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FOREWORD

A Word from the Editor-in-Chief

Dear colleagues,

In your hands is the Book of Proceedings of the X International Scientific Agricultural Symposium "AGROSYM 2019", which I hope you will find useful in your work. As many as 900 contributions, from 82 countries, have been accepted for oral or poster presentations. Symposium themes cover all branches of agriculture and are divided into 7 sessions: 1) Plant production, 2) Plant protection and food safety, 3) Organic agriculture, 4) Environmental protection and natural resources management, 5) Animal husbandry, 6) Rural development and agro-economy, 7) Forestry and agroforestry. Papers dealing with agricultural engineering and technology were included into one of the seven sessions depending on their focus.

In the plenary lectures were addressed interesting topics; one keynote was on biotechnology and two others dealt with organic farming in Australia and Europe. This confirms the role of AGROSYM as a forum for open discussions and exchanges on agriculture, food, the environment and rural development in the Balkans and beyond. Many of the papers identify a number of approaches and market-based incentives to encourage producers to achieve higher levels of performance (from both economic and environmental points of view) and as a result to meet the expectations of governments and consumers.

The successful management of agricultural resources to satisfy changing human needs, while maintaining or enhancing the quality of the environment and conserving natural resources, indicate a long-term agricultural development imperative. Advances in productivity, profitability and stability of modern cropping, animal and forestry systems will have to be achieved globally on an ecologically sustainable basis. Today, it is obvious that conventional methods of agricultural production, while providing sufficient food and various products to humanity, have led to a number of negative impacts, including the transgression of many planetary boundaries. These negative impacts raise serious questions about the long-term sustainability of high-input agriculture and call for a genuine transition towards sustainable agro-food systems, which achieve food and nutrition security for present and future generations within the safe operating space for humanity.

Full texts of the submitted communications will be available on the website of AGROSYM (http://agrosym.ues.rs.ba). Each paper included in the present Book of Proceedings was positively reviewed.

Much appreciation is due to the authors of all papers submitted and presented at the symposium as well as to all symposium participants whose ideas and contributions allowed rich and lively discussions during the various sessions. Many thanks to all reviewers, session moderators and colleagues for their help in editing the Book of Proceedings. Special thanks go to all co-organizers, partners and sponsors for their unselfish collaboration and comprehensive support.

Editor-in-Chief

Dusan Kovacevic, PhD

East Sarajevo, 12 October 2019

CONTENT

VARIABILITY OF LENGTH OF SPIKE AND NUMBER OF SPIKELETS PER SPIKE IN WHEAT (*Triticum aestivum* L.)

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Abstract

Variability of length of spike and number of spikelets spike^{-1} 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^{-1} 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^{-1} 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^{-1} was higher in second year at the analysed wheat cultivars. The wheat cultivar Dejana expressed the longest spike (12.50cm) in the second experimental year while the wheat cultivar Sumadinka had the shortest spike (8.91cm) in the first year. On the base of results were established variability of both analysed spike traits in wheat cultivars. Also, this results showed significant differences among wheat cultivars according to length of spike and number of spikelets spike^{-1}, which are determined by 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^{-1} 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 (Álvaro *et al*., 2008). Spike length had positive relationship with number of spikelets spike^{-1} 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 (Knežević *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^{-1} in genetically divergent wheat cultivars grown in different environmental conditions.

Materials and Methods

The twenty geneticaly divergent winter wheat cultivars were used for study of length of spike and number of spikelets spike^{-1} during two season of vegetative growth year (2015/16 and 2016/17). The experiment was performed in randomized block design in three replications 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^{-1} 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 and significant differences were tested by means of test value of $LSD_{0.05}$ and $LSD_{0.01}$.

Weather conditions

In the first year experiments 2015/206, the average temperature was 9.9 °C and the total amount of precipitation was 651mm. In the second year of experiment 2016/17 average temperature was 13.0 °C and the total amount of precipitation was 523 mm. The average rainfall in the first year (651mm) was significantly higher than in the second year (523.1 mm), and than for ten years - 417.8 mm (Table 1). For plants growth in the second year was more favorable regime of temperature and precipitation. During October-November, a greater amount of water residue in the second year (161.7 mm) was higher than in the first year (120.8 mm) but in both years weather condition in this period was favorable for seed germination and development of plants to be in good condition for survive in the future winter period. Also, in the two months (October-November) the average temperature values were similar in both year of experiment. During the 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 more favorable in the second year experiment (Table 1).

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	**9.96**	
Temperature °C	2016/17	10.6	6.8	0.0	-4.7	5.2	10.8	11.1	16.8	22.1	**8.74**	
2000-2010		11.8	6.4	1.7	-0.1	2.6	5.9	11.6	16.4	20.4	**8.5**	
Precipitatin (mm)	2015/16	56.8	64.0	9.0	86.2	52.7	157.9	39.9	135.9	48.6	72.3	**651.0**
Precipitatin (mm)	2016/17	84.1	77.6	9.4	22.0	35.0	57.0	82.0	100.0	56.0	41.1	**523.1**
2000-2010		61.0	44.3	44.6	30.0	29.9	33.2	52.9	52.6	69.3	46.4	**417.8**

Results and Discussion

The length of spike in the first year of experiment varied in range 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^{-1} 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^{-1} 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^{-1} per year, that indicating diversity of studied cultivars.
Similar results were reported in previous investigation of Serbian wheat (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-1

	length of spike (cm)			*Number of spikelets spike^{-1}*		
Cultivars	First year 2015/16	Second year 2016/17	Average	First year 2015/16	Second year 2016/17	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 significantly different between first and second experimental years (Table 2). Generally, in average all studied wheat cultivar in both year expressed higher values in relation to average value of length of spike in the first year. 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) and grain yield (Marijanović *et al*., 2010).

Table 3. Components of phenotypic variance for length of spike (cm) of wheat – in 1st and 2nd 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^{ns}	-	-	2	0.111	0.056	0.9978^{ns}	-	-
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, in both year of experiment, were established for the number of spikelet spike^{-1} (Table 4). The number of spikelets spike^{-1} at the analysed wheat cultivars variate and were significantly different among the cultivars and between the years of experiment. Generally, the all tested cultivars had higher number of spikelet spike^{-1} in second year than in first year of experiment (Table 2).

Table 4. Components of phenotypic variance for number of spikelets spike^{-1} 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^{ns}	-	-	2	0.709	0.355	0.7949^{ns}	-	-
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^{-1} (Akram *et al*., 2008). The spike length has strong indirect influence on yieald through number of spikelets spike^{-1} and futher on number of grain and size and weight of grain (Zečević *et al*., 2004). Improvements in the number of grains per spikelets related with increasing the number of grains spike^{-1}.

Conclusions

In this investigation the differences were determined among wheat genotypes according to values of length of spike and number of spikelets spike^{-1}. The highest values of length of spike expressed wheat cultivar Dejana (12.50cm) in the first experimental year while the least in wheat Šumadinka (8.91cm) in first experimental year, too. Breeding programs in the aim of improvement of spike traits of wheat need develop on the base of use wide germplasm resources and conduct in the different environments. Increasing of wheat grain yield is achievable through improving of all morphological, physiological traits of spike as well other organs of wheat.

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