VARIATION OF SOME PRODUCTIVITY ELEMENTS AT THE EAR OF WHEAT DEPENDING ON FERTILIZATION

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Abstract: *The studies and research were aimed at assessing the impact of the fertilisation system on some productivity elements in winter wheat (Triticum aestivum L. ssp. vulgare). Mineral fertilisation had a differentiated influence on some productivity elements in winter wheat, represented by ear length, number of grains per ear, and grain weight. Ear length was between 6.65 and 8.98 cm, fertilisers having a differentiated impact on ear size. The number of grains per ear was determined by the PK factor within the range 5.25-8 units, while grain weight was within 0.01 and 0.18 g. Nitrogen influenced the variation of ear size in a different way depending on both the rate of nitrogen fertiliser and by the PK level. The number of grains per ear was determined by the factor N within the range 4.75-14.0 units and grain weight ranged within 0.07-0.27 g.*

Key words*: correlations, mineral fertilizer, model, productivity elements, winter wheat*

INTRODUCTION

Formation of production at winter wheat (*Triticum aestivum* L. ssp. *vulgare*) is a complex process determined genetically, that is influenced of vegetation conditions and by the technological factors, and that have as a results certain generous manifestation of the genotype and of phenotypic expression [9], [13], [24].

Productivity elements in winter wheat are given by the ear density per m^2, ear length, the number of spikelet's, the number of grains per ear, the grain weight, and by the volume of 1,000 grains. These elements are the result of the interaction of the biological capacity of the cultivar with the environmental and technological factors among which fertilisers have a major importance in the development of agricultural production [23], [18]. Various studies have assessed the influence of technological or environmental factors on wheat productivity elements [4]. A high importance was given to the nutritional status of wheat crop by different nutrients as macronutrients [6], [8], [12] or micronutrients [10], [1], [16], [17], [11]. Also studies have been conducted on optimizing fertilization of agricultural crops, especially on wheat, in different climatic conditions, technological and socio-economic [19], [20], [21]. Depending on the quality of primary agricultural production were also conducted studies on the nutritional value of different types of food [15].

Within this research, was assessed the influence of mineral fertilisation system (combinations of fertilisers and rates) on productivity elements at winter wheat ear, Alex cultivar, under the soil and climate conditions specific to the Banat Plain.

MATERIALS AND METHODS

In our research, we monitored the impact of mineral fertilisation on some productivity features in winter wheat ear.

The experiments were of the bi-factorial type 4 x 5 set on sub-divided plots:

Factor A: phosphorus and potassium fertilisation	Factor B: nitrogen fertilisation
$a_1 - P_0K_0$ – control	$b_1 - N_0$
$a_2 - P_{50}K_{50}$	$b_2 - N_{50}$
$a_3 - P_{100}K_{100}$	$b_3 - N_{100}$
$a_4 - P_{150}K_{150}$	$b_4 - N_{150}$
	$b_5 - N_{200}$

Winter wheat cultivar Alex was cultivated (*Triticum aestivum* ssp. *vulgare*), with a high quantitative and qualitative potential; a demi-early cultivar. It has a medium size (90-100 cm), a demi-vitreous grain, a volume of 1,000 grains of 45-50 g, a hectolitric volume of 78-80 kg/hl, a gluten percentage of 20-30, and of 1st quality, i.e. a very good bread-making potential. Its yielding potential is 7-8 t ha^{-1}.

The experiment area had the specific features of the Banat Plain, with a cambic chernozem, poorly gleyed, with neuter reaction (pH = 6.65-6.78), medium to good humus supply (H = 3.28), nitrogen index IN = 3.87, high base saturation degree (85-88%), low mobile phosphorus supply (P_{AL} = 18.75 ppm), and medium potassium supply (K = 132 ppm).

Climate conditions can be characterised by multi-annual average values such as: 603.3 mm precipitations and temperatures of 10.9°C. During the experimental period 2009-2010, the level of precipitations was 788.6 mm and the average of temperatures was 11.3° C.

The experimental results were analyzed by ANOVA, for emphasizing variance, and for calculating the limits of significance of the differences. For the analysis of experimental data were used: EXCEL statistical calculation module, from the package Office 2007, and SPSS software.

RESEARCH RESULTS

Productivity elements in winter wheat are given by the ear density per m^2, by ear length, number of spikelets, number of grains, and grain weight per ear. Was studied the impact of fertilisation system on the following productivity features of the wheat ear: ear length, number of grains, and grain weight per ear.

These productivity elements are well-defined and are genetically determined, but they depend on vegetation factors, among which the nutrition level plays an important role.

Compared to the genetic potential of the cultivar, ear length varied depending on nutrition conditions between 6.65 and 8.9 cm. The amplitude of the variation is determined by both PK fertilisation and nitrogen (N). The PK factor impacts ear length within the range 7.30-7.95 cm. Within each PK unit (module) the factor N impacts ear length with much wider limits, i.e. 6.65-8.98 cm, Table 1.

The number of grains per ear has oscillated between 28.0 and 43.75 (average values) and was impacted in different ways depending on nutrition elements.

The PK factor has determined changes between 28.0 and 36.0 and the factor N, with different PK modules, has determines variations of the number of grains within the range 32.75 and 43.75. The grain weight per ear is the productivity feature also impacted, with high amplitude, by fertilising elements.

The PK factor has determined variations of the grain weight per ear within the range 0.77-0.95 g, and the factor N on a PK fund has determines variations within the range 0.84 and 1.35.

ANOVA test showed the existence and sources of variance, between experimental data by varying the two independent factors, N and PK respectively, Table 2.

Table 1

Productivity features in the Alex winter wheat cultivar ear, determined by N and PK fertilizer

Fertilisation variants		Ear length		Number of grains / ear		Grain weight / ear	
Factor A PK	Factor B N	Ear length (cm) ± standard error	Differences / significance	Number of grains / ear ± Standard error	Differences / significance	Grain weight (g) ± Standard error	Differences / significance
P_0K_0	N_0	6.65 ± 0.23	-	28.00± 1.76	-	0.77± 0.024	-
	N_{50}	7.33± 0.23	0.68*	32.75± 1.52	4.75	0.84± 0.012	0.07
	N_{100}	7.73± 0.20	1.08***	34.75± 1.45	6.75**	0.91± 0.020	0.14
	N_{150}	7.63± 0.17	0.98***	38.75± 0.88	10.75***	0.94± 0.023	0.17*
	N_{200}	7.95± 0.21	1.30 ***	42.00± 2.18	14.00***	1.04± 0.043	0.27***
$P_{50}K_{50}$	N_0	7.30± 0.34	0.65*	33.25± 2.51	5.25*	0.78± 0.028	0.01
	N_{50}	7.85± 0.10	1.20***	35.50± 2.18	7.50**	0.88± 0.058	0.11
	N_{100}	7.95± 0.17	1.30***	36.25± 0.88	8.25***	0.93± 0.068	0.16*
	N_{150}	8.28± 0.16	1.63***	40.50± 2.96	12.50***	0.99± 0.037	0.22**
	N_{200}	8.00± 0.26	1.35***	41.00± 2.60	13.00***	1.08± 0.076	0.31***
$P_{100}K_{100}$	N_0	7.23± 0.15	0.57*	33.25± 1.66	5.25*	0.85± 0.025	0.08
	N_{50}	7.85± 0.06	1.20***	35.50± 2.84	7.75**	0.95± 0.030	0.18*
	N_{100}	8.43± 0.18	1.78***	40.25± 1.52	12.25***	0.94± 0.032	0.17*
	N_{150}	8.30± 0.23	1.65***	40.75± 1.15	12.75***	1.01± 0.031	0.24**
	N_{200}	8.90± 0.15	2.25***	42.75± 2.90	14.75***	1.16± 0.097	0.39***
$P_{150}K_{150}$	N_0	7.95± 0.23	1.30***	36.00± 3.21	8.00**	0.95± 0.039	0.19*
	N_{50}	8.33± 0.13	1.68***	37.75± 2.33	9.75***	0.99± 0.035	0.22**
	N_{100}	8.87± 0.17	2.23***	42.25± 1.76	14.25***	1.12± 0.064	0.35***
	N_{150}	8.88± 0.25	2.23***	43.75± 2.02	15.75***	1.35± 0.129	0.58***
	N_{200}	8.98± 0.22	2.33***	43.75± 1.45	15.75***	1.22± 0.071	0.45***
Limits the significance of differences (LSD)		LSD 5% = 0.560 LSD1% = 0.745 LSD 0.1% = 0.969		LSD 5% = 4.807 LSD1% = 6.393 LSD 0.1% = 8.316		LSD 5% = 0.152 SDL1% = 0.202 SDL 0.1% = 0.263	

Table 2

ANOVA test

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	15400.74	2	7700.37	1213.82	1.89E-47	3.158843
Within Groups	361.6031	57	6.343914			
Total	15762.34	59				

Relations link between the dependent variable (ear length, number of grains, grain weight) and factors of production was determined according to nitrogen amounts allocated (N) and the cumulative doses of phosphorus and potassium (PK), using a relationship (1), of the type:

$$f(N, PK) = aN + bPK + c \qquad (1)$$

where: N – nitrogen doses kg active substance (a.c.) ha^{-1}; PK – phosphorus and potassium doses a.c. ha^{-1}; a, b, c – calculated coefficients.

In the case of wheat ear length, a linear function of the Grade I, which depends exclusively on the the amount of nitrogen, would have led to an average correlation coefficient (*rsq.=0,420*). Testing the change of correlation coefficient, with the introduction of the factor PK, has been observed a value R Square change = 0.464, statistically ensured, with Sig. F change <0.001.

A test regarding to introduction of other factors (N^2, PK^2, N * PK) has brought only a small change in the correlation coefficient R Square Change = 0.05, which although is statistically ensured, has conducted to coefficients of regression function with low statistical confidence. This led us to the idea of using the proposed functional model that gave the expression (2).

$$f(N, PK) = 0.00556\,N + 0.003698\,PK + 6.908 \qquad (2)$$

where: N – nitrogen doses kg active substance (a.c.) ha^{-1}; PK – phosphorus and potassium doses a.c. ha^{-1}.

An reasoning, similar, has determined to be chosen as a model, expression (3), for the study of the dependency of number of grains in relation whith two factors, namely N quantities, and cumulative doses of P and K.

$$f(N, PK) = 0.05012\,N + 0.01755\,PK + 30.293 \qquad (3)$$

where: N – nitrogen doses kg active substance (a.c.) ha^{-1}; PK – phosphorus and potassium doses a.c. ha^{-1}.

Thus, changing the correlation coefficient with the introduction PK factor was *R Square change* =0.218 with *Sig. F change* < 0.001, compared to N as a singular factor, for which baseline was *rsq.* = 0.710. The introduction of the factors, N^2, PK^2, N*PK not gave the changes of the correlation coefficient, statistically insured. For a grain weight was obtained expression (4).

$$f(N, PK) = 0.00146\,N + 0.000728\,PK + 0.729 \qquad (4)$$

where: N – nitrogen doses kg active substance (a.c.) ha^{-1}; PK – phosphorus and potassium doses a.c. ha^{-1}.

In this case, with the introduction of the PK factor was observed that *R Square change* =0.328 with *Sig. F change* < 0.001, the initial value being 0.532. And in this case was not appropriate to introduce factors, N^2, PK^2, N*PK, who did not bring significant changes in the correlation coefficient.

Using functional models outlined above, they were shown in Table 3 theoretical values of the dependent variables, denoted as: ear length*, number of grains*, grain weight*. In Figures 1, 2 and 3 were represented graphically, the experimental and respectively theoretical values for different quantities of fertilizer allocated.

Productivity elements of wheat ear were studied in different ecotypes, in relation to the countries of origin of biological material, climatic conditions for cultivation, and production factors [7].

The influence of residual nutrients or those directly applied through fertilization, on the productivity elements of wheat ear has been the subject of various studies due to their importance in the formation of production and quality [3], [18].

Following of a major role in nutrition at wheat crop, many studies have followed the influence of N, P and K in the productivity elements of the wheat ear, and on production in general [14], [2], [5], [22]. The results of this study were within the trend of variation of productivity elements of the ear of wheat, presented in literature and in other studies from this area.

Table 3

Adjusted values of the dependent variable (ear length, number of grains, grain weight)

N	PK	ear lenght*	number of grains*	grain weight*
0	0	6.908	30.293	0.729
50	0	7.186	32.799	0.802
100	0	7.464	35.305	0.875
150	0	7.742	37.811	0.948
200	0	8.020	40.317	1.021
0	100	7.278	32.048	0.802
50	100	7.556	34.554	0.875
100	100	7.834	37.06	0.948
150	100	8.112	39.566	1.021
200	100	8.389	42.072	1.094
0	200	7.648	33.803	0.875
50	200	7.925	36.309	0.948
100	200	8.204	38.815	1.021
150	200	8.482	41.321	1.094
200	200	8.759	43.827	1.167
0	300	8.017	35.558	0.947
50	300	8.295	38.064	1.020
100	300	8.573	40.57	1.093
150	300	8.851	43.076	1.166
200	300	9.129	45.582	1.239

* Theoretical values calculated

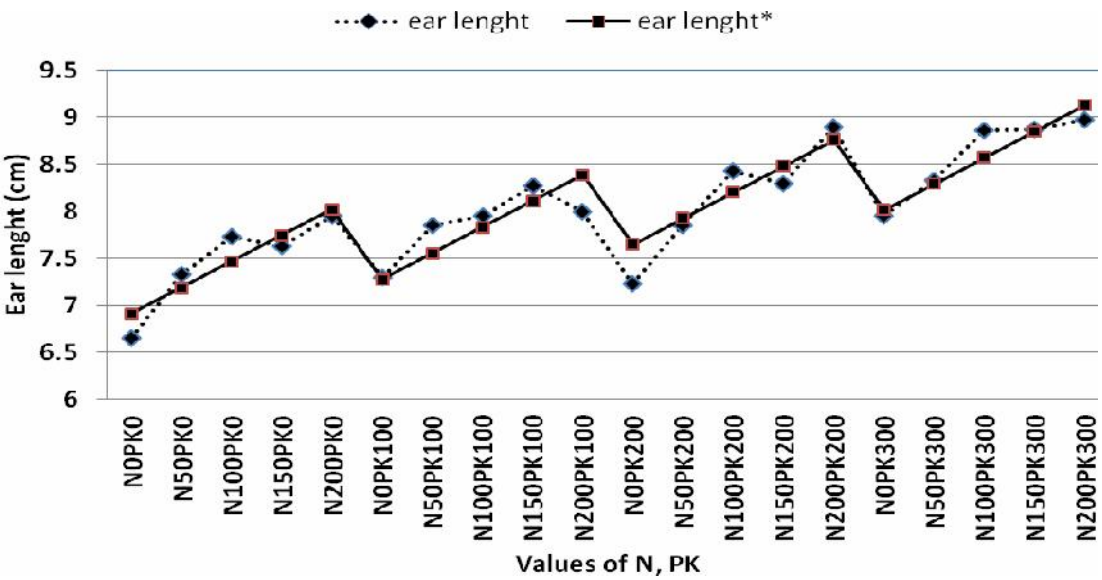

Figure 1. Theoretical values (*) vs. experimental values for ear length in wheat, Alex cultivar

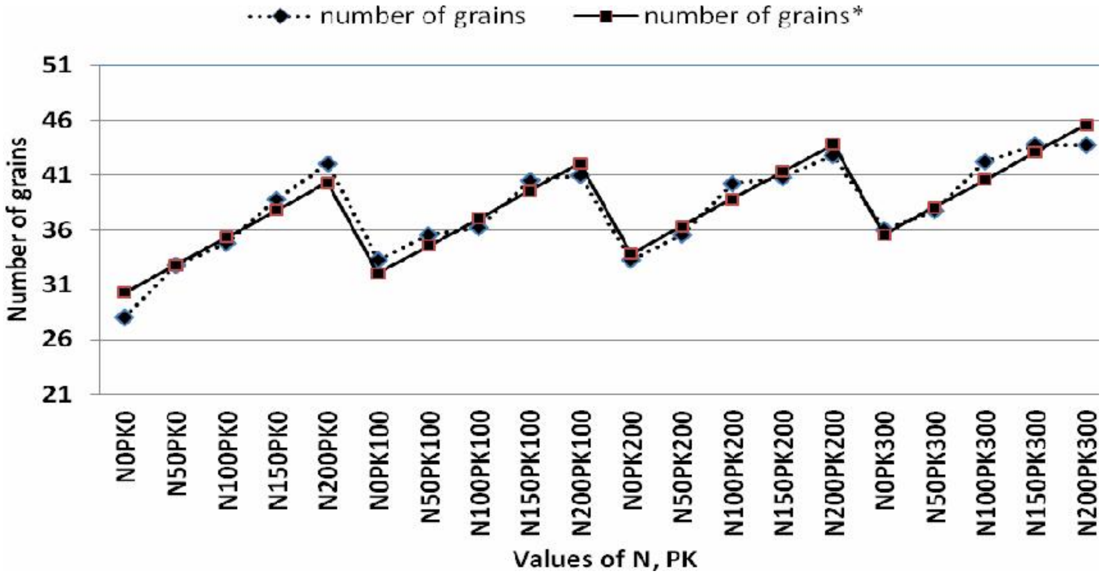

Figure 2. Theoretical values (*) vs. experimental values for numbers of grains in wheat, Alex cultivar

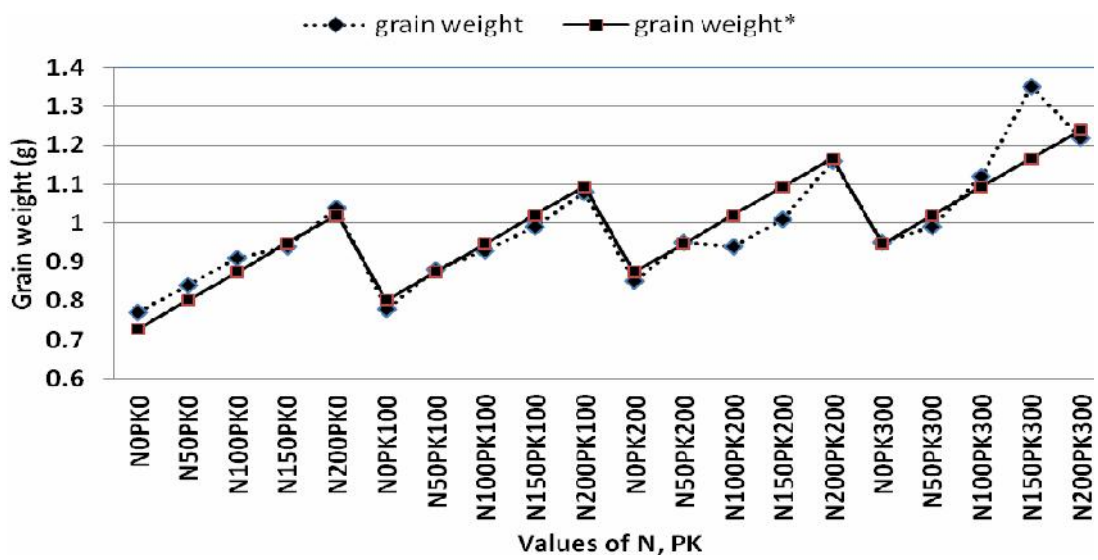

Figure 3. Theoretical values (*) vs. experimental values for grain weight in wheat, Alex cultivar

CONCLUSIONS

Production features we have analysed – ear length, number of grains per ear, and grain weight per ear – are impacted by the nutrition factor with values ensured statistically, which reflects a high degree of correlation between the nutrition factor and the manifestation of these features.

Ear length is impacted within the range 7.30-7.95 cm by the PK factor and 7.33-

7.95 cm by the factor N. The combined impact of the nutrition elements leads to wider variations ranging within 7.85-8.98 cm.

The number of grains per ear varied depending on the fertilising elements and on the rate, with values between 28.0 and 36.0 due to the fertilisation with PK and within 28.0-42.0 due to the factor N.

Grain weight ranges within 0.77-0.95 g under the impact of PK fertilisation and within the range 0.84-1.35 g under the impact of the factor N, in correlation with the factor PK.

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