UDC 575:633.11
DOI: 10.2298/GENSR1401027K
Original scientific paper

VARIABILITY OF GENOTYPE AND INHERITANCE OF GRAIN NITROGEN CONTENT IN WINTER WHEAT (*Triticum aestivum* L.)

Desimir KNEŽEVIĆ[1], Sonja MARIĆ[2], Vlado KOVAČEVIĆ[2], Nevena DJUKIĆ[3], Srdjan ATANASIJEVIC[4]

[1]University of Priština, Faculty of Agriculture, Kosovska Mitrovica, Lesak, Kosovo and Metohia, Serbia
[2]University J. J. Strossmayer in Osijek, Faculty of Agriculture, Osijek, Croatia
[3]University of Kragujevac, Faculty of Natural Science, Department of Biology, Kragujevac, Serbia
[4]Technical College of Professional Studies, in Kragujevac, Department of Informatics, Kragujevac, Serbia

Knežević D., S. Marić, V. Kovačević, N. Đukić, and S. Atanasijević (2014): *Variability of genotype and inheritance of grain nitrogen content in winter wheat* (*Triticum aestivum* L.)-. Genetika, Vol 46, No. 1, 27-32.

In diallel crosses (without reciprocals) of four genetically divergent wheat cultivars (Yugoslavia, Osijecanka, Zitnica, and NS Rana 2) the variability and inheritance of nitrogen content in wheat plant were investigated. The mode of inheritance, gene effect, heritability in parent cultivars and F_2 hybrids were studied. The different mode of inheritance: partial dominance, intermediate and overdominance for analyzed trait was established. Among parent cultivars, the highest nitrogen contents had Novosadska Rana 2 (3.52%). The combination Zitnica/NS Rana 2 in F_2 grain generation was the best for nitrogen content.

Key words: cultivars, hybrids, inheritance, nitrogen, wheat

INTRODUCTION

The ideal cultivar for high grain yield or for any other desirable traits need to express genetic potential in different environment with low value of variance in different environmental factors of growing (JOSHI *et al*. 2002; DREZNER *et al*., 2006; PETROVIĆ *et al*., 2006). High temperature after anthesis has negative influence in grain filling. Also, decreases of grain weight could be influenced by abiotic stress in early stage of filling what is the expressed in reduction of protein

Corresponding author: Desimir Knežević-Faculty of Agriculture, University of Priština, Kosovska Mitrovica, Lesak 38219, Kopaonicka bb., Kosovo and Metohija, Serbia, Phone: +381 64 614 8882 e-mail deskoa@ptt.rs

and starch accumulation (KNEZEVIC *et al*., 2007a; BALLA *et al*., 2008). One of the main tasks of breeders is to develop model of plant growth for efficient assimilation and translocation of nitrogen. For that it is necessary to improve application of fertilizers, pesticides, water etc. as well knowledge of assimilation, utilization and translocation of nitrogen in wheat plant (JOLANKAI & NEMETH, 2002; WILHELM *et al*., 2002). By promoting large numbers of progeny in the breeding process there is a chance of identifying phenotypes with favorable gene combinations for determining efficient nitrogen utilization. Nitrogen plays main role in wheat nutrition because of its importance in protein and nucleic acid synthesis as well plant productivity (KNEZEVIC & NOVOSELSKAYA-DRAGOVICH, 2007; TORBICA *et al*. 2008; DJUKIC *et al*. 2011). The very important for plant productivity is intensities of genotype reaction on nitrogen uptake on environment and its utilization in plants represents nitrogen efficiency utilization (GAMZIKOV&NOSOV, 2010; ZEČEVIĆ *et al*. 2010; KHALILZADEH *et al*., 2011). Although grain protein composition depends primarily on genotype, it is significantly affected by environmental factors and their interactions (TRIBOÏ *et al*., 2003). Therefore created semi-dwarf wheat cultivars characterized by efficient nitrogen utilization and translocation from vegetative organs to grain (KNEZEVIC *et al*., 2007b DAKHIM *et, al*. 2012).

The aim of this paper is to investigate mode of inheritance of nitrogen uptake in wheat genotypes and variability of grain nitrogen contents and perspective of wheat breeding for this trait.

MATERIALS AND METHODS

The variability of nitrogen concentration in grain used four divergent wheat cultivars (Yugoslavia, Osijecanka, Zitnica and NS Rana 2) which created in different breeding centers. Diallel crosses without reciprocals were performed and developed six hybrids combination. The experiment was carried out at the experimental field of the Center for Small Grains in Kragujevac. For this study, seed materials of parents and 6 crosses combination was sown in 1.0 m long rows, with row to row distance of 20 cm and plant to plant distance of 10 cm. Nitrogen concentration was analyzed at the full maturity stage by analysis of 120 plants per genotypes (40 plants per replication) for parents and F_2 hybrids of grain. Analysis of variance and test of significant differences for analysed traits computed by using MSTAT.

RESULTS AND DISCUSSION

Nitrogen content in grain of wheat is indicator of assimilate synthesis per unit of accessible nitrogen and in the same time represents measure of N utilization. If the reduction of yield with increased concentration of nitrogen in the grain, the genotypes have reduced efficiency and utilization of nitrogen fertilizer. However, choosing the reduced concentration of nitrogen in grain, in order to increase productivity, can lead to deterioration in the quality of grain as raw material for food industry.

Wheat cultivars that are in the research were as parents, in terms of nitrogen content in grain have expressed their differences. Thus, grain nitrogen content ranged from 2.95% as it was Osijecanka, and that was the least value, to 3.52% as the highest value that was in NS Rane 2.

Table 1. Average value of nitrogen contents in F_2 grain of hybrids and parent wheat cultivars

Cultivar	*Yugoslavia*	*Osijecanka*	*Zitnica*	*NS Rana 2*	$LSD_{0.05}$	$LSD_{0.01}$
Yugoslavia	3.01	3.40^{sd}	2.84^{-sd}	3.25^{i}	2.62	3.52
Osijecanka		2.95	3.01^{-pd}	3.00^{pd}		
Zitnica			3.30	3.80^{sd}		
NS Rana 2				3.52		
* d=bominance; sd=overdominance; pd=partial dominance; i=intermediate						

Among investigated combinations in the F_2 generation, the lowest average content ($\bar{X}$) of nitrogen in the grain had Yugoslavia/Zitnica (2.84%) and with the highest content was a combination of Zitnica/NS rana 2 (3.80%) table 1. Similar values of the variation in grain nitrogen concentration, while different mode of inheritance of N concentration in wheat grain were found (KNEZEVIC, 1997).

The most common type of inheritance of nitrogen in the tested hybrid combinations was over- dominance (50.03%). Partial dominance were expressed on the level of 33.3% and intermediate inheritance expressed to a lesser extent (16.66%). The concentration of nitrogen can be used as an indicator after harvest about supply plant with nitrogen.

Assessed values of the variability of nitrogen content in parental cultivars included in investigations indicate that there were gaps among them (tab.2).

Table 2. Computed statistical parameters of nitrogen contents in grain wheat

Cultivar Hybrid combination	Hybrid's Generation	X	$s_{\bar{x}}$ (%)	S^2	S	C_v(%)	h^2 (%)
Yugoslavia	P_1	3.01	0.06	0.10	0.32	10.1	
Osijecanka	P_2	2.95	0.03	0.11	0.33	10.8	
Zitnica	P_3	3.30	0.04	0.16	0.40	11.4	
NS Rana 2	P_4	3.52	0.16	0.23	0.48	12.2	
Yugoslavia/Osijecanka	F_2	3.40	0.08	0.17	0.41	11.6	30.4
Yugoslavia/Zitnica	F_2	2.84	0.16	0.20	0.45	14.4	35.8
Yugoslavia/NS Rana 2	F_2	3.25	0.08	0.12	0.35	9.8	32.6
Osijecanka/Zitnica	F_2	3.01	0.18	0.17	0.41	11.2	52.2
Osijecanka/NS Rana 2	F_2	3.00	0.08	0.11	0.33	9.9	42.3
Zitnica/NS Rana 2	F_2	3.80	0.15	0.14	0.37	10.8	26.6

Thus, with the highest coefficient of variation (CV) for this trait was NS Rana 2 (12.2%) and the lowest was Yugoslavia (10.1%). In the F_2 grain generation, the smallest variation in grain nitrogen content was found in hybrid combination Osijecanka/NS Rana 2 (9.9%) and highest Yugoslavia/Osijecanka (11.6%). The majority of hybrid combination expressed high variability of nitrogen concentration than in F_2 grain generation.

The concentration of nitrogen in the grain shows genotypic specificity (JEUFFROY, *et al*. 2002 ZEČEVIĆ *et al*. 2007). Cultivar differences in nitrogen concentration in the aboveground part may

affect the differences in yield, through the influence on the intensity and length of the activity of vegetative organs and protein content. Differences in nitrogen concentration in plants usually are differences in the amounts of nitrogen in vegetative organs, whose reutilization done much of the grain protein synthesis. However, some studies showed that the cultivars with high and low protein content in grain did not differ according to the concentration of nitrogen in the period to flowering (GÓRNY *et al.,* 2011) and that protein content is quantitatively inherited trait, strongly influenced by environmental factors and connected to grain yield and plant height (CLARKE *et al.,* 2009). The connection between high nitrogen content at maturity and high N uptake after anthesis, indicating that in wheat the proportion of the assimilated N used immediately in the developing grain, but there was no strong N translocation from vegetative parts of the main shoots in wheat and reproductive organs. This could be advantage in wheat breeding for high yield and high efficiently use available N in different growing conditions (KNEZEVIC *et al*. 2007b; MUURINEN *et al.,* 2007*).*

Heritability for grain nitrogen content was different for all combinations. The lowest value was found in hybrid combination Yugoslavia/Osijecanka and the highest at Zitnica/NS rana 2. The mean value of heritability for all analyzed hybrid combinations was 36.65% (table 2.).

This is based on the relationship between the development of grains and protein content, precisely, grain protein concentration was found to be more related to N availability during plant development than to dry weight or N concentration in various plant parts (Malik et al., 2012). Specifically, under the influence of enhanced nitrogen nutrition are increasing the yield and protein content, and finally only up increasing the protein content. Yield increases until the nitrogen concentration reaches an appropriate value (KRALJEVIC-BALALIC *et al*., 2001; PETROVIC *et al*., 2006). For most cultivars nitrogen concentration value is between 1.8 and 2.15%. Minimum value of the concentration of nitrogen in the grain that gives the maximum yield varies depending on genotype and growing conditions (GAMZIKOVA *et al*. 1991; ZEČEVIĆ *et al*. 2009).

CONCLUSION

Grain contents of nitrogen in analyzed wheat genotypes are different. For the increasing of N content is necessary create new genotypes with high efficiency of nitrogen absorption as well with high capacity of utilization, translocation and accumulation. The development of new genotypes with high efficiency of nitrogen uptake and capacity of nitrogen utilization will contribute to decreasing rate of application of nitrogen fertilizers. In this investigation were developed genotypes, by crossing *Zitnica/NS Rana 2* in F_2, which expressed the highest nitrogen contents and represents promising genotypes for cultivar creation with high yield low requirements for fertilizer application. For successful breeding is a necessary use parent with low requirement of nitrogen and high efficiency of absorption, utilization and translocation of nitrogen to grain.

ACKNOWLEDGEMENT

This work was supported by the Project TR 31092, Ministry of Education and Science of Republic of Serbia.

Received July 12th, 2012
Accepted November 05th, 2013

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VARIJABILNOST I NASLEDJIVANJE SADRŽAJA AZOTA U ZRNU GENOTIPOVA OZIME PŠENICE (*Triticum aestivum* L.)

Desimir KNEŽEVIĆ[1], Sonja MARIĆ, Vlado KOVAČEVIĆ[2],
Nevena DJUKIĆ[3], Srdjan ATANASIJEVIC[4]

[1]Univerzitet u Prištini, Poljoprivredni fakultet, Kosovska Mitrovica, Lešak, KIM, Srbija
[2] Sveučilište J.J. Strossmayera, Poljoprivredni fakultet u Osijeku, Osijek, Hrvatska
[3]Univerzitet u Kragujevcu, Prirodno-matematički fakultet, Institut za biologiju, Kragujevac, Srbija
[4]Visoka tehnička škola strukovnih studija u Kragujevcu, Odsek za informatiku Kragujevac, Srbija

Izvod

U radu je izučavano variranje sadržaja azota u zrnu sorti i hibrida pšenice. U izučavanjima su obuhvaćene 4 genetički divergentne sorte pšenice (Jugoslavija, Osiječanka, Žitnica, i NS Rana 2) i F_2 hibridi dobijeni u dialelnom ukrštanju (bez recipročnih). Izučavano je nasleđivanje sadržaja azota u zrnu kod F_2 hibrida i ustanovljno je da su se ispoljili različiti tipovi nasleđivanja sadržaja azota: parcijalna dominacija, intermedijarno nasleđivanje i superdominacija. Najveću vrednost sadržaja azota kod sorti imala je Novosadska rana 2 (3,52%) a najmanju Osiječanka (2,95%). Kod hibrida F_2 generacije najveći saržaj aota je nadjen u kombinaciji Žitnica/NS Rana 2 (3,80%), Jugoslavija/Osiječanka (3,40%) koji predstavljaju najperspektivnije genotipove u daljem programu oplemenjivanja za ovo svojstvo.

Primljeno 12. VII.2012.
Odobreno 05. XI. 2013.