EVALUATION OF THE YIELD AND QUALITY OF DIFFERENT WINTER WHEAT GENOTYPES ON CHERNOZEM SOIL

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Abstract

We have investigated the effect of the nutrient supply on the yield, the protein content and the gluten content of different winter wheat genotypes on chernozem soil. Our experimental results suggest that the genotype and the nutrient supply had considerable influence on both the yield and the quality traits.

Key words: winter wheat, fertilization, yiled, quality, protein, gluten content

INTRODUCTION

Montemurro *et al.* (2007) conducted a three-year study on the response of winter wheat to optimized nitrogen supply. Higher doses than N_{120} kg ha^{-1} did not influence wheat development, yield and nitrogen uptake significantly. Gutierrez *et al.* (2010) found differences between the yields of varieties due to differences in genotypes. The different wheat varieties responded with different yields, to the specific environmental factors (Mengistu *et al.* 2010, Borghi *et al.*, 1997). Somnez (2007) concluded that the yield quantity and the protein content of grain were determined by the crop year, the genotype and the nutrient supply. With the increase of the nitrogen doses, the protein content of grains was increased proportionally but the varieties responded differently to the increase of the nitrogen doses.

There is significant interaction between the genotype, the nitrogen supply, the protein quality and composition, and the qualitative characteristics of the dough (Luo *et al.*, 2000, Saint Pierre *et al.* 2007, Pedersen and Jorgensen 2007). Stoeva and Ivanova (2009) found that the significant differences in the gluten content were caused by fertilization and crop year effect. Positive correlation was experienced between the wet gluten content and the nutrient supply (Alda *et al.*, 2010). According to Kindred *et al.* (2008), the amount of nitrogen doses influences the protein content of grains to a greater extent than variety effect. Zecevic *et al.* (2010) found that nitrogen fertilization significantly increased the wet gluten content. The highest increase was found at the dose of N_{120} kg ha^{-1}. The varieties responded to the increase of nitrogen doses in a different manner.

MATERIAL AND METHOD

The long-term experiment was carried out at the Látókép Experimental Station of the Institute of Crop Sciences, University of Debrecen. The experimental station is located 15 km west of Debrecen in the Hajdúság. The soil of the experiment is calcareous chernozem and can be classified into the loam category, its pH is near neutral and it has medium humus content.

The long-term experiment was set up in 1983. Our study contains the results of the season 2016-2017. The small-plot field experiment was set up in a split-split-spot design in four replications. Six fertilization levels were applied in the treatments. In addition to the control, the basic dosage of N=30 kg ha^{-1}, P_2O_5=22.5 kg ha^{-1} and K_2O=26.5 kg ha^{-1} and 2-,3-, 4- and 5-fold dosages were applied. The total P and K dosages were applied in the autumn, 50% and 50 % of the N fertilizer dosages were applied in the autumn and in the spring. The forecrop was sweet maize.

In the experiment five different genotypes of winter wheat were examined: Lukullus, Lennox, Cellule, Falado, Premio.

The precipitation values during the season and the temperature data during the period of 2016-2017 are presented in *Table 1*.

Table 1

Main meteorological data of the tested crop year (Debrecen, 2016-2017)

	Oct.	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Marc.**	**Apr.**	**May**	**Jun.**	**Total/ Average**
Precipitation (mm) 2016/2017	92,1	55,5	4	27,5	31,4	24,5	50,4	31,9	62,3	379,6
30 year's average	30,80	45,20	43,50	37,00	30,20	33,50	42,40	58,80	79,50	400,9
Difference	+61,30	+10,30	-39,50	-9,50	+1,20	-9,00	+8,00	-26,90	-17,20	-21,3
Temperature (°C) 2016/2017	9,1	4,1	-2,3	-6,6	1,4	8,4	10,1	16,3	20,9	6,8
30 year's average	10,30	4,50	-0,20	-2,60	0,20	5,00	10,70	15,80	18,80	6,9
Difference	-1,20	-0,40	-2,10	-4,00	+1,20	+3,40	-0,60	+0,50	+2,10	-0,12

In the cropyear 2016/2017, October and November precipitation was above average, and temperatures were favorable for development and firming of the wheat stands. In December, January and February, the amount of precipitation was less than the average of many years and the

snow provided enough protection against winter frosts for wheat stands. The favorable warm spring weather had positive impact on the stands, and accelerated their growth. Precipitation was less in March, May and June. 21.3 mm less rain fell than the average of many years (400.9 mm), and the temperature of the growing season was 0.12 °C lower than the average of many years (6.9 °C).

RESULTS AND DISCUSSION

During our research our aim was to investigate the effect of genotype, nutrient supply.

In the control plots variety Cellule (6158 kg ha^{-1}) had also good results as well as variety Fallado (6101 kg ha^{-1}). Lukullus (5099 kg ha^{-1}), Premio (5154 kg ha^{-1}) and Premio (5154 kg ha^{-1}) had lower average yield.

Table 2

Effect of fertilization on the yields (kg ha^{-1}) of different winter wheat variety in the long-term experiment (Debrecen, 2016-2017)

Variety	Treatment						Average
	Ø	N_{30}+PK	N_{60}+PK	N_{90}+PK	N_{120}+PK	N_{150}+PK	
Lukullus	5099	6058	7439	7481	7806	7901	**6964**
Lennox	5439	7033	7919	8480	8334	7764	**7495**
Cellule	6158	7405	8890	9194	9104	9407	**8360**
Falado	6101	7550	8288	9022	9210	9491	**8277**
Premio	5154	6330	7161	7869	8425	8172	**7185**
Average	**5590**	**6875**	**7939**	**8409**	**8576**	**8547**	**-**
$LSD_{5\%\ Variety}$	*322*						
$LSD5\%_{\ Treatment}$	*186*						
$LSD5\%_{\ Interaction}$	*789*						

The lowest maximum yield (7901 kg ha^{-1}) was obtained with variety Lukullus at N_{150}+PK nutrient level. Variety Premiko (8425 kg ha^{-1}) had lower yield maximum at N_{90}+PK nutrient level, variety Lennox reached good yield maximum (8480 kg ha^{-1}) at N_{120}+PK nutrient level. The highest maximum yields were reached with variety Falado (9491 kg ha^{-1}) at N_{150}+PK nutrient level, and with variety Cellule (9407 kg ha^{-1}) at optimal nutrient level (N_{150}+PK).

In our study, we wanted to find the answer to that how intensely the nutrient supply influence the quality parameters.

The protein content proved to be favorable at the N_{60}+PK nutrient level. The protein content values ranged from 10.8% to 12.7% in the average of the varieties. In the control plots Lukullus (12.9%) reached the highest protein content, varieties Cellule (11.4%) and Falado (11.3%) reached the lowest protein content in case of control treatment. The best results were achieved at the N_{60}+PK nutrient dose, by varieties Lukullus (13.40%), Lennox (12.8%) and Premio (12.5%).

Table 3

Effect of fertilization on the quality parameters of different winter wheat variety in the long-term experiment (Debrecen, 2016-2017)

Variety	**Treatment**							
	Protein content (%)			**Average**	**Gluten content (%)**			**Average**
	Ø	**N_{60}+PK**	**N_{120}+PK**		**Ø**	**N_{60}+PK**	**N_{120}+PK**	
Lukullus	12.9	13.4	11,9	**12,7**	30.0	31.5	26.5	**29.3**
Lennox	12.6	12.8	11.2	**12.2**	27.2	28.5	23.3	**26.3**
Cellule	11.4	11.4	9.7	**10.8**	22.0	24.7	18.8	**21.8**
Falado	11.3	11.9	10.6	**11.3**	23.7	25.8	21.6	**23.7**
Premio	11.9	12.5	10.7	**11.7**	24.9	27.3	21.9	**24.7**
Average	**12.0**	**12.4**	**10.8**	**-**	**25.6**	**27.5**	**22.4**	**-**
$LSD_{5\%}$ Variety	0.51				1.0			
LSD5% Treatment	0.34				1.0			
LSD5% Interaction	0.76				2.1			

The gluten content of winter wheat varieties in the control plots varied between 23.7% (Falado) and 30.0% (Lukullus). The average wet gluten content of varieties was 25.6%. At nutrient level of N_{120}+PK values ranged between 18.8% (Cellule) and 26.5% (Lukullus). The highest gluten contents were achieved by varieties Lukullus (31.5%), Lennox (28.5%) and Falado (25.8%) at the N_{60}+PK nutrient dose.

CONCLUSIONS

The yield and the quality parameters of the winter wheat varieties were modified by the nutrition supply, genotype and the cropyear. Our

results suggest that the genotype and the nutrient supply had considerable influence on both the yield and the quality parameters. As a result of drier weather during the generative phenophases (May and June) weaker quality were experienced. Drier period in the summer although to a lesser extent, had impact on the yields winter wheat.

It can be concluded variety Falado and variety Cellule reached the highest yield both in the control plots (6101-6158 kg ha^{-1}) and at the N_{150}+PK nutrition level. The lowest yield reached by the variety Lukullus (7901 kg ha^{-1}).

In case of the quality parameters, variety Lukullus (13.4%) and Lennox (12.8%) reached the highest protein content and the highest gluten content (31.5% - 28.5%) at the N_{60}+PK nutrition level. Variety Cellule had the lowest protein content (11.4%) and the lowest gluten content (24.7%) at the N_{60}+PK nutrition level.

Winter wheat reacts positively to fertilizers, thus, providing the appropriate nutrition level, negative effects of the cropyear can be reduced to different extents, the extent to which we can reduce those negative ecological effects depends on nutritional response of varieties.

REFERENCES

1. Alda, L. M., Lazureanu, A., Alda, S., Baluta, D., Sirbulescu, C., Gogoasa, I., 2010, Wet gluten analysis depending on cultivar, fertilization, herbicide application and climate conditions, in winter wheat. Journal of Horticulture, Forestry and Biotechnology 14. pp.23-26.
2. Borghi, B., Corbellini, M., Minoia, C., Palumbo, M., Di Fonzo, N., Perenzin, M., 1997, Effects of Mediterranean climate on wheat bread-making quality. *Eur. J. Agron.,* 6, pp.145–154.
3. Gutierrez, M., Reynolds, M. P., Raun, W. R., Stone, M. L., Klatt, A. R., 2010, Spectral water indices for assessing yield in elite bread wheat genotypes under well-irrigated, water-stressed, and high-temperature conditions. Crop Sci., 50, pp.197–213.
4. Kindred, D. R., Verhoeven, T. M. O., Weightman, R. M., Swanston, J. S., Agu, R. C., Brosnan, J. M., Bradley, R. S., 2008, Effects of variety and fertiliser nitrogen on alcohol yield, grain yield, starch and protein content, and protein composition of winter wheat. Journal of Cereal Science. 48. 1. pp. 46–57.
5. Luo, C., Branlard, G., Griffin, W. B., McNeil, D. L., 2000, The Effect of Nitrogen and Sulphur Fertilisation and their Interaction with Genotype on Wheat Glutenins and Quality Parameters. Journal of Cereal Science 31. pp.185-194.
6. Mengistu, N., Baenziger, P. S., Nelson, L. A., Eskridge, K. M., Klein, R. N., Baltensperger, D. D., Elmore, R. W., 2010, Grain yield performance and stability of cultivar blends vs. component cultivars of hard winter wheat in Nebraska. *Crop Sci*., 50, pp.617–623.
7. Montemurro, F., Convertini, G., Ferri, D., 2007, Nitrogen application in winter wheat grown in Mediterranean conditions: effects on nitrogen uptake, utilization efficiency, and soil nitrogen deficit. Journal of Plant Nutrition 30. pp.1681-1703.

8. Pedersen, L., Jørgensen, J. L., 2007, Variation in rheological properties of gluten from three biscuit wheat cultivars in relation to nitrogen fertilisation. Journal of Cereal Science 46. pp.132–138.
9. Saint Pierre, C. Peterson, C. J., Ross, A. S., Ohm, J. B., Verhoeven, M. C., Larson, M., Hoefer, B., 2007, Winter wheat genotypes under different levels of nitrogen and water stress: Changes in grain protein composition. Journal of Cereal Science 47. pp.407-416.
10. Sonmez, F., 2007, Effect of nitrogenous fertilizer on grain yield and grain protein concentration in winter wheat. *Asian J. Chem.*, 19, pp.256–260.
11. Stoeva, I., Ivanova A., 2009, Interaction of the technological properties of common winter wheat varieties with some agronomy factors. Bulgarian Journal of Agricultural Science 15. pp.417-422.
12. Zecevic, V., Knezevic, D., Boskovic, J., Micanovic, D., Dozet, G., 2010, Effect of nitrogen fertilization on winter wheat quality. Cereal Research Communications 38. pp. 243-249.