THE IMPACT OF N, P AND K FERTILIZATION ON THE QUALITY OF WHEAT PRODUCTION GROWN AT SDE TIMISOARA

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***Abstract**: The quantity and composition of proteins ensure the nutritional quality of wheat grains. Cultivar, climatic conditions and fertilization are determining factors in grain protein accumulation. This paper examines the impact of nitrogen, phosphorus and potassium fertilizers on the protein content of wheat kernels. The wheat variety grown was Ciprian. The experimental field in the Experimental Didactic Station, in the soil and climatic conditions of the year 2019-2020.Through this research the influence of nitrogen, phosphorus and potassium fertilization on the protein component was investigated.The experimental variants had the following gradations of the experimental factors: chemical nitrogen fertilizers N0,N30,N60,N90,N120. An agrofoundation of phosphorus and potassium fertilizers was provided as follows: P0K0, P40K0, P80K0, P40K40 and P80K80. Of the three mucilages nitrogen plays an essential role in protein accumulation in the grain. The protein percentage was between 11.28-15.55% , under the influence of fertilization, and the highest values were recorded at the nitrogen dose levels 12.93(N30) and 15.44% (N120). The application of one-sided phosphorus and potassium fertilizers does not contribute to the increase of protein content in the grain, on all four P and K agroforests the increases are statistically insignificant. Nitrogen fertilizers resulted in statistically significant increases in protein content as follows: N30-1.65%, N60-2.98%, N90-3.80% and N120-4.16%.*

In conclusion, protein accumulation in the grain is in close correlation with soil nitrogen concentration.

***Keywords**: autumn wheat, climatic conditions, fertilization, production quality*

INTRODUCTION

Of the two types of fertilizers studied, both unilaterally and in interaction, nitrogen has a fundamental role in obtaining valuable qualitative productions for winter wheat. Compared to the unfertilized control, the unilateral administration of nitrogen brings a very significant increase in the percentage of protein (AGAPIE, 2020)

Also, the content of protein substances, as well as the other cereals, varies within wide limits, giving higher values related the culture conditions and increased doses of nitrogen fertilization. Tripples et al., 1977, citat de MATEI et.all. 2014).

Nitrogen ensures rooting and twinning of plants, increases the number of spikelet's in the ear and the number of fertile flowers in the spikelet, increases the number of grains in the ear and the mass of grains of the ear, it favorably influences their content in protein substances.

Phosphorus increases the effect of nitrogen, and, together with it, it favorably influences the development of the root system of plants, twinning, it increases the resistance of plants to overwintering, drought, fall and disease, it improves the quality of the crop, and it speeds up maturity.

Potassium favors the accumulation of carbohydrates and increases the resistance of plants to frost, drought, fall and diseases.Nitrogen use coefficients have values of 30-50%, of phosphorus - 6-25%, and of potassium - 20-70%. (IMBREA, 2013)

Wheat has a high food content. The large areas on which it is sown, as well as the attention it enjoys, are due to the high carbohydrate and protein content of the grains and the ratio between these substances, corresponding to the requirements of the human body; to the fact

that the plant has great ecological plasticity, being cultivated in areas with very different climates and soils with the possibility of full mechanization of the crop (BÎLTEANU. et al., 1991, 1998).

From October to March, i.e. from sprouting to spring, wheat uses 8 - 22% of N, 12 - 25% of P2O5 and 12 - 15% of K2O, although during this period the amount of dry matter synthesized represents only 3% of the total (BÎLTEANU cited by PIRSAN, 2013). Interactions between climatic conditions specific to the experimental years and fertilizers contributed 15.6% to yield formation (ȘTEFĂNESCU cited by PIRSAN, 2013).

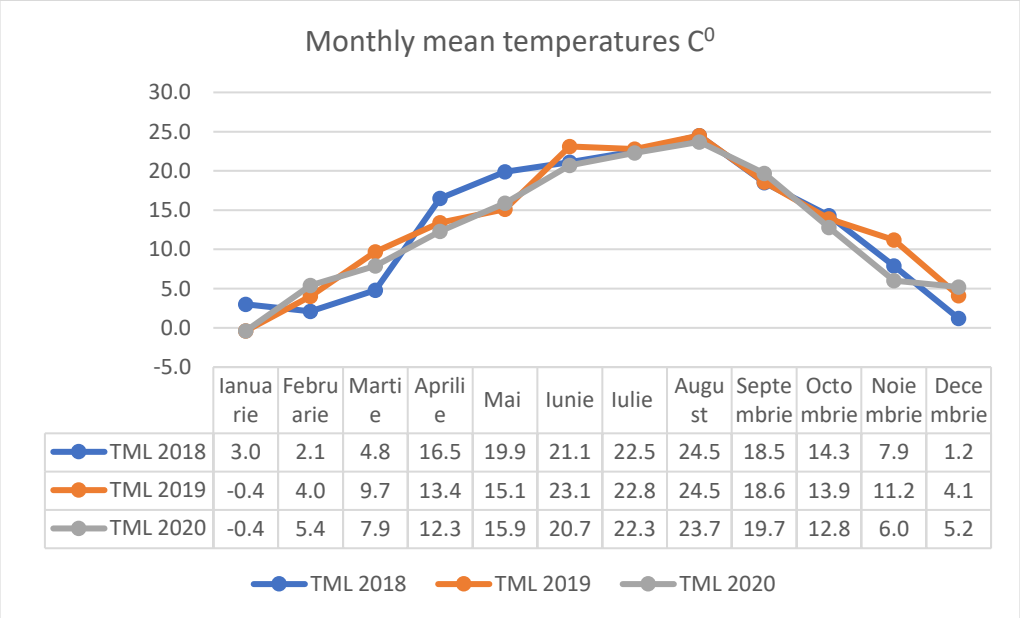
MATERIAL AND METHOD

The research was carried out in the agricultural year 2019-2020 in SDE Timisoara and a two-factor experiment was organized with the following experimental configuration of variants: factor A with 5 graduations - phosphorus and potassium fertilization (a1 - P0K0, control variant; a2 - P40K0; a3 - P80K0; a4 - P40K40; a5 - P80K80 and factor B - nitrogen fertilization with graduations: b1 - N0, unfertilized control variant; b2 - N30; b3 - N60; b4 - N90; b5 - N120.

The biological material cultivated was the Ciprian variety. The technology applied was specific to wheat cultivation. The protein content in the grain is presented correlated with the level of fertilization.

The results obtained in the two years of experimentation were statistically interpreted using the method of analysis of variance (ANOVA).

From a climatic point of view, the microzone of the Didactic-Experimental Station is temperate continental moderate, falling within the moderate continental climate, at the interface between the sector of climatic province with oceanic influence and the sector of climatic province with sub-Mediterranean influences.



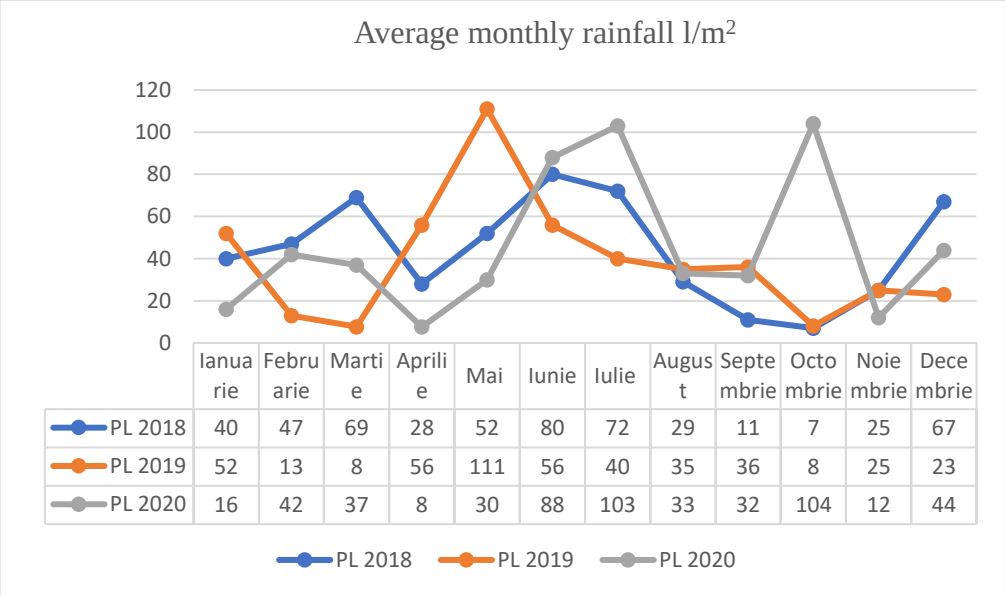
	Ianuarie	Februarie	Martie	Aprilie	Mai	Iunie	Iulie	August	Septembrie	Octombrie	Noiembrie	Decembrie
TML 2018	3.0	2.1	4.8	16.5	19.9	21.1	22.5	24.5	18.5	14.3	7.9	1.2
TML 2019	-0.4	4.0	9.7	13.4	15.1	23.1	22.8	24.5	18.6	13.9	11.2	4.1
TML 2020	-0.4	5.4	7.9	12.3	15.9	20.7	22.3	23.7	19.7	12.8	6.0	5.2

Fig. 1 Annual average temperature 2018-2020
Source: Timisoara Meteorological Station

The figure above shows the variation of the thermal regime for Timisoara in the period 2018-2020. From Fig.1. it can be seen that, in the analyzed period, in the months of June-July, the highest values were recorded in July 2020, daily values exceeded 32-33 0C, while the monthly average in July was 25.6 0C. it should be noted that, negative monthly values were recorded in January 2019 and 2020

The multi-year average rainfall at the Timisoara Meteorological Station is 631 mm.

The climatic data recorded by the Timisoara Meteorological Station to which we refer by analogy, the temperature values in October was 17.98 C, a month warmer than the multi-year average.



	Ianuarie	Februarie	Martie	Aprilie	Mai	Iunie	Iulie	August	Septembrie	Octombrie	Noiembrie	Decembrie
PL 2018	40	47	69	28	52	80	72	29	11	7	25	67
PL 2019	52	13	8	56	111	56	40	35	36	8	25	23
PL 2020	16	42	37	8	30	88	103	33	32	104	12	44

Fig. 2 Average annual rainfall, Timișoara 2019-2020

Source: processed data from Timisoara Meteorological Station

Regarding the rainfall regime shown in Figure 2, we can say that the highest rainfall amounts were recorded in autumn 2020, about 180 l/m^2

RESULTS AND DISCUSSIONS

Influence of nitrogen, phosphorus and potassium fertilizers on protein content (%) in 2019

Table 1.

Significance of P,K and N fertilizer application differences on protein content (%)

Sursa de variatie	**SSP [SP]**	Grade de libertate	**Suma ponderata a patratelor [s^2]**	Test F		semnificatia
				valoarea	p	
PK	0.34	4	0.08	0.18	0.946030	ns
N	232.86	4	58.22	127.54	0.000000	***
PK*N	8.66	16	0.54	1.19	0.299282	ns
Eroare	34.23	75	0.46			
Total	276.09					

Semnification for test F:

- ns p>0.05 ;
- * p≤0.05 ;
- ** p≤0.01 ;
- *** p≤0.001
  - Factor PK [A]: p>0.05
  - Factor N[B] : p< 0.001
  - Interaction PK*N [AxB] ; p>0.05

From the table 1. the F-test by analysis of variance, the results show that:

- - Fertilizers with P and K, have insignificant action. The value of protein content obtained at the 5 PK doses is homogeneous, there are no significant differences between the 5 doses;
- - N fertilization has a very significant action;
- - Interaction of the two AxB factors, have insignificant action.

Note that the action of N fertilizers is much greater than the action of phosphorus and potassium even the interaction of the two factors AxB

Table 2.

Influence of phosphorus and potassium fertilization on protein content (%)

Factor PK	Proteina [%]	Dif. [%]	Semnif
V1 – martor (nefertilizat -**P0K0**	**13.76**	**mt**	
V2 – fertilizat cu -P40K0	13.90	0.15	ns
V3 – fertilizat cu -P80K0	13.74	-0.02	ns
V4 – fertilizat cu -P40K40	13.80	0.04	ns
V5– fertilizat cu -P80K80	13.78	0.02	ns
DL 5% = 0.43% DL 1% = 0.57 DL 0.1% = 0.73			

From the data presented in Table 2 we note that at all fertilization levels the protein content obtained from the N30 - N120 doses is clearly higher than the N0 dose. Compared to the b1-N0 control, very significant increases were obtained, regardless of the nitrogen dose applied.

The excess protein content, compared to the non-fertilized N0 control, ranged from 1.7 - 4.2%.

Table 3.

Influence of nitrogen fertilization on protein content (%)

Factor N	Proteina	Dif.	Semnif
V1 – martor (nefertilizat – **N0**	**11.28**	**mt**	
V2 – fertilizat cu – N30	12.93	1.65	***
V3 – fertilizat cu – N60	14.26	2.98	***
V4 – fertilizat cu – N90	15.08	3.80	***
V5 – fertilizat cu – N120	15.44	4.16	***
DL 5% = 0.43% DL 1% = 0.57 DL 0.1% = 0.73			

Test DUNCAN for factors and interaction factors

TEST DUNCAN pt α5% - factor PK DL 5% = 0.43 %

Primary data				Date sorate			
a1	1 =	13.76	A	a2	2 =	13.90	A
a2	2 =	13.90	A	a4	4 =	13.80	A
a3	3 =	13.74	A	a5	5 =	13.78	A
a4	4 =	13.80	A	a1	1 =	13.76	A

a5 5 = 13.78 A a3 3 = 13.74 A

After the 10 combinations [C_5^2] a single homogeneity class was obtained

The protein content, regardless of the PK dose used, belongs to the same homogeneity class, so all values are homogeneous, not significantly different from each other. Regardless of the dose used, you get about the same percentage of protein 13.8 - 14.0

TEST DUNCAN pt α5% - factor N DL 5% = 0.43 %

Primary data				Date sorate			
b1	1 =	11.28	D	b5	5 =	15.44	A
b2	2 =	12.93	C	b4	4 =	15.08	A
b3	3 =	14.26	B	b3	3 =	14.26	B
b4	4 =	15.08	A	b2	2 =	12.93	C
b5	5 =	15.44	A	b1	1 =	11.28	D

Following the 10 comparisons [C_5^2] classes A - D were obtained. It should be noted that any of the 5 gradings differs significantly from all other gradings, except b5 [N120] and b4 [N90] [they are part of the same homogeneity class - class A]. (MIHOC, 1980)

The highest percentage of protein 15.44 and 15.08 respectively was obtained for b5[N120] and b4[N90] - class A, values that differ significantly from the other combinations. The lowest percentage of 11.28% was obtained in b1[N0] - class D, significantly different from all other combinations.

TEST DUNCAN pt α5% - INTERACTION PKxN DL 5% = 0.95

Primary data				Date sorate			
Mean	1 =	11.46	IJK	Mean	25 =	15.77	A
Mean	2 =	12.40	HI	Mean	20 =	15.72	A
Mean	3 =	14.47	CDE	Mean	5 =	15.46	AB
Mean	4 =	14.99	ABCDE	Mean	10 =	15.41	ABC
Mean	5 =	15.46	AB	Mean	19 =	15.41	ABC
Mean	6 =	11.36	JK	Mean	9 =	15.15	ABCD
Mean	7 =	13.39	FG	Mean	14 =	15.10	ABCD
Mean	8 =	14.22	DEF	Mean	4 =	14.99	ABCDE
Mean	9 =	15.15	ABCD	Mean	15 =	14.84	ABCDE
Mean	10 =	15.41	ABC	Mean	24 =	14.73	BCDE
Mean	11 =	11.36	JK	Mean	3 =	14.47	CDE
Mean	12 =	13.28	FGH	Mean	18 =	14.42	DE
Mean	13 =	14.11	EF	Mean	8 =	14.22	DEF
Mean	14 =	15.10	ABCD	Mean	13 =	14.11	EF
Mean	15 =	14.84	ABCDE	Mean	23 =	14.06	EF
Mean	16 =	10.58	K	Mean	7 =	13.39	FG
Mean	17 =	12.86	GH	Mean	12 =	13.28	FGH
Mean	18 =	14.42	DE	Mean	17 =	12.86	GH
Mean	19 =	15.41	ABC	Mean	22 =	12.71	GH
Mean	20 =	15.72	A	Mean	2 =	12.40	HI
Mean	21 =	11.62	IJ	Mean	21 =	11.62	IJ
Mean	22 =	12.71	GH	Mean	1 =	11.46	IJK
Mean	23 =	14.06	EF	Mean	6 =	11.36	JK
Mean	24 =	14.73	BCDE	Mean	11 =	11.36	JK
Mean	25 =	15.77	A	Mean	16 =	10.58	K

Mean 1 –a1b1
Mean 2 – a1b2
Mean 3 – a1b3
Mean 4 – a1b4
Mean 5 – a1b5
Mean 6 – a2b1
Mean 7 – a2b2
Mean 8 – a2b3
Mean 9 – a2b4
Mean 10 – a2b5
Mean 11 – a3b1
Mean 12 – a3b2
Mean 13 –a3b3
Mean 14 – a3b4
Mean 15 – a3b5
Mean 16 – a4b1
Mean 17 – a4b2
Mean 18 – a4b3
Mean 19 – a4b4
Mean 20 – a4b5
Mean 21 – a5b1
Mean 22 – a5b2
Mean 23 – a5b3
Mean 24 – a5b4
Mean 25 –a5b5

Following 300 comparisons[C_{25}^2] classes A - K were obtained.

The highest value of protein approx 15.8 percent is obtained in a5b5[P80K80 and N120] and a4b5[P40K40 and N120] - class A, which differs significantly from the other combinations that do not contain the letter A.

Last place a4b1[P40K40 and N0] 10.6 percent - class K, differs significantly from all other combinations that do not contain the letter K.

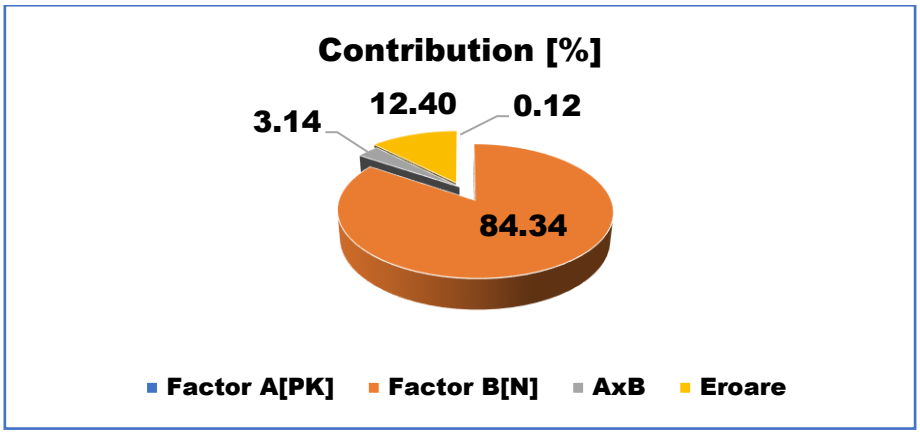


Fig. 3 The contribution of factors A[PK], B[N] and the interaction AxB

The highest contribution to grain chemical composition and protein percentage was made by nitrogen fertilizers 84.3% and P and K fertilizers contributed 0.1% to protein content and AxB interaction of the two experimental factors was 3.1%.

Protein substances represent in normal conditions between 12-15% of the grain mass, being mainly located in the peripheral parts of the grain (sheath, aleurone layer, embrion).

Protein content % as a function of temperature, precipitation and fertilizers with P, K and P

Table 3

Table for examining regression coefficients

	Beta	Std.Err. of Beta	B	Std.Err. of B	t(294)	p-level	semnification
Intercept			**14.55925**	2.444941	5.95484	0.000000	
^{0}C	-0.116004	0.035634	**-0.30728**	0.094389	-3.25544	0.001264	**
Pp	-0.018688	0.035634	**-0.00233**	0.004448	-0.52446	0.600356	ns
doza P	0.068274	0.028008	**0.00480**	0.001971	2.43770	0.015374	*
doza K	0.059125	0.028008	**0.00389**	0.001843	2.11103	0.035614	*
doza N	0.892864	0.024755	**0.04433**	0.001229	36.06738	0.000000	***

R = 0.905* ; R^2 = 0.82**

The t-test coefficients and statistically assured regression coefficients are:

Temperature coefficient is statistically assured as distinctly significant, P and K dose have significance and N dose is statistically assured as highly significant.
Exception coefficient (Pp) which is not statistically assured (CIUCU, 1971)

Table 4

Table of variances for examination of multiple correlation

Source of variation	**SPA**	**Freedom grades (Gl)**	**Variant s^2**	**F(5, 294)**		
				value	**p-level**	**Signification**
Regress.	1091.127	5	218.2254	267.5534	0.00	***
Residual	239.796	294	0.8156			
Total	1330.923					

According to the F-test the linear relationship between 0C, Pp, P, K, N and protein is statistically assured. This relationship is highly significant.

The tabular value F0.01 ; 5 ; 294 = 3.11, is much lower than the value of F calculated from empirical data, Fcal = 267.5534, so the hypothesis that the regression between protein, temperature (0C), precipitation (Pp), fertilizers with P, K and N is linear is accepted.

Table 5

Partial elasticity coefficients for the protein equation as a function of climatic factors (temperature, precipitation) under the influence of P, K and N fertilization.

Independent variable	**regression coefficient**	**Mean [independent variable]**	**protein [dependent variable] mean [%]**	**coefficient of elasticity**
^{0}C	**-0.30728**	10.367	13.497	**-0.23602**
Pp	**-0.00233**	369.000		**-0.06379**
dose P	**0.00480**	48.000		**0.01709**
dose K	**0.00389**	24.000		**0.00692**
dose N	**0.04433**	60.000		**0.19706**

E1 = -0.23602, coefficient of elasticity of factor x1 [0C]. When increasing the temperature level by 1 percent, the protein decreases by 0.23602%.

E2 = -0.06379, coefficient of elasticity of factor x2 - Pp. When increasing Pp by 1%, the protein decreases on average by 0.064%.

E3= = 0.01709, elasticity coefficient of factor x3 - P dose. Increasing P dose by 1%, protein increases on average by 0.02%.

E4= 0.00692, elasticity coefficient of factor x4 - K dose. When increasing the K dose by 1%, the protein increases on average by 0.01%.

E5 = 0.19706, coefficient of elasticity of factor x5 - dose N. Increasing dose N by 1 %, protein increases by 0.2%.

CONCLUSIONS

The application of one-sided phosphorus and potassium fertilizers does not contribute to the increase of protein content in the grain, on all four P and K agroforests the increases are statistically insignificant.

Nitrogen fertilizers resulted in statistically significant increases in protein content as follows: N30-1.65%, N60-2.98%, N90-3.80% and N120-4.16%.

In conclusion, protein accumulation in the grain is in close correlation with soil nitrogen concentration. (ANDREI, 1995)

In conclusion, the greatest influence is had by the temperature variable, followed by N dose, Pp, P dose, and lastly K dose [conf elasticity coefficient].

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