Madras agric. J. 62 (6) : 331 — 337, June, 1975.

Genetic Analysis of Three Pod Characters in Bhendi (*Abelmoschus esculentus* (L) Moench)

By

T. SWAMY RAO and P. M. RAMU *

ABSTRACT

Varieties A E107, Seven Dhari and White Velvet are good combiners and heterosis breeding could be considered with A E107, Pusa Sawani, White Velvet and Red Wonder

INTRODUCTION

Meagre information on the genetics of quantitative characters is available for *bhendi* (*Abelomoschus esculentus* (L) Moench). A study on genetic variability, heterosis, general and specific combining ability and nature of gene action for important quantitative characters is of immense help to breeding programme in this crop. With this view, the present study was undertaken.

MATERIAL AND METHODS

The first experiment consists of 20 varieties of *bhendi* and the second experiment consists of 15 hybrids and 6 parents, which were crossed in diallel fashion without reciprocals. Two experiments were laid out separately in randomized block design with three replications for each experiment during *kharif* 1973 at the College of Agriculture, Dharwar. Seeds were sown with a spacing of 60 X 45 cm. Observations were recorded on five randomly selected plants for pod girth, length of pod, number of edges on the pod and green pod yield. The estimates of variance of components, heritability in broad sense and genetic advance were calculated as suggested by Burton (1952), the path coefficient analysis by the method of Dewey and Lu (1959), the heterosis as suggestsd by Turner (1953), potence ratio as given by Wigan (1944), combining ability by the method of Griffing (1956) and the nature of gene action was estimated according to the method of Hayman (1954).

RESULTS AND DISCUSSION

The genetic parameters for three quantitative characters are presented in Table 1. Wide difference observed between genotypic and phenotypic coefficients of variation for pod girth might be due to more of environmental effect on the above character compared to other characters which are comparatively less influenced by environment. However, heritability in broad sense was highest for length of pod. Eventhough, the heritability in broad sense and also genetic advance were more in pod length, the expected genetic

* Department of Agricultural Botany, College of Agriculture, Dharwar.

TABLE 1. Genetic parameters for three quantitative characters in *bhendi*

Parameters	Pod girth (cm)	Length of pod (cm)	No. of edges on the pod
Range	1.57–2.07	13.89 – 15.29	5.00–8.80
Mean	1.85	15.22	6.49
S. E.	±1.612	±0.501	±0.860
(a) Genotypic C. V.	19.45	9.59	24.00
(b) Phenotypic C. V.	89.70	10.04	34.00
Heritability in broad sense (percentage)	21.68	84.52	51.55
Genetic advance	0.574	1.730	0.994
Expected genetic advance (percentage)	30.81	11.56	14.54

advance was considerably less. According to Panse (1957) it is indicative of non-additive gene effects of high heritability (broad sense) coupled with low expected genetic advance and *vice versa*. Similarly expected genetic advance is more for pod girth, but lower heritability was observed. The pod length has significant positive correlation with yield, whereas other two had negative insignificant correlation with yield This is further substantiated by path coefficient analysis (Table 2) that the length of pod revealed the highest direct effect on yield followed by number of edges on the pod. It is also clear from the data that other residual factors contribute greater influence on yield than the characters under study.

TABLE 2. Path coefficient analysis of yield and its three components in *bhendi*

Characters	Direct effect	Indirect effect on yield through X_1	X_2	X_3	Correlation with yield (r)
Pod girth X_1	−0.0034	—	+0.265	−0.307	−0.0354
Length of pod X_2	+0.3390	−0.0026	—	−0.0170	+0.3200*
No. of edges on the pod X_3	+0.1288	+0.1792	−0.4467	—	−0.2390
Residual factors =	+0.8880				

* Significant at 5 percent

Higher magnitude of *g. c. a.* variance compared to *s. c. a.* variance indicates that additive gene action is in operation for the inheritance of three quantitative characters under study (Table 3).

The heterosis and potence ratio are presented in Table 4. Among the fifteen hybrids, eleven crosses showed negative heterosis for pod girth in which crosses (2 X 3), (3 X 5), showed significantly higher values of heterosis

TABLE 3. Analysis of variance of combining ability for quantitative characters in *bhendi*

Source	D. F.	Mean sum of squares: Pod girth (cm)	Length of pod	No. of edges on the pod
G. C. A.	5	0.0280**	3.654**	2.948**
S. C. A.	15	0.0220**	0.448**	0.287**
Error	40	0.0012	0.060	0.014

** Significant at 1 per cent

TABLE 4. Heterosis over best parent and potence ratio in *bhendi*

Cross	Pod girth		Length of pod		No. of edges on the pod	
	Heterosis	Potence ratio	Heterosis	Potence ratio	Heterosis	Potence ratio
1×2	— 2.0	0.00	—15.86**	— 0.97	+ 8.4	—1.54
1×3	— 0.5	+ 1.33	— 5.32	+ 0.06	—18.3**	—1.57
1×4	— 3.3	— 1.60	— 8.48	+ 0.59	—23.9**	—0.66
1×5	— 9.6	— 0.90	— 8.32	— 1.06	—26.8**	—4.00
1×6	— 2.0	— 0.77	— 4.04	+ 13.60	—19.7**	—3.00
2×3	— 1.0	— 5.00	—18.53**	+ 1.94	+ 5.6	+1.53
2×4	—27.8**	+15.00	—19.58**	+ 2.26	+ 2.8	+1.25
2×5	— 3.0	+ 1.33	—18.47**	+ 1.60	+ 1.4	+1.08
2×6	+ 0.5	+19.00	—11.98**	+ 0.49	0.0	+1.00
3×4	0.0	—12.00	— 1.10	—114.30	—21.1**	+1.00
3×5	—11.6*	— 1.43	— 0.63	— 2.40	—14.1*	+2.10
3×6	0.0	+ 5.00	+ 0.39	+ 1.07	—23.9**	+0.30
4×5	— 5.6	+ 0.30	— 9.98*	+ 0.54	—18.3**	+2.00
4×6	— 4.5	— 1.00	— 4.60	— 0.13	—14.1**	+7.00
5×6	— 3.5	— 1.20	—10.14*	+ 1.51	—26.7**	—0.66
S. E.	± 0.106		± 0.55		± 0.381	

* and ** significant at 5 and 1 per cent.

in a desired direction. It is also substantiated further by the potence ratio indicating the presence of over-dominance. The other crosses showed insignificant positive heterosis. Only one cross (3 X 6) showed positive insignificant heterosis for pod length, whereas the crosses (2 X 4), (2 X 3), (2 X 5), (1 X 2), (2 X 6), (5 X 6) and (4 X 5) showed significantly negative heterosis in an undersirable direction, which is again supported by potence ratio suggesting the presence of over-dominance. Heterosis for number of edges on the pod was observed in 10 crosses in a desired direction while crosses (1 X 5), (5 X 6), (3 X 5), (1 X 6), (1 X 4), (1 X 3), (4 X 5), (3 X 5) and (4 X 6) showed significantly negative heterosis. Only 5 crosses exhibited positive heterosis towards undesirable direction. The heterosis in these crosses was also due to overdominance. The cross (3 X 6) exhibited heterosis for both pod length and number of edges on the pod in desirable direction, whereas the crosses (2 X 3) and (3 X 5) showed desirable heterosis for pod girth. Thus, the crosses involving Pusa Sawani x A E 107, Red Wonder x Pusa Sawani and Pusa Sawani x White Velvet could be employed for exploitation of hybrid vigour in *bhendi* for the above characters.

White Velvet and Dwarf Green showed significantly negative *g. c. a.* effects suggesting more additive effects for low pod girth among parents (Table 5). Similar results were also observed for fruit length in which A E 107, Seven Dhari and Pusa Sawani exhibited significantly positive *g. c. a.* effects whereas the other three parents showed negative *g. c. a.* effects. Number of edges in the pods of White Velvet, Seven Dhari, and A E 107 showed significantly negative *g. c. a.* effects for lower number of edges on the pod. Thus it was evident that A E 107 and Seven Dhari were better combiners in desirable direction for pod and number of edges on the pod whlie White Velvet was a good combiner for pod girth.

Crosses (P2 X P4), (P4 X P6), (P1XP6) showed negative s. c. a. effects for lower pod girth, whereas pod length in (P3 X P4), (P3 X P6) and (P3 X P5) exhibited positively significant *s. c. a.* effects suggesting the non-additive effect for this character (P3 X P6) was the only cross which exhibited a significantly negative *s. c. a.* effects for number of edges on the pod. Five crosses showed negative insignificant *s. c. a.* effects for number of edges on the pod in desirable direction. Hence, the crosses Pusa Sawani x A E 107, Pusa Sawani x Dwarf Green and Red Wonder x Dwarf Green could be employed for exploitation of heterosis. These results agree very well with the mean *per se* performance of parents and hybrids (Table 5).

Data on genetic components of variation, their proportions and differences for three quantitative characters are presented in Table 6. High level of significance of h^2 indicates the high level of net dominance effects of overall loci in determining pod girth as well as number of edges on the pod. But D and H_2 components are significant at 5 per cent in case of number of edges on the pod only, which

TABLE 5. Mean performance of parents and hybrids and estimates of general and specific combining effects for three quantitative characters in *bhendi*.

Treatments	Girth of pod		Length of pod		No. of edges on the pod	
	Mean (cm)	Effects g. c. a.	Mean (cm)	Effects g. c. a.	Mean (cm)	Effects g. c. a.
Parents						
P1	1.98	+0.050**	17.93	+0.443**	4.90	—0.300 **
P2	1.90	—0.006	15.13	—1.215	7.10	+1.100 **
P3	1.92	+0.050**	16.10	+0.235**	5.60	—0.050
P4	1.93	—0.028*	16.13	—0.046	5.50	—0.080
P5	1.45	—0.118**	16.57	—0.148*	4.70	—0.370
P6	1.89	+0.050**	18.03	+0.730**	5.30	—0.230 **
S. E. $\hat{g}$.		±0.012		±0.08		±0.045
Crosses		s. c. a.		s. c. a.		s. c. a.
1×2	1.94	+0.003	15.17	—0.470**	7.70	+0.800**
1×3	1.99	+0.030	17.07	—0.020	5.80	+0.100
1×4	1.91	+0.020	16.50	—0.310**	5.40	—0.300
1×5	1.79	—0.004	16.50	—0.180**	5.20	—0.200
1×6	1.90	—0.057	17.30	—0.280**	5.70	+0.200
2×3	1.92	+0.054	14.67	—0.760**	7.50	+0.400 **
2×4	1.43	—0.316**	14.50	—0.650**	7.30	+0.200
2×5	1.92	+0.184	14.70	—0.350**	7.20	+0.400 **
2×6	1.99	+0.089	15.87	—0.060	7.10	+0.200
3×4	1.98	+0.087	17.83	+1.230**	5.60	—0.300
3×5	1.75	—0.043	16.90	+0.400**	6.10	+0.500**
3×6	1.98	+0.023	17.10	+0.720**	5.40	—0.400**
4×5	1.87	+0.155	16.23	+0.010	5.90	—0.300
4×6	1.89	—0.098	17.20	+0.100*	6.10	+0.400**
5×6	1.91	+0.122	16.20	—0.790**	5.20	—0.200
S. E. $\hat{S}ij$.		±0.0969		± 0.047		± 0.117

* and ** significant at 5 and 1 per cent.

TABLE 6. Genetic components of variation and their population and difference for three quantitative characters in *bhendi*

	Pod girth	Pod length	No. of edges on the pod
D	0.0322	0.894	0.651*
	(±0.0921)	(± 0.425)	(± 0.168)
F	0.0508	— 1.238	— 0.646*
	(± 0.0722)	(± 0.519)	(± 0.205)
H1	0.1941	1.516**	0.825
	(± 0.1500)	(± 0.108)	(± 0.420)
H2	0.1800	0.698	0.860*
	(± 0.1341)	(± 0.964)	(± 0.380)
h^2	13.9800**	0.094	0.628**
	(± 0.0902)	(± 0.649)	(± 0.034)
E	0.0068	0.393	0.071
	(± 0.0222)	(± 0.18)	(± 0.057)
$(H1/D)^{\frac{1}{2}}$	1.926	1.3	0.368
H2/4 H1	0.259	0.115	0.115
$\frac{KD}{KR} = \frac{(4DH_1)^{\frac{1}{2}} + F}{(4DH_1)^{\frac{1}{2}} - F}$	3.190	0.305	0.388
$K = h^2/H2$	11.542	0.135	0.725
H1—H2	0.0141	0.818	—0.041**
r between yr and wr+vr	0.0539	— 0.204	0.95**
Heritability in narrow sense (per cent)	16.13	17.16	27.07
t^2	56.01**	— 0.1806	0.026
	Significant	NS	NS

* And ** Significant at 5 and 1 per cent.

suggests the significant additive variance and the proportion of dominance variance due to positive and negative effects of genes on number of edges on the pod. In case of pod length, H_1 component was found to be highly significant suggesting the variance due to dominance effects of genes. An overall measure of the degree of dominance indicated the presence of overdominance for pod girth and length of pod, whereas it was partial dominance for number of edges on the pod. The data indicate the unequal distribution of positive and negative alleles amongst the parents for all the characters under study. The data indicate the presence of dominant genes among the parents for pod girth and the recessive alleles for the other two characters. Further the dominant genes have positive effect on pod length, while they have negative effect on pod girth and number of edges on the pod.

REFERENCES

BURTON G. W. 1952, Quantitative inheritance, in grasses. Prop. 6th Inter Grassland Con., 1: 277-283

DEWAY, J. R. and K. H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat-grass seed production. *Agron. J. 51:* 515-18.

GRIFFING, B. 1956, Concept of general and specific combining ability in relation to diallel crossing systems. *Aust. J. biol. Sci., 9:* 463-93.

HAYMAN, B. I. 1954. The Theory and analysis of diallel crosses. *Genetics 39:* 789-809.

PANSE, V. G. 1957. Genetics of quantitative characters in relation to plant breeding. *Ind. J. Genet. 17:* 318-327.

TURNER, J. H. 1953. A study of heterosis in upland cotton. II Combining ability in breeding effects. *Agron. J. 43:* 487-490.

WIGAN, L. G. 1944, Balance and potence in natural populations. *J. Genet., 46:* 150-60.

unequal distribution of positive and negative alleles amongst the parents for all the characters under study. The data indicate the presence of dominant genes among the parents for pod girth and the recessive alleles for the other two characters. Further the dominant genes have positive effect on pod length, while they have negative effect on pod girth and number of edges on the pod.

REFERENCES

BURTON G. W. 1952, Quantitative inheritance, in grasses. Prop. 6th Inter Grassland Con., 1: 277-283

DEWAY, J. R. and K. H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat-grass seed production. *Agron. J. 51:* 515-18.

GRIFFING, B. 1956, Concept of general and specific combining ability in relation to diallel crossing systems. *Aust. J. biol. Sci., 9:* 463-93.

HAYMAN, B. I. 1954. The Theory and analysis of diallel crosses. *Genetics 39:* 789-809.

PANSE, V. G. 1957. Genetics of quantitative characters in relation to plant breeding. *Ind. J. Genet. 17:* 318-327.

TURNER, J. H. 1953. A study of heterosis in upland cotton. II Combining ability in breeding effects. *Agron. J. 43:* 487-490.

WIGAN, L. G. 1944, Balance and potence in natural populations. *J. Genet., 46:* 150-60.