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Studies on transgressive segregation in F_2 and backcross F_2 for grain yield and its components in *rabi* sorghum [*Sorghum blcolor* (L.) Moench]

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ABSTRACT

Sorghum \ [*Sorghum bicolor* (L) Moench] is an important crop in semi-arid tropics (SAT) region because of it's ability to survive and give yield under moisture stress. India is the second largest grain producer and ranks seventh in productivity. The present study was undertaken to generate the transgressants possessing more number of desirable attributes. Experimental material consisted of four crosses *viz* SPV 1359 x SPV 1452 (Cross I), SPV 1452 x RSE 907-11 (Cross II), SPV 1359 x RSE 90-7-11 (Cross III) and RSLG 1072 x RSE 90-7-11 (Cross IV) involving four diverse parents of *rabi* sorghum. These parents and their F_2's and backcross F_2's were grown in Randomized Block Design with three replications. Parents were grown in two rows and F_2 and backcross F_2 population were grown on in twenty rows. The studies revealed that transgressive segregants were recorded in each of the four crosses for all the seven characters expect earhead breadth in F_2's and B_2 F_2 generation of cross III and cross IV, respectively. In case of grain yield per plant, the highest proportion of individuals (8.0 to 34.99 %) transgressed beyond the increasing parent, consistently in all the four crosses.

Key words : Sorghum, Backcross, Trangressive, Segregation.

INTRODUCTION

Sorghum \ (*Sorghum bicolor* (L) Moench) is an important crop in semi-arid tropics (SAT) region because of it's ability to survive and give yield under moisture stress. India is the second largest grain producer and ranks seventh in productivity. The difference between productivities of India and the first ranking country is about five times. Major reasons for this low yield are that nearly 60% of the crop area falls under submarginal agroclimatic and edaphic conditions, which is characterized by low soil fertility and recurring moisture stress.

In India *rabi* sorghum is grown in Maharashtra, Karnataka, Gujarat, Rajasthan Madhya Pradesh and Andhra Pradesh. In Maharashtra *rabi* sorghum is grown on light and medium soils where the productivity is 450 kg/ha. Which is very low as compared to national and international average.

Much needs to be done for improvement of *rabi* Sorghum. In spite of new biotechnological methods for improvement, the conventional breeding methods are still proving better. Transgressive breeding aims at isolating gene combinations (recombinants) which possesses new characters or a higher intensity of a trait. These genotypes are superior to either parents. Transgressive segregants are produced by crossing parents possessing desired traits in the required intensity, but controlled by different set of genes, tends to ensure release of transgressive segregants. A character absent in the original parents may appear in the segregating generations (Gardner, 1968). In recombination breeding contribution of desirable plus genes by each parent gives rise to transgressive segregants. It can be used as a positive tool in sorghum breeding, Hence, the present study was undertaken to generate the transgressants possessing more number of desirable attributes.

MATERIALS AND METHODS

Experimental material consisted of four crosses *viz* SPV 1359 x SPV 1452 (Cross I), SPV 1452 x RSE 907-11 (Cross II), SPV 1359 x RSE 90-7-11 (Cross III) and RSLG 1072 x RSE 90-7-11 (Cross IV) involving four diverse parents of *rabi* sorghum. These parents and their F_2's and backcross F_2's were grown in Randomized Block Design with three replications. Parents were grown in two rows and F_2 and backcross F_2 population were grown on in twenty rows. The ten competitive plants from each of the parental lines and 100 plants from each of the F_2 and backcross F_2 randomly selected and observations were recorded for 7 quantitative traits. Data collected an individual plant for seven characters were used for studying transgressive segregation. The means, standard deviations, standard error and standard variate were calculated as per the procedure given by Panse and Sukhatme (1965), while normal deviation (N.D.) value / limiting value corresponding to range of parental means at 5% probability level was calculated by following formula:

$$\text{N.D. value} = \frac{P^{-(+)} + 1.966\ P^{(+)} - x}{6}$$

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where, p $^{-(+)}$ = Mean of increasing parent, 6P$^{(+)}$= Standard deviation of increasing parent, x^{-} = Mean of segregating, 6 = Standard deviation of segregating generation

The segregants showing deviation beyond the normal deviation would be the transgressive segregants.

RESULTS AND DISCUSSION

The studies revealed that transgressive segregants were recorded in each of the four crosses for all the seven characters expect earhead breadth in F_2's and B_2 F_2 generation of cross III and cross IV, respectively. In case of grain yield per plant, the highest proportion of individuals (8.0 to 34.99 %) transgressed beyond the increasing parent, consistently in all the four crosses. Transgressive segregants were recorded up to 0.66 to 4.66 fors day to 50 % flower, 5.33 to 25.66 % for plant height, 0.33 % to 10.33 % for earhead breadth, 8.66 to 31.66 % for earhead length, 9.0 to 22.66 % for fodder yield and 5.33 to 16.33 % for 1000 grain weight (Table 1).

Smith (1966) observed that there was no limitation on type of characters, which might respond to transgressive breeding. He recoded transgressive segregation for various agronomic characters. Tripathi *et al*. (1976) reported maximum number of transgressive segregants for panicle length and 1000 grain weight. From the study of Exotic x Indian crosses of *kharif* sorghum, they observed seven transgressive segregants for yield. Bhag Mal and Mishra (1985) recorded positive transgressive segregation for height and culms thickness indicating that the prospects are good for the recovery of the plant types with improved yield and quality from this material.

Frequency of transqressive segregants varied from cross to cross for different character (Table 2). Maximum frequency of transgressive segregants was 105 for grain yield per plant, 95 each for earhead length and fodder yield per plant, 49 for 1000 grain weight, 31 for earhead breadth, 14 for days to 50% flower and 77 for plant height were found in various crosses.

A ranking based on the proportion of desirable transgressive segregants in different generations,

Table 2 : Number of transgressive segregants obtained in different generations of four crosses

Characters	Cross No.	Increasing parent	No. of transgressive segregants		
			F_2	B_1F_2	B_2F_2
Days to 50 % flower	I	SPV 1452	2	2	10
	II	SPV 1452	9	10	7
	III	RSE 90-7-11	10	7	14
	IV	RSE 90-7-11	5	10	5
Plant height(cm)	I	SPV 1359	23	37	58
	II	RSE 90-7-11	77	68	35
	III	SPV 1359	32	23	16
	IV	RSLG 1072	39	31	30
Earhead breadth (cm)	I	SPV 1359	6	26	15
	II	RSE 90-7-11	7	31	27
	III	SPV 1359	-	9	9
	IV	RSLG 1072	14	1	-
Earhead length (cm)	I	SPV 1359	26	37	43
	II	RSE 90-7-11	94	59	36
	III	SPV 1359	95	57	55
	IV	RSLG 1072	71	65	52
1000 grain weight (g)	I	SPV 1452	26	26	41
	II	SPV 1452	49	28	27
	III	RSE 90-7-11	39	16	16
	IV	RSLG 1072	19	25	20
Fodder yield /plant (g)	I	SPV 1359	33	48	27
	II	RSE 90-7-11	60	57	51
	III	SPV 1359	95	83	65
	IV	RSLG 1072	68	37	32
Grain yield/plant (g)	I	SPV 1359	30	45	24
	II	RSE 90-7-11	69	84	87
	III	SPV 1359	105	78	61
	IV	RSLG 1072	72	44	41
Total			1188	1044	904

Table 1 : Per cent transgressive segregations in four crosses

Sr. No.	Characters	Per cent transgressive segregants											
		Cross I			Cross II			Cross III			Cross IV		
		F_2	B_1F_2	B_2F_2	F_2	B_1F_2	B_2F_2	F_2	B_1F_2	B_2F_2	F_2	B_1F_2	B_2F_2
1.	Days to 50% flower	0.66	0.66	3.33	3.0	3.33	2.33	3.33	1.33	4.66	1.66	3.33	1.66
2.	Plant height (cm)	4.0	5.33	9.0	25.66	22.66	11.66	10.66	7.66	5.33	13.0	10.33	10.0
3.	Earhead bradth	2.0	8.66	5.0	2.33	10.33	9.0	-	3.0	3.0	4.66	0.33	-
4.	Earhead length (cm)	8.66	12.33	14.33	31.33	19.66	12.0	31.66	[4.0	18.33	23.66	21.66	17.33
5.	Grain yield/ plant	10.0	15.0	8.0	11.0	14.33	12.33	15.0	9.66	7.66	24.0	14.66	18.66
6.	Fodder yield/plant	11.0	16.0	9.0	20.0	19.0	17.0	10.0	2.66	4.0	22.66	12.33	10.66
7.	1000 grain weight	8.66	8.66	13.66	16.33	9.33	9.0	12.93	5.33	5.33	6.66.	8.33	6.33

Table 3 : Extended limits of characters achieved in the transgressants of four crosses

Characters	Highest intensity of characters expression in four crosses			
	Cross 1	Cross 2	Cross 3	Cross 4
Days to 50 % flower	70 (74.37)	69 (73.93)	70 (74.24)	70 (73.87)
	B_2F_2	B_2F_2	B_1F_2	B_1F_2
Plant height (cm)	250 (154.33)	235 (174.33)	240 (188.5)	265 (184.67)
	B_2F_2	F_2	B_1F_2	B_2F_2
Earhead breadth (cm)	8.0 (5.02)	71,0 (4.33)	8.0 (5.02)	8.0 (4.97)
	B_1F_2	B_1F_2	B_1F_2	F_2
Earhead length (cm)	22.0 (15.78)	22 (14.57)	22 (15.53)	21.5 (15.45)
	B_1F_2	F_2	F_2	F_2
1000 grain weight (g)	49.4 (32.07)	51.7 (33.6)	49.1 (32.36)	52.65 (34.31)
	B_2F_2	F_2	F_2	B_1F_2
Fodder yield/ plant (g)	206.8 (97.45)	148.8 (75.96)	143.7 (91.1)	171.3 (83.73)
	F_2	B_1F_2	F_2	B_1F_2
Grain yield / plant (g)	135.8 (53.61)	112.1 (39.73)	114.1 (50.06)	122.2 (45.49)
	B_1F_2	B_2F_2	B_2F_2	F_2

(Figures in bracket are the values of increasing parent for respective character)

Table 4 : Promising transgressive segregants having combination of desirable attributes

Generation	Pl. No.	DAF	PLH	EHB	ELH	TGW	FRY	GRY	% grain yield increased
				Cross I : SPV 359 x Spy 1452					
F_2	58	81	220	6.5	18.0	36.6	156.1	97.6	182.05
B_1F_2	12	77	210	8.0	20.0	42.9	203.7	135.8	253.30
B_2F_2	83	79	230	7.0	19.0	43.9	1&.9	112.2	209.28
SPV 1359	-	78.3	192.3	5.02	15.78	30.49	97.45	53.61	-
SPV 1452	-	74.37	154.3	3.82	13.42	32.07	63.08	29.79	-
				Cross II : SPV 1452 x RSE 90-7-11					
F_2	71	77.0	225	5.0	19.5	51.70	126.5	101.2	254.71
B_1F_2	293	74.0	210	7.0	20.0	39.85	145.7	111.9	281.85
B_2F_2	211	75.0	215	6.5	20.0	47.85	125.5	112.1	282.15
SPV 1452	-	73.9	163.8	3.83	13.5	33.60	63.30	30.59	-
RSE90- 7 -11	-	75.0	174.3	4.33	14.5	30.66	75.96	39.73	-
				Cross III : SPV 1359 x RSE 90-7-11					
F_2	33	74	225	4.5	20.0	25.2	125.6	104.3	208.34
B_1F_2	88	73	220	5.0	19.0	39.16	122.8	101.9	203.55
B_2F_2	79	81	195	6.0	20.0	46.35	131.2	114.1	227.92
SPV 1359	-	79.1	188.5	5.02	15.5	32.06	91.10	50.06	-
RSE90-7-11	-	74.2	162.5	4.08	14.8	33.36	76.05	41.64	-
				Cross IV : RSLG 1072 x RSE 90-7-11					
F_2	23	73	210	7.0	21.0	45.5	130.7	122.2	268.63
B_1F_2	99	76	205	4.5	18.0	32.4	139.0	103.4	227.30
B_2F_2	10	74	210	5.0	17.0	40.6	153.4	109.6	240.93
RSLG 1072	-	75.2	184.6	4.97	15.4	34.31	83.73	45.49	-
RSE90-7-11	-	73.8	153.3	4.25	14.4	31.48	63.56	32.59	-

Pl.No.- Plant Number, DAF - Days to flowering, PLH - Plant height (cm), EHB - Earhead breadth (cm), ELH - Earhead length (cm) GRY - Grain yield / plant (g), FRY - Fodder yield / plant (g), TGW - 1000 grain weight (g)

indicated that top ranks for majority of characters were shared by F_2 followed by B_1B_2 depending upon the parent used as the increasing parent. In this study F_2 was proved to be more resourceful for recovering higher proportion of transgressive segregants, probably because of maximum variability in the parents in this generation as compared to backcrossing, which resulting gradual decrease in the variability. Similar results were obtained in pearl millet by Joshi (1999) who reported highest proportion of transgressive segregants in F_2 for total no of tillers, no of productive tillers, earhead length, earhead girth, 1000 grain weight and grain yield per plant. Comparison of the relative proportions of transgressive segregants in F_2 of backcrosses and F_2 generations above suggest that in F_2, there were greater number of trangressants for yield in combination with other characters as compared to F_2's backcrosses.

Apart form the frequency of transgressive segregants, it would be of interest to examine the intensities of characters achieved in transgressants in each of the cross and this provide an insight into the extended limits The extended limits achieved by transgressants in respect of various characters in four crosses are given in (Table 3). In the present study, the highest yielding transgressants in cross I, II, III and IV produced 135.8, 112.1, 114.1, and 122.2 g per plant, respectively against 53.61,39.73, 50.06 and 45.49 per plant produced by their respective increasing parent (Table 4). These intensities of expression for grain yield in percentage 153.3 (Cross I), 182.1 (Cross II), 127.9 (Cross III), and 160.3 (Cross IV) were higher than those of their respective parents.

Conclusion:

From the studies on transgressive segregation it could be concluded that.

– Desirable transgessive segregants were observed for all the characters in each of the four crosses except for earhead breadth in F_2 of cross III and B_2 F_2 of cross IV.

– Maximum transgressive segregants were noticed for grain yield per plant, fodder yield per plant, earhead length and plant height insistently.

– Maximum transgressants were recorded for days to 50 %flowering and earhead breadth.

– On the basis of high values of transgressive segregants observed in all the characters it could be concluded that when desired intensity of a character is not available in the parents, transgressive breeding can successfully be used to extend the limit of the character.

– The higher proportion of desirable transgressive segregants was obtained with higher intensity in F_2, followed by segregating population of backcrosses involving increasing parent.

– Simultaneous transgression of grain yield with fodder yield, earhead length, plant height was common suggesting dependency of yield on these charcters.

– The most promising transgressive segregants *viz.*; individual plant number 58 in F_2 ,12 in B_1F_2 and 83 in B_2 F_2 of cross I , 71 in F_2, 293 in B_2 F_2 and 211 in B_2F_2 of cross II, 33 in F_2, 88 in B_1F_2 and 79 in B2 F2 of cross III and 238 in F_2, 99 in B_1F_2 and 10 in B_2F_2 of cross IV needs further evaluation which may prove their immense value.

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