Variation and Heritability of Six Characters in Bean (Phaseolus vulgaris L.) Genotypes

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INTRODUCTION:

Breeding for increased seed yield is the major objective in any plant breeding program. Progress in breeding for economic characters that are quantitative in inheritance and therefore subject to environment variability is determined by the nature and magnitude of genetic variability. Such characters present difficulty in selection programs since heritability variations are often masked by non-heritable variation. Hence there is a need to partition overall variability into heritable and non-heritable components with the aid of genetic parameters such as genotypic and phenotypic coefficients of variation and heritability. This study was undertaken to estimate the variation, heritability (in the broad sense) and the expected genetic advance.

MATERIALS AND METHODS:

A total of eighteen bean (Phaseolus vulgaris L.) genotypes were planted on 13, May 1992 at Randolph Farm, Research Station of Virginia State University, Petersburg, Virginia. The experiment was conducted in a randomized complete block design with four replications. Each plot consisted of four 5 m long rows with 0.75 m between rows.

At green-pod stage, each genotype was evaluated by harvesting one meter length of the two center rows of each plot. The harvested materials were immediately put into plastic bags and brought to the laboratory. Ten plants from each harvested plot were randomly picked and the following data as described by Nienhuis and Singh (1985), were recorded: Main stem height, number of nodes plant^{-1}, number of pods plant^{-1}, 100 pod weight, and pod length. The pods from each harvested plot were pulled by hand and the weight was recorded and presented as green pod yield kg ha^{-1}. Analysis of variance was carried out as described by Steel and Torrie (1980). The genotypic, phenotypic, and error variances were calculated as described by Prasad et al. (1981). The variance components were used to compute the phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV), heritability (in the broad sense) and genetic advance. The GCV and PCV were calculated according to the methods of Kumar et al. (1985) : GCV = 100 (σ_g)/X and PCV = 100 (σ_p)/x, where σ_g and σ_p are the genotypic and phenotypic standard deviation, and x is the mean of the characters under consideration. Broad sense heritability estimates (H_{BS}^2) were calculated according to the formula of Allard (1960): $H^2_{BS} = (\sigma^2_g / [\sigma^2_g + \sigma^2_e])$.

RESULTS AND DISCUSSION:

Highly significant ($P < 0.01$) differences were observed for the sixth characters studied. Mean green pod yield of the genotype was 9979 kg ha^{-1} and ranged from 5108 to 14,633 kg ha^{-1}. Estimates of genotypic and error variance components for the six characters are given in Table 1. It can be concluded that the phenotypic variability observed in the different characters is influenced more by genetic factors than non-genetic. This is due to the fact that estimate of genotypic variance is higher than that of the error.

Characters such as number of pods plant^{-1} and plant height (cm) have high PCV values (Table 1). Moderate PCV values were found for number of nodes plant^{-1}, pods length, and 100 pod weight (g); and a low value for pod yield. The genotypic coefficient of variability (GCV)

showed the same trend as PCV and ranged from 1 for pod yield to 22% to number of pods plant^{-1}. In general, genetic variability was observed in all characters though the magnitude differ.

The heritability estimate ranged from 64 to 92%. The green pod yield had the lowest and pod length had the highest. Direct selection for green pod in bean has a limited scope for further improvement as indicated by its low values of heritability, GCV, and PCV. The genetic advance expected from selecting the top 10% of the cultivars as a percentage of the mean varied from 1 for green pod yield to 34 for number of pods plant^{-1}. Number of pods plant^{-1}, pod length, and plant height have shown high values in the order mentioned. Hundred pod weight and number of nodes plant^{-1}, number of pods plant^{-1} indicated moderately high genetic advance; and heritability estimates of these characters were also high. This investigation indicates that there is a potential for green pod yield improvement indirectly through number of pods plant^{-1} and pod length selection.

Table 1. Estimates of genotypic variance (σ^2_g), phenotypic variance (σ^2_p), error variance (σ^2_e), phenotypic coefficient of variability (PCV), genotypic coefficient of variability (GCV), heritability (H^2), genetic advance and genetic advance as percentage of the mean for the six bean cultivars.

Character	σ^2_g	σ^2_p	PCV	GCV	H^2	GA	GA as % of the mean
			%				
Pod yield (kg ha^{-1})	6492	10074	01	01	64	113	1
100 pod weight (g)	2603	3864	12	14	67	73	17
Plant height (cm)	22	29.00	15	13	76	07	20
No. of nodes plant^{-1}	0.48	0.65	13	11	73	01	16
No. of pods plant^{-1}	12.50	17.11	26	22	73	05	34
Pod length (cm)	2.22	2.41	13	13	92	03	22

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