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Assessment of Productive Potential of Peanut Varieties (*Arachis hypogaea L.*) from the Bulgarian Breeding Program and Opportunities for Genetical Improvement

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Abstract*—The study was conducted in the experimental field of IPGR Sadovo in the period 2016-2017. Three peanut varieties type Valencia from the Bulgarian breeding program: Kalina, Kremena and Tsvetelina, are morphologically assessed. The aim of the study is to establish the possibility of genetic control over indicators directly related to productivity. The influence of the variety, the impact of the climate and the growing conditions, as well as the effect of the two factors on gynophores number, the fruit number and their weight were investigated. The relations between the studied signs are clarified. The components of the variation, phenotypic and genotypic variance are evaluated. The genetic progress and the genetic progress as a percentage of the mean are defined. The results show that the conditions of the environment are the strongest sources of variation for the studied signs. The gynophores number and the fruit number per plant are in direct positive relation to the fruit weight per plant as an element of the yield. In the studied components of the yield there is no possibility for genetic control. Their manifestation depends on applied agro-technology and the meteorological conditions. The future breeding work for obtaining high-yield peanut varieties requires finding out signs indirectly related to increasing the fruit weight per plant and possessing genetic control.*

Keywords*—*elements of productivity, environmental conditions, genetic control, peanuts.

I. INTRODUCTION

The yield of peanuts is of a complex polygene characteristic and its components are in strong relations between them (Stamatov, 2015; Stamatov and Deshev, 2015; Stamatov and Deshev, 2015a). The peanut yield depends strongly on agro-technology and environmental conditions (Giayetto et al., 2013; Gulluoglu et al., 2016). Stamatov and Deshev (2015) proved that there is a direct positive relationship between the fruit weight per plant and the yield, which confirms the results of Chifchijan and Stamatov (2007).

The nature and dimension of the genetic variability is essential for any program aimed at the crop breeding improvement. Conclusions, depending on the nature and dimension of genetic variability, are of vital importance for the planning of an effective breeding program for increasing the potential of the sign in new genotypes. Establishing of adequate variances due to phenotype, genotype, and environment allows targeted breeding activities and hybridization capabilities. The genetic advance explains the degree of progress in the indicator achieved in a variety through a certain breeding pressure. The high genetic advancement offers the most appropriate breeding. It also shows the presence of gene interactions in the expression of the indicator, suggesting reliable crop improvement by selecting such signs. Assessments of genetic advancement are more reliable and meaningful than individual parameter evaluation (Nyquist and Baker, 1991). According to Teklu et al. (2014), the higher phenotypic variance (PCV%) versus the genotype variance (GCV%) indicates that significant impact on the expression of the indicator have the growing conditions and the environment.

The aim of the study is to establish the possibility of genetic control over indicators directly related to productivity of Bulgarian peanut varieties.

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II. MATERIAL AND METHODS

1. *Place of the experiment*

The study was conducted in the experimental field of the Institute of Plant Genetic Resources – Sadovo, located in the Southern Bulgaria. The area of Sadovo is characterized by a transient continental climate, with its typical frequent and prolonged droughts. The average temperature for peanut vegetation recorded by a 120 year period is 3165.2°C with the maximum daily average temperatures of 23.7°C in August. The amount rainfall in the area is with a non-permanent character and it is equal to 247.3 l/m^2 for the peanut growing period. The droughts during the active vegetation in July-August are typical.

2. *Plant material*

The experiment was conducted with three peanut varieties type Valencia from the Bulgarian breeding achievements. The Kalina variety was created in 1987, Kremena – in 2005, and Tzvetelina – in 2008.

3. *Staging of the experiment*

The plants of all tested varieties are sowed at 70 cm between row distance and 6 cm within the row. Thereby, 166 666 plants per hectare were harvested from each variety.

4. *Data collecting and studied parameters*

The data is collected from randomized plants in the ripening phase of the fruit in 2016 and 2017. The following morphological parameters were studied: gynophores number, fruit number and the fruit weight per plant.

5. *Statistical methods*

The analysis was performed using the statistical package SPSS 19.0.By using a two-factor dispersion analysis the influence of the variety, the impact of climate and growing conditions, as well as the effect of the two factors on the gynophores number, the fruit number and the fruit weight per plant were evaluated.

The correlation analysis showed the relations between the gynophores number and the fruit number on one side and the fruit weight per plant on the other.

The evaluation of variation components, phenotypic and genotypic variance was performed using the method proposed by Burton and Devane (1953) as follows:

Environmental variance: $(\sigma^2 e) = Mse$

Phenotypic variance: $(\sigma^2 p) = (\sigma^2 g + \sigma^2 e)$

$$\text{Genotypic variance } (\sigma^2 g) = \frac{Mse - Mst}{r}$$

Where:

Mse Mean square error
Mst Mean square treatment
r Replication

$$\text{Phenotypic coefficients of variation (PCV)} = \frac{\sqrt{\sigma^2 px}}{x} \times 100$$

$$\text{Genotypic coefficients of variation (GCV)} = \frac{\sqrt{\sigma^2 gx}}{x} \times 100$$

Where:

$\sigma^2 p$ Phenotypic variance
$\sigma^2 g$ Genotypic variance
x Grand mean of a character

According Johnson et al. (1955) the genetic advancement (GA) and genetic advancement as a percentage of the mean (GAM) are identified:

$$GA = \frac{K \times \sqrt{\sigma^2 p} \times \sigma^2 g}{\sigma^2 p}$$

Where:

GA Expected genetic advance
Standardized selection differential at 5% selection intensity (K = 2.063)
$\sigma^2 p$ Phenotypic variance
$\sigma^2 g$ Genotypic variance

$$GAM(\%) = \frac{GA}{x} \times 100$$

Where:

GAM Genetic advance as percentage of mean
GA Expected genetic advance
x Grand mean of a character

III. RESULTS AND DISCUSSION

The analysis of the results presented in (Table 1) shows that the gynophores number are proved influenced by the growing year and the interaction between year-genotype. However, with a much higher variance is the growing year. The impact on the fruit number per plant has been proven for the growing year, the variety and the interaction between them. The strongest source of variation exists again the growing year and the weakest shows the variety. The fruit weight per plant repeats the effects and influences by the fruit number.

Table .1: Sources of variation in the studied elements of productivity

Variation	Source	Indi-cators	MS	Sig.	η %
Between variants	Year	GN	16236.150***	0.000	95.75
		FN	7958.017***	0.000	92.05
		FWP, g	17988.553***	0.000	87.43

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	Variety	GN	32.467	0.663	0.38
		FN	109.117*	0.037	2.52
		FWP, g	553.805**	0.005	5.38
	Inter-action	GN	328.200*	0.020	3.87
		FN	234.617***	0.001	5.43
		FWP, g	739.008***	0.001	7.18
	Error	GN	78.472		24.99
		FN	31.161		19.46
		FWP, g	92.791		24.35

***Significance for α=0.001, ** significance α=0.01, *significance α=0.05

Gynophores number (GN), Fruit number (FN), Fruit weight per plant (FWP, g)

Table.2. Relationship between the studied elements of productivity

Elements of productivity	GN	FN	FWP (g)
GN	1	0.916**	0.901**
FN		1	0.953**
FWP, g			1

***Significance for α=0.001, ** significance α=0.01, * significance α=0.05

Gynophores number (GN), Fruit number (FN), Fruit weight per plant (FWP, g)

The data in Table 2 suggests an existing direct positive relationship between the gynophores number and the fruit number per plant on one side and the fruit weight per plant on the other. Increasing the gynophores number and the fruit number directly leads to increasing of fruit yield, measured by the fruit weight per plant.

For the purpose of the crop breeding improvement on agricultural crop we need to establish the possibility of genetic control over the studied elements of productivity. From the results presented in the Table 3 it is visible that the phonotypical coefficient of variation by the indicator gynophores number per plant is higher than 10 and significantly exceeds the genotype variation coefficient.

Table.3. Estimation of phonotypical and genotypic coefficient of variation, genetic progress and genetic progress of the mean in the studied indicators

Indicators	*PCV %*	*GCV %*	*GA*	*GAM %*
GN	*17.89*	*3.12*	*0.36*	*1.73*
FN	*48.79*	*9.18*	*0.78*	*3.68*
FWP, g	*73.71*	*9.50*	*0.81*	*2.53*

Gynophores number (GN), Fruit number (FN), Fruit weight per plant (FWP, g), Phenotypic coefficient of variation (PCV %), Genotypic coefficient of variation (GCV %), Genetic advance (GA), Genetic advance of mean (GAM %)

According to the classification of Deshmukh et al. (1986), PCV and GCV values more than 20% are considered as high, values less than 10% are considered as low and values between 10 and 20% are medium. Regarding this argument, medium influence over gynophores number per plant shows the environment and negligible influence provokes the genotype. Thus, the genetic advance and the advance of the mean by this indicator are weak (Johnson et al., 1955).

By the number of fruit per plant the phonotypical coefficient of variation has a significant value, indicating the great influence on the environment in formation of this indicator. The opportunities for genetic control are weak, because the genetic variation coefficient is less than 10%. For that reason, the genetic progress and the genetic progress of the mean are with low values.

The phenotypic coefficient of variation has a significant value and it is the maximum by the three indicators. The genetic control is again weak with a genetic coefficient of variation of 9.50. This is the reason for the low genetic progress and also low progress of the mean.

For increasing the variability of the studied signs, genetically distant parental mature forms or the possibilities of mutagenesis should be used (Tiwari et al., 2011). The genetic variance of the fruit number per plant using mutagenesis methods was achieved by Nadaf et al. (2009).

IV. CONCLUSION

The environment, as a function of applied agro-technology and the meteorological conditions, is the major source of variation of the studied parameters.

The gynophores number and the number of fruit per plant are in direct positive relation to the fruit weight per plant as an element of yield.

There is no possibility for genetic control of the studied yield components. Their manifestation depends on the applied agro-technology and the conditions of the environment.

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In a future breeding program targeting high-yield peanut varieties, the signs with genetic control that are indirectly associated with increasing the fruit weight per plant should be revealed.

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