Variability, Heritability and Correlation Studies in Bean (*Phaseolus vulgaris* L.) Genotypes

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Abstract: The aim of this study was to determine the effects of some yield components on yield via path analysis, estimating correlation coefficients and heritability in 21 bean (*Phaseolus vulgaris* L.) genotypes. Differences between genotypes in yield, leaf area, pod length and width, pod number per plant, fresh pod weight, seed number per pod, 1000 seed weight were found to be very significant. Correlations between pod number per plant and yield, fresh pod weight and yield, seed number per pod and yield were found to be significant and positive. Low broad sense heritabilities assign that if compared with pod width and seed number per plant, environmental effects on yield, fresh pod weight, pod length, pod number per plant and leaf area were found to be much higher. So, Er-85 and Er-211 genotypes were determined as highest yielding, fresh pod weight had the highest effect on yield and environmental factors were highly effective on yield, wet pod weight, pod length, pod number per plant and leaf area.

Key words: Bean · correlation · heritability and variability

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is an important food worldwide and a significant source of nutrients because of its contents of fiber, proteins and vitamins. It is traditionally a basic food crop in many developing countries and it serves as a major plant protein source for rural and urban poor. Common bean are grown extensively in five major production areas; Eastern and Southern Africa, North and Central America, South America, Eastern Asia and Western and South-eastern Europe [1]. United States of America, Brazil, India and China are by far the largest bean producing countries in the world. In recent years, Turkey would be considered a significant common bean producing country. Continued efforts and a comprehensive research approach are required to increase and stabilize Turkey's bean yields to ensure a dependable product for domestic and export markets. There is a need to resolve many of the yield, disease and food quality problems that limit the production and consumption of beans in our country, Turkey. Basic and applied research directed toward the effects of abiotic and biotic factors on adaptation, disease resistance and food quality are needed to maintain and facilitate bean production and to improve their safety and reliability as a food source for Turkey's consumers. The potential of a crop to respond favorably to breeding programs depends on the nature and magnitude of variability. Grain yield is a complex character and is the product of many yield components [2] and knowledge of existing genetic variations and the association between various yield traits and their heritability assumes importance [3].

Heritability in the narrow and broad sense is important for the plant breeder since the effectiveness of selection depends on the additive portion of genetic variance in relation to total variance [4, 5]. This study deals with the determination the effects of some yield components on yield via path analysis, estimating correlation coefficient and heritability in 21 genotypes.

MATERIALS AND METHODS

This study was carried out in a Completely Randomised Block Design with three replications at Horticultural Research Institute in Erzincan, Turkey in 1996-1998. Twenty one bean genotypes were used and plot size was $1.2 \times 6 = 7.2 \text{ m}^2$ at planting, $1.2 \times 5 = 6 \text{ m}^2$ at harvesting. Observations were recorded on yield, leaf

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Table 1: Differences among genotypes in terms of characters

Genotypes	Yield (kg da^{-1})	Leaf area (cm^2)	Pod length (cm)	Pod width (cm)	Pod num. per plant	Wet pod weight (g)	Seed number per Pod	1000 seed weight (g)
Er-68	271.4 A-C	34.8 A-C	12.4 A-E	13.3 A-C	35.0 HI	6.7 A	4.4 A-G	422.5 C-E
Er-71	283.6 A-C	31.3 BC	12.8 A-C	11.4 EF	57.1 A-D	6.3 A-C	5.4 A-C	376.3 E-G
Er-76	233.3 A-D	31.5 BC	11.8 B-F	11.6 EF	44.7 D-H	5.6 A-C	3.8 C-G	344.2 G
Er-83	289.3 AB	32.1 BC	10.0 G	12.3 C-F	47.7 C-G	4.5 C	3.7 C-G	386.8 D-G
Er-85	333.6 A	29.9 C	11.1 B-G	11.9 D-F	41.1 E-H	5.4 A-C	4.2 A-G	361.2 FG
Er-86	222.1 B-D	31.4 BC	12.6 A-E	11.6 EF	34.8 Hİ	5.7 A-C	4.7 A-F	379.2 E-G
Er-98	239.2 A-D	30.5 A-C	10.4 EG	11.6 EF	52.1 A-E	5.0 A-C	4.2 A-G	358.8 FG
Er-109	283.7 A-C	36.6 A-C	13.5 AB	13.3 A-C	46.4 D-H	6.6 AB	4.1 B-G	468.3 A-C
Er-128	294.8 AB	42.4 AB	13.7 A	13.7 AB	61.7 AB	6.3 A-C	5.2 A-D	483.5 A-C
Er-139	248.3 AD	29.7 C	12.1 B-G	11.7 D-F	33.1 İ	5.6 A-C	4.1 B-G	361.2 FG
Er-161	298.7 AB	32.8 BC	12.4 A-E	13.5 AB	41.5 E-I	6.3 A-C	4.2 A-G	455.3 B-D
Er-166	278.7 A-C	37.7 A-C	11.3 B-G	11.7 D-F	48.7 C-G	5.7 A-C	4.6 A-F	456.7 B-D
Er-189	257.5 A-C	39.8 A-C	11.1 D-G	13.7 A	42.7 E-I	5.7 A-C	3.6 D-G	501.3 AB
Er-200	233.9 A-D	38.4 A-C	11.1 D-G	13.2 A-C	32.9 I	6.0 A-C	5.1 A-E	493.5 AB
Er-210	260.1 A-C	38.5 A-C	10.9 D-G	12.9 A-D	42.4 E-I	5.7 A-C	3.4 E-G	414.2 C-E
Er-211	324.4 AB	38.4 A-C	12.8 A-C	11.8 D-F	60.3 A-C	6.7 A	5.9 A	390.5 D-G
Er-212	271.2 A-C	34.3 A-C	12.4 A-E	13.7 AB	51.3 B-F	6.6 A	5.1 A-E	478.3 A-C
Karacasehir	176.4 B-D	32.8 BC	11.3 C-G	11.2 F	65.4 A	4.8 BC	5.7 AB	219.2 H
Sahin	144.4 CD	40.4 A-C	11.3 C-G	12.4 B-F	34.0 I	5.6 A-C	2.8 G	536.7 A
Sehirali	111.1 D	38.7 A-C	10.9 E-G	13.4 A-C	39.2 F-I	5.0 A-C	3.1 FG	462.2 BC
Yunus	98.7 D	46.2 A	12.6 A-E	13.4 A-C	37.7 G-I	5.4 A-C	3.2 FG	438.7 B-E
Year	**	**	ns	ns	**	ns	ns	**
Genotype	**	**	**	**	**	**	**	**
Year x Gen.	**	*	**	ns	**	ns	**	**

Table 2: Correlations between characters

	Pod len.	Pod wid.	P.N. per Pl.	Wet P. We.	Se. N. per P.	1000 S.W.	Yield
Leaf area	0.249**	0.355*	-0.152	0.216*	-0.028	0.404**	0.064
Pod len.		0.260**	0.180*	0.672**	0.436**	0.179*	0.144
Pod wid.			-0.178*	0.407**	-0.062	0.566**	0.022
P.N. per Pl.				0.140	0.364**	-0.221*	0.260**
Wet P. We.					0.521**	0.275**	0.400**
Se.N. per P.						-0.199*	0.319**
1000 S.W.							0.047

area, pod length and width, pod number per plant, fresh pod weight, seed number per pod, 1000 seed weight [3, 4, 6-9]. Effects of some yield components on yield via path analysis, estimating correlation coefficient and heritability were made [4, 10-14].

RESULTS AND DISCUSSION

Results obtained from 21 bean genotypes as an average of two years were given in Table 1. Differences between genotypes in yield, leaf area, pod length and width, pod number per plant, wet pod weight, seed number per pod, 1000 seed weight were found to be very significant (p<0.01). Though the interaction year x genotype in yield, pod length, pod number per plant, seed number per pod, 1000 seed weight were found to be very significant (p<0.01), the interaction year x genotype in leaf

area was determined as significant (p<0.05). Highest values were taken form Er-85 genotype in yield (333.6 kg da^{-1}), Yunus genotype in leaf area (46.2 cm^2), Er-128 genotype in pod length (13.7 cm), Er-189 genotype in pod width (13.7 cm), Karacşehir genotype in pod number per plant (65.4), Er-211 genotype in wet pod weight and seed number per pod (6.7 g and 5.9, respectively), Şahin genotype in 1000 seed weight (536.7 g). In some studies related to this study, it was pointed out that yield was ranged in 168.5-353.3 kg da^{-1} [15-17]. On the other hand, our results in 1000 seed weight and fresh weight per plant confirm the findings of Abak *et al.* [18], Alan *et al.* [19], Duman *et al.* [20] and Ranalli [21].

Correlations among characters were given in Table 2. Correlations between pod number per plant and yield, wet pod weight and yield, seed number per pod and yield were found to be significant and positive.

Table 3: The effects of yield components on yield

	For pod length		
	Path coefficient	%	Correlation coefficient
Direct effect	-0.082	16.85	0.244**
Indirect effect			
By leaf area	0.010	1.95	
By with	-0.040	8.30	
By pod per plant	0.012	2.38	
By wet pod weight	0.290	59.01	
By seed number per pod	0.050	9.54	
By 1000 seed weight	0.010	1.89	
	Wet pod weight		
	Path coefficient	%	Correlation coefficient
Direct effect	0.432	67.56	0.400**
Indirect effect			
By leaf area	0.008	1.30	
By pod length	-0.055	8.70	
By pod width	-0.064	10.01	
By pod number per plant	0.009	1.41	
By seed number per pod	0.056	8.76	
By 1000 seed weight	0.014	2.24	
	Seed number per pod		
	Path coefficient	%	Correlation coefficient
Direct effect	0.107	26.02	0.319**
Indirect effect			
By leaf area	-0.001	0.26	
By pod length	-0.036	8.72	
By pod width	0.009	2.35	
By pod number per plant	0.023	5.71	
By wet pod weight	0.225	54.41	
By 1000 seed weight	-0.010	2.49	

Table 4: Broad sense heritability in characters

Characters	Broad sense her.	Characters	Broad sense her.
Leaf area	0.26	Seed number per plant	0.62
Pod length	0.16	1000 seed weight	0.26
Pod number per plant	0.22	Pod width	0.84
Wet pod weight	0.15	Yield (kg ha^{-1})	0.11

Dixit and Dubey [3] found that significant correlations pod number per plant and yield, wet pod weight and yield. Our results were also in consistent with Kaul *et al.* [8].

The effects of yield components on yield via path analysis were given in Table 3. In this Table and Figs. 1 & 2, only important correlated characters with yield were examined.

Direct effect of pod length on yield was negative (-0.082) and 16.85%; and the highest indirect effect via wet pod weight were (0.290 and 59.01%). Direct effect of wet pod weight on yield were positive (0.432) and 67.56% and the highest indirect effect via pod width were (-0.064 and 10.01%). Direct effect of seed number per pod on yield were positive (0.107) and 26.02% and the highest indirect effect via wet pod weight were (0.225 and 54.41%). Li [11] pointed out that what characters are efficient could be determined confidently. As resembling our results that Dixit and Dubey [3] found that wet pod weight and seed number per pod have highest direct effect on yield.
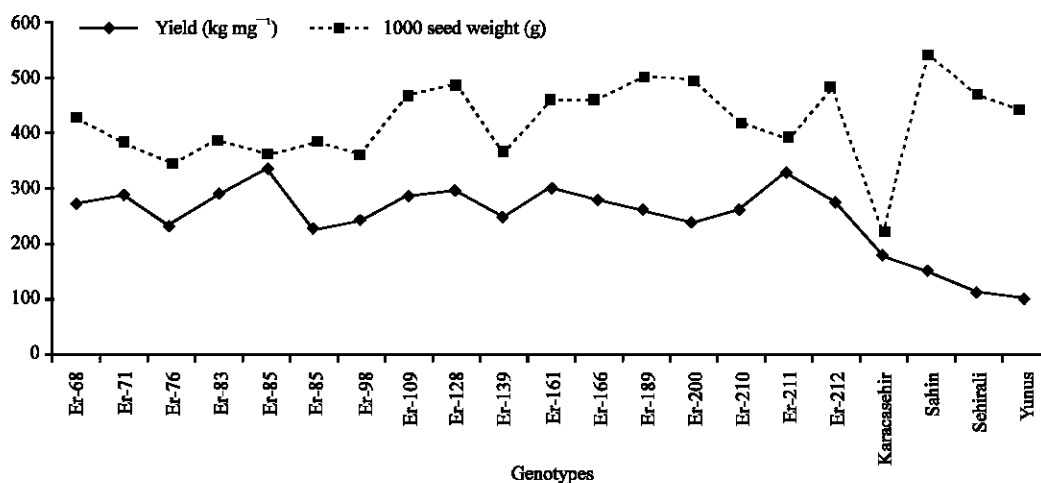
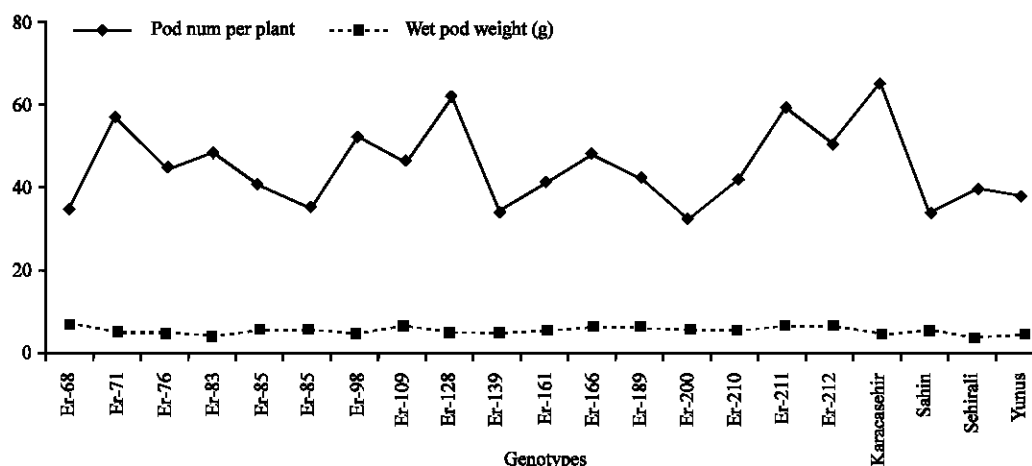Fig. 1: Yields and 1000 seed weights of genotypes

Fig. 2: Pod numbers per plant and wet pod weights of genotypes

Broad sense heritabilities in characters were given in Table 4. The highest broad sense heritabilities were determined in pod width and seed number per plant with 0.84 and 0.62. Low heritabilities were taken from yield (0.11), wet pod weight (0.15), pod length (0.16), pod number per plant (0.22) and leaf area (0.26).

Low broad sense heritabilities assign that if compared with pod width and seed number per plant, environmental effects on yield, wet pod weight, pod length, pod number per plant and leaf area were found to be much more higher. Many researchers stated that broad sense heritability could assign inheritance of characters examined and be used in breeding programmes [5, 7, 12]. Dixit and Dubey [7] found highest heritability in seed number and it was determined that yield and 1000 seed weight were much more affected by environmental effects [5, 7, 10, 12-15].

So, Er-85 and Er-211 genotypes were determined as highest yielding genotypes, wet pod weight had the highest effect on yield and, environmental factors were highly effective on yield, wet pod weight, pod length, pod number per plant and leaf area.

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