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INDIVIDUAL AND JOINT EFFECT OF SOME QUANTITATIVE TRAITS ON GRAIN YIELD OF TRITICALE AND BARLEY

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Abstract

This paper presents the two year results of a study dealing with individual and joint effect of major yield components on grain yield of representative Serbian cultivars of triticale and winter barley. The trials have been set at two locations (Kraljevo and Zaječar, Serbia), where two triticale cultivars (KG-20, Tango) and four barley cultivars (Jagodinac, Rekord, Premium, Kristal) were grown in five fertilization and liming variants. The observed traits were the following: plant height, spike length, number of spikelets per spike, and number of grains per spike. Individual effect of yield components on grain yield was measured by simple regression, and their joint effect by multiple regression. When triticale is concerned, the all four investigated traits showed the significant effect on grain yield, but when joint effect was considered by multiple regression, only plant height and number of grains per spike showed the same effect. In barley, such significant individual effect was restricted on spike length, number of spikelets per spike and number of grains per spike, but the joint effect was significant only for intercept value and number of grains per spike. Values of adjusted R^2 coefficient showed that those four parameters were clearly responsible for a great part of variation in grain yield in both species among the investigated cultivars and fertilization variants.

Key words: *Triticale, Barley, Grain yield, Yield components, Regression.*

Introduction

Barley shows a great economical importance because of its versatile utilization. It mainly serves as animal feed and raw material in brewing industry, but it has increasingly been used as a food, characterized by high nutritive value and certain health promoting properties (Biberdžić et al., 2010).Triticale is the plant species which becomes more and more important in animal feeding. Grain yield changed during the last century and yield increase had resulted mostly from the development of plant selection and breeding techniques, so that yield genetic potential achieved by new winter barley varieties reached over 11 t/ha (Pržulj and Momčilović, 1999), and the one of triticale even greater values.

Grain yield is a complex trait of outstanding economic significance, dependent upon a number of hereditarily determined traits and environmental conditions in which plant is developing (Madić et al., 2005). Therefore, contribution of various plant traits to grain yield is a permanent subject of studies in plant breeding.

Plant height is an important agronomic trait for morphogenesis and grain yield formation in wheat. An appropriate plant height is a prerequisite for attaining the desired yield in wheat breeding programs. The introduction of dwarfing traits into plants has achieved tremendous increase in wheat grain yield during the „Green Revolution“ (Peter, 2003). Therefore, it is essential to elucidate the genetic basis of plant height in order to gain further increase of grain yield (Cui et al., 2011).

Spike length is one of the important yield components, not only because longer spike offers more room for spikelets, but also because it is the source of assimilates closest to grains.

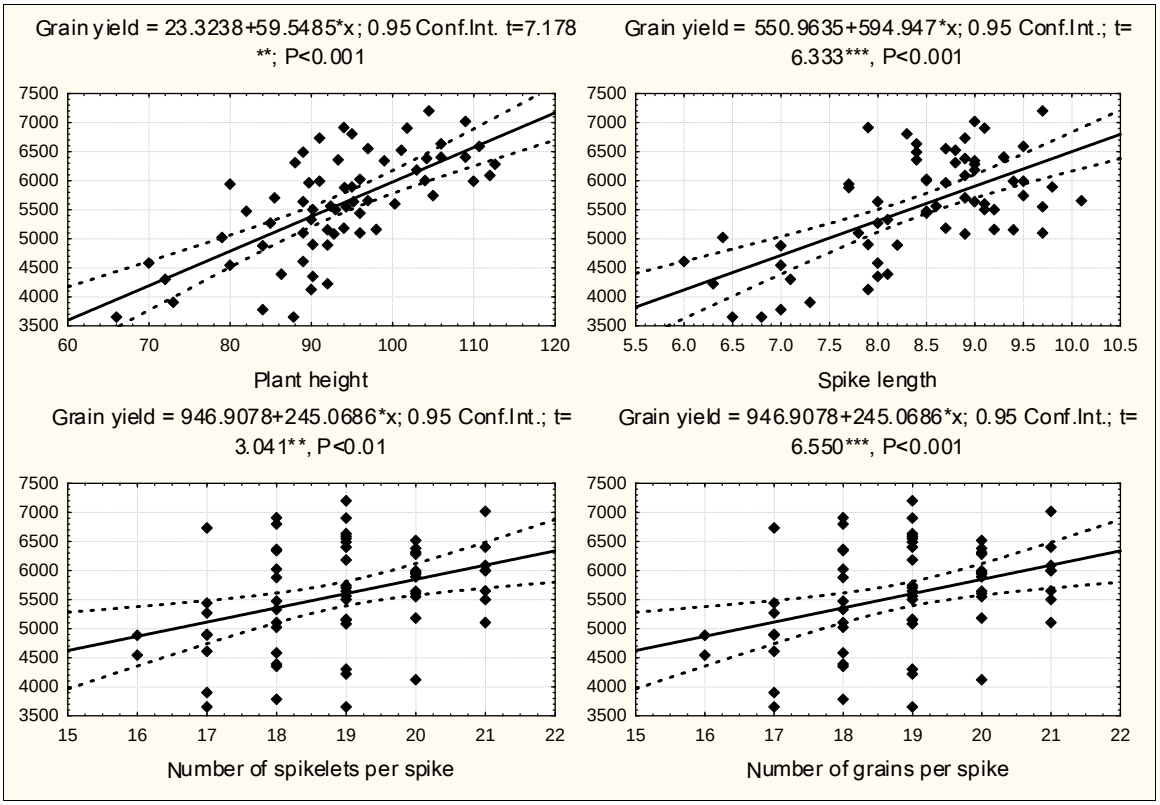
Spike structure is more effective in utilizing illumination than the other parts of the plant, and it also will stay green and functional for a longer time. Because of these features, it contributes up to 20-30% of the dry matter accumulated in grains (Sharma et al., 2003).
Number of spikelets and grains per spike, together with grain mass, are also among crucial yield components. In fact grain yield is the product of productive tiller number per square unit, number of grains per spike and 1000 grain mass. Saleem et al. (2006***)*** found strong, significant genotypic and phenotypic correlation between grain yield and spike length and between grain yield and number of spikelets per spike.
This study has been aimed to investigate individual and joint effect of major yield components on grain yield of representative Serbian cultivars of triticale and winter barley.

Material and methods

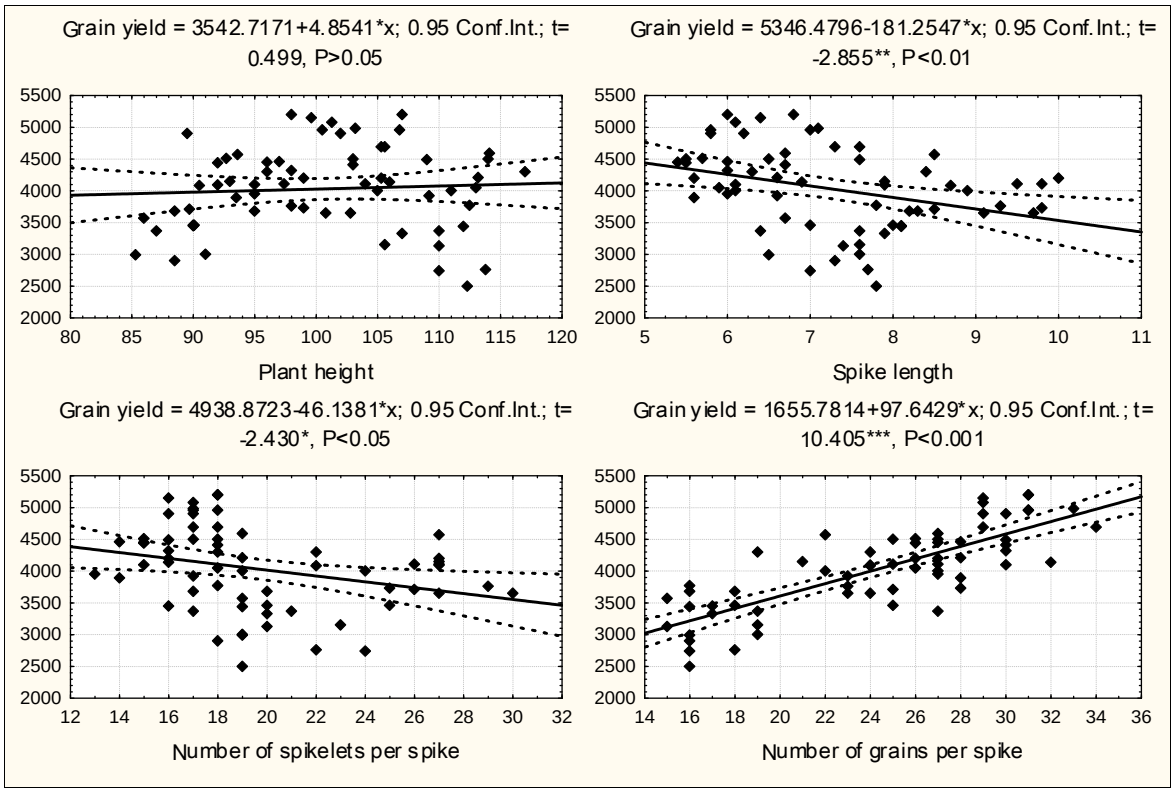
The trials have been set at two locations (Kraljevo and Zaječar, Serbia) during 2009/10 and 2010/11, where two triticale cultivars (KG-20, Tango) and four barley cultivars (Jagodinac, Rekord, Premium, Kristal) were grown in five fertilization and liming variants have been set in random complete block design with four replications. Otherwise, growing practice was standard. The observed traits were the following: plant height, spike length, number of spikelets per spike, and number of grains per spike. Individual effect of yield components on grain yield was measured by simple regression and their joint effect by multiple regression. The input data for both species were for the all cultivars and fertilization and liming variants, in order to get a better estimate of the part of grain yield variation explained by the investigated grain yield components.

Results and discussion

Simple regression analysis for triticale (graph 1) shows that the all independent variables had a positive effect on grain yield, and that effect was significant at the level of $P<0.001$ for plant height, spike length and number of grains per spike, while for number of spikelets per spike level of significance was $P<0.01$. Dependence of triticale grain yield upon each investigated yield component is quantitatively expressed by corresponding regression equation given in graph 1.
Simple regression analysis for winter barley (graph 2) shows quite different tendency. Plant height had no significant effect on grain yield. Spike length and number of spikelets per spike showed significant negative effect on grain yield at significance level of $P<0.01$, while number of grains per spike had significant positive effect on grain yield at level of significance of $P<0.001$. Dependence of winter barley grain yield upon each investigated yield component is quantitatively expressed by corresponding regression equation given in graph 2.
Multiple regression analysis of individual and joint effect of the studied parameters on triticale grain yield showed that plant height ($\beta=0.438^{***}$) and number of grains per spike ($\beta=0.432^{***}$) had significant effect on grain yield, while the effect of other two traits and intercept value were not significant. Adjusted R^2 value (0.577) showed that 57.7% of the observed variation in triticale grain yield was explained by the studied four traits. F test for goodness of fit was significant at level of $P<0.001$ (tab. 1).



Graph 1. Effects of the observed traits on triticale genotypes' grain yield (simple regression)



Graph 2.Effects of the observed traits on barley genotypes' grain yield (simple regression)

Table 1. Effects of the observed traits on triticale genotypes' grain yield calculated by multiple regression analysis.

	β	SE (β)	B	SE (B)	t (d.f.59)	P value
Intercept	--	--	-1955.76	1164.632	-1.679	0.098383
Plant height	0.438	0.108	38.74	9.563	4.051***	0.000151
Spike length	0.168	0.130	159.11	123.523	1.288	0.202732
Spikelets per spike	-0.203	0.110	-137.99	74.540	-1.851	0.069151
Grains per spike	0.432	0.122	98.15	27.644	3.551***	0.000762
R=0.777; R^2=0.604; adjusted R^2=0.577; goodness of fit: F(4, 59)=22.479P<0.0000						

The results of multiple regression analysis of individual and joint effect of the studied parameters on winter barley grain yield showed that only number of grains per spike (β=0.778***) had significant effect on grain yield, and intercept value was also significant but at the level of P<0.01. The effect of other three traits was not significant. Adjusted R^2 value (0.621) showed that 62.1% of the observed variation in winter barley grain yield was explained by the studied four traits. F test for goodness of fit was significant at level of P<0.001 (tab. 2).

Table 2. Effects of the observed traits on barley genotypes' grain yield calculated by multiple regression analysis.

	β	SE (β)	B	SE (B)	t (d.f.59)	P value
Intercept	--	--	2447.00	734.317	3.332**	0.001491
Plant height	-0.056	0.078	-4.272	6.026	-0.709	0.481135
Spike length	-0.053	0.133	-28.31	70.883	-0.399	0.691035
Spikelets per spike	-0.032	0.131	-5.04	20.475	-0.246	0.806455
Grains per spike	0.778	0.083	95.31	10.206	9.339***	0.000000
R=0.803; R^2=0.645; adjusted R^2=0.621; goodness of fit: F(4, 59)=26.778P<0.0000						

Establishing individual and joint effect of principal yield components on grain yield in various conditions of nitrogen nutrition has a potential use in breeding cultivars with stable grain yield in various nitrogen nutrition levels. Values of adjusted R^2 coefficient showed that those four parameters were clearly responsible for a great part of variation in grain yield in both species (57.7 and 62.1%, respectively) among the investigated cultivars and fertilization variants.

Conclusion

On the basis of the study, dealing with individual and joint effect of major yield components on grain yield of representative Serbian cultivars of triticale and winter barley, we can conclude the following:

In triticale the all studied traits had a positive effect on grain yield measured by simple regression, and that effect was significant at the level of P<0.001 for plant height, spike length and number of grains per spike, while for number of spikelets per spike level of significance was P<0.01.

Simple regression for winter barley showed that plant height had no significant effect on grain yield. Spike length and number of spikelets per spike showed significant negative effect on

grain yield at significance level of P<0.01, while number of grains per spike had significant positive effect on grain yield at level of significance of P<0.001.

In triticale, multiple regression analysis showed that plant height and number of grains per spike had significant effect on grain yield, while the effect of other two traits and intercept value were not significant.

Multiple regression for winter barley showed that only number of grains per spike had significant effect on grain yield, and intercept value was also significant. The effect of other three traits was not significant.

Values of adjusted R^2 coefficient showed that those four parameters were clearly responsible for a great part of variation in grain yield in both species among the investigated cultivars and fertilization variants.

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