STUDY OF NITROGEN FERTILIZATION AT MAIZE CROP IN A.R.D.S. SECUIENI CONDITIONS

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Abstract

In the structure of chemical fertilizers, the nitrogenous ones occupy the main place by their contribution in the determination of crop increase, favorably influencing the accumulation of protein substances in maize.
The paper presents the results obtained at A.R.D.S. Secuieni in a long-lasting experience with chemical fertilizers at maize crops.
The researchers investigated the influence of nitrogen fertilizers on corn crops at A.R.D.S. Secuieni during 2014 – 2016 and had two directions of approach:
- the study of the technical efficiency regarding the contribution of nitrogen fertilizers on the obtained yields, the production increase and the marginal increase, in order to optimize the soil - plant system (maximizing the yield and rationalization of the fertilizer);
- the study of the economic efficiency of nitrogen fertilizers application (values of production increase, costs, income, profit, profit rate, unit costs) by differential application of fertilizer inputs.

Key words: fertilization, nitrogen, maize

Corn is one of the most productive agricultural plants grown in our country. Due to the great economic importance and the fact that it meets favorable growth and development conditions in several areas and in the next years it will have the largest share in the crop structure.

To harness their productive potential, plants need adequate amounts of water, light, heat and mineral nutrients. The removal of nutrients from the soil by their absorption into the plant, by leaching or other processes related to the natural dynamics of soils, attract after them the reduction of the nutrient content of the mobile elements and the gradual decline of soil fertility. For these reasons, it is imposed as an objective necessary to compensate by the application of fertilizers that substitute the consumption with the crops, as well as the decrease of nutrient mobility through the natural processes of absorption, fixation, immobilization (Borlan Z., 1994, Davidescu D., 1981).

Of the chemical fertilizers, the decisive role in the production of corn is fertilized by nitrogen fertilizers. Both for economic reasons and environmental requirements, they need to be properly managed and used, given the complex behavior of this nutrient in the soil and the ease with which they are lost in the form of nitrates. In addition, the promotion of the concept of sustainable agriculture entails the application of technical and economical production technologies with permanent solutions with real protection of the environment and of the beneficiaries and ensuring not only the productivity of the involved factors but also a real optimization of the production components (Lupu Cornelia et al. 1993, Petcu Gh. et al. 2003, Mihăilă V. et al. 1996).

The paper aims to analyze the technical and economic efficiency of nitrogen fertilizers application to maize culture under the conditions of A.R.D.S. Secuieni.

MATERIAL AND METHOD

The results obtained and presented in this scientific paper come from a long term experience with nitrogen fertilizers, placed under pedoclimatic conditions at SCDA Secuieni since 1975, in a bean-wheat-corn rotation.

Soil type: Cambic faeoziom with the following characteristics:

- humus content – 1.81%, medium supply;
- NO_3: 16 ppm – medium supply;
- P_{AL}: 56.6 ppm - medium supply;
- K_2O: 102.1 ppm – poor supply;
- pH: 5.98 – slightly acid.

The settlement method - subdivided plots.

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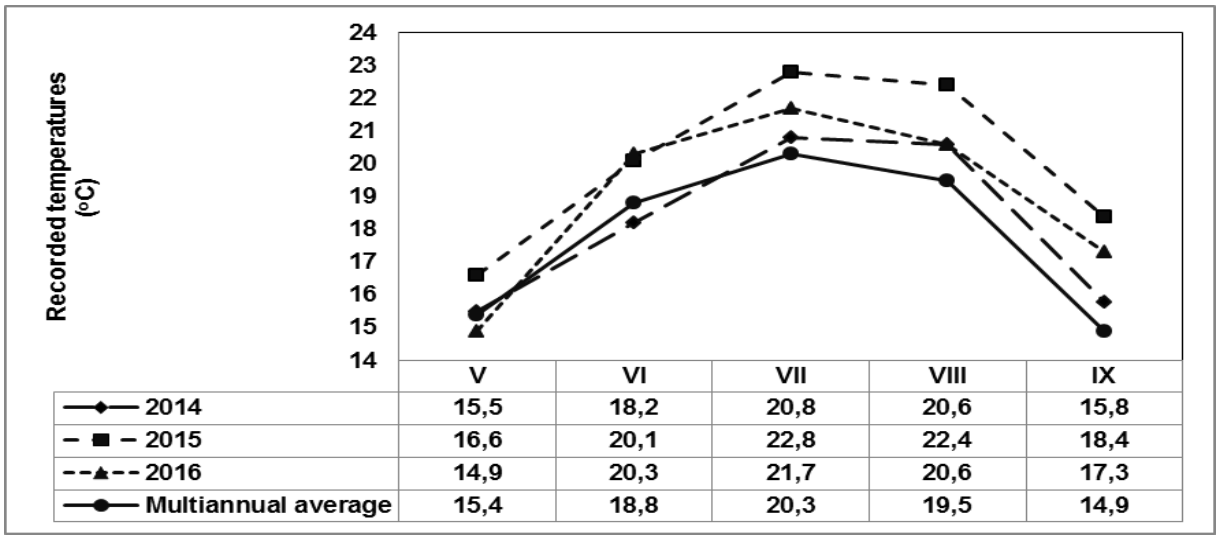
On an agrofond of 80 kg/ha P_2O_5, five variants of nitrogen fertilization were experimented respectively N_0, N_{40}, N_{80}, N_{120} and N_{160}.

This paper presents the results obtained at A.R.D.S. Secuieni during 2014 - 2016. From the thermal point of view, all three analyzed years were considered warm, exceeding the multiannual average of 8.8 °C (*figure 1*).

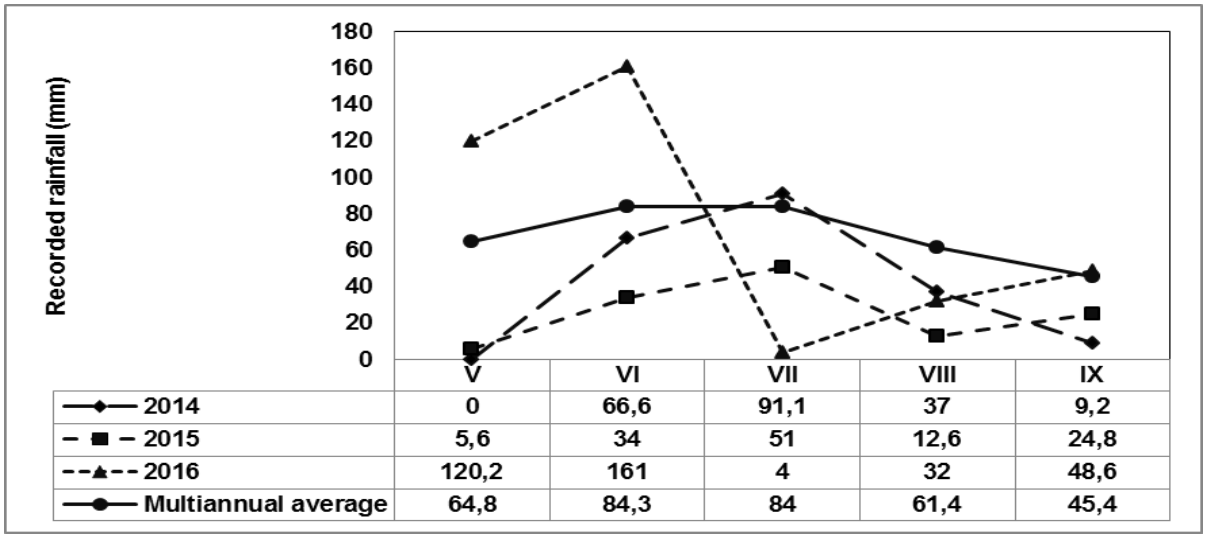


	V	VI	VII	VIII	IX
2014	15,5	18,2	20,8	20,6	15,8
2015	16,6	20,1	22,8	22,4	18,4
2016	14,9	20,3	21,7	20,6	17,3
Multiannual average	15,4	18,8	20,3	19,5	14,9

Figure 1 **Temperature chart recorded at A.R.D.S. Secuieni meteorological station, during the growing season of corn (2014 – 2016)**

From a pluviometric point of view the years 2014 and 2015 were drought, and 2016 was a favorable year for corn growth and development (*figure 2*).

Data processing was done using the variance analysis method and with the help of correlations and regressions (Săulescu N. and Săulescu N.N., 1967).



	V	VI	VII	VIII	IX
2014	0	66,6	91,1	37	9,2
2015	5,6	34	51	12,6	24,8
2016	120,2	161	4	32	48,6
Multiannual average	64,8	84,3	84	61,4	45,4

Figure 2 **Precipitation chart recorded at A.R.D.S. Secuieni meteorological station, during the growing season of corn (2014 – 2016)**

RESULTS AND DISCUSSIONS

a) Grain production.

Under 2014 conditions, through the application of nitrogen fertilizers, the corn yields oscillated between 7437 - 9021 kg/ha, in 2015 the yields ranged between 4933 - 5921 kg/ha and in 2016 the yields varied between 8011 - 10314 kg/ha. On average, over the three years studied, the yields were between 6793 - 8419 kg/ha (*table 1*). Between the applied nitrogen doses and the obtained productions were positive correlations statistically ensured, very significant (*figure 3*).

Table 1

The influence of nitrogen fertilization on maize yield under A.R.D.S. Secuieni conditions (2014 - 2016)

N dose (kg/ha a.s.)	Obtained yields (kg/ha)				Relative yield (%)	Difference (kg/ha)	Significance
	2014	2015	2016	Average 2014 - 2016			
N_0	6846	4489	7215	6183	100	Mt.	-
N_{40}	7437	4933	8011	6793	110	610	***
N_{80}	8034	5146	9088	7423	120	1240	***
N_{120}	8470	5666	9878	8005	129	1822	***
N_{160}	9021	5921	10314	8419	136	2236	***
DL 5 % (kg/ha)	82	210	202	165			
DL 1 % (kg/ha)	109	278	269	219			
DL 0.1 % (kg/ha)	141	360	348	283			

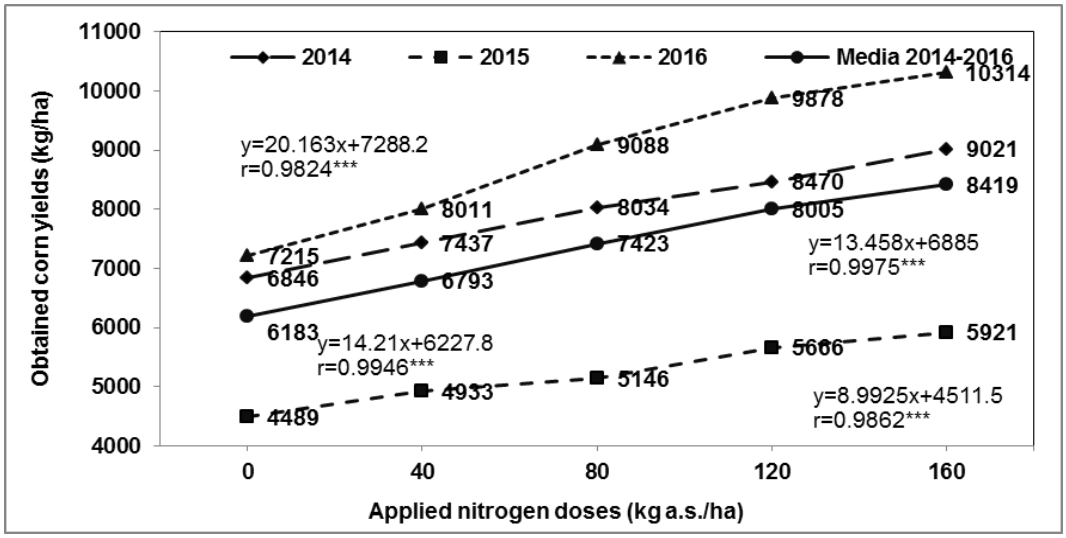


Figure 3 **The correlation between nitrogen doses and maize yield, Secuieni 2014 - 2016**

b) Production increases.

In 2014, the production increases at corn by nitrogen fertilizer application ranged from 1188 (N_{80}) - 2175 kg/ha (N_{160}), the average increase being of 1394 kg/ha; in 2015 the increases were between 657 (N_{80}) - 1432 kg/ha (N_{160}), the average increase was 927 kg/ha, and in 2016 the increases ranged between 1873 (N_{80}) -3099 kg/ha (N_{160}), the average increase was 2108 kg/ha.

Table 2

Production increases obtained in corn crop by the application of nitrogen fertilizers, Secuieni 2014 – 2016

N dose (kg/ha a.s.)	Production increases (kg/ha)			
	2014	2015	2016	Average 2014 - 2016
N_{40}	591	444	796	610
N_{80}	1188	657	1873	1240
N_{120}	1624	1177	2663	1822
N_{160}	2175	1432	3099	2236
$\bar{x}$ average increase	1394	927	2108	1476
%	94	63	143	100
				s = 1181 c_v = 80 %

On average for 2014-2016 the production increases ranged between 1240 (N_{80}) and 2236 kg/ha (N_{160}), and the average yield was of 1476 kg/ha. The standard deviation was of 1181 kg/ha, and the coefficient of variation was of 80% (*table 2*). The correlations between the two variables are direct and very tight (*figure 4*).

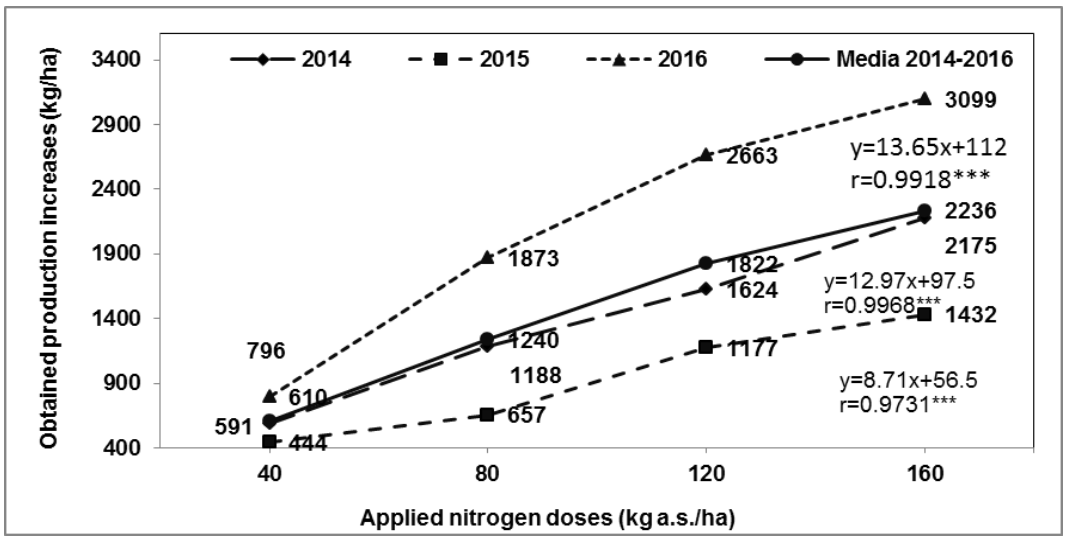


Figure 4 **The correlation between the nitrogen doses and the production increase in maize, Secuieni 2014 – 2016**

c) Marginal production increase.

In 2014, corn production yields per kg nitrogen were between 13.53 kg/kg N at N_{120} dose, 14.85 kg/kg N at N_{80} dose, the average increase was of 14.19 kg/kg N.

The yield increases obtained at maize per 1 kg of nitrogen applied in 2015 were of 8.21 kg/kg N at N_{80} dose and 9.81 kg/kg N at N_{120} dose (the average increase being of 9.52 kg/kg N).

In 2016 the yield increases obtained at maize per 1 kg nitrogen were between 19.37 kg/kg N at N_{160} dose and 23.41 kg/kg N at N_{80} dose, the average increase being of 21.22 kg/kg N. The standard deviation had a value of 11.70 and the variation coefficient of 78 % (*table 3*).

Table 3

Marginal production increases obtained in maize by the application of nitrogen fertilizers, Secuieni 2014 – 2016

N dose (kg/ha a.s.)	Production increases (kg of corn grains/kg nitrogen a.s.)			
	2014	2015	2016	Average 2014 - 2016
N_{40}	14.78	11.10	19.90	15.25
N_{80}	14.85	8.21	23.41	14.49
N_{120}	13.53	9.81	22.19	15.18
N_{160}	13.59	8.95	19.37	13.97
$\bar{x}$ average increase	14.19	9.52	21.21	14.98
%	95	64	142	100
				$s^2 = 136.89$ $s = 11.70$ $c_v = 78$ %

Between the applied nitrogen doses and the production increases per 1 kg of nitrogen was an indirect correlation, the correlation coefficient (r) being interpreted as being significantly negative (2014-2016) (*figure 5*).

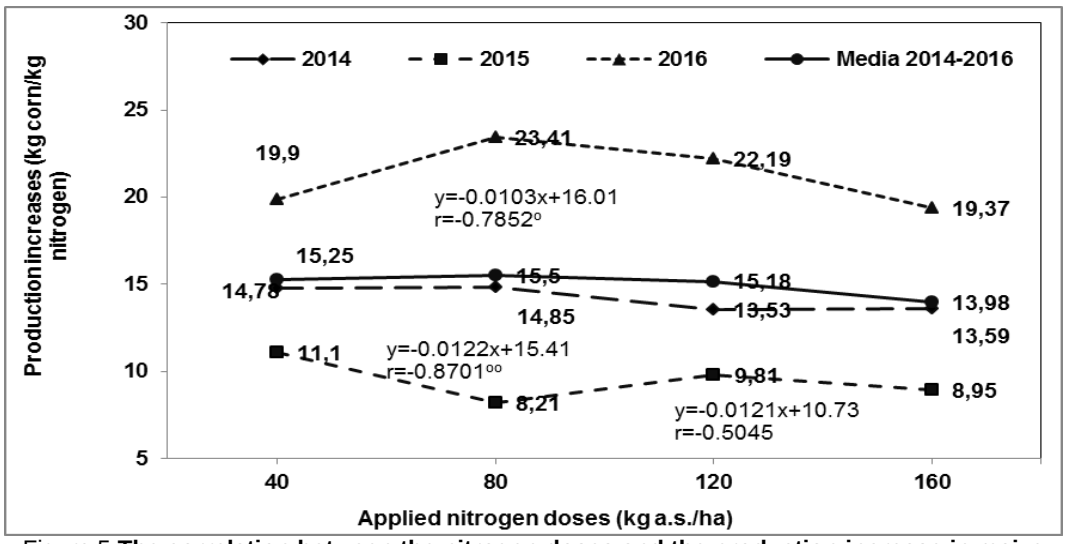


Figure 5 **The correlation between the nitrogen doses and the production increase in maize achieved with 1 kg of nitrogen fertilizer, Secuieni 2014 - 2016**

Additional costs have been incurred in applying nitrogen fertilizers between 267 lei/ha (N_{40}) and 866 lei/ha (N_{160}). Expenditure incurred with application of one kg of nitrogen a.s. were between 5.4 lei/kg N at N_{160} dose and 6.67/kg N at N_{40} dose.

The income obtained (2014-2016) by applying one kg of nitrogen were of 6.57 lei at N_{160} dose and 7.29 lei at N_{80} dose. The profit rate was of 4.58% at N_{40} dose and 9.04% at N_{120} dose (*table 4*).

Table 4

Technical - economic indicators obtained from nitrogen fertilization in maize, Secuieni 2014 – 2016

Nr. crt.	Specification		UM	Applied nitrogen dose				
				N_0	N_{40}	N_{80}	N_{120}	N_{160}
1	Production of corn grains		kg/ha	6183	6793	7423	8005	8419
2	The production increase obtained at the fertilizer application		kg/ha	-	610	1240	1822	2236
3	The marginal increase achieved in the application of 1 kg of nitrogen a.s.		kg b/kg N	-	15.25	15.50	15.18	13.98
4	Value	Main production (Prod. x 0.47 lei)	lei/ha	2906	3191	3489	3762	3957
		d. c. val. Of the production increase obtained by nitrogen ferilization (increase x 0.47 lei)	lei/ha	-	286	583	856	1051
5	Income obtained by application of one kg of nitrogen a.s.		lei/kg N	-	7.16	7.29	7.13	6.57
6	Costs	Total	lei/ha	2784	3051	3251	3450	3650
7		d. c. expense supplement at nitrogen fertilization	lei/ha	-	267	467	666	866
		d.c. expense with the application of 1 kg of nitrogen a.s.	lei/kg N	-	6.67	5.84	5.55	5.41
8	Profit earned (Income - Expenses)		lei/ha	122	140	238	312	307
9	Profit obtained with one kg of nitrogen a.s.		lei/kg N	-	0.49	1.45	1.58	1.16
10	Profit Rate (Profit / Expenses) x 100		%	4.38	4.58	7.32	9.04	8.41

On average the total costs of applying fertilizer to corn (2014-2016) were between 3051 lei/ha (N_{40}) and 3650 lei/ha (N_{160}).

The income obtained on average on corn (2014-2016) was of 3191 lei/ha (N_{40}) and 3957 lei/ha at N_{160} dose.

The profit obtained at corn on average (2014-2016) by the application of nitrogen fertilizers was between 140 lei/ha at N_{40} dose and 312 lei/ha at N_{120} dose (*figure 6*).

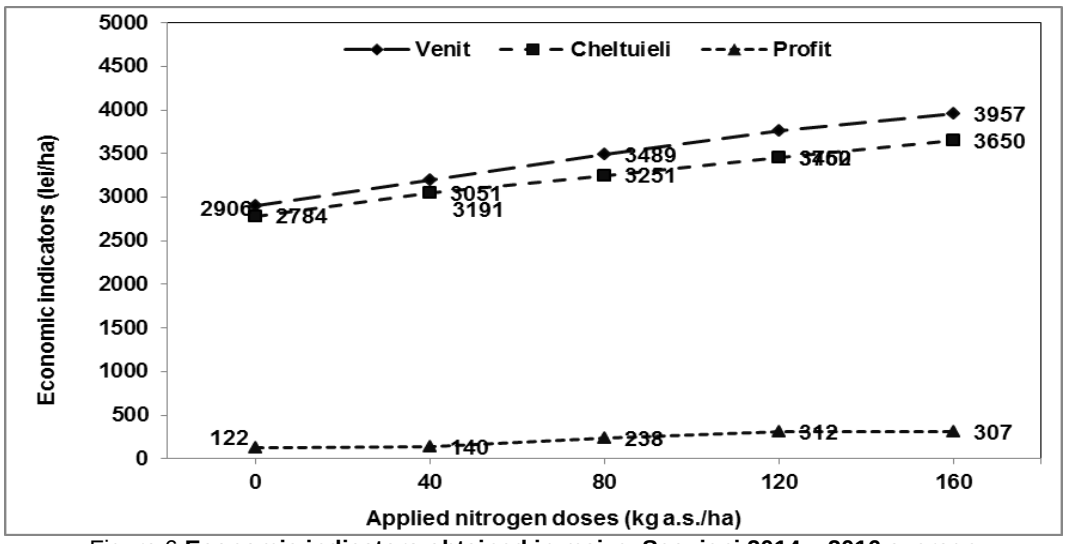


Figure 6 **Economic indicators obtained in maize, Secuieni 2014 – 2016 average**

CONCLUSIONS

The climatic conditions have influenced the level of achieved yield;

The average yields obtained at maize during 2014-2016 period ranged from 6183 to 8419 kg/ha;

The application of nitrogen fertilizers has yielded average production increases (2014-2016) of 610 - 2236 kg/ha (10 - 36%);

Marginal production increases at the application of nitrogen fertilizers had values of 15.25 - 13.98 kg grains/kg N a.s .;

The profit obtained by applying nitrogen fertilizers ranged between 140 - 312 lei/ha and the profit rate fluctuated between 4.58 - 9.04%.

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