RESEARCH ARTICLE

EVALUATION OF BACK CROSS PROGENIES OF INTERGENERIC HYBRIDS INVOLVING *ERIANTHUS ARUNDINACEUS* FOR DEVELOPING SUGARCANE VARIETIES WITH DIVERSE GENETIC BASE

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Abstract

In recent years, considerable attention is being given to *Erianthus* spp., the genus with high biomass potential and high tolerance to biotic and abiotic stresses, as a source for imparting these traits in to commercial sugarcane hybrids which were historically developed with *S. officinarum* and *S. spontaneum* lineage. In the present study, 734 progenies from nine families obtained by back crossing intergeneric hybrids involving *Erianthus* to commercial varieties were evaluated for number of stalks / clump, HR Brix and stalk diameter. Number of stalks in the population ranged from 3 to 80 while stalk diameter was in the range of 0.4 - 3.3 cm. Coefficient of variation was high for millable stalks (46.5 - 70.5%) and low to moderate for stalk diameter (16.3 - 28.3%). Average HR Brix for the population was only 13.35 with a range of 3.8 - 21.4%. Coefficient of variation was also low for HR Brix (15.3 - 23.3%). Although some transgressive segregants were obtained in each population for individual traits, the frequency of selectable types among the families with more than 16% HR Brix and above 2.00 cm stalk diameter was found to be low (4.3%). This indicates that further back crossing with commercial canes/ intermating among the best clones will be required for obtaining commercially acceptable types.

Key words: Intergeneric hybrids, back cross, *Erianthus arundinaceus,* variability

Introduction

Sugarcane (*Saccharum* spp.) is an important cash crop in most of the tropical and subtropical regions and contributes to about 75% of the world's sugar. Modern sugarcane cultivars are complex polyploids derived through interspecific hybridization between *Saccharum officinarum* and the wild species *Saccharum spontaneum* L. Traditionally, *S. spontaneum* had been used as a source for imparting high productivity and tolerance to various biotic and abiotic stresses in sugarcane varieties. However, sugarcane cultivars currently under cultivation have a narrow genetic base tracing back to less than 20 *S. officinarum*, two *S. spontaneum* and a couple of *S. sinense* and *S. barberi* clones which is a serious limitation in improving sugarcane productivity. In view of this, attempts are being made at all cane breeding stations to cross sugarcane with other genera of the "*Saccharum* complex", a rich and variable primary genetic resource pool (Harlan and De Wet 1971) to broaden and diversify the genetic base of sugarcane varieties.

Erianthus arundinaceus, a related genus in the *Saccharum* complex with tall and thick canes, has a number of important traits such as growth vigor, wide adaptation, excellent ratooning ability, relatively

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high stalk numbers, very high biomass, and disease and pest resistance (D'Hont et al. 1995). This is of great interest as a potential source of parental germplasm to sugarcane breeders (Cai et al. 2005). Intergeneric hybrids enabled the sugarcane breeders to impart various highly heritable traits from allied genera to *Saccharum* progenies which may serve as foundation stocks for future breeding work in sugarcane (Li et al. 1950). The high polyploidy in sugarcane helps the progeny to overcome barriers in distant hybridization with other genera within the complex (Janaki Ammal 1942). Intergeneric hybridization offers the greatest promise for further improvement of existing germplasm by incorporating useful genes from wild relatives into commercial sugarcane (Grassl 1972; Shanmughasundaram et al. 2010).

Saccharum x *Erianthus* crosses are difficult to make and had very low success rates, which had been a serious limitation in the utilization of this potential genus. At Sugarcane Breeding Institute, Coimbatore, introgression of *Erianthus* spp. has been in progress since 1980's leading to the production of a number of intergeneric hybrids over the years. The hybrids had greater productivity but lacked major economic traits like sugar content. These hybrids were back crossed to commercial sugarcane varieties in an attempt to improve them further with respect to agronomic traits. The objective of the present study was to develop and evaluate variability in number of stalks, HR Brix and stalk diameter in the back cross progenies of intergeneric hybrids between *Saccharum* and *Erianthus* to develop cultivars with commercial acceptance.

Materials and methods

Four true intergeneric hybrids involving *Saccharum officinarum* and *Erianthus arundinaceus* were crossed with seven commercial canes viz., Co 775, CoH15, Co 62198, CoH 70, Co 1148, Co 94008 and CoLk 8102 during the 2006 flowering season and a total of nine backcrosses were made. Out of these, six crosses involved *S. officinarum* x *E. arundinaceus* (OE) intergeneric hybrids as female parent and three involved *E. arundinaceus* x *S. officinarum* (EO). Fluff was collected and sown during February 2007. One month old seedlings were transferred to polybags and kept in the net house till May 2007. A total of 734 seedlings obtained from the nine backcrosses were transplanted to the field at East Chithirai Chavadi farm of Sugarcane Breeding Institute, Coimbatore, India (427 MSL). Ten seedlings were planted in each single row plot with intra and inter row spacing of 45cm and 90cm respectively. The number of seedlings obtained in each cross varied from 49 to 143 (Table 1). These seedlings were ratooned during April, 2008 and evaluated clonally for the number of stalks, HR Brix and stalk diameter during February 2009. Stalk diameter was measured on five mature stalks per seedling at approximately middle of the stalk and mid internode using digital vernier caliper. HR Brix (% soluble solids w/w in the juice) was estimated using a Hand-held refractometer (0-32 scale) from juice taken from the middle of the stalk. The significance of family as well as group differences was tested by analysis of variance (ANOVA) for each variable. Group means were tested using the least significant difference test (LSD) at a probability level of 5%.

Table 1. Details of the parents used in the study

S. No.	Cross		No. of progenies	Parentage of female parent
	Female	Male		
1	OE-1	Co 775	58	DB 95-918 (Sugarcane hybrid) x ERI 2385 (*E. arundinaceus)*
2	OE-1	CoH 15	143	DB 95-918 x ERI 2385
3	OE-1	Co 62198	115	DB 95-918 x ERI 2385
4	OE-38	CoH 70	78	DB 95-918 x ERI 2385
5	OE-45	Co 1148	58	DB 95-918 x ERI 2385
6	OE-45	Co 94008	49	DB 95-918 x ERI 2385
7	EO-1	CoH 15	63	IND 90-828 (*E. arundinaceus)* x PIO 00-847 (*S. officinarum*)
8	EO-1	Co 62198	100	IND 90-828 x PIO 00-847
9	EO-1	CoLk 8102	70	IND 90-828 x PIO 00-847
		Total	734	

O x E : *S. officinarum* x *E. arundinaceus*
E x O : *E. arundinaceus* x *S.officinarum*

Results and discussion

Variability is a pre-requisite for successful selection of superior progenies from segregating generations. A population is said to be superior when it shows high mean coupled with high variability. Mean performance serves as the basis for eliminating undesirable crosses and variability helps to choose a potential cross since it indicates the extent of recombination for initiating effective procedures. According to Allard (1960), high mean and high variability for a character in the segregating population constituted the ideal source for exercising selection. The present investigation aims to determine the magnitude and extent of variability and pattern of segregation in nine backcross families of intergeneric hybrids involving *Erianthus*.

The analysis of variance revealed significant differences among the families as well as the two groups (O x E, E x O) for all three traits studied (Table 2). The mean, range, coefficient of variation for three different traits viz., number of stalks, HR Brix and stalk diameter in nine back cross families are given in Table 3. The number of stalks ranged from three to 80 in the population. The mean number of stalks was the highest in the family OE-1 x Co 775 (23.59) and lowest in OE-45 x Co 94008 (11.02). The mean no. of stalks in the progenies increased significantly when EO hybrids were used as female parents.

Coefficients of variation (CV) of nine back cross families for three traits varied considerably. Low CV was obtained in both HR brix and stalk diameter whereas high CV was observed in number of stalks.

Table 2. Analysis of variance and mean values for no. of stalks/clump, HR Brix and stalk diameter

Source of variation	Mean sum of square			
	df	No. of stalks/ clump	HR Brix	Stalk diameter (cm)
Between families	8	2197.44**	195.72**	10.15**
Between groups	1	9676.90**	1001.70**	52.14**
Error	725	119.18	6.15	0.14
Means				
OE Group		15.97[a]	14.14[a]	1.85[a]
EO Group		23.77[b]	11.63[b]	1.27[b]

** Significant at $P < 0.01$

Similar trend had been reported with respect to number of stalks, stalk diameter and HR brix in populations involving commercial hybrids and in interspecific hybrid populations (Nagarajan et al. 2000). For number of stalks, highest CV of 70.5% was observed in the family OE-45 x Co 94008, though the mean was only 11.02, which was the lowest among the families. Though it had maximum CV, the selections would be very low because of low mean value. The families EO-1 x Co 62198, OE-1 x Co 775 and EO-1 x CoH 15 recorded both high mean and CV and selection in these families would be more effective for number of stalks. The mean number of stalks was higher when EO hybrids were used as female parent compared to OE. This may be due to the greater influence of *Erianthus* when it was used as female parent in the development of intergeneric hybrids.

For HR Brix, the population mean was significantly higher when OE hybrids were used as female (13.35%) than when EO hybrids were used (11.63%). The higher Brix was from *S. officinarum* when it was used as female in the development of intergeneric hybrids. CV for HR Brix ranged from 15.3% in OE-1 x CoH 70 to 23.3% in EO-1 x CoH 15 (Table 3). Some of the transgressive segregants, particularly in OE-1 x CoH 15 and OE-1 x Co 62198, had shown high HR Brix of more than 20.0%. Hence selection will be rewarding in these populations for juice quality quantified in terms of HR Brix.

The mean stalk diameter was the highest in the family OE-45 x Co 94008 (2.18cm) and the lowest in EO-1 x Co H15 (1.20cm); the population mean was 1.66 cm. The stalk diameter was significantly higher when OE hybrids were used as female parent indicating the influence of *S. officinarum* in determining the trait. The CV in the nine backcross families was fairly uniform. Tai and Miller (1988) have also reported similar trends in the intergeneric hybrids of sugarcane involving *Erianthus* and *Miscanthus*.

Table 3. Mean, range and coefficient of variation for no. of stalks/ clump in back cross progenies involving *E. arundinaceus*

Cross		n	No. of stalks/clump			HR Brix			Stalk diameter (cm)		
Female	Male		Mean	Range	CV (%)	Mean	Range	CV (%)	Mean	Range	CV (%)
OE-1	Co 775	58	23.59	6.0-60.0	54.9	13.48	6.8-19.4	18.9	1.67	0.8-2.6	28.2
OE-1	CoH 15	143	16.95	4.0-45.0	53.0	14.92	8.8-21.4	17.2	1.63	0.8-2.4	22.8
OE-1	Co 62198	115	17.17	4.0-60.0	61.0	14.59	8.6-20.8	19.0	1.72	0.8-2.8	23.0
OE-38	CoH 70	78	12.28	4.0-35.0	50.2	13.89	8.0-17.8	15.3	2.12	0.8-3.3	22.1
OE-45	Co 1148	58	12.70	3.0-39.0	66.0	13.18	6.8-16.8	16.6	2.17	1.4-3.0	16.3
OE-45	Co 94008	49	11.02	3.0-28.0	70.5	13.16	8.2-17.8	17.6	2.18	1.3-2.9	19.5
EO-1	CoH 15	63	24.57	9.0-67.0	51.6	12.04	3.8-17.8	23.3	1.20	0.7-1.9	19.6
EO-1	Co 62198	100	25.79	6.0-80.0	63.6	12.60	4.0-18.4	19.9	1.36	0.4-2.4	23.3
EO-1	CoLk 8102	70	20.17	6.0-45.0	46.5	9.87	6.0-16.0	19.10	1.21	0.7-2.2	28.3
	Total	734	18.44	3.0-80.0	64.5	13.35	3.8-21.4	21.4	1.66	0.4-3.3	30.2

Number of stalks, stalk diameter and HR Brix are important traits based on which selections are made at the seedling stage in sugarcane. Normally clones without the minimum acceptability levels for these traits will be rejected during selection (Tai and Miller 1988). Data on HR Brix and stalk diameter in nine back cross families were used to estimate the percentage of desirable progenies at four different levels for HR Brix (14,16,18 and 20%) and stalk diameter (2.2, 2.4, 2.6 and 2.8 cm) and presented in (Table 4). The percentage of progenies with <18% HR Brix was very low and only one backcross family OE-1 x Co 62198 had the highest percentage of acceptable progenies (8.7%) followed by OE-1 x CoH 15 (8.4%). For stalk diameter at 2.8 cm level, three families, *viz.* OE-45 x Co1148, OE-45 x Co 94008 and OE-38 x CoH 70 had progenies with 5.2, 6.1 and 6.4% respectively. Only 5.7% of the progenies in the whole population had more than 18% Brix and it was further reduced to 3.4 % when selected at 20% Brix. For stalk diameter, there were only 5.7% and 2.0% selectable progenies at 2.6 and 2.8 cm levels. Though for individual traits some transgressive segregants were obtained in each population, the selectable types among the families with more than 16% HR Brix and above 2.00 cm stalk diameter were found to be very low (4.3%) in the population.

The stalk diameter and HR Brix were high when *Saccharum* x *Erianthus* hybrids were used as female parent. On the contrary, no. of millable stalks was high when EO hybrids were used as female parent. The number of progenies with acceptable levels of no. of millable stalks, stalk diameter and HR Brix were few in the population, suggesting that

Table 4. Percentage of selectable progenies at four different levels for HR Brix and cane diameter

Cross		n	HR Brix				Stalk diameter (cm)			
Female	Male		<14	<16	<18	<20	<2.4	<2.6	<2.8	<3.0
OE-1	Co 775	58	46.6	13.8	1.7	0.0	8.6	3.4	0.0	0.0
OE-1	CoH 15	143	66.4	34.3	8.4	2.8	2.8	0.0	0.0	0.0
OE-1	Co 62198	115	64.3	29.6	8.7	0.9	9.6	0.9	0.3	0.0
OE-38	CoH 70	78	47.4	17.9	0.0	0.0	29.5	17.9	6.4	2.6
OE-45	Co 1148	58	36.2	10.3	0.0	0.0	25.9	19.0	5.2	3.4
OE-45	Co 94008	49	34.7	12.2	0.0	0.0	40.8	22.4	6.1	0.0
EO-1	CoH 15	63	27.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0
EO-1	Co 62198	100	29.0	9.0	1.0	0.0	1.0	0.0	0.0	0.0
EO-1	CoLk 8102	70	1.4	0.0	0.0	0.0	1.4	0.0	0.0	0.0
	Total	734	45.2	19.6	5.7	3.4	11.2	5.7	2.0	1.0

further back crossing to commercial varieties may be required to improve yield and quality traits. Since most of the economically important traits in sugarcane are quantitative in nature controlled by multiple genes (Stevenson 1965), it is essential to develop large populations to obtain commercially acceptable clones.

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