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Heritability and genotypic correlations of same dry bean quantitative traits

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Abstract

Dry bean is considered a staple cop in comparison with other leguminous crops in Albania. Some 15-17 thousand hectares are cultivated with crop each year in Albania, ranking this country among the main growers in Europe with regard to land acreage per capita. Most of dry bean cultivars cultivated in Albania are landraces with long life cycle and stable yields. Nevertheless these cultivars revealed yield fluctuations due to stresses caused by environmental changes in the last twenty years. Overcoming yield shortages has been the focus of a breeding program aiming at breeding new half determinant cultivars adaptable to earlier sowing dates, and with improved yield components such as number of pods per plant, number of beans per pod. 1000 beans weight, etc. This objective was achieved through a classical breeding program in which five dry beans landraces and introduced cultivars were crossed with each other. Final data were used to calculate crossing ability among these populations, genetic heritability, and genotypic correlations of some quantitative traits. These results may serve to improve the bean yielding capacity via classical breeding methods.

Key Words: Genotypic correlations, trait heritability, environmental stresses

Introduction

Plant breeder use selection methods aiming at improving multiple plant traits [3,5]. Environmental conditions play an important role in the expression of plant traits during breeding process. In these circumstances, identification of permanent links among different plant traits as well as potentiality of these traits to be inherited from parents to progenies is indispensible [6,7,9,10]. Calculation of genetic correlations among plant characteristics, and the heritability of these traits are important tools in quantitative genetics which help in choosing suitable breeding strategies. The efficiency of plant breeding is increased when the heritability coefficients have high values [2,8,9].

Breeding new dry bean cultivars in Albania started twenty years ago. The most important activities in dry bean breeding programs were the following: designing plant ideotype, selection of the best parents along with their crossing ability, trait heritability, and the genotypic correlations among different plant traits.

Materials And Methods

Five dry bean cultivars were used in these study. Two of them, named respectively Shijak and Kallmet were landraces. The other three, namely M4403, Pindak, and P320 were introduced from abroad. The above mentioned cultivars had several trait differences among them. Shijak has a bean weight as well as high capacity of pod productions; Kallmet has large beans and short life cycle; M4403 has high capacity of pod production and low bean weight; Pindak has a short life cycle, and so on. Breeding program was executed at Lushnja Experimental Station according to randomized block design in three replications during three years: 2005, 2006 and 2007. Hybrid seeds (F_0) produced in 2005 were planted in 2006 (F_1) and 2007 (F_2) together with their parental populations in single rows 5 meter long (F_1 populations and parent plants), and in three rows 5 meter long each of them (F_2 populations and parent parents). Within and among rows planting distances were 20 cm and 70 cm respectively. Experimental data were provided based on plant measurements at maturity stage (five plants in F_1 and ten plants in F_2).

Results And Discussions

Data shows significant differences among parent plants and hybrid progenies ($p<0.01$ and $p<0.05$) plant characteristics, both in F_1 and F_2 (Table 1).

Coefficients of genetic determination and correlations were calculated as well.

Coefficients of genetic determination

Calculation of genetic determination coefficients (table 2) helps to get quick and positive results during dry bean breeding.

Table 1: Analysis of variance for different dry bean genotypes.

Source of Variations	*df*	*Pods/plant*			*Beans/plant*		
		F_1 2004	F_1 2005	F_2 2005	F_1 2004	F_1 2005	F_2 2005
Cultivar/Hybrid	24	561.72**	172.43**	91.00**	14799.14**	3270.86**	2620.69**
Replications	2	28.18	4.82	35.81**	161.95	25.70	1001.68**
Error	48	14.53	24.08	5.89	279.23	367.10	120.11

Source of Variations	*df*	*Yield/plant*			*Beans/pod*		
		F_1 2004	F_1 2005	F_2 2005	F_1 2004	F_1 2005	F_2 2005
Cultivar/Hybrid	24	1493.79**	503.02**	240.18**	1.192**	1.126**	0.827**
Replications	2	20.00	7.99	134.42**	0.061	0.011	0.095*
Error	48	20.83	49.95	14.63	0.060	0.078	0.021

**, *: P<0.01, P<0.05

Table 2: Coefficients of genetic determination of dry bean cultivars and hybrids.

Nr	*Plant traits*	*Cultivars*		*Hybrid populations*		
		2004	2005	F_1 2004	F_1 2005	F_2 2005
1	Pods/plant	0.98	0.97	0.91	0.77	0.80
2	Beans/plant	0.87	0.89	0.93	0.70	0.83
3	Yield/plant	0.97	0.92	0.96	0.77	0.82
4	Beans/pod	0.91	0.98	0.99	0.72	0.86

High values of these coefficients imply that genetic factors play an important role in traits variation within a population (more than 70%), whereas an environmental factors contribute for less than 30% to these variations.

Based on the results presented in table 2 we can conclude that these plaint traits can be used successfully in dry bean breeding.

Genotypic correlations among quantitative traits

Positive genotypic correlations among most plant traits were found, except for 1000 beans weight which was negatively correlated with the rest plant traits (table 3).

In 2005 the only exception form is found in the hybrid populations where beans/pod don't show positive correlations with pods/plant, beans/plant, and bean yield per plant. This deviation from the rule might be explained with a stronger influence of the environmental factors on the hybrid populations than on cultivars.

The existence of positive correlations among some yield components means that improving one trait would result in the improvement of the rest of them. Selection for higher plant yield would most probably result in the reduction of the 1000 bean weight or in the best case in no improvement, as this trait is negatively correlated to the rest of yield components presented in this study.

There are strong correlations among some plant traits in F-1 and F-2 (table 3). This fact is important because it makes possible an efficient plant breeding. It is of particular interest the correlation among beans per plant and 1000 beans weight.

Table 3: Genotypic correlations among some yield components in dry bean cultivars and hybrids.

		F_1 2004			
		Pods/plant	Beans/plant	Yield/plant	Beans/pod
Beans/plant	Cultivars	0.99***			
	Hybrid populations	0.97***			
Yield/plant	Cultivars	.0.91**	0.88**		
	Hybrid populations	0.81**	0.75***		
Beans/pod	Cultivars	0.93**	0.97***	0.92**	
	Hybrid populations	0.42*	0.62**	0.19	
1000 beans weight	Cultivars	- 0.38	- 0.48	- 0.06	- 0.50
	Hybrid populations	- 0.38	- 0.56	- 0.09	- 0.55**

		F_1 2005			
		Pods/plant	Beans/plant	Yield/plant	Beans/pod
Beans/plant	Cultivars	0.97***			
	Hybrid populations	0.93***			
Yield/plant	Cultivars	0.93**.	0.80**		
	Hybrid populations	0.93***	0.85***		
Beans/pod	Cultivars	0.69	0.91**	0.49	
	Hybrid populations	- 0.06	0.28	-0.19	
1000 beans weight	Cultivars	- 0.51	- 0.75	-0.21	-0.93**
	Hybrid populations	0.08	- 0.15	0.37	-0.85**

		F_2 2005			
		Pods/plant	Beans/plant	Yield/plant	Beans/pod
Beans/plant	Cultivars	0.97***			
	Hybrid populations	0.96***			
Yield/plant	Cultivars	0.93**.	0.80**		
	Hybrid populations	0.93**	0.84***		
Beans/pod	Cultivars	0.69	0.91**	0.49	
	Hybrid populations	0.38	0.59*	-0.21	
1000 beans weight	Cultivars	- 0.51	-0.75	-0.21	-0.93**
	Hybrid populations	-0.16	-0.37	0.18	-0.71**

***, **, *: P<0.001, P<0.01, P<0.05

Conclusions

- High values of coefficients of genetic determination show that quantitative traits may successfully be used as selection criteria in breeding dry bean hybrid populations.
- Yield per plant is positively correlated with pod number per plant and beans per plant.
- There is strong negative correlation among 1000 beans weight and beans per pod.
- It is possible to select for dry bean lines with simultaneously large number of beans and 1000 bean weight. Breeding for the above mentioned

traits makes possible the increase of dry bean yield through genetic manipulation.

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