot disease was independent of their positions. However, proportion of rejection of border seedlings was more (4.5%) at C2 stage of selection in comparison to interior positioned seedlings (2.2%). Finally, 3 clones were selected and raised to Co clone status from 12 crosses. The interesting observation was that none of the clones selected from border field positions was finally selected and given Co number. All the 3 selected clones, which were given Co numbers were from interior field positions. In general, the border seedling ratooned clumps were very vigorous, which increases the temptation (of the breeder) to select those clones. Similar trend was observed in 2 selected crosses except that proportion of selection and/or rejection at different stages of selection varied from that in whole population (Table 1). These results indicated the lack of correlation between single stool seedling ratoon and clonal stages (Reddy and Reddy 1988) and hence

Table 1 Effect of seasons and field positions on number of clones selected at different stages of selection in seedling nursery

Category	Season/ field position	No. of clones selected	Number of clones rejected at					Under evaluation	Clones given Co numbers
			Cl	Red rot susceptibility	C2	Preliminary trial	PZVT		
Effect of seasons									
Population	Winter	332	263 (79.2)	49 (14.8)	10 (3.0)	3 (0.9)	5 (1.5)	2 (0.6)	0
(12 crosses)	Spring	424	314 (74.1)	77 (18.2)	11 (2.6)	5 (1.2)	10 (2.4)	4 (0.9)	3 (0.7)
Selected	Winter	70	44 (62.9)	15 (21.4)	3 (4.3)	3 (4.3)	4 (5.7)	1 (1.4)	0
Crosses (2)	Spring	114	70 (61.4)	24 (21.1)	2 (1.8)	4 (3.5)	10 (8.8)	1 (0.9)	3 (2.6)
Effect of field positions									
Population	Border	199 (26.3)	152 (76.4)	33 (16.6)	9 (4.5)	2 (1.0)	2 (1.0)	1 (0.5)	0
(12 crosses)	Interior	557 (73.7)	425 (76.3)	93 (16.7)	12 (2.2)	6 (1.1)	13 (2.3)	5 (0.9)	3 (0.5)
Selected	Border	56 (30.4)	37 (66.1)	12 (21.4)	2 (3.6)	2 (3.6)	2 (3.6)	1 (1.8)	0
Crosses (2)	Interior	128 (69.6)	77 (60.2)	27 (21.1)	3 (2.3)	5 (3.9)	12 (9.4)	1 (0.8)	3 (2.3)

PZVT, Pre-zonal varietal trial

Figures in parentheses indicate the values in percentage

the sugarcane breeders should not be tempted to select the vigorous border field positioned seedlings. Bakshi Ram *et al*. (1997) identified low repeatability of traits, insignificant regression co-efficients, and low proportion of clones outyielding the best standard variety at selection and evaluation stages as the reasons for ineffectiveness of selection at the single stool ratoon seedling stage. The efficiency of selection in ratoon also depends on the magnitude of the genotype × year interaction and on whether the ratoon crop of each clone is determined mainly by genotype, by genotype × year interaction (Skinner *et al*. 1987). In the present study, variations over years did exist, as selection and evaluation stages clones were grown during different crop seasons.

Field positions vs seasons

Effect of season of ratooning and position of seedlings on selection and/or rejection at different stages is presented in Table 2. Of the 199 clones selected from border positions, 41.2% were selected from winter ratooned clumps, whereas 58.8% were selected from spring ratooned clumps. Proportion of rejection of clones at C1 stage was higher from winter ratooned clones in comparison to spring ratooned clones. This indicated that influence of environment on expression of clones at seedling ratoon stage and clonal stage was more in case of winter ratooned selections. As a result, the association between seedling ratoon and clonal stage is expected to be weaker in winter ratooned selections than that in spring ratooned selections. At later stages, proportion of rejection/selection did not vary much between seasons and field positions. However none of the clones selected from winter ratooned clumps and border field positions were given Co number. Three selections were only from spring ratooned interior positioned clumps.

Effect of seasons and field positions on mean performance

Effect of seasons and field positions on mean performance of clones from 12 crosses at seedling ratoon stage is presented

Table 2 Clones selected at different stages of selection in sugarcane

Category	Position	Season	No. of clones selected	Number of clones rejected at					Under evalution numbers	No. of clones given
				C1	Red rot susceptibility	C2	Prelimi-nary trail	PZVT		
Population (12 crosses)	Border	Winter	82	67 (81.7)	9 (11.0)	4 (4.9)	1 (1.2)	1 (1.2)	0	0
		Spring	117	85 (72.6)	24 (20.5)	5 (4.3)	1 (0.8)	1 (0.8)	1 (0.8)	0
	Interior	Winter	250	196 (78.4)	40 (16.0)	6 (2.4)	2 (0.8)	4 (1.6)	2 (0.8)	0
		Spring	307	229 (74.6)	53 (17.3)	6 (2.0)	4 (1.3)	9 (2.9)	3 (1.0)	3 (1.0)
Selected crosses (2)	Border	Winter	19	13 (68.4)	3 (15.8)	1 (5.3)	1 (5.3)	1 (5.3)	0	0
		Spring	37	24 (64.9)	9 (24.3)	1 (2.7)	1 (2.7)	1 (2.7)	1 (2.7)	0
	Interior	Winter	51	31 (60.8)	12 (23.5)	2 (3.9)	2 (3.9)	3 (5.9)	1 (2.0)	0
		Spring	77	46 (59.7)	15 (19.5)	1 (1.3)	3 (3.9)	9 (11.7)	0	3 (3.9)

PZVT, Pre-zonal varietal trial

Figures in parentheses indicate the values in percentage

Table 3 Mean performance of selected clones of population (12 crosses) and selected crosses (2) in seedling ratoon nursery

Season	Position	No. of clones selected	Number of millable canes	Stalk diameter (cm)	Stalk length (cm)	HR Brix
Population (*12 crosses*)						
Winter	Border	82	7.49	2.53	229.23	17.52
	Interior	250	6.53	2.46	221.14	17.74
	Mean	332	6.77	2.48	223.14	17.69
Spring	Border	117	8.24	2.49	223.23	17.63
	Interior	307	7.38	2.46	229.10	17.53
	Mean	424	7.62	2.47	227.48	17.56
Selected crosses (*2*)						
Winter	Border	19	6.53	2.55	237.89	17.48
	Interior	51	5.61	2.48	230.78	18.40
	Mean	70	5.86	2.50	232.71	18.15
Spring	Border	37	7.03	2.50	224.73	17.66
	Interior	77	6.57	2.47	232.21	18.11
	Mean	114	6.72	2.48	229.78	17.96

in Table 3. Ratooning during winter season has resulted in reduction in mean number of canes and stalk length. As a result of reduction in number of millable canes (NMC) and stalk length, increase in HR Brix of the population was observed in winter ratooned seedlings. However, ratooning seasons did not influence the mean stalk diameter. This indicated the importance of stalk diameter as an effective selection criterion (Bakshi Ram *et al*. 1996). Border effect on winter ratooned clumps resulted in increase in mean performance of all the traits except HR Brix. This might be the result of negative association of NMC and stalk length with HR Brix (Bakshi Ram *et al*. 2004). In spring ratooned clumps, border effect resulted in improvement in all traits except stalk length. This might be due to comparatively higher adverse effect of high temperature and hot winds on the border seedlings. Mean performance of winter ratooned interior positioned clumps was the poorest for all traits except for HR Brix, whereas the mean performance of spring ratooned interior positioned clumps was the poorest for all traits except stalk length.

In selected 2 crosses, ratooning during winter has resulted in improvement in all the traits except NMC in comparison with spring ratooning (Table 3). The comparison of mean performance of the population and mean of 2 crosses (which yielded 3 selections) indicated similar trend in winter ratooned seedlings. The trend of performance of 2 selected crosses was different from the trend of the population in spring ratooned seedlings. More specifically mean HR Brix of interior positioned seedlings from 2 selected crosses was the highest, whereas it was the lowest in case of the population (Table 3). In other words, combination of more stalk length and high HR Brix increased the chances of selection for giving Co numbers.

Better ratoonability, when harvested during winter months, is an important trait of sugarcane clones in north-western zone. This trait would increase the profitability of sugarcane growers and competitiveness of sugarcane crop. This would enable the farmers to take second ratoon crop after the harvest of first ratoon crop during winter. Further, the sugar recovery in sugar mills would also increase with the increase in area under ratoon crop. Hence, it is warranted to evolve sugarcane clones for better ratoonability during winter months. The results of the study indicated the ineffectiveness of selection in winter ratooned seedling nursery as none of the selected clones was raised to Co clone status. This may be due to increased genotype × environment component. The chances of success in selection for better ratoonability during winter would be improved by increasing the selection intensity in seedling ratoon nursery. To increase the efficiency of selection in winter ratooned seedlings, rejection of poor clumps would be helpful in reducing the population because the clones with poor ratoonability are not expected to attain commercial status.

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