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VARIATION OF WHEAT GRAIN YIELD 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 yield of three wheat varieties. A trial was set up using split-plot method in four replications in Pancevo in the period 2004-2006. Seed was divided according to the size in five fractions: 1.8, 2.0, 2.2, 2.5 and 2.8 mm. There were very significant differences in wheat grain yield due to years, varieties, seed size and years x seed size interaction. The highest average wheat grain yield of 6.57 t/ha was recorded in 2005, significantly higher than the yield in 2004 and 2006. The yield of Pobeda and PKB-Christina varieties was significantly higher than the one of Vizija variety (at P<5%). For significance level of 1%, there were no differences in grain yield between the tested varieties. The highest wheat grain yield of 6.88 t/ha and 6.54 t/ha was achieved in the case of 2.5 and 2.2 mm-seed sizes. Wheat grain yields obtained in the cases of the other seed fractions (1.8, 2.0 and 2.8 mm) were significantly lower. The highest wheat grain yield was achieved in 2005 in the case of 2.5 mm-seed size, significantly higher than all the other values of years x seed size interaction.

Key words: wheat, variety, year, seed size, grain yield.

INTRODUCTION

The aim of the present research was to determine if there are differences in productivity between seed sizes, to measure the advantage of large seed over small one in the conditions of new crop management practices and new winter wheat varieties, and to determine if the interaction between seed size and varieties or years exists. Few researchers examined completely this problem and there are contradictions between earlier researchers and modern ones. The question of seed size importance is still discussed.

Many authors found that the seed of certain size and weight has positive influence upon grain yield. Kissebach (1924, quoted by Kaufmann et Mc Fadden, 1960) and Taylor (1928, quoted by Borojević, 1964) determined that seed of larger weight and size had higher viability and influence upon yield than the seed with smaller weight and size. According to Taylor (1928) and Borojević (1964), 18 % to 20% higher yield was achieved in the fields sown with large seed as compared with fields of the same variety sown with small seed.

Ivanov (1970) pointed out that good seed traits are represented by viability, and in the first place, by the germination capacity and vigour of initial growth. By evaluating seed traits, the researchers pointed out the role and significance of seed size, noticed the advantage of large and heavier seed over small, and lighter one (Davies, 1927; Taylor, 1928; Milton, 1935; Kaufmann and Mc Fadden, 1960; Borojević, 1964; Marić et al., 1967 and 1969). Kissebach (1924, quoted by Kaufmann et al., 1960) thought that although higher yield was obtained from large seeds than from small ones, these differences in the yield could be compensated by sowing the same seed amount of different size fractions. In that way, a larger number of grains would be in the small fractions (in the same amount).

Johannsen (1926) examining the variations of seed size within an inbred line, found out that they are not inheritable and that there is no need to select for seed size within one

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inbred line. Bartel and Martin (1938) and Marchetti (1948) stated that the growth of large seed plantlets in laboratory conditions was faster only the first 8-14 days. After this period, those differences disappeared. Antoniani (1966) pointed out that there were no significant differences between large and small seed regarding germination, although large seed always shows somehow higher germination.

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 the 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 high yielding potential;
- Vizija variety – a mid-season variety with the good kernel quality, suitable for growing in the intensive and less intensive production conditions. This variety is very adaptable and has high genetic potential for grain yield.

The trial was set up at "Tamis" Institute in Pancevo from 2003/04 to 2005/06, 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. Preceding crop was sunflower during all three years with the usual crop management practices used for wheat in the Republic of Serbia.

Hand harvest was done in the phase of full ripeness, and threshing was done with thresher, after which grain yield was determined.

Data were statistically analyzed using analysis of variance. Year, variety and seed sizes were taken into consideration in the analysis. The results were presented as three years averages.

RESULTS AND DISCUSSION

Pobeda variety had the highest grain yield in the triennial average (5.73 t/ha), followed by PKB-Christina variety (5.68 t/ha) and Vizija variety (5.05 t/ha). The difference between varieties was significant (Tables 1 and 2). Significant differences were determined between the years of testing. The year 2006 especially contributed to this, as the yield was lower than the previous two years (2004 and 2005), because the attack of fungal diseases on vegetative organs and especially on spikes was higher (Tables 1 and 2).

By increasing seed size up to 2.5 mm, yield increased. In the case of 1.8 mm seed size the average yield was 3.47 t/ha, in the case of 2.0 mm seed size yield was 4.66 t/ha, in the case of 2.2 mm seed size average yield was 6.54 t/ha, while in the case of 2.5 mm seed size the average yield increased to 6.88 t/ha. In contrast, in the case of 2.8 mm seed size the average yield significantly decreased, to 4.80 t/ha. Differences in the grain yield depending on the seed size were significant.

Highly significant interaction between years when the researches were done and seed size was determined (Table 1).

Table 1. Analysis of variance of grain yield

Source of variance	Degrees of freedom	Mean square	F-value	F- table	
				0.05	0.01
Repetition	3	0.163	0.168	2.68	3.95
Variety (V)	2	4.999	5.162**	3.07	4.79
Error	6	0.968	-	2.18	2.96
Year (Y)	2	52.390	100.189**	3.07	4.79
V x Y	4	0.760	1.457	2.45	3.48
Seed size (T)	4	36.387	69.789**	2.45	3.48
V x T	8	0.828	1.589	2.02	2.66
Y x T	8	11.034	21.162**	2.02	2.66
V x Y x T	16	0.516	0.989	1.73	2.15
Error	126	0.521			
Total	179				

The interactions between examined varieties and research years, between varieties and seed size, as well as the triple interaction between varieties, years and seed size, were not significant (Table 1).

Sarić (1952) established that larger seed germinate with greater number of primary roots and that this number depends upon 1000 kernel weight and variety traits. Skripčinskii (1954), Manner (1965), Ravenska (1965), Janjatović (1968) came to the same results. Borojević (1964) examined the impact of different seed fractions on grain yield and other wheat characteristics. His researches showed that, in the case of large seed, higher germination viability and faster germ growth are present, as well as higher number of spikes per area unit and higher percent of large seeds in yield are formed in the crop. This author stated that the advantages of large seed are the result of more developed germ, higher number of roots and larger quantity of endosperm.

These researches certify the results of Nosatovskii (1965). However, Nadvornik (1927) thought that the differences between large and small seed were not the result of larger quantity of endosperm. More vigorous plants developed from heavier seed from which this author removed endosperm, than it was the case with the plants originating from the lighter fraction seed.

Marić et al. (1967, 1969) examined the impact of different specific seed weights on the growth, development and yield. They established certain advantages of seed of larger specific weight in the case of maize and soybean over seed of smaller specific weight. Larger and stronger plants, which contained more dry matter and which had higher grain yield, were formed from the seed of larger weight. Jeftic (1977) stated that tillering knot is formed deeper by sowing large seed and as a result, viability and plant resistance to stresses increases.

Table 2. Grain yield, in t/ha, for different wheat varieties and different seed size (3-year average)

Year (Y)	Seed size (T)	Variety (V)			$YT_{\bar{x}}$	$Y_{\bar{x}}$
		PKB Christina	Pobeda	Vizija		
2003/04	1.8	4.250	4.138	3.600	3.996	5.491
	2.0	4.720	5.115	4.315	4.717	
	2.2	7.065	6.807	6.298	6.723	
	2.5	7.125	7.763	6.772	7.220	
	2.8	4.980	4.780	4.640	4.800	
$VY_{\bar{x}}$		5.628	5.715	5.125		
2004/05	1.8	4.015	4.078	3.642	3.912	5.771
	2.0	4.470	5.115	4.315	4.633	
	2.2	7.403	7.565	7.528	7.498	
	2.5	7.792	8.807	7.435	8.012	
	2.8	4.980	4.780	4.640	4.800	
$VY_{\bar{x}}$)		5.732	6.069	5.512		
2005/06	1.8	3.405	3.920	3.175	3.500	4.746
	2.0	4.470	5.115	4.315	4.633	
	2.2	5.690	5.520	4.965	5.392	
	2.5	5.300	5.505	5.415	5.407	
	2.8	4.980	4.780	4.640	4.800	
$VY_{\bar{x}}$		4.769	4.968	4.502	$T_{\bar{x}}$	
Average $VY_{\bar{x}}$	1.8	3.890	3.045	3.472	3.469	
	2.0	4.553	5.115	4.315	4.661	
	2.2	6.719	6.631	6.263	6.538	
	2.5	6.739	7.358	6.541	6.879	
	2.8	4.980	4.780	4.640	4.800	
$V_{\bar{x}}$		5.676	5.726	5.046	5.269	
	V	Y	T	Y T		
$LSD_{0.05}$	0.44	0.26	0.34	0.58		
$LSD_{0.01}$	0.67	0.34	0.44	0.77		

CONCLUSIONS

In triennial average, the highest grain yield was obtained in Pobeda variety (5.73 t/ha), followed by PKB-Christina variety (5.68 t/ha) and at Vizija variety with the lowest grain yield (5.05 t/ha). Differences between varieties were highly significant. Highly significant difference was established between the years when researches were carried out. The year 2006 especially contributed to this, as the yield was lower compared with the previous two years (2004 and 2005). By increasing seed size from 1.8 mm up to 2.5 mm, yield increased from 3.47 t/ha to 6.88 t/ha, while in the case of 2.8 mm seed size yield significantly decreased to 4.80 t/ha. The effect of seed size on grain yield, depending on seed size was highly significant. Highly significant interaction was established between the years when the researches were carried out and seed size. Interactions between varieties and years, between varieties and seed size, and between varieties, years and seed size were not significant.

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