

# **BOOK OF PROCEEDINGS**

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## PREFACE

### A Word from the Editor-in-Chief

Dear colleagues,

In your hands are the Proceedings of the 9<sup>th</sup> International Scientific Agricultural Symposium “AGROSYM 2018” held on 4-7 October 2018 in Jahorina, Bosnia and Herzegovina. The Symposium gathers about 1200 participants from 85 different countries and organizers received over 1200 abstracts/full papers. Symposium themes covered all branches of agriculture and were divided into seven sessions: 1) Plant production, 2) Plant protection and food safety, 3) Organic agriculture, 4) Environmental protection and natural resources management, 5) Animal husbandry 6) Forestry and Agro-forestry, and 7) Rural Development and Agro-economy.

In the plenary lectures was presented the importance of new information and communication technologies for agriculture in the 21<sup>st</sup> century and biological protection in plant production. Furthermore, a particular attention was devoted to avoiding knowledge waste through networking and partnership.

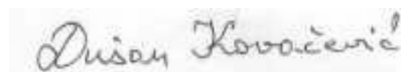
Agriculture has a complex relationship with natural resources and the environment, thus attributing specific environmental effects to agriculture is difficult and not fully understood. Today, it is obvious that conventional methods of agricultural production, in addition to providing sufficient food and other products, have led to a number of negative impacts, including direct or indirect effects on human health. Excessive use of agrochemicals can cause various disorders in the biological equilibrium of agroecosystems and beyond. These negative impacts raise serious questions about long-term sustainability of high-input agriculture. Measures to protect soil and water in agriculture include comprehensive and complex undertakings and pre-planned measures. These problems are a constant reason for ‘popularisation’ of all ecological trends in agriculture (e.g. organic agriculture, permaculture, biodynamic agriculture, conservation agriculture, regenerative agriculture, integrated farming, agroecology, etc.). Meanwhile, there are also calls for a genuine, deep transformation of agro-food systems that goes beyond ‘ecologisation’ of agricultural production. All these developments in agricultural research field, as well their implications on farmers’ fields, were discussed during the 4 days of AGROSYM 2018.

All papers included in the Proceedings were peer-reviewed. Full texts of the accepted contributions are available in electronic form on AGROSYM website (<http://agrosym.unssa.rs.ba>).

I hope that the Proceedings will be useful to many agriculturalists and to those engaged in related fields and enable better collaboration of scientists, researchers and producers.

Many thanks to all the authors, reviewers, session moderators and colleagues for their help in editing the Proceedings “AGROSYM 2018”. Special thanks go to all co-organizers for their unselfish collaboration and comprehensive support.

East Sarajevo, 07<sup>th</sup> October 2018



Prof. Dušan Kovačević, Editor-in-Chief

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### Abstract

Variability of length of spike and number of spikelets spike<sup>-1</sup> have share in forming of grain yield of wheat. The aim of this study was estimation of variability of length of spike and number of spikelets spike<sup>-1</sup> in 20 genetically divergent wheat cultivars grown in different environmental conditions. The experiment was set up as a randomised block design in three replications. Obtained results indicated differences in average values of length of spike and number of spikelets spike<sup>-1</sup> among tested cultivars in both years of experiment. In average for all cultivars length of spike was higher in the second year than in first year of experiment. Also, average value of number of spikelets spike<sup>-1</sup> was higher in second year at the analysed wheat cultivars. The wheat cultivar Dejana expressed the highest length of spike (12.50cm) in average in the second experimental year while the wheat cultivar Sumadinka had the least length of spike (8.91cm) in average in the first year. Based on the results was established, variability of wheat cultivars for the both analysed traits of spike, as well as, significant differences between the wheat cultivars according to length of spike and number of spikelets spike<sup>-1</sup>, which are in dependence of genetic and environmental factors.

**Keywords:** wheat, variability, spike length, spikelets, cultivars.

### Introduction

Wheat (*Triticum aestivum* L.) is one of the most important crops as a source of food for the people worldwide. Increasing of wheat grain yield is the main task of breeders which require effort in improving characteristics of spike traits, grain, stem, leaf and root traits. The long and fertile spike potentially can contribute to improvement of grain yield of wheat (Zečević et al., 2008; Knezevic et al., 2014). Spike length together with number of spikelets and number of florets per spike represent great potential for yield improvement (Zečević, et al., 2004; Dimitrijević et al., 2011) through developing grain number spike<sup>-1</sup> and as a source of assimilate in grain filling period as well as forming grain yield. Increasing of number of spikelets potentially related to increasing of number of grains (Álvarez et al., 2008). Spike length had positive relationship with number of spikelets spike<sup>-1</sup> at both genotypic and phenotypic levels (Akram et al., 2008). Floral development is an important part of the pre-anthesis stage. Anther and ovary growth as well efficient pollination connected to grain number per spike, grain size and grain weight (Guo et al., 2015). Grain number per spike is related to floret survival (Gonzalez et al., 2011; Sreenivasulu and Schnurbusch, 2012). Spike structure has advantages in utilizing light in compare to other parts of plant and contribute to



increasing of yield. Also, spike together with awns contribute to longer stay green area duration. All these characteristics of spike contribute to accumulate in average 20-30% of dry matter depends of genetic and environmental factors as well as their interaction (Knezevic et al., 2015; Branković et al., 2015). The effect of genetic and environmental factor at the length of spike and development of number of spikelets per spike need further investigation. Increasing of genetic capacity of spike traits is a potential direction of increasing grain yield of wheat (Knezevic et al., 2012).

The aim of this paper was investigation of variability of length of spike and number of spikelets spike<sup>-1</sup> in genetically divergent wheat cultivars grown in different environmental conditions.

### **Materials and methods**

The twenty genetically divergent winter wheat cultivars were used for study of length of spike and number of spikelets spike<sup>-1</sup> during two season of vegetative growth year (2015/16 and 2016/17). The experiment was performed in randomized block design in three replication on the field in Kraljevo, Serbia. The seeds of varieties were sown at the distance of 0.05m in rows of 1m length among which was the distance of 0.2m. For analysis of length of spike and number of spikelets spike<sup>-1</sup> were used 60 plants in full maturity stage (20 plants per replication). For statistical analysis used MSTAT C version 5.0. The significant differences between the average values were estimated by F-test values. The analysis of variance was performed according to a random block system with one factor significant difference was tested by means of the value of LSD test.

### **Weather conditions**

In the first year experiments 2015/206, the average temperature was 9.9 °C and the total amount of precipitation was 651.00 mm. In the second year of experiment 2016/17 average temperature was 13.0 °C and the total amount of precipitation was 523.0 mm. The average rainfall was 651.00 mm in the first year and significantly higher than in the second year (523.1 mm), and significantly higher than average values for ten years - 417.8 mm (table 1). For plants growth in the second year was more favorable regime of temperature and precipitation.

Table 1. Average monthly temperature and total monthly precipitation in Kraljevo

	Period	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Xm	Total
Temperature °C	2015/16	11.6	7.3	3.3	-0.1	8.8	7.8	14.1	15.5	21.3	<b>9.96</b>	89.64
Temperature °C	2016/17	10.6	6.8	0.0	-4.7	5.2	10.8	11.1	16.8	22.1	<b>8.74</b>	78.66
2000-2010		11.8	6.4	1.7	-0.1	2.6	5.9	11.6	16.4	20.4	<b>8.5</b>	76.5
Precipitatin (mm)	2015/16	56.8	64.0	9.0	86.2	52.7	157.9	39.9	135.9	48.6	72.3	<b>651.0</b>
(mm)	2016/17	84.1	77.6	9.4	22.0	35.0	57.0	82.0	100.0	56.0	41.1	<b>523.1</b>
2000-2010		61.0	44.3	44.6	30.0	29.9	33.2	52.9	52.6	69.3	46.4	<b>417.8</b>

During October-November, a greater amount of water residue was in the second year (161.7 mm) than in the first (120.8 mm), which represents a favorable period of germination of plants and better condition of plants for survive in the coming winter period, while during the preiod February-April amount of precipitation in the first year (250.5 mm) was higher than in the second (174.0 mm), although the distribution of rainfall was favorable in the second year of the experiment. Also, in the two months (October-November) the average temperature values were similar, wherein the sum of the temperature for the period February april 30.7 °C in the first year, more than the amount for the same period in the second year - 27.1 °C (table 1).

### Results and discussion

The length of spike in the first year of experiment varied in ratio of 8.91-11.11 cm with average value 9.92 cm, while in second year varied from 10.03 to 12.50 cm with average value 11.09 cm. Number of spikelets spike<sup>-1</sup> in the first year of experiment varied in interval of 20.85 - 24.38 with mean value 22.79, while in second year number of spikelets spike<sup>-1</sup> varied between 21.23 and 25.0 with average value 23.53 (table 2). The obtained results showed significant differences in the average values of length of spike and number of spikelets spike<sup>-1</sup> per year, that indicating diversity of studied cultivars. Similar results were reported in previous investigation of Serbian wheat genotypes (Zečević et al., 2008; Knezevic et al., 2012) as well as for Italian and Spanish wheat cultivars (Álvaro et al., 2008).

Table 2. Variability of length of spike and number of spikelets spike<sup>-1</sup>

Cultivars	length of spike (cm)			Number of spikelets spike <sup>-1</sup>		
	First year	Second year	Average	First year	Second year	Average
Evropa 90	11.09a	12.07b	11.58	22.83cde	23.00defg	22.92
Dejana	11.11a	12.50a	11.80	24.38a	24.87ab	24.62
Sila	9.95bcd	10.54ijk	10.24	22.40de	24.38abc	23.39
Omega	10.06 bcd	11.27cd	10.66	22.80cde	23.50cdefg	23.15
Lasta	10.07 bcd	11.23cd	10.65	22.00ef	23.33cdefg	22.66
Milica	10.05 bcd	10.83efghi	10.44	23.63abc	23.65cdef	23.64
Partizanka	10.43abc	11.53c	10.98	23.67abc	24.00abcde	23.83
Pobeda	9.50de	10.73ghij	10.12	23.67abc	24.00abcde	23.83
Dična	9.99bcd	11.14cdef	10.56	23.00bcde	24.00abcde	23.50
NSR-5	9.96bcd	10.03l	10.00	23.10bcd	22.90efg	23.00
Alfa	9.59cde	11.07defg	10.33	24.00ab	25.00a	24.50
Rodna	9.50de	11.30cd	10.40	22.67cde	23.33cdefg	23.00
Agrounija	9.56cde	10.76fghij	10.16	22.27de	22.83fg	22.55
Zadruga	10.50ab	10.30kl	10.40	20.85g	21.23h	21.04
KG -75	10.55ab	12.35ab	11.45	21.08fg	23.20defg	22.14
Šumadinka	8.91e	10.97defgh	9.94	22.48de	22.40g	22.44
Levčanka	9.56cde	10.65hijk	10.10	23.67abc	23.73bcdef	23.70
Oplenka	8.98e	10.36jkl	9.67	23.08bcd	23.92abcdef	23.50
Gruža	9.56cde	10.93defghi	10.24	22.00ef	23.35cdefg	22.67
KG-56	9.41de	11.21cde	10.31	22.39de	24.05abcd	23.22
Average	9.92	11.09	10.50	22.79	23.53	23.16

The significant differences among the investigated wheat cultivars were established for the length of spike (table 3). Also, the values of length spike of analysed genotypes were significant different between first and second experimental years (table 2). Generally, in average all studied wheat cultivar in both year and in average expressed higher values of length of spike. This indicates response of genotypes to environmental conditions.

Differences among cultivars according to value of spike length are affected more by genotype than by relationships to the geographic origin (Dotlačil et al., 2003). The length of spike controls by additive and nonadditive gene with prevalence of additive gene effects (Ljubičić et al., 2014). Also, the sensitivity of length of spike under environmental variation noticed (Zečević et al., 2008; Knezevic et al., 2014) and represent important components of wheat yield. The environmental factors as well temperature values, precipitation, nutrition have influence on increasing of capacity of spike (Petrović et al. 2008; Knežević et al., 2016).

Table 3. Components of phenotypic variance for length of spike (cm) of wheat – in 1<sup>st</sup> and 2<sup>nd</sup> year

Source of variance	First Year						Second Year					
	DF	SS	MS	F	LSD		DF	SS	MS	F	LSD	
					0.05	0.01					0.05	0.01
Repetitions (R)	2	0.500	0.250	0.9270 <sup>ns</sup>	-	-	2	0.111	0.056	0.9978 <sup>ns</sup>	-	-
Genotypes (G)	19	20.606	1.085	4.0247**	0.886	1.212	19	23.938	1.260	22.6335**	0.404	0.553
Error	38	10.240	0.269	-	-	-	38	2.115	0.056	-	-	-
Total	59	31.345	-	-	-	-	59	26.165	-	-	-	-

The significant differences among the tested wheat cultivars were established for the number of spikelet spike<sup>-1</sup> in both year of experiment (table 4). The number of spikelet spike<sup>-1</sup> at the analysed wheat cultivars varied and were significantly different between the cultivars between and between the years of experiment. Generally at the all tested cultivars the number of spikelet spike<sup>-1</sup> in second year was the higher than in first year of experiment (table 2).

Table 4. Components of phenotypic variance for number of spikelets spike<sup>-1</sup> in wheat

Source of variance	First Year						Second Year					
	DF	SS	MS	F	LSD		DF	SS	MS	F	LSD	
					0.05	0.01					0.05	0.01
Repetitions (R)	2	1.265	0.632	1.7152 <sup>ns</sup>	-	-	2	0.709	0.355	0.7949 <sup>ns</sup>	-	-
Genotypes (G)	19	47.646	2.508	6.8009**	1.038	1.419	19	41.244	2.171	4.8668**	1.141	1.560
Error	38	14.012	0.369	-	-	-	38	16.949	0.446	-	-	-
Total	59	62.922	-	-	-	-	59	58.902	-	-	-	-

The investigated trait highly depended to genetic and environmental factors (Zečević et al. 2004; Dodig et al., 2008). The spike length is yield components which highly positively correlated to number of spikelets spike<sup>-1</sup> (Akram et al., 2008). The spike length has strong indirect influence on yield through number of spikelets spike<sup>-1</sup> and further on number of grain and size and weight of grain (Zečević et al., 2004). Improvements in the number of grains per spikelets mean increasing the number of grains spike<sup>-1</sup>.

### Conclusions

In this investigation were determined differences among wheat genotypes according to values of length of spike and number of spikelets spike<sup>-1</sup>. The highest values of length of spike (12.50cm) in Dejana cultivar expressed in the first experimental year while the least (8.91cm) in wheat Šumadinka had in first experimental year. Breeding programs need conduct in the different environments in the aim of improvement of spike traits by using germplasm resources. Increasing of wheat grain yield is achievable through improving of all morphological, physiological characteristics of spike as well other organs of wheat.

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