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Inheritance of the Traits - Seed's Color and Plant Habitus, in *Phaseolus vulgaris* L. Cross (BAT 477 X Dobroudjanski Ran)

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Abstract

A study to establish the inheritance of the traits color of seeds and plant habit, in common bean cross BAT 477 x Dobrudjanski ran, was conducted. It has been found that in the F_1-generation were exhibited dominant traits - brown seeds, purple color and III-a type of habitus. In F_2-generation the disruption by the coloration of flowers was in ratio 3 purple : 1 white (0,50 <P> 0,20). The ratio of disruption by the traits brown : beige seeds (0,20 <P> 0,10) and brown : white seeds (0,50 <P> 0,20) was also 3 : 1, while beige : white seeds - was 1 : 1 (0,90 <P> 0,50). The ratio of disruption by the trait type of habitus was also 3 : 1 (III-a : III-b type), (0,90<P>0,50). A monogenic control of studied traits was found. Brown and beige colors of seeds are probably controlled by different alleles of the same gene. It was established that traits color of flowers and color of seeds are relatively inherited.

Key words: Common bean, habitus, inheritance, *Phaseolus vulgaris* L., seeds

Introduction

Alleles of the genes: Gy, C, R, J, G, B, Rk interact with the gene V, as well as among each other and as a result of that, produce different shades of the common bean seed coat color (Basset et al., 2002).

Shaw and Norton (1918, cited by Basset et al., 2002) subdivided the group of yellow-black colored common bean seeds on the following subgroups: seeds with yellow seed coat (control of the gene C), brown (gene F), and black (gene G). They define the following dominance between genes: G → F → C. These authors suggest that the light-brown color of the seeds was determined by the additional gene H.

Kooiman (1920, cited by Basset et al., 2002) proposes a new scheme for determination of the seed's color, which is completely different from the previous ones. According to this scheme, three genes interact with the essential gene A, to display the corresponding seed coat color. These three genes are B, C and D. The genotype A-B- defines a lemon-yellow color, while the A-C- determines the yellow or orange color. A-D- control gray-yellowish seed coat color. All of these genes, in different genotypic combinations, control the diversity of common bean seed coat colors and patterns.

The type of habitus is an important trait for common beans. Plants with indeterminate growth habit prevailing in most parts of the world. Inheritance of this trait is subject to Mendel's laws for monohybrid disruption (Tarán et al., 2002).

Determinate type of the common bean habitus is controlled by the gene *fin*, and indeterminate - by the dominant allele of this gene *Fin* (Coyne and Schuster, 1974; Koinange at al., 1996; Park et al., 1999).

Tarán et al. (2002) establish the existence of another gene that controls the type of habitus, located in another linkage group.

The aim of this study was to determine the genetic control and inheritance mode of some quality traits in common bean cross BAT 477 x Dobrudjanski ran.

Materials and methods

The studies were conducted during the period 2011 - 2014 year at the Agricultural University - Plovdiv. A cross between genotypes BAT 477 x Dobrudjanski ran was made.

Genotype BAT 477 (line of CIAT, Colombia) is known for its high ability to increase nitrogen fixation, with increased tolerance to stress - drought and low phosphorus content in the soil, so it is used as a control in the study of drought tolerance in common beans (CIAT 2004 - Annual

Report). Plants of BAT 477 are with III-a type of habitus, the main stem and its branches ended with a vegetative bud. Plant lodging and do not prone to wrapping (Genchev, 2007). Its seeds are small and dark-brown and the flowers – are purple with a small bract.

Bulgarian cultivar Dobrudjanski ran is high-yielding, less voluble, resistant to lodging and suitable for two-phase harvesting. The plants' habitus is III-b type, the main stem and its branches ended also with a vegetative bud. Plants lodging and tends to wrap. Color of the seeds is white, and the flowers are white with an average size of the bract (Genchev, 2007).

The compliance between the factual and expected
theoretical decay in F_2 and F_3-generations are defined by the "chi-square" (χ^2), (Genchev et al., 1975).

Results and discussion

A genetic analysis was conducted in our investigations to identify the inheritance of quality traits - seed's and flower's colors and type of the plant habitus in cross between common bean genotypes BAT 477 x Dobrudjanski ran.

As a result of the crossing of the parent plants was established that in F_1-generation was observed uniformity in the purple color of the flowers and colored seed's coat. This proves that these traits are dominant.

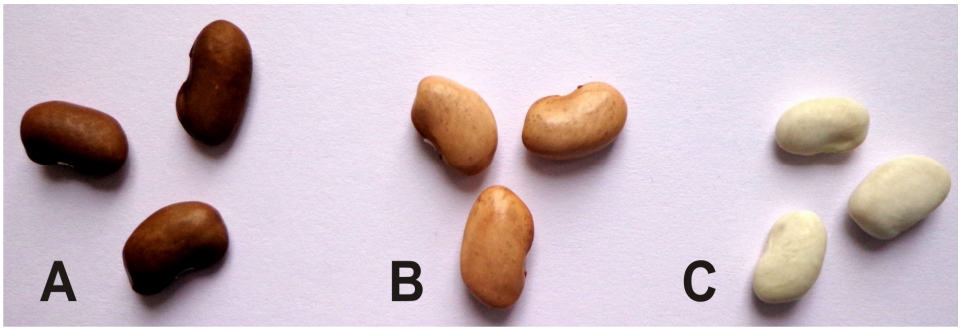

Fig. 1. Seed's coat color in F_2-generation in the cross between genotypes BAT 477 x Dobrudjanski ran.

As a result of disruption in the F_2-generation were formed two phenotypic classes with respect to the flower's color - plants with purple and other with white flowers, while concerning the colors of the seed's coat were formed three phenotypic classes - white, beige, and brown (Figure 1; Table 1).

It should be noted that all the plants with a purple flower's color were with a seed's colored coat (beige or brown). These two traits are probably coupled. Similar claims were made by Emerson (1909) and Apostolova (2006).

Table 1. Disruption in F_2-generation of the common bean cross between the genotypes BAT 477 x Dobrudjanski ran in inheritance of the trait seed's color

Trait	Seed's color			Ratio	χ^2	P
	Brown	Beige	White			
Parents	P1		P2			
F_1-generation	F_1					
Number of plants with seeds in F_2-generation	450	170		3 : 1	1,93	0,20<P>0,10
		170	160	1 : 1	0,30	0,90<P>0,50
	450		160	3 : 1	0,50	0,50<P>0,20

The ratio of seed's color disruption in F_2-generation (brown : beige and brown : white) was approximately 3 : 1. Obtained values of χ^2 and P (0,20 <P> 0,10 and 0,50 <P> 0.20) prove the significance of the manifested pattern. The same ratio of disruption was achieved by tracking the inheritance of the trait - flower's coloration.

The ratio of the disruption in the evaluation of seed's color in beige and white, was approximately 1 : 1 (0,90 <P> 0,50).

The results of the investigated trait indicated a similarity to the scheme for monohybrid inheritance and disruption, and also prove that the three seed's coat colorations were controlled by different alleles.

In a study of inheritance of the trait plant's habitus (Table 2) was set that in the F_1 -generation all plants were with III-a type. This proves the dominant nature of this trait. In the F_2-generation were formed two phenotypic classes – plants with III-a and III-b type of the habitus, in the ratio of disruption approximately 3 : 1. Obtained values for χ^2 and P (90% <P> 50%) prove the significance of the demonstrated pattern. Disruption, on the base of the studied trait, indicated also the scheme of monohybrid inheritance and disruption.

Table 2. Disruption in F_2-generation of the common bean crossing between the genotypes BAT 477 x Dobrudjanski ran in inheritance of the trait plant's habitus

Trait	Type of the habitus: BAT 477 (III-a type)	Type of the habitus: Dobrudjanski ran (III-b type)	Ratio	χ^2	P
Number of plants in F_2-generation	485	160	3 : 1	0,014	0,90<P>0,50

Same ratios of disruptions for the traits – flower's and seed's coat colorations and habitus' type, were received in F_3-generation, which confirmed their monogenic control.

It should be noted, that in F_3-generation were counted only plants, holders of the respective traits in the families where was found phenotypic disruption. Results of the studied families, where plants were with homozygous genotypes (families that do not disrupted phenotypically), were not included in that article.

In conclusion it can be said, that in the studied cross the flower's and seed's coat colorations and the habitus' type of common bean plants, have monogenic control. In F_1-generation dominates III-a type of the habitus, colored flowers and seeds. It was found linkage between the genes determining coloration of the flowers and seed coat.

According to Genchev (2007), however, depending on the plant's habitus, the genetic control can be of one dominant gene (as in our studies), of two complementary genes, each with its owned expression; two complementary genes, where one has, and the other do not has such expression, three complementary genes in which the two complementary genes have owned expression, and the third one - do not has such expression.

Conclusion

In F_1-generation of the cross between the genotypes BAT 477 x Dobrudjanski ran, were manifested dominant traits - brown seeds, purple flowers and III-a type of the habitus.

In F_2-generation, disruption on the base of the trait – flower's coloration was in the ratio of 3 purple : 1 white (0,50 <P> 0,20). The ratio of the disruption of the trait - color of the seed's coat – brown : beige (0,20 <P> 0,10) and brown : white (0,50 <P> 0,20) was also 3 : 1, while the ratio beige : white seeds was 1 : 1 (0,90 <P> 0,50).

Disruption on the base of the trait – type of the habitus, in F_2-generation, was also in a ratio 3 : 1 (III-a : III-b type), (0,90 <P> 0,50).

It was found a monogenic control of the studied traits. Brown and beige coloration of the seeds probably were controlled by different alleles of the same gene.

Traits - coloration of the flowers and seeds were linked inherited.

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