INFLUENCE OF THE CROP ROTATION AND THE REGIME OF NUTRITION LEVEL ON THE CONTENT OF NITROGEN, PHOSPHORUS, POTASSIUM AND RAW PROTEIN OF SEEDS IN WINTER WHEAT CULTIVATED ON THE PRELUVOSOILS IN THE WESTERN PLAIN OF ROMANIA

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RESEARCH ARTICLE

Abstract

The quality of production is related to a series of physical and chemical characteristics of plants which gives a positive mark to the applied agrotechnical methods for the correlation of the latter to the production obtained on the surface unit.
A more intense accumulation of the biomass which determines an intensification of the photosynthesis positively influences the chemical composition of the final product – the grains.
The total content of N (nitrogen) in the winter wheat grains was influenced by the crop rotation and the nutrition system. The raw protein content follows the natural way similarly to nitrogen total content being influenced mainly by the crop rotation and the regime of nutrition level.
There weren't observed any essential changes of the total P (phosphorus) and K (potassium) content under the influence of the crop rotation and the regime of nutrition level.

Keywords: crop rotation, regime of nutrition level, raw protein, seeds, winter wheat
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INTRODUCTION

Some analyses have been made to establish the quality of the final product regarding the content of N, P, K in wheat seeds and raw protein (Oproiu, Cernescu, 1970; Bandici, Domuţa, Ardelean, 2003).

The main component of the chemical composition of the seeds is represented by the glucides (62-75 %) of the fresh wheat grain mass, the proteins 10-16 %, lipids 1.8-2.6 %, cellulose 2-3.5 % and mineral substances 1.5-2.3 % (Hera, 1986 b). A series of analyses of the N, P, K and raw protein content in the wheat grains have been made in order to specify the quality of the final product (Austin, 1978, Zăhan, Zăhan, 1989; Bandici, 1997; 2001).

The production quality is related to a series of physical and chemical characteristics of the plants which gives a positive mark to the agrotechnical applied measures for the correlation of this with the production obtained for/on the surface unit (Munteanu, Cernea, Morar et al., 2008).

The research performed in this field made clear the fact that quality is conditioned by the species and the cultivated hybrid, the climatic conditions of the cultivating year and also by the technology applied to the agricultural plants. To justify some of these aspects with consequences regarding the quality of the final production, we make some references to the specialised scientific literature, i.e. Hera Cr. et al.(1986a) underline the importance of nitrogen for the increase of the protein content, wet and dry gluten and for the improvement of the quality indicators of gluten. The authors also mention the importance of the ameliorative plant (the pea) for the quality indicators of the wheat. Boldea Eleonora et al. (1986) also mention the importance of the new species of wheat for the quality of raw protein and gluten.

The twinning of the plants is stimulated by the optimum moisture as well as by the presence in proper quantities and proportions of nourishing elements, especially nitrogen and phosphorus (Lazany, 2000, Lazany, 2003).

Their balanced combination, as well as an appropiate agrotechnical system adapted to edaphic and climatic characteristics of the zone lead to increased yields of superior quality.

The quality of the yield is influenced by many factors. Protein accumulation in the grains is influenced by wheat type, cultivar,

climate conditions, natural fertility of the soil, nitrogen doses used, irrigation (Ionescu, 1985). The gluten content of the wheat grain is influenced first of all by climate conditions (Bandici,1997, Domuţa et. all., 2007, 2008).

Usually, the level of protein from wheat grains is a very important parameter of the yield, the protein content of the wheat grain can be 10-16% (Muntean et. al, 2008) but it can have the limits of 4-25% (Bandici, 1997, Bandici et. al., 2003). Protein acumulation in the grains is influenced by the wheat type, cultivar, climate conditions, natural fertility of the soil, nitrogen doses used, irrigation (Domuţa and al., 2007, 2008, Bandici, 2018).

The paper analyses the crop rotation and irrigation influence on the protein content of the wheat grain in the conditions of the moderate wet area of the Crisurilor Plain (Domuţa, 2012)

The production quality is a feature connected to several physical and chemical characteristics of plants and confers a positive note to the applied agrotechnical measures, having in view the correlation of quality with the obtained production on a surface unit (Soltner, 1990, Salisbury, Ross., 1995).

MATERIAL AND METHOD

The experiment was made at Agricultural Research and Development Station (A.R.D.S.) Oradea, Romania, on the preluvosoil, in the period 2019-2021.

On the ploughing depth, the soil is low acid (pH=6.8), humus content is low (1.75 %), phosphorus (22.0 ppm) and potassium (845.4 ppm) have medium values; macroagregates hydrostability is high and bulk density (1.44 g/cm^3) is high, too.

For species "Delia" winter wheat grains, a series of chemical tests were made regarding the content of N (nitrogen), P (phosphorus), K (potassium) and raw protein accordind to the precursory and the nutrition system. The nitrogen was determined using the Kjieldahl method, the phosphorus was determined by colorimetry with ammonium molybdite and tin chloride reduction. The potassium was determined through flame photometry and the raw protein was determined through calculation (Nt x 5.7 %).

RESULTS AND DISCUSSIONS

Analysing the data in Table 1, regarding the influence of crop rotation and regime of nutrition level on the total N (nitrogen) content in the wheat seeds, we can see that both the crop rotation and regime of nutrition level influenced the content of this element in seeds. Therefore, comparing the wheat monoculture with wheat cultivation that was preceded by corn = maize or pea (3 and 4 years crop rotation) the latter induces an increased production of 22.4-53.8 %.

As an ameliorative plant, pea determined the increase of N (nitrogen) content in the crop as a consequence of its symbiotic particularities. Compared to the unfertilized type, with a value of 1.37 g/100 g.d.w. (grains of dry substance = wheat), mineral and organo-mineral fertilization determine important increase of N, i.e. 38.7 % and 62 %.

Table 1

The influence of crop rotation and regime of nutrition level of the content of *nitrogen* of the seeds in winter wheat cultivated on preluvosoils, Oradea, 2019-2021

Investigated factors	Total N, g/100 g.d.w.	Nitrogen %	Difference +/-
a. Rotation			
Wheat – Monoculture (Control)	1.43	100	-
Maize (W-M)	1.75	122.4	+0.32
Pea (P-W-M)	2.20	153.8	+0.77
Pea (P-W-M-M)	1.95	136.4	+0.52
b. Regime of nutrition level			
N_0P_0 (Control)	1.37	100	-
$N_{120}P_{80}$	1.90	138.7	+0.53
$N_{120}P_{80}$+10 t/ha manure	2.27	162.0	+0.85
	LSD 5% = 0.66 g/100 g.d.w. LSD 1% = 1.25 g/100 g.d.w. LSD 0.1 % = 2.35 g/100 g.d.w.		

Note: Non-significant=under 0.66; * Significant =0.66-1.25; ** = Significantly different =1.25 – 2.35; ***very significant = over 2.35.

In point of the factors interaction: crop rotation x regime of nutrition level (Table 2), we note that no matter the forerunner plant used, mineral or organo-mineral fertilisation increase by 12.1-86.7 %. The lowest values of total nitrogen content can be found in the wheat monoculture (1.24-1.65 g/100 g.d.w.) compared to short wheat – maize rotation (1.27-2.07 g/100 g.d.w) or to 3 and 4 year wheat – pea crop rotation – (1.70-2.78 g/100 g.d.w. and 1.28-2.39 g/100 g.d.w.).

Table 2

Influence of the factors interaction: crop rotation x regime of nutrition level on the content of *nitrogen* of the seeds in wheat cultivated on preluvosoils, Oradea, 2019-2022

Regime of nutrition level	To,tal Nitrogen g/100 g.d.w.	Nitrogen, %	Difference +/-
a. Wheat – Monoculture (Control)			
N_0P_0 (Control)	1.24	100	-
$N_{120}P_{80}$	1.39	12.1	+0.15
$N_{120}P_{80}$+10 t/ha manure	1.65	33.1	
b. Maize (W-M)			
N_0P_0 (Control)	1,27	100	-
$N_{120}P_{80}$	1.90	49.6	+0.63
$N_{120}P_{80}$+10 t/ha manure	2.07	63.0	+0.80
c. Pea (P-W-M)			
N_0P_0 (Control)	1.70	100	-
$N_{120}P_{80}$	2.13	25.3	+0.43
$N_{120}P_{80}$+10 t/ha manure	2.78	63.5	+1.08
d. Pea (P-W-M-M)			
N_0P_0 (Control)	1.28	100	-
$N_{120}P_{80}$	2.18	70.3	+0.90
$N_{120}P_{80}$+10 t/ha manure	2.39	86.7	+1.11
	LSD 5% = 0.66 g/100 g.d.w. LSD 1% = 1.25 g/100 g.d.w. LSD 0.1 % = 2.35 g/100 g.d.w.		

Note: Non-significant=under 0.66; * Significant =0.66-1.25; ** = Significantly different =1.25 – 2.35; ***very significant = over 2.35.

Concerning the total raw protein content (Nt x 5.7), in *Table 3 and 4*, we note the direct link between the N content and raw protein.

In this case, the crop rotation and the regime of nutrition level in the process induce important raw protein increase, which, in case of 3 year wheat-pea crop rotation may rise up to 12.58 g/100 g.d.w., compared to monoculture of 8.15 g/100 g.d.w. The highest values of raw protein increase were established in the organo-mineral fertilisation process of 12.58g/100 g.d.w., compared to the witness/control (N_0P_0) 7.92 g/100 g.d.w. In the case of raw protein, no matter what the precursory was, the organo-mineral fertilisation determined the highest values of raw protein content which varied between 9.43 g/100 g.d.w., in wheat monoculture and 15.84 g/100 g.d.w., in pea (3 year crop rotation).

Table 3

The influence of crop rotation and regime of nutrition level on the content of *raw protein* of the seeds in wheat cultivated on preluvosoils, Oradea 2019– 2022

Investigated factors	Raw protein , g/100 g.d.w.	Raw protein, %	Difference +/-
a. Crop rotation			
Wheat – Monoculture (Control)	8.15	100	-
Maize (W-M)	9.96	118.5	+1.81
Pea (P-W-M)	12.58	154.3	+4.43
Pea (P-W-M-M)	11.23	137.8	+3.08
b. Regime of nutrition level			
N_0P_0 (Control)	7.92	100	-
$N_{120}P_{80}$	10.84	136.9	+2.92
$N_{120}P_{80}$+10 t/ha manure	12.68	160.1	+4.76
	LSD 5% = 0.66 g/100 g.d.w. LSD 1% = 2.25 g/100 g.d.w. LSD 0.1 % = 4.35 g/100 g.d.w.		

Note: Non-significant=under 0.66; * Significant =0.66-2.25; ** = Significantly different =2.55 – 4.35; ***very significant = over 4.35.

Table 4

Influence of the factors interaction: crop rotation x regime of nutrition level on the content of *raw protein* of the seeds in wheat cultivated on preluvosoils, Oradea 2019-2022

Investigated factors	Raw protein g/100 g.d.w.	Raw protein %	Difference +/-
a. Wheat – Monoculture (M_t)			
N_0P_0 (Control)	7.07	100	-
$N_{120}P_{80}$	7.95	112.4	+0.88
$N_{120}P_{80}$+10 t/ha manure	9.43	133.3	+2.36
b. Maize (W-M)			
N_0P_0 (Control)	7.26	100	-
$N_{120}P_{80}$	10.83	149.2	+3.57
$N_{120}P_{80}$+10 t/ha manure	11.79	162.4	+4.53
c. Pea (P-W-M)			
N_0P_0 (Control)	9.72	100	-
$N_{120}P_{80}$	12.17	125.2	+2,45
$N_{120}P_{80}$+10 t/ha manure	15.84	163.l	+6.12
d. Pea (P-W-M-M)			
N_0P_0 (Control)	7.62	100	-
$N_{120}P_{80}$	12.43	163.1	+4.81
$N_{120}P_{80}$+10 t/ha manure	13.65	179.1	+6.03
	LSD 5% = 0.66 g/100 g.d.w. LSD 1% = 2.25 g/100 g.d.w. LSD 0.1 % = 4.35 g/100 g.d.w.		

Note: Non-significant=under 0.66; * Significant =0.66-2.25; ** = Significantly different =2.55 – 4.35; ***very significant = over 4.35

Regarding the total content of phosphorus in the wheat seeds, in *Table 5* and *Table 6* we note that neither crop rotation, regime of nutrition level, nor their interaction led to significant differences, regardless of the quality of the crop rotation or organo-mineral fertilisation, except the pea (3 year crop rotation) when the mineral or organo-mineral fertilisation determined more than 10 % increase of the total content of phosphorus**.**

Regarding the total content of potassium in the wheat seeds, in *Table 7 and 8* under the individual influence of both the observed factors and their interactions, we could notice significant difference.

Table 5

Influence of the crop rotation and regime of nutrition level on the content of *phosphorus* of seeds in wheat cultivated on preluvosoils, Oradea 2019-2022

Investigated factors	Total P, g/100 g.d.w.	Phosphorus %	Difference +/-
a. Crop rotation			
Wheat – Monoculture (Control)	0.36	100	-
Maize (W-M)	0.36	100	-
Pea (P-W-M)	0.40	111.0	+0.04
Pea (P-W-M-M)	0.36	100	-
b. Regime of nutrition level			
N_0P_0 (Control)	0.36	100	-
$N_{120}P_{80}$	0.37	102.8	+0.01
$N_{120}P_{80}$+10 t/ha manure	0.38	105.5	+0.02
	LSD 5% = 0.165 g/100 g d.w. LSD 1% = 0.219 g/100 g d.w. LSD 0.1 % = 0.281 g/100 g d.w.		

Note: Non-significant=under 0.165; * Significant =0.165-0.219; ** = Significantly different =0.219 – 0.281; ***very significant = over 0.281

Table 6

Influence of the factors interaction: crop rotation x regime of nutrition level on the content of P (*phosphorus)* of the seeds in wheat cultivated on preluvosoils, Oradea 2019-2022

Investigated factors	Total P g/100 g.d.w.	Phosphorus %	Difference +/-
a. Wheat – Monoculture (M_t)			
N_0P_0	0.36	100	-
$N_{120}P_{80}$	0.37	102.8	+0.01
$N_{120}P_{80}$+10 t/ha manure	0.36	100	-
b. Maize (W-M)			
N_0P_0	0.36	100	-
$N_{120}P_{80}$	0.36	100	-
$N_{120}P_{80}$+10 t/ha manure	0.37	102.8	+0.01
c. Maize (P-W-M)			
N_0P_0	0.36	100	-
$N_{120}P_{80}$	0.40	111.1	+0.04
$N_{120}P_{80}$+10 t/ha manure	0.44	122.2	+0.01
d. Pea (P-W-M-M)			
N_0P_0	0.35	100	-
$N_{120}P_{80}$	0.36	102.8	+0.01
$N_{120}P_{80}$+10 t/ha manure	0.37	105.7	+0.02
	LSD 5% = 0.165 g/100 g d.w. LSD 1% = 0.219 g/100 g d.w. LSD 0.1 % = 0.281 g/100 g d.w.		

Note: Non-significant=under 0.165; * Significant =0.165-0.219; ** = Significantly different =0.219 – 0.281; ***very significant = over 0.281

Table 7

Influence of the crop rotation and regime of nutrition level on the content of K (*potassium)* of the seeds in wheat cultivated on preluvosoils,Oradea 2019-2022

Investigated factors	Total K g/100 g.d.w.	Potassium %	Difference +/-
a. Crop rotation			
Wheat – Monoculture (M_t)	0.64	100	-
Maize (W-M)	0.67	104,7	+0.03
Maize (P-W-M)	0.64	100	-
Pea (P-W-M-M)	0.63	98,0	+0.01
b. Regime of nutrition level			
N_0P_0	0.67	100	-
$N_{120}P_{80}$	0.63	94.0	-0.04
$N_{120}P_{80}$+10 t/ha manure	0.63	94.0	-0.04
	LSD 5% = 0.165 g/10 plants s.u. LSD 1% = 0.219 g/10 plants s.u. LSD 0.1 % = 0.281 g/10 plants s.u.		

Note: Non-significant=under 0.165; * Significant =0.165-0.219; ** = Significantly different =0.219 – 0.281; ***very significant = over 0.281

Table 8

Influence of the factors interaction:crop rotation x regime of nutrition level on the content of K (*potassium)* of the seeds in wheat cultivated on preluvosoils, Oradea 2019-2022

Investigated factors	Total K, g/100 g.d.w.	Potassium %	Difference +/-
a. Wheat – Monoculture (M_t)			
N_0P_0	0.62	100	-
$N_{120}P_{80}$	0.65	104.8	+0.03
$N_{120}P_{80}$+10 t/ha manure	0.65	104.8	+0.03
b. Maize (W-M)			
N_0P_0	0.75	100	-
$N_{120}P_{80}$	0.65	86.7	-0.10
$N_{120}P_{80}$+10 t/ha manure	0.65	80.0	-0.15
c. Maize (P-W-M)			
N_0P_0	0.65	100	-
$N_{120}P_{80}$	0.65	100	-
$N_{120}P_{80}$+10 t/ha manure	0.63	96.9	-0.02
d. Pea (P-W-M-M)			
N_0P_0	0.66	100	-
$N_{120}P_{80}$	0.64	97.0	-0.02
$N_{120}P_{80}$+10 t/ha manure	0.58	87.9	+0.08
	LSD 5% = 0.165 g/100 g d.w. LSD 1% = 0.219 g/100 g d.w. LSD 0.1 % = 0.281 g/100 g d.w.		

Note: Non-significant=under 0.165; * Significant =0.165-0.219; ** = Significantly different =0.219 – 0.281; ***very significant = over 0.281

CONCLUSIONS

A more intense accumulation of the phytomass which determines an intensification of the photosynthesis positively influences the chemical composition of the final product - the grains.

The total content of N in the winter wheat grains was influenced by the crop rotation and the nutrition level. The raw protein content follows the natural way similarly to nitrogen total content being influenced mainly by the crop rotation and the regime of nutrition level

There weren't observed any essential changes of the total P and K content under the influence of the crop rotation and the regime of nutrition level.

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