

**THE INHERITANCE OF PLANT HEIGHT IN WINTER WHEAT
(*TRITICUM AESTIVUM* L.)**

Veselinka ZEČEVIĆ, Desimir KNEŽEVIĆ, Danica MIĆANOVIĆ, Milanko
PAVLOVIĆ, and Dušan UROŠEVIĆ

Agriculture Research Institute SERBIA, Center for Small Grains Kragujevac,
34000 Kragujevac, Serbia and Montenegro

Zečević V., D. Knežević, D. Mićanović, M. Pavlović, and D. Urošević (2005): *The inheritance of plant height in winter wheat (Triticum aestivum L.)*. – Genetika, Vol. 37, No. 2, 173-179.

Four winter wheat varieties (Srbijanka, Partizanka, KG-56 and PKB-111) have been selected for diallel crossing in order to study the mode of inheritance, gene effect and genetic variance components for the plant height in F_2 generation. Sixty plants of parents and F_2 generation were used for analysis. The mode of inheritance was done on the basis of the significance of components of genetic variance and the regression analysis. The inheritance of plant height in the most crossing combinations was superdominance. The combining ability analysis was found to be highly significant, which means both additive and non-additive type of gene actions. The best general combining ability manifested KG-56 variety, and the best specific combining ability have shown hybrids KG-56 x PKB-111, Srbijanka x PKB-111 and Partizanka x KG-56. The genetic variance components, average degree of dominance and regression line indicated superdominance in the inheritance of plant height. The dominant alleles frequency was higher than recessive alleles frequency, which confirmed the ratio of dominant/recessive alleles.

Key words: diallel analysis, inheritance, plant height, winter wheat

INTRODUCTION

Yield is a complex character and is the result of many quantitative traits which controlled by numerous genes each having small effects. Improving direct and some other indirect components, grain yield can be improved. The nature and influence of the genetic control of traits were appreciated by breeders, hybridization and selection strategies were developed and utilized. New wheat varieties were resulting in great genetic diversity.

Investigation of mode of inheritance, combining ability and components of variance for each yield traits are very important for the breeders to evaluate newly developed genotypes for their parental usefulness (KRALJEVIĆ-BALALIĆ and BOROJEVIĆ, 1985). The plant height is one of important yield components of wheat which investigated a question in many its aspects.

The objective of this study was to examine the inheritance of plant height in different varieties of winter wheat.

MATERIAL AND METHODS

Winter wheat varieties (Srbijanka, Partizanka, KG-56 and PKB-111) were studied to analyze the nature of gene effects for plant height. Four-parental diallel cross, excluding reciprocals, was grown in a randomized complete block design with three replications at experimental field in Small Grains Research Center Kragujevac. Sixty plants in F_2 progenies were selected randomly in three replications (twenty per replication) for genetic analysis of plant height.

Table 1. Mean values and the inheritance of plant height in wheat (parents and F_2)

Parents	Srbijanka	Partizanka	KG-56	PKB-111
1. Srbijanka	54.0	62.5 ^{sd}	62.0 ^{sd}	64.3 ^{sd}
2. Partizanka		56.4	67.5 ^{sd}	58.8 ^{sd}
3. KG-56			53.9	65.8 ^{sd}
4. PKB-111				48.5

LSD: 0.05= 4.25; 0.01=5.82

The components of genetic variance were analyzed following the models of HAYMAN (1954) and JINKS (1954). The regression analysis was conducted by the method of MATHER and JINKS (1971). The combining ability analysis was done following Method 2, Model 1 of GRIFFING (1956).

RESULTS AND DISCUSSION

Analysis of variance indicated significant differences existed among parents and hybrid combinations. The highest mean value had Partizanka variety (56.4 cm), while the shortest variety was PKB-111 (48.5 cm). The hybrid combinations had higher values than parents, what indicated overdominance (heterosis) in inheritance of plant height in wheat (Table 1). Regarding the plant height, the effect of heterosis were found in all hybrid combinations. Previous results (KRALJEVIĆ-

BALALIĆ and MIHALJČEVIĆ, 1989; TSVETKOV, 1992) showed dominance, heterosis (KRISHNA and RAM, 1994) and intermedial gene effects in inheritance of plant height in wheat. The mode of inheritance of plant height and effect of heterosis and its intensity in individual quantitative characters depend not only on the hybrid combination, but also on its interaction with the environment (HRAŠKA, 1976; TSILKE *et al.*, 1979).

Table 2. ANOVA for combining ability for plant height

Source of variance	DF	SS	MS	F _e	F _t	
					0.05	0.01
GCA	3	30.26	10.09	12.23**	3.20	5.10
SCA	6	304.26	50.71	61.67**	2.70	4.00
E	18	-	0.82	-	-	-
GCA/SCA	0.20					

Table 3. GCA values for plant height

Parents	Values	Rank	SE	LSD	
				0.05	0.01
Srbijanka	-0.01	3	-	-	-
Partizanka	0.79	2	0.52	1.10	1.51
KG-56	1.04	1	-	-	-
PKB-111	-1.82	4	-	-	-

Table 4. SCA values for plant height

Hybrid combinations	Value	LSD	
		0.05	0.01
Srbijanka x Partizanka	2.35	-	-
Srbijanka x KG-56	1.60	2.20	3.02
Srbijanka x PKB-111	6.76**		
Partizanka x KG-56	6.30**		
Partizanka x PKB-111	0.47		
KG-56 x PKB-111	7.21**		
SE	1.05		

Combining ability analysis indicated significant differences between the parents for GCA and between the crosses for SCA of plant height, what means that in inheritance of this character both additive and non-additive gene effects were present (Table 2). However, the high values of GCA variance showed the greater importance of additive gene action in inheritance of this trait (SHARMA *et al.*, 2004). This results are agree with previous (SHARMA *et al.*, 1978; KRALJEVIĆ-BALALIĆ, 1985; BEBYAKIN and KOROBOVA, 1990; WAGOIRE *et al.*, 1998; JOSHI *et al.*, 2002; 2003; NOVOSELOVIĆ *et al.*, 2004).

The variety KG-56 had the highest positive general combining ability for plant height, but the highest negative GCA had PKB-111 variety with the lowest

plant height (Table 3). These parents could be used as donors in future breeding programs.

Table 5. Components of genetic variance for plant height

Components of variance	Values in F ₂ generation
D	10.32
F	16.39
H ₁	520.00**
H ₂	274.22**
H ₂ /4H ₁	0.13
$\sqrt{H_1/D}$	7.10
u	0.84
v	0.16
Kd/Kr	1.01

The specific combining ability was positive at all cross combinations and the best specific combining ability for plant height have shown hybrids KG-56 x PKB-111; Srbijanka x PKB-111 and Partizanka x KG-56 (Table 4). These results are in agreement with previous (IVANOVSKA *et al.*, 2003; GORJANOVIĆ and KRALJEVIĆ-BALALIĆ, 2004).

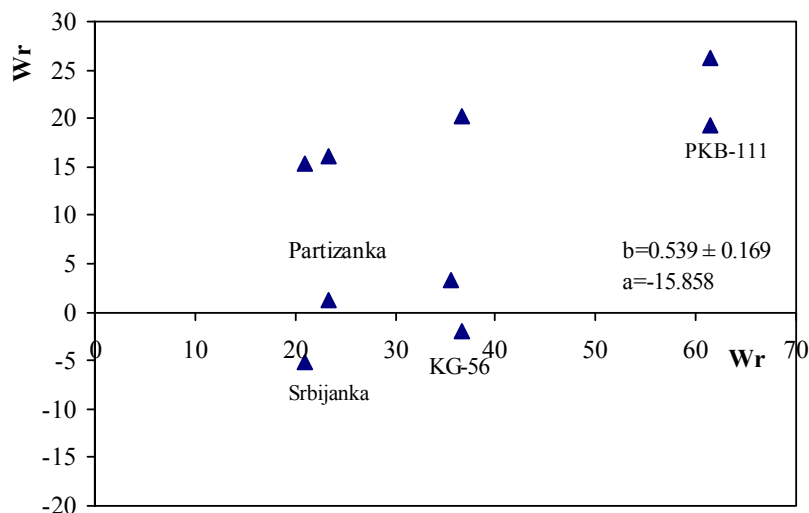


Fig.1. Vr/Wr regression analysis for plant height of wheat in F₂ generation

On the basis of the analysis of components of genetic variance for plant height in wheat (Table 5) it can be concluded that dominant component (H₁ and H₂) was significantly higher than the additive (D) and additive x dominant effect was positive, what indicated the predominance of dominant gene effects for this trait (SINGH *et al.*, 1988). This confirmed by the frequency of dominant alleles (u=0.84) in relation to the recessive ones (v=0.16) for plant height. The estimate of

H₂ component was smaller than H₁ indicating that positive and negative alleles at the loci governing this character were not equally in proportion among parents. The component F which is a measure of co-variance between additive and dominance effect was positive suggesting a higher proportion of dominant alleles controlling this character. The calculated degree of dominance $\sqrt{H1/D} = 7.10$ was above unit, what indicated superdominance in inheritance of plant height. The ratio of whole dominant and recessive genes (K_d/K_r=1.01) in all parents was above unit what indicated the predominance of dominant gene effects for this trait. According to the obtained results, dominant and recessive genes were not symmetrically arranged in parents as indicated by the ratio of H₂/4H₁, that was not close to the theoretical value 0.25. Similar results were obtained by KRALJEVIĆ-BALALIĆ (1985) and PETROVIĆ *et al.* (1995).

The regression analysis (V_r/W_r) indicated superdominance for plant height because regression line intersected the W_r axis below the origin (Fig.1). The varieties Srbijanka, Partizanka and KG-56 had higher dominant genes, but variety PKB-111 which is far away from the origin had higher recessive genes for plant height in wheat.

Received March 9th, 2005

Accepted April 5th, 2005

REFERENCES

- BEBYAKIN V.M. and N.I. KOROBOVA (1990): Gene interaction effect which controlling wheat yield and quality components. Dokladi VASHNIL, 5, 2-6. /in Russian/.
- GORJANOVIĆ B. and M. KRALJEVIĆ-BALALIĆ (2004): Nasleđivanje visine stabljike i dužine klasa kod pšenice. Zbornik abstrakata III kongresa genetičara Srbije, 124.
- GRIFFING B. (1956): Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci., 9, 463-493.
- HAYMAN B.I. (1954): The theory and analysis of diallel crosses. Genetics, 39, 789-809.
- HRAŠKA Š. (1976): Interaction of the genotype and environment in the presence of the effect of heterosis in wheat. Genetika, 8 (1), 49-61.
- IVANOVSKA S., M. KRALJEVIĆ-BALALIĆ, and C. STOJKOVSKI (2003): Diallel analysis for plant height in winter wheat. Genetika, 35 (1), 11-19.
- JINKS J.I. (1954): The analysis of continuous variation in a diallel cross of *Nicotiana rustica* varieties. Genetics, 39, 767-789.
- JOSHI S.K., S.N. SHARMA, D.L. SINGHANIA, and R.S. SAIN (2002): Genetic analysis of quantitative and quality traits under varying environmental conditions in bread wheat. Wheat Information Service, 95, 5-10.
- JOSHI, S., S.N. SHARMA, D. SINGHANIA, and R.S. SAIN (2003): Genetic analysis of yield and its component traits in spring wheat. Acta Agronomica Hungarica, 51 (2), 139-147.
- KRALJEVIĆ-BALALIĆ M. (1985): Nasleđivanje visine stabljike, bokorenja i prinosa zrna po biljci kod pšenice. Matica srpska, 69, 121-130.
- KRALJEVIĆ-BALALIĆ M. and S. BOROJEVIĆ (1985): Nasleđivanje visine stabljike i žetvenog indeksa pšenice. Arhiv za poljoprivredne nauke, 46 (3), 253-266.

- KRALJEVIĆ-BALALIĆ M. and M. MIHALJČEVIĆ (1989): Genetičke i fenotipske korelacije komponenti prinosa pšenice. Abstrakti sa II simpozijuma "Savremena populaciono-genetička istraživanja u Jugoslaviji", 19.
- KRISHNA R. and L. RAM (1994): Heterosis in bread wheat. *Genetika*, 26 (1), 37-42.
- MATHER K. and J.L. JINKS (1971): *Biometrical Genetics*. Sec. Ed., Chapman and Hall, London.
- NOVOSELOVIĆ D., M. BARIĆ, G. DREZNER, J. GUNJAČA, and A. LALIĆ (2004): Quantitative inheritance of some wheat plant traits. *Genetic and Molecular Biology*, 27 (1), 92-98.
- PETROVIĆ S., M. KRALJEVIĆ-BALALIĆ, and M. DIMITRIJEVIĆ (1995): The mode of inheritance and gene effects for plant height and harvest index in different wheat genotypes. *Genetika*, 27 (3), 169-180.
- SHARMA J.C., Z. AHMAD, and A.N. KHANNA (1978): Combining abilities in relation to wheat breeding. *Indian J. Plant Breeding*, 38 (1), 77-85.
- SHARMA, S.N., U. MENON, and R.S. SAIN (2004): Combining ability for physiological traits in spring wheat over environments. *Acta Agronomica Hungarica*, 52 (1), 63-68.
- SINGH I., I.S. PAWER, and S. SINGH (1988): Detection of additive, dominance and epistatic components of genetic variation for some metric traits in wheat. *Genet. Agr.*, 42 (4), 371-378.
- TSILKE R.A., O.T. KACHUR, and S.A. SADYKOVA (1979): Variability for genetic parameters in a diallel analysis of quantitative characters of common spring wheat. II. The stem length. *Genetika*, 15 (2), 273-285. /in Russian/.
- TSVETKOV S. (1992): Utilization of short-stemmed common wheat, Tom Pouce Blanc for common and durum wheat breeding. I. Analysis in F₁ and F₂. *Wheat Information Service*, 75, 31-35.
- WAGOIRE W.W., O. STOLEN, and R. ORTIZ (1998): Combining ability analysis in bread wheat adapted to the East African highlands. *Wheat Information Service*, 87, 39-41.

NASLEĐIVANJE VISINE STABLJIKE OZIME PŠENICE (*TRITICUM AESTIVUM* L.)

Veselinka ZEČEVIĆ, Desimir KNEŽEVIĆ, Danica MIĆANOVIĆ, Milanko PAVLOVIĆ i Dušan UROŠEVIĆ

Institut za istraživanja u poljoprivredi SRBIJA, Centar za strna žita Kragujevac,
34000 Kragujevac, Srbija i Crna Gora

Izvod

U radu je ispitivan način nasleđivanja, efekat gena, kombinacione sposobnosti i komponente genetičke varijanse za visinu stabljike kod četiri sorte ozime pšenice (Srbijanka, Partizanka, KG-56 i PKB-111). Ukrštanje sorti je urađeno po metodi dialela, a ispitivanja nasleđivanja izvršena su na biljkama F₂ generacije na uzorku od 60 biljaka. U nasleđivanju visine stabljike preovladavala je superdominacija i parcijalna dominacija. Utvrđene su visoko signifikantne razlike za opšte i posebne kombinacione sposobnosti, što znači da u nasleđivanju ovog svojstva značajnu ulogu imaju aditivna i neaditivna komponenta genetičke varijanse. Najbolje opšte kombinacione sposobnosti za visinu stabljike ispoljila je sorta KG-56, a najbolje posebne kombinacione sposobnosti pokazali su hibridi KG-56 x PKB-111, Srbijanka x PKB-111 i Partizanka x KG-56. Ustanovljeno je da glavni deo genetičke varijanse čini dominantna komponenta u nasleđivanju visine stabljike. U ekspresiji ovog svojstva preovladavali su dominantni u odnosu na recesivne gene. To potvrđuje frekvencija dominantnih alela i odnos ukupnog broja dominantnih prema recesivnim alelima. Genetička analiza je pokazala da je u nasleđivanju visine stabljike došlo do superdominacije.

Primljeno 9. III 2005.
Odobreno 5. IV 2005.