VARIABILITY OF PHOTOSYNTHETIC PARAMETERS INSELECTED WHEAT (*TRITICUM AESTIVUM* L.)VARIETIES

Biljana M. Bojovic, Dragana Jakovljevic and Milan Stankovic

Abstract: The aim of this study was to explain the genetic variability of seven varieties of wheat (*Triticum aestivum* L.) and two varieties of triticale (hybrid wheat x rye) at unfertilized soil.The investigations included pigments content, leaf area, nitrogen content in the leaf, leaf and mesophyll thickness.Obtained results showed that there is a clear genetic variability in all tested components. Per study values for yield especially the prominent Lazarica genotype and both varieties hybrid species triticale – KG 20 and Knjaz,which also had the highest values for most parameters of productivity.Therefore, these genotypes of wheat can be recommend for organic production.

Key words: chlorophyll content, leaf area, leaf and mesophyll thickness, harvest index

Introduction

One of the most commonly cultivated crops in organic production is wheat. In addition to the rice, wheat is mostly used in human nutrition. Bread wheat (*Triticum aestivum* L.) is one of the most important small cereal crops widely produced in Serbia. In conventional production, in Serbia, wheat is grown on 460-600 000 hectares on which to produce up to 2.3 million tons of wheat. Area under organic production of wheat in 2010 amounted to 234 ha, i.e. 5% of the total area under organic production in Serbia (Marz et al., 2012).It is in the world to produce in areas ranging from 209 to 232 million hectares, or from 560 to 676 million tons of grain (Hristov et al., 2012). In this situation, we may resort to using two factors: variety, as a biological agent and cropping as a technological solution that enables different level of expression of the genetic potential of varieties. This means that we should favor those traits of plant species that have the strongest effect on productivity. Plant productivity depends on several factors, which need to find those varieties which have a very strong one or more of the desired properties, and crossing these varieties all the desired properties to connect to the hereditary basis of one genotype (Khokhar et al., 2010) From a theoretical standpoint, the correlation of morphological characteristics and physiological process provide new interpretations of the mechanism of ion to complete the picture of varietal characteristics(Dhonde et al., 2000;Degewione et al., 2013). Practical significance of this research is that it can make the synthesis of organic materials more cost-effective, both in terms of quantity and quality.

Grain yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations. According to plant breeding, direct selection for yield as such could be misleading. A successful selection depends upon the information on the

University of Kragujevac, Faculty of Science, Radoja Domanovica 12, Kragujevac, Serbia (biljanab@kg.ac.rs).

genetic variability and association of morph-agronomic traits with grain yield (Shoran et al., 1995; Ali et al., 2008).Therefore, the objective of this study was to determine the extent of genetic variability of photosynthetic components and associated traits (pigments content, leaf area, nitrogen content in the leaf, leaf and mesophyll thickness) and compare the direct and indirect influence of the traits on harvest index and grain yield.

Material and methods

We used seven wheat cultivars (Lazarica, Studenica, Matica, Takovcanka, Pobeda, KG-56, KG-100) and two triticale (wheat x rye hybrid) cultivars (Knjaz, KG-20). Plant material obtained from agricultural field located in Small Grains Research Center of Kragujevac. Samples of plant material (above ground parts of plants) were taken at the beginning of flowering from plot that is not fertilized at last 10 years. The results are shown as the average value from all three measurements.The content of nitrogen, phosphorus and potassium in the soil before the start of the experiment is given in Tab. 1.

Table 1. Nitrogen, phosphorus and potassium content in unfertilized soil before start of experiment

	pH				N		P_20_5		K_20	
	H_20		KCl		%		mg/100g		mg/100g	
Soil depth (cm)	0	20	0	20	0	20	0	20	0	20
	5.56	5.90	4.28	4.39	0.17	0.17	4.00	3.11	21.80	22.96

The *content of photosynthetic pigments* was determined by a modified spectrophotometric method according to Wellburn (1994);determination of*total nitrogen content*was carried out bymicromethodbyKjeldahl(1883).*Anatomical preparations* prepared used are standard paraffin method and staining methods;*Leaf area* was determined by leaf parameters method (Salerno et al., 2005).

Results and discussion

Chlorophyll and carotenoids content

The content of total chlorophyll, chlorophyll a and b ratio as well as the content of carotenoids varied, depending on the genotype (Tab. 2). The highest chlorophyll content was registered in hybrid variety Knjaz (2.477 mg/g), and the lowest in Takovcanka wheat genotype (0.984 mg/g). In other genotypes chlorophyll content ranged from 1.053 to 1900 mg/g. Carotenoids content was much lower than the content of chlorophyll in all varieties and its values are less varied depending on the genotype. The highest values for carotenoids content had hybrid sort Knjaz (0.448 mg/g), and the Pobeda had lowest (0.216 mg/g). In the other genotypes recorded values were between 0.236 and 0.379 mg/g. On the basis of the obtained data we can conclude that the most favorable content of photosynthetic pigments was in hybrid varieties, triticale. Photosynthetic pigments content is directly related to the productivity of plants, which implies the selection of these varieties for organic production.The content of chlorophyll and carotenoids in plants as well as their importance for the development of the photosynthetic apparatus and productivity studied by many researchers in the past, and intensive testing of these pigments continue today (Wellburn, 1994; Adrian and Tarchevski, 2000; Aranya et al., 2003; Kof et al., 2004). Many researchers confirm the importance of carotenoid pigment in complex and prove that the content of chlorophyll and carotenoid is more important for the productivity of plants than assimilation surface (Lichtenthaler et al., 1983;Kof et al., 2004).

Leaf area

Leaf area is the main determinant of plant productivity, and better understanding of the causes of variation of the yield of plants depends on a fuller knowledge of the dynamics of its development and size. Genotypes of wheat have varied greatly in leaf area. The highest leaf area had genotype KG 100 (54.861 cm^2) and the lowest genotype Lazarica (20.106 cm^2). Leaf area at the other genotypes ranged from 26.406 to 46.163 cm^2 (Tab. 2).

Table 2. Chlorophyll and carotenoids content, leaf area and nitrogen content in leaf at different wheat varieties

	Chlorophyll a+b (mg/g)	Carotenoids (mg/g)	Leaf area (cm^2)	Nitrogen content (%)
Lazarica	1.526	0.318	20.106	3.33
Studenica	1.053	0.370	35.668	1.95
Matica	1.412	0.358	26.406	2.57
Takovcanka	0.984	0.236	34.945	3.09
Pobeda	1.582	0.216	46.163	3.02
KG 56	1.182	0.338	29.184	2.92
KG 100	1.440	0.345	54.861	2.47
Knjaz	1.900	0.448	30.382	2.34
KG 20	2.477	0.379	37.346	2.87

Nitrogen content in the leaf

Nitrogen content was varied depending on the genotype of wheat, too. The highest value was measured in Lazarica genotype (3.33%) while other values ranged between 1.95 and 3.09% (Tab.2).Representation of mineral elements in plants depends on the intensity of adoption and dynamic synthesis of organic matter (Kastori, 1981). The content of mineral substances in plants not in all cases faithfully displays the status of these substances in the soil. The low mineral content in plants can be induced to insufficient content of these substances in soil; also a high mineral content in plants does not mean that the land is rich in these substances. The increase in the content of mineral elements in plants can come and due to other factors such as reduction in production of mineral substances and others. In the later stages of growth and development of plants, the concentration of minerals in plants depends primarily on the intensity of ions adoption. Later, the concentration of minerals in plants gradually reduces and mostly depends on the dynamics of the synthesis of organic matter.

Leaf thickness and mesophyll thickness

Leaf thickness and mesophyll thickness were varied depending of genotype much more than other parameters. Maximum thickness of the leaf had a variety Lazarica (192 μm), and minimum KG 56 (only 90μm). Other varieties had the thickness of the leaf ranged 130 and 110 μm. The thickest mesophyll had a variety Lazarica (148 μm), too, while the cultivar Studenica had the lowest value for mesophyll (57.3μm). For other varieties of measured values were between 58.1 and 85.6μm. Mesophyll occupying most of the percentage at Lazarica variety (77%), and lowest in Studenica (57.3%) (Tab. 3).It can be concluded that there are significant differences in the anatomical structure of leaves in different wheat varieties related to the thickness of leaf and mesophyll, which could have an impact on the content of chlorophyll and organic production in general.Mesophyll thickness is a prerequisite for the accommodation of a large number of chloroplasts with photosynthetic pigments.Varieties, whose leaves had thicker mesophyll, had a greater amount of chlorophyll. This can be proved by comparing the results in Table 2 and Table 3. Average minimum mesophyll was found for Studenica and Takovcanka, which are at the same time, had the lowest average total chlorophyll content in the leaf. Average maximum mesophyll thickness had Lazarica, Knjaz and KG 20 and they had the highest amount of total chlorophyll compared to other varieties. Based on these results, it can be argued that mesophyll thickness and the amount of chlorophyll have a positive correlation.Similar results were found at Merkulov et al. (1996) and White and Montes (2005).

Table 3. Leaf thickness and mesophyll thickness at different wheat varieties

	Leaf thickness (μm)	Mesophyll thickness (μm)	Mesophyll thickness /leaf thickness (%)
Lazarica	192	148	77
Studenica	100	57.3	57.3
Matica	112	68.3	60.9
Takovcanka	130	58.1	62.0
Pobeda	110	74.7	67.1
KG 56	90	80.5	64.5
KG 100	124	78.5	63.3
Knjaz	119	85.6	71.9
KG 20	118	83	70.3

Harvest index and yield

Harvest index varied depending of different variety of wheat.The obtained values show that the highest harvest index had Lazarica (39.46%) and the lowest KG 56 (26.62%). For other varieties the average values for harvest index were between 28.35 and 37.87% (Tab. 4).Harvest index is an indicator of yield and therefore is one of the most important parameter of plants productivity. The results obtained in this type of research have great practical significance. Also, this is the safest indicator of the existence of differences among varieties of wheat because the yield is result of operation to external factors to the plant as well as the influence of physiological and biochemical processes in the plant.

Table. 4. Harvest index and yield at different wheat cultivars

	Harvest index(%)	Yield (kg/ha)
Lazarica	39,46	2800
Studenica	37,87	2137
Matica	32,61	1995
Takovcanka	31,57	2150
Pobeda	37,57	1980
KG 56	26,62	1957
KG 100	30,96	2176
Knjaz	33,09	2774
KG 20	28,35	2250

To exploit the potential for yield and quality of wheat, must take into account the specificities of each variety, which are manifested in the differences in morpho-physiological properties (Pepo, 2000). Based on the results obtained for the yield can be confirmed that the varieties Lazaricaand Knjaz had the highest harvest index, and had the highest yield from the entire plot. For this reason, these two varieties can be recommended for growing in organic production, because they showed the best results in photosynthetic parameters on the unfertilized soils that are a precondition for better productivity.

Conclusion

Selection, using genetics, has the task to create a model plant that can best take advantage of optimal environmental conditions, without used synthetic agents from conventional production, such as mineral fertilizers, pesticides and growth stimulants. It is very important for organic production of wheat.Organic production or biological farming is a big movement that seeks to promote agriculture and depriving it of all ingredients that are harmful to man and the environment. It is a system of sustainable agriculture which is based on a high respect for ecological principles.

References

Adrianova Yu.E., Tarchevski I.A. (2000). Chlorophyll and Plant Productivity. Science, Moscow: 125-226

AliY., Atta B.M., Akhter J., Monneveux P., Lateef Z. (2008). Genetic variability, association and diversity studies in wheat *(Triticum aestivum*L.) germplasm. Pak. J. Bot., 40(5): 2087-2097

Aranya T., Pimnongkol N.D. (2003). Photosynthetic activity of MSMA-resistant and susceptible common cocklebur. Pesticide Biochem.Physiol., 76*:* 46-54.

Degewionne,A., Dejene,T., Sharif, M. (2013). Genetic variability and traits association in bread wheat *(Triticum aestivum L.)* genotypes. Int. Res. J. Agri. Sci., 1(2*):* 19-29

Dhonde, S.R., Kute, N.S., Kanaweall D Gandsrade, N.D. (2000). Variability and character association in wheat(*Triticum aestivum* L.). Agri. Sci. Digest., 20: 19-106

HristovN., Jevtic R., Lalosevic M., Frasiga F., Rajkovic M., Kalencici M. (2012). Manual for Organic Production of Wheat.Institute of Field and Vegetable Crops. Novi Sad

Kastori R. (1981). The content and layout of biogenic elements in wheat. In: Physiology of wheat, 79-103

Khokhar M.I., Hussein M., Zukiffal M., Ahmad N., Sabar W. (2010). Corellation and path analysis for yield and yield contributing characters in wheat *(Triticum aestivum* L.). African Journal of Plant Sciences, 4(11), 464-466

Kjeldahl J. (1883). New method for the determination of nitrogen in organic substances.ZeitschriftfüranalytischeChemie, 22 (1), 366-383.

Kof E.M., Oorzhak A.S., Vinogradova I.A., Kelibernnaya Z.V., Krendeleva T.E., Kukarskikh Z.V., Kondykov I.V., Chuvasheva E.S. (2004). Leaf Morfology, Pigment Complex and Productivity in Wild Type and afila Pea Genotips. Russian Journal of Plant Physiology, 51, 449-454.

Lichtenthaler H.K., Wellburn A.R. (1983).Determination of Total Carotenoides and Chlorophylls a and b of Leaf Extracts in Different Solvents.Biochem. Soc. Trans., 591-592.

Marz U., Stolz T., Kalentic M., Miskovic N. (2012).Organic Agriculture in Serbia. National Association, Novi Sad, 8-17

Merkulov Lj., Ivezic J., Pajevic S., Krstic B. (1996). Anatomical and physiological characteristics of wheat flag leaf. Abstract book, 1st. Congress of Biologists of Macedonia , Ohrid, 91.

Pepo P. (2000). Variety specific fertilization in wheat production. In: Wheat in global environment (Z. Bedo and L. Lang. eds). Kluwer Academic Publishers., 639-645.

Salerno A., Rivera C.M., Rouphael Y. (2005).Leaf area estimation of radish from simple linear measurements.Advances of Horticulture Sciences, 19(4), 213–215

Shoran J., Tandon J.P. (1995).Genetic divergence in winter wheat (*Triticum aestivum* L.). Indian Journal of Genetics, 55, 406-409

Wellburn A.R. (1994). The special determinations of chlorophylls a and b as well as total carotenoides using various solvents with spectrophotometers of different resolution. Journal of Plant Physiology, 144, 307-313.

WhiteJ.W., Montes R.C. (2005). Variation in parameters related to leaf thickness in common bean (*Phaseolus vulgaris* L.). Field Crops Research, 91, 7-21