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THE HERITABILITY OF SOME QUANTITATIVE TRAITS FOR THE SPRING BARLEY WITH TWO ROWS

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ABSTRACT

The main morphoproductive traits that have made the subject of this study were represented by: the length of the ear, the number of grains/ear and weight of the grains.

At the base of choosing the parental forms stood the criteria of homozygosity and the phenotypic differentiation between parents, being analyzed a number of six hybrid combinations. In order to estimate the additive (a) gene effects, dominance (d) and epistatic interactions type additive x additive (aa), additive x dominant (ad), dominant x dominant (dd) involved in the heritability of the traits listed previously, it was necessary to establish the environments: from parental populations, genetic populations from progenies (F1 and F2) and the backcross generations (BCI and BCII).

Keywords: morphoproductive traits, gene effects, genotypes, spring barley, Gamble

INTRODUCTION

By OSSCARSON et al., (1996), the barley is widely used for animal feeding and in manufacturing beer, but lately there is interest in increasing the use for human nutrition.

The worldwide production of barley represents about 30% of corn production, but comparative to this, barley has more proteins, methionine, lysine, cysteine and tryptophan.

As it is known, in the heritability of the quantitative traits (the elements of the production and some morphological traits) there is a high number of genes with reduced and related effects, acting frequently additive in the determination of the trait in discussion. In speciality literature, these genes are known under the name of polygenes. Besides the additive action of the polygenes in the heritability of the quantitative traits, there is another type of

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intra allelic interactions (the domination and the recessiveness) and inter allelic (the epistasis), all of them causing in the end a complex heritability of these traits.

With the purpose of choosing as precise as possible the genitors, used in future hybridization programs, which because of the processes of recombination would give the possibility of apparition and selection of some valuable transgressive segregations, it was tried to estimate the gene effects and the interaction between the ones that occur in the heritability of some significant morphoproductive traits.

MATERIAL AND METHOD

To estimate the gene effects involved in the heritability of the quantitative traits, components of production, the genetic model of analysis proposed by HAYMAN (1958) and applied by GAMBLE (1962) was used.

In this regard, the mean values of the traits of parental populations and genetic populations of descendants were analyzed, being estimated the additive gene effects (a), dominance (d) and epistatic interactions type additive x additive (aa), additive x dominant (ad), dominant x dominant (dd) involved in the heritability of the analyzed traits.

At the base of choosing the parental forms stood the criteria of homozygosity and the parents have been differentiated more or less regarding the analyzed traits, being conducted a number of six hybrid combinations which involved 12 genotypes.

The genotypes that were the subject of this study were represented by two local varieties (Jubileu – SCDA Turda; Prima – SCDA Suceava) and ten foreign varieties (Thuringia, Victoriana, Vienna – Saaten Union; Odisey, Chronicle, Salome – Limagrain; Magnif, Anabelle – Czech genotypes).

For each trait was measured a number of 50 plants.

RESULTS AND DISCUSSIONS

The mean values of the studied population

In the table 1 are presented the performances of the parents and the segregating generations for an important trait of production, the length of the ear, the parents registering values between 8,60 and 10,90 cm, outstanding the genotypes Jubileu and Anabelle.

At the level of the generation F1 in most combinations, except the combinations 1 and 4, the length of the ear is superior to the mean of the one best parent, indicating in these situations a heterosis effect quite emphasized, that's probably due to the effects of supradomination. In F2 a slight depression can be seen at the same four combinations, but it is insignificant and probably indicates the accumulation of the additive genes in heterotic state in this generation.

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Regarding the backcross generations, it can be said that in the case of the ear length the behavior in these generations corresponds with the performances of the crossing parent in cause. A deviation from this behavior can be seen for the combination 1, which confirms the probabilistic character of this method.

The mean values of the number of grains/ear of the six populations studied is rendered in the table 2. From the analysis of this table it can be deducted a reduced intensity of the heterosis phenomenon for this trait so as at almost all combinations the mean of the generation F1 has intermediate values between the couple of parents, with the exception of the combination 5, where the mean of the generation F1 is above the mean of the best parent. Even if at the level of the backcross generations it isn't registered any big differences comparative with the parental forms, however it can be noticed the influence of the best parent in almost all the combinations (except combination 1).

The performances of one of the most important components of the production, the weight of the grains/ear are represented in the table 3, the parents registering values between 0.99 and 1.45g/ear.

The values of this trait at the level of the backcross generations, has superior values comparative with the values of the generations F1 and F2 as well as the one of the parental populations, except the first combination.

Table 1: The mean values of the ear length (cm) for the parental populations, F1, F2, BCI and BCII in a system of backcrosses at spring barley (Turda 2016)

	POPULATIONS					
COMBINATION	**P1**	**P2**	**F1**	**F2**	**BCI**	**BCII**
CB1 (Thuringia x Jubileu)	9,60	10,80	8,80	11,50	10,40	8,00
CB2 (Prima x Victoriana)	10,10	9,60	10,50	9,50	11,00	10,70
CB3 (Magnif x Odisey)	9,70	10,40	10,80	10,20	11,00	11,60
CB4 (Victoriana x Anabelle)	9,80	10,90	10,40	10,80	12,00	11,60
CB5 (Chronicle x Salome)	8,60	9,20	9,40	8,60	9,20	10,10
CB6 (Viena x Anabelle)	9,20	9,70	10,00	8,90	10,40	10,00

CB- COMBINATION

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Table 2: The mean values of the number of grains/ear for the parental populations, F1, F2, BCI and BCII in a system of backcrosses at spring barley (Turda 2016)

	POPULATIONS					
COMBINATION	**P1**	**P2**	**F1**	**F2**	**BCI**	**BCII**
CB1 (Thuringia x Jubileu)	25	30	26	29	28	27
CB2 (Prima x Victoriana)	31	25	28	27	32	27
CB3 (Magnif x Odisey)	28	27	27	30	31	31
CB4 (Victoriana x Anabelle)	28	31	27	26	29	31
CB5 (Chronicle x Salome)	25	25	28	27	28	30
CB6 (Viena x Anabelle)	28	30	29	27	30	28

The superiority of the generation F2 comparative with F1 at three of the six combinations indicates the presence of the transgressive segregation phenomena for this trait. The backcrosses of the combination Prima x Victoriana can be highlighted, possessing the highest mean value of the grains weight/ear at their level.

Table 3: The mean values of the grains weight /ear (g) for the parental populations, F1, F2, BCI and BCII in a system of backcrosses at spring barley (Turda 2016)

	POPULATIONS					
COMBINATION	**P1**	**P2**	**F1**	**F2**	**BCI**	**BCII**
CB1 (Thuringia x Jubileu)	1,03	1,45	1,04	1,31	1,37	1,22
CB2 (Prima x Victoriana)	1,34	1,27	1,37	1,37	1,71	1,53
CB3 (Magnif x Odisey)	1,2	1,19	1,12	1,35	1,59	1,53
CB4 (Victoriana x Anabelle)	1,29	1,42	1,27	1,21	1,52	1,69
CB5 (Chronicle x Salome)	0,99	1,10	1,23	0,93	1,28	1,49
CB6 (Viena x Anabelle)	1,29	1,03	1,46	1,2	1,42	1,30

Estimating the gene effects

The reduced absolute values of the additive gene effects, suggests a reduced breeding value of the length of the ear (table 4). However, if we add the effect of the additive genes with the epistatic type aa, we can say that for this trait the breeding value is quite important. Regarding the dominant genes we can notice a very significant contribution in the heritability of the length of the ear, this being reflected in absolute values superior to the additive gene effects. In fact, in five out of the six studied combinations, the values of the dominant effects are superior to the epistatic ones (type aa and ad). All these

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come to strengthen the major role of the domination effects in conditioning the length of the ear.

The major contribution of the dominance effects in expressing the length of the ear was also reported by CIULCĂ et al. (2012), that proves that the study of heritability for the length of the ear indicates in the genetic determinism of this trait, the presence of the dominance phenomena and non-allelic interaction.

Table 4: The estimation of the gene effects concerning the length of the ear in a set of six hybrids combinations of spring barley (Turda 2016)

THE GENE EFFECTS						
COMBINATION	**m**	**a**	**d**	**aa**	**ad**	**dd**
CB1 (Thuringia x Jubileu)	11,54***	2,42***	-10,57***	-9,23***	3,01***	10,32***
CB2 (Prima x Victoriana)	9,53***	0,3	5,66***	5,07***	0,03	-7,65***
CB3 (Magnif x Odisey)	10,22***	-0,58*	4,94***	4,17***	22,9***	-7,59***
CB4 (Victoriana x Anabelle)	10,18***	0,32	6,53***	6,43***	0,88***	-12,8***
CB5 (Chronicle x Salome)	8,58***	-0,9***	4,55***	4,08***	-0,59**	-5,82***
CB6 (Viena x Anabelle)	8,92***	0,4	5,63***	5,12***	0,64*	-7,14***

*significant at 5%, **significant at1%, ***significant 0,1%

The reduced implication of additive genes for the number of grains/ear, reflected in the quite low values they possess (table 5), show a lower breeding value, but the contribution of the very significant aa effects shows the significant participation of additivity in the heritability of this trait. Only in the case of one combination (BCII) the additive genetic effects are truly significant.

In the case of the combinations 5 and 6, the additive gene effects are just distinct significant, and in the situation of the combinations 1, 3 and 4 it isn't registered any signs at the additive level. A way more significant involvement in conditioning this trait can be given to the dominance genes, this being emphasised by the absolute superior values and from the meanings given to this effects.

The gene epistasis type aa, ad, dd has itself an important role in controlling this trait, especially the epistatic effects type aa and dd. Besides, similar results have been presented also by REZA et al. (2009), that highlighted the importance of the dominance and epistatic phenomena in the hereditary transmission of the number of grains/ear.

On the other side, ESHGHI et al. (2010), in a system of diallel crossings affirms that the additive effects of the genes in controlling this trait are bigger comparative with the dominance ones. The same author affirms that in conditions of drought, the dominance effects of the genes are bigger in controlling this trait.

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From these affirmations it can be deduced the genetic complexity of the trait and the role of the environmental conditions in the formation of phenotypic expression. The majority of the researches show that the weight of the grains/ear has a quite complex heritability, recommending that the selection for this trait to be done in late generations.

In the case of this trait, the differences between the additive effects and the dominance ones are reduced, but even though, there can be noticed in table 6 a significant contribution of the dominance effects controlling this trait.

A significant action of the additive genes, but with subunit and absolute values can be noticed in the case CB 1, 2 and 5. Regarding the epistatic effects type aa and ad, it can be noticed that in almost all the combinations they have reduced values comparative with the dominant ones, however the effects type aa have a significant influence of the majority of combinations, except CB1.

Really significant effects in the genetics of this trait, it's registered also at the level of the epistatic effects type dd. SHERWAN ESMAIL TOFIQ et al. (2015) affirm themselves also that the non-additive gene effects comparative with the additive ones have a bigger contribution in controlling this trait.

Table 5: Estimating the mean effects of the genes amongst the number of grains in a set of six hybrid combinations of spring barley (Turda 2016)

THE GENE EFFECTS						
COMBINATION	**m**	**a**	**d**	**aa**	**ad**	**dd**
CB1 (Thuringia x Jubileu)	29***	1	-7,5***	-6***	3,5***	3***
CB2 (Prima x Victoriana)	27***	5***	10***	10***	2*	-16***
CB3 (Magnif x Odisey)	30***	0,15	3,26***	3,22***	-0,27	-16,54***
CB4 (Victoriana x Anabelle)	26,4***	-1,7	10,48***	13,2***	-0,58	-19,75***
CB5 (Chronicle x Salome)	26,52***	-1,9**	11,57***	8,32***	-2**	-15,82***
CB6 (Viena x Anabelle)	27,32***	1,35*	5,95***	6,02***	2,03**	-6,17***

*significant at 5%, **significant at1%, ***significant 0,1%

Table 6: Estimating the mean effects of the genes amongst the weight of the grains/ear in a set of six hybrid combinations of spring barley (Turda 2016)

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COMBINAȚIA	**m**	**a**	**d**	**aa**	**ad**	**dd**
CB1 (Thuringia x Jubileu)	1,31***	0,15***	-0,26***	-0,06*	0,36***	-0,55***
CB2 (Prima x Victoriana)	1,37***	0,18***	1,07***	1***	0,15***	-2,13***
CB3 (Magnif x Odisey)	1,35***	0,06	0,78***	0,85***	-0,37	-32,29***
CB4 (Victoriana x Anabelle)	1,21***	-0,16*	1,49***	1,57***	-0,1	-2,74***
CB5 (Chronicle x Salome)	0,93***	-0,21***	2,01***	1,82***	-0,15**	-2,8***
CB6 (Viena x Anabelle)	1,2***	0,12**	0,92***	0,63***	0,01	-0,82***

*significant at 5%, **significant at1%, ***significant 0,1%

CONCLUSIONS

In the achievement of producing barley are implied a series of physiological independent processes, that are outcrossing step by step in the course of the vegetation period being under the influence of environmental conditions a significant period of time (from sunrise to physiological maturity).

The superiority of generation F1 towards the parental forms regarding the length of the ear, indicates the presence of the heterosis phenomenon in the case of this trait at four out of six studied combinations. In conditioning the length of the ear, the most important part is given to the dominant gene effects, but also to the epistatic ones.

For the number of grains/ear, the high values of the dominance effects involved in the expression of the number of grains/ear indicates the fact that the selection for this trait could give favorable results in the late generations of selection. However from the analysis of the gene effects, in the case of certain combinations the important role of the additive effects can be observed, fact that would indicate that selection work should be done in early generations. Therefore, it is recommended to continue the selection for the number of grains/ear, combined with the production per se. The importance of the different types of genetic actions, that controls the number of grains/ear, is different according to the hybrid combination, consequently being genotype dependent.

From the analysis of the genetic effects that condition the weight of the grains, it can be noticed the important role of the dominance effects but also of the epistatic ones. The additive effects have lower values and act differently depending on the combination, but almost in all cases have very significant or significant values. Therefore it would be indicated that the selection for the weight of the grains/ear to be done in late generations.

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The success of the selection works depends to a large extent of the rapidity and the certitude of the segregation's evaluation of combinations and of the fidelity with which the phenotype reflects the genotype.

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