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YIELD AND YIELD COMPONENTS OF SPRING BARLEY AS AFFECTED BY ORGANIC AND LOW INPUT SYSTEM

VPLYV EKOLOGICKÉHO A LOW INPUT SYSTÉMU NA ÚRODU A ÚRODOTVORNÉ PRVKY JAČMEŇA JARNÉHO

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A field experiment was conducted in order to determine the influence of an organic and low input system on the yield and selected yield components of spring barley. The experiment was carried out during 2000–2005 on Luvi-Haplic Chernozem on an experimental station of the RIPP in Western Slovakia. Significantly higher yield of spring barley grain was found in the low input system (5.02 t ha^{-1}) compared to the organic system (4.80 t ha^{-1}). Similarly, the yield of dry matter, thousand of kernels weight and kernels per spike were significantly higher in the low input system. The yield of straw and evaluated yield components (number of spike per m^{-2}, kernel bulk density, and amount of kernels larger than 2.5 x 20.0 mm) were not influenced by used farming systems. Each investigated yield component was highly significantly influenced by weather conditions during the years. In spite of significantly higher grain yield in the low input system in comparison to the organic system, we recommend both cropping systems for spring barley growing under the studied soil-climatic conditions.

Key words: spring barley, organic system, low input system, yield components

Grain yield in barley can be expressed as a function of spikes per square meter, kernels per spike, and kernel weight, which together are referred to as yield components. Yield components are formed during successive stages in the ontogeny of plants (Sinebo, 2002).

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 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). There is no strict definition of low external input technology, however, the following innovations are among the most prominent examples – in soil and water management there are conservation tillage, mulches, and cover crops; in soil fertility enhancement there are manures and composts, biomass transfer, and green manures; and in controlling weeds and pests there can be mentioned intercrops, crop rotation and integrated pest management (Tripp, 2006). Some technologies are recognized as fundamental requirements for mitigate climate-stress, as surface protection during and out of the growing season, and cover plants and maintaining favourable habitat for earthworms – it is similarly suitable to cash and cover plants (Birkas et al., 2008).

Organic farming does not use almost any synthetic substance such as chemical pesticides and fertilizers (with a limited exceptions), but it uses 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 organic and low input system on the grain yield and yield components of spring barley.

Materials and methods

The yield components of spring barley varieties Atribut (2000–2002) and Nitran (2003–2005) were studied in the field experiment under 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, 79 mg kg^{-1} available P, 266 mg kg^{-1} available K and 258 mg kg^{-1} available Mg – Mehlich II method. The experimental details of the plant culture are shown in Table 1.

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 undersown 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 organic system were performed in accordance with the IFOAM rules. Mechanical

Table 1 Experimental details of plant culture of spring barley in Borovce during 2000–2005

Years (1)	Primary tillage date (2)	Sowing date (3)	Crop emergence date (4)	Date of harvest (5)	Weather condition from sowing to harvest (6)	
					rainfall in mm (7)	sum of temp (^{o}C) (8)
1999/ 2000	17 Nov	5 April	15 April	25 July	128	1 804
2000/2001	14 Nov	21 March	6 April	27 July	266	1 687
2001/2002	21 Nov	12 March	31 March	11 July	194	1 917
2002/2003	22 Nov	20 March	3 April	8 July	83	1 795
2003/2004	10 Nov	1 April	14 April	22 July	106	1 477
2004/2005	3 Nov	30 March	11 April	25 July	255	1 871

Tabuľka 1 Údaje experimentu pestovania jačmeňa jarného v Borovciach v rokoch 2000–2005
(1) roky, (2) základné obrábanie pôdy, (3) dátum sejby, (4) dátum vzchádzania, (5) dátum zberu, (6) počasie od sejby do zberu, (7) zrážky, (8) suma teplôt v ^{o}C

weed control, allowed seed treatment, and merely organic fertilisers were used. Two weeks after the harvest straw and crops residues were ploughed in by tillage and the catch crops phacelia and mustard were sown (15 kg ha^{-1} for each crop). Green manure was incorporated into the soil at the time of primary tillage by mouldboard ploughing into the depth of 0.18–0.20 m for spring barley and peas, and into the depth of 0.25–0.30 m for potatoes. During the first week of September, 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 the analysis of variance using the Statgraphics procedure and the F-test (Fisher`s protected LSD test).

Results and discussion

Presented work is focused on the comparison of different farming systems on spring barley crop, but considers also the influence of weather conditions on grain yield and yields components.

The yield of spring barley grain varied from 4.22 t ha^{-1} in 2000 to 5.73 t ha^{-1} in 2004. The average yield of grain was significantly higher (P < 0.01) in the low-input system (5.02 t ha^{-1}), what is by 4.4 % higher compared to the organic one (4.80 t ha^{-1}). Our results are in accordance with other findings, which confirmed lower yield of cereals in the organic farming system compared to the low-input farming system (Žák et al. 2006; Macák et al. 2007).

The productivity of arable crop rotations for organic farming is often low, which fact is caused by lack of N, because on these farms the use of artificial fertilisers is prohibited and availability of animal manure is limited (Olesen et al., 2002).

The significance of the yield components and crop yield of spring barley grown in an organic and a low input system is stated in the Table 2. In spite of non significant influence of the evaluated farming system on the yield of straw, the total yield of spring barley grain and yield of dry matter (Table 2) was significantly (P < 0.01) influenced by farming systems. Significantly higher parameter weight of thousand kernels was reached in the low input system (44.90 g) in comparison to the organic one (43.49 g). Rajala et al. (2007) mentioned that the principal yield determining trait in two-row barley was grain number per m^{2}, whereas grain weight had lower effect on grain associated with grain yield. Spike length and number of kernels per spike are closely associated yield components. Significantly longer spikes and higher number of kernels per spike were noted in the low input system (77.32 mm, 23.25 pcs.) in comparison to the plants grown in the ecological system (73.4 mm, 22.74 pcs.).There was found no significant effect of the used farming systems to the other studied yield components (number of spikes per m^{-2}, kernel bulk density, amount of kernels larger than 2.5 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 the studied years. This is in agreement with results reached by many other authors (Candráková et al., 1999b; Kováč et al., 2006; Martinková et al., 2007).

Partitioning of the variance showed (Table 3) that conditions prevailing during the specific year were the most important factor in determining grain yield of spring barley

Table 2 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 (1)	Years (Y) (2)	Systems (S) (3)	*Y × S*
Yield of spring barley grain (4)	39.48**	11.61**	4.33*
Yield of straw (5)	26.46**	4.47 NS	1.44 NS
Yield of dry matter (6)	39.01**	11.20**	4.28*
Number of spikes per m^{-2} (7)	4.36**	0.06 NS	0.28 NS
Kernels per spike (8)	97.00**	5.01*	6.63**
Thousand of kernels weight TKW (9)	19.29**	11.40**	2.00 NS
Kernel bulk density in g L^{-1} (10)	47.32**	0.84 NS	1.09 NS
Amount of kernels larger than 2.5 mm x 20.0 mm in % (11)	1.95**	3.00 NS	1.61 NS

*, ** significant at P < 0.05 and P < 0.01 probability level respectively, NS non significant
*, ** preukazný na hladine pravdepodobnosti P < 0,05 a P < 0,01, NS nepreukazný

Tabuľka 2 F štatistika z ANOVA pre prvky úrodnosti a úrodu jačmeňa jarného pestovaného v ekologickom a low input systéme v rokoch 2000–2005
(1) úrodotvorné prvky, (2) roky, (3) systémy, (4) úroda zrna jačmeňa jarného, (5) úroda slamy (6) úroda sušiny, (7) počet klasov na m^{2}, (8) počet zŕn v klase, (9) hmotnosť tisíc semien, (10) objemová hmotnosť zrna, (11) podiel zrna nad sitom 2,5 x 20,0 mm v %

Table 3 Components of variance (ANOVA), partitioning of the yield components and the yield of spring barley for the years 2000–2005

Yield components (1)		Years (Y) (2)	Systems (S) (3)	Y × S	Residual (4)	Total (5)
Yield of spring barley grain (6)	sum of square (SS) (12)	10.32	0.60	1.13	0.78	16.53
	variance (% of total) (V) (13)	62.40	3.60	6.80	4.70	–
Yield of dry mater (7)	sum of square (SS) (12)	40.06	2.30	4.39	3.08	64.11
	variance (% of total) (V) (13)	62.5	3.60	6.90	4.80	–
Number of spikes per m^{-2} (8)	sum of square (SS) (12)	92,437.60	280.30	5,933.67	63,521.00	332,687.7
	variance (% of total) (V) (13)	27.80	0.10	1.80	19.10	–
Thousand of kernels weight TKW (9)	sum of square (SS) (12)	202.49	23.94	21.02	31.48	314.32
	variance (% of total) (V) (13)	64.40	7.60	6.70	10.00	–
Kernel bulk density in g L^{-1} (10)	sum of square (SS) (12)	15.759.3	56.33	362.94	998.94	18,655.49
	variance (% of total) (V) (13)	84.50	0.30	2.00	5.40	–
Amount of kernels larger than 2.5 mm x 20.0 mm (%) (11)	sum of square (SS) (12)	336.05	16.89	45.47	84.34	609.17
	variance (% of total) (V) (13)	55.20	2.80	7.50	13.90	–

Tabuľka 3 Rozdelenie variancie (ANOVA) na zložky pre prvky úrodnosti a úrodu jačmeňa jarného v rokoch 2000–2005
(1) úrodotvorné prvky, (2) roky, (3) systémy, (4) zvyšok, (5) celkový, (6) úroda zrna jačmeňa jarného, (7) úroda sušiny, (8) počet klasov na m^2, (9) hmotnosť tisíc semien, (10) objemová hmotnosť zrna, (11) podiel zrna nad sitom 2,5 x 20,0 mm v %, (12) suma štvorcov, (13) variabilita (% z celkovej)

(62.40 %), the number of spikes per square meter (27.80 %) was due to the favourable conditions of the evaluated farming systems relatively resistant to the year condition.

Since the yield of grain and nearly all yield components were higher in the low input system, we recommend its usage for spring barley growing under the studied soil-climatic conditions. Organic 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 under suitable growing conditions and with proper technology of farming (Lalic et al., 2007).

However, the results obtained in our study showed that the combination of the studied years x farming systems slightly diminished the influence of the farming system. Thus, as a conclusion, considering the interaction of farming systems under the real weather conditions during the years, we can recommend usage of both farming systems for spring barley grown under the studied soil-climatic conditions. The results of our study may support adopting environmentally sound farming system in Slovakia.

Súhrn

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 úroda zrna jarného jačmeňa bola dosiahnutá v low-input systéme hospodárenia (5,02 t ha^{-1}) v porovnaní s ekologickým systémom (4,80 t ha^{-1}). Podobne i úroda sušiny, hmotnosť tisícich semien a počet zŕn v klase boli preukazne vyššie v low-input systéme. Úroda slamy a skúmané úrodotvorné prvky (počet klasov na m^2, objemová hmotnosť zrna a obsah zŕn väčších ako 2,5 x 20,0 mm) neboli ovplyvnené hodnotenými systémami hospodárenia. Všetky skúmané úrodotvorné prvky boli vysoko preukazne ovplyvnené poveternostnými podmienkami v jednotlivých rokoch. I keď úroda zrna a celkovej biomasy bola preukazne vyššia v low-input systéme v porovnaní s ekologickým systémom, odporúčame pre pestovanie jarného jačmeňa aplikovať v daných pôdno-klimatických podmienkach oba systémy.

Kľúčové slová: jačmeň jarný, ekologický systém, low input systém, úrodotvorné prvky.

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EFFECT OF FIELD BEANS (*VICIA FABA* L.) AND AGE OF LAYERS ON SOME PRODUCTION PARAMETERS

VPLYV ZARADENIA BÔBU OBYČAJNÉHO (*VICIA FABA* L.) DO KŔMNEJ ZMESI PRE NOSNICE NA ŽIVÚ HMOTNOSŤ A PRODUKCIU VAJEC

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The aim of this experiment was to study the influence of field beans (FB) and also birds' age on some production performances of commercial layers. Raw Faba Bean "RFB" 10 %, 20 % and 30 % were compared with Roasted Faba Bean "RoFB" 10 %, 20 % and 30 %, and both groups were compared with control C. The experiment was performed in a seven-group laying test with 3 repetitions, with a total number of 630 birds aged 43 weeks. Body weight (BW), egg production (EP), feed consumption (FC), and feed conversion ratio (FCR) were studied. BW was not essentially affected by treatments. A significantly higher EP was observed in T4 (10% RoFB). The lowest EP was registered in T2 (20% RFB) and T3 (30% RFB), but values in T1, T5 (20% RoFB) and T6 (30% RoFB) groups were insignificantly higher than C. In the group T2 there was a significant reduction in FC, and a significant increase in the group T4 was observed. A significantly higher value of FCR was observed in T4, while significantly lower values were obtained in T2 and T3. An increase of the birds' age had not essential effects on the BW of hens, but other values were significant and fluctuated in our experiment. EP decreased insignificantly from the week 44 of bird's age. FC increased significantly and progressively with advanced ages. FCR was lowered gradually and significantly as the age of the birds increased.

Key words: *Vicia faba*, layers, egg production, feed consumption, feed conversion

Inclusion of certain grain legumes at low to moderate concentrations in layer diets may boost production and improve the efficiency of feed utilization. The use of grain legumes for poultry is restrained by the uncertainty on the amount and the effect of anti-nutritional factors (ANFs) they may contain (Wiryawan and Dingle, 1999). Flaeh et al., (1998) pointed out numerous anti-nutritional factors in FB seeds (proteinas inhibitors, tannins, vicine, convicine, heme agglutinins, phytic acid, and saponin). Heat treatment is one of the most effective means to dispose anti-nutritional factors in legume seeds (Mohsin, 2000). Al-Nouri (1979) commented that roasted FB seeds contained proteins utilized more efficiently than obtained from other treatments. Thus the nutrition value improved and odor and flavours make it more palatable to birds. Brufau et al. (1998) observed that FB seeds treated with heat can improve the utilization of faba beans, containing high ANFs.

Using RFB in the 20 % and 30 % version in layers' diets did not affect body weight (Guillaum and Bellec, 1977; Naber, 1988).

By using 10%RFB in layers' diets, egg production was not affected significantly (Wilson and Teague, 1974; Robblee et al., 1977; Matteos and Puchal, 1982). Robblee et al. (1977) Matteos and Puchal, 1982; Naber, 1988) also found that using 20%RFB with sufficient quantities of methionine and cystine in the diet did not affect the egg production. (Wilson and Teague, 1974; Castanon and Perez-Lanzac, 1990) however found insignificant decreases. In trials with hens which consumed diets containing 30 % RFB for a long period, egg production decreased significantly ($p \leq 0.05$), in the (Davidson, 1973; Robblee et al., 1977; Guillaume and Bellec, 1977; Campbell et al., 1980) experiments. However, Robblee et al. (1977) observed the reverse effect when using 30%RFB in the diet. (Nanakaly, 1998; Al-Haweizy, 2002) observed a significant decrease in egg production with advanced birds' age.

Including RFB in layers' diets resulted in a decrease of feed consumption and symmetrically an increase of RFB levels (Mateos and Puchal, 1982; Castanon and Perez-Lanzac,