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EFFECT OF SEED PROTECTION ON THE MASS OF 1,000 GRAINS OF THREE WINTER WHEAT GENOTYPES, INOCULATED WITH *TILLETIA TRITICI*

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ABSTRACT

A trial was set up in field conditions during 2003/04-2005/06 with seven different treatments of seed protection and three winter wheat varieties. Vizija variety had lower mass of 1,000 grains in comparison with Pobeda and PKB-Christina varieties, the difference being highly significant. By changing seed protection mode, the mass of 1,000 grains changed. A highly significant difference was established between control (39.8 g) and the variants treated by diviconazole (41.5 g). However, the mass of 1,000 grains of variants treated by difeconazole, carboxine + tiran and tebuconazole + triazoxine was at the level of controls and significant differences among these treatments were not determined. Treatment of electronic seed protection by means of plasma electrons showed significantly lower mass of 1,000 grains than it is the case of fungicidal protection by diviconazole, being on the level of control. Highly significant differences were established between years when the research was performed. High interactions between variety x years, variety x treatment, year x treatment and variety x year x treatment, were established. Strong positive correlation was established between mass of 1000 grains and wheat yield.

Key words: wheat, variety, seed, fungicide, mass of 1,000 grains.

INTRODUCTION

The mass of 1,000 grains is a mass of air-dried and not damaged grains. It is used as one of the parameters for assessing the quality of grain. When grains are of equal size, those with bigger mass will be of better use for flour, and will grow better.

The mass of 1,000 grains, as a final component of grain yield, depends on many components that develop in the previous phases of ontogenesis. Because there is a hyper-production of all organs of the plant in each phase of wheat plant growth, it is possible to affect the mass of 1,000 grains by agro-ecological conditions, agro-technical measures such as time and quality of sowing, mineral fertilizers and irrigation. It depends on the variety and ranges widely.

Unfavourable conditions during the growth of wheat plant can be partly compensated by creating favourable conditions that will enlarge mass of 1,000 grains.

The adequate seed protection is the only way of providing high production level. In Serbia, unprotected seed is sown on about 50% of areas under small grain cereals. This percentage has to be significantly lower. It has to be achieved through intensive work in order to reach the level of developed countries, such as Denmark, where nearly 85% of total planted winter cereals and 90% of total planted spring cereals is sown by protected and certified seed (Nielsen et al., 1998). Inadequate seed protection against disease pathogens, or its omission, could cause big problems occurring in the case of

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infection with *Tilletia caries*, *Drechslera graminea, Ustilago nuda* and *Urocystis occulta.* In agro-ecological conditions of Serbia and in our varieties, the mass of 1,000 grains ranges from 33 g to 45 g, 38 g on average (Šarić et al., 1997; Protić et al., 2007). In the developed countries of Europe, it is considered that certified seed of spring and winter cereals and high percent of non-certified seed from production (85-90 %) is treated with fungicides (Nielsen and Scheel, 1997).

Tilletia caries occurring on wheat is especially significant pathogen because its presence makes impossible the use of that grain in nutrition. In our scientific literature, there are many works dealing with research problems of different fungicides efficiency against *Tilletia tritici.* But efficiency of applied fungicides was determined according to the realized percent of infection (Matijević and Rajković, 1995; Matijević et al., 1993, 1994; Ivanović, 1992; Milosević et al., 1998), or to their influence upon germination and seed germination viability (Matijević, 1993a, 1993b).

In wheat, seed size is positively correlated with seed vigour: larger seeds tend to produce more vigorous seedlings (Cookson et al., 2001). Although many reports suggest that larger seeds produce seedlings with better early growth and increased competitive ability against weeds and pests (Chastain et al., 1995; Douglas et al., 1994), the sheer range of examined in the literature is cause for careful interpretation of results on seed vigour. Using the method of multiple linear regressions, Hassan and Saad (1996) proved that the mass of grains per spike, the mass of 1,000 grains and the number of grains per spike were the most important components of yield, and that they could be used as selection criteria to increase the wheat grain yield.

Kaushik et al. (1996) proved that the mass of 1,000 grains was in significant positive correlation with the mass of grain per plant and biological yield per plant. A significant positive correlation between mass of 1000 grains and grain yield was found by Sarkar et al. (1988), Pawar at al. (1989), Collaku (1989), Hadjichristodoulou (1989), Singh et al., (1995), Protić (1999).

MATERIAL AND METHODS

Three winter wheat varieties, being different according to tillering type, stem height, leaf position, duration of vegetation, genetic potential for grain yield and quality, were used in this trial. They are as follows: Pobeda, Vizija and PKB-Christina. The experiment was set up in trial field of "Tamis" Institute in Pančevo (2003/04-2005/06) using split-plot method, four replications, including five variants plus plasma electron protection with positive and negative control. The size of elementary plot was 5 m^2 (1 x 5 m). Mechanical sowing was done in mid-October. Sowing density was 600 germinated kernels m^{-2} and row spacing was 10 cm. Seed was previously artificially inoculated with teleutospores of *Tilletia tritici* (Rajković, 1999).

After that, seed was treated with the following active substances: difeconazole (30 g l^{-1}), diviconazole (20 g l^{-1}), combination of carboxine (200 g l^{-1}) and tiran (200 g l^{-1}), combination of tebuconazole (20 g l^{-1}) and triazoxine (20 g/l g l^{-1}), and the fifth variant is plasma electrons seed protection which was done in Schmidt Seeger AG, Beilngries, Germany. Hand harvest was done during full ripeness phase, and threshing was done by a thresher. After that, mass of 1,000 grains was determined. Data were processed statistically using analysis of variance by MSTAT - C program, Michigan State University, Version 1. Year, variety and seed protection mode were taken as factors in the analysis. The results were shown as triennial average.

RESULTS AND DISCUSSION

Mass of 1,000 grains

On triennial average, the variety "Pobeda" had the largest mass of 1,000 grains (42.1g), then "PKB-Christine" (40.4 g) variety followed, and the variety "Vizija" had the lowest mass of 1,000 grains (38.2 g). These differences between the varieties in the mass of 1,000 grains were statistically highly significant (Tables 1, 2).

On 3-years average, and averaged over all cultivars, a highly significant difference was established between control (39.8 g) and

the variant treated by diviconazole (41.5 g). The variants treated with difeconazole, carboxine + tiran and tebuconazole + triazoxine had the mass of 1,000 grains on the level of controls, with no significant difference among these treatments. Treatment of electronic seed protection by means of plasma electrons showed significantly lower mass of 1,000 grains than it is the case of fungicidal protection by diviconazole, being on the level of control, although it was expected much more of it as a new seed protection mode (Tables 1, 2).

Seed protection mode, in the case of the same variety, had significant influence upon mass of 1,000 grains in all examined varieties. For example, mass of 1,000 grains ranged from 38.4 g in the case of "PKB-Christina" variety treated by tebuconazole + trizoxine to 41.7 g in the same variety treated by carboxine + tiran. In the case of "Pobeda" variety, mass of 1,000 grains ranged from 39.8 g in the case of treatment by difeconazole to 44.3 g in the case of treatment by plasma electrons. "Vizija" variety had mass of 1,000 grains ranging from 36.4 g in the case of treatment by plasma electrons to 40.5 g in the case of treatment by diviconazole (Table 2).

Highly significant differences were established between the years when examination was carried out, as well as interactions of variety x year, year x treatment and variety x year x treatment (Table 1).

Table 1. Analysis of variance of the mass of 1,000 grains in the case of different wheat varieties and different ways of protection of seed artificially inoculated with *Tilletia tritici*

Source	Df	Sum of squares	Mean Square	F Value
Replication	3	16.146	5.382	1.517
Variety (V)	2	645.298	322.649	90.951**
Year(Y)	2	12314.571	6157.285	1735.666**
V x Y	4	170.800	42.700	12.037**
Treatment (T)	6	75.116	12.519	3.529**
V x T	12	342.891	28.574	8.055**
Y x T	12	323.594	26.996	7.601**
V x Y xT	24	296.440	12.352	3.482**
Error	180	659.836	3.548	
Total	251	14844.691		

** P≤1%

The research results, regarding the impact of different seed protection modes in the case of several winter wheat varieties upon mass of 1,000 grains, have significant importance because the protection efficiency was reflected by the mentioned parameters.

Protić et al. (2005) established highly significant differences in the seed size between the research years, locality and genotypes, then highly significant interactions of year x locality, year x genotype, locality x genotype and year x locality x genotype.

The significance of the interaction variety x treatment indicates that for mass of 1,000 grains there are significant genetic, morphological and physiological differences between the varieties.

There are also significant differences in the efficacy of treatments in protecting seeds. In three-year investigation the highest mass of 1,000 grains (44.3 g) was obtained by variety Pobeda whose seeds were treated with plasma electrons.

Correlation between grain yield and mass of 1,000 grains

Strong positive correlation was established between grain yield and mass of 1000 grains, significant at 1% probability level (r + 0.793**).

The established regression equation between grain yield and mass of 1,000 grains was:

$$Y = 2.26 + 0.115x$$

This shows that the increase of mass of 1,000 grains of one gram will increase grain yield on the average by 0.115 t.ha^{-1} (Figure 1).

Table 2. Mass of 1,000 grains in winter wheat varieties and different ways of protection of seed artificially inoculated with *Tilletia tritici* (2003/04-2005/06 year)

Year (Y)	Way of protection (T)	Variety (V)			$YT\bar{x}$	$Y\bar{x}$
		PKB-Christina	Pobeda	Vizija		
2004	Difeconazole	40.0	42.1	38.4	40.2	40.9
	Diviconazole	39.3	43.3	39.6	40.7	
	Carboxine + Tiran	41.9	43.5	38.6	41.3	
	Tebuconazole + Triazoxine	38.5	41.6	38.5	39.5	
	+C/+ Control	39.2	43.5	39.1	40.6	
	Control	40.3	44.2	38.7	41.1	
	Plasma electrons	40.0	48.5	39.1	42.5	
	$YV\bar{x}$	39.9	43.8	38.8		
2005	Difeconazole	51.0	46.1	44.8	47.3	48.5
	Diviconazole	51.3	53.1	49.0	51.1	
	Carboxine + Tiran	49.7	50.5	43.0	47.7	
	Tebuconazole + Triazoxine	44.5	51.5	46.2	47.4	
	+C/+ Control	49.7	50.0	46.4	48.7	
	Control	46.8	51.0	47.1	48.3	
	Plasma electrons	49.9	52.1	44.5	48.8	
	$YV\bar{x}$	49.0	50.6	45.9		
2006	Difeconazole	34.0	31.3	31.7	32.4	31.4
	Diviconazole	33.3	31.5	33.0	32.6	
	Carboxine + Tiran	33.4	30.0	32.9	32.1	
	Tebuconazole + Triazoxine	32.3	34.5	33.5	33.4	
	+C/+ Control	34.1	30.9	26.2	30.4	
	Control	31.7	32.8	25.8	30.1	
	Plasma electrons	27.7	32.1	25.7	28.5	
	$YV\bar{x}$	32.4	31.9	29.8	$T\bar{x}$	
Average ($TV\bar{x}$)	Difeconazole	41.6	39.8	38.3	39.9	40.3
	Diviconazole	41.3	42.6	40.5	41.5	
	Carboxine + Tiran	41.7	41.3	38.1	40.4	
	Tebuconazole + Triazoxine	38.4	42.5	39.4	40.1	
	+C/+ Control	41.0	41.5	37.2	39.9	
	Control	39.6	42.7	37.2	39.8	
	Plasma electrons	39.6	44.3	36.4	40.0	
	$V\bar{x}$	40.4	42.1	38.2		

Level of significance

		V	Y	T	VY	VT	YT	VYT
LSD	5%	0.57	0.57	0.88	0.99	1.52	1.52	2.63
	1%	0.76	0.76	1.15	1.31	2.00	2.00	3,43

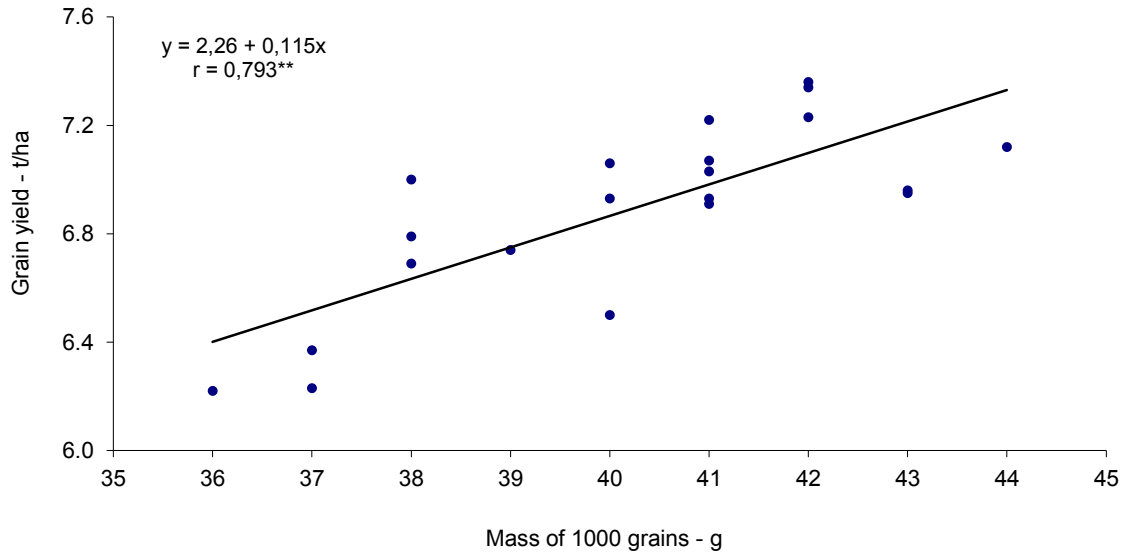

Figure 1. Regression between mass of 1,000 grains and grain yield

CONCLUSIONS

It was established that seed protection mode is one of the factors which have significant influence upon mass of 1,000 grains. In the years of research, mass of 1,000 grains ranged from 31.4 g in 2006 to 48.5 g in 2005, the difference being highly significant. "Vizija" variety had lower mass of 1,000 grains (38.2 g) in comparison to "Christina" variety (40.4 g) and "Pobeda" variety (42.1 g), the difference being highly significant. Highly significant average difference between control (39.8 g) and variants treated by diviconazole (4.15 g) was established. Significant differences were not determined between other protection variants and control. Treatment of electronic protection by means of plasma electrons showed significantly lower mass of 1,000 grains, than the protection using fungicide diviconazole and was on the level of control. Highly significant interaction was established between examined varieties and years when researches were carried out. The interaction between varieties and treatments, between years and treatments, as well as between varieties x years x treatments were also highly significant. Strong positive correlation was established between mass of 1,000 grains and grain yield.

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