Agri. Res. J. Kerala, 1976 14 (2) 13—20

GENE ACTION IN BHINDI

R. S. KULKARNI,[1] T. SWAMY RAO[2] and K. VIRUPAKSHAPPA[3]

College of Agriculture, Dharwar Campus

A knowledge of the nature of gene action for yield components and diversity amongst the parents is essential for formulating any breeding programme. In the present study an attempt has been made to compare the relative performance of F_2 and first backcross progenies of 6x6 diallel set of crosses in *Bhindi* and to examine the utility of this technique characters, viz. Days to flowering, plant height and number of pods per plant.

Materials and Methods

Six genetically diverse inbreds of *bhindi* (Seven dhari, Red wonder, Pusa sawani, Dwarf green, White velvet and AE 107) were crossed in all possible combinations without reciprocals. F,'s were selfed by bagging the flowers to produce F_2 seeds and F_1's were back crossed to both their parents to obtain first back-cross generation seeds. The F_2 and back cross generations were grown along with the parental selfs in kharif 1974-75 at the Agriculture College, Dharwar in a randomised block design with three replications. Spacing between and within rows were 45 cm and 30 cm respectively. One row of each parent, twelve and four rows of F, and first back cross generations respectively were sown in 3 m long rows. Days to flowering, plant height and number of fruits per plant were recorded on five plants in parents and on all the plants in F_2 and back cross generations.

Means of parents, F_1s and first back cross generations were utilized for statistical analysis. The method adopted by Hayman (1954) was followed for analysing the components of variance.

Results and Discussion

The estimates of genetic components of variation with their proportions and difference for three quantitative characters in F_2, BC_1 and BC_1 generations are presented below.

Days *to flowering:* Estimates of genetic components are presented in Table-1.

Present address: 2. Plant Breeder (Potato), Potato Research Station, Madenur P. O., Hassan, Karnataka State.

1. 3. Research Assistants, Agricultural Botany Division, U. A. S. Hebbal, Bangalore-560024.

Table 1

Estimates of genetic components with their proportions and difference for days to flower in different generations of 6x6 diallel crosses in *bhindi*

Components	Generations		
	F_2	BC_1	BC_1
D	1.777 ±1.221	2.015** ±0.133	1.657** ±0.259
F	3.902 ±2.982	2.438** ±0.325	2.593** ±0.632
H_1	8.740** ±3.098	2.800** ±0.337	5.907** ±0.657
H_2	6.33* ±2.768	1.981** ±0.301	4.567** ±0.587
h^2	-0.378 ±1.863	1.519** ±0.203	12.957** ± 0.395
E	0.691 ±0.461	0.453** ±0.050	0.811** ±0.098
$(H_1/D)^{\frac{1}{2}}$	2.218	1.179	1.888
$H_2/4H_1$	0.181	0.177	0.193
KD/KR	2.961	3.108	2.415
$K = h^2/H_2$	-0.060	0.767	2.837
H_1-H_2	2.409	0.819	1.340
Corr. value between $(W_r + V_r)$ and Y_r	-0	-0.652	-0.928
Heritability in the narrow sense in percentage.	18.9	52.6	20.1
t^2	-15.052	0.100	0.958

Significant at 5% ** Significant at 1 %

The significance of H_1 and H_2 indicated the operation of dominant genes in respect of this character in F_2 generation. However net dominant effect (h^2) .. the loci was not significant. The presence of overdominance indicated by $(H_1/D)^{\frac{1}{2}}$ value. Unequal distribution of the positive and negative allels is indicated by $H_2/4H_1$ being 0.181 and this is further empasized by the fact that H_1-H_2 is not equal to zero. F value is insignificant and positive indicating that there are dominant alieles in the parents for the character.

KD/KR value is more than one, suggesting the presence of more of dominant genes in the parents. K value (h^2/H_2) indicated that atleast one dominant gene was in operation in controlling days to flowering. The heritability of the character in the narrow sense is 18.9 psr cent suggesting the minor part played by additive genes in controlling the character. Negative correlation between Y_r and ($W_r + V_r$) revealed the operation of dominant genes in positive direction. The *V* test indicates the failure of the diallel model.

In BC, generation, high level significance of D, H_1, H_2 and h^2 indicated the operation of additive and dominant genes in respect of days to flowering The presence of overdominance was indicated by $(H_1/D)^{\frac{1}{2}}$ value. $H_2/4H_1$ was not equal to 0.25 indicating the unequal distribution of the positive and negative allels. This is supplimented by H_1-H_2 value being not equal to zero. KD/KR value being more than one indicated the presence of dominant genes among all the parents. Significant positive F value indicated that there are dominant allels in the parents for the character. K value (h^2/H_2) suggested that at least one group of dominant genes was controlling days to flowering. The heritability of the character in the narrow sense was 52.6 per cent which indicated that additive genetic variation constituted a very large portion of the phenotypic variation. Dominance was in the direction of lateness as shown by the negative correlation between (W + V) and Y

Significance of D, H_1, H_2 and h^2 suggests that both additive and dominant genes were important in governing days to flowering in BC_1 generation. $(H_1/D)^{\frac{1}{2}}$ which measures th . overall degree of dominance was 1.888 thus, indicating over dominance. $H_2/4H_1$ (0.193) being not equal to 0.25 suggests the asymmetry of gene distribution. Confirmation ofthe same is observed by high KD/KR value (2.415) and H_1-H_2 being not equal to zero. Positive F value suggests that there are dominant allels for the character in the parents. K value (h^2/H_2) indicated that atleast three dominant genes were in operation in controlling the character. The herbita-bllity of the character being 20.1 per cent in the narrow sense indicated that the major part of the phenotypic variability was non-additive. Significant negative correleation between Y and (W + V) shows that there was do-minance for late flowering.

Plant height: Components of genetic variation have been presented in Tab!e-2. High significance of H_1 and H_2 in F_2 generation indicated the operation of dominant genes in respect of this character. Significance of h suggests that the dominant gene effects were important in determining plant height. D componant was negative which might have arisen due to excess of error variance. The overall degree of dominance measured by $(H_1/D)^{\frac{1}{2}}$ being more

Table 2

Estimates of genetic components with their proportions and difference for plant height in different generations of 6x6 diallel crosses in *bhindi*

Components	Generations		
	F_2	BC_1	BC_1
D	-5.796 ± 9.120	$-36.450^{*} \pm 7.292$	$-20.128^{**} \pm 7.692$
F	-18.600 ± 22.280	-12.390 ± 17.817	31.493 ± 18.792
H_1	$98.350^{**} \pm 23.152$	$314.164^{**} \pm 18.514$	$98.239^{**} \pm 19.528$
H_2	$104.720^{**} \pm 20.682$	$268.595^{**} \pm 16.539$	$113.868^{**} \pm 17.444$
h^2	$423.851^{**} \pm 13.920$	$1010.272^{**} \pm 11.132$	$533.695^{**} \pm 11.741$
E	$44.704^{**} \pm 3.447$	$75.358^{**} \pm 2.756$	$59.037^{**} \pm 2.907$
$(H_1/D)^{\frac{1}{2}}$	4.119	2.936	2.209
$H_2/4H_1$	0,266	0.214	0.290
KD/KR	0.439	0.891	0.477
$K = h^2/H_2$	4.047	3.761	4.687
H_1-H_2	-6.370	45.569	-15.629
Corr. value between $(W_r + V_r)$ and Y_r	-0.917	-0.761	-0.600
Heritability in the narrow sense in percentage	-1.90	-6.10	-5,80
t^2	-5.421	-2.259	-3.854

* Significant at 5%   ** Significant at 1%

than one (4.119) suggests overdominance. The value of $H_2/4H_1$, was 0.266 which is not equal to 0.25 indicating the unequal distribution of positive and negative alleles and this was further confirmed by KD/KR being not equal to one and F value being negative. This values also suggest the presence of more of recessive genes in parents. This fact is further strengthened by H -H value. h^2/H_2 indicated that atleast four groups of dominant genes were in operation in controlling plant height. Heritability in the narrow sense being. 1.9 per cent revealed that additive genetic variation constituted a very low-proportion of the phenotypic variation. Dominance was in the direction of tallness as indicated by the negative correlation between (W , V) and Y

H H and h^2 being significant in B(generation pointed out that dominance was important in governing plant height in *bhindi*. D component was negative due to greater error variance. $(H_1/D)^{\frac{1}{2}}$ value (2.936) being more than one suggests the operation of overdominance in controlling plant height. $H_2/4H_1$ value being less than 0.25, H_1-H_2 not 1 to zero and KD/KR indicated the fact that the positive and negative alleles were unequally distributed in the parents. Atleast four groups of dominant genes were found to control the plant height. Heritability in the narrow sense was poor (6.10 per cent) indicating the minor part played by additive genes in controlling plant height. Dominance was in the direction of tallness as revealed by negative correlation between (W + V) and Y

In BC_1 generation high significance of H_1 H_2 and h^2 suggested the operation of dominant genes in respect of plant height. Excess of error variance was responsible for D component being negative. Operation of dominant genes in respect of this character was evident from the value $(H_1/D)^{\frac{1}{2}}$ being 2.209. Unequal distribution of genes is revealed by $H_2/4H_1$ being not equal to 0.25, H_1-H_2 not equal to zero and KD/KR value being not equal to one F value suggests the presence of more of recessive genes in parents. Atleast five groups of dominant genes are responsible for controlling this character. Poor heritability in the narrow sense suggested the minor part played by additive genes in controlling plant height. Correlation between Y and (W 4 V) being negative indicated the operation of dominant genes in positive direction.

Number of fruits per plant: Components of genetic variation are presented in Table-3.

Significance of D at one per cent and significance of H_1 at five per cent probability level suggests the operation of additive and dominant genes in respect of this character. $(H_1/D)^{\frac{1}{2}}$ which measures the overall degree of dominance was 0.712, indicating the operation of partial dominance. The value of $H_2/4H_1$ (0.106) not equal to 0.25 suggests asymmetry of gene distribution for number of fruits. This was also evident by high KD/KR value (3.147) and H_1-H_2 being not equal to zero. Highly significant positive F value indicates the unequal distribution of genes and more of dominant genes in parents. K value revealed that atleast one group of dominant genes was in operation in controlling the number of fruits per plant. Heritability estimate was 64.4 per cent the narrow sense indicating that the major part of the phenotypic variability was additive. Positive correlation between Y and (W + V) reveals that dominance was in the direction of lower number of fruits.

Table 3

Estimates of genetic components with their proportions and difference for number of fruits per plant in different generations of 6 X 6 diallel crosses in *bhindi*

Components	Generations		
	F_2	BC_1	BC_1
D	5.954** ±0.352	5.745** ±0.549	5.032** ±1.254
F	4.389** ±0.859	4.747** ±1.341	0.703±3.064
H_1	3.017* ±0.893	8.953** ±1.394	8.221* ±3.184
H_2	1.277±0.798	6.979** ±1.245	6.168* ±2.844
h^2	-0.624±0.537	11.853** ±0.838	12.414** ±1.914
E	1.205** ±0.133	1.414* ±0.208	2.126** ±0.474
$(H_1/D)^{\frac{1}{2}}$	0.712	1.248	1.278
$H_2/4H_1$	0.106	0.195	0.187
KD/KR	3.147	1.989	1.116
$K=h^2/H_2$	-0.489	1.698	2.013
H_1-H_2	1.740	1.974	2.053
Corr. value between $(W_r + V_r)$ and Y_r	0.060	-0.644	-0.662
Heritability in the narrow sense in percentage	64.40	36.80	23.8
t^2	0.727	0.417	-0.028

* Significant at 5% Significant at

High level significance of D, H_1, and h^2 in BC, generation indicated the operation of additive and dominant genes in respect of this character, overdominance was indicated by $(H_1/D)^{\frac{1}{2}}$ being 1.248. Asymmetry of gene distribution for this character was revealed by the value $H_2/4H_1$ (0.166) and was further confirmed by high KD/KR value (1.989) and H_1-H_2 not being equal to [illegible]. Significant positive F value indicates excess of dominant genes in the parents. K value being 1.698 suggested the operation of atleast two groups of dominant genes, controlling number of fruits per plant. Heritability estimate in the narrow sense was 36.80 per cent indicating the major part of phenotypic variability additive. The negative correlation between Y and W V suggested that the dominance was in the direction of higher number of fruits per plant.

High level significance of D and h^2 and significance of H and H revealed the operation of additive and dominant genes in respect of this character in BC_1 generation $(H_1/D)^{\frac{1}{2}}$ being more than one (1.275) suggested the operation of over dominance. The value $H_2/4H_1$ (0.187) not equal to 0.25 and H_1-H_2 value being not equal to zero indicated the unequal distribution of the positive and negative alleles. Positive F value and KD/KR value being more than one indicated the presence of more of dominant genes in the parents. h^2/H_2 value being 2.013 suggested the operation of atleast three groups of dominant genes, controlling number of fruits per plant. Heritability in the narrow sense being 23.8 per cent revealed the part played by additive genes in total phenotypic variability. The dominance was in the direction of more number of fruits per plant as indicated by negative correlation between Y and (W + V.

Jinks and Hayman (1953) have developed a diallel cross method which provides estimates of genetic parameters in F_1 generation. Jinks (1956) has extended the same to F, and back cross generations. This method was followed in the present study which was undertaken with a view to understand the nature of combining ability and gene action of some of the quantitative characters contributing to yield so as to enable to suggest the appropriate breeding procedure for adoption. Previous reports on nature of gene action in *bhindi* are not available and hence this is the first report of its kind in this crop.

Days to flowering: Study of genetic components revealed that both additive and dominant gene actions were important in first back cross generations whereas dominant gene action was prevailing in F_2 generations. Overdominance was indicated for the character which may be spurious because of presence of non-allelic interactions. Unequal distribution of positive and negative alleles was indicated. K value indicated atleast three groups of dominant genes in BC_1 generation. Dominance was in the direction of late flowering. Additive gene action was more in BC_1 generation as indicated by high narrow sense heritability.

Plant height: Significance of H_1, H_2 and *tf* in all the three generations indicated that dominance had a greater part in controlling the character. Overdominance prevailed in all the generations so also the unequal distribution of positive and negative alleles. K value indicated four or five groups of dominant genes controlling the character. Dominance was towards tallness as indicated by correlation coefficient between Y and (W + V).

Number of fruits per plant: Significance of H_1 in F_2 and BC_1 and high level significance in BC_1 revealed the role of dominance in the expression of the character. F_2 generation indicated partial dominance while BC_1

and BC_1 indicated overdominance. Unequal distribution of effects was observed in all the generations. K value indicated one to three groups of dominant genes controlling the character. Dominance was towards lower number of pods in F_2 while it was towards greater number of pods in BC_1 and BC_1, which might be due to the accumulation of the dominant genes in BC_1 and BC_1 generations. This was also reflected in narrow sense heritability which was high in I generation.

Summary

Estimates of components revealed that both additive and non-additive type of gene actions were operating for all three characters. Number of fruits per plant showed predominantly additive gene action while days to flower and plant height showed non-additive gene action. Dominance was found to be acting in the direction of earliness, tallness and greater number of fruits per plant. Asymmetrical distribution of positive and negative alleles was observed for all the characters in all the generations. Days to flowering and number of fruits per plant were controlled by one to three groups of dominant genes while it was four to fiive for plant height. Overdominance was observed for all the three characters.

സംഗ്രഹം

മൂന്നു സ്വഭാവങ്ങളെ സംബന്ധിച്ചിടത്തോളവും, കൂട്ടിച്ചേർന്നതും കൂട്ടിച്ചേരാത്തതുമായ ജീൻപ്രവർത്തനങ്ങളും നിലവിലുണ്ടെന്നാണ് ഘടകങ്ങളുടെ ആകലനത്തിൽ നിന്നും മനസ്സിലാകുന്നത്. ഒരു ചെടിയിൽ നിന്നുള്ള ഫലങ്ങളുടെ എണ്ണത്തെ സംബന്ധിച്ചിടത്തോളം മുഖ്യമായും കൂട്ടിച്ചേർന്ന ജീൻപ്രവർത്തനവും, പൂക്കാനെടുത്ത കാലം, ചെടിയുടെ ഉയരം എന്നീ സ്വഭാവങ്ങളെ സംബന്ധിച്ചിടത്തോളം കൂട്ടിച്ചേരാത്ത ജീൻപ്രവർത്തനവും ആണ് നിലവിലുള്ളതെന്നുകണ്ടു. കുറഞ്ഞ മൂപ്പ്, കൂടുതൽ ഉയരം, ഒരു ചെടിയിൽ നിന്നും കൂടുതൽ ഫലങ്ങളും എന്ന രീതിയിലാണ് പ്രകടതത്തിന്റെ പ്രവർത്തന ശൈലി കണ്ടത്. എല്ലാതലമുറകളിലും എല്ലാസ്വഭാവങ്ങൾക്കും ധനാത്മകവും ഋണാത്മകവും ആയ അലീലുകളുടെ അസമവിതരണം ദൃശ്യമായി. പൂക്കാനെടുത്ത സമയം, ഒരു ചെടിയിൽ നിന്നുള്ള ഫലങ്ങളുടെ എണ്ണം എന്നീ സ്വഭാവങ്ങൾക്കാധാരമായി മൂന്നു ഗ്രൂപ്പുകളിൽപ്പെട്ട പ്രകടതാജീനുകളും, ചെടിയുടെ ഉയരത്തെ സംബന്ധിച്ചിടത്തോളം, നാലു മുതൽ അഞ്ചു വരെ ഗ്രൂപ്പുകളിൽപ്പെട്ട പ്രകടതാജീനുകളുമാണുള്ളത്. മൂന്നു സ്വഭാവങ്ങൾക്കും അധിപ്രകടതം കണ്ടിരുന്നു.

REFERENCES

Hayman, B. I., 1954. Analysis of variance of diallel tables. *Biometrics,* **10** *(2):* 235-244.

Jinks, J. L., 1956. The F and backcross generations from a set of diallel crosses. *Heredity* 10: 1 - 31.

Jinks, J. L., and B I. Hayman, 1953. The analysis of diallel crosses Meize Genetics Co-oper. Newsletter, *21:* 48 - 54.

(*M.* S. *received:* 15-6-1976)