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## INHERITANCE OF PLANT HEIGHT, SPIKE LENGTH AND NUMBER OF SPIKELETS PER SPIKE IN *DURUM* WHEAT

**ABSTRACT:** Using the line x tester analysis we studied the combining ability and gene effects of plant height, spike length and number of spikelets per spike in *durum* wheat. The results of the study show that non-additive genes play more important role than additive genes in the inheritance of plant height, number of spikelets per spike in both years and in inheritance of spike length only in the first year of research. Variety Belfugito, the best general combiner for plant height and number of spikelets per spike, combined well in two best hybrids: Belfugito x Alifen and Belfugito x Yavaros 79, and these hybrids may be used in wheat breeding programs. In the majority of the cases, good specific combining ability (SCA) effects were associated with crosses of two genetically divergent parents having at least one parent as a good general combiner.

**KEY WORDS:** combining ability, gene effects, *durum* wheat, yield components

### INTRODUCTION

The choice of parents is a very important task in a breeding program. Combining ability studies are used by plant breeders to select parents with maximum potential of transmitting desirable genes to the progenies. In autogamous crops like wheat, where the ultimate aim is to develop pure line varieties, the estimates of general combining ability (GCA) are very useful because the variance due to general combining ability is attributable to additive gene action and A x A interaction which can be fixed in further generations, while the variance due to specific combining ability is attributable to non-additive gene action. The gene effects and combining ability of yield components were already studied by a number of scientists using diallel analysis (Knežević and Kraljević-Balalić, 1993; Menon and Sharma, 1994; Menon and Sharma, 1995; Perović, 1995; Petrović et al., 1995; Joshi et al., 2002).

This study was therefore, undertaken to obtain information regarding the combining ability and gene effects of plant height, spike length and number of spikelets per spike in *durum* wheat using line x tester analysis.

## MATERIALS AND METHODS

Five *durum* wheat (*Triticum turgidum durum*) genotypes: Mexicali 75 (MEX), Yantar odeskij (UKR), Belfugito (ITA), Monodur (FRA) and Kunduru (TUR) were crossed with each of the three testers: Durumko (SCG), Yavaros 79 (MEX) and Alifen (CHL). The parent varieties and their F<sub>1</sub> hybrids were examined in randomized block design, with three replications. All parents were selected on the basis of different phenotypic expression and geographic origin.

The experiment was conducted at the experiment field of the Institute of Field and Vegetable Crops, Novi Sad, during 2000—2002. Sowing was done in the beginning of the October, in 1.2 m<sup>2</sup> plot, with a 10—12 cm space inside the row, and a 20 cm space between rows. Three traits were studied at full maturity: plant height, spike length and number of spikelets per spike. All traits were determined in 5 plants per replication. The combining ability and gene effects were studied using GEN software package (Program for quantitative genetic analysis) — line x tester analysis, described by Singh and Choudhary (1979).

## RESULTS

The analysis of variance for plant height, spike length and number of spikelets per spike showed highly significant differences amongst genotypes in both years. The genotype x environment interaction was also highly significant in both years of investigation.

The analysis of variance for line x tester for spike length indicated that significant differences existed between parents (both years), interaction parents vs. crosses (both years), crosses (second year), lines (second year), testers (second year) and interaction line x tester (first year). Analysis of variance for plant height showed that significant differences existed between parents (first year), parents vs. crosses (both years), crosses (first year), lines (both years), testers (first year) and interaction line x tester (both years). For number of spikelets per spike significant differences existed between parents (second year), parents vs. crosses (second year), crosses and lines (both years), testers (first year) and line x tester (both years) (Table 1).

The estimation of the genetic components of variation, as well as the ratio of GCA/SCA showed that the additive component was lower than the dominance component which suggests that, in both years of the investigation, plant height and number of spikelets per spike were predominantly controlled by non-additive gene action. Spike length was predominantly controlled by non-additive gene action in the first year, while in the second year spike length was controlled mostly by additive genes (Table 1).

Tab. 1. — ANOVA line x tester for yield components in *durum* wheat

Source of variation	DF	Mean squares					
		Plant height		Spike length		Number of spikelets	
		2001	2002	2001	2002	2001	2002
Replication	2	17.62	3.39	0.13	0.03	0.07	1.20
Treatments	22	877.94**	437.66**	0.81**	0.53**	8.63**	4.65**
Parents	7	1144.26**	459.25	1.47**	0.43**	7.01	6.49**
P vs. C	1	1360.21**	722.15**	2.23**	0.54**	-0.01	2.43*
Crosses	14	710.33**	406.55	0.38	0.57**	10.06**	3.88*
Lines	4	889.44**	727.14*	0.66	0.50**	22.44**	9.73**
Testers	2	2641.24**	440.23	0.05	0.67**	12.45*	0.15
L x T	8	138.05**	237.83**	0.33**	0.08	3.27**	1.89**
Error	44	7.86	4.77	0.10	0.07	0.38	0.58
Total	68						

	Components of genetic variance					
	Plant height		Spike length		Number of spikelets	
	2001	2002	2001	2002	2001	2002
GSA	20.23	5.97	0.002	0.017	0.24	0.07
SCA	43.39	77.69	0.075	0.005	0.96	0.44
GCA/SCA	0.47	0.08	0.027	3.40	0.25	0.16

\*  $p < 0.05$ ; \*\*  $p < 0.01$

The estimates of general combining ability pointed out that the best general combiner for plant height in the first year was Mexicali 75, while in the second year it was Belfugito (Figure 1). For spike length the best combiner in the first year was Yantar odeskij, while in the second year it was Mexicali 75 (Figure 2). For number of spikelets per spike the best combiners were Belfugito, in the first year, and Kunduru in the second year of research (Figure 3).

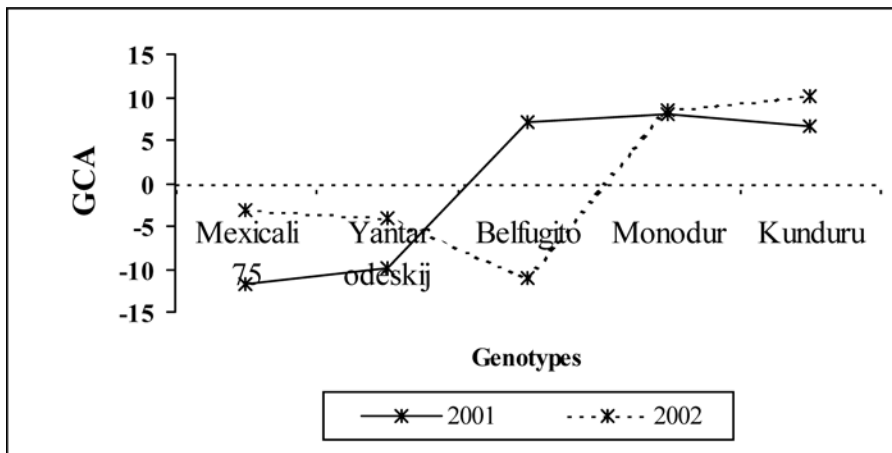


Fig. 1. — GCA for plant height in *durum* wheat

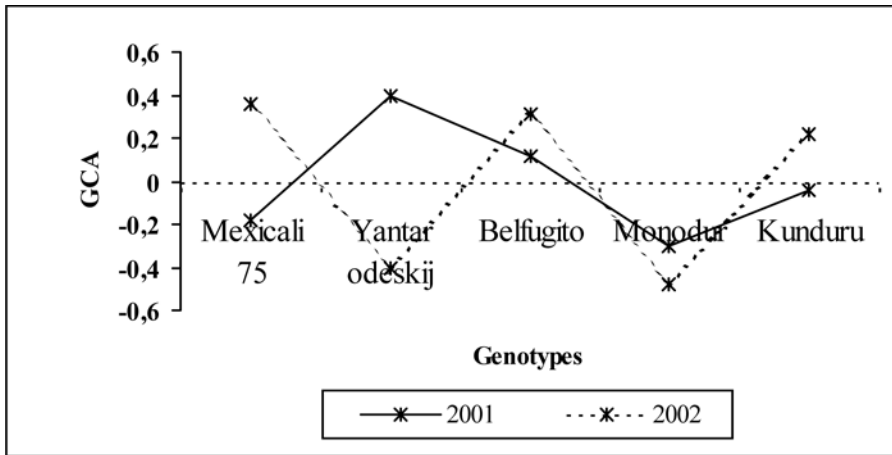


Fig. 2. — GCA for spike length in *durum* wheat

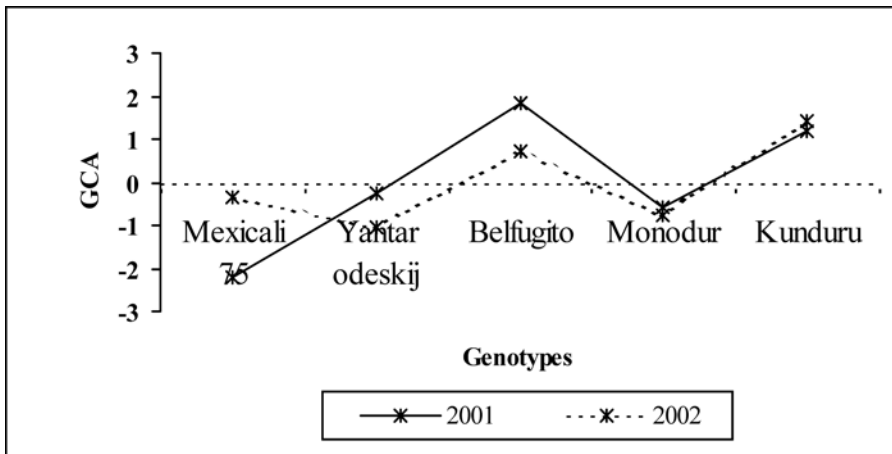


Fig. 3. — GCA for number of spikelets per spike in *durum* wheat

The hybrid which showed significant positive SCA for spike length in the first year was Belfugito x Yavaros 79, while in the second year there was no significant SCA. For plant height, the best specific combiner in the first year was Kunduru x Alifen, while in the second year it was Belfugito x Alifen. In case of number of spikelets per spike the best specific combiners were Mexicali 75 x Yavaros 79 in the first year, and Monodur x Alifen and Belfugito x Yavaros 79 in the second year of research (Table 2).

Tab. 2. — Specific combining ability for yield components in wheat

Hybrid	Plant height		Spike length		Number of spikelets	
	2001	2002	2001	2002	2001	2002
1. Mexicali 75 / Durumko	-5.04*	-8.59*	-0.07	0.12	-0.19	-0.49
2. Mexicali 75 / Yavaros 79	3.26*	4.97*	0.26	0.03	1.10*	0.48
3. Mexicali 75 / Alifen	1.78	3.62*	-0.19	-0.15	-0.91*	0.00
4. Yantar odeskij / Durumko	-5.03*	-2.94*	0.22	0.08	0.79*	0.75
5. Yantar odeskij / Yavaros 79	-0.33	-6.00*	-0.08	-0.13	0.01	-0.55
6. Yantar odeskij / Alifen	5.37*	8.94*	-0.13	0.05	-0.80*	-0.20
7. Belfugito / Durumko	-1.91	6.58*	-0.34	-0.14	-0.60	0.24
8. Belfugito / Yavaros 79	-2.43	8.42*	0.40*	0.19	0.86*	0.86
9. Belfugito / Alifen	4.35*	-15.00*	-0.06	-0.05	-0.26	-1.10*
10. Monodur / Durumko	2.01	2.82*	-0.12	0.12	-0.28	-0.12
11. Monodur / Yavaros 79	-2.16	-5.85*	-0.22	-0.18	-0.66	-0.75
12. Monodur / Alifen	0.14	3.03*	0.34	0.06	0.94*	0.87*
13. Kunduru / Durumko	9.97*	2.13	0.31	-0.18	0.28	-0.38
14. Kunduru / Yavaros 79	1.67	-1.54	-0.36	0.09	-1.30*	-0.05
15. Kunduru / Alifen	-11.63*	-0.59	0.05	0.09	1.03*	0.42
S.E. (PKS)	1.62	1.26	0.18	0.15	0.36	0.44

\*  $p < 0.05$

## DISCUSSION

The estimation of genetic components of variation showed that non-additive gene effects were predominant in inheritance of plant height and number of spikelets per spike. Similar results were obtained by Sing et al. (1984), Menon and Sharma (1994), Petrović et al. (1995). However, some authors (Kraljević-Balalić and Dimitrijević, 1992; Knežević et al., 1995; Joshi et al., 2002; Sharma et al., 2002) reported that those traits were affected mainly by additive gene action. Spike length was predominantly controlled by non-additive gene actions in the first year, which is in agreement with studies of Srivastava et al. (1981) and Sharma et al. (2003). In the second year of research the spike length was predominantly controlled by additive gene action. Similar results were obtained by Mihajev and Kraljević-Balalić (1981) and Joshi et al. (2002).

The best general combiners with maximum number of favorable alleles for traits under study are: Mexicali 75 and Belfugito (for plant height), Yantar odeskij and Mexicali 75 (for spike length) and Belfugito and Kunduru (for number of spikelets per spike). These genotypes may be exploited in the crossing programs in obtaining superior segregants.

Variety Belfugito, the best general combiner for plant height and number of spikelets per spike combined well in two best hybrids: Belfugito x Alifen and Belfugito x Yavaros. Therefore, suitable segregates may be expected from these cross combinations. In majority of the crosses positive SCA effect were associated with crosses of two genetically divergent parents having at least one parent as a good general combiner, which is in agreement with studies of

Kraljević-Balalić and Borojević (1985), or two poor general combiners. The crosses involving high x low and low x low combiners genetic interaction might be additive x dominance and dominance x dominance type in nature, respectively. Therefore, the heterosis observed in these crosses will be not-fixable and possibility of good segregants will be rare (Sing et al., 1980). The combinations of two good general combiners not showing positive SCA may be due to the fact that parents were not diverse, while in those crosses with high SCA involving high x high general combiners, the genetic interaction might be additive x additive, which is fixable in further generations and can be used in wheat breeding.

#### REFERENCES

- Joshi, S. K., Sharma, S. N., Singhania, D. L., Sain, R. S. (2002): *Genetic analysis of quantitative and quality traits under varying environmental conditions in bread wheat*, Wheat Inf. Service, 95, 5—10.
- Knežević, D., Kraljević-Balalić, Marija (1993): *Genetic analysis of grain weight per spike in wheat*, Genetika, 25 (1), 71—75.
- Knežević, D., Kraljević-Balalić, Marija, Urošević, D. (1993): *A study of gene effects for plant height by diallel crossing in wheat*, Genetika, 25, 1, 57—61.
- Kraljević-Balalić, Marija, Borojević, S. (1985): *Nasleđivanje visine stabljike i žetvenog indeksa pšenice*, Arhiv za poljoprivredne nauke, 46 (163), 253—266.
- Kraljević-Balalić, Marija, Dimitrijević, M. (1992): *Genetička analiza broja klasića po klasu kod pšenice*, Savremena poljoprivreda, 40, 6, 77—80.
- Menon, U., Sharma, S. N. (1994): *Combining ability analysis for yield and its components in bread wheat over environments*, Wheat Inf. Service, 79, 18—23.
- Menon, U., Sharma, S. N. (1995): *Inheritance studies for yield and yield component traits in bread wheat over the environments*, Wheat Inf. Service, 80, 1—5.
- Mihaljev, I., Kraljević-Balalić, Marija (1981): *Genetska analiza kvantitativnih svojstava pšenice*, Genetika, 13, 3, 265—280.
- Perović, D. (1995): *Inheritance of stem height and yield components in wheat hybrids in F<sub>4</sub> and F<sub>5</sub> generations*, M Sci. Thesis. Faculty of Agriculture, Zemun.
- Petrović, S., Kraljević-Balalić, Marija, Dimitrijević, M. (1995): *The mode of inheritance and gene effects for plant height and harvest index in different wheat genotypes*, Genetika, 27, 169—180.
- Sharma, S. N., Sain, R. S., Sharma, R. K. (2002): *The genetic system controlling number of spikelets per ear in macaroni wheat over environments*, Wheat Inf. Service, 95, 36—40.
- Sharma, S. N., Sain, R. S., Sharma, R. K. (2003): *Genetics of spike length in durum wheat*, Euphytica, 130, 155—161.
- Sing, R. K., Chaudharz, B. D. (1979): *Biometrical methods in quantitative genetic analysis*, Kalayani Publishers, New Delhi.
- Srivastava, R. B., Luthra, O. P., Sing, D., Goyal, K. C. (1981): *Genetic architecture of yield, harvest index and related traits in wheat*, Cereal Res. Commun., 9, 1, 31—37.

## НАСЛЕЂИВАЊЕ ВИСИНЕ СТАБЉИКЕ, ДУЖИНЕ КЛАСА И БРОЈА КЛАСИЋА ПО КЛАСУ КОД *DURUM* ПШЕНИЦЕ

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### Резиме

У раду су помоћу линија х тестер анализе испитиване комбинационе способности и ефекти гена за висину стабљике, дужину класа и број класића по класу код *durum* пшенице, користећи пет линија, три тестера и њихове хибриде.

Резултати испитивања показују да су неадитивни гени имали већи значај у наслеђивању висине стабљике и броја класића по класу у обе године истраживања, док су у наслеђивању дужине класа имали већи значај само у првој години истраживања. Најбољи општи комбинатори за висину стабљике били су генотипови Mexicali 75 и Belfugito. За дужину класа најбоље опште комбинационе способности имали су Yantar odeskij и Mexicali 75, док су за број класића по класу најбољи општи комбинатори били Belfugito и Kunduru. Сорта Belfugito, најбољи општи комбинатор за висину стабљике и број класића по класу, дала је два хибрида са најбољим посебним комбинационим способностима (Belfugito х Alifen и Belfugito х Yavaros 79), који се као такви препоручују за даљи рад на opleмњивању пшенице. У већини случајева хибриди са добрим посебним комбинационим способностима настали су укрштањем два различита родитеља од којих је бар један био добар општи комбинатор.