UDC 575.21
Orginal scientific paper

VARIABILITY OF PLANT HEIGHT AND HARVEST INDEX OF VARIOUS WHEAT GENOTYPES CULTIVATED ON CHERNOZEM AND SOLONETZ

Zoran KAPOR, Sofija PETROVIĆ and Miodrag DIMITRIJEVIĆ

Department of Field and Vegetable Crops, Faculty of Agriculture, University of Novi Sad, Serbia

Kapor Zoran, Sofija Petrović and Miodrag Dimitrijević (2006): *Variability of plant height and harvest index of various wheat genotypes cultivated on chernozem and solonetz*. - Genetika, Vol. 38, No. 1, 75-82.

Solonetz is a type of halomorphic soil which is present on 80 000 ha in Vojvodina. Field experiments were conducted during 1999/2000 vegetation periods, involving eleven wheat genotypes cultivated on solonetz, location Kumane, and on chernozem, location Rimski Šančevi. The variability of plant height and harvest index on different soil types was investigated, as well as the correlation between these two yield parameters. The goal of this research was to establish the significance of various genotypes and soil type effects on plant height and harvest index, as well as the reaction of genotypes regarding different amelioration rates on solonetz.

Key words: solonetz, chernozem, plant height, harvest index, wheat

Corresponding author: Zoran Kapor, Chair for Genetics and Plant Breeding, Department of Field and Vegetable Crops, Faculty of Agriculture, Trg Dositeja Obradovica 8, University of Novi Sad. Phone number 064/118-6114, e-mail: zkapor@neobee.net

INTRODUCTION

There are over 1,8 million hectars of cultivating soil in Vojvodina (MINISTRY OF AGRICULTURE, AQUACULTURE AND FORESTRY, 1997) and the majority (about one million) is chernozem. On the other side, besides chernozem, various less fertile soil types are present in Vojvodina, such as solonetz. Solonetz is a type of halomorphic soil with unfavorable physical and chemical properties, especially due to increased concentration of sodium and clay. This soil type is present on 80 000 ha in Vojvodina (ŽIVKOVIĆ *et al.*, 1972) and in the region of Banat is most commonly used as a pasture. Amelioration, which includes incorporation of phosphogypsum, can transform solonetz into a cultivating soil (BELIC *et al.*, 2003). Wheat (*Triticum aestivum ssp. vulgare*) is one the most important field crops which is cultivated on 210 million hectars in the world and furnishes food for seventy percent of world population (FAO, 2002; JEVTIĆ, 1986). In Serbia and Montenegro, wheat is cultivated on 500-600 000 ha (MINISTRY OF AGRICULTURE, AQUACULTURE AND FORESTRY, 1997). The importance of wheat is indulged by the Government's strategy for the development of wheat improvement and wheat breeding programmes. The unanimous goal of all plant breeding programmes is increasing yield and product quality. One way of increasing yield is by selecting superior genotypes. The other possibility is increasing the cultivation area by selecting genotypes that are tolerant to soil types that are not suitable for intensive agriculture, such as solonetz. The ratio of vegetative and generative plant parts is very important for plant yield. Vegetative plant parts consist mainly of stem, hence in this research plant height was investigated. Plant height is a trait that is governed both by minor and major genes and represents the distance between the tillering knot and spike tip. Wheat genotypes with longer stems consume more nutrients for the development of vegetative parts, and the risk of lodging is greater. Contemporary breeding programmmes develop wheat genotypes with shorter stem because of the greater translocation assimilatives into the generative organs, resulting in greater yield (BOROJEVIĆ, 1983). Harvest index is the other investigated parameter representing the ratio of economic yield (grain, fruit etc.) and total biogical yield (BOROJEVIĆ, 1983).

The goal of this research was to determine the effect of soil type and genotype on plant height and harvest index, as well as their correlation on different soil types.

MATERIAL AND METHODS

Eleven cultivars originated from the Institute of Field and Vegetable Crops of Novi Sad were chosen for the experiment: Partizanka, Sremica, Jugoslavija, Stamena, Sara, Tiha, Zlatka, Pesma, Pobeda, NS Rana 5 and Renesansa. The field experiment was situated on two locations. Location one was in Kumane, Banat, on the soil type solonetz. The other location was Rimski Sancevi on the soil type chernozem. The experiment was organised as a random

block design including three replications and the size of the experimental plot of 2.5 m². Genotypes examined on solonetz, in Kumane, were cultivated on a control treatment, on a treatment including 25 t/ha of phosphogypsum amelioration and on a treatment including 50 t/ha of phosphogypsum amelioration. The experiment observed phenotypic variation of plant height (cm) and harvest index on all four soil treatments (three treatments on solonetz-Kumane, one on chernozem-Rimski Sancevi). The results of the field experiment were analysed using the statistical treatment model for the two factor experimental design (HADŽIVUKOVIĆ, 1991):

$$X_{ijk} = \mu + \alpha i + \beta j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

μ - general mean
α_i - effect of the i-level for the first factor
β_j - effect of the j-level for the second factor
$(\alpha\beta)_{ij}$ - interaction between the first and the second factor
ε_{ijk} - error

Statistical analysis was performed using the Statistica 7.1 program, regarding cultivars as a first factor (11 levels), and regarding soil as the second factor (4 levels). ANOVA was performed for plant height and for harvest index, separately. The comparison of the mean values was performed for the significant factor using Tukey test for the significance levels of α=0,05 and α=0,01.

The correlation between the plant height and the harvest index was calculated using the formula for the correlation coefficient:

$$r = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2 \sum_{i=1}^{n}(Y_i - \bar{Y})^2}}$$

The correlations between the plant height and the harvest index were calculated separately for every soil treatment.

RESULTS

The ANOVA for the two factor design showed that for plant height, the effect of the soil factor was significant, while the cultivar factor and the interaction between soil and cultivar had no effect for the variation (Table 1). The absence of the cultivar effect could be explained by the similar genetic origin of the cultivars from the Institute of Field and Vegetable Crops in Novi Sad. The interaction between the two factors wasn't a significant source of variation.

Table 1. - Factorial ANOVA for plant height

Sources of variation	Sum of squares	Degrees of freedom	Mean square	F-value
Soil	32824,6	3	10941.5	144,068**
Cultivar	1349,7	10	135,0	1,777
Soil*Cultivar	3020,2	30	100,7	1,326
Erorr	6683,3	88	75,9	

Considering the significance of the soil factor, the comparison of the plant height mean values regarding different soil treatment was performed using the Tukey test. Highly significant greatest plant height mean value was established on chernozem (80.7 cm) (Table 2 and 3). Highly significant lowest plant height mean value was established, as expected, on solonetz control tretament (36.7 cm), considering that plants which grow in a hostile environment tend to shorten the vegetitative and transfer to the generative stadium as quickly as possible. Plant height mean value established on solonetz treatment including 25 t/ha of phosphogypsum amelioration (53.0 cm) and on solonetz treatment including 50 t/ha of phosphogypsum amelioration (59.3 cm) were in the middle between the results on chernozem and on solonetz control treatment, indicating that plants reacted to the given soil amelioration. The difference between the mean values on solonetz amelioration treatments (25 and 50 t/ha of phosphogypsum) was only significant, and not highly significant.

Table 2. - Tukey test for plant height means regarding different soil types for α=0,05

	Soil treatment	Plant height Mean	1	2	3	4
1	Solonetz control treatment	36,71	****			
2	Solonetz including 25 t/ha of phosphogypsum	53,00		****		
3	Solonetz including 50 t/ha of phosphogypsum	59,25			****	
4	Chernozem	80,72				****

Table 3. - Tukey test for plant height means regarding different soil types for α=0,01

	Soil treatment	Plant height Mean	1	2	3
1	Solonetz control treatment	36,71		****	
2	Solonetz including 25t/ha of phosphogypsum	53,00	****		
3	Solonetz including 50 t/ha of phosphogypsum	59,25	****		
4	Cherozem	80,72			****

As well as plant height ANOVA, the harvest index ANOVA for two factor design showed soil factor as the only significant source of variation (Table 4). Considering harvest index as a relative yield parameter, this result could be explained by the same reaction of the cultivars to different soil types, regarding both vegetative and generative biomass production.

Table 4. - Factorial ANOVA for harvest index

	Sum of squares	Degrees of	Mean square	F-value
Souces of variation		freedom		
Soil	0,21499	3	0,07166	31,93**
Cultivar	0,03351	10	0,00335	1,49
Soil*Cultivar	0,04258	30	0,00142	0,63
Erorr	0,19748	88	0,00224	

After establishing the significance of the soil factor, the comparison of the harvest index mean values was performed using the Tukey test (Table 5 and 6). Highly significant lowest harvest index mean value was established on the solonetz control treatment (0.415). The greatest harvest index mean values were established on the most fertile soil type i.e. chernozem (0.521), as well as on solonetz including 50 t/ha of phosphogypsum amelioration treatment (0.500), leading to the conclusion that the investigated genotypes had a positive reaction to the soil amelioration. Harvest index mean value established on the solonetz treatment inlcuding 25 t/ha of phosphogypsum (0.464) is statisticly lower at the significance level of a=0.05, than the mean vaulue established on solonetz treatment including greater rate of 50 t/ha of phosphogypsum (0.500), as well as for the plant height, concluding that plants reacted only partially to different amelioration rates.

Table 5. - Tukey test for harvest indext means regarding different soil types for α*=0,05*

	Soil treatment	Harvest index	1	2	3
1	Solonetz control treatment	0,415		****	
2	Solonetz including 25 t/ha of phosphogypsum	0,464			****
3	Solonetz including 50 t/ha of phosphogypsum	0,500	****		
4	Chernozem	0,521	****		

Table 6. - Tukey test for harvest index means regarding different soil types for α*=0,01*

	Soil treatment	Harvest index	1	2	3
1	Solonetz control treatment	0,415			****
2	Solonetz including 25 t/ha of phosphogypsum	0,464	****		
3	Solonetz including 50 t/ha of phosphogypsum	0,500	****	****	
4	Chernozem	0,521		****	

The correlation between plant height and harvest index was examined using the correlation coefficient (Table 7). Regarding plants cultivated on the control treatment of solonetz (r=0.05), there wasn't any correlation between the two traits. Plant cultivated on the solonetz treatment including both 25 th/ha of

phosphogypsum (r=-0.51) and 50 t/ha of phosphogypsum (r=-0.62) showed highly significant greatest negative correlation, pointing out on the reduction of the harvest index due to the increase of the vegatitve ?? mass, which is in acordance to previous research (BOROJEVIĆ, 1986). The experiment treatment on chernozem showed negative correlation (r=-0.37) which is only significant at the a=0.05 level.

Table 7. - Correlations between plant height and harvest index regarding different soil types.

Soil	Solonetz control treatment	Solonetz including 25t/ha of phosphogypsum	Solonetz including 50 t/ha of phosphogypsum	Chernozem
Correlation coefficient	0,05	-0,51**	-0,62**	-0,37*
Table values				
á=0,05	0,35	0,35	0,35	0,35
á=0,01	0,45	0,45	0,45	0,45

CONCLUSION

Investigated reaction of various wheat genotypes to different soil types, as well as different amelioration rates of solonetz for plant height and harvest index showed that investigated genotypes reacted equally to the soil factor, and that the cultivar factor was not significant. These results could be explained by the same origin of cultivars involved in the research. On the other hand, soil factor was indicated as the signifiant source of variation. Ranking and comparing mean values on different soil treatments indicated that plants did react to the amelioration on solonetz, but that mean values were not at the same level as the mean values established on the most fertile soil, i.e chernozem. The results of this investigation could help further research in the amelioration of unfavourable soil types and the increase of the total cultivation area.

Correlations, as well as ANOVA results, showed that plants cultivated on solonetz including amelioration are approaching the results obtained from plants cultivated on chernozem. Plants cultivated on the control treatment of solonetz showed no correlation between the investigated traits. On the other side, the results obtained from the plants cultivated on solonetz including amelioration express negative correlations that are present on chernozem treatment and are in acordance with previous research conducted in intensive agriculture (BOROJEVIĆ, 1986).

Acknowledgement. - This work was supported by the Serbian Ministry of Sciences and Environment Protection: Grant No TR 6880B.

REFERENCES

BELIĆ, M.(1999): Uticaj meliorativnih mera na adsorptivni kompleks solonjeca. Doktorska disertacija, Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad.

BELIĆ, M., DIMITRIJEVIĆ, M., HADŽIĆ, V., PETROVIĆ, SOFIJA, NEŠIĆ, LJILJANA (2003): Uticaj meliorativnih mera na promenu svojstava solonjeca i varijabilnost prinosa različitih genotipova pšenice. Nove tehnologije i edukacija u funkciji proizvodnje hrane. Naučno stručno savetovanje agronoma Republike Srpske sa međunarodnim učešćem, Teslić, 10-14. mart, Zbornik izvoda 92-93.

BOROJEVIĆ, S (1990): Genetski napredak u povećanju prinosa pšenice. VII jugoslovenksi simpozijum o naučno-istraživačkom radu na pšenici, Novi Sad 12-16. jun 1989, Savremena poljoprivreda 38, 25-47.

BOROJEVIĆ, S. (1983): Genetika i tehnološke promene koje su izazvale preokret u oplemenjivanju biljaka (akademska beseda). Vojvođanska akademija nauka i umetnosti, Novi Sad.

BOROJEVIĆ, S (1986): Žetveni indeks u funkciji povećanja prinosa. Poseban otisak, Poljoprivredne aktuelnosti 25, br. 1-2.

FAO STATISTICS (2002), www.FAO.org

HADŽIVUKOVIĆ, S. (1991): Statistički metodi s primenom u poljoprivrednim i biološkim istraživanjima. Drugo izdanje, Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad, pp.584.

JEVTIĆ, S. (1986): Pšenica. Naučna knjiga, Beograd.

MINISTARSTVO POLJOPRIVREDE, VODOPRIVREDE I ŠUMARSTVA (1997): Zemljišna politika, politika iskorišćavanja voda i ekologija. Separat 1, Republika Srbija, Beograd.

PETROVIĆ, SOFIJA, DIMITRIJEVIĆ, M., KRALJEVIĆ-BALALIĆ, MARIJA (2000): Interakcija genotip/spoljna sredina i stabilnost žetvenog indeksa pšenice. Zbornik izvoda, III JUSEM, 73, Zlatibor, 28. maj-1. jun 2000..

ŽIVKOVIĆ, B., NEJGEBAUER, K.V., TANASIJEVIĆ, Đ., MILJKOVIĆ, N., STOJKOVIĆ, L., DREZGIĆ, P. (1972): Zemljišta Vojvodine. Institut za poljoprivredna istraživanja, Novi Sad.

Received May 16, 2006
Accepted Jun 19, 2006

VARIJABILNOST VISINE BILJKE I ŽETVENOG INDEKSA RAZLIČITIH GENOTIPOVA PŠENICE GAJENIH NA ČERNOZEMU I SOLONJECU

Zoran KAPOR, Sofija PETROVIĆ i Miodrag DIMITRIJEVIĆ

Poljoprivredni fakultet, Novi Sad, Srbija

Izvod

Solonjec je vrsta halomorfnog zemljišta koji je u Vojvodini prisutan na 80 000 ha. Tokom vegetacione sezone 1999/2000. izvršeni su poljski ogledi u kojima je ispitivano jedanaest genotipova pšenice gajenih na solonjecu, na lokalitetu Kumane, i na černozemu, na lokalitetu Rimski Šančevi. U ovom istraživanju ispitivana je varijabilnost visine biljke i žetvenog indeksa na različitim zemljištima, kao i korelacije između ova dva parametra. Cilj ovog istraživanja je utvrđivanje značajnosti efekta različitih genotipova i zemljišta na visinu biljke i žetveni indeks, kao i reakcija ispitivanih genotipova na mere popravke solonjeca.

Primljeno 16. maja 2006.
Odobreno 19. juna 2006.