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Effect of selected factors of cultivation technologies for the production of winter barley in years with different weather conditions

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Abstract

The aim of the work was to determine the impact of the different variants of organo-mineral nutrition, tillage methods and varieties on the grain yield of winter barley, depending on the weather conditions and the year. We studied winter barley varieties (Graciosa, Malwinta) in polyfactorial experiments, in years 2008-2009. Four levels of different fertilization were monitored, where organo - mineral fertilizer Condit, non – root fertilization with preparation Hakofyt in combination with commercial fertilisers (saltpetre + P and K, ammonium nitrate + P and K) were compared. There were two soil cultivation methods studied (A = conventional tillage, C = minimize tillage). From the results follows a statistically significant (r = -0.8130 ***) interaction relationship between the year and the soil cultivation method. Minimized tillage favourably reflected in a year with better weather condition, where in interaction with organo – mineral fertilizer ensured the highest grain yield for both varieties. In drier year the conventional tillage was preferable in interaction with off root nutrition Hakofyt + saltpetre with limestone.

Key words: winter barley, fertilization, soil cultivation methods

Introduction

In conditions of climatic changes, balance in field ecosystems is disturbed. Global changes could impact the formation of cereal biomass in several ways could be reflected on achieved results of last years in barley yield amount and quality (Molnárová et al. 2006). Winter barley belongs to those field crops, which are capable for a very intensive use of the growing environment factors. Into a complex of production measures enabling the usage of potential and biological production abilities of the environment and barley genotype also belongs a systematic soil cultivation and nutrition regulation. According to Sleziak (2000) it is possible to increase the yield potential utilization in malting barley for 60-70 % using proper production system. Barley is sensitive to poorly cultivated soil and its physical properties. Influence of different soil cultivation methods on grain yield of cereals has been studied by many authors (Procházková at al. 1997; Kubinec and Kováč 1998). High specific requirements of malting barley for nutrients indicate a demand to monitor the nutrient content during the vegetation. Here is a chance for non-root nutrition and its importance is partially confirmed by various authors (Varga and Filová, 2004; Molnárová, 2008 and others). The aim of the research was to determine the impact of the different variants of organo-mineral nutrition, tillage methods and varieties on the grain yield of winter barley, depending on the weather conditions and the year.

Material and methods

The polyfactorial field trials were established on the experimental base of the Faculty of Agrobiology and Food Resources SAU in Nitra in years 2008 and 2009. Experimental base is classified and characterized according to Špánik et al. (2002) as a macroregion - warm, region - mostly warm and subregion - very dry. The average total annual rainfall is 561 mm, for vegetation period 333 mm. The average annual temperature is 9.7 ^{o}C. Trials were

conducted on orthic luvisoils. The soils inorganic nitrogen content was 9 – 14 mg.kg^{-1}, phosphorus content (medium) 48 - 64 mg.kg^{-1} and potassium content (medium - high) 206-345 mg.kg^{-1} with active pH 5.9 - 6.5 (Tobiášová and Šimanský 2009). To determine the available nutrients we used Melich II method for P and K determination and colorimetric method for N determination. The trials were established by split plot method in three repetitions. Each allotment was a size of 14 m^2. After white mustard as a preceding crop, we monitored two winter barley varieties: Graciosa, Malwinta. Four variants fertilization were evaluated: unfertilized control (a), Condit mineral at the doses of 1 t.ha^{-1} (b), 60 kg N as nitrate saltpetre with limestone + leaf fertilizer (Hakofyt extra)+ P (22,7 kg.ha^{-1}) K (36 kg.ha^{-1}) (c), 60 kg N as NH_4NO_3 + leaf fertilizer (Hakofyt extra) + P (22,7 kg.ha^{-1}) K (36 kg.ha^{-1}) (d). Thirdly we monitored two soil cultivation methods: conventional tillage (A - ploughing to the depth of 0.20 meters) and minimized tillage (C -disk harrowing to the depth from 0.10 to 0.12 meters). Leaf fertilizer Hakofyt extra is an effective product on natural basis. 1 liter contains at least: 120 g nitrogen, 3.0 grams of phosphorus (P_2O_5), 4.0 grams of potassium (K_2O), 1.0 g humic acid and 0.4 grams of boron. Trace elements (Cu, Mn, Fe, Zn) contained are in chelated form and the growth stimulator in natural base provide more efficient use of nitrogen, phosphorus and potassium in the primary fertilization. Soil samples were taken to determine the N_{an}, P and K content before fertilization. Doses of P and K of fertilizers were calculated according to substitution system for yield level of 7.0 t ha^{-1}. Results were evaluated by analysis of variance in Statistica 8 (Tukey – test).

Result and discussion

Table 1. Grain yield of winter barley by different variants fertilization and soil cultivation in 2008 and 2009

Variety	Tillage	Nutrition	2008	2009	Mean 2008 -2009
MALWINTA	A	a	10.32	8.38	9.35
		b	10.08	8.42	9.25
		c	10.46	9.10	9.78
		d	11.27	8.63	9.95
		x	10.53	8.63	9.58
	C	a	11.64	6.09	8.87
		b	12.13	7.60	9.86
		c	11.70	7.58	9.64
		d	11.78	7.68	9.73
		x	11.81	7.24	9.52
GRACIOSA	A	a	9.65	6.83	8.24
		b	11.16	7.42	9.29
		c	10.70	8.00	9.35
		d	11.37	6.89	9.13
		x	10.72	7.29	9.00
	C	a	10.73	6.20	8.47
		b	11.49	6.28	8.88
		c	11.14	7.12	9.13
		d	11.28	7.70	9.49
		x	11.16	6.83	8.99

Winter barley grain yields were affected not only by particular factors (fertilization, soil cultivation, variety), but fluctuated greatly depending on the course of weather conditions during the year in vegetation period (Table 1). During the 2007/2008 vegetation season the distribution of rainfall and average temperature were very favourable for formation of winter barley. Total rainfall in September to November reached 31,6 to 91.2 mm, 87.7 to 228,0 % of climatic normal (cl. n.) with an average temperature of 3.6 to 13.7 °C (Graf 1, 2). The condition of vegetation was optimal and before the arrival of winter, the crop was in BBCH 22 – 23, which provided a good overwintering with reduction of 3 %. Favourable distribution of rainfall during the spring vegetation ensured a beneficial condition for the creation of other yield formatting elements: the number of productive tills, as well as the number and weight of grains in the ear, which provided in interaction of nutrition and soil cultivation a good

grain yield. The weather conditions were less favourable in 2008/2009 vegetation season. Normal September with a rainfall 51.5 mm (77.6 % cl. n) (Graph 2) and the first decade of October ensured a good conditions for germination and emergence, but subsequent drought in the second decade of October and in November had a negative impact on the formation of tills, which made out after winter. Winter rainfalls (57.6 mm, 41.1 mm, 45.9mm) (Graph 2) from December to February, ensured sufficient tillering and thus the number of tills with the number of plants had an utmost share in the yield formation. Between the years statistical difference was proved. Achieved results showed a statistically significant difference effected by soil cultivation in the 2007/2008 vegetation season and in 2008/2009 vegetation season effected by soil cultivation (Table 2, 3; Graph 4, 5). Average grain yield for the entire experiment in the 2007/2008 vegetation season reached 11.06 t.ha^{-1}. On average of all variants of nutrition, both varieties reacted more positively to the minimized tillage than to the conventional tillage. The differences between the yields concerning the tillage methods were proved and reached 0.86 t.ha^{-1} in the favour of the minimized tillage. (Table 2). Effect of nutrition on grain yield was dependent on the soil cultivation, but the differences were not proved. By the minimization tillage (C) organo - mineral fertilizer

Table 2. Effect of soil cultivation methods on the grain yield of winter barley

2007/2008		2008/2009	
Methods	**Yield (t.ha^{-1})**	**Methods**	**Yield (t.ha^{-1})**
Conventional tillage	10.63 a	Conventional tillage	7.97 a
Minimized tillage	11.49 b	Minimized tillage	7.03 b

Mean values marked in the same column by the different letter are significantly differ (P < 0.05).

Condit showed more effect, which provided the highest grain yield for the entire experiment (11.49 resp. 12.13 t.ha^{-1}) (Table 1) for both varieties. By the conventional tillage the favourable combination was Hakofyt with NH_4NO_3 (Table 1). Favourable weather conditions lead to a balanced yield of both varieties. In 2008/2009 the average grain yield (7.50 t.ha^{-1}) was lower for 3.56 t.ha^{-1} compared with the previous year (Table 4, Graph 3). Significant effect of year on the grain yield is also proved by a correlation relationship (r = - 0.8130 ***) (Graph 5). Effect of the soil cultivation methods and the variety was statistically proved. Concerning the soil cultivation methods, unlike the previous year, both varieties reacted positively to the conventional tillage (A), in which the grain yield compared with minimized tillage was on average higher by 0.94 t.ha^{-1} for both varieties. These results are only partly comparable with the results of authors Mean values marked in the same column by the different letter are significantly differ (P < 0.05)

Table 3. Effect of the year on the grain yield of winter barley

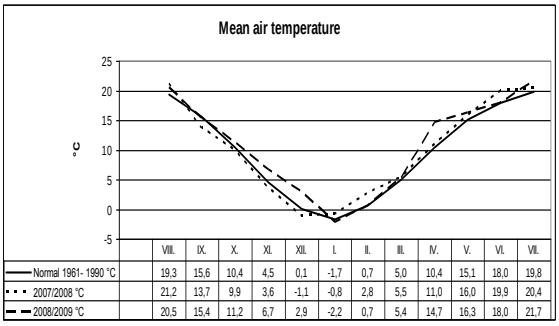
2008/2009		Meam 2008 - 2009	
Variety	**Yield (t.ha^{-1})**	**Variety**	**Yield (t.ha^{-1})**
Graciosa	7.06 a	Graciosa	9.00 a
Malwinta	7.94 b	Malwinta	9.58 b

Mean values marked in the same column by the different letter are significantly differ (P < 0.05).

Table 4. Effect of the year on the grain yield of winter barley

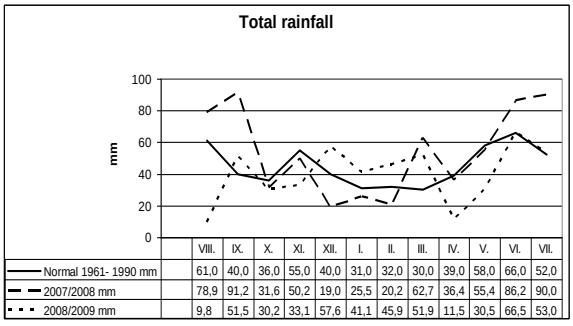
Year	**Yield (t.ha^{-1})**
2008	11.06 b
2009	7.50 a

Procházková et al. (1997) who's detected an equivalent yield like by conventional tillage in shallow soil cultivation and no - till sowing under cereals in the corn production area. The advantage of the minimized tillage was proved only in 2007/2008 with good weather conditions. Less favourable weather conditions statistically affected the grain yield of the monitored varieties. In dry conditions more adaptable appeared to be the Malwinta, which provided a statistically higher yield by 0.88 $t.ha^{-1}$ compared to the Graciosa (Table 3). Malwinta also had significantly higher yield by 0.58 $t.ha^{-1}$ on two years average (Table 3). Differences between the yields affected by nutrition were not statistically proved and were dependent on the tillage method. The combination of non – root nutrition Hakofyt + saltpetre with limestone caused a yield increase of 10.9 resp. 11.71 % at the conventional tillage by both varieties. In minimized tillage combination of Hakofyt + NH_4NO_3 was more affective resulting in higher yields by 12.61 and 12.42 % (Table 1). Fecenko (1997) achieved a yield increase of winter wheat by 9.1 % with application of humates.



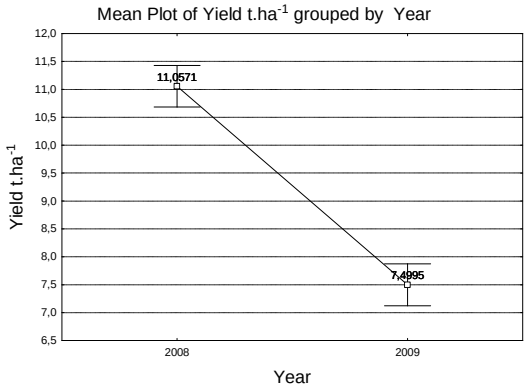
	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.	VII.
Normal 1961- 1990 °C	19,3	15,6	10,4	4,5	0,1	-1,7	0,7	5,0	10,4	15,1	18,0	19,8
2007/2008 °C	21,2	13,7	9,9	3,6	-1,1	-0,8	2,8	5,5	11,0	16,0	19,9	20,4
2008/2009 °C	20,5	15,4	11,2	6,7	2,9	-2,2	0,7	5,4	14,7	16,3	18,0	21,7

Graph 1

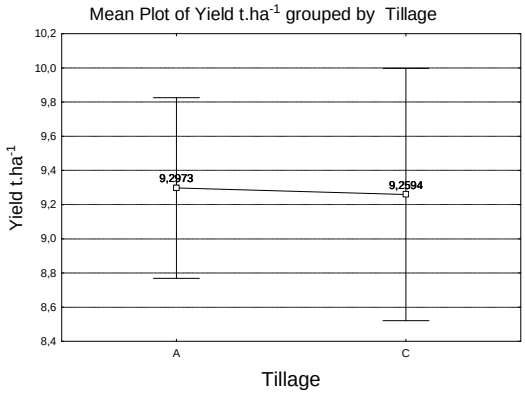


	VIII.	IX.	X.	XI.	XII.	I.	II.	III.	IV.	V.	VI.	VII.
Normal 1961- 1990 mm	61,0	40,0	36,0	55,0	40,0	31,0	32,0	30,0	39,0	58,0	66,0	52,0
2007/2008 mm	78,9	91,2	31,6	50,2	19,0	25,5	20,2	62,7	36,4	55,4	86,2	90,0
2008/2009 mm	9,8	51,5	30,2	33,1	57,6	41,1	45,9	51,9	11,5	30,5	66,5	53,0

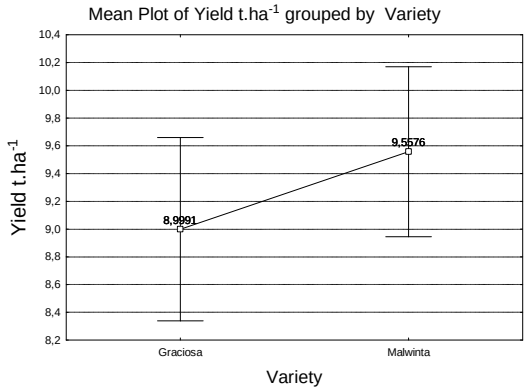
Graph 2



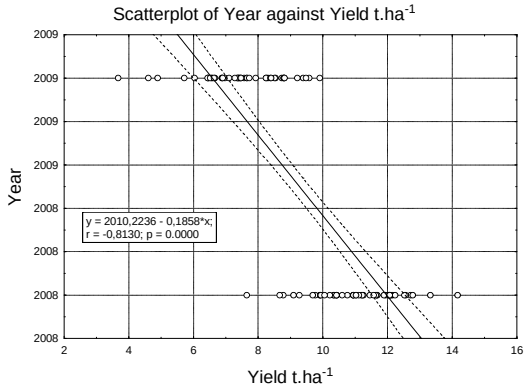
Graph 3. Mean values and ± 0.95 confidential intervals



Graph 4. Mean values and ± 0.95 confidential intervals



Graph 5. Mean values and ± 0.95 confidential intervals



Graph 6. Corrlelation coefficient between yield and year

Conclusion

Effect of cultivation on the grain yield was significantly influenced by year, significant increase of yield by minimized tillage was proved in the year with favourable weather conditions. Conventional tillage was preferable in the year with unfavourable distribution of rainfall during the vegetation. Application of organo – mineral fertilizer Condit increased the yield in the interaction with the minimized tillage only in year with favourable weather conditions. There were higher yields in applications of Hakofyt + NH_4NO_3 compared with the combination of Hakofyt + nitrate saltpetre with limestone in a favourable growing season by both of the soil cultivation methods. Suitability of combination Hakofyt + nitrate saltpetre with limestone was confirmed only in the dry year in the interaction with conventional tillage.

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