YIELD COMPONETS OF SPRING BARLEY AS AFFECTED BY DIFFERENT FARMING SYSTEMS

VPLYV PESTOVATEĽSKÝCH SYSTÉMOV NA ÚRODOTVORNÉ PRVKY JAČMEŇA JARNÉHO

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Abstract: *A field experiment was conducted in order to determine the influence of an ecological and low input system on the yield and selected yield components of spring barley. The experiment was carried out for during 2000-2005 on Luvi-Haplic Chernozem on an experimental station of the RIPP in Western Slovakia. Significantly higher (P<0.01) yield of spring barley was found in low input system compared to ecological one. Similarly the yield of dry matter was significantly higher (P<0.01) in low input system. Other studied yield components (number of spike per m^{-2}, kernels bulk density, and percentage of kernels larger than 2.5 mm x 20.0 mm) were not influenced by used farming systems. Each investigated yield component was highly significantly influenced by weather conditions during years. Since yield and some yield components were higher in low input system, we recommend use it for spring barley growing in studied soil-climatic conditions. When combine the studied years and farming systems, the influence of farming system was slightly lowered, and differences between ecological compared to low input system in yield of spring barley and dry matter were significant at level (P<0.05). Therefore, when consider the combination of farming systems in weather conditions during years, we can recommend use of both farming systems for spring barley growing in studied soil-climatic conditions.*

Abstrakt: *V poľných podmienkach sme skúmali vplyv ekologického a low-input systému hospodárenia na úrodu a vybrané úrodotvorné prvky jarného jačmeňa. Experiment prebiehal na černozemi hnedozemnej v rokoch 2000-2005 na experimentálnej ploche VÚRV Piešťany – západné Slovensko. Preukazne vyššia (P<0,01) úroda jarného jačmeňa bola dosiahnutá v low-input systéme hospodárenia v porovnaní s ekologickým. Podobne i úroda sušiny a hmotnosť tisícich semien boli preukazne vyššie (P<0,01) v low-input systéme. Ostatné skúmané úrodotvorné prvky (počet klasov na m^{-2}, objemová hmotnosť zrna a obsah zŕn väčších ako 2,5 mm x 20,0 mm) neboli ovplyvnené systémami hospodárenia. Všetky skúmané úrodotvorné prvky boli vysoko preukazne ovplyvnené poveternostnými podmienkami v jednotlivých rokoch. Keďže úroda a vybrané úrodotvorné prvky boli vyššie v low-input systéme, odporúčame používať tento systém na pestovanie jarného jačmeňa v daných pôdno-klimatických podmienkach. Avšak, keď sme skombinovali pestovateľské roky so systémami hospodárenia, vplyv systémov hospodárenia sa čiastočne znížil, a rozdiely medzi ekologickým a low-input systémom v úrode jarného jačmeňa a sušiny sa znížil na preukaznú hodnotu (P<0,05). Preto ak uvažujeme o kombinácii systém hospodárenia a poveternostné podmienky počas skúmaných rokov, odporúčame využívanie oboch systémov hospodárenia na pestovanie jarného jačmeňa v daných pôdno-klimatických podmienkach.*

Keywords: *spring barley, farming system, yield components*
Kľúčové slová: *jarný jačmeň, systémy hospodárenia, úrodotvorné prvky*

INTRODUCTION

The yield and quality of spring barley have a high degree of variability depending on both weather and soil conditions and applied soil and crop management.

Low-input systems are characterized by reduced fertilization (40-50 % of the conventional system. This is achieved by target mineral fertilization (CANDRÁKOVÁ et al.

1999a) and by the regulated application of liquid manure and minimizing soil cultivation. Cultural practices aimed at reducing weeds are also included in low-input farming systems (KOVÁČ and MACÁK 2007). As with organic farming, the emphasis is on the whole system with crop rotation being a key component. The purpose of utilizing low input systems is to minimize the use of pesticides and fertilizers (BOND and GRUNDY 2001).

Organic farming almost does not use any synthetic substance such as chemical pesticides and fertilizers (with a limited exceptions), but uses of natural methods such as crop rotation. Organic farms have significantly higher biodiversity, reduce energy consumption and cause less water pollution than intensive farms.

The present study was undertaken to assess the influence of an ecological and low input system on the yield and selected yield components of spring barley.

MATERIALS AND METHOD

The yield components of spring barley varieties Atribut (2000-2002) and Nitran (2003-2005) were studied in the field experiment at the conditions of ecological and low input farming systems at the experimental station of the Research Institute of Plant Production in Western Slovakia (E 17°75’, N 48°58’). The location has a continental climate with an average annual temperature of 9.2°C and an average annual precipitation of 593 mm. The main soil type is a Luvi-Haplic Chernozem on carbonate loess with loamy to clay-loamy texture with a pH KCl 6.5-7.2, humus content 1.8-2.0 % - Tyurin method (ORLOV et al. 1981), 79 mg kg^{-1} available P, 266 mg kg^{-1} available K and 258 mg kg^{-1} available Mg - Mehlich III method (1984).

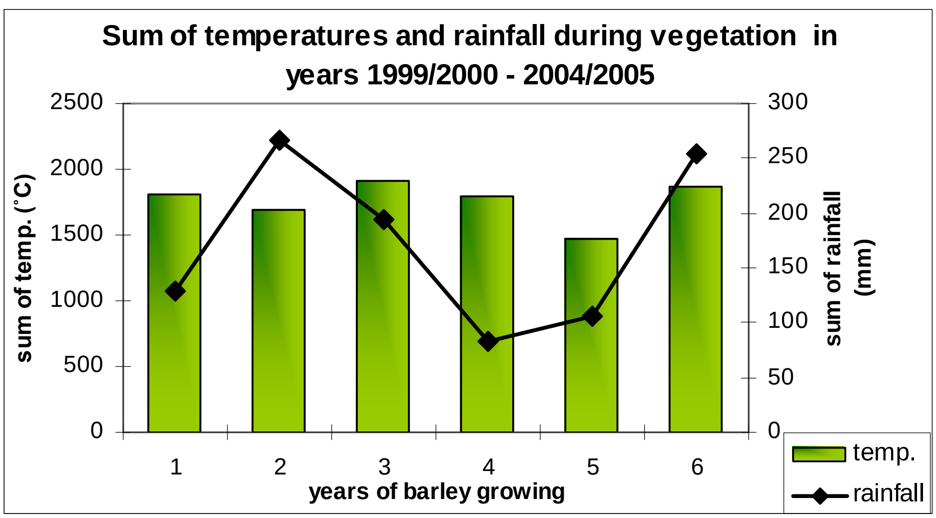

Figure 1: Sum of temperatures and rainfall during vegetation in years 1999/2000 - 2004/2005

The experiment was a split-plot designed with four replicates of a six-course crop rotation. The crop was designated to be the main plot factor and the cropping system was designated to be the subplot factor. The subplots were 3 m by 20 m in size. The pattern of a six-crop rotation was as follows: 1) common pea, 2) winter wheat and catch crops for green manure (phacelia and mustard), 3) early potato and catch crops for green manure (phacelia and mustard), 4) spring barley under sown with red clover, 5) first year red clover, and 6) winter wheat and catch crops for green manure (phacelia and mustard).

The cultural practices in the Ecological System (ES) were performed in accordance with EC Regulation No 2092/91 and the national Act 415/2002 dealing with ecological farming and food production in Slovak Republic. Mechanical weed control, allowed seed treatment and merely organic fertilisers were used. Two weeks after harvest straw and crops residues were ploughed in by tillage and the catch crops phacelia and mustard were sown. Green manure was incorporated into the soil by for spring barley, peas and potatoes. 30 t ha^{-1} of farm yard manure was ploughed into the potato plots and 15 t ha^{-1} into the winter wheat plots.

Low Input System (LIS) uses the same production practices as ecological farming but allows the limited use of pesticides and mineral fertilization inputs. LIS was designed for a low level of mineral nitrogen fertilization with a dose of 30 kg N ha^{-1} to spring barley. Straw and crop residues were incorporated into the soil along with P, K mineral fertilizers and calculated according to input-output balance. Integrated pest management practices were also used.

The data were statistically evaluated by an analysis of variance using the Statgraphics procedure and the F-test (Fisher`s protected LSD test).

RESULTS AND DISCUSSION

Spring barley is crop of a very high economic risk for farmers, due to its high sensitivity to external growth factors. Present work mainly focused on the comparison of different farming systems on spring barley crop, but considers also the influence of weather conditions on total yield.

The average total yield of spring barley grain was significantly higher ($P<0.01$) in low-input system (5.02 t ha^{-1}) what is by 4.4% higher compared with ecological one (4.80 t ha^{-1}). Our results are in accordance with other authors who confirmed lower yield of cereals in ecological compared to low-input farming system (ŽÁK et al. 2006; MACÁK et al. 2007).

The productivity of arable crop rotations for organic farming is often low caused by lack of N because use of artificial fertilisers is prohibited and availability of animal manure is limited on these farms (OLESEN et al. 2002). Organic fertilisers can ensure high levels of nutrients through high rates of fertilisers applied per area unit, but the speed of accessibility of the nutrients is much lower, as it depends on the processes of decomposition and transformation of the manure in the soil. As a result, fertilisation with these resources asks for another working strategy for the effects to be cumulative and effective progressively, taking into account the different degree of accessibility of the nutrients in the organic fertilisers (SALA et al. 2007). Organic farms have usually lower yields, and organic cereal yields are typically 60-70% of conventional yields.

Significance of the yield components and crop yield of spring barley grown in an ecological and a low input system is stated in table 1. Beside the total yield of spring barley grain (table 1), also another yield components as a yield of dry matter and thousand of kernel weight were significantly ($P<0.01$) influenced by farming systems. The higher yields of dry matter and thousand of kernel weight were reached in low input system (9.90 t ha^{-1} and 44.90g) in comparison to ecological system (9.46 t ha^{-1} and 43.49g). There was found no significant effect of used farming systems on other studied yield components (number of spike per m^{-2}, kernels bulk density, amount of kernels larger than 2.5 mm x 20.0 mm).

The overall findings indicate that the total yield of grain and all investigated yield components were highly significantly ($P<0.01$) influenced by weather conditions during studied years (Table 1). This is in agreement with results reached by many other authors (CANDRÁKOVÁ et al. 1999b; KOVÁČ et al. 2006; MARTINKOVÁ et al. 2007; PIRSAN et al. 2006; WAGNER et al. 2006).

Table 1

F statistics from ANOVA for yield components and crop yield of spring barley grown in an ecological and a low input system in the years 2000-2005

Yield components	Years (Y)	Systems (S)	Y x S
Yield of spring barley	39.48**	11.61**	4.33*
Yield of dry mater	39.01**	11.20**	4.28*
Number of spikes per m^{-2}	4.36**	0.06 NS	0.28 NS
Thousand of kernels weight TKW	19.29**	11.40**	2.00 NS
Kernels bulk density (g L^{-1})	47.32**	0.84 NS	1.09 NS
Amount of kernels larger than 2.5 mm x 20.0 mm (%)	1.95**	3.00 NS	1.61 NS

*, ** significant at *P < 0.05* and *P < 0.01* probability level respectively, NS non significant

Table 2

Components of variance (ANOVA), partitioning of yield components and yield of spring barley for the years 2000-2005

Yield components		Years (Y)	Systems(S)	Y x S	Residual	Total
Yield of spring barley	sum of square	10.32	0.60	1.13	0.78	16.53
	variance			4.33		
Yield of dry mater	sum of square	40.06	2.30	4.39	3.08	64.11
	variance			4.28		
Number of spike per m^{-2}	sum of square	92,437.60	280.30	5,933.67	63,521.00	332,687.7
	variance			0.28		
Thousand of kernels weight TKW	sum of square	202.49	23.94	21.02	31.48	314.32
	variance			2.00		
Kernels bulk density (g L^{-1})	sum of square	15,759.3	56.33	362.94	998.94	18,655.49
	variance			1.09		
Amount of kernels larger than 2.5 mm x 20.0 mm (%)	sum of square	336.05	16.89	45.47	84.34	609.17
	variance			1.61		

SS - sum of square, V - variance (% of total)

Since yield of grain and nearly all yield components were higher in low input system, we recommend use it for spring barley growing in studied soil-climatic conditions. Also ŽÁK et al. (2006) who investigated yield and energy parameters of winter wheat stated that both ES and LIS can be advice for winter wheat growing in practice, but in term of energy production rate more certain is winter wheat growing in low-input farming system. Ecological farming systems have positive effect on the environment. It is possible to achieve high grain yield and adequate special purpose quality of malting barley by usage of adequate barley assortment, but only in suitable growing conditions and with proper technology of farming (LALIC et al. 2007).

However, the results obtained in our study shoved that combination of the studied years x farming systems slightly diminished the influence of farming system, and differences between ecological compared to low input system in total yield of spring barley grain and dry matter were significant at level ($P<0.05$). Thus, as conclusion, when consider the interaction of farming systems in real weather conditions during years, we can recommend use of both farming systems for spring barley growing in studied soil-climatic conditions.

CONCLUSIONS

Compared farming systems significantly influenced nearly all evaluated yield components beside number of spike per m^{-2}, weight of kernels per spike, kernels bulk density and percentage of kernels larger than 2.5 mm x 20.0 mm.

Each investigated yield component was highly significantly influenced by weather conditions during years.

Results obtained in this study showed that both evaluated farming systems of spring barley growing can be advice use in practice in studied soil-climatic conditions.

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