

RESEARCH REGARDING THE LONG-TERM FERTILIZATION ON THE WINTER WHEAT YIELD, AT A.R.D.S. SECUIENI

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Abstract

Winter wheat is a demanding plant to the fertilizers application having an high consumption of nutrients: N – 24 – 36 kg/t wheat; P₂O₅ – 12 – 18 kg/t wheat; K₂O – 18 – 36 kg/t wheat; CaO – 6 – 10 kg/t wheat; MgO – 3 – 45 kg/t wheat. The radicular system is poorly developed, exploring a low volume of soil, with low power of absorption and leaching of the nutrient elements. One of the important links in this crop technology is the application of fertilizers which influence the quantity, quality and economic levels of the obtained yields. The paper aims to interpret from a technical point of view the obtained data and production functions resulting from the application of different doses of fertilizers with nitrogen and phosphorus. The data come from a long experience with chemical fertilizers for wheat, located at A.R.D.S. Secuieni during 2013-2015. Through the application of fertilizers containing nitrogen and phosphorus at wheat (compared with the control variant N₀P₀) were obtained production increases between 12 - 58% representing 1018 kg wheat/ha - 2909 kg wheat/ha. The phosphorus fertilizers brought average increases compared with the unfertilized variant P₂O₅ of 7 – 17% representing 451 kg wheat/ha – 987 kg wheat/ha. In the case of nitrogen fertilizers the average increases compared to the control variant N₀ were of 14 – 36% representing 763 kg wheat/ha – 1954 kg wheat/ha. Wheat production increases were related with the applied fertilizer doses settling highly significant correlations. The production increases achieved by applying 1 kg a.s. of fertilizer had average values of 5.71 – 11.27 kg wheat/kg P₂O₅ at the fertilizers with phosphorus and 12.21 – 19.07 kg wheat/kg N at the fertilizers with nitrogen. These increases were directly correlated with the fertilizer doses used in winter wheat crop.

Key words: wheat, increases, nitrogen, phosphorus, yield.

Winter wheat finds favorable growing conditions in Central Moldavian Plateau, and is area has a large share in the crops structure.

One of the important links in this culture technology is the application of fertilizers, determining factor in the quantitative, qualitative and economic levels of the obtained crops (Balteanu Gh. *et al.*, 1989; Budoii Gh. *et al.*, 1978; Lupu Cornelia *et al.*, 2014; Munteanu L. S. *et al.*, 2003; Saulescu N. A. *et al.*, 1967; Stefanescu Maria *et al.*, 1997).

The multitude of factors that influence the fertilizers effectiveness, creates difficulties in determining the optimal dosage of fertilizers, all the more so as some influencing factors are difficult to predict and considered (climatic conditions and production prices) (Lupu Cornelia *et al.*, 2014).

This paper aims to interpret from a technical point of view the data and production functions resulted from the application of different doses of fertilizers with nitrogen and phosphorus.

The analyzed parameters (production, increase designed with a kg of fertilizer, etc.) are basic elements to optimize fertilization system

MATERIAL AND METHOD

The data come from a wheat long term experience located in A.R.D.S. Secuieni - Neamt (1975) in a 3-year rotation (wheat - corn - beans).

The settlement method - subdivided plots in five repetitions.

Soil type: cambic chernozom; pH: 5.7 – 6.6; humus: 2.55 – 2.31%; N total: 0.15 – 0.16%; P₂O₅ – 17 ppm; K₂O – 195 ppm.

The studied factors:

A – phosphorus fertilizers:

- a1 – P₂O₅ - 0
- a2 – P₂O₅ - 40
- a3 – P₂O₅ - 80
- a4 – P₂O₅ - 120
- a5 – P₂O₅ - 160

B – nitrogen fertilizers:

- b1 – N₀
- b2 – N₄₀
- b3 – N₈₀

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b4 – N₁₂₀

b5 – N₁₆₀

Cultivated variety: Glosa.

The data processing was done through variance analysis, correlations and regressions method.

The 2012 - 2015 research period is characterized by a pluviometric regime close to the annual average in 2012 - 2013 and 2013 - 2014 agricultural years and deficiency (- 201.3 mm) in 2014-2015 agricultural year (*figure 1*).

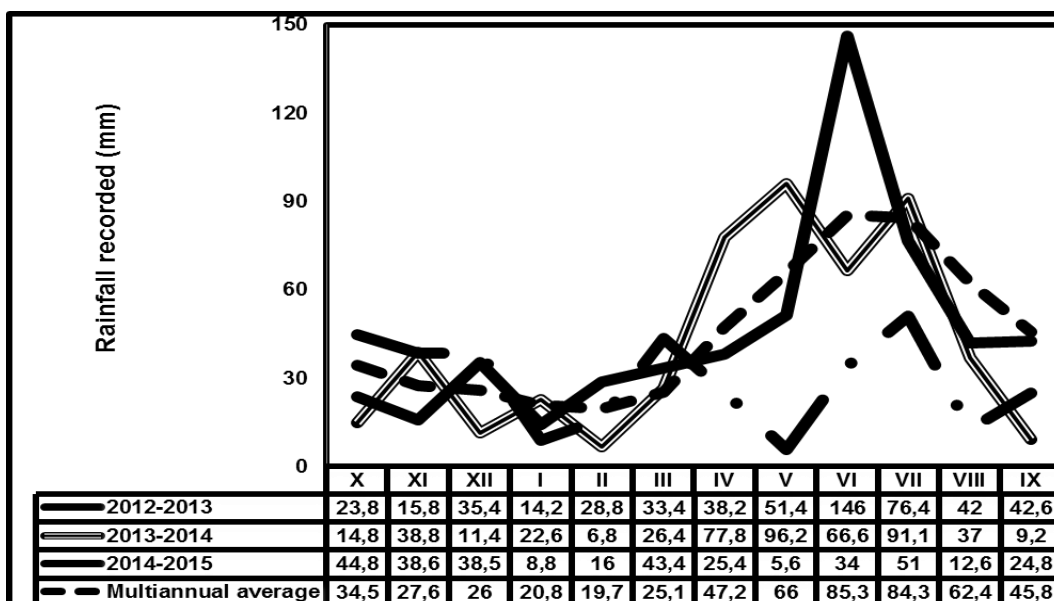


Figure 1 Monthly and annual rainfall (mm) recorded at A.R.D.S. Secuieni during 2013 - 2015 and the multiannual average

The thermal regime has registered values close to the annual average during the 2012 - 2013 agricultural year and was in surplus in 2013 -

2014 (+ 1.2°C) and 2014 - 2015 (+ 1.5°C) agricultural years (*figure 2*).

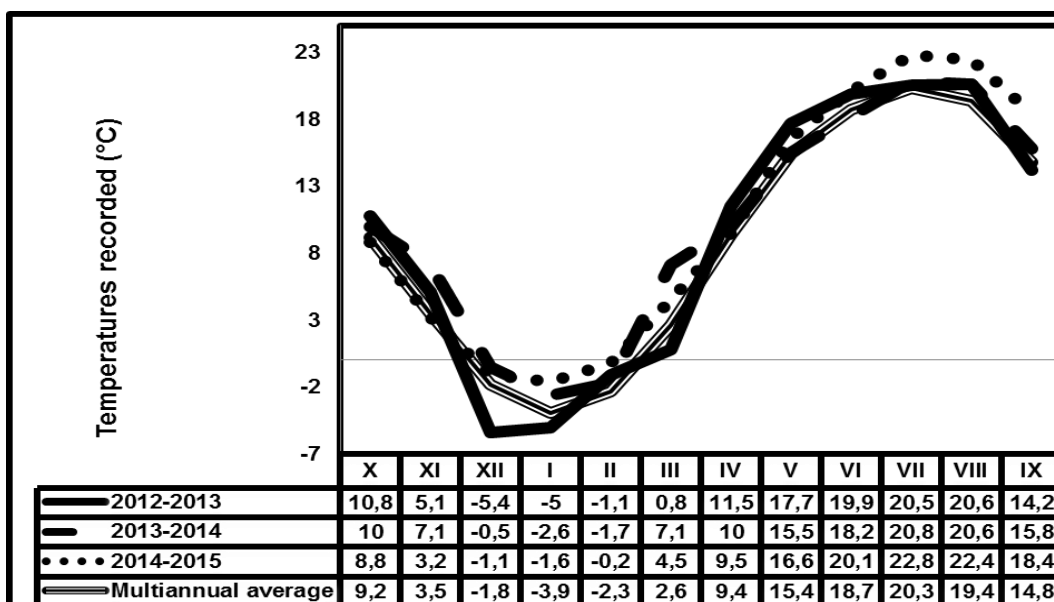


Figure 2 Average monthly and annual temperatures (°C) recorded at A.R.D.S. Secuieni during 2013 - 2015 and the multiannual average

RESULTS AND DISCUSSIONS

Wheat production achieved during 2013 - 2015 period showed variations due to the fertilizer doses applied as well to the climatic conditions.

At the unfertilized variant (N₀P₀) the yields ranged between 4681 kg wheat/ha - 5444 kg wheat/ha, and through the application of fertilizers with nitrogen and phosphorus yields ranged from 5449 kg wheat/ha - 8357 kg wheat/ha (*table 1*).

Table 1

The influence of NP fertilizers on the winter wheat yields at A.R.D.S. Secuieni 2013 – 2015

Fertilizers		Wheat yields kg/ha					Diff.	Sign.
Phosphorus kg/ha	Nitrogen kg/ha	2013	2014	2015	Wheat average yields kg/ha (2013 – 2015)	Relative yield %		
P ₂ O ₅ - 0	N ₀	4681	4915	5444	5013	100	mt.	
	N ₄₀	5531	5449	5900	5627	112	614	xxx
	N ₈₀	5883	5784	6242	5970	119	957	xxx
	N ₁₂₀	6149	6219	6531	6300	126	1287	xxx
	N ₁₆₀	6556	6419	7244	6740	134	1727	xxx
P ₂ O ₅ - 40	N ₀	4779	5275	5723	5259	105	246	x
	N ₄₀	5865	5882	6347	6031	120	1018	xxx
	N ₈₀	6489	6320	6347	6519	130	1506	xxx
	N ₁₂₀	6727	6537	7165	6810	136	1797	xxx
	N ₁₆₀	7143	6802	7718	7221	144	2208	xxx
P ₂ O ₅ - 80	N ₀	5081	5516	6071	5556	111	543	xxx
	N ₄₀	6194	6038	6742	6325	126	1312	xxx
	N ₈₀	6615	6697	6982	6765	135	1752	xxx
	N ₁₂₀	6904	6971	7510	7128	142	2115	xxx
	N ₁₆₀	7508	7035	8076	7540	150	2527	xxx
P ₂ O ₅ - 120	N ₀	5271	5689	6145	5702	114	689	xxx
	N ₄₀	6400	6454	6860	6571	131	1558	xxx
	N ₈₀	7006	6842	7263	7037	140	2024	xxx
	N ₁₂₀	7069	7342	7646	7352	147	2339	xxx
	N ₁₆₀	7781	7628	8357	7922	158	2909	xxx
P ₂ O ₅ - 160	N ₀	5329	5543	6240	5704	114	691	xxx
	N ₄₀	6700	6008	6976	6561	131	1548	xxx
	N ₈₀	7044	6585	7346	6992	139	1979	xxx
	N ₁₂₀	7306	6910	7725	7310	146	2297	xxx
	N ₁₆₀	7870	7202	7868	7647	152	2634	xxx
DL (kg/ha)		NXP ₂ O ₅						
5%		145	131	403	231			
1%		193	174	535	307			
0.1%		249	225	690	397			

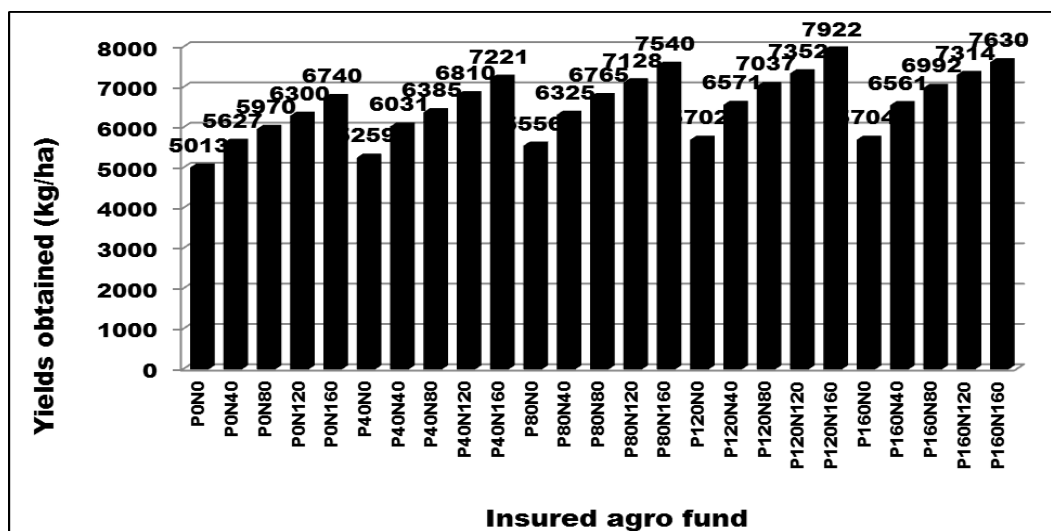


Figure 3 The influence of nitrogen and phosphorus fertilizers on wheat yield (average 2013-2015) at A.R.D.S. Secuieni

The average production of the unfertilized variant during 2013 - 2015 period was of 5446 kg wheat/ha and through the application of fertilizers with nitrogen and phosphorus the averages ranged between 5627 kg wheat/ha - 7922 kg wheat/ha (figure 3). Applying fertilizers with phosphorus

(after the five graduations averages of nitrogen fertilizers) resulted in achieving some average yields, during 2013-2015 period between 6381 kg wheat/ha - 6844 kg wheat/ha. The average of the variant without phosphorus (2013 - 2015) was of 5930 kg wheat/ha (table 2).

Table 2

The influence of phosphorus fertilizers on the winter wheat yields at A.R.D.S. Secuieni 2013 – 2015

Phosphorus dose (kg/ha)	Wheat yields kg/ha					Diff.	Sign.
	2013	2014	2015	Wheat average yields kg/ha (2013 - 2015)	Relative yield %		
P ₂ O ₅ - 0	5760	5757	6272	5930	100	mt.	
P ₂ O ₅ - 40	6241	6163	6740	6381	107	451	xxx
P ₂ O ₅ - 80	6460	6451	7076	6662	112	732	xxx
P ₂ O ₅ - 120	6706	6791	7254	6917	117	987	xxx
P ₂ O ₅ - 160	6850	6450	7231	6844	115	914	xxx
DL (kg/ha)	phosphorus						
5%	95	69	204	128			
1%	130	96	282	176			
0.1%	179	132	388	242			

Between the applied doses of phosphorus and the obtained yields was established a very strong positive correlation (figure 4). The application of nitrogen fertilizers during 2013 –

2015 period after the five graduations averages of phosphorus fertilizers led to the obtaining of some yields that ranged between 6223 kg wheat/ha - 7414 kg wheat/ha.

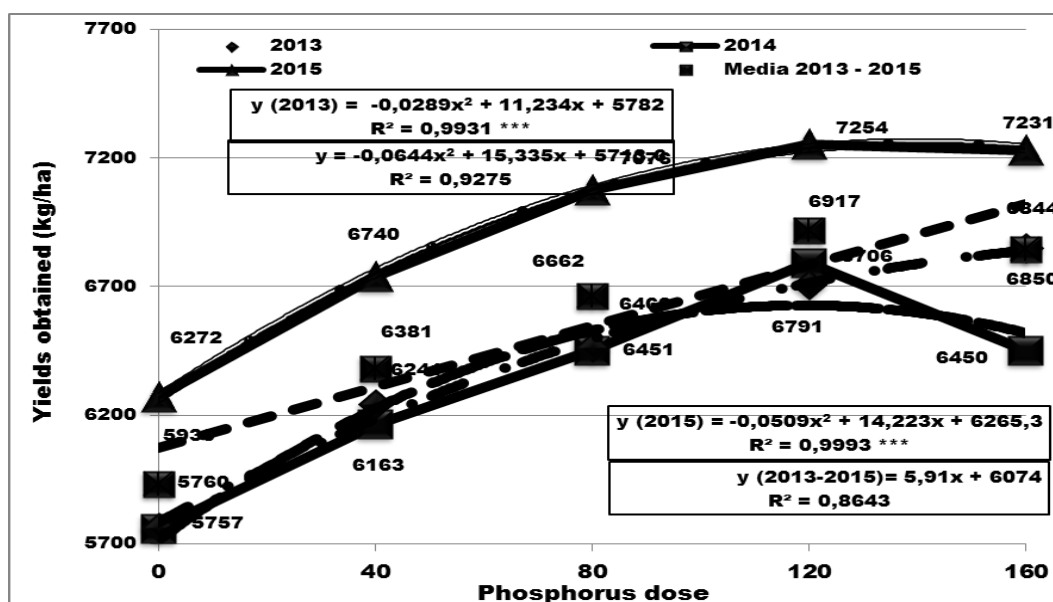


Figure 4 The correlation between the phosphorus doses and the wheat yield, 2013 – 2015

The variant unfertilized with nitrogen recorded yields between 5068 - 5925 kg wheat/ha and the 2013 - 2015 period average, 5460 kg wheat/ha (table 3).

Between the applied doses of nitrogen and the obtained yields was established a very strong positive correlation (figure 5).

Table 3

The influence of nitrogen fertilizers on the winter wheat yields at A.R.D.S. Secuieni 2013 – 2015

Nitrogen dose kg/ha	Wheat yields kg/ha					Diff.	Sign.
	2013	2014	2015	Wheat average yields kg/ha (2013 – 2015)	Relative yield %		
N ₀	5068	5388	5925	5460	100	-	
N ₄₀	6138	5966	6565	6223	114	763	xxx
N ₈₀	6607	6446	6916	6656	122	1196	xxx
N ₁₂₀	6831	6796	7315	6981	128	1521	xxx
N ₁₆₀	7372	7017	7853	7414	136	1954	xxx
DL	nitrogen						
5%	68 kg/ha	58 kg/ha	180 kg/ha	107 kg/ha			
1%	86 kg/ha	77 kg/ha	239 kg/ha	141 kg/ha			
0.1%	111 kg/ha	100 kg/ha	309 kg/ha	182 kg/ha			

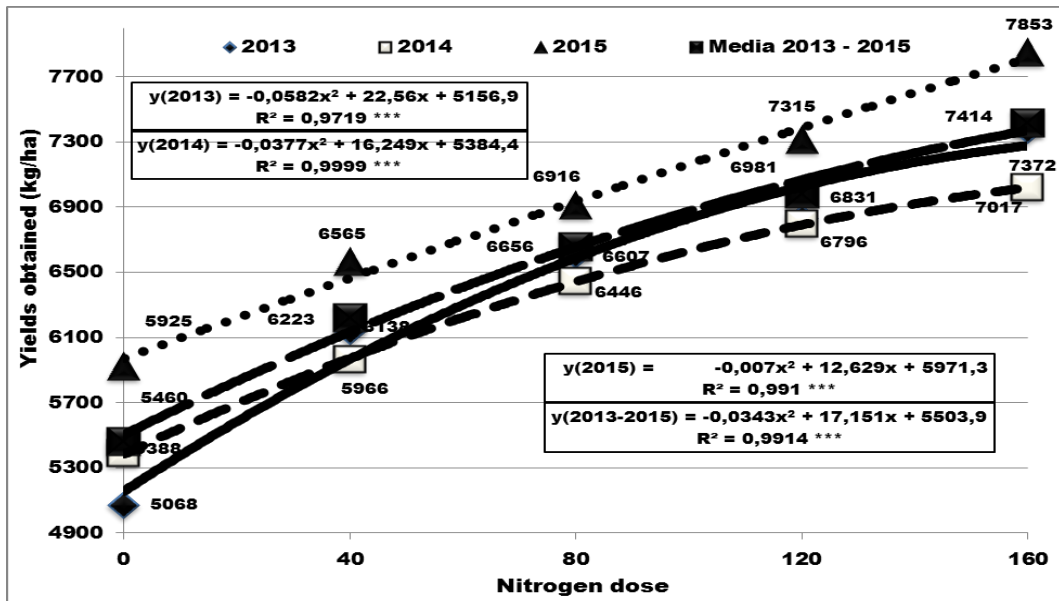


Figure 5 The correlation between the nitrogen doses and the wheat yield, 2013 – 2015

Yield increases

The average yield increases through the application of fertilizers with nitrogen and phosphorus, compared to the unfertilized variant were of 45-58% (246-2909 kg wheat/ha). They were directly correlated with the type and dosage of the applied fertilizer.

Lower yield increases were recorded in the variants which were unilaterally fertilized with phosphorus fertilizers (5-14% representing 246-691 kg wheat/ha) and lower doses of nitrogen (N40) (12-31% representing 614 - 1558 kg wheat/ha).

The application of N40 - N160 nitrogen doses realized yielded increases of 20-44% (1018-2208 kg wheat/ha) on P₂O₅ – 40 agrofund; increases of 26-50% (1312-2527 kg wheat/ha) on P₂O₅ – 80 agrofund; increases of 31-58% (1558-

2909 kg wheat/ha) on P₂O₅ – 120 agrofund and increases of 31-52% (1548-2634 kg wheat/ha) on P₂O₅ - 160 agrofund (table 1).

The yield increases achieved by applying phosphorus fertilizers (after the five graduations averages of nitrogen fertilizers) compared to the variant unfertilized with phosphorus were 7-15% (451-987 kg wheat/ha). The increases were ascending (5 - 14%) at the application of P₂O₅ - 40 – P₂O₅ - 120 doses (table 2).

The yield increases achieved by applying nitrogen fertilizers (after the five graduations averages of phosphorus fertilizers) compared to the variant unfertilized with nitrogen were of 14 – 36% (763 – 1954 kg wheat/ha) (table 3).

Between the yield increases and the doses of phosphorus and nitrogen were positive correlations, very significant (figure 6, 7).

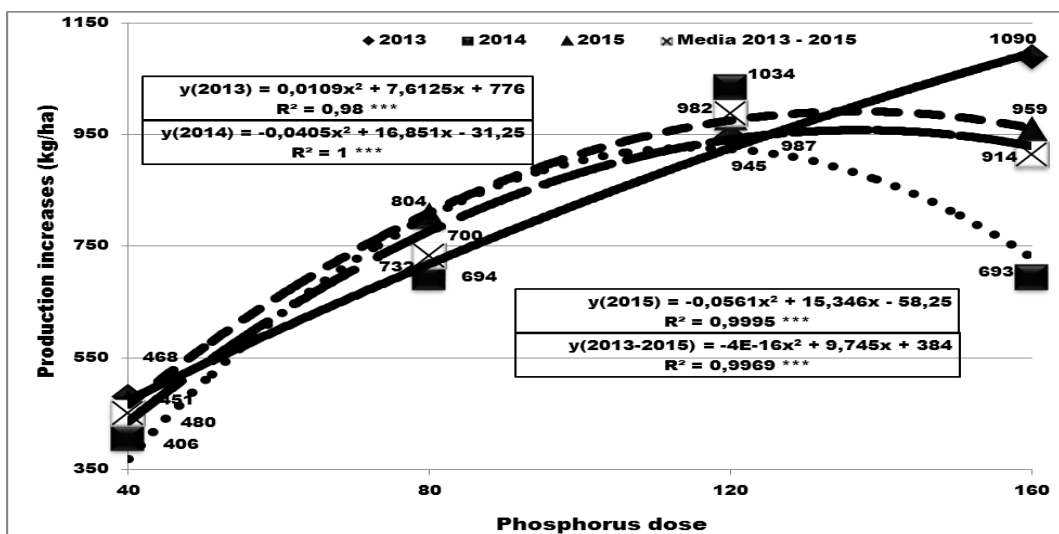


Figure 6. . The correlation between the phosphorus doses and the wheat yield increase, 2013 – 2015

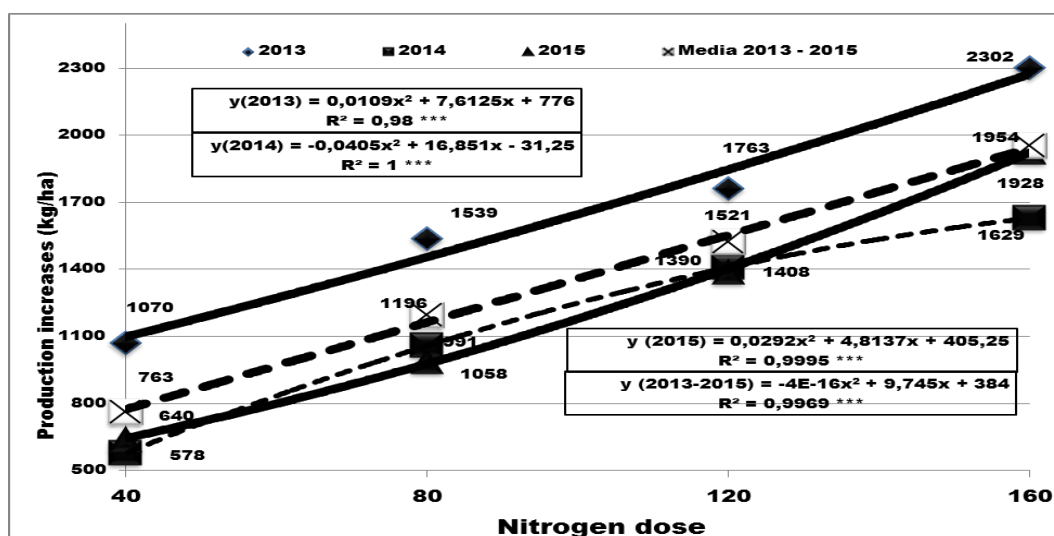


Figure 7. The correlation between the nitrogen doses and the wheat yield increase, 2013 – 2015

During 2013 – 2015 the yield increase variation at the application of phosphorus fertilizer was of 406 – 480 kg wheat/kg P₂O₅ at P₄₀ dose; 694 – 804 kg wheat/kg P₂O₅ at P₈₀ dose; 945 -1034

kg wheat/kg P₂O₅ at P₁₂₀ dose; 693 – 1090 kg wheat/kg P₂O₅ at P₁₆₀ dose (table 4).

Table 4

The influence of NP fertilizers on winter wheat yield increases - A.R.D.S. Secuieni

PN doses	Wheat yield increases kg/kg a.s.			Average increases kg wheat/kg a.s. (2013 – 2015)	Marginal increase variation kg wheat/kg a.s.	Average marginal increase kg wheat/kg a.s.
	2013	2014	2015			
P ₂ O ₅ - 40	480	406	468	451	10.15 – 12.00	11.27
P ₂ O ₅ - 80	700	694	804	732	8.67 – 10.05	9.15
P ₂ O ₅ - 120	945	1034	982	987	7.87 – 8.61	8.22
P ₂ O ₅ - 160	1090	693	959	914	4.33 – 6.81	5.71

At the phosphorus fertilizers application the yield increase achieved by applying 1 kg of P₂O₅ a.s. had values of 10.15 – 12.00 kg wheat/kg P₂O₅ (media 11.27 kg wheat/kg P₂O₅) at P₄₀ dose; 8.67 – 10.05 kg wheat/kg P₂O₅ (media 9.15 kg wheat/kg P₂O₅) at P₈₀ dose; 7.87 – 8.61 kg wheat/kg P₂O₅ (media 8.22 kg wheat/kg P₂O₅) at P₁₂₀ dose and 4.33 – 6.81 kg wheat/kg P₂O₅

(media 5.71 kg wheat/kg P₂O₅) at P₁₆₀ dose (table 4).

During the research period the yield increase at the application of the nitrogen fertilizers was between: 578 – 1070 kg wheat/kg N at N₄₀ dose; 991 - 1539 kg wheat/kg N at N₈₀ dose; 1390 - 1763 kg wheat/kg N at N₁₂₀ dose and 1629 - 1928 kg wheat/kg N at N₁₆₀ dose (table 5).

Table 5

The influence of NP fertilizers on winter wheat yield increases - A.R.D.S. Secuieni

PN doses	Wheat yield increases kg/kg a.s.			Average increases kg wheat/kg a.s. (2013 – 2015)	Marginal increase variation kg wheat/kg a.s.	Average marginal increase kg wheat/kg a.s.
	2013	2014	2015			
N ₄₀	1070	578	640	763	14.45 – 26.75	19.07
N ₈₀	1539	1058	991	1196	12.39 – 19.24	14.95
N ₁₂₀	1763	1408	1390	1521	11.58 – 14.69	12.67
N ₁₆₀	2302	1629	1928	1954	10.18 – 14.39	12.21

By applying nitrogen fertilizer the yield increases achieved per kg N a.s. fertilizer were: 14.45 – 26.75 kg wheat/kg N (media 19.07 kg wheat/kg N) at N₄₀ dose; 12.39 – 19.24 kg wheat/kg N (media 14.95 kg wheat/kg N) at N₈₀ dose; 11.58 – 14.69 kg wheat/kg N (media 12.67

kg wheat/kg N) at N₁₂₀ dose and 10.18 – 14.39 kg wheat/kg N (media 12.21 kg wheat/kg N) at N₁₆₀ dose (table 5).

The number of grains/ear ranged between 31.01 to 33.94 depending on the phosphorus dose applied (table 6).

Table 6

The influence of phosphorus fertilizers on the lan productivity elements in winter wheat crop - A.R.D.S. Secuieni

Fertilizer doses	No. ears/sqm	Diff.	Sign.	No. grains/ear	Diff.	Sign.	MTG g	Diff.	Sign.
P ₂ O ₅ - 0	478	mt.	-	30.10	mt.	-	42.48	mt.	-
P ₂ O ₅ - 40	484	6	-	31.01	1		42.92	0.44	x
P ₂ O ₅ - 80	482	4	-	33.01	3	xx	42.56	0.08	-
P ₂ O ₅ - 120	487	9	-	33.94	3.93	xxx	42.19	0.29	-
P ₂ O ₅ - 160	485	7	-	33.24	3.23	xxx	42.83	0.35	-
	DL ears (P ₂ O ₅)			DL grains/ear P ₂ O ₅			DL MTG g (P ₂ O ₅)		
	5% - 17			5% - 1.41			5% - 0.415		
	1% - 25			1% - 2.05			1% - 0.604		
	0.1% - 38			0.1% - 3.08			0.1% - 0.906		

The nitrogen fertilizers have affected the number of ears/sqm that ranged between 484 - 495 ears/sqm, the number of grains per ear

between 30.67 to 36.02 and the MTG fluctuated between 42.53 to 42.90 g depending on the dose of the nitrogen applied (table 7).

Table 7

The influence of nitrogen fertilizers on the lan productivity elements in winter wheat crop - A.R.D.S. Secuieni

Fertilizer doses	No. ears/sqm	Diff.	Sign.	No. grains/ear	Diff.	Sign.	MTG g	Diff.	Sign.
N ₀	466	mt.	-	28.39	mt.	-	42.15	mt.	-
N ₄₀	484	18	xx	30.67	2.28	xxx	42.53	0.38	
N ₈₀	481	15	x	32.38	3.99	xxx	42.90	0.75	
N ₁₂₀	490	24	xxx	33.78	5.39	xxx	42.88	0.73	
N ₁₆₀	495	29	xxx	36.02	7.63	xxx	42.49	0.34	
	DL ears (N)			DL grains/ear (N)			DL MTG g (N)		
	5% - 13			5% - 1.01			5% - 0.581		
	1% - 17			1% - 1.35			1% - 0.776		
	0.1% - 22			0.1% - 1.78			0.1% - 1.021		

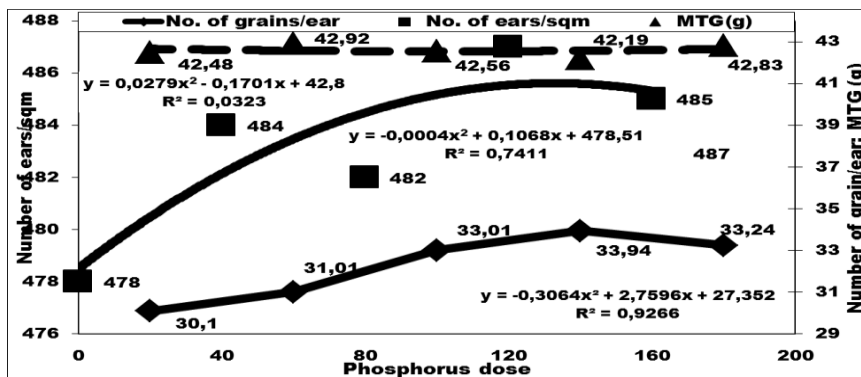


Figure 8. The correlation between the phosphorus doses and the productivity elements at wheat, 2013 – 2015

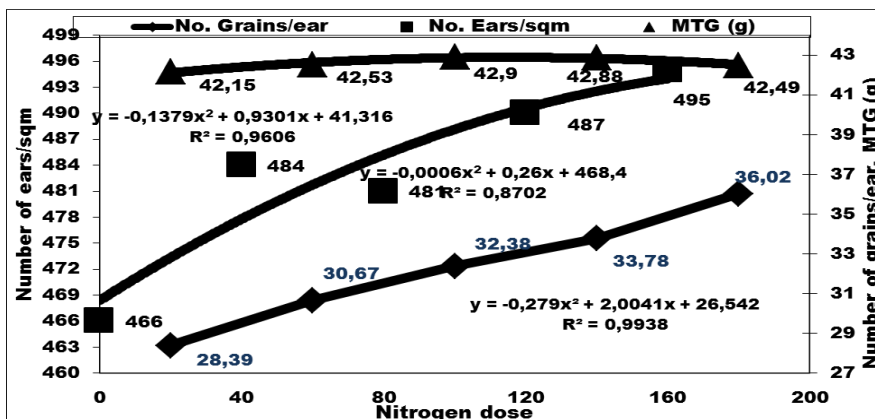


Figure 9. The correlation between the nitrogen doses and the productivity elements at wheat, 2013 – 2015

CONCLUSIONS

The wheat yields achieved by applying phosphorus and nitrogen fertilizers have fluctuated depending on the applied doses and the climatic conditions of the agricultural year. Between the doses of fertilizer applied and the obtained yields were established strong correlation.

Compared to the unfertilized variant N_0P_0 the application of chemical fertilizers in winter wheat ($N_{40} - N_{160}$ and $P_{2O_5} - 40 - P_{2O_5} - 160$) has achieved yield increases of 11 – 58% (543 – 2909 kg wheat/ha).

The achieved yield increases were closely correlated with the fertilizer type and dose and the climatic conditions during the research.

The nitrogen fertilizers have recorded higher average increases (14 – 36% representing 763 – 1954 kg wheat/ha), as compared to the phosphorus fertilizers, in which case the average yield increases were lower (7 – 17% representing 451 – 914 kg wheat/ha).

The yield increases achieved by applying 1 kg fertilizer a.s. had average values of 5.71 – 11.27

kg wheat/kg P_{2O_5} at the phosphorus fertilizers and 12.21 – 19.07 kg wheat/kg N at the nitrogen fertilizers. These increases were indirectly correlated with the doses of fertilizer used.

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