The Inheritance of Five Characters in F_1 Progeny of Sugarcane

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ABSTRACT

Seven pairs of reciprocal and six single crosses were analysed and compared for five major gene controlled characters e.g., internode shape, cane colour, bud shape, sheath colour and auricle shapes. Segregation was observed in the F_1 generation indicating heterogenous and complex genetic state of sugarcane parents. Various ratios of ligulate and eligulate progeny (5:1, 3:1 and 1:1) was obtained indicating complicating segregation. Thus, the utilization of these characters of the parents as a marker become difficult.

Key words : Inheritance, F_1 progeny, sugarcane.

INTRODUCTION

Most of the commercial sugarcane varieties grown are mainly complex polyploids, even sometimes aneuploids, Thus, the inheritance follows a complicated and nonrepatable patterns, even some simple major gene controlled Mendelian characters show this complexity. Inspite of this, any sugarcane improvement programme using hybridization and selection should include marker and genetic analysis of easy to follow quantitative characters. Because, without genetic knowledge and marker genes of some kinds, it will be difficult to assume the success of hybridization and selection. Moreover, parthenogenesis (Raghavan, 1954 and Skinner, 1956) and pollen contamination are very likely to interfere with intended crossing.

As the parents involved are commercial varieties propagated vegetatively and are probably not genetically pure, one can not expect homogenous and uniform F_1 from the reciprocal or similar crosses. Here, the intention is to only consider parents and F_1 for information on genetic behaviour of the hybrids in relation to inheritance of character of their parents, success of hybridization and selection for desirable genotypes.

MATERIALS AND METHODS

Materials used in this study are comprised of 13 parents of sugarcane obtained from the Germplasm Bank of BSRI, Ishurdi, Pabna and used for seven reciprocal and six single crosses. The sugarcane varieties/clones involved were examined for easily visible characters from parents to hybrids. Efforts ISSCT to standardize the methods of describing the characteristics of sugarcane clone has resulted in indentifying a large number of botanical characters (Skinner, 1972; Daniels, 1972). Five important characters present in the varieties/clones used in this study :

A. Internode shape (Cylindrical, conoidal and bobbin)
B. Cane colour (Green, yellow green, greenish yellow and brown)
C. Bud shape (Triangular, oval, ovate, rectangular)
D. Sheath colour (Green, pale green, deep green)
E. Auricle shape- types (Present or absent).

The varieties/clones were described regarding these characters on the present (+) or absent (-) scale. A group of canes from the stool were used. For accuracy, the observation on the parents and hybrids were repeated twice. Data were collected only at maturity on 8-9 months old cane. Characters showed some phenotypic variation probably associated with environments, so several stalks were examined in each of the stools to obtained a reliable information.

RESULTS AND DISCUSSION

The scored phenotypes of parents and F_1 families for various characters are summarized in Tables 1, 2, 3, 4 and 5.

Internode Shape : Internode shapes of various types were long been recognised in sugarcane (Skinner, 1972). Most of the commercial varieties in Bangladesh are cylindrical in shape. All the parents included in this have cylindrical shape internode except two parents (BC_2 and My 54-29). But the progeny of most of the crosses have three phenotypes (Cylindrical, conoidal and bobbin shapes) except crosses CoL 73 x I 101-66, I 28-80 x I 327-86 and I 95-78 x I 28-80 (Table 1).

The segregation in F_1 progeny indicated that the materials were highly heterozygous and more than one gene were involved in most of the cases. The parents I 101-66, I 95-78, I 28-80 and CoL 73 as involved in crosses CoL 73 x I 101-66, I 28-80 x I 327 - 86 and I 95-78 x I 28-80 did not show any segregation in F_1.

Table 1. Transmission of internode shapes in hybrids.

Cross	Parents	Hybrids		
		Cylindrical	Conoidal	Bobbin
CI 85-80 x CP 44-154 CP 44 - 154 x CI 85-80	Cylindrical, Cylindrical	41	1	2
I 327- 86 x CP 44-154 CP 44-154 x I 327-86	Cylindrical, Cylindrical	41	4	1
CP 44-154 x I 95-78 I 95-78 x CP 44-154	Cylindrical, Cylindrical	34	4	-
I 95-78 x I 327-86 I 327-86 x I 95-78	Cylindrical, Cylindrical	38	-	2
I 95-78 x CI 85-80 CI 85-80 x I 95-78	Cylindrical, Cylindrical	38	3	1
CI 85-80 x I 327-80 I 327-80 x CI 85-80	Cylindrical, Cylindrical	39	1	2
Isd 16 x MY 54-29 MY 54-29 x Isd 16	Cylindrical, Conoidal	28	12	-
BC_2 x I 523-86	Conoidal, Cylindrical	17	3	-
I 28-80 x CP 44-154	Cylindrical, Cylindrical	18	1	-
Co 530 x Saipan 17	Cylindrical, Cylindrical	18	2	-
CoL 73 x I 101-66	Cylindrical, Cylindrical	20	-	-
I 28-80 x I 327 - 86	Cylindrical, Cylindrical	19	-	-
I 95-78 x I 28-80	Cylindrical, Cylindrical	19	-	-

Cane colour : The stem (rind) colour of the varieties /clones included in the study varied from green, yellowish green, greenish yellow to brown.

The F_1s including reciprocal crosses produced seedlings which exhibited regular segregation of green, yellow green and greenish yellow types (Table 2). Only one brownish seedling appeared among 20 seedling from the cross Co 530 x Saipan 17, where parent Saipan 17 has brownish colour. The result did not fit simple Mendelian ratio because of high heterozygosity and polyploid nature of the species. The reciprocal differences also pointed to this complication.

Table 2. Cane colour of F_1 and parent lines.

Cross	Parents	Hybrids				
		Green	Yellow	Yellow green	Green yellow	Brown
CI 85-80 x CP 44-154	Green yellow, Green yellow	6	-	6	11	-
CP 44-154 x CI 85-80		12	-	5	4	-
I 327 -86 x CP 44-154	Green, Green yellow	15	-	3	5	-
CP 44-154 x I 327 -86		11	-	3	9	-
CP 44-154 x I 95-78	Green yellow, Green	10	6	2	-	-
I 95-78 x CP 44-154		12	4	3	-	
I 95-78 x I 327-86	Green, Green	12	-	5	3	-
I 327-86 x I 95-78		10	-	2	8	-
I 95-78 x CI 85-80	Green, Green yellow	8	-	9	4	-
CI 85-80 x I 95-78		12	-	6	3	-
CI 85-80 x I 327-80	Green yellow, Green	12	-	7	2	-
I 327 -80 x CI 85-80		8	-	9	4	-
Isd 16 x MY 54-29	Green, Green yellow	13	-	4	3	-
MY 54-29 x Isd 16		11	-	2	8	-
BC_2 x I 523-86	Green, Green	12	-	5	3	-
I 28-80 x CP 44-154	Yellow green, Green yellow	12	-	5	2	-
Co 530 x Saipan 17	Green yellow, Brown	15	-	-	4	1
CoL 73 x I 101-66	Green, Yellow green	15	-	4	1	-
I 28-80 x I 327-86	Yellow green, Green	11	-	6	2	-
I 95-78 x I 28-80	Green, Yellow green	16	-	2	1	-

Bud shapes : Skinner (1972) also included bud shape as an identifying character. The most common shape was round in (BC_2, CP 44-154 Saipan-17 and CI 85-80), followed by triangular (parents I 95-78, I 28-80 and CoL 73), oval (Parents I 101-66, and I 523-86), ovate (Parents I 28-80, Co 530 and I 327-86) and rectangular (parents Isd 16). In the F_1, there were more variation, in all six different types (Table 3). However, round bud shape was indicated to be the most common type in the progeny, whereas rectangular and bulgy were types, Again highly complicated inheritance pattern was indicated.

Table 3. Bud shape of F_1 and parent lines.

Cross	Parents	Hybrids					
		TR	RO	OV	OVA	REC	BUL
CI 85-80 x CP 44-154	RO, RO	-	16	1	-	-	-
CP 44-154 x CI 85-80			14	8	-	-	-
I 327-86 x CP 44-154	OVA, RO	-	17	-	3	-	3
CP 44-154 x I 327 -86		-	17	-	5	-	1
CP 44-154 x I 95-78	RO, TR	9	10	-	-	-	-
I 95-78 x CP 44-154		10	8	-	-	-	-
I 95-78 x I 327-86	TR, OVA	7	2	-	10	-	-
I 327-86 x I 95-78		10	3	-	7	-	-
I 95-78 x CI 85-80	TR,RO	5	15	-	-	-	-
CI 85-80 x I 95-78		8	16	-	-	-	-
CI 85-80 x I 327 -80	RO, OVA	-	10	-	8	-	3
I 327-80 x CI 85-80		-	8	-	2	-	1
Isd 16 x MY 54-29	REC, TR	12	5	-	-	3	-
MY 54-29 x Isd 16		15	-	-	-	5	-
BC_2 x I 523-86	RO, OV	-	10	8	-	-	2
I 28-80 x CP 44-154	OVA, RO	-	14	-	4	-	1
Co 530 x Saipan 17	OVA, RO	2	12	-	6	-	-
CoL 73 x I 101-66	TR, OV	5	10	5	-	-	-
I 28-80 x I 327-86	OVA, OVA	-	-	9	6	-	2
I 95-78 x I 28-80	TR, OVA	10	4	-	5	-	-

TR = Triangular, RO = Round, OV = Oval, OVA = Ovate, REC = Rectangular, BUL = Bulgy

Sheath colour : Leaf sheath colour was included by Skinner as an identifying character. He suggested 15 different colours, but in the present material three e.g. green, olive green and brownish green were observed. Green shealth was very common, of the 13 parents, eight were green, three were olive green and two were brownish green (Table 4). Most of the crosses again exhibited irregular segregation in the F_1 generation, indicating high level of heterozygosity and polyploidy in the material.

Table 4. Sheath colour of F_1 and parent lines.

Cross	Parents	Hybrids		
		Green	Olive green	Brown green
CI 85-80 x CP 44-154	Brown green, green	19	3	-
CP 44-154 x CI 85-80		17	4	-
I 327-86 x CP 44-154	Green, green	23	-	-
CP 44-154 x I 327-86		17	5	-
CP 44-154 x I 95-78	Green, green	14	5	-
I 95-78 x CP 44-154		16	3	-
I 95-78 x I 327-86	Green, green	15	4	1
I 327-86 x I 95-78		18	2	-
I 95-78 x CI 85-80	Brown green,green	18	2	1
CI 85-80 x I 95-78		15	4	2
CI 85-80 x I 327-80	Brown green, green	13	5	3
I 327-80 x CI 85-80		16	2	5
Isd 16 x MY 54-29	Brown green, green	10	8	2
MY 54-29 x Isd 16		17	-	3
BC_2 x I 523-86	Olive green, green	14	2	4
I 28-80 x CP 44-154	Green, green	15	3	-
Co 530 x Saipan 17	Olive green, green	15	5	-
CoL 73 x I 101-66	Olive green, green	15	2	3
I 28-80 x I 327-86	Green, green	13	6	-
I 95-78 x I 28-80	Green, green	13	3	-

Auricle (presence/absence) : All the parents (I 523-86, CP 44-154, I 95-78, I 28-80, Co 530,My 54-29, Saipan 17, CI 85-80 and I 327-86) expect three (I 101-66, BC_2 and Isd 16) had transitional type auricle (Table 5). The presence of auricle in both the parents of 15 crosses did not result in F_1 families with all ligular progeny; this indicated heterogeneous nature of the parents involved. The F_1 families exhibited various ratio of ligulate, elegulate progeny (5:1, 3:1 and 1:1) indicating complicated segregation. The progeny from crosses between ligulate and elegulate parents resulted in similar families indicating the heterozygosity of the ligular parents. The segregation of other auricle e.g. lanceolate, dentoid and deltoid (Table 5) in the F_1 also indicated complicated patten.

Table 5. Transmission of auricle transitional (TT), lanceolate (LT), deltoid (DT) and dentoid (DD) types.

Cross	TT			LT			DT			DD		
	P	A	R	P	A	R	P	A	R	P	A	R
CI 85-80 x CP 44-154	42	2	5:1	-	-	-	-	-	-	9	34	1:3
CP 44-154 x CI85-80												
I 327-86 x CP 44-154	38	8	5:1	18	28	1:1	-	-	-	-	-	-
CP 44-154 x I 327 -86												
CP 44-154 x I 95-78	34	4	5:1	-	-	-	1	27	1:3	-	-	-
I 95-78 x CP 44-154												
I 95-78 x I 327-86	22	18	1:1	6	34	1:3	28	12	3:1	-	-	-
I 327-86 x I 95-78												
I 95-78 x CI 85-80	32	11	3:1	-	-	-	18	24	1:1	-	-	-
CI 85-80 x I 95-78												
CI 85-80 x I 327-80	36	6	5:1	7	35	1:3	-	-	-	22	20	1:1
I 327-80 x CI 85-80												
Isd 16 x MY 54-29	29	11	3:1	16	24	1:1	26	14	3:1	-	-	-
MY 54-29 x Isd 16												
BC_2 x I 523-86	12	8	1:1	7	13	1:3	8	12	1:1	10	11	1:1
I 28-80 x CP 44-154	16	3	3:1	-	-	-	-	-	-	7	12	1:1
Co 530 x Saipan 17	18	2	5:1	-	-	-	12	8	1:1	-	-	-
CoL 73 x I 101-66	18	2	5:1	4	16	1:3	8	12	1:1	-	-	-
I 28-80 x I 327-86	10	9	1:1	5	14	1:3	-	-	-	7	12	1:1
I 95-78 x I 28-80	14	5	3:1	-	-	-	-	-	-	7	12	1:1

It was not intended to include a detail genetical study, only the F_1 progeny was involved in the study. The parents and progeny were classified for these characters and segregation was observed in F_1 indicating the heterozygous and genetics state of parents. Characteristics ratios (5:1, 3:1 and 1:1) were often observed in the F_1 families indicating tetrasomic, complicated disomic or other complex aneuploidy inheritance in these crosses. Jananki Ammal (1937) reported tetrasomic inheritance with complicated pattern of 5:1 in the F_1 for ligular process (auricle) in an interspecific cross of sugarcane. Batcha and Palanichamy (1977) latter confirmed this. However, the fact that most of the F_1 plants were ligulate and indicated the presence of ligulate as dominant over the absence in the present study too.

Result of Batcha and Palanichamy (1977) of an interspecific cross also indicated the presence of auricle is dominant over the absence. They reported two duplicated genes with disomic inheritance. The presence of more phenotypic classes for characters like stem colour and bud shape indicated the involvement of more than one genes and /or gene interaction. The results of the present study also indicated that cylindrical intermode shape, green cane colour, round bud shape and green sheath colour may be controlled by dominant marker genes.

Though a number of good characters could be identified in the sugarcane varieties/ clones, due high levels of heterzygosity, complex polyploid and chromosome number variation as well as segregation in the F_1 complicated pattern occur and utilization of these traits as marker become difficults. However, consideration a number of characters together gives some idea about the authenticity of the hybrids.

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