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ANALYSIS OF HETEROSIS FOR POD YIELD AND ITS COMPONENTS IN RELATION TO GENETIC DIVERGENCE OF THE PARENTS AND SPECIFIC COMBINING ABILITY OF THE CROSSES IN COWPEA (*VIGNA UNGUICULATA* (L.) WALP.)

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ABSTRACT

Manifestation of heterosis for pod yield and its four components, plant height/vine length, pods/plant, pod length, and pod weight, was examined in relation to genetic divergence of the parents and specific combining ability status of the crosses in a diallel cross of cowpea. Genetic divergence of parents was estimated by Mahalanobis D^2 statistic. Heterosis did not always occur in crosses between widely divergent parents, but in some crosses which involved much less divergent parents. It appeared that the frequency of heterotic crosses as well as magnitude of heterosis was much related to the specific combining ability status of the crosses. However, consideration of genetic divergence of the parents involved in the crosses along with positive sca status of the crosses would prove to be useful in predicting heterosis.

Key words: Cowpea, heterosis, combining ability, genetic divergence.

Heterosis in F_1 generation is of much importance in self-pollinated crops like cowpea as heterotic crosses may give transgressive segregates for economic traits in the advanced generations. Genetic divergence of the parents has been reported to be essential for the manifestation of heterosis in their crosses in several leguminous crops [1–3]. On the other hand, there have been reports when heterosis was not observed even when divergent parents were crossed [4–6]. Keeping these observations in view, heterosis in a 5 x 5 half-diallel cross of cowpea was evaluated for pod yield and its components in relation to the genetic divergence of the parents and specific combining ability (sca) of the crosses.

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MATERIALS AND METHODS

Based on the divergence, as measured by Mahalanobis' D^2 statistic, 25 cowpea (*Vigna unguiculata* (L.) Walp.) genotypes belonging to three cultigroups (Unguiculata, Biflora and Sesquipedalis) were grouped into four distinct clusters using the Tocher's method [7]. From the four clusters, five genotypes, viz., Birsa Sweta and Check Barbati of the cultigroup Sesquipedalis, Pusa Dofasli of cultigroup Unguiculata, and Assam Local 1 and Dumca Local 1 of cultigroup Biflora were selected as parents for the diallel cross. The parents were crossed in all possible combinations (excluding reciprocals). The 5 parents and 10 F_1 progenies were grown in randomized block design with two replications. The data recorded on each entry for plant height/vine length, pod/plant, pod length, pod weight, and pod yield/plant were subjected to combining ability analysis followed Method II, Model I of Griffing [8]. Heterosis was worked out both over midparent (MP) and better parent (BP), and their significance (at 5% level) was determined by t test.

RESULTS AND DISCUSSION

The data on MP and BP heterosis for the six quantitative traits are presented in Table 1. Majority of the crosses exhibited significant positive MP heterosis for plant height/vine length, pods/plant and pod yield/plant, but half of them registered negative heterosis for pod length and weight. Nine crosses recorded significant positive BP heterosis for pods/plant and six crosses for pod yield/plant. Majority of the F_1s did not surpass their respective better parents for plant height/vine length, pod length and pod weight. Only two crosses, Assam Local 1 x Dumca Local 1 and Pusa Dofasli x Dumca Local 1, both being Biflora x Biflora, exhibited significant positive MP as well as BP heterosis for all the characters under study. Manifestation of heterosis for pod yield and its components is in agreement with earlier reports [9–11]. The ranks of the crosses on the basis of the heterosis and per se performance did not match which was possibly due to differences in the performance of parent themselves. It would be therefore judicious to consider per se performance along with heterosis while identifying promising crosses for further breeding programme.

Genetic divergence of the parents used is given in Table 2. Heterosis in the crosses Birsa Sweta x Dumca Local 1 and Check Barbati x Dumca Local 1 for pod number and pod yield could be explained by high parental divergence but such explanation is difficult to propose for heterosis recorded in the cross Pusa Dofasli x Dumca Local 1 which had the lowest parental divergence. Extremely divergent parents (Assam Local 1 x Birsa Sweta) did not produce heterotic combination for pod yield, while the crosses having very low parental divergence (Assam Local 1 x Dumca Local 1 and Pusa Dofasli x Dumca Local 1) were heterotic even over the better parents not only for pod yield but also for all the four yield

Table 1. Heterosis in F_1 for pod yield and its four components in cowpea

Cross	Plant height		Pods/plant		Pod length		Pod weight		Pod yield/plant	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
Assam Local 1 x Pusa Dofasli	57.8	42.5	14.5	—	13.5	-7.6	28.7	9.4	46.7	10.2
Assam Local 1 x Check Barbati	12.5	-28.1	36.3	24.7	7.3	-23.3	—	-33.4	40.9	—
Assam Local 1 x Birsa Sweta	—	-35.8	58.0	51.3	15.0	-46.3	-38.2	-63.6	—	-43.0
Assam Local 1 x Dumca Local 1	45.0	25.2	38.3	36.8	28.5	11.2	42.3	21.1	115.5	87.4
Pusa Dofasli x Check Barbati	12.3	-24.6	38.5	10.9	-8.7	-23.1	—	-28.8	46.8	34.2
Pusa Dofasli x Birsa Sweta	—	-33.5	64.6	37.2	-15.3	-39.9	-37.3	-60.7	14.3	-21.8
Pusa Dofasli x Dumca Local 1	44.3	37.1	118.0	86.4	12.2	—	23.9	23.6	308.3	261.8
Check Barbati x Birsa Sweta	-15.1	-23.8	61.8	53.9	-21.0	-36.3	-23.6	-41.9	20.8	-12.8
Check Barbati x Dumca Local 1	23.3	-14.8	46.8	35.6	—	-18.0	15.2	-14.7	77.1	36.2
Birsa Sweta x Dumca Local 1	25.0	-18.6	98.2	92.2	-7.8	-37.3	—	-35.6	105.0	26.9

Note. Nonsignificant heterosis has not been mentioned.

components. Thus the realised heterosis when considered against corresponding D values between the parents of the crosses, an one to one correspondence may not necessarily be established between them. In fact, it should be realised that genetic divergence and heterosis may not proceed hand in hand because of internal balancing or even cancelling of various components of heterosis.

To relate heterosis with the specific combining ability status of the crosses, general combining ability (gca) of parents and specific combining ability (sca) of the crosses are given in Table 3. Almost all heterotic crosses exhibited significantly positive sca status for the character under study. The crosses with significantly negative sca, even if having very high parental divergence, generally did not exhibit heterosis, especially over better parent. For example, the crosses, Assam Local 1 x Birsa Sweta and Pusa Dofasli x Birsa Sweta exhibited negative heterosis and negative sca for all the characters except pods/plant.

Table 2. Parental divergence of the crosses of cowpea

Cross	Clusters of parents		Intra- or inter-cluster D value*	D value between parents
	females	males		
Assam Local 1 x Pusa Dofasli	4	4	29.8	31.2
Assam Local 1 x Check Barbati	4	3	53.1	72.0
Assam Local 1 x Birsa Sweta	4	2	93.2	133.0
Assam Local 1 x Dumca Local 1	4	4	29.8	33.6
Pusa Dofasli x Check Barbati	4	3	53.1	54.6
Pusa Dofasli x Birsa Sweta	4	2	93.2	111.7
Pusa Dofasli x Dumca Local 1	4	4	29.8	19.1
Check Barbati x Birsa Sweta	3	2	74.6	66.9
Check Barbati x Dumca Local 1	3	4	53.1	54.9
Birsa Sweta x Dumca Local 1	2	4	93.2	115.6

*Note. D values within and between clusters relate to the clusters when the parents of the cross belong to the same (intra-) or different (inter-) clusters.

Marked heterosis and positive sca were registered only for pods/plant in these crosses. Heterosis was absent in the crosses with significantly negative sca combined with low parental divergence for a particular character. The only exceptions were the crosses Assam Local 1 x Pusa Dofasli for pods/plant and Pusa Dofasli x Dumca Local 1 for pod length. However, only MP heterosis was recorded in these two crosses for the characters mentioned above and the magnitude of heterosis was also low. It is to be mentioned that the variety Pusa Dofasli is a good general combiner for pod number. From the above observations it becomes apparent that the parental divergence may not serve as a very reliable parameter for predicting heterosis. On the other hand, whatever be the nature of parental divergence (high or low), the positive sca effects of the crosses continue to maintain high heterotic expression for different characters.

In this context, the crosses Birsa Sweta x Dumca Local 1 and Check Barbati x Dumca Local 1 gave some interesting readings. Both these crosses involved Sesquipedalis and Biflora cultigroups which were widely divergent (Table 2). Significantly positive sca effects was revealed for pod number and pod yield/plant in these two crosses and marked heterosis was also manifested for the mentioned characters. The per se performance of these crosses for pod number and pod yield was also very high. In fact, highest pod yield of 372.6 g/plant was recorded in the cross Birsa Sweta x Dumca Local 1. This would suggest that high genetic divergence of the parents in association with high positive sca effects would

Table 3. Gca of parents and sca of crosses for pod yield and its components on cowpea

Parent or cross	Plant height	Pods per plant	Pod length	Pod weight	Pod yield per plant
Gca:					
Assam Local 1	– S	– S	– S	– S	– S
Pusa Dofasli	– S	+ S	– S	– S	– S
Check Barbati	+ S	– S	+ S	+ S	– S
Birsa Sweta	+ S	+ NS	+ S	+ S	+ S
Dumca Local 1	– S	+ S	– S	– S	+ NS
Sca:					
Assam Local 1 x Pusa Dofasli	+ S	– S	+ S	+ S	+ S
Assam Local 1 x Check Barbati	+ S	+ S	+ S	+ S	+ S
Assam Local 1 x Birsa Sweta	+ NS	+ S	– S	– S	– S
Assam Local 1 x Dumca Local 1	+ S	+ NS	+ S	+ S	+ S
Pusa Dofasli x Check Barbati	+ S	+ NS	– S	+ NS	+ S
Pusa Dofasli x Birsa Sweta	– NS	+ S	– S	– S	– S
Pusa Dofasli x Dumca Local 1	+ S	+ S	– S	+ S	+ S
Check Barbati x Birsa Sweta	– S	+ S	– S	– S	+ S
Check Barbati x Dumca Local 1	+ S	+ NS	+ S	+ S	+ S
Birsa Sweta x Dumca Local 1	+ S	+ S	– S	+ S	+ S

+S —significantly positve; – S —significantly negative; +NS —positive but nonsignificant; and – NS —negative but nonsignificant.

likely to manifest high heterosis for the character concerned. Gca effects of the parents of the two above mentioned Sesquipedalis x Biflora crosses revealed that predominantly additive gene action and complementary epistatic effect were in operation for maximising the expression of pod number and yield/plant. Hence, parental genetic divergence should not be ignored, rather it must be considered along with sca of the crosses for predicting heterosis.

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