Genotype	1977	1978	1980	Mean	b	s^2d
86. 2470/12	6.0	6.2	3.68	5.29	1.37	1.55**
87. 4210 (26)	5.0	6.4	4.21	5.20	1.40	-0.004
88. 1260/12	4.5	5.5	3.59	4.53	1.18	0.06
Mean	4.36	5.45	3.91	4.58	1.00	
SEm±	0.11	0.19	0.08	0.83	1.05	
CD 5%	0.30	0.52	0.21			

genotypes in a breeding programme will help in improving the productivity of the crop in its growing areas.

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HETEROSIS IN SORGHUM UNDER DIFFERENT ENVIRONMENTS*

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ABSTRACT

Six parents in sorghum viz, Co18, 148, Co 23, Co 22, CSV. 3 and As. 3880 were crossed in all possible combinations and the hybrids along with the parents were studied for three economic traits under four different environments consisting two seasons and two manurial levels. For panicle length, number of grains/panicle and grain yield/panicle, heterosis was observed in most of the crosses. Among the parents Co 23 showed high mean expression for number of grains and grain yield. Further the hybrids involving Co 23 as one of the parents revealed high per se performance and heterosis for grain yield.

KEY WORDS : Sorghum, Heterosis, Environments.

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Crop improvement programmes involve strengthening the genetic potentialities through development of new recombinations among the available variability and identification of specific environments. With a view to identify potential new hybrids under four specific environments the present study was undertaken.

MATERIALS AND METHODS

Six parents of sorghum (*Sorghum bicolor* (L.) Moench) viz., Co 18 (P_1), 148 (P_2), Co 23 (P_3), Co 22 (P_4), CSV 3 (P_5) and AS 3880 (P_6) were crossed in all possible combinations and the resulting 30 hybrids along with the six parents were raised in a randomised block design replicated thrice in two seasons viz., summer 1981 (January-April) and Monsoon 1981 (July-October) under two fertility conditions (High fertility: 100 N + 80 P_2O5 + 60 K_2O and low fertility: No fertilizer). The four environments were E_1 : 1981 summer season : high fertility, E_2 : 1981 summer season : low fertility, E_3 : 1981 monsoon season: high fertility and E_4 : 1981 monsoon season: low fertility.

Each genotype was raised in three rows of 3.0 m length in each replication. A spacing of 45 cm x 15 cm was followed. Observations on panicle length, number of grains/panicle and grain yield/panicle were recorded on ten plants selected at random in each genotype under each replication. Heterosis over the better parent (dii) was estimated and expressed as percentage of increase.

RESULTS AND DISCUSSION

The differences among the genotypes under all the environments in respect of the above three traits were highly significant. A distinct superiority in the mean expression of the hybrids over the parents was evidenced for all the three characters reported under all the environments, indicating their superior performance. Among the parents, P_3 (Co 23) was superior in mean expression for number of grains/panicle and grain yield/panicle. For panicle length, the mean expression over environments was high in P5 X P6. The estimation of heterosis showed positive heterosis for this trait, in P_3 X P_6, P_4 X P_6, P_5 X P_4' and P_5 X P_6 at all the environments. The highest expression of 39.37 per cent over better parent was observed in P_5 X P_4 at E_4 (Table 1).

The hybrid mean for number of grains/panicle ranged from 1370.80 (E_4) to 2161.76 (E_1), which was far above the parental mean (Table 2). The hybrid p_5 x P_6 recorded the maximum number of grains/panicle at E_1 and E_3. The highest number of grains/panicle (3672.60) was observed in P_5 X P_6 at E_3.

In respect of grain yield, hybrid vigour was generally observed in most of the hybrids at all the environments. The highest percentage of heterosis of 208.85 over the better parent was exhibited by the hybrid in P_5 X P_4 at E_2. The hybrid P_3 X P_1 recorded the highest percentage of heterosis (126.20) over the better parent at E_3. At other environments also this hybrid recorded fairly high degree of heterosis and highest *per se* performance (Table 3).

Rao and Murthy (1970), Goyal and Joshi (1976), Palaniswamy (1977), Singhania (1980), Indi and Goud (1981) and Patel *et al.* (1982) also observed heterosis for panicle length, number of grains and grain yield in sorghum.

Comparing the four environments, better expression for all the three characters was observed at E_1 (summer sowing with fertilizers) closely followed by E_3 (monsoon sowing with fertilizers). The hybrids P_2 X P_3, P_3 P_2, P_3 X P_5, P_3 X P_6, P_4 X P_3 and P_5 X P_3 recorded considerably high grain yield. Thus the parent p_3 (Co 23)

Table 1. **Mean expression and percentage of heterosis over better parent (dii) for panicle length in sorghum.**

Cross	E1		E2		E3		E4	
	Mean	dii	Mean	dii	Mean	dii	Mean	dii
P1	11.0	–	9.1	–	11.5	–	7.0	–
P2	15.7	–	15.4	–	19.6	–	15.0	–
P3	20.0	–	17.9	–	21.3	–	17.2	–
P4	22.6	–	19.1	–	23.3	–	19.7	–
P5	26.5	–	25.3	–	25.6	–	21.3	–
P6	31.9	–	30.3	–	28.7	–	28.1	–
P1 X P2	15.6	-0.5	13.1	-15.0	15.2	-22.6	10.2	-31.6
P1 X P3	19.4	-2.8	17.7	-1.2	18.9	-11.3	12.0	-30.0
P1 X P4	18.2	-19.1	16.8	-11.9	19.8	-14.9	12.6	-36.1
P1 X P5	16.4	-37.9	18.5	-27.0	15.2	-40.5	13.9	-34.4
P1 X P6	21.4	32.8	20.3	-32.9	23.7	-17.4	18.5	-34.0
P2 X P1	18.0	14.6	14.9	-3.1	16.2	-17.2	16.5	9.9
P2 X P3	23.6	18.0	22.3	24.5	23.9	11.8	25.1	46.2
P2 X P4	24.8	9.8	23.1	20.9	24.7	5.9	19.6	-0.5
P2 X P5	25.2	-5.1	24.3	-4.2	27.0	5.2	25.9	21.8
P2 X P6	30.6	-4.1	27.8	-7.9	31.5	9.5	24.3	-13.2
P3 X P1	19.3	-3.6	17.9	0.0	19.2	-10.0	17.1	0.3
P3 X P2	24.6	21.8	22.9	28.0	26.8	25.5	21.5	24.8
P3 X P4	26.4	17.0	22.3	16.6	23.9	2.6	18.8	-4.8
P3 X P5	31.7	19.2	29.4	15.7	33.4	30.5	20.0	-6.0
P3 X P6	33.0	3.3	30.3	0.0	32.2	12.1	28.6	2.0
P4 X P1	18.8	-16.7	16.8	-11.8	18.9	-18.8	15.4	-21.6
P4 X P2	25.8	14.4	20.4	6.5	24.5	5.3	20.8	5.6
P4 X P3	27.6	14.4	23.5	23.0	24.7	6.0	19.7	-0.0
P4 X P5	31.0	22.1	30.7	21.2	30.8	20.0	27.8	30.8
P4 X P6	33.9	16.8	31.2	3.1	33.2	15.3	30.8	9.5
P5 X P1	25.6	6.1	22.6	-10.8	26.6	3.7	18.6	-12.2
P5 X P2	27.1	-3.6	25.4	0.2	23.6	-7.9	20.6	3.0
P5 X P3	29.7	2.0	27.3	7.6	30.7	19.9	26.7	25.3
P5 X P4	35.4	11.9	31.4	23.9	33.7	31.3	29.7	39.3
P5 X P6	40.5	33.3	33.4	10.4	38.3	33.3	29.0	3.2
P6 X P1	24.8	26.8	21.9	-27.6	25.0	-13.0	17.3	-38.1
P6 X P2	31.0	-22.3	29.1	-3.7	30.4	5.8	24.4	-13.0
P6 X P3	30.9	-2.8	29.2	-3.5	29.0	0.7	26.6	-5.3
P6 X P4	33.4	-3.2	29.4	-2.9	30.1	4.8	26.9	-4.2
P6 X P5	37.1	4.5	37.2	23.0	29.9	3.9	25.7	-8.3
Parental Mean	21.7	16.1	19.5	–	21.7	–	18.0	–
Hybrid Mean	26.6	–	24.4	–	26.0	–	21.5	–
SE	0.64	–	0.79	–	0.74	–	0.53	–
CD	1.79**	–	2.22**	–	2.09**	–	1.50**	–

Table 2. Mean expression and percentage of heterosis over better parent (dii) for Number of grains panicle in sorghum.

Cross	E1		E2		E3		E4	
	Mean	dii	Mean	dii	Mean	dii	Mean	dii
P1	1250.2	–	905.6	–	1054.8	–	728.7	–
P2	1054.4	–	750.7	–	931.6	–	573.6	–
P3	1553.1	–	1177.7	–	1650.5	–	786.4	–
P4	1311.4	–	1111.0	–	1585.4	–	1081.9	–
P5	1444.5	–	958.9	–	1208.4	–	938.1	–
P6	1328.5	–	1063.0	–	1665.4	–	904.6	–
P1 X P2	1309.9	4.4	1054.4	16.4	1040.1	1.3	781.3	7.2
P1 X P3	1898.6	22.2	1746.7	48.3	1962.9	18.9	1263.9	28.1
P1 X P4	1420.6	8.3	1184.6	6.6	1208.3	-23.7	920.3	-14.9
P1 X P5	1907.3	32.0	1735.1	80.9	1751.2	44.9	1305.4	39.1
P1 X P6	2221.6	67.2	2046.2	92.6	2049.7	23.0	1469.6	62.4
P2 X P1	1829.4	46.3	1494.6	65.0	1512.3	43.3	1115.0	53.0
P2 X P3	2894.7	86.3	2270.9	92.8	2898.5	75.6	2178.5	120.8
P2 X P4	1454.3	10.9	872.6	-21.4	1275.9	-19.5	906.1	-16.2
P2 X P5	1732.1	19.9	1119.5	16.7	1130.4	-6.4	786.3	-16.1
P2 X P6	2055.6	54.7	1860.0	74.9	2148.5	29.0	1096.2	21.1
P3 X P1	2809.2	80.8	2053.4	74.3	2747.1	66.4	2235.5	126.6
P3 X P2	2051.1	32.0	1778.4	42.5	1683.6	2.0	1059.8	7.4
P3 X P4	2379.7	53.2	1731.8	47.0	2155.5	30.6	1478.7	36.6
P3 X P5	2434.4	56.7	1792.7	52.2	2276.1	37.9	1675.3	69.8
P3 X P6	3088.7	98.8	2652.0	125.1	2884.2	73.1	2236.1	126.6
P4 X P1	1424.7	8.6	1191.7	7.2	1243.1	-21.5	837.2	-22.6
P4 X P2	1518.0	15.7	1268.7	14.1	1552.3	-2.0	995.6	-7.9
P4 X P3	2703.5	74.0	1103.0	-6.3	2897.0	75.5	2094.3	93.5
P4 X P5	3202.4	121.6	2073.6	86.6	2571.6	62.2	1501.5	38.7
P4 X P6	1925.0	44.8	1064.3	-4.2	1979.6	18.8	1448.3	33.8
P5 X P1	1424.3	-1.4	1191.1	24.8	1110.4	-8.1	705.8	-24.7
P5 X P2	1556.2	7.7	805.3	-16.0	1258.3	4.1	900.3	4.0
P5 X P3	2452.5	57.9	1867.3	58.5	2825.8	71.2	2310.4	134.2
P5 X P4	3114.9	115.6	2397.9	115.8	3161.9	99.4	1988.1	83.7
P5 X P6	3362.2	132.7	2501.2	135.3	3672.6	120.5	1808.1	32.7
P6 X P1	2020.1	52.0	1326.7	24.8	2074.5	24.8	888.5	-1.7
P6 X P2	1713.9	29.0	1222.1	14.9	1578.6	-5.2	912.1	8.8
P6 X P3	2193.5	41.2	2120.4	80.0	2120.2	27.3	1329.4	34.7
P6 X P4	3220.8	142.4	2195.6	97.6	3447.2	106.9	1718.0	58.7
P6 X P5	1936.4	34.0	1771.5	66.5	2237.2	34.2	969.4	3.3
Parental Mean	1323.7	–	994.5	–	1349.3	–	868.4	–
Hybrid Mean	2161.7	–	1652.5	–	2082.5	–	1370.8	–
SE	24.87	–	17.15	–	55.00	–	52.92	–
CD	70.15**	–	48.38**	–	155.90**	–	149.24**	–

Table 3. Mean Expression and percentage of heterosis over better parent (dii)for grain yield/panicle in sorghum.

Cross	E1		E2		E3		E4	
	Mean	dii	Mean	dii	Mean	dii	Mean	dii
P1	28.6	–	22.2	–	25.0	–	17.6	–
P2	24.8	–	17.0	–	20.7	–	12.3	–
P3	31.3	–	27.3	–	31.6	–	24.8	–
P4	27.2	–	19.4	–	29.7	–	17.7	–
P5	28.6	–	20.3	–	26.2	–	18.7	–
P6	22.3	–	15.5	–	22.7	–	11.1	–
P1 X P2	25.8	-9.7	21.0	-5.3	22.1	-11.6	21.2	20.2
P1 X P3	56.5	80.1	51.9	90.1	56.4	78.4	49.7	99.8
P1 X P4	36.4	26.9	32.5	46.5	32.2	8.6	21.5	21.1
P1 X P5	45.9	60.2	41.8	88.2	39.6	50.9	25.4	35.5
P1 X P6	52.8	84.1	47.0	111.7	45.9	33.4	30.4	72.3
P2 X P1	38.7	34.8	32.7	47.5	35.6	42.1	20.8	18.3
P2 X P3	63.7	103.1	51.6	89.2	64.3	103.2	49.1	97.7
P2 X P4	34.7	27.2	26.1	34.6	32.8	10.7	20.2	13.8
P2 X P5	41.4	44.7	30.7	51.0	29.8	13.9	19.0	1.1
P2 X P6	47.4	90.7	35.2	106.9	42.7	87.4	26.6	115.4
P3 X P1	69.7	122.1	61.0	123.4	71.5	126.2	61.2	146.4
P3 X P2	59.0	88.1	46.1	68.9	54.7	73.1	41.0	65.0
P3 X P4	54.4	73.6	41.7	53.0	51.6	63.1	40.7	63.8
P3 X P5	63.3	101.9	52.9	93.9	60.8	92.1	51.6	107.4
P3 X P6	64.2	104.5	56.6	107.3	66.5	110.3	52.5	11.2
P4 X P1	37.0	29.0	31.3	40.9	35.2	18.4	28.5	60.2
P4 X P2	32.5	19.4	27.2	40.2	31.1	4.9	24.0	35.1
P4 X P3	65.0	107.3	51.2	87.6	65.0	105.7	51.4	107.0
P4 X P5	47.8	67.1	44.2	117.5	42.2	42.1	34.5	84.0
P4 X P6	43.6	60.0	40.1	106.7	47.4	59.6	27.3	53.5
P5 X P1	32.0	11.7	27.5	24.1	32.0	22.1	23.6	25.8
P5 X P2	28.9	1.1	21.1	3.8	31.2	19.2	21.4	14.3
P5 X P3	67.9	116.4	51.1	87.1	69.0	118.3	54.7	120.1
P5 X P4	71.1	148.6	62.8	208.8	67.0	125.6	49.7	165.1
P5 X P6	53.0	85.4	40.6	99.6	54.6	108.1	35.5	89.3
P6 X P1	48.1	67.7	45.0	102.7	44.7	78.6	29.8	69.3
P6 X P2	42.6	71.5	32.0	87.7	38.6	69.6	26.0	110.8
P6 X P3	42.1	34.1	32.4	18.7	43.1	36.5	36.1	45.4
P6 X P4	48.9	79.1	43.9	126.3	50.3	69.3	40.9	130.0
P6 X P5	44.6	55.9	40.6	99.6	45.7	74.2	39.1	108.3
Parental Mean	27.0	–	20.3	–	26.0	–	17.1	–
HybridMean	48.6	–	40.7	–	46.8	–	35.1	–
SE	0.58	–	0.49	–	0.62	–	0.75	–
CD	1.62**	–	1.37**	–	1.74**	–	2.12**	–

has been identified to be a potential parent to produce superior hybrids, besides its high *per se* performance. Among the other parents, P_5 (CSV 3) was found to combine well with P_3, P_4 and P_6 besides recording good *per se* performance for grain yield. This supports the view of Gilbert (1958), that if the parents themselves possess the desirable characters at a high level of expression, the breeding programme will be effective.

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GENETIC VARIABILITY IN KODO MILLET (*PASPALUM SCROBICULATUM* L.)

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ABSTRACT

Fifty genotypes of Kodo millet were used to study the genetic variability among them for six economic attributes. The genotypic coefficient of variation was high for straw yield. Plant height, 1000-grains weight and straw yield exhibited higher heritability estimates. Straw yield also recorded the highest genetic advance indicating that it is controlled by additive gene action and that phenotypic selection for its improvement will be effective.

KEY WORDS : Kodomillet, variability

The aim of the present investigation was to have information regarding the variability, heritability and genetic advance of six characters in kodo millet.

MATERIALS AND METHODS

Fifty genotypes of kodo millet were chosen from the germplasm back maintained at National Pulses Research Centre, Vamban, Pudukkottai. The experiment was conducted during Kharif 1983 inrandomized block design with two replications. A spacing of 45 x 15 cm was adopted. At maturity five plants were chosen at random and observations were recorded on plant height, number of basal and nodal tillers, 1000 - grain weight (without husk), straw and grain yield.

The phenotypic and genotypic variances and genetic advance were calculated according to Johnson *et al.* (1955). The methods suggested by Burton (1952) was used to compute phenotypic and genotypic coefficients of variability (PCV and GCV). Heritability in broad sense was estimated based on the formula of Lush (1940).

RESULTS AND DISCUSSION

The variances due to genotypes for all the six traits were significant. The range, phenotypic and genotypic variances, PCV and GCV, heritability and genetic advance