YIELD COMPONENTS OF WINTER BARLEY AND TRITICALE AS AFFECTED BY NITROGEN FERTILIZATION

Milan BIBERDŽIĆ, Dragana STOŠOVIĆ, Nebojša DELETIĆ, Saša BARAĆ, Slaviša STOJKOVIĆ

University of Priština, Faculty of Agriculture Kosovska Mitrovica – Zubin Potok
Jelene Anžujske bb, 38228 Zubin Potok, Serbia,
Corresponding author: mbiberdzic@gmail.com

Abstract: *Grain yield and quality reached by small grains are variable and affected by many factors, primarily by genotype, agroecological conditions and the applied production technology. This investigation, carried out in the vicinity of Bijelo Polje (Montenegro), has been aimed to compare yield components of triticale and barley grown under the same agroecological conditions. The investigation lasted two years (2005-2007), at a weakly carbonate-supplied soil. Nitrogen fertilizer was dosed equally for both plant species (80, 100 and 120 kg ha^{-1} N). The obtained results showed that the highest values of 1000 grain mass, hectoliter mass and grain yield of barley were reached with nitrogen dose of 80 kg ha^{-1}N. The highest values of those parameters in triticale were obtained with nitrogen dose of 120 kg ha^{-1}. The highest grain yield of barley (4397 kg ha^{-1}) was given with 80 kg ha^{-1} of nitrogen, while in triticale the highest grain yield (6040 kg ha^{-1}) was reached with nitrogen dose of 120 kg ha^{-1}. The difference between barley and triticale was 1643 kg ha^{-1}, and that was caused by a higher number of grains per spike in triticale. Having in mind these two crops are mainly used as animal feed, results of this study point to a proper choice of what crop ought to be grown in particular area, especially in households doing animal husbandry.*

Key words**:** *nitrogen, 1000 grain mass, hectoliter mass, barley, triticale, grain yield.*

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 (PRŽULJ et al., 1996). Triticale is the plant species which becomes more and more important in animal feeding. Production technology of both crops, especially mineral nutrition, is crucial for economical success. According to the most of reports, barley takes out of field the highest quantity of nitrogen, than potassium, and the lowest quantity of phosphorus. Number of plants, number of grains per spike, and 1000 grain mass are three principal yield components. Thus, HAMID and GRAFIUS (1978), SINGH (1987) and ORE (1991) pointed out that there was a medium to high, positive correlation between number of grains per spike and grain yield. WIEGAND and CUELLAR (1981) also pointed to grain yield as mainly affected by grain mass. According to MILOVANOVIĆ (1993), triticale grain yield is influenced positively by number of spikes per m², and negatively by protein content. ROJO et al. (1987) stated that main effect on triticale grain yield is shown by 1000 grain mass and number of spikelets per spike, while number of spikes per plant had an insignificant effect. Triticale's grains are large, and its 1000 grain mass ranges from 40-64 g, so it is most often above the values observed in wheat and barley (REHMETULIN et al., 1988; PRŽULJ, 1989; etc).

This study has been aimed to evaluate productive elements of spike and grain yield of winter barley and triticale, as affected by increasing nitrogen fertilizer doses.

MATERIAL AND METHODS

At the location near Bijelo Polje (Montenegro), during 2005/06 and 2006/07, field trials with two plant species (barley and triticale) and three nitrogen fertilizer doses (80, 100

and 120 kg/ha N) have been set in random complete block design with four replications. Otherwise, growing practice was standard. Determining number of grains per spike, 1000 grain mass and hectoliter mass was done during ripening stage from area of 0.5 m². After harvesting, grain yield was measured in each plot, and standardized at water content of 14%. The obtained results have been processed by analysis of variances, and the differences were compared with LSD values for probabilities of error $P<0.05$ and $P<0.01$.

RESULTS AND DISCUSSIONS

The soil on which the trials were set (tab. 1) is weakly carbonated: the total carbonate content was low (1.05-1.47%). Value of pH in salt solution points to mild soil acidity. The soil is well-supplied by humus (3.98-4.35%), and has low levels of available phosphorus (5.68-8.71 mg/100g of soil) and potassium (4.47-3.71 mg/100g of soil).

Table 1

Chemical characteristics of the soil

Depth cm	pH		$CaCO_3$ %	humus %	P_2O_5 mg/100g of soil	K_2O mg/100g of soil
	H_2O	nKCl				
0-10	6.41	5.62	1.05	3.98	5.68	4.47
10-25	6.33	5.63	1.47	4.35	8.71	3.71

Table 2

Meteorological data

Month	Average monthly temperature (T°C)		Total monthly rainfall (mm)	
	2005/06	2006/07	2005/06	2006/07
October	9.7	11.4	85.2	39.5
November	3.3	2.6	116.1	74.6
December	1.2	0.3	182.5	182.5
January	-2.6	1.8	36.6	92.9
February	0.4	4.8	87.7	45.8
March	4.2	7.0	180.8	104.7
April	11.1	11.5	58.4	15.7
May	14.6	16.0	78.6	60.8
June	16.8	19.8	119	76.9
July	19.0	21.9	52.9	23.9

During 2005/06, in the period October-July, there was 997.8 mm of rainfall, while in the same period of 2006/07 there was 717.3 mm of rainfall (tab. 2). Having in mind a higher amount of rainfall during autumn, winter and spring months, as well as not so high temperature during grain filling stage, the season 2005/06 can be considered as more favorable for crop shooting, emerging and wintering, but also for yield forming in regard to the season 2006/07.

The following tables show some yield components of winter barley and triticale as affected by nitrogen fertilizer dose.

Number of grains per spike of barley (tab. 3) rose by increasing of nitrogen applied, and was the highest (28) at nitrogen dose of 100 kg ha^{-1}. Dose of 120 kg ha^{-1} N caused a drop of number of grains per spike, which had a negative effect on grain yield. The effect of number of grains per spike on total grain yield forming is also pointed by MARTINIELLO (1987) and WIEGAND and CUELLAR (1981).

Table 3

Yield components of barley (two-year mean)

Nitrogen dose (kg ha^{-1})	Number of grains per spike	1000 grain mass (g)	Hectoliter mass (kg)	Grain yield (kg ha^{-1})
0	22.2	36.8	60.2	3820
80	25.7	43.5	62.8	4397
100	28.0	42.6	62.3	4298
120	21.2	39.8	60.4	3610
LSD 0.05	1.11	0.46	0.67	244.64
LSD 0.01	1.48	0.62	0.90	326.69

Mass of 1000 grains is an indicator of grain size, and is one of the three principal yield components. Nitrogen fertilization showed a significant effect on 1000 grain mass of barley (tab. 3), so it was the highest at nitrogen dose of 80 kg ha^{-1} (43.5 g). Further increase of nitrogen dose caused a significant drop of 1000 grain mass.

Hectoliter mass (tab. 3) followed a similar tendency of increase as 1000 grain mass, and the highest average value (62.8 kg) was reached at nitrogen dose of 80 kg ha^{-1}. At the dose of 100 kg ha^{-1} N, hectoliter mass slightly dropped, but that decrease was not statistically significant.

Grain yield, as the main goal of every production attempt, is influenced by many factors. The highest grain yield (4397 kg ha^{-1}) was reached with the nitrogen dose of 80 kg ha^{-1} (tab. 3). Further increase of nitrogen dose caused a drop of barley grain yield, so the highest dose of 120 kg ha^{-1} even caused barley stalk lodging. JELIĆ et al. (2007) reported that the greatest barley grain yield was observed at the nitrogen dose of 70 kg ha^{-1} with seeding rate of 350 grains/m^2. Correlation between grain yield and number of grains per spike is found by SRIVASTAVA et al. (1981). JOVANOVIĆ et al. (1992) considered that there very often were compensatory relationships among yield components during grain yield formation. According to the study of PERIĆ (1978), 77.6% of the total average increase of barley grain yield was reached only by nitrogen fertilization, while the rest 22.4% was the result of phosphorus and potassium in interaction with nitrogen.

Unlike barley, yield components of triticale showed a different growth tendency. Thus, the number of grains per spike rose by increasing nitrogen dose up to 120 kg ha^{-1} (tab. 4). That rise was highly significant up to nitrogen dose of 100 kg ha^{-1}, while the highest nitrogen dose only caused a slight increase of number of grains per spike, which was not statistically significant. Mass of 1000 grains in triticale increased in a highly significant manner by increasing nitrogen doses. It was the greatest at the highest nitrogen dose and amounted 36.6 g. The same tendency was observed when hectoliter mass was analyzed, and it was the greatest at the highest nitrogen dose (70.1 kg). It can be clearly seen that the 1000 grain mass of barley was higher than the one of triticale, which is the result of different characteristics shown by different species, and that is also pointed out by Jelić et al. (1998).

Table 4

Yield components of triticale (two-year mean)

Nitrogen dose (kg ha^{-1})	Number of grains per spike	1000 grain mass (g)	Hectoliter mass (kg)	Grain yield (kg ha^{-1})
0	47.6	32.2	64.6	4384
80	52.8	35.1	67.7	5692
100	54.6	35.8	68.9	5989
120	55.9	36.6	70.1	6040
LSD 0.05	1.60	0.67	0.53	266.04
LSD 0.01	2.14	0.64	0.71	341.92

Grain yield of triticale showed a similar growth tendency as yield components did. The greatest grain yield was reached at the highest nitrogen dose of 120 kg ha^{-1}, but the difference in grain yield between doses of 100 and 120 kg ha^{-1} was not statistically significant (tab. 4). However, having in mind that there was not any statistically significant difference between those two doses, we could recommend nitrogen dose of 100 kg/ha not only as the optimal one, but also as the most economical one when commercial production of this crop is in question. These results and recommendations are similar to the results reported by Jelić et al. (1998).

The highest values of the investigated yield components of barley were reached at the nitrogen level of 80 kg ha^{-1}, while triticale reached the greatest values at the highest nitrogen dose of 120 kg ha^{-1}. Number of grains per spike, hectoliter mass and grain yield were much greater in triticale than in barley. Only 1000 grain mass of barley was higher than the same parameter of triticale, which was expected because triticale grains were known as characterized by unsatisfactory grain fulfillment. The difference between barley and triticale regarding grain yield was 1643 kg ha^{-1}, which was mainly caused by higher number of grains per spike in triticale. If we compare grain yield of both crops at the nitrogen fertilization level of 80 kg ha^{-1}, we can see that triticale gave a higher grain yield by 1295 kg ha-1, which was significant. These data point out to a better economical reason to grow triticale crops in regard to the barley ones. Having in mind these two crops are mainly used as animal feed, results of this study point to a proper choice of what crop ought to be grown in particular area, especially in households doing animal husbandry.

CONCLUSIONS

On the basis of the two-year results we can conclude the following:

– The highest number of grains per spike of barley was reached at the nitrogen dose of 100 kg ha^{-1};

– The greatest 1000 grain mass, hectoliter mass, as well as grain yield of barley were reached at the nitrogen dose of 80 kg ha^{-1};

– The highest number of grains per spike, 1000 grain mass, hectoliter mass, as well as grain yield of triticale were observed at the nitrogen dose of 120 kg ha^{-1};

– The difference between barley and triticale regarding grain yield was 1643 kg ha^{-1};

– At the same nitrogen dose of 80 kg ha^{-1}, triticale gave higher grain yield by 1295 kg ha^{-1};

– When investment level is the same, triticale crops are more gainful than the barley ones.

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