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GENETIC ANALYSIS OF PRODUCTIVE TILLERING IN WHEAT

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The inheritance, gene effect and combining ability for productive tillering in 4 divergent cultivars (Srbijanka, Partizanka, KG. 56 and PKB 111) were studied in diallel crosses (without reciprocals). Plants of the F_2 generation were analyzed. The results obtained showed that inheritance of productive tillering was different (partial dominance, dominance and over-dominance). Analysis of the genetic components of variance showed that dominance played a more important role in the inheritance of producitve tillering than additive variance. The frequency of dominant alleles was higher than that of recessive ones. The degree of dominance was higher than one, which indicated over-dominance for all crossing combinations. Regression analysis indicated a dominant mode of inheritance (over-dominance). Parent cultivars showed the presence of genetic diversity in the arrangement of dominant and recessive genes for productive tillering. Analysis of variance for combining ability showed that non additive gene effects had a higher impact in the inheritance of productive tillering. Also the GCA/SCA ratio was lower than one indicating a preponderance of non additive gene action. The best general combiner was Partizanka cultivar, but the higest value of specific combining ability occurred in the Srbijanka x PKB 111 combination.

Key words: tillering, gene effects, combining abilities, regression, cultivar, wheat

INTRODUCTION

Tillering is a component of wheat yield developing at the beginning of plant ontogeny. The tillers are produced on the border of the hypocotyl and epicotil (knot of tillering). Productive tillering represents the number of tillers with productive ears (Jevtić, 1986).

This trait is very important in wheat breeding. Wheat selection for tillering should have more information about the genetic control of this trait (Kraljević-Balalić, 1991).

The aim of this work was to investigate the mode of inheritance, gene effects and combining ability for productive tillering in the F_2 generation of wheat.

MATERIALS AND METHODS

Diallel crosses (without reciprocals) were made between 4 divergent cultivars of wheat (Srbijanka, Partizanka, KG-56 and PKB 111). Parents and the F_2 generation were grown in 1992/93 on the experimental field of the Center for Small Grains Kragujevac. The seeds were sown in 1 m long rows, with 0.25 m spaces between the rows and a 0.10 m distance between each seed in the row. The experiment was carried out in a randomized block trial with three replications. Analysis of productive tillering in the parents and F_2 generation was done in the full maturity stage with 60 plants (20 plants per replication). The genetic components of variance were analyzed according to the methods of Hayman (1955) and Jinks (1954), and regression analysis by the method of Mather and Jinks. Combining ability analysis was made following method 2, model I of Griffing (1956).

Table 1. Mean value and inheritance of productive tillering in wheat (parents and F_2 generation)

Parents	Srbijanka	Partizanka	KG-56	PKB-111
Srbijanka	8,40	$10,87^{h}$	$8,37^{d}$	$11,71^{h}$
Partizanka		10,30	$10,56^{pd}$	$9,96^{pd}$
KG-56			11,22	$10,28^{pd}$
PKB-111				7,62
LSD	0.05	3.03		
	0.01	4.15		

pd = partial dominance
d = dominance
h = heterosis (over dominance)

RESULTS AND DISCUSSION

The results showed that there were significant differneces between parents in relation to the mean values of productive tillering. The highest number of productive tillers was exhibited by KG-56 cultivar (x = 11.22), and the lowest by PKB-111 cultivar (x = 7.62) (Table 1). The number of productive tillers in the F_2 generation varied from 8.37 in the Srbijanka x KG-56 combination to 11.71 in the Srbijanka x PKB-111 combination (Table 1).

The mode of inheritance for number of productive tillers in the F_2 generation was different (partial dominance, dominance and over-dominance) and it was dependent on the crossing combination. In the hybrid Srbijanka x PKB-111 positive heterosis was expressed. Partial dominance was present in the cross combinations Partizanka x PKB-111 and KG-56 x PKB-111 (Table 1).

Analysis of the genetic components of variance showed that dominacne played a more important role in the inheritance of productive tillering than additive variance (values H1 andH2 are higher than the vaule of parameter D). The F value (additive x dominance effect) was positive, which means that in the inheritance of productive tillering dominant prevail over recessive alleles. The dominant and recessive alleles were not arranged identically (H2/4H1 = 0.32). The frequency of dominant alleles was higher (u = 0.76) than the frequency of recessive alleles (v = 0.24) which is in agreement with the computed F value. The degree of dominance was higher than one (H1/D = 3.55) which indicated over-dominance for all crossing combinations. These resutls are in agreement other investigations (Karaivanov and Kostova, 1983; Kraljević-Balalić, 1986; Kraljević-Balalić and Mihaljčević, 1989; Kraljević-Balalić and Petrović, 1991; Kren and Vlach, 1983; Mustafaev *et al.*, 1986; Tsenov, 1990; Gupta *et al.*, 1988; Patel and Bains, 1984; Pavlović *et al.*, 1994). The ratio of total number of dominant and recessive alleles in all parents was higher than one (Kd/Kr = 1.63), indicating that dominant prevail over recessive alleles (Table 2).

Table 2. Components of genetic variance for productive tillering in wheat

Components of variance	Values in F_2 generation
D	1.04
H_1	13.12
H_2	16.80
F	1.76
E	1.04
$H_2/4H_1$	0.32
u	0.76
v	0.24
$\sqrt{H_1/D}$	3.55
K_D/K_R	1.63

Regression analysis showed a dominance mode of inheritance for productive tillering in wheat. It confirmed the considerable distance of the regression line from a parabola. The regrassion line cut the Wr axis below the point of origin indicating over-dominance for productive tillering taking into consideration all cros combinations. The arrangement of dominant and recessive genes was different in the parents. The Partizanka and KG-56 cultivar possessed an excess of dominant genes, while Sribjanka and PKB-111 possessed an excess of recessive genes for this trait (Figure 1).

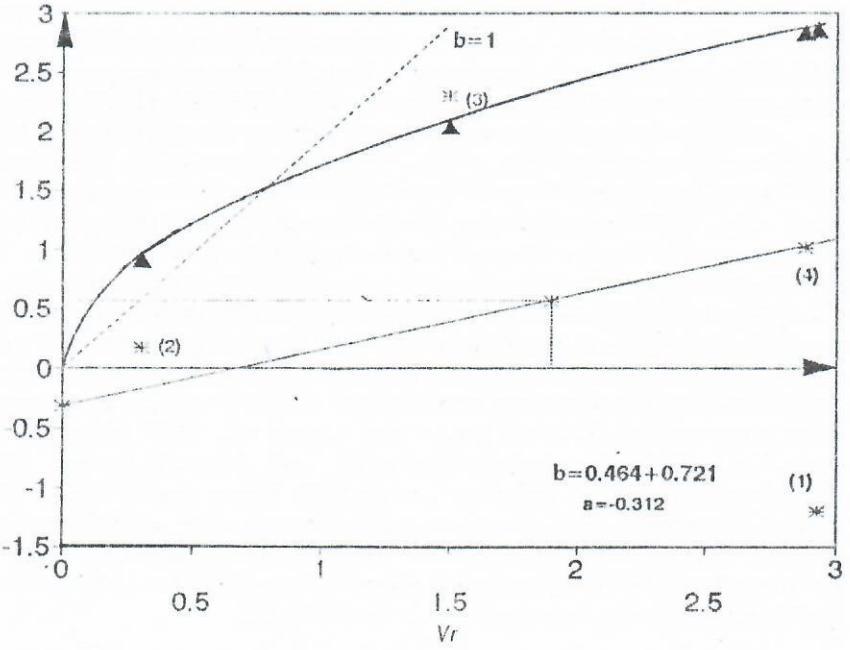

Fig. 1. Regression VrWr analysis for productive tillering in wheat (P and F_2)

All arrays the on VrWr graph (Fig. 1) were below the theoretical line of regression (b = 1) while on the WrW' graph (Fig. 2) two arrays 1 (Srbijanka) and 3 (KG-56) were above the theoretical regression line (b = 1/2). This arrangement of points on both graphs indicated the presence of interallelic interaction for the inheritance of productive tillering.

Combining ability of productive tillering – Analysis of variance for combining ability showed that productive tillering was under additive and non-additive gene control. The GCA/SCA = 0.48 ratio was lower than one indicating a preponderance of non-additive gene action (domination and epistasis), (Table 3). The best general combiner was Partizanka cultivar, but the highest value of specific combining ability occurred with the Srbijanka x PKB-111 combination, (Table 4, 5). On the base of the results obtained we can recommend the Partizanka cultivar in crosses for development hybrids and lines with increases of productive tillering.

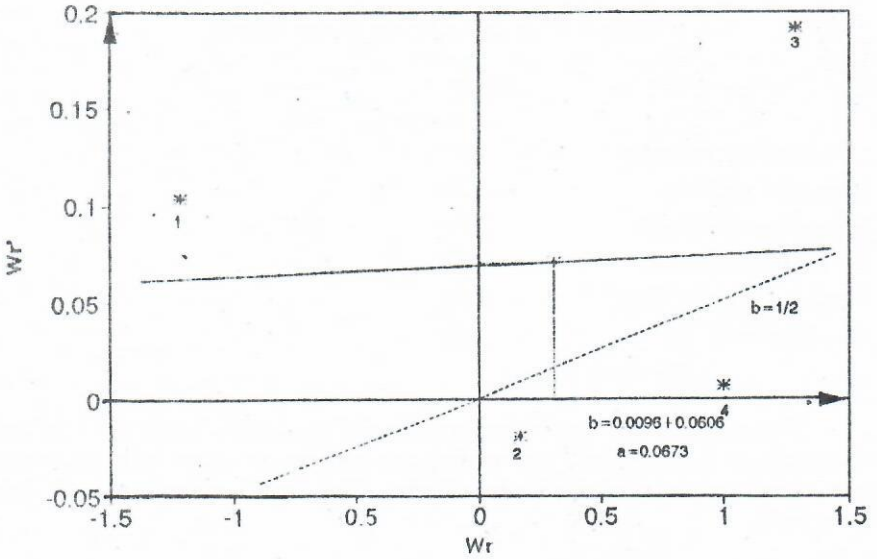

Fig. 2. Wr/W' regression for productive tillering in wheat (P and F_2)

Table 3. Analysis of variance of combining ability for productive tillering in wheat

Source of variation	DF	SS	MS	F	Ft	
					0,05	0,01
GCA	3	3.18	1.06	1.01	3.2	5.1
SCA	6	13.28	2.21	2.12	2.7	4.0
E	18		1.04			
GCA/SCA					0.48	

GCA = general combining ability
SCA = specific combining ability

Table 4. GCA values for productive tillering

Parents	Values	Rank	SE	LSD	
				0.05	0.01
Srbijanka	- 0.32	3	-		
Partizanka	0.39	1	0.59	1.23	1.69
KG-56	0.34	2	-		
PKB-111	- 0.41	4	-		

Table 5. SCA values for productive tillering

Direct cross	Value	LSD	
		0.05	0.01
Srbijanka x Partizanka	0.87		
Srbijanka x KG-56	- 1.58		
Srbijanka x PKB-111	2.51*	2.47	3.39
Partizanka x KG-56	- 0.09		
Partizanka x PBK-111	0.05		
KG-56 x PKB-111	0.43		
SE=1.18			

The cultivars with the highest number of productive tillers (KG-56 and Partizanka cv.) can be used in breeding programmes to create new genotypes with a high potential of productive tillering. This trait is connected with high grain yield.

CONCLUSION

The mean values for number for productive tillers in the parents were significantly different.

The mode of inheritance for productive tillering in the F_2 generation was different (partial dominance, dominance and over-dominance) and it was dependent on crossing combination.

Heterosis appeared in the Srbijanka x PKB-111 combination for productive tillering. Dominance gene effects are more important for the inheritance of productive tillering than additive ones. The frequency of dominant alleles was higher than for recessive alleles.

Regression analysis showed a dominant mode of inheritance (over-dominance), for all crossing combinations with the presence of interallelic interaction.

Parent cultivars showed the presence of genetic diversity in the arrangement of dominant and recessive genes for productive tillering.

Analysis of variance for combining ability showed that productive tillering is under additive and non-additive gene control. Non-additive gene effects had a higher impact in the inheritance of productive tillering.

The best general combiner is Partizanka cultivar, but the highest value of specific combining ability was observed with the Srbijanka x PKB-111 combination.

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GENETIČKA ANALIZA PRODUKTIVNOG BOKORENJA PŠENICE

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Izvod

U dialelnom ukrštanju (bez recipročnog) četiri divergentne sorte pšenice (Srbijanka, Partizanka, KG-56 i PKB-111) proučavan je način nasleđivanja, efekti gena i kombinacione sposobnosti za produktivno bokorenje. Proučavanja su izvršena na biljkama F_2 generacije. Na osnovu dobijenih rezultata može se zaključiti da je način nasleđivanja produktivnog bokorenja bio različit (parcijalna dominacija, dominacija i super dominacija) i zavisio je od kombinacije ukrštanja. Analiza komponenti genetičke varijanse ukazuje da su dominantni genetički efketi za nasleđivanje ovog svojstva značajniji u odnosu na aditivne. Frekvencija dominantnih alele je veća od frekvencije recesivnih. Prosečan stepen dominacije je veći od jedinice, što ukazuje da se radi o superdominaciji uzevši u obzir sve kombinacije ukrštanja. Regresiona analiza ukazuje na dominantni tip nasleđivanja (superdominacija) pri čemu su roditelji bili divergentni u pogledu rasporeda dominantnih i recesivnih alela. Analiza varijanse kombinacionih sposobnosti pokazuje veći udeo neaditivnih genetičkih efekata, pri čemu je odnos OKS/PKS manji od jedinice. Od ispitivanih sorti najbolji opšti kombinator za produktivno bokorenje je Partizanka, a najveću vrednost PKS imala je kombinacija Srbijanka x PKB-111.

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