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STUDIES ON PHENOTYPIC AND GENOTYPIC CO-EFFICIENT OF VARIABILITY AND ESTIMATES OF HERITABILITY IN F_2 AND F_3 GENERATIONS IN SORGHUM (*Sorghum bicolor* (L) Moench) CROSSES

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Six quantitative traits of sorghum in F_2 and F_3 generations derived from three inter-varietal crosses were analysed for their mean performance variability and heritability estimates. The study revealed that cross C had high mean and high variability for number of leaves, ear weight, 100 grain weight and grain yield. But for plant height and ear length, the cross combinations B and A appeared to be respectively superior for mean and variability. Heritability estimates in F_2 and F_3 population indicated that cross combination C is more suitable for effective selection to obtain quick results than the other two cross combinations for all characters excepting ear length. But heritability estimates were low in both F_2 and F_3 in all the three crosses for grain yield.

A knowledge of genetic variability in sorghum is helpful in selecting a suitable plant type. The high genetic variability is a pre-requisite for effective selection (Sivasubramanian and Madhava Menon, 1973). The variability can be enhanced in the segregating populations through hybridization.

Burton (1952) observed that high genetic co-efficient of variation alone is not indicative of the selection value and that heritability estimates also have to be taken into account. The heritability estimates provides information on the degree of transmission of characters from parent to progeny. Such estimates fecilitate evaluation of hereditary and environmental portions of the phenotypic variation and thus aid in selection.

MATERIALS AND METHODS

The investigation was carried out at the Department of Agricultural Botany, Agricultural College and Research Institute, Madurai. Three crosses namely, 2219A x SPV 351 (Cross A), 2219 A x Usilampatti-2 (Cross B) and 2760 AxCO 24 (Cross C) with their five parents viz , 2219 B, 2760B, CO 24, Usilampatti-2 (local) F_1 and SPV 351 were studied in and F_2 generations. A total of 600 segregants from each cross with their five parents were studied in F_2 generation. Thirty out of 600 F_2 plants were randomly selected and forwarded to F_3 generation and raised with their five parents in randomized block design replicated thrice. Each selected F_2 plants was considered as individual family and allotted to a individual row in each replication.

The observations were made on all plants in F_2 and F_3 excepting sterile segregants and for parents, or a total of 150 plants. Observations were recorded on (1) plant height (2) number of leaves (3) ear length

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(4) ear weight (5) 100 gain weight and (6) grain yield. According to Goulden (1952) the variance existing in F_2 and F_3 cross combinations is considered as phenotypic variance whereas the variance existing in parents is considered as environmental variance Phenotypic and genotypic co-officients of variations were calculated by the methods given by Burton (1952). Heritability in broad sense and genetic advance were calculated by the method suggested by Johnson *et. al* (1955). The range of heritability was categorised into low (0-30 per cent). moderate (31-60 per eent) and high (61-per cent and above).

RESULTS AND DISCUSSION

The mean, variability and heritability estimates for the six quantitative characters of F_2 generation are presented in table 1. The range for mean, variability and heritability estimates of F_3 families of three crosses are presented in Table 2. The best cross was selected based on high mean, high variability with minimum environmental influence and high heritability estimates.

According to Finker *et. al* (1973) cross or family with highest mean was relatively effective in identifying the superior segrents. The potentiality of a cross is measured not only by mean but also on the extent of variability (Allard 1960). When mean serves as a basis for eliminating undesirable crosses, variability helps to choose a potential cross since variabillty indicates the extant of the recombination for initiating effective selection.

When the aspects of mean is considered as an index of selection, cross B followed by cross C registered high expression of mean in both F_2 and F_3 generations for plant height; cross C followed by cross A in F_2 and cross B followed by oross C in F_3 generation recorded high mean expression for number of leaves; cross A followed by cross C had high expression of mean in both F_2 and F_3 generations for ear length; for 100 grain weight cross C followed by cross A in F_2 and again cross C followed by cross B in F_3 generations recorded high expression of means. For ear weight and grain yield, cross C followed by cross A had high mean expression in both F_2 and F_3 generations. So, for combination of characters particularly for yield and important yield components cross C is superior in both F_2 and F_3 generations based upon their mean performance.

Variability in a population is measured by the estimates like phenotypic and genotypic variances and phenotypic and genotypic co-efficients of variation Cross C has shown moderate to high variability in both F_2 and F_3 generations for all the characters except plant height. Cross B and cross A have shown high variability in both F_2 and F_3 generations for plant height and ear length respectively. Patel *et al.* (1980) for plant height, Dhimmar and Desai (1978) for ear length, Panchal *et al.* (1979) for ear weight, Shinde *et al.* (1979) for 100 grain weight and for grain yield also recorded high variability in the segregating generations.

Table 1. Mean, phenotypic variance, genotypic variance and heritability estimates in F_3 generation of sorghum crosses

Characters	Mean	Variance		PCV per cent	GCV per cent	Heritability (per cent)	Genetic advance	Genetic advance as percentage of mean (per cent)
		Phenotypic	Genotypic					
Plant height (cm)								
Cross A	153.64±1.75	1835.55	1577.88	27.88	25.85	85.96	75.87	49.38
Cross B	212.17±2.00	2394.60	2136.93	23.06	21.78	89.23	89.90	42.37
Cross C	205.9 ± 1.55	1442.16	1184.49	18.44	16.71	82.13	64.25	31.20
Number of leaves								
Cross A	11.56 ± 0.10	7.55	3.28	23.76	15.68	43.49	2.49	21.28
Cross B	10.53 ± 0.10	5.02	0.75	21.29	8.22	15.02	0.68	6.50
Cross C	11.90 ± 0.10	7.18	2.91	22.52	14.34	40.53	2.24	18.79
Ear length (cm)								
Cross A	23.80 ± 0.24	37.56	20.58	25.75	19.06	54.79	6.92	29.06
Cross B	19.71 ± 0.17	20.72	3.74	23.09	9.80	18.05	1.69	8.59
Cross C	21.40 ± 0.20	25.64	8.66	23.66	8.66	33.78	3.53	16.47
Ear weight (g)								
Cross A	48.43 ± 0.72	312.30	115.33	36.48	22.17	36.93	13.45	27.76
Cross B	38.21 ± 0.63	237.54	40.57	40.34	16.67	17.08	5.42	14.19
Cross C	53.80 ± 0.71	297.68	100.71	32.07	18.66	33.83	12.03	22.35
100 grain weight (g)								
Cross A	2.28 ± 0.02	0.16	0.11	17.54	14.28	66.22	0.54	23.94
Cross B	2.21 ± 0.02	0.27	0.22	23.56	21.22	80.08	0.87	39.37
Cross C	2.73 ± 0.03	0.49	0.44	25.64	24.19	88.98	1.28	46.99
Grain yield (g)								
Cross A	29.80 ± 0.57	196.61	18.77	47.05	10.36	9.55	2.76	9.25
Cross B	23.14 ± 0.58	203.84	26.00	61.71	22.04	12.76	3.76	16.21
Cross C	31.20 ± 0.60	216.11	38.27	47.12	19.82	17.71	5.36	17.19

0-30% = Low heritability; 31-60% = Moderate heritability; 61% and above : High heritability

Table 2. Range for mean, phenotypic variance, genotypic variance and heritability estimutes in F_3 families of sorghum crosses.

Characters	Mean	Variance		PCV %	GCV %	Heri-tabi-lity (%)	Genetie advance	Genetic advance as percentage of Mean (%)
		Pheno-typic	Geno-typic					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
t height (cm)								
Cross A	85.93 ± 3.03 to	273.96 to	53.95 to	14.92 to	6.62 to	19.69 to	6.72 to	6.05 to
	124.13 ± 5.79	1006.80	786.79	32.36	27.59	78.15	51.08	48.59
Cross B	110.88 ± 3.28 to	323.03 to	154.10 to	12.66 to	8.15 to	31.89 to	11.81 to	10.78 to
	180.59 ± 6.20	1154.27	934.26	26.71	23.68	80.94	56,66	43.23
Cross C	100.75 + 3.09 to	287.58 to	67:57 to	11.19 to	8.23 to	23.49 to	8.21 to	8,33 to
	197.30 ± 6.29	1188.87	968.86	28.83	25.25	81.49	57.88	45.55
Number of leaves								
Cross A	8.33 ± 0.28 to	2.33 to	0.80 to	17.15 to	10 43 to	34.33 to	1.08 to	13.83 to
	9.87 ± 0.49	7.14	5,61	28.49	25.29	78.57	4.33	46.19
Cross B	8.77 ± 0.29 to	2,63 to	1.10 to	17.39 to	11.44 to	41.83 to	1.39 to	15.25 to
	11.93 ± 0.56	9.51	7,98	27.22	23 68	83.91	5.34	44.74
Cross C	8.27 ± 0.30 to	2.78 to	1.25 to	15.50 to	10.26 to	44,96 to	1.52 to	13.98
	11.60 ± 0,64	12.30	10.77	38.57	36.06	87.56	6.32	69.46
Earlength (cm)								
Cross A	17.99 ± 0.55 to	9.60 to	0.00 to	13.59 to	0.00 to	0.00 to	0 00 to	0.00 to
	25.48 ± 1.33	52.69	43.78	31.58	28.78	83.08	12.42	54.03
Cross B	17.03 ± 0.46 to	4,38 to	0.00 to	12.66 to	0.00 to	0.00 to	0.00 to	0.00 to
	21.99 ± 1.02	30.91	22.00	29.95	25.27	70.17	8.15	43.92
Cross C	15.92 ± 0,52 to	8.09 to	0.00 to	14 20 to	0.00 to	0.00 to	0.00 to	0.00 to
	23,81 ± 1,01	30,88	30.97	28.45	24.50	77.66	10.09	45.45

TABLE 2 (Contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ear weight (g)								
Cross A	31.89 ± 1.53 to 50.40 ± 3.21	70.42 to 310.04	0.00 to 222.61	23.76 to 39.81	0.00 to 33.03	0.00 to 71.80	0.00 to 26.04	0.00 to 56.47
Cross B	30.48 ± 1.22 to 40.95 ± 3.11	44.38 to 290.09	0.00 to 202.66	10.84 to 42.83	0.00 to 35.80	0.00 to 69.86	0.00 to 24.51	0.00 to 61.64
Cross C	33.18 ± 1.50 to 49.13 ± 3.56	67.16 to 380.81	0.00 to 293.38	20.06 to 44.31	0.00 to 38.76	0.00 to 77.04	0.00 to 30.97	0.00 to 69.83
100 grain weight (g)								
Cross A	1.91 ± 0.04 to 2.35 ± 0.10	0.04 to 0.33	0.00 to 0.29	9.54 to 27.36	0.00 to 25.47	0.00 to 87.88	0.00 to 1.03	0.00 to 48.58
Cross B	1.97 ± 0.04 to 2.47 ± 0.06	0.04 to 0.12	0.00 to 0.18	8.83 to 20.98	0.00 to 18.75	0.00 to 81.82	0.00 to 0.79	0.00 to 35.22
Cross C	1.91 ± 0.04 to 2.70 ± 0.13	0.06 to 0.50	0.02 to 0.46	11.57 to 28.06	6.83 to 26.48	33.73 to 92.00	0.16 to 1.33	7.80 to 52.75
Grain yield (g)								
Cross A	21.50 ± 1.14 to 34.15 ± 2.48	38.98 to 184.52	0.00 to 123.28	27.44 to 48.34	0.00 to 39.52	0.00 to 69.67	0.00 to 20.39	0.00 to 66.57
Cross B	18.26 ± 1.04 to 28.95 ± 2.08	32.37 to 129.44	0.00 to 68.20	25.47 to 50.37	0.00 to 36.49	0.00 to 52.69	0.00 to 12.36	0.00 to 54.45
Cross C	19.06 ± 1.32 to 35.50 ± 2.96	52.56 to 262.42	0.00 to 200.18	28.09 to 57.34	0.00 to 50.21	0.00 to 76.57	0.00 to 25.52	0.00 to 90.56

0—30% = low heritability
31—60% = medium heritability
61% and above = high heritability

High phenotypic and genotypic variances for number of leaves in F_1 were noted in cross A followed by C. But in F_2, high variances were observed in cross C followed by cross B. This reverse expression may be due to the susceptibility of the trait to the enviroumental influence that existed in different seasons (Mahmud and Kramer, 1951 and Murray and Verhalen, 1969). The trends in differences between PCV and GCV for number of leaves in cross A is similar i. e. minimum difference in F and maximum diffence in F_2 generations. This indicates that cross A can not be relied upon for number of leaves and it appears to be highly influenced by environmental factors.

High heritabiity indicates that the phenotype strongly reflects genotype and the individuls that are superior for particular trait should possess also desirable genes for that trait and should transmit them to their off spring.

Johnson *et al.* (1955) suggested that heritability estimates along with genetic advance shall be more useful and valid in predicting yield under phenotypic selection than heritability estimates alone. High heritability associated with high genetic gain indicates the predominant role of additive gene action in-controlling the expression of these characters. High heritability with high genetic advance as percentage of mean shows the most effective condition for selection.

The heritability estimatee for all the six characters indicated that moderately high to high heritability has been prevalent for all the characters in both F_1 and F_2 of cross C. Naphade (1974) for plant height, Panchal *et al.* (1979) Patel *et al.* (1980) for ear length, Liang and Walter (1968) and Panchal *et al.* (1979) for 100 grain weight also recorded high heritability and high genetic advance. The heritabillty estimates were low in all the three cross combinations only for grain yield. Liang and Walter (1968) and Liang *et al.* (1972) also reported low heritability in segregating generations for grain yield. It can be then safely concluded that combination C is more suitable for effective selection to obtain quick results than the other two combinations as far as heritability estimates are concerned.

Thus it is clear for combination of characters selection in the cross combination C will yield quicker results. But for plant height and ear length the cross combinations B and A appeared to be respectively superior for selection based on highly mean, variability and heritability estimates.

REFERENCES

ALLRD, R. W. 1960. *Principles & Plant Breeding.* John Wily and Sons. Inc. USA.

BURTON, G. W. 1952. Quantitative inheritance in grass. *Proc. 6th Internat. Grass Land Cong.* 1: 277-283.

DHIMMAR, L. R. and K. B. DESAI, 1978. Genetic variability, Correlation and path-co-efficient analysis of grain yeild in some types of winter sorghum. *Sorghum News Lett.* 21 : 23.

FINKNER, V. C., C. G. RONELIRT and D. L. DAVIS. 1973. Heritability of rachis node number of *Avena Setiva* L. *Crop Sci.*, 13(1) : 84-85.

GOULDEN, C. H. 1952. ***Methods of Statistical analysis.*** John Wily and Sons, Inc. New York.

JOHNSON, H. W., H. F. ROBINSON and R. E. COMSTOCK. 1955. Estimates of genetic and environmental variability in soybeans. *Agron. J.*, 47 : 314-318.

LIANG. G. H. L. and T. L. WALTER, 1968. Haritability estimates and gene effects for agronomic traits in grain sorghum (*S. vulagare* Pers.). *Crop. Sci.* 8 : 77-81.

LIANG, G. H. L., C. R. REDDY and A. D. DAYTON. 1972. Heterosis and heritability estimates in a systematic series of grain sorghum genotypes. *Crop. Sci.*, 12 : 409-411

MAHMUD, I. and H. H. KRAMER. 1951. Segregation for yield, height and maturity following a soybean cross. *Agron. J.*, 43: 605-609.

MURRAY, J. C. and L. M. VERHALEN. 1969. Genetic studies of earlines yield and fibre properties in cotton *Gossypium hirsutum L.*). *Crop Sci.*, 9: 752-755.

NAPHADE, D. S. 1974. Heritability and genetic advance for yield, flowering and plant height following a sorghum cross. *Indian Sci. Abstr.*, 10 (1). Abstr. No. 1010.

PANCHAL, H. G., K. B. DESAI and S. B. S. TIKKA 1979. Estimation of heritability through Parent-offspring regression analysis in sorghum. *Sorghum News Lett.*, 22 : 16-17.

PATEL, R.H., K.B. DESAI, K.R.V. RAJA and R.K PARIKLAR. 1980. Estimates of heritability and other genetic parameters in an F_3 population of sorghum. *Sorghum News Lett.*, 23-22-24.

SHINDE, V. K , Y. S. NERKAR and B. N. KATE PALLEWAR. 1979. Studies of genetic variability in winter sorghum selection. *Sorghum News Lett.*, 22: 13.

SIVASUBRAMANIAN, S. and P. MADHAVA MENON. 1973. Genotypic and phenotypic variability in rice *Madras agric. J.*, 60 (9-12) 1093-1096.