WINTER WHEAT PRODUKTIVITY AND QUALITY IN SUSTAINABLE FARMING SYSTEMS

PRODUKTIVITA A KVALITA PŠENICE LETNEJ FORMY OZIMNEJ V UDRŽATEĽNÝCH SYSTÉMOCH HOSPODÁRENIA

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Abstract: *The aim of this research work was to evaluate the quantitative and qualitative parameters of winter wheat cultivated in ecological (ES) and integrated (IS) farming systems. Farming systems were established in fall of 1990 at a research base near Nitra in South Slovakia region on brown clay loamy soil. The experimental field altitude is 178 m., average year temperature was 10.4ºC and average annual precipitations was 582 mm. The chemical inputs of integrated system were replaced by multifunctional crop rotation, ecological plant nutrients, mechanical and physical weed control and optimal soil cultivation in ecological system. In the 2005-2007 the effect of two different farming systems (ecological and integrated) and two levels of fertilization on qualitative parameters of winter wheat were observed. Year of farming had highest influence on production parameters. Falling number and wet gluten had been influence by year of farming, fertilization and system of farming. Fertilization and system of farming did not have any significant influence on gluten index.*

Abstrakt: *Cieľom výskumnej úlohy bolo zhodnotiť kvantitatívne a kvalitatívne parametre pšenice letnej formy ozimnej v dvoch systémoch hospodárenia: ekologickom (ES) a integrovanom (IS). Pestovateľské systémy boli založené na jeseň roku 1990 vo vedecko-výskumnej báze pri Nitre na južnom Slovensku, na hnedozemnej, ílovito-hlinitej pôde. Nadmorská výška výskumnej oblasti je 178 m n.m., priemerný ročný úhrn zrážok bol 582 mm a priemerná ročná teplota bola 10,4ºC. Chemické vstupy v integrovaným systéme boli nahradené multifunkčným osevným postupom, ekologickým manažmentom živín, mechanickou a fyzikálnou reguláciou burín a optimálnym obrábaním pôdy. Počas rokov 2005-2007 bol sledovaný vplyv pestovateľských systémov a dvoch úrovni hnojenia na kvalitatívne parametre pšenice letnej formy ozimnej. Pestovateľský ročník mal signifikantný vplyv na produkčne parametre pšenice letnej. Pádové číslo a mokrý lepok boli významne ovplyvnene ročníkom pestovania, hnojením a systémom hospodárenia. Hnojenie a sústava preukazne neovplyvnili gluten index.*

Key words**:** *ecological, integrated farming systems, qualitative, quantitative parameters of winter wheat*
Kľúčové slová: *ekologický, integrovaný pestovateľský systém, kvalitatívne, produkčne parametre pšenice letnej formy ozimnej*

INTRODUCTION

Organic agriculture has rapidly developed world-wide during the last few years. It is practised in almost all countries of the world, and its share of agricultural land and farms is growing. The total organically managed area is more than 24 million hectares world-wide (WILLER AND YUSSEFI, 2004). Development of this type of agricultural production in Slovakia started in year 1991 in connection with experience and development trends in West European countries. Organic agriculture is an production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony. Organic growing system offers an alternative way how to be environment friendly and satisfy crop production at the same time.

Many inputs and practices used by farmers are also used in sustainable agriculture. Sustainable farmers, however, maximize reliance on natural, renewable, and on-farm inputs

(WASCHER, 2000). Equally important are the environment, social and economic impacts of a particular strategy. Converting to sustainable practices does not mean simple input substitution. Frequently, it substitutes enhanced management and scientific knowledge for conventional inputs, especially inputs that harm the environment on farms and in rural communities. The goal is to develop efficient, biological system which do not need high levels of material inputs.

From the importance and quantity point of view, the cereals, in particular wheat, has the highest level of consumption in the world, and provides about 40 percent of the nutritional energy worldwide, especially in the developing countries. The implementation of this work, which is for the enhancement of yield and quality of wheat, as well as the optimal utilization of chemical fertilizers and performance of the animal manure to the point of reaching sustainable agriculture, defines the objective of this research work.

MATERIALS AND METHOD

The aim of this research work was to evaluate the quantitative and qualitative parameters of winter wheat cultivated in ecological (ES), integrated (IS) farming systems and apply more holistic view on development of farming systems. A project was initiated in 1990 at the Research Experimental Station at Dolna Malanta near Nitra, which is experimental base of the Faculty of Agrobiology and Food Resources of Slovak University of Agriculture in Nitra. It belongs to a warm agro-climatic macroregion, arid subregion and to agroclimatic distinct of predominantly mild winter. Ecological and integrated arable farming systems were established in the fall of 1990 on brown clay-loamy soil. The altitude of experimental field is 178 m, average year temperature was 10.4ºC and average annual precipitation was 582 mm. The field trial was observed during three vegetative periods, from 2005 to 2007. It is ordered into four blocks in three repetitions. The chemical inputs of integrated system were replaced by multifunctional crop rotation, ecological plant nutrition, mechanical and physical weed control and optimal soil cultivation in ecological system.

Quantitative (yield, thousand grain weight, number of spikes per m^2 and number of grains per spike) and qualitative parameters (gluten index, wet gluten and falling number) were evaluated in three repetition, according to Slovak technical standards and ICC standards. Obtained data were statistically evaluated by correlation, analysis of variance (ANOVA) and the significant differences were calculated by LSD test. Significance is indicated at $P \leq 0.05$.

RESULTS AND DISCUSSION

System of farming and fertilization did not show any statistically significant effect on thousand grain weigh (TGW) and number of spikes per m^2 (Table 1). The highest number of spikes per m^2 (615.1) and yield (6.7 $t.ha^{-1}$) were in IS with fertilization (Figure 1), but the highest TGW (38,45 g) was in ES with FYM. The number of grain per spike was significantly influenced by system of farming and level of plant nutrition.

Table 1

Agronomic evaluation of winter wheat in ecological ant integrated system (2005-2007)

System	***Crop nutrition***	***Yield t ha $^{-1}$***	***TGW g***	***No of spikes per m^2***	***No of grains per spike***
ECOLOGICAL	manure	5.57 a	38.45 a	547.56 a	26.44 ab 24.65
	without manure	5.36 a	37.78 a	571.56 a	a
INTEGRATED	fertilized	6.70 b	38.12 a	615.11 a	28.15 b
	unfertilized	5.48 a	38.05 a	556.89 a	25.92 ab

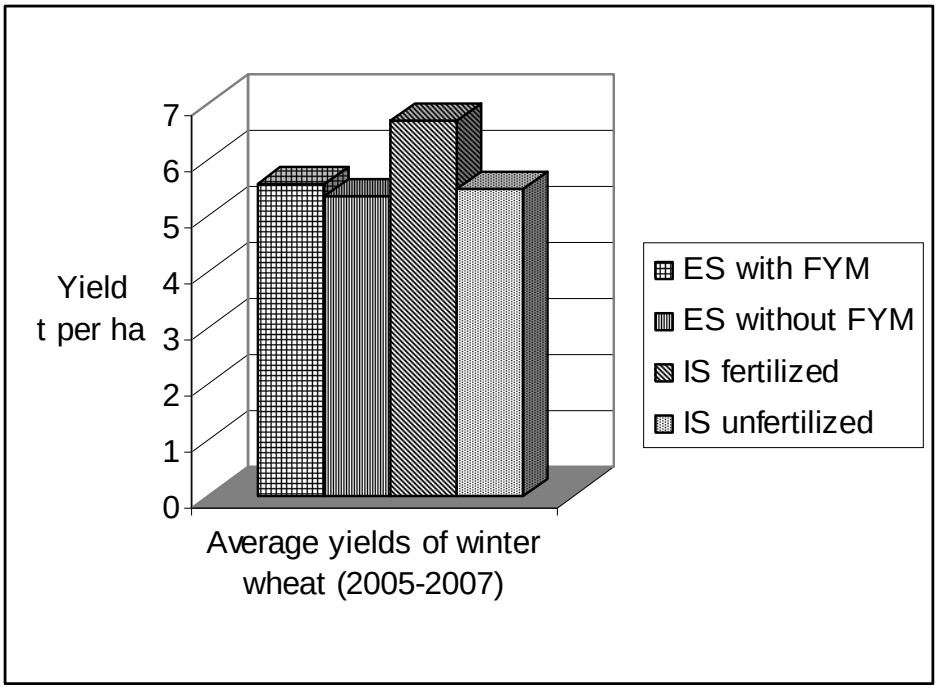

Figure 1.Average yields of winter wheat (2005-2007)

Winter wheat yield was 10.2 % lower in ecological system as compared to the integrated one. Production parameters of winter wheat were influenced by the year of experiment (meteorological conditions). Weigh of thousand grains and the number of grains per spike were significantly higher in 2006, but the number of spikes per m^2 was higher in 2005 (Table 2).

Table 2

Agronomical evaluation of winter wheat (2005-2007)

Parameters	***System***		***Crop nutrition***		***Year of farming***		
	ecological	integrated	fertilized	unfertilized	2005	2006	2007
Yield t ha $^{-1}$	5.47 a	6.09 a	6.13 a	5.42 a	5.09 a	7.16 b	5.08 a
TGW g	38.11 a	38.09 a	38.29 a	37.92 a	37.02 a	39.49 b	37.80 a
No of spikes per m^2	586.00 a	559.06 a	581.33 a	564.22 a	602.33 b	579.00 ab	537.00 a
No of grains per spike	25.55 a	27.04 a	27.30 b	25.28 a	22.56 a	31.19 c	25.12 b

Baking quality of winter wheat was measured and evaluated by using standard method to determine winter wheat quality. Wet gluten, falling number and gluten index are evaluated in this work.

The winter wheat quality was defined by using Slovak technical standards and ICC standards, which evaluate the content and quality of gluten. The best quality indicated by Gluten Index was in integrated farming system without fertilization (94,5%) (Table 3).

Years of farming influenced all qualitative parameters of winter wheat. These results correspond with Lacko-Bartošová (2005) findings, where 30% differences in wet gluten caused by year of farming was achieved.

The lowest value of wet gluten was achieved under the treatment without fertilization in integrated system of farming (19,32%). The highest value of wet gluten was reached under the variant with fertilization in integrated system of farming (25,02%) (Figure 2).

Table 3

Qualitative parameters of winter wheat

System	***Crop nutrition***	***Falling number (s)***	***Wet gluten (%)***	***Gluten index (%)***
ECOLOGICAL	manure without manure	291.67 b 306.11 a	23.66 a 23.07 a	93.08 a 93.88 a
INTEGRATED	fertilized unfertilized	309.44 a 307.44 a	25.02 c 19.32 b	92.57 a 94.46 a

The falling number defines alpha amylase activity in grain. It gives an indication of amount of sprout damage that has occurred within a wheat sample (Moudrý and Prugar, 2002) Generally a falling number value of 350 seconds or longer indicates low enzyme activity and poor quality for milling and baking purposes. Value below 200s indicate high levels of enzyme activity. Significantly the lowest falling number was in ES with manure (291,7s), the highest in IS with fertilization (309,4s) (Figure 2). Falling number and wet gluten had been influence by year of farming, fertilization and system of farming. Fertilization and system of farming did not have any significant influence on gluten index (Table 4).

Table 4

Quality of winter wheat (2005-2007)

Parameters	***System***		***Crop nutrition***		***Year of farming***		
	ecological	integrated	fertilized	unfertilized	2005	2006	2007
Wet gluten (%)	23.36 b	22.17 a	24.34 b	21.19 a	16.2 b	25.6 a	26.5 a
Falling number (s)	298.88 a	308.44 b	300.55 a	306.77 b	230.91 a	299.75 b	380.33 c
Gluten index (%)	93.47 a	93.51 a	92.82 a	94.16 a	97.75 b	90.87 a	91.85 a

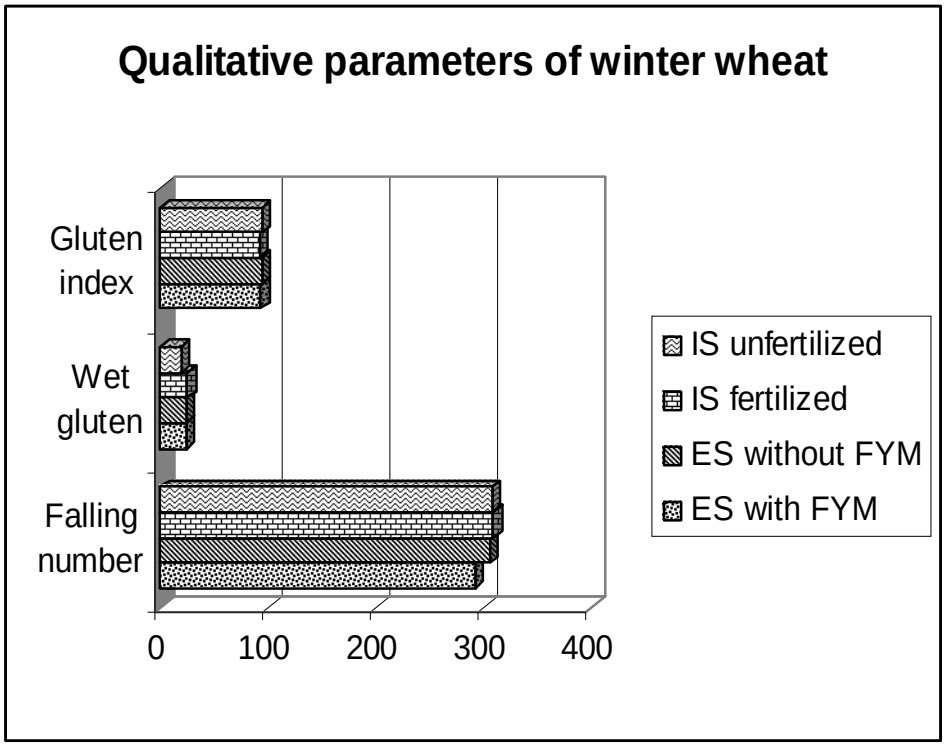

Figure 2.Qualitative parameters of winter wheat (2005-2007)

CONCLUSIONS

System of farming and fertilization did not show any statistically significant effect on thousand weigh (TGW) and number of spikes per m^2 . Winter wheat yield in ecological system was 10,2 % lower as compared to the integrated one. The lowest value of wet gluten was achieved under the treatment without fertilization in integrated system of farming and the highest one was reached under the treatment with fertilization in integrated system. Falling number and wet gluten are depended on the meteorological characteristic of experimental year, fertilization and system of farming. In our case, we detected low enzyme activity (falling number was over 300s). Using amylolitic enzymes the deficit can be eliminated and might improve the gluten quality. Fertilization and system of farming did not have any significant influence on gluten index.

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LITERATURE

1. WILLER, H., YUSSEFI, M., *"The World of Organic Agriculture Statistics and Emerging Trends"*, Bonn: International Federation of Organic Agriculture Movements, Germany, 2004, 167 pg., ISBN 3-934055-33-8.
2. LACKO-BARTOŠOVÁ, M., *"Udržateľné a ekologické poľnohospodárstvo"*, Nitra: SPU, 2005, 575 pg., ISBN 80-8069-556-3
3. MOUDRÝ, J., PRUGAR, J., *"Biopotraviny.Hodnocení kvality, zpracování a marketing"*, Praha: ÚZPI, 2002, 36 pg.
4. WASCHER, D., *"Agri-environmental Indicators for Sustainable Agriculture in the Europe"*, Tilburg: European Centre for Nature Conservation, 2000, 240 pg., ISBN 90-767662-02-3.