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Spike Length of Winter Wheat Varieties According to Different Ways of Seed Protection

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Abstract

The trial was set up under field conditions during 2003/04–2005/06 with seven different treatments of seed protection and three winter wheat varieties. It was established that the manner of seed protection affected the spike lenght considerably. The variety Pobeda had a shorter spike (8.1 cm) than the varieties PKB-Christina (8.8 cm) and Vizija (9.1 cm). The difference is highly significant. By comparing the length of the spike from the aspect of applied protection, a highly significant difference was established between +c/+control (8.5 cm) and the variants being treated with fungicides difenoconazole, diviconazole, carboxin + tiran and tebuconazole + triazoxin. Then, a highly significant difference was established between the control and variants treated with diviconazole and plasma electrons. The variant plasma electrons seed protection was on the level of the control. In all the years of testing, the variety Vizija had the longest spike (from 8.3 to 10.0 cm), whilst the variety Pobeda had the shortest (from 7.5 to 8.9 cm). This interaction is highly significant. A highly significant difference has been established between the year when the research was performed, and a high interaction between variety × years, variety × treatment, year × treatment and variety × year × treatment, was established.

Key words: fungicide, seed, spike, variety, wheat.

1. Introduction

The spike is not only an organ that contains grain, but also an organ that plays a great role in photosynthetic activity, due to its large green area and the place where it is located. The spike area accounts for 20 – 25 % of total green area of the primary stem at the heading stage, 25 to 30 % at the milk stage and 40 to 50 % at the wax-ripe stage BOROJEVIĆ & ĆUPINA [4].

After fertilisation, the green parts of the spike participate in the formation of the grain, due to their location and proximity to high-percent grains. The facts about the relatively high photosynthetic activity of wheat spike have led researchers in the last few years to believe that the green parts of the spike play a positive role in grain filling, and this function of the spike may be more important than the function normally attributed to chaffs and grain clippings in the protection of plant reproductive organs from adverse factors. Therefore, the photosynthetic process can also occur in the green parts of the spike, chaffs, grain clippings, the awn, even in the grain so long it is green. The spike is a source of assimilates, and not an acceptor as was previously thought due to the grain. Thus, it is important to provide for an optimal assimilating area for the spike, its green area index (*sph*) and its duration (*spd*), PROTIĆ [12, 13 & 14]. KOBILJSKI & al. [8]; determined a highly significant positive correlation between the length of spike and grain yield in their research on the effects of spike size on wheat grain yield.

New wheat varieties that vary in their morpho–physiologic traits and spike length are constantly emerging. Therefore, the aim of this paper was to determine the effect of different ways of seed protection on the length of the spike.

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2. Material and Methods

Three winter wheat varieties (Pobeda, Vizija and PKB-Christina), which differed according to tillering type, stem height, leaf position, duration of vegetation, and genetic potential for grain yield and quality, were used in this trial. The experiment was set up in trial field of the "Tamis" Institute in Pančevo (2003/04–2005/06) using the split-plot system, four replications, including five variants of chemical protection plus plasma electron protection, with a positive and a negative control. The size of elementary plot was 5 m^2 (1 × 5 m). Mechanical sowing was realized in mid October. The sowing density was 600 germinating kernels/m^2 and the row spacing was 10 cm. The seeds had previously been artificially inoculated with teleutospores *Tilletia tritici* (1 g/kg). After that, the seeds were treated with the following active substances: difenoconazole (30 g/l), diviconazole (20 g/l), a combination of carboxin (200 g/l) and tiran (200 g/l), and a combination of tebuconazole (20 g/l) and triazoxin (20 g/l). The fifth variant was seed protection with plasma electrons, which was performed at Schmidt Seeger AG, Beilngries, Germany. The sample size for measuring the length of spike was 30 spikes in the full maturity stage .

The data were processed statistically by analysis of variance using the MSTAT - C program, Michigan State University, Version 1. The year, variety and manner of seed protection were taken as factors in the analysis. The results are presented as triennial averages.

3. Results and Discussion

After a three-year period of research, the variety Vizija had the longest spike (9.1 cm). The variety PKB-Christina had the second longest spike (8.8 cm), and the variety Pobeda had the shortest spike (8.1 cm). These differences were statistically highly significant (Table 1, 2).

The analysis of variance showed that the differences established between the years when the research was performed were highly significant, which is often the case in the study region (Tables 1 and 2).

From the aspect of the applied protection, a highly significant difference in the length of the spike was evidenced between the control (8.6 cm), the +c/ +control (8.5 cm) and the plasma electron (8.6 cm) on one hand, among which there were no significant differences, and the variants treated with the fungicides difenoconazole, carboxin + tiran and tebuconazole + triazoxin on the other. The fungicide diviconazole had the largest impact on the development of the spike length (Tables 1 and 2).

During all years of the research, the variety Vizija had the longest spike (from 8.3 to 10.0 cm), and the Pobeda variety had the shortest one (from 7.5 to 8.9 cm), which is a highly significant interaction (Tables 1 and 2). The variety Vizija had a spike length ranging from 8.9 cm (control treatment, plasma electrons and fungicide tebuconazole + triazoxin treatment) to 9.2 cm (carboxin + tiran treatment).

The variety PKB-Christina had a spike length ranging from 8.3 cm (+c/+control treatment) to 9.0 cm (diviconazole treatment). The variety Pobeda had a spike length ranging from 7.9 cm (control and +c/+control treatment) to 8.4 cm (tebuconazole + triazoxin treatment). The differences were highly significant (Tables 1 and 2).

A highly significant interaction between variety × year × treatment was evidenced (Table 1).

It is understandable that the photosynthetic activity of spike participates to 30 to 40 % in the formation of the grain (BOONSTRA [3]; ASANA & MANI [1]; BIRECKA & DAKIĆ-WLODKOWSKA [2]; STOY [17]; VOLDANG & SIMPSON [20]; KUMAKOV [9]; EVANS & RAWSON [6]). A significant and positive correlation between the length of the spike and the mass of grain was determined by TIWARI & RAWAT [19].

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Table 1. Analysis of variance of the results the length of spike in the case of different wheat varieties and different ways of protection of seeds artificially inoculated with *Tilletia tritici*

Source	*Df*	Sum of squares	Mean Square<	*F* Value	Significance
Repetition	3	1.158	0.386	3.5439	
Variety (V)	2	39.505	19.753	181.3692	**
Error	6	0.653	0.109		
Year(Y)	2	108.517	54.259	635.7033	**
V × Y	4	4.728	1.182	13.8479	**
Treatment (T)	6	2.576	0.429	5.0301	**
V × T	12	4.822	0.402	4.7079	**
Y × T	12	5.793	0.483	5.6563	**
V × Y × T	24	10.822	0.451	5.2829	**
Error	180	15.363	0.085		
Total	251	193.938			

According to these authors, genotypic variability mostly affects the length of the spike. Significant positive correlations between grain mass and spike length were determined by SUBHANI & KHALIG [18] and KUMAR & HUNSHAL [10], while a significant positive correlation between stem height and spike length was determined by CAVASSIM & BOREM [5]. Low genotypic correlations between grain yield and spike length were obtained by MAHDY [11]. According to JOŠT [7], the spike length should be from 10 to 15 cm.

The results obtained in the present demonstrated a significant impact of different ways of seed protection on the test weight in three winter wheat varieties. Highly significant differences were found between control and fungicide treated variants. The difference between the electronic way of protection using plasma electrons and the control was not significant. Wheat seed protected with the fungicide diviconazole had significantly the highest values of the test weight PROTIĆ & al. [15].

It was found that the manner of seed protection had a significant influence on grain yield. By comparing the yield from this aspect, highly significant differences were evidenced between the control and variants treated with diviconazole, difenoconazole, carboxin + tiran and tebuconazole + triazoxin. No significant difference was established between the variants treated with diviconazole and difenoconazole, while treatment with carboxin + tiran and tebuconazole + triazoxin resulted in significantly lower yields but with no significant difference between them being established. The electronic way of protection with plasma electrons resulted in significantly a lower grain yield than protection with the fungicides.

For all examined variants where seed protection was performed, significant differences in grain yields in comparison to the respective control yields were established. Highly significant differences were established between the years when research was realised as well as for the variety × year interaction PROTIĆ & al., [16].

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Table 2. The length of spike in cm of different winter wheat varieties and different way of protection of seeds artificially inoculated with *Tilletia tritici* (2003/04 – 2005/06 year)

Year (Y)	Way of protection (T)	Variety (V)			YT_x^-	Y_x^-
		PKB-Christina	Pobeda	Vizija		
2004	Difeconazole	8.6	7.4	7.9	8.0	8.0
	Diviconazole	8.5	7.7	8.2	8.1	
	Carboxine + Tiran	8.2	7.1	8.4	7.9	
	Tebuconazole + Triazoxine	8.8	7.6	8.2	8.2	
	+C/+ Control	7.6	7.5	8.8	8.0	
	Control	8.5	7.3	8.3	8.0	
	Plazma electrons	7.9	7.7	8.2	7.9	
	YV_x^-	8.3	7.5	8.3		
2005	Difeconazole	8.1	8.2	9.4	8.6	8.4
	Diviconazole	8.4	8.0	9.3	8.6	
	Carboxine + Tiran	8.6	8.2	9.5	8.8	
	Tebuconazole + Triazoxine	8.0	8.2	8.7	8.3	
	+C/+ Control	8.4	7.6	8.8	8.3	
	Control	8.3	7.5	8.2	8.0	
	Plazma electrons	7.9	7.9	8.9	8.2	
	YV_x^-	8.2	7.9	9.0		
2006	Difeconazole	9.5	9.3	10.0	9.6	9.6
	Diviconazole	10.1	8.8	10.2	9.7	
	Carboxine + Tiran	9.9	8.5	9.7	9.4	
	Tebuconazole + Triazoxine	10.0	9.3	9.8	9.7	
	+C/+ Control	9.0	8.7	9.9	9.2	
	Control	9.6	9.0	10.3	9.6	
	Plazma electrons	10.2	9.1	9.8	9.7	
	YV_x^-	9.8	8.9	10.0	T_x^-	
Average (TV_x^-)	Difeconazole	8.7	8.3	9.1	8.7	8.7
	Diviconazole	9.0	8.2	9.2	8.8	
	Carboxine + Tiran	8.9	8.0	9.2	8.7	
	Tebuconazole + Triazoxine	8.9	8.4	8.9	8.7	
	+C/+ Control	8.3	7.9	9.2	8.5	
	Control	8.8	7.9	8.9	8.6	
	Plazma electrons	8.7	8.2	8.9	8.6	
	V_x^-	8.8	8.1	9.1		

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Level of significance

		V	Y	T	VY	VT	YT	VYT
LSD	5%	0.12	0.09	0.14	0.15	0.23	0.23	0.41
	1%	0.19	0.14	0.18	0.20	0.31	0.31	0.54

4. Conclusions

It was evidenced that the manner of seed protection has a significant influence on the spike length. The variety Pobeda had a shorter spike (8.1 cm) than the varieties PKB-Christina (8.8 cm) and Vizija (9.1 cm). This difference is highly significant. By comparing the spike length with respect to the applied protection, a highly significant difference was evidenced between the +C/+Control (8.5 cm) and the variants treated with difenoconazole, diviconazole, carboxin + tiran and tebuconazole + triazoxin. Furthermore, a highly significant difference was established between the variants treated with diviconazole and those treated with plasma electrons or the control. The protection provided by plasma electrons was on the level of the control. The variety Vizija had the longest spike (from 8.3 to 10.0 cm), and the variety Pobeda the shortest (from 7.5 to 8.9 cm) during all years of the research. This interaction was highly significant. A highly significant difference was established between the years when the research was performed and high interactions between variety × years, variety × treatment, year × treatment and variety × year × treatment were established.

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