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HETEROSIS AND HERITABILITY FOR YIELD AND YIELD COMPONENTS IN F_1 AND F_2 GENERATIONS OF A BEAN CROSS[1]

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ABSTRACT

An experiment was carried out from 1969 to 1972 to study heterosis and to estimate heritability for some quantitative characters in two varieties of bean (*Phaseolus vulgaries* L.). Varieties studied were Torbat from Iran and Pinto111 from the UnitedStates. Two varieties, their reciprocal hybrids and their F_2 progenies were field tested and number of pods per plant, number of seeds per pod, weight of 100 seeds and seed yield per plant were studied.

No significant quantitative differences were found between reciprocal hybrids, indicating no cytoplasmic effect. Heterosis was observed for weight of 100 seeds and yield per plant but not for number of pods per plant and number of seeds per pod.There was no indication of heterosis in the F_2 progenies. Heritability estimates (broad sense) were 46.72, 47.82,63.36 and 70.61% for number of pods per plant, seed yield per plant, weight of 100 seeds and number of seeds per pod, respectively, which are relatively large.

INTRODUCTION

Several investigations have been undertaken to study heterosis and heritability in bean, *Phaseolus vulgaris* L. Heterosis was observed for leaf area in the F_1 generation of intra-specific crosses between varieties Algarrobo and Michelite (4). Heterosis for number of stems, plant height and number of pods have been shown in the F_1 crosses of 12 bean

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varieties (3). In the F_1 generation of two crosses in the dry bean, heterosis for plant height was present. Heterosis for height can be explained by the multiplicative interaction on the phenotypic level of the components of the trait (1). In 21 F_1 lines obtained from crosses between 14 Iranian, French and American varieties, heterosis was observed for yield components (6). Parent-progeny regression was used to estimate heritability for total seed yield, number of pods per plant, number of seeds per pod and mean seed weight in bean. Very low estimates were obtained for all traits (2).

The present study was undertaken in order to measure heterosis and heritability (broad sense) for four different traits in beans.

MATERIALS AND METHODS

Reciprocal crosses between Pinto 111 and Trobat were made in greenhouse in 1968. Pinto 111 is an American variety, early flowering, with small plants, whereas Torbat is an Iranian one, rather late in maturity and tall. F_1 plants were grown in the greenhouse to obtain F_2 seed. Seeds from parents, F_1 and F_2 hybrids were planted in the field in 1971 at Karaj, Iran, in a randomized complete block design with three replications. Number of pods, number of seeds per pod, seed yield and 100 seed weight were recorded for each of 38 Torbat (P_1) plants, 54 Pinto 111 (P_2) plants, 25 $P_1 \times P_2$ plants (F_1),50 $P_2 \times P_1$ plants (F_1) and 207 F_2 plants.

Values of t for the comparison of means with both equal and unequal variances, unpaired and unequal numbers were calculated according to Steel and Torrie (7). For each comparison, variances of the two items were compared by an F-test and the t-values were then claculated for equal or unequal variances, accordingly. Comparisons were made between: (a) parents, (b) reciprocal F_2 crosses, (c) F_1 and midparents, (d) F_2 and midparents and (e) F_2 and F_1.

The broad sense heritability was calculated by the formula suggested by Mahmud and Kramer (5):

$$h^2 = \frac{VF_2 - \sqrt{VP_1 \times VP_2}}{VF_2} \times 100$$

where h^2 = heritability, $VF_2 = F_2$ variance and VP_1 and VP_2 are parent variances.

RESULTS AND DISCUSSION

Table 1 presents mean values of four different traits for parents, mid-parents, F_1 and F_2 generations.

Table 1. Mean values of different traits for parental, F_1 and F_2 generations and genetic variances and heritabilities in a bean cross.

Generation or criterion	No. of plants	No. pods / plant	No. seed / pod	100 seed wt., g	Seed yield, g
P_1	38	38.4	4.1	23.1	36.8
P_2	54	23.0	3.3	31.5	23.6
P	92	29.3	3.6	28.0	29.1
$F_1=P_1 \times P_2$	25	32.5	3.8	30.0	37.5
$F_1=P_2 \times P_1$	50	32.4	3.7	30.0	35.7
F_1	75	32.4	3.7	30.0	36.3
F_2	207	29.9	3.5	28.4	29.1
Genetic variance		81.6	0.4	13.9	105.9
Heritability,%		46.7	70.6	63.4	47.8

Torbat possessed greater number of pods and seeds per pod and higher seed yield than Pinto 111; however, Pinto 111 had heavier seeds than Torbat. No significant differences were observed between the reciprocal F_1 hybrids, suggesting that cytoplasmic inheritance was of little importance in this study. Heterosis measured on the F_1 mean and mid - parental values was observed for 100 seed weight and seed yield. Thus, heterosis for the complex trait yield can be explained by the multiplicative interaction on the phenotypic level of the components: number of seeds per pod, number of pods per plant and seed weight per pod. F_2 means were not significantly different from mid-parental values in all traits. F_1 hybrids were superior to F_2 lines only for yield and 100 seed weight.

Table 1 also shows the genetic variance and heritability estimates of four different

traits in beans. For yield heritability is 47.8, but for the three yield components, i.e., number of pods per plant, seed weight and number of seeds per pod, it is 46.7, 63.4 and 70.6%, respectively. Therefore, selection in the F_2 population for number of seed per pod and seed weight could be used to obtain high yielding lines after several generations of selection when the characters are fixed and no segregation is observed. In general, the heritability values obtained in this experiment are rather high as is often the case in experiments conducted in only a single environment. This is because genotype x environment interactions cannot be measured and hence appear in the genetic variances.

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