THE TEST WEIGHT OF SEVERAL WINTER WHEAT GENOTYPES UNDER VARIOUS SOWING DATES AND NITROGEN FERTILIZER RATES

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ABSTRACT

Four winter wheat varieties were studied at three sowing dates and five nitrogen fertilizer rates, under field conditions. On average over all sowing dates and fertilizer rates was highest in the variety Evropa-90 (83.8 kg) and lawest in the variety PKB-Lepoklasa (82.0 kg). A test weight reduction was observed from the first to the third sowing date in all studied varieties, but mostly in the variety Pobeda. The highest test weight was observed at 60 and 90 kg N ha^{-1} while the increase of N rates over these values led to an insignificant decrease of test weight in all studied varieties.

Key words: wheat, nitrogen, nutrition, sowing date, test weight.

INTRODUCTION

Test weight is especially important for several food grain crops, particularly for those on which this trait is compulsory measured. The test weight is the first measurable/weighable qualitative trait of cereal grain mentioned in history, from the 19th century. Since then a great attention has been paid to it. Although it was introduced into regulations during the 20th century, it is hardly mentioned in the seed legislation.

The test weight is a weight of one hectolitre of wheat expressed in kilograms. As it is a volume measure, its value depends on a large number of factors, which depend on studied material and methods, and have positive or adverse effects. However, in spite of all this, the test weight has been accepted in the trade as a measure of quality in wheat and other cereals, due to simple and expeditious measurements. Hence, a variety characterized with a higher test weight, other traits being similar to oter varieties, can be better utilized for flour production and therefore this trait can be used orientatively for the evaluation of milling quality.

The test weight varies from 60 to 84 kg hl^{-1}. In wheat of hight quality it is above 76 kg hl^{-1}, while a value of below this limit implies wheat of low quality. Šaric et al. (1996) mention that, according to the evaluation of processing quality of the *Triticum aestivum* varieties intended for whole grain processing, the minimum required test weight is 800 kg m^{-3}.

Jevtic (1981, 1992) defines the seed test weight using its dependence on the seed density, shape and size, with the emphasis on the fact that the test weight is an important parameter of quality and that it can be used to estimate the amount of grain in a warehouse. Miric et al. (2006) state that both, the test weight and, 1,000-grain weight, have increased in time as a contribution of plant breeding.

The aim of the present study was to study the effects of sowing dates, nitrogen fertilizer rates and varieties on wheat grain test weight, as well as of other factors affecting this essential trait of grain. However, the principal goal of this paper was to find key factors of formation of a high test weight and to establish models of the optimum production of grain with highest test weight.

MATERIAL AND METHODS

Four winter wheat varieties differing in tiller type, stem height, leaf position, vegetation duration, grain quality and yield, were used as material.

The four-replicate trial was set up according to the split-plot system on the marshy black soil in the experimental field of the AC - Agroe-

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konomic Institute in Padinska Skela, Belgrade in the period from 1997/1998 to 1999/2000.

Sunflower was preceding crop in all there years. The cropping practices common to wheat in the Republic of Serbia were applied. The elementary plot size was 10 m^2 (2 x 5 m). Sowing was done manually on all three sowing dates (October 10^{th}, 25^{th} and November 10^{th}).

The sowing density in all years of investigation was 600 germinating seeds m^{-2}. The following rates of nitrogen fertilizers were applied: 0, 60, 90, 120 and 150 kg ha^{-1}. The complete rates of phosphorus (60 kg ha^{-1}) and potassium (40 kg ha^{-1}), as well as, 30 kg nitrogen ha^{-1} were incorporated prior to primary tillage. A total of 70% and 30% of remaining nitrogen was applied in the beginning of the third and fifth stage of organogenesis, respectively.

Harvest was done manually at the full maturity stage, while threshing was done by a combine and then a test weight was determined. The statistical data processing and the analysis of variance were performed at the Institute for Plant Protection and Environment. The varieties, sowing dates and nitrogen fertilizer rates were considered as factors in the analysis.

Results were presented as the three year average.

RESULTS AND DISCUSSION

The test weight of wheat grain depends on the grain size, shape and density.

Results obtained in our studies unambiguously show that the effects of certain cropping practices and climatic factors were not identical in all four varieties (Table 1).

Moreover, obtained results point out that the test weight was almost equal in medium late maturity varieties PKB-Arena and Evropa-90 over all three sowing dates, while it decreased from the first to the third sowing date in the varieties PKB-Lepoklasa and Pobeda (Table 1).

According to Mišic (1965), the test weight of grain of high quality wheat varieties was equal on the first three sowing dates, but reliably higher than test weights on remaining sowing dates among which there also were not significant differences. The grain test weight of the variety PKB-Lepoklasa decreased from the first towards the third sowing date, while it was the highest in the variety Pobeda on the second sowing date. Furthermore the test weight of the variety Pobeda was significantly lower on the third sowing date than the weights on the first two sowing dates. The smallest changes in the test weight occurred over both years and nitrogen fertilizer rates. The nitrogen rate of 60 kg nitrogen per hectare increased the test weight (82.3 kg) in the variety PKB-Lepoklasa and later the test weight gradually decreased up to 150 kg nitrogen per hectare (81.9 kg). The test weight of the variety Pobeda and PKB-Arena and Evropa-90 increased on the first sowing date up to 120 and 90 kg nitrogen ha^{-1}, respectively. The more pronounced in test weight was observed only in the variety PKB-Lepoklasa (Table 1).

Acording to results of the three-year study, large differences in test weight existed among the stated varieties. The highest, and lowest test weight were observed in varieties Evropa-90 and PKB-Lepoklasa, respectively (Table 1).

Based on results of studies on different genotypes of winter wheat carried out by Protic et al. (1996), Šaric et al. (1997), Mihailovic and Protic (1997), test weight ranged from 76.1 do 82.1 kg hl^{-1}. According to long-term studies, Protic et al. (1993, 1994, 1995) concluded that test weight of winter wheat grain under agroecological conditions of Serbia ranged from 80.0 (PKB-Padinka) to 86.4 (BG-Maksima) kg hl^{-1}. Ščepanovic (1979) pointed out that the test weight of winter wheat grain decreased with later sowing and was the highest at nitrogen fertiliser rates of 60 and 90 kg ha^{-1}.

Jevtic (1984) established the highest values of test weight when wheat was harvested at full maturity. Ivanovski et al. (1987) found out that lodged crops had lower test weight and 1,000-grain weight, test weight beeing less affected than 1,000-grain weight, and that sowing traits of seeds and processing qualities of grain were decreased. Ivanovski (1991) proved heritability of the test weight, but also its susceptibility to climatic and edaphic factors. Mišic et al. (1995) proposed the goal of breeding programmes of

new winter wheat varieties should be a test weight of minimum than 80 kg hl^{-1}.

Table 1. Test weight of several winter wheat genotypes at different sowing dates and nitrogen fertilizer rates (three year average)

Sowing dates (S)	N rates (N)	Varieties (V)					
		PKB-Lepoklasa	Pobeda	PKB-Arena	Evropa-90	SNx	Sx
I	0	81.7	82.6	83.2	83.3	82.7	83.2
	60	82.7	83.1	84.0	83.7	83.4	
	90	82.7	83.3	83.9	83.7	83.4	
	120	82.4	83.4	83.8	83.6	83.3	
	150	82.2	82.9	83.7	83.5	83.3	
II	**SVx**	**82.3**	**83.1**	**83.7**	**83.6**		83.3
	0	81.4	82.5	83.2	83.3	82.6	
	60	82.5	83.3	84.0	84.1	83.5	
	90	82.5	83.4	84.0	84.2	83.5	
	120	82.1	83.6	83.9	83.9	83.3	
	150	82.2	83.3	84.0	84.1	83.4	
	SVx	**82.1**	**83.2**	**83.8**	**83.9**		
III	0	80.7	81.8	83.2	83.3	82.2	83.0
	60	81.6	83.0	83.9	84.3	83.2	
	90	81.8	82.8	84.2	84.3	83.2	
	120	81.7	82.7	84.1	84.0	83.1	
	150	81.3	83.0	83.9	84.1	83.1	
	SVx	**81.4**	**82.7**	**83.9**	**84.0**	**N_x**	
NVx	0	81.2	82.3	83.2	83.3	82.5	
	60	82.3	83.2	84.0	84.0	83.4	
	90	82.3	83.2	84.1	84.0	83.4	
	120	82.1	83.2	83.9	83.8	83.3	
	150	81.9	83.1	83.9	83.9	83.2	
	Vx	**82.0**	**83.0**	**83.8**	**83.8**		

Significance levels

		S	V	N	VS	SV	NS
LSD	5%	0.29	0.41	0.11	0.69	0.70	0.19
	1%	0.39	0.54	0.14	0.97	0.88	0.24
		NV	VN	SN	NSV	SRD	RSD
LSD	5%	0.20	0.45	0.35	0.37	0.76	0.70
	1%	0.28	0.59	0.46	0.48	1.03	0.98

Dragovic and Maksimovic (2000) studied the test weight under irrigation conditions and found out a significant increase as compared to values obtained under dry conditions.

Lazovic and Vojvodic (1988) proved heritability of the test weight in spring wheat, but also that the varieties with lower test weight (72.5-72.8 kg hl^{-1}) overyielded varieties with a higher test weight (82.5 kg hl^{-1}). Zivanovic et al. (2000) studied the seed weight in spring wheat varieties grown on acid soils with the ameliorated treatments of fertilizing and found out that all combinations resulted in a higher 1000-grain weight (up to 34.8%), but all these treatments led to the reduction of the wheat test weight, and this should be additionally explained.

CONCLUSIONS

The test weight averaged over studied sowing dates and nitrogen fertilizer rates was the highest, in the variety Evropa - 90 (83.8 kg), and the lawest in variety PKB-Lepoklasa (82.0 kg). A decrease in the test weight was observed from the

first towards the third sowing date in all studied varieties, but this decrease was most pronounced in the variety Pobeda. The highest test weight was obtained at the 60 and 90 kg of nitrogen fertilizers ha^{-1}, further increase of the rates insignificantly reducing test weight in all observed winter wheat varieties.

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