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IMPACT OF NUTRIENT LEVEL AND SEED DENSITY ON THE YIELD OF SOME WINTER WHEAT VARIETIES

ISTVÁN KRISTÓ[1], KATALIN IRMES[1], PÉTER JAKAB[2], MELINDA TAR[1]

[1] National Agricultural Research and Innovation Centre, Department of Field Crops Research, Alsó Kikötő sor 9., H-6726 Szeged, Hungary
[2] University of Szeged Faculty of Agriculture, Andrássy str. 15., H-6800 Hódmezővásárhely, Hungary
kristo.istvan@noko.naik.hu

ABSTRACT
The effects of four different nutrient levels (60 kg ha^{-1} N, 0 kg ha^{-1} P_2O_5, 0 kg ha^{-1} K_2O; 90 kg ha^{-1} N, 30 kg ha^{-1} P_2O_5, 30 kg ha^{-1} K_2O; 120 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5, 60 kg ha^{-1} K_2O; 150 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5, 60 kg ha^{-1} K_2O), as well as three different seeding rates (300, 500 and 700 seeds m^{-2}) on different winter wheat breeds have been investigated in this publication. The research was established in one growing season (2017/2018), with 5 winter wheat varieties (GK Arató, GK Bagó, Cellule, Lithium, GK Petur), in 4 repeats, on 10 square meter random layout plots in the research farm of the Department of Field Crops Research of National Agricultural Research and Innovation Centre, in Szeged-Öthalom. We determined the yield and evaluated our results with analysis of variance according to the different nutrient levels and seeding rates. Increasing the seed density, the yield of winter wheat increased too, in a decreasing rate. Increased nutrient inputs resulted in higher yields. The reaction to the fertilizers was very different among the varieties, we could show different yield order at different nutrient levels and seed density. Our results proved that the use of different varieties and agrotechnical elements cause a big difference in yield, which also determines the economic efficiency of the farm.

Keywords: winter wheat, variety, yield, nutrient level, seeding rate

INTRODUCTION

Winter wheat (*Triticum aestivum* L.) is cultivated on 210-220 million hectares in the world yearly and on 1.1-1.2 million hectares in Hungary. Nearly two-third of the arable land is sown with cereals, which winter wheat is one of the most important. The last years' economical, climatic and cultivar changes gave new jobs to agrotechnical researches in Central Europe. We can ensure or even develop the profitability of winter wheat with changes made in the agrotechnical factors (nutrient supply), with the selection of variety suitable for the area and with the right farming practices (seeding density). HORNOK ET AL. (2006) emphasized particular function of varieties in landscape production. The author revealed that the environmental circumstances are determinative factors in the productivity and yield safety of winter wheat cultivars. Moreover, PEPÓ (1995) and BANIUNIENE AND ZEKAITE (2005) regard the cultivar-growing season relation as of high importance. According to ÁGOSTON AND PEPÓ (2005), the agricultural and physiological speciality of the winter wheat cultivars have more important effect on grain yield than the pathology factors.
Regarding the work of PEKÁRY (1971) the increase of quantity of seeds did not influence the yield of winter wheat. On the other hand, according to RAGASITS (1998) very dense wheat population increases not only the fungal diseases, but the competition between plants also, which finally leads to decrease of the yield.
The research on the nutrient treatment of the winter wheat is versatile and extensive in Hungary. MATUZ ET AL. (2007), TANÁCS (2007) and TANÁCS ET AL. (2006) examined the

effects of fertilizers and fungicide treatments on the quality, while JOLÁNKAI ET AL. (2006) on the quantity of the crop. PEPÓ (2004) proved significant differences among the fertilizer needs, utilization and reaction of the winter wheat cultivars. A dosage of 300-350 kg/ha NPK is the optimum nutrient for winter wheat. This nutrient quantity can modify the ecological, biological and agrotechnical factors. There are significant differences between fertilizer and N reaction of different winter wheat genotypes (PEPÓ, 2014). It is important to improve newer and newer breeds, and to define the optimal nutrient supply and seeding rate of winter wheat varieties, as a result of climate-change habitats, not only from agrotechnical, but also from economic point of view.
In our investigation, we were looking for the answer, whether the seeding density and nutrient supply had any effects on the yield of the different winter wheat varieties.

MATERIAL AND METHOD

The effects of four different nutrient levels (60 kg ha^{-1} N, 0 kg ha^{-1} P_2O_5, 0 kg ha^{-1} K_2O; 90 kg ha^{-1} N, 30 kg ha^{-1} P_2O_5, 30 kg ha^{-1} K_2O; 120 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5, 60 kg ha^{-1} K_2O; 150 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5, 60 kg ha^{-1} K_2O), as well as three different seeding rates (300, 500 and 700 seeds m^{-2}) on different winter wheat breeds have been investigated in this publication. The research was established in one growing season (2017/2018), with 5 winter wheat varieties (GK Arató, GK Bagó, Cellule, Lithium, GK Petur), in 4 repeats, on 10 square meter random layout plots in the research farm of the Department of Field Crops Research of National Agricultural Research and Innovation Centre, in Szeged-Öthalom. We determined the yield and evaluated our results with variance analysis according to the different nutrient levels and seeding rates. The distribution of precipitation in the growing season is shown in *Figure 1*.

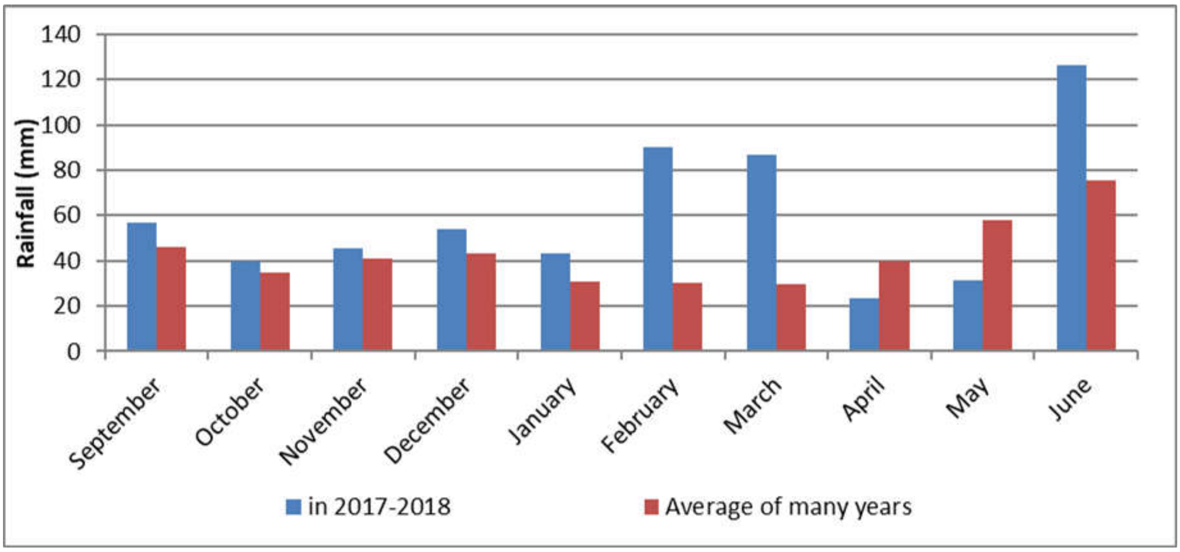

Figure 1. The distribution of precipitation in the vegetative period of winter wheat

RESULTS

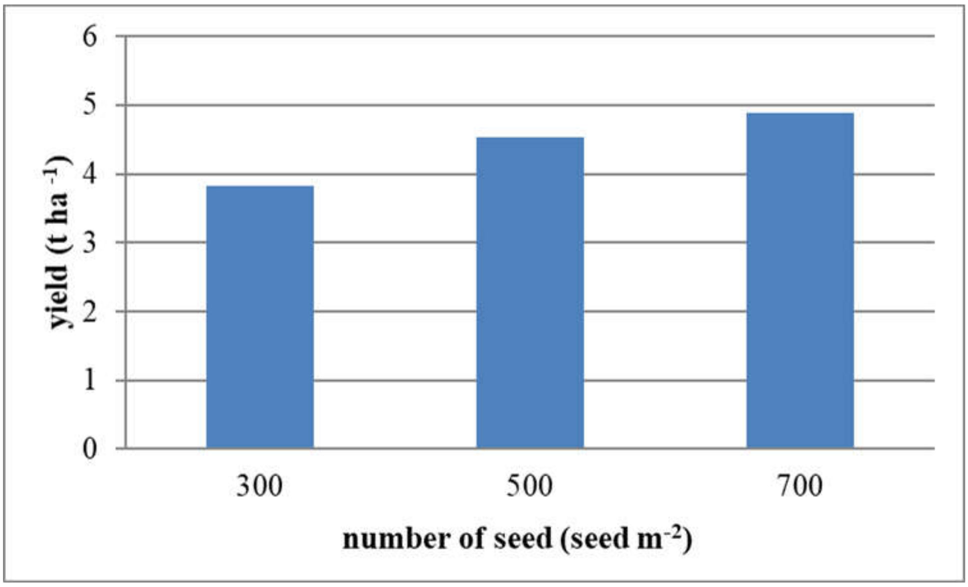

Figure 2. Effect of seed density on yield of winter wheat

In average of varieties and nutrient levels by increasing seed density has reached higher yield of winter wheat in a decreasing rate (*Figure 2)*.

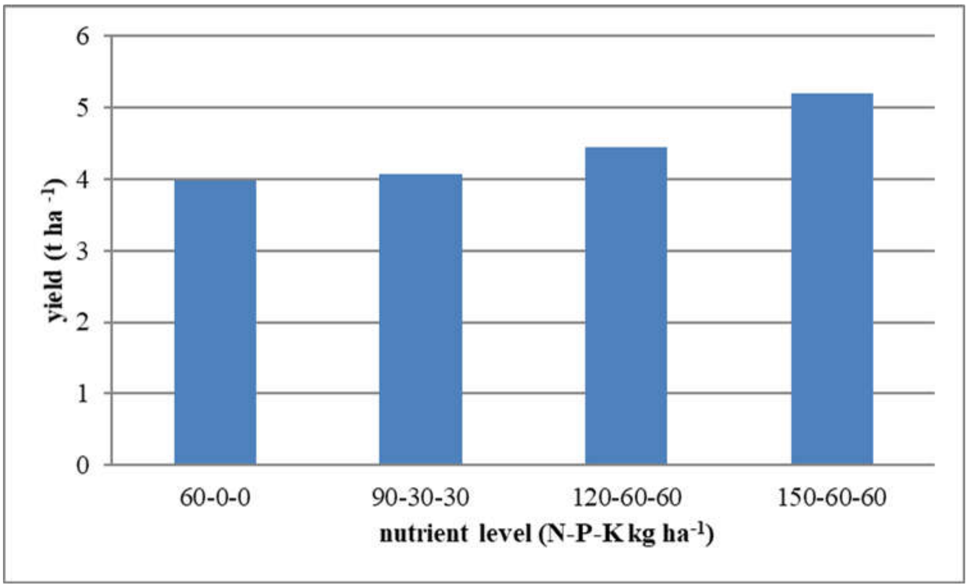

Figure 3. Effect of nutrient level on yield of winter wheat

In average of varieties and seed density by increasing nutrient levels has reached higher yield of winter wheat (*Figure 3)*.
On the plots supplied with only 60 kg ha^{-1} N, compared with the varieties in the average seeding density it can be determined that the highest yield was achieved with the Lithium variety, which produced significantly more than the lowest-yielding Cellule and GK Arató (*Table 1*). Evaluating the seed number, we can see that increased yield increase the seed number, so the difference between the two extreme sowing densities (300 seed m^{-2} and 700 seed m^{-2}) can be statistically proved.

Table 1. Effect of variety and seed number on yield of winter wheat, in different nutrient level

Nutrient level (N-P-K kg ha^{-1})	Seed number (Seed m^{-2})	GK Arató	GK Bagó	Cellule	Lithium	GK Petur	Average	$LSD_{5\%}$
60-0-0	**300**	3.19	3.52	2.79	4.17	3.11	**3.35**	**0.8**
	500	3.67	3.85	3.38	5.05	3.76	**3.94**	
	700	3.98	4.55	4.00	5.58	4.99	**4.62**	
	Average	**3.62**	**3.97**	**3.39**	**4.93**	**3.95**	**1.27**	
	$LSD_{5\%}$	**1.03**						
90-30-30	**300**	3.80	3.78	3.19	4.02	3.73	**3.71**	**0.71**
	500	4.23	4.04	3.85	4.91	3.90	**4.18**	
	700	4.86	3.92	4.52	4.57	3.78	**4.33**	
	Average	**4.30**	**3.91**	**3.85**	**4.50**	**3.80**	**1.12**	
	$LSD_{5\%}$	**0.65**						
120-60-60	**300**	3.88	3.88	3.68	3.91	3.36	**3.74**	**0.84**
	500	4.75	4.40	5.03	4.66	4.24	**4.61**	
	700	5.22	4.35	5.57	5.45	4.25	**4.97**	
	Average	**4.61**	**4.21**	**4.76**	**4.67**	**3.95**	**1.32**	
	$LSD_{5\%}$	**0.76**						
150-60-60	**300**	5.37	4.31	4.13	4.59	4.28	**4.53**	**1.10**
	500	6.55	4.67	5.41	5.51	4.80	**5.39**	
	700	7.39	4.37	6.39	5.71	4.41	**5.65**	
	Average	**6.44**	**4.45**	**5.31**	**5.27**	**4.50**	**1.34**	
	$LSD_{5\%}$	**0.85**						

On the parcels treated with 90 kg ha^{-1} nitrogen, 30 kg ha^{-1} phosphorus and 30 kg ha^{-1} potassium, Lithium produced the highest yields again, while GK Petur produced the lowest yields. There were significant differences between the yields of these two varieties. As the seed density increased, the yield increased, too, but this could not be confirmed statistically.

On the parcels treated with 120 kg ha^{-1} nitrogen, 60 kg ha^{-1} phosphorus and 60 kg ha^{-1} potassium, Cellule produced the highest yields again, while GK Petur produced the least one. There were significant differences between these two yields of the varieties.

On the parcels treated with 150 kg ha^{-1} nitrogen, 60 kg ha^{-1} phosphorus and 60 kg ha^{-1} potassium, GK Arató was the best, and the GK Bagó produced the least. There were significant differences between the yields of GK Arató and the other investigated varieties. Evaluating the seed numbers of the average varieties, it can be determined that increased seed density increase yield, but significant difference could be detected only from 300 seed m^{-2} to 700 seed m^{-2}density.

On 300 seed m^{-1} seed density parcels, compared with the varieties in the average nutrient levels, we could determine that the highest yield was achieved by Lithium and the lowest was found for the Cellule, including a statistically verifiable difference (*Table 2*). Evaluating the nutrient level in the average varieties, it can be determined that the increasing amount of nutrients resulted higher yields. Statistically, it has been proved that the maximum yield is recorded in the parcels of 150 kg ha^{-1} nitrogen, 60 kg ha^{-1} phosphorus and 60 kg ha^{-1} potassium.

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Table 2. Effect of variety and nutrient level on the yield of winter wheat, in different seed density

Seed number (Seed m^{-2})	Nutrient level (N-P-K kg ha^{-1})	GK Arató	GK Bagó	Cellule	Lithium	GK Petur	Average	$LSD_{5\%}$
300	**60-0-0**	3.19	3.52	2.79	4.17	3.11	**3.35**	**0.75**
	90-30-30	3.80	3.78	3.19	4.02	3.73	**3.71**	
	120-60-60	3.88	3.88	3.68	3.91	3.36	**3.74**	
	150-60-60	5.37	4.31	4.13	4.59	4.28	**4.53**	
	Average	**4.06**	**3.87**	**3.45**	**4.17**	**3.62**	**1.17**	
	$LSD_{5\%}$	**0.57**						
500	**60-0-0**	3.67	3.85	3.38	5.05	3.76	**3.94**	**0.74**
	90-30-30	4.23	4.04	3.85	4.91	3.90	**4.18**	
	120-60-60	4.75	4.40	5.03	4.66	4.24	**4.61**	
	150-60-60	6.55	4.67	5.41	5.51	4.80	**5.39**	
	Average	**4.80**	**4.24**	**4.42**	**5.03**	**4.17**	**1.16**	
	$LSD_{5\%}$	**0.82**						
700	**60-0-0**	3.98	4.55	4.00	5.58	4.99	**4.62**	**0.92**
	90-30-30	4.86	3.92	4.52	4.57	3.78	**4.33**	
	120-60-60	5.22	4.35	5.57	5.45	4.25	**4.97**	
	150-60-60	7.39	4.37	6.39	5.71	4.41	**5.65**	
	Average	**5.36**	**4.30**	**5.12**	**5.33**	**4.36**	**2.05**	
	$LSD_{5\%}$	**1.03**						

On the 500 seed m^{-1} seed density parcels, compared with the varieties in the average nutrient levels, we could state that the Lithium was the most successful and the weakest performing was GK Petur. The difference in yields between these two varieties is statistically justifiable. Evaluating the nutrient level in the average of varieties, it can be stated that the increasing nutrient levels have resulted in increasing yield. The maximum yield was obtained on the parcels of 150 kg ha^{-1} nitrogen, 60 kg ha^{-1} phosphorus and 60 kg ha^{-1} potassium, which were statistically higher than the yield of the other nutrient levels. On the 700 seed m^{-1} seed density parcels, compared with the varieties in the average nutrient levels, we could state that the maximum yield was achieved by GK Arató, the lowest achieved by the GK Bagó winter wheat variety. Statistically verifiable difference could be found only between these two varieties. Evaluating the nutrient level in the average of the varieties, it can be stated that the maximum yield was obtained on the parcels of 150 kg ha^{-1} nitrogen, 60 kg ha^{-1} phosphorus and 60 kg ha^{-1} potassium, which was statistically higher than 60 kg ha^{-1} nitrogen, 0 kg ha^{-1} phosphorus and 0 kg ha^{-1} potassium yield of parcels and 90 kg ha^{-1} nitrogen, 30 kg ha^{-1} phosphorus and 30 kg ha^{-1} potassium yield of parcels.

CONCLUSIONS

Our results show that increasing the seed density, the yield of winter wheat is increased too, in decreasing rate. From the results of our one-year survey, we can conclude that increasing nutrient inputs resulted in higher yields. The fertilizer reaction of the varieties was very different, we could show different yield order at different nutrient levels and seed densities. Examination of varieties is necessary for variety-specific and production site-specific agrotechnology and precision crop production. The results show that the use of different varieties and agrotechnical elements cause high difference in yield, which also determines the economic efficiency of the farm.

REFERENCES

ÁGOSTON, T., PEPÓ, P. (2006): Az őszibúza-fajták termőképességének és minőségi paramétereinek vizsgálata a Hajdúságban. Növénytermelés 55(5-6): 371-382.

BANIUNIENE, A., ZEKAITE, V. (2005): Development of winter wheat in relation to sowing date, seed rate and weather conditions. Zemdirbyste, Mokslo Darbai 92: 80-92.

HORNOK M, PEPÓ P., Balogh Á. (2006): Evaluation of quality and quantity parameters in winter wheat production on chernozem soil. Cereal Research Communications 34: 481-484.

JOLÁNKAI, M., SZENTPÉTERY, Z., HEGEDŰS, Z. (2006): Pesticide residue dischange dynamics in wheat grain. Cereal Research Communications 34(1): 505-509.

MATUZ, J., KRISCH, J., VÉHA, A., PETRÓCZI, I.M., TANÁCS, L. (2007): Effect of the fertilization and the fungicide treatment on the alveografic quality of winter wheat. Cereal Research Communications 35(2): 1193-1196.

PEKÁRY, K. (1971): A vetésidő, a vetéssűrűség és a műtrágyázás hatása néhány őszibúza-fajta termésalakulására. Pp. 209-217 p. In: Bajai, J. (ed.): Búzatermesztési kísérletek 1960-1970. Budapest: Akadémiai Kiadó. 641 p.

PEPÓ, P. (1995): Újabb adatok az őszi búza fajtaspecifikus tápanyagellátásához. Debreceni Agrártudományi Egyetem Tudományos Közleményei 32: 125-142.

PEPÓ, P. (2004): Őszi búza fajtaspecifikus tápanyag-reakciójának vizsgálata tartamkísérletben. Növénytermelés 53(4): 339-350.

PEPÓ, P. (2014): Őszi búza (*Triticum aestivum* L.) fajtaspecifikus tápanyagreakciója. In: A fenntartható növénytermesztés fejlesztési lehetőségei. Debreceni Egyetem Mezőgazdaság-, Élelmiszertudományi és Környezetgazdálkodási Kar, Debrecen. 186-192 p.

RAGASITS, I. (1998): Búzatermesztés. Budapest: Mezőgazda Kiadó. 152 p.

TANÁCS, L. (2007): Seasonal and genotype effect on the alveographic value of winter wheats. Cereal Research Communications 35(2): 1197-1200.

TANÁCS, L., VÉHA, A., PETRÓCZI, I.M. (2006): Műtrágyával és fungiciddel kezelt aestivum búzák nedvessikér-tartalom, valorigráfos és alveográfos vizsgálatai az évjáratok függvényében. Növénytermelés 55(5-6): 335-355.