VARIABILITY OF NUMBER OF KERNELS PER SPIKE IN WHEAT CULTIVARS (*Triticum aestivum* L.)

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ABSTRACT

In this paper was analyzed number of kernels per spike in 20 genetically divergent wheat cultivars originated from different breeding centers in Serbia. Investigation conducted during two seasons which characterized different climatic condition. For analysis used samples of 60 wheat plants (20 plants in 3 replications) which were harvested in full maturity stage. The differences in average values for number of kernels per spike in studied cultivars were determined. The variability of number of kernels per spike was established. In average, number of kernels per spike for all cultivars was higher in second year 72.22 than in first experimental year 68.73. The highest number of kernels/spike in both year expressed Tanjugovka cultivar and the lowest Yugoslavia cultivar. Average value of coefficientvariation for all cultivars varied from 14.19 in first year to 12.92 in second year. Average number of kernels per spike for both year of growing, varied from 54.56 in cultivar Yugoslavia to 77.83 in cultivar Tanjugovka. Significant differences for number of kernels/spike were found among cultivars in both years as well between years. Heritability in wide sense for number of kernels/spike was 79.13%.

Key words: cultivar, kernels, spike variability, wheat

Introduction

The wheat yield is affected by many factors: genetic, environment and theirs interaction. The value of yield varied in dependence of yield components such as stem height, leaf area, spike length, number of spikelets per spike and number of kernels per spike were also found associated with the vegetative growth period. Number of kernels per spike associated by the number of spikelets per spike, number of florets per spikelet as well efficiency of pollination and seed developing in florets. These components are in direct connection with productivity in wheat (Knezevic et al., 2007) and barley (Madic et al., 2009) which can modify under different environmental factor. These traits and numerous other morpho-physiological traits associated with yield, which contribution is different because of specific relationships depend of environment. Increasing of yield reached by early sowing (Arain et al., 2001; Sial et al., 2000). Temperatures and water stresses in postanthesis period have influence on reduction of kernels developing and filling in wheat (Sial et al., 2005; Mohammadi et al., 2011). Deficit of water effect to enhance competitiveness of the weeds and in such or similar unfavorable environmental condition, wheat has reduced yield.

Genetic potential of wheat yield represents yield of a cultivar grown in environments which is adoption of nutrients and water regime, pesticide application have influence to wheat yield and quality improvement (Miflin, 2000; Paunovic et al., 2006; Kovacevic, 2007). Also, creation of new cultivars and adoption of optimal growing technology will contribute to increasing of wheat yield (Sial et al., 2000; Arain et al., 2002; Okuyama et al., 2005). Improvement of wheat yield based on breeding concept and use large germ-plasm and best cultivars as a parent. It mean that is necessary select cultivars for hybridization after analysis of certain traits of yield (Vandeleur and Gill, 2004; Knezevic et al., 2006). The success in breeding process is not simple because of complex relationships between grain yield and yield components. Some of yield components is in positive correlation and other is in negative correlation what make difficulties in efficiency of selection genotypes on yield increasing, because in improvement of one component usually causes decreasing value of another components (Ahmed and Khaliq, 2007). Also, some yield component expressed different genotypic correlation and value in dependence of normal and stresses environmental condition. A lot of study reported that number of kernels per spike had positive correlation, which indicated that this traits can used as a selection criteria for wheat (Eid, 2009). However, success in breeding is in dependence from heritability of these traits, i.e., from the ratio of genetic variance within the total phenotypic variance as well as the ratio of the components of genetic variance (Singh et al. 2004; Zecevic et al., 2009).

The aim of this paper is study of variability of number of kernels per spike in genetically divergent wheat cultivars grown in different environmental condition.

Materials and Methods

The variability of number of kernels per spike was studied in 20 cultivars created in three different Serbian wheat breeding centers Kragujevac, Zemun and Novi Sad. For this investigation used cultivars: Morava, Sumadinka, KG – 56, KG – 58, KG – 75, Oplenka, Gruzanka, Orasanka, Levcanka, Gruza (Kragujevac), Agrounija, Zadruga, Kompas (Zemun) and NS Rana 2, Tanjugovka, Somborka, Yugoslavia, Danica, Kremna, Pobeda (Novi Sad). The experiment was performed in randomized block design in three replications on the experimental field of Center for Small Grains in Kragujevac, Serbia. The seeds of cultivars were sown at the distance of 0.05m in rows of 1m length among which was the distance of 0.2m. Spike of primary (main) stem of selected 60 wheat plants were used for analysis number of kernels per spike (20 spikes per replication). After analysis were computed: the average value (x); the variance (σ^2); the coefficient of variation (V) as an index of relative variability of the trait. 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, allowing the calculation of the components of variance (σ^2_g-genetic).

Results and Discussion

The analysis of cultivars showed significant differences among cultivars for number of kernels per spike in each year. In the first year of study the number of kernels was the least in wheat cultivar Yugoslavia (49.15) an the highest in cultivar Levcanka (77.68), while in second year the least number of kernels per spike 59.98 was in Yugoslavia cultivar and the highest in Tanjugovka (81.73).

In average for both year of investigation the least value of number of kernels per spike was found in cultivar Yugoslavia (54.56) and the highest in cultivar Tanjugovka (77.83) table 1.

The average value for all cultivars in the first year was 68.73 kernels per spike, while in the second year was 72.22 kernels per spike. These values are significantly different (tab.1).

Similar results for variability of number of kernels per spike in study of another wheat cultivars established (Knezevic et al. 2000). However, investigation under drought stress condition (Eid, 2009) showed extremely low, ranged between 13.4 and 17.3 number of kernels per spike. This reduced number of kernels per spike connected with water stress influence in stage of embryogenesis and development of kernels in final number (Riaz and Chwodhry, 2003).

The obtained different values and large number of kernels/spike could be explained primarily by type of sowing, helping to ensure optimal conditions for the development of a large number of spikelets and florets, on the other hand, creating favorable conditions for flowering and pollination, resulting in higher average values for the number of grains per spike. For high yield of wheat is desirble spike with more than 18 spikelets and in average 3 kernels/spikelets. Productive traits of spike varied in the same cultivars in different years of investigation established in other study that indicating high influence of environmental factors on the expression of spike traits (Agoston and Pepo, 2005; Dakhim et, al. 2012).

Indicators of variability, the coefficient of variation and standard deviations indicate a relatively high variability of this trait. The coefficient of variation of number of kernels/spike indicates that the highest variation in the first year had cultivar Sumadinka (V=20.27%) and in the second year cultivar Gruzanka (V=16.94%) while the least average value of coeficient of variation in the first year was in cultivar Agrounija (V=6.90%) and in the second year cultivar KG-58 (V=9.86%). Cultivar Agrounija had the least variation in the average for both years (V=8.56%), while the highest variability was determined in the cultivar Sumadinka (V=16.34%). In average for all investigated cultivars the coefficient of variation was 14.19% in the first year was higher in relation to average value 12.62% for all cultivars in the second year. Looking for all cultivars and years of testing the average coefficient of variation was V=13.56% (tab.1).

These values variability of kernel number per spike are consistent with studies of Knezevic et al. (2006).

The high value of heritability (h^2=79.36%) indicates the high heredity of number of kernels per spike. The high value of heritability in wide sence found Mohammadi et al. (2011).

Table 1. Average value of number of kernels per spike in wheat cultivars

	2005			2006			Average values		
	$\bar{X} \pm s\bar{x}$	S	CV%	$\bar{X} \pm s\bar{x}$	S	CV%	$\bar{X} \pm s\bar{x}$	S	CV%
Morava	71,10±0,76	5,88	8,27	61,98±0,89	6,87	11,08	66.54±0.82	6.38	9.68
Šumadinka	70,95±1,86	14,38	20,27	71,40±1,14	8,86	12,41	71.18±1.5	11.62	16.34
KG – 56	71,05±1,54	11,21	15,78	79,65±1,20	9,31	11,69	75.35±1.37	10.26	13.74
KG - 58	75,05±1,01	7,86	10,47	73,65±0,78	6,81	9,25	74.35±0.89	7.33	9.86
KG – 75	76,12±1,48	11,50	15,12	72,12±1,14	8,86	11,49	74.12±1.31	10.18	13.30
Oplenka	71,90±1,87	14,52	20,19	79,20±1,26	9,78	12,35	75.55±1.31	12.15	16.27
Gružanka	77,00±1,51	11,71	15,21	74,15±1,62	12,56	16,94	75.57±1.31	12.14	16.08
Orašanka	55,18±1,21	9,39	17,02	62,62±1,22	9,44	15,08	58.90±1.22	9.42	16.05
Levčanka	77,68±1,58	12,23	15,75	74,85±1,34	10,41	13,90	76.26±1.46	11.32	14.82
Gruža	73,38±1,63	12,63	17,20	77,57±1,53	11,82	15,24	75.48±1.58	12.22	16.22
Agrounija	69,02±0,99	7,67	6,90	71,12±0,94	7,26	10,21	70.07±0.96	7.46	8.56
Zadruga	60,62±1,25	9,66	15,94	67,02±1,09	8,41	12,54	63.82±1.17	9.04	14.24
Kompas	69,67±1,27	9,86	14,15	70,93±1,04	8,02	11,30	70.30±1.16	8.94	12.72
NS Rana 2	67,17±1,00	7,77	11,57	72,05±1,32	10,21	14,17	69.61±1.16	8.99	12.87
Tanjugovka	73,83±1,57	12,17	16,49	81,73±1,56	12,06	14,75	77.83±1.56	12.12	15.62
Somborka	66,22±1,29	10,06	15,19	68,92±1,43	11,07	16,06	67.57±1.36	10.56	15.62
Yugoslavia	49,15±0,87	6,79	13,82	59,98±0,81	6,25	10,43	54.56±0.84	6.52	12.12
Danica	55,31±0,74	5,74	10,38	61,73±0,24	7,14	11,56	58.52±0.49	6.44	10.97
Kremna	66,93±0,98	6,60	9,50	69,73±1,36	10,57	15,16	68.33±1.17	8.58	12.33
Pobeda	77,28±1,46	11,33	14,66	73,97±1,23	9,55	12,92	75.62±1.34	10.44	13.79
$\bar{X} \pm s\bar{x}$	**68.73±1.29**	9.95	14.19	**72.22±1.16**	9.26	12.92	**70.48±1.22**	9.60	13.56

	0.05	1,4.64		0.05	0.274		0.05	2.016
LSD for cultivars	0.01	1.928	LSD for years	0.01	0.396	LSD cultivar/year	0.01	2.698
Coeficient of variation**: 13.56 %** heritability in wide sence**:79,36 %**								

The relationship between yield components is under genetic control, which can vary in depending on the of environment. The high value of heritability indicates less influence of environment on this traits and genetic relationships is based on pleotropic gene effect or linkage of genes. Such genetic relation expressed through positive correlation between traits in normal and stressed environmental condition (Rana et al.,1999). However, correlation between spike length and number of spikes was negative under control conditions but positive under drought condition (Eid, 2009). In investigation of salt tolerant cultivars the correlation coefficient between spike length and number of kernel per spike were positive and significant (Ranjbar et al., 2010), and that grain yields of salt-tolerant cultivars were significantly correlated with number of kernel per spike. For the sensitivity of yield components is necessary estimate stability of cultivar by studying plant reaction to environmental specificity (Dimitrijevic et al., 2011)

Analysis of variance showed highly significant differences among the tested cultivars for number of kernels per spike. Differences in average number of kernels per spike for all cultivars per year of investigation were highly significant, as well as for and interaction cultivar/year. Analysis of variance of certain components share of the total phenotypic variability indicate that the largest impact belongs to the genetic variability (63.92%), followed by interaction of cultivar/year (29.89%), while the lowest was a 2.72 % share of the year (tab. 2). The similar results were reported by (Knezevic et al., 2000; Zecevic et al. 2009; Mohammadi et al., 2011).

Table 2. Component variance analysis for number of kernel per spike

Source of variance	–Degree of freedom (DF)	- Mean square (MS)	F-test	Components of variance	
				σ^2	%
Repetitions (R)	2	1.385			
cultivars	19	238.436	132.224**	32.11	63.92
years	1	264.221	145,943**	1.364	2.72
Interaction (CxY)	19	46.892	26.126**	15.011	29.89
Error(E)	78	1.802		1.746	3.47
Total	117			50.231	

Heritability value of the phenotypic variance is influenced by genetic factor and can use as useful indicator in breeding processes. On the base of heritability values breeders can estimate with high probability expected value of genetic advance in selection genotypes under specific environment. (Singh and Chaudhary, 2006; Dodig et al., 2007). In the case of low heritability what was found for number of kernels (Eid, 2009) we can expect slow improvement in selection.

CONCLUSION

The values the number of grains per spike reached in this study showed that the differences between the analyzed cultivars, and by years of experimental investigation. This indicate that genotype and environment have influence to variation of number of kernels per spike, which everage value in this sudy ranged from 54.56 kernels in cultivar Yugoslavia, to 77.83 kernels in cultivar Tanjugovka. The largest share of the genotypes with 63.92% of variance and interaction genotype/year with 29.89% was established for the expression of number of kernels per spike in analyzed wheat cultivars. Cultivars Tanjugovka, Pobeda, Gruza and Levcanka expressed high and stable value of number of kernels/spike and represent perspective parents for breeding program. For improvement of yield is necessary increase influence of genetic factor for all yield components. The higher impact of genetic factor in expression of number of kernels per spike as well other yield components will decrease effect of interaction genotype/environment. On the base of improvement of genetic control for increasing capacity of spike as well as morhpho-anatomical structure and physiological function breeders will successfully create cultivars with increased value of yield components.

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