THE INFLUENCE OF NITROGEN AND PHOSPHORUS FERTILIZERS ON THE WHEAT YIELD UNDER THE PEDOCLIMATIC CONDITIONS FROM LOVRIN IN THE PERIOD 2016-2019

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Abstract. *Getting to know the natural conditions and the technological features for a certain crop presents a special economic and social importance, both for the big agricultural exploitation and for the small producer. Relations of a varied and complex reciprocity are established between the properties of the soil and the main technological elements, fact shown by the level of wheat yields in the period 2016-2019, on a typical Chernozem soil, slightly gleyic, epicalcaric, medium clay loam/medium clay loam from Lovrin, Timis County. Regarding these considerations, the paper presents several aspects regarding the role and the physical-geographical characteristics of nitrogen and phosphorus fertilizers on the wheat production, based on studies with the theme "**Research on pedoclimatic and anthropogenic factors that condition land productivity from the Low Plain of Banat**" carried out during the doctoral school, respectively from September 28, 2016 and until now. The research consists of the accumulation of scientific data regarding the evolution of some components of agricultural land productivity, related to the cosmic-atmospheric and telluric-edaphic supply, necessary to substantiate current crop technologies for their efficient use through a thorough knowledge. Thus, the paper presents the results regarding the influence of nitrogen and phosphorus fertilizers on the wheat production in the agricultural period 2016-2019, in the physical-geographical and climatic-edaphic conditions from the Low Plain of Banat. Taking into account these aspects regarding the existence of risks, due to various manifestations of natural factors and irrational human interventions, in this paper we tried to transfer the descriptive theoretical activities to analytical ones that lead to practical solutions related to the sustainable management of edaphic resources. The research is in line with the substantiation of sustainable agriculture systems, responding to the requirements of establishing the scientific database necessary to substantiate some technologies and the elaboration of integrated agroecosystem management measures. The importance of this paper derives from the fact that the soil/land properties are differentiated in the territory, both by the variation of the pedogenesis factors and conditions, and by the fact that in the plant production system the productive potential of the soil intersects with the human effort. Hence, we can talk about a cultural technically-economically conditioned productivity, a result of the contribution of soil, climatic factors, human labour, investments with water and fertilizers, quality seed, all vitally integrated by plants in the biomass production.*

Keywords*: fertilizers, production, wheat, climate, soil.*

INTRODUCTION

Since the vegetal production is realized in the most diverse conditions: natural ecosystems (without or with very few anthropogenic interventions), or extensive or intensive agroecosystems (with the direct or indirect involvement of the state), it imposes the deepest knowledge of all ecological determinants with an urgent necessity.

There are complex and reciprocal relationships that can be established between the main properties of the soil and the cultivated species. Thus, soil properties can exert a decisive influence in terms of root system development, mineral nutrition, ensuring the aerohydric and thermal regime necessary for the development of the main physiological processes, while plants and phytocenoses, in their turn, act both directly and indirectly on the state of soil fertility.

In order to determine the complex relationships that are established between the different properties of the soil, a series of researches were carried out, both in Romania and around the world, which found the diagnosis in relation to their differentiated contribution on land productivity and plant favourability (Berbecel et al. 1979, Borza et al., 2007, David et al., 2006, 2018, Dumitru et al., 2000, Dumitru Elisabeta et al., 2000, Lăzureanu et al., 2003, Rogobete et al., 1997, Teaci, et al., 1980, Țărău et al., 2018). Thus, it was established that between these properties and the geomorphological-hydrological ones there are interrelations that determine the level of yields up to the level given by the “climate-envelope”, characteristic of different pedoclimatic areas (Teaci 1980).

Taking these considerations into account, based on the research conducted during the doctoral school, we present here some aspects regarding the effect of nitrogen and phosphorus fertilizers on the wheat production, under specific natural conditions from the Low Plain of Banat and the features of the area. All these elements define the current and potential level of yields.

MATERIAL AND METHOD

The researches regarding the ecopedological conditions were conducted in accordance with the "Methodology of Elaboration of Pedological Studies" (vol I, II, III) elaborated by ICPA Bucharest in 1987, completed with specific elements from the Romanian Soil Taxonomy System (SRTS-2003/2012), as well as other updated normative acts (MADR Order 278/2011).

The analyzes and other determinations were performed in the ***physico-chemical analysis laboratory “O.S.P.A-U.S.A.M.V.B.T”***, *Faculty of Agriculture, BUASVM Timişoara*, at 1**19, Calea Aradului, accredited by RENAR** according to STAS SR EN ISO/CEI 17025, through the **accreditation certificate no. LI 1001/2013**.

The experiments were placed on a typical Chernozem soil, slightly gleyic, epicalcaric, medium clay loam/medium clay loam in the area of Lovrin, dominant within the *Galaţca Plain (Pesac-Lovrin-Teremia)* and with a large area in the Low Plain of Banat.

The study began with field research in the fall of 2016 (4.10.2016), when phosphorus fertilizers (46% triple superphosphate) were administered for the 4 supply levels (P_{40}, P_{80}, P_{120}, P_{160}). The experiment was bifactorial of type 5x5 with plots subdivided into 4 repetitions (100 plots), the experimental factors being those in table 1.

The precursor plant was the soybean for all three years of cultivation.

The variety used as research material was Ciprian.

Table 1

Doses of nitrogen and phosphorus fertilizers

Wheat	
Factor A	**Factor B**
Nitrogen	**Phosphorus**
a_1- 0 kg/ha	b_1- 0 kg/ha
a_2– 30 kg/ha	b_2 – 40 kg/ha
a_3– 60 kg/ha	b_3 – 80 kg/ha
a_4 – 90 kg/ha	b_4 – 120 kg/ha
a_5– 120 kg/ha	b_5 – 160 kg/ha

Nitrogen fertilizers were applied in fractions: for wheat, 40% of the dose in early spring and 60% of the dose when the straw elongated.

The main elements of the cultivation technology for the three years are approximately the same in terms of date of sowing, fertilizer administration, harvesting, etc.

In order to achieve the proposed objectives, observations and measurements were made, both in the experimental field and in laboratory analyzes.

The processing and interpretation of these experimental results was done by statistical analysis of variants, developed by Fischer in 1923, described and explained by Săulescu N. A. and Săulescu N. N., 1967, the statistical calculation being performed using a computer (PC).

RESULTS AND DISCUSSIONS

In the autumn of 2016, the research began in the experimental field when phosphorus fertilizers (superphosphate 46%) were administered for the 5 supply levels (P_0, P_{40}, P_{80}, P_{120}, P_{160}), after which the wheat crop was established in the agricultural year 2017-2018, respectively 2018-2019, as it results from the technical box (table 2).

The experiment was placed on a typical Chernozem soil, slightly gleyic, epicalcaric, medium clay loam/medium clay loam, dominant within the *Galaţca Plain (Pesac-Lovrin-Teremia)* and representative for the Low Plain of Banat, being part of the Mureş Plain.

In order to be able to notice the influence of the ecopedological conditions and of the technological elements on land productivity, a soil profile was opened from which several samples were collected, within the area considered uniform, both pedologically and morphologically.

Within the soil profile, the samples were collected on pedogenetic horizons, both in natural settlement (unchanged), and in modified settlement.

The collection of soil samples in the natural (unmodified) location for the characterization of certain physical and hydrophysical features was done in metal cylinders of known volume at the momentary soil moisture and in cardboard boxes (specially made) for its micromorphological characterization.

Following the morphogenetic study of the soil profile and the research of the sheets with analytical measurements (table 3), a series of micromorphological characteristics results, namely the microstructure of the Am horizon is predominantly spongy generated by an intense fauna (earthworms, mesofauna) and biological (roots) activity. Moreover, for the processed horizon (Ap, 0-20 cm) the microstructure is of cracking with isolated gaps with a degradation (more accentuated in the compacted layer Atp, 20-38 cm) of the initial zoobiological structure following soil works.

The morphological and micromorphological properties of the soil indicate a developmental stage characteristic of soils from the cernisols class, having the profile of the type Ap-Atp-Am-AC - Cca.

Due to the structural aggregates, well and moderately developed, with small sizes and well-made porosity on the entire soil profile (except for the Atp layer 20-38 cm), they allow good aeration and the development of a rich root system.

Therefore, the horizons that make up the soil profile are crossed by a large network of grooves generated by the roots of plants, more or less decomposed.

Among the chemical properties that influence the composition and way of life of ecosystems and that have a significant role on soil fertility the more important are: reaction, calcium carbonate content, humus content, nutrient supply, etc.

The reaction of the soil (ind. 63, M.E.S.P.-1987), in relation to the type of soil and the material on which it was formed, has some specific features. PH values oscillate within the norms, for the parent materials in the area, indicating a slightly alkaline reaction (7.3-8.4) in the range of 20-100 cm, respectively moderately alkaline (8.5-9.0) between 100 -130 cm and strongly alkaline (9.1-9.4) between 130-200 cm.

The calcium carbonate content (ind. 61, MESP-1987) has low values (<1%) in the range of 20-38 cm, then gradually increases to depth, reaching the maximum value (21.50%) in the carbonate-cumulative horizon (Ccag1 = 100-130cm), as confirmed by the data presented (table 3).

The degree of saturation in bases (ind.69, M.E.S.P.-1987) is an equally important indicator for soil characterization. In the case of the researched profile, its values place the soil in the class of soils saturated in bases. (table 2).

Table 2

Physico-mechanical, hydro-physical and chemical characteristics of the typical Chernozem, slightly gleyic, epicalcaric medium clay-loam/medium clay-loam from Lovrin

HORIZONS	UM	Ap	Atp	Amk	ACk	Cca	$Ccag_1$	$Ccag_2$-ac	$Ccag_3$ ac
Depths	cm	20	38	56	75	100	130	150	200
Interval for U%	cm	0-10	-25	-50	+75	-100	-125		
Gross sand (2.0 – 0.2 mm)	%	2.9	2.2	2.2	1.6	1.3	1.6	1.2	0.6
Fine sand (0.2 – 0.02)	%	30.7	33.7	33.8	33.1	37.6	28.9	28.2	28.6
Dust (I + II) (0.02-0.002 mm)	%	31.1	30.8	28.3	29.8	30.8	31.8	35.4	38.3
Colloidal clay (under 0.002)	%	35.3	33.3	35.8	35.5	30.3	37.7	35.2	32.5
Physical clay (dust II +colloidal clay)	%	54.6	54.3	48.3	48.8	44.3	41.1	41.3	

TEXTURE		TT	TT	TT	TT	LL	TT	TP	TP
Specific density (Ds)	g/cm^3	2.43	2.44	2.47	2.49	2.52	2.55		
Apparent density (Da)	g/cm^3	1.35	1.44	1.21	1.18	1.19	1.46		
Total porosity (Pt)	%	45.00	40.00	51.00	52.00	52.00	42.00		
Aeration porosity (Pa)	%	10.69	-3.57	20.88	22.03	24.87	-9.72		
Compaction ratio (Cr)	%	13.31	18.69	-0.32	-4.12	-1.67	16.49		
Hygroscopicity coefficient (HC)	%	8.79	8.50	8.48	8.33	7.17	6.73		
Wilting coefficient (WC)	%	13.18	12.75	12.72	12.50	10.76	10.10		
Field capacity (FC)	%	25.90	25.30	24.90	25.40	22.80	22.11		
Total capacity (TC)	%	33.83	27.77	42.14	44.06	43.69	28.76		
Useful water capacity (UC)	%	12.75	12.55	12.18	12.90	12.04	12.01		
pH in water		6.60	7.28	7.95	8.05	8.40	8.90	9.32	9.30
Carbonates ($CaCO_3$)	%	-	0.47	4.06	9.80	18.60	21.50	20.20	19.60
Humus	%	3.55	3.35	3.30	2.70	1.05			
Nitrogen indicator (IN)		3.07	3.35	3.30	2.70	1.50			
Humus reserve (50)	to/ha	90,45	86,63	47,92	225,00				
Mobile P	ppm	75.7	50.5	38.7	8.7	7.0			
Mobile K	ppm	205	160	160	132	115			
T	me/100g				24.4	23.5	15.2	20.2	25.7
Na	me/100g					0.21	1.10	1.37	1.32
Na% T	%					0.90	5.14	7.68	6.84
Salts	mg/100g				74.3	88.8	145.9	148.5	159.1
Degree of saturation in bases(V)	%	80.6	100	100	100	100	100	100	100

The humus content (***ind.70,*** **M.E.S.P.-1987),** differs both depending on the climatic conditions and on the whole complex of pedogenetic factors. Thus, depending on the granulometric composition and the mineralogical features, the humus content of the researched profile (table 1) shows medium values between 0-20 cm, small on the interval 20-56cm and very small between 56-100cm.

Humus reserve between 0-50 cm (ind. 144, M.E.S.P.-1987), very large, namely 225.00 t/ha.

The value of the nitrogen index (ind 142, MESP-1987) of 3.07 in the processed layer Ap (0-20 cm), as well as in the subsequent horizons (Atp = 3.35 Am = 3.30), indicates a medium-good condition nitrogen supply (table 3.).

The phosphorus content (ind.72, MESP-1987), in the researched profile, shows very high values (over 72 ppm) in the processed layer Ap (0-20cm), high (37-72 ppm) between 20-56 cm, after which it decreases suddenly (table 3).

The potassium content (ind. 73, M.E.S.P.-1987) is high (201-300 ppm) in the processed layer Ap (0-20cm), medium (131-200 ppm) between 20-75 cm, then it decreases (table 3).

Data recorded at the Local Station located in Lovrin were used for the **characterization of the climatic conditions** specific to the agricultural years **in the period 2016-2019**.

The climate in the reference area is temperate continental with Mediterranean influences. The average multiannual temperature is 10.9ºC (table 3), and the average multiannual rainfall is 521.4 mm (table 4) at the LOVRIN Meteorological Station.

Table 3

Average monthly, annual (2016-2019)
and multiannual temperatures in the period 1946-2017 (mm)

Agricultural year	monthly												Annual
	IX	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
16-17	18.8	11.6	6.2	3.1	-5.3	3.2	9.4	10.9	16.9	22.1	28.9	24.1	12.5
17-18	17.7	12.5	6.5	2.9	5.3	0.8	3,6	16,5	19,9	21,9	22.3	24.7	12.8
18-19	18.3	15.1	7.8	1,0	-0.4	4.6	9	13.4	15.1	22.3	21.6	23.9	12.7
normal	**17.9**	**11.3**	**5.4**	**1.5**	**-1.2**	**0.8**	**5.5**	**11.0**	**16.6**	**19.7**	**21.6**	**21.7**	**10.9**

Deviations

Agricultural year	monthly												Annual
	IX	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
16-17	+2	-0.4	+1	+1.7	-4.1	+2.4	+4.2	+0.2	+0.3	+2.3	+6.7	+2.4	+1.6
17-18	+0.9	+1.4	+1	+1.9	+6.4	0	-1.6	+5.8	+3.6	+2.1	+0.1	+3	+2.1
18-19	+1.5	+3.9	+2.3	-0.1	+0.7	+3.8	+3.7	+2.7	-1.2	+2.5	-0.6	+2.2	+1.8

Table 4

Average monthly, annual (2016-2019)
and multiannual rainfall in the period 1946-2017 (mm)

Agricultural year	monthly												Annual
	IX	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
16--17	48,0	112,0	37,0	3,0	20,0	25,0	30,0	54,0	29,0	40,0	30,0	22.5	450.5
17-18	34.0	32.0	35.0	16.0	53.0	58.0	86,0	40,0	50,0	152,0	85.0	58.0	698.0
18-19	29,0	10,0	21,0	41,0	58,0	15,0	15,0	34,0	92,0	88,0	55,0	18,0	476.0
normal	42.7	40.6	48.2	40.1	32,0	29.4	32.6	42.9	56.8	67.8	55.8	32.5	521.4

Deviations

Agricultural year	monthly												Annual
	IX	**X**	**XI**	**XII**	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
16-17	+5.3	+71.4	-11.2	-37.1	-12.0	-4.4	-2.6	+11.1	-27.8	-27.8	-25.8	-10.0	-70.9
17-18	-8.6	-10.5	-13.0	-23.7	+21.0	+28.6	+53,4	-2,9	-6,8	+84,2	+29.2	+25.5	+176.6
18-19	-13,7	-30,6	-27,2	+0,9	+26,0	-14,4	-17,6	- 8,9	+35,2	+20,2	-0,8	-14,5	-45,4

From the data presented in tables 3 and 4, it results that in terms of temperatures, they were higher in the experimental years: temperature increases by 1.6ºC in the agricultural year 2016-2017, 2.1ºC in the agricultural year 2017-2018, and 1.8ºC in the agricultural year 2018-

2019. As for precipitations, compared to the multiannual average there was a deficit of 70.9 mm in the agricultural year 2016-2017, 45.4 mm in the agricultural year 2018-2019 and a surplus in the agricultural year 2016-2017.

In order to evaluate the impact of meteorological conditions on land productivity, the recorded figures were compared with the significance of precipitation amounts (reference limits in relation to agricultural requirements, table 5), using data from the Timiş County Agroclimatic Resources (Berbecel, 1979).

Table 5

Significance of precipitation amounts
(reference limits in relation to agricultural requirements)

Period	Significance of precipitation amounts				
	Very dry	Dry	Satisfactory	Optimal	Surplus
September-October	Under 40	41-60	61-80	81-150	Over 150
November-March	Under 100	101-150	151-200	201-300	Over 300
April	Under 20	21-30	31-40	41-70	Over 70
May-July	Under 100	101-150	151-200	201-300	Over 300
Annual	Under 350	351-450	451-600	601-700	Over 700

Table 6

Significance of precipitation amounts in relation to agricultural requirements
in the period 2016-2017

Characteristic periods										
Agricultural year	IX-X	Significance	XI-III	Significance	IV	Significance	V-VII	Significance	Annual	Significance
16-17	160,0	surplus	115,0	dry	54,0	satisfactory	99,0	very dry	450,5	dry
17-18	66,0	satisfactory	248,0	optimal	40,0	very dry	180.4	satisfactory	698.0	optimal
18-19	39.0	very dry	150.0	dry	34,0	satisfactory	253.0	optimal	476,0	satisfactory
normal	83,3	optimal	182,3	satisfactory	42,9	optimal	180,4	satisfactory	521,4	satisfactory

From the facts presented regarding the pluviometric regime from the agricultural year 2016-2017, it results that as a whole it was a dry year (table 6).

Regarding the agricultural year 2017-2018, this was a year in which the precipitation amounts registered optimal values. In April there was a large deficit of precipitation.

The agricultural year 2018-2019 is characterized by satisfactory values of precipitation. The September-October period was very dry and continued between November and March.

In April-April the values were satisfactory, and in May-July the values were optimal.

Compared to the multiannual precipitation values of 521.4 mm, we find that the researched area falls within the limit of satisfactory values.

The level of recorded yields had different values in the mentioned period, as it results from the presented data (tables 7-9).

In the agricultural year 2016-2017, for the control variant (unfertilized N_0P_0) a yield of 4856 kg/ha was obtained (table 7).

The maximum yield was obtained for the variant $N_{90}P_{160}$, namely 7069 kg/ha.

The unilateral phosphorus fertilization resulted in yields between 5178 and 6100 kg/ha (N_0P_{40} – N_0P_{160}). Nitrogen applied alone brought yields between 5501 and 5960 kg/ha (N_{30}-N_{120}).

In the agricultural year 2017-2018 **for the control variant (unfertilized N_0P_0), the yield was 4320 kg/ha (table 8).**

The highest yield was obtained for variant $N_{90}P_{160}$, namely 6189 kg/ha.

The unilateral phosphorus fertilization resulted in yields between 4459 and 5641 kg/ha (N_0P_{40} – N_0P_{160}). Nitrogen applied alone produced yields between 5051 and 5444 kg/ha (N_{30}-N_{120}).

In the agricultural year 2018-2019 for the control variant (unfertilized N_0P_0) a yield of 3943 kg/ha was obtained (table 9).

The maximum yield was recorded for variant $N_{60}P_{120}$, namely 5203 kg/ha.

The unilateral phosphorus fertilization led to yields between 4083 and 4583 kg/ha (N_0 P_{40} – N_0P_{120}). Nitrogen applied alone produced yields between 4565 and 4773 kg/ha (N_{30}-N_{120}).

Table 7

The effect of nitrogen and phosphorus fertilizers
on wheat (Ciprian variety) on a typical Chernozem soil in the agricultural year 2016-2017

Variant	Average yield kg/ha	Difference kg/ha	%	Significance
N_0 P_0	**4856**	0	100	
N_{30} P_0	5501	645	113	
N_{60} P_0	5516	660	114	
N_{90} P_0	5857	1001	121	*
N_{120} P_0	5960	1104	123	*
N_0 P_{40}	5178	322	107	
N_{30} P_{40}	5641	785	117	
N_{60} P_{40}	5936	1081	122	*
N_{90} P_{40}	5945	1089	122	*
$N_{120}P_{40}$	5985	1129	123	*
N_0 P_{80}	5434	578	112	
N_{30} P_{80}	5998	1142	124	*
N_{60} P_{80}	6603	1748	136	***
N_{90} P_{80}	6674	1818	137	***
N_{120} P_{80}	6355	1499	131	**
N_0 P_{120}	5434	578	112	
N_{30} P_{120}	5702	846	117	
N_{60} P_{120}	6616	1760	136	***
N_{90} P_{120}	6616	1760	136	***
N_{120} P_{120}	6563	1707	135	***
N_0 P_{160}	6100	1244	126	**
N_{30} P_{160}	6538	1682	135	***

N_{60} P_{160}	6808	1953	140	***
N_{90} P_{160}	**7069**	2213	146	***
N_{120} P_{160}	6292	1436	130	**

		AxB	BxA
DL	5%	656.8	664.1
	1%	870.1	885.6
	0.1%	1125,1	1157,0

From the data analysis (table 8), it results that compared to the control N_0P_0, significant and very significant yields were obtained for most variants, except for the variants: $N_{30}P_0$, $N_{60}P_0$, N_0P_{40}, N_{30} P_{40}, N_0 P_{80}, N_0 P_{120}, N_{30} P_{120} whose yields are not statistically ensured.

Table 8

The effect of nitrogen and phosphorus fertilizers
on wheat (Ciprian variety) on a typical Chernozem soil in the agricultural year 2017-2018

Variant	Average yield kg/ha	Difference kg/ha	%	Significance
N_0 P_0	**4320**	--	100	
N_{30} P_0	5051	731	117	
N_{60} P_0	5268	948	122	**
N_{90} P_0	5439	1119	126	**
N_{120} P_0	5444	1124	126	**
N_0 P_{40}	4459	139	103	
N_{30} P_{40}	5243	923	121	**
N_{60} P_{40}	5518	1198	128	***
N_{90} P_{40}	5609	1289	130	***
$N_{120}P_{40}$	5009	779	118	*
N_0 P_{80}	4794	475	111	
N_{30} P_{80}	5506	1187	128	***
N_{60} P_{80}	5604	1285	130	***
N_{90} P_{80}	5626	1307	130	***
N_{120} P_{80}	5557	1237	129	***
N_0 P_{120}	5216	897	121	*
N_{30} P_{120}	5726	1406	133	***
N_{60} P_{120}	5792	1472	134	***
N_{90} P_{120}	5815	1496	135	***
N_{120} P_{120}	5716	1396	132	***
N_0 P_{160}	5641	1321	131	***
N_{30} P_{160}	5913	1593	137	***
N_{60} P_{160}	5996	1677	139	***
N_{90} P_{160}	**6189**	1869	132	***
N_{120} P_{160}	6200	1881	144	***

AxB BxA

DL 5%	646,9	684,7
1%	860,4	924,0
0.1%	1119,2	1231,0

The combined application of nitrogen and phosphorus fertilizers leads to yields between 5243 (N_{30} P_{40}) and 6189 kg/ha, recording yield increases between 923 and 1869 kg/ha (table 8). Distinct significant increases were recorded in almost all situations, except for variants N_{60} P_0, N_{90} P_0, N_{120} P_0, N_{30} P_{40}, for which they were very significant, and variants $N_{120}P_{40}$, N_0 P_{120} with significant values.

Table 9

The effect of nitrogen and phosphorus fertilizers
on wheat (Ciprian variety) on a typical Chernozem soil in the agricultural year 2018-2019

Variant	Average yield kg/ha	Difference kg/ha	%	Significance
N_0 P_0	**3943**	-	**100**	**-**
N_{30} P_0	4565	623	116	*
N_{60} P_0	4585	643	116	*
N_{90} P_0	4713	770	120	**
N_{120} P_0	4773	830	121	**
N_0 P_{40}	4083	140	104	-
N_{30} P_{40}	**4160**	218	106	-
N_{60} P_{40}	4488	545	114	*
N_{90} P_{40}	4440	498	113	-
$N_{120}P_{40}$	4590	648	116	*
N_0 P_{80}	3973	30	101	-
N_{30} P_{80}	4820	878	122	**
N_{60} P_{80}	4685	743	119	**
N_{90} P_{80}	4813	870	122	**
N_{120} P_{80}	4840	898	123	**
N_0 P_{120}	4583	640	116	*
N_{30} P_{120}	4860	918	123	**
N_{60} P_{120}	**5203**	1260	132	***
N_{90} P_{120}	4968	1025	126	***
N_{120} P_{120}	5105	1163	130	***
N_0 P_{160}	4315	373	109	-
N_{30} P_{160}	5053	1110	128	***
N_{60} P_{160}	4835	893	123	**
N_{90} P_{160}	5020	1078	127	***
N_{120} P_{160}	4695	753	119	**

	AxB	BxA
DL 5%	504,9	530,7
1%	675,9	705,8
0.1%	887,4	918,2

The combined application of nitrogen and phosphorus fertilizers leads to yields between 4160 (N_{30} P_{40}) and 5203 kg/ha (N_{60} P_{120}), recording yields increases between 218 and 1260 kg/ha (table 9).

CONCLUSIONS

The area where the research and the experiments were carried out is part of the Mureş-Bega Interfluvium, part of the Mureş Plain.

The origin of the plain is attributed to the great Pleistocene Delta of the Mureş, which flowed here towards the Pannonian Lake at the beginning of the Quaternary.

The macroclimatic features of the researched area are determined by its geographical position, which is specific to a certain circulation of air masses of various types. The plain from the Mureş-Bega interfluvium lies at the interference of the air masses with oceanic nuances of western origin, and of those with continental aspect of eastern origin, suffering in addition the invasion of warm southern air masses that cross the Mediterranean Sea.

The climate is temperate continental with Mediterranean influences. The average multiannual temperature is 10.9^{o}C, and the average multiannual rainfall is 521.4 mm at LOVRIN Meteorological Station.

Regarding the rainfall in the periosd 2016-2019, it can be seen that compared to the multiannual average there was a deficit of 70.9 mm in the agricultural year 2016-2017, while the rainfall recorded in the agricultural year 2017-2018 exceeded the multiannual average by 176 mm, a fact reflected in the level of yields obtained: **4856 kg/ha** in the first year (2016-2017) and **4320 kg/ha** in the following year (2017-2018).

The agricultural year 2018-2019 as a whole is characterized by satisfactory values of precipitation, with a deficit of 45.4 mm compared to the multiannual average, the level of yield recorded being still below the level of 2016-2018.

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