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VARIATION OF GRAIN WEIGHT PER SPIKE OF WHEAT DEPENDING ON VARIETY AND SEED SIZE

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ABSTRACT

The aim of research was to establish the influence of seed size on grain weight per spike of three wheat varieties. A trial was set up using split-plot method in four replications in Pančevo in the period 2004-2006. The seed was divided according to the size in four fractions: 1.8, 2.0, 2.2, 2.5 and 2.8 mm. A significant interaction was determined between the tested varieties and the years of testing, whilst a highly significant interaction was determined between the years of testing and the seed size, the varieties and the seed size, between the tested varieties, the years of testing and the tested seed size. The highest grain weight per spike was determined in PKB-Christina variety (2.29 g), and Pobeda variety (2.25 g), whilst Vizija variety had the lowest grain weight per spike (2.11 g). The difference was highly significant. The analysis of variance determined a highly significant difference between the years when the experiment was conducted, which is often seen in this region. Highly significant differences in the grain weight per spike were determined at different seed sizes. Larger seeds produced higher grain weight per spikes, highest weight being obtained with largest seeds (≥ 2.8 mm).

Key words: wheat, variety, grain weight per spike, seed size.

INTRODUCTION

Grain weight per spike, as the last yield component, is the final in the development of many components that occur in the early ontogenic stages. Grain weight per spike plays a significant role in yield formation, because it directly affects harvest index. Grain weight per plant directly reflects the efficient use of nutrients and their translocation into generative parts of a plant (Borojević, 1983).

Grain weight can be influenced by cultural practices, if there is a genetic base. It could be expected that grain weight per spike is in correlation with parameters whose activity decreases in the period after heading, so the selection of these traits (main leaf area, internodes, spikes and duration of their photosynthetic rates) (Protić, 1980, 1982, 1983), as well as for the translocation of assimilates from leaves and stem to grain, is of special importance for producing high grain weight. Because there are genetic differences between varieties, it is necessary to find genotypes in which that translocation is efficient and to incorporate their genes into a new variety model.

Kobiljski et al. (1996) pointed out that there was a highly significant positive correlation between grain yield and grain weight per spike (r = 0.90). This shows that it is possible to make new wheat genotypes that would achieve high grain yield by increasing grain weight.

Seed size is important in determining stand establishment and early growth, and can have effects on further wheat plant development. Large seeds of wheat have higher germination energy and total

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germination. The plants from large seeds grow faster; they have a thicker stem, higher vigour and stronger tillering than plants from small seeds. As a result, large seeds (≥2.8 mm) yielded about 20% higher than medium large seeds (2.5 to 2.8 mm), and about 15% higher than small seeds (Borojević, 1964; Todorović et al., 2011). The aim of this paper is to determine the influence of seed size on one of the main components of yield (grain weight per spike) in three winter wheat varieties. These researches should help increasing grain weight per spike, in other words, to achieve higher yields per unit area.

MATERIAL AND METHODS

Three winter wheat varieties, different according to the tillering, stem height, leaf position, vegetation duration, genetic potential for grain yield and quality, were included in the trial, as follows: PKB-Christina variety – a mid-season variety of lower height, good disease resistance and cold hardiness, with a high genetic potential for grain yield and quality; Pobeda variety - a mid-season variety of good cold hardiness, lodging and powdery mildew resistance, it is currently our leading variety, known for its wide adaptability and a high yielding potential and Vizija variety –a mid-season variety with a good kernel quality, suitable for growing in intensive and less intensive production conditions. This variety is very adaptable and has a high genetic potential for grain yield.

The trial was set up at "Tamiš" Institute in Pančevo from 2003/2004 to 2005/2006, with split-plot system in four repetition and five different seed sizes (1.8, 2.0, 2.2, 2.5 and 2.8 mm). Elementary plot size was 5 m^2 (1 x 5 m). Mechanical sowing was done in the mid-October. Sowing density was 600 germinating kernels/m² and row spacing was 10 cm. Soil type was calcareous chernozem. The preceding crop was sunflower during all three years, with the usual crop management practices used for wheat in the Republic of Serbia. Hand harvesting was done in the phase of full ripeness, and threshing was done with thresher. The sample size for counting grain weight per spikes was 30 spikes in the stage of full maturity.

Data were processed statistically using the analysis of variance by MSTAT - C program, Michigan State University, Version 1. Year, variety and seed size were taken as factors in the analysis. The results were shown as a triennial average.

RESULTS AND DISCUSSION

Grain weight per spike is an important component of yield. A change in grain weight per spike drastically influences the final yield. In this research, the highest grain weight per spike was determined in PKB-Christina variety (2.29 g), and Pobeda variety (2.25 g), whilst Vizija variety had the lowest grain weight per spike (2.11 g).

The differences are statistically highly significant (Table 1 and 2). The analysis of variance determined a highly significant difference between the years when the experiment was conducted, which is often seen in this region.

That was particularly obvious in 2004, when the grain weight per spike was lower than in 2005 and 2006. There were some more severe fungal infections of vegetative organs, especially the spikes, in 2004 (Tables 1 and 2).

Highly significant differences in grain weight per spike were determined by different seed sizes. Thus, 1.8 mm-seed size gave 1.74 g grain weight per spike, and 2.0 mm-seed size gave 1.91 g grain weight per spike, whilst 2.2 mm-seed size gave 2.15 g grain weight per spike. 2.5 mm-seed size gave 2.49 g grain weight per spike and 2.8 mm seed size gave 2.79 g grain weight per spike (Tables 1 and 2). The continuous increase in grain weight per spike with increasing seed size was different from the behaviour of grain yield, which increased up to 2.5 mm seed size, but significantly decreased in the case of 2.8 mm seed size (Todorović et al., 2011). Obviously the largest seed size caused a decrease in the number of spikes per unit area, which counterbalanced the positive effect on grain weight per spike.

A highly significant interaction was determined between the tested varieties and

the years of testing, the years of testing and the seed size, between the varieties and the seed size, between the varieties, the years of testing and the tested seed size (Table 1).

The production of organic matter per spike and spike weight are directly related with grain number and grain weight per spike. Grain number per spike depends on spikelet number, flower number per spike, the success of pollination and the success of the early organogenetic stages of flowers (Kraljević-Balalić, 1978).

Table 1. Analysis of variance: grain weight per spike of wheat varieties and different seed size

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Significance
Repetition	3	0.047	0.016	0.3698	
Variety (V)	2	1.069	0.535	12.6843	**
Year (Y)	2	9.070	4.535	107.5771	**
V x Y	4	2.964	0.741	17.5789	**
Seed size (T)	4	14.732	3.683	87.3671	**
V x T	8	5.709	0.714	16.9294	**
Y x T	8	6.514	0.814	19.3153	**
V x Y x T	16	5.665	0.354	8.3989	**
Error	132	5.565	0.042		
Total	179	51.335			

** P ≤ 1

Table 2. Grain weight per spike of wheat varieties and different seed size

Year (Y)	Seed size, mm (T)	Variety (V)			YT $\bar{x}$	Y $\bar{x}$
		PKB- Christina	Pobeda	Vizija		
2004	1.8	1.24	1.19	1.81	1.41	1.97
	2.0	1.33	1.32	1.91	1.52	
	2.2	1.77	1.61	1.96	1.78	
	2.5	2.56	2.59	2.01	2.39	
	2.8	2.81	2.72	2.74	2.76	
	VY $\bar{x}$	1.94	1.89	2.09		
2005	1.8	1.68	1.85	1.68	1.74	2.16
	2.0	1.77	2.02	1.81	1.87	
	2.2	2.06	2.28	1.86	2.07	
	2.5	2.56	2.59	2.02	2.39	
	2.8	2.81	2.72	2.74	2.76	
	VY $\bar{x}$	2.18	2.29	2.02		
2006	1.8	2.38	2.02	1.81	2.07	2.52
	2.0	2.56	2.59	1.88	2.34	
	2.2	2.81	2.72	2.30	2.61	
	2.5	2.95	2.77	2.36	2.69	
	2.8	3.02	2.82	2.74	2.86	
	VY $\bar{x}$	2.74	2.58	2.22	T $\bar{x}$	
VT $\bar{x}$	1.8	1.77	1.69	1.77	1.74	2.22
	2.0	1.89	1.98	1.87	1.91	
	2.2	2.21	2.20	2.04	2.15	
	2.5	2.69	2.65	2.13	2.49	
	2.8	2.88	2.75	2.74	2.79	
	V $\bar{x}$	2.29	2.25	2.11		

	Level of significance							
		V	ZY	T T	VVY	VVT	YYT	VVYT
LSD	5 %	00.07	00.07	00.10	00.13	00.17	00.17	00.29
	1 %	00.10	00.10	00.13	00.17	00.22	00.22	00.38

Using larger seeds increases seed rates per unit area and production costs. However, increased production costs were significantly less than the increase in yield per unit area, obtained by sowing larger seeds.

Higher estimates of heritability coupled with better genetic advance facilitate selection in developing new genotypes with desirable characteristics. Ajmal et al. (1995), Singh et al. (1999), Ghimirary and Sarkar (2000) and Shazly et al. (2000) found high heritability estimates, along with greater values of genetic advance, for the number of grains per spike.

Determination of correlation coefficients between various characters helps to obtain best combinations of attributes in wheat crop for obtaining higher return per unit area.

Nabi et al. (1998), Silva et al. (1998), Amar (1999), Dokuyueu and Akkaya (1999), and Shah et al. (1999) reported positive correlation of grain yield with grains per spike and 1000 grains weight both at genotypic and phenotypic levels. Although number of tillers, spikelets per spike, grains per spike and 1000 grain weight had positive correlations with grains yield, grain number per spike and 1000 grains weight were most important as contributing traits towards yield.

Dwivedi et al. (2002) found that total biomass showed the highest direct effect on grain yield, which was followed by tillers per plant and grain weight per ear. Correlation studies indicated that grain yield per plant had a positive correlation with grain yield per spike and grain number per spike; grain yield per spike with harvest index and grain number per spike on all the three dates of sowings. Thousand-grain weight was an important yield-contributing trait in rainfed situation and it showed a positive correlation with harvest index and the sowing dates (Mishra et al., 2001).

CONCLUSIONS

In triennial average, the highest grain weight had PKB-Christina variety (2.29 g), and Pobeda variety (2.25 g), whilst Vizija variety had the lowest grain yield (2.11 g). The difference was highly significant. The analysis of variance determined a highly significant difference between the years when the experiment was conducted, which is often seen in this region.

A highly significant difference was also determined between the seed size groups tested. Larger seeds produced higher grain weight per spikes, highest weight being obtained with largest seeds (≥2.8 mm). At the same time a highly significant interaction was determined between the years of testing and the seed size, the varieties and the seed size, as well as between the tested varieties, the years of testing and the tested seed size. This indicated that the effect of seed size was influenced by variety and weather conditions.

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