THE INFLUENCE OF NITROGEN FERTILIZATION ON THE YIELD OF CIPRIAN WINTER WHEAT VARIETY

V. BUCUR[1]; Alina Laura AGAPIE[2]; J. CRNOBARAC[3]; N. M. HORABLAGA[2]; Georgeta POP[1].

[1] Banat's University of Agricultural Sciences and Veterinary Medcine „King Michael I of Romania" from Timisoara, Romqnia;
[2] Agricultural Research an Developement Station Lovrin, Romania;
[3] University of Novi Sad, Serbia.
Corresponding author: vukasin.bucur@gmail.com

Abstract. *Winter wheat is one of the most important crops of our country and of the Western or the Banat's Plain, where it covers on average around 200.000 ha of the tillable land and accounts for roughly 10% of the total national area covered by this crop every year (IMBREA, 2014). This paper aims to highlight the correlation of the yield quantity and the fertilization levels of nitrogen on the Ciprian winter wheat variety, in the pedo-climatic conditions of RADS Lovrin in between 2015-2017 years. For this trial we used the following nitrogen graduations: N_0 - control, which yielded an average of 5299 kg/ha, N_{30} - with an average yield of 5988 kg/ha, N_{60} with 6505 kg/ha, N_{90} with 7030 kg/ha average and N_{120} with average yield of 7114 kg/ha, respectively, for both experimental years. The results for each variant ware obtained using the analysis of variance method and they are consistent with existing data on the subject matter.*

Keywords*: winter wheat, yield, nitrogen, fertilization.*

INTRODUCTION

Wheat is one of the most important cereals, with a great share in the food industry, is considered basic food for a big proportion of the world's population (35-40%) and is the second plant cultivated worldwide as a surface area after rice, thusly heaving great meaning for our country (BÎLTEANU, 2003). For the past 50 years in Romania, the areas cultivated with wheat varied quite a lot, with a maximum of 3.04 million hectares in 1962 and a minimum of 1.42 million hectares in 2003, but also the average yield per hectare fluctuated significantly, between 1.29 to/ha in 1964 and 3.66 to ha/ha in 2011 (FAOSTAT, 2016). In the western part of Romania, the Banat's Plain, where our study takes place, about a quarter of the tillable land is covered by this crop each year (IMBREA, 2014) and this fact attributes to it's economical importance.

Besides the economical standpoint and it's nutritional values there are some technical advantages to this crop such as: suitable climatic conditions, crop rotation, total mechanization of the work and relatively high yields. Winter wheat is usually preferred in this region due to higher yields primarily and spring varieties are sown only if the autumns are very wet and the sowing cannot be done.

Wheat is particularly pretentious to fertilization due to a radicular system that explores a low volume of soil, and has a weaker power of solubilization and absorption of nutrients. Wheat consumes relatively small amounts of nutrients. For a production of 5000 kg/ha of grain per hectare and the corresponding secondary production, wheat consumes: 114 kg of nitrogen, 57 kg of phosphorus and 107 kg of potassium (HERA, 1980, cited by POP, 2007), resulting in a specific consumption per 100 kg of grains and straw of 2.28 kg nitrogen, 1.14 kg phosphorus and 2.14 kg potassium.

Our aim for this study is to determine the influence of fertilization, specifically that of nitrogen, on the production of grains in the Ciprian wheat variety under climate and soil conditions of the Banat's Plain in Timis County and asses an optimal fertilization system for wheat to increase the yield at minum cost.

MATERIAL AND METHODS

The biological material taken into study is the winter wheat variety Ciprian, developed and produced for commercialization by the Lovrin Agricultural Research and Development Station, a winter wheat variety certified in 2003, with a 236 days vegetation period, suitable for bread and bakery belonging to B1 quality class. Its genetic potential is of 7-8 t/ha grain yield and averaged 5520 kg/ha on 12 testing sites from different locations.

This study took place on ARDS Lovrin's research fields under a long-term experience (since 1967) on a weakly-glazed chernozem with a pH in H_2O between 6.2 and 6.9, a mobile P content between 6.2 and 12.5 ppm, mobile K content between 200 and 300 ppm and an average humus content of 3.5%. Average rainfall throughout the year is 500 to 600 mm and the averege temperature is 10.8°C.

The expirimental field is organized in subdivided plots placed in a randomized block with three repetitions. The area of one plot is 36 m^2 (9m x 4m) and trhe harvested area of a plot is 24 m^2 (8m x 3m).

In this paper our focus was mainly on the effects of nitrogen based fertilizares, considering that it has the bigest impact on the yield and constitutes a large proportion of the inputs in terms of spending.

The previous crop was soybean, so there was no need for nitrogen aplication in the fall. In the spring, the nitrogen (in the form of ammonium nitrate 33.5%) was applied fractionatlly 40% at the resumption of the vegetation and 60% at the elongation of the straw. The following graduations of nitrogen fertilization ware tested: N_0 = control - unfertilized, N_{30} = 30 kg/ha N a.s., N_{60} = 60 kg/ha N a.s., N_{90} = 90 kg/ha N a.s., and N_{120} = 120 kg/ha N a.s., where N a.s. is nitrogen active substance. Previous studies have shown that using doses higher then N150 the gain production values are decreasing along with the increasing of the doses (IMBREA, 2008).

The data was statistically anlized using the one way ANOVA (analisys of variance) procedure (SĂULESCU, 1967) which is commonly used in experimental agriculture and was calculated using the production functions developed by (CRISAN, 1975).

RESULTS AND DISCUSSIONS

For the year 2016, the calculated average grain productions per hectare for every variant (Figure 1) range from 3740 kg of grains per hectare for the control (unfertilized) to 5790 kg grains per hectare for the variant 5, fertilized with 120 kg per hectare nitrogen active substance, and we can see that they increase as the dose of applied nitrogen increases.

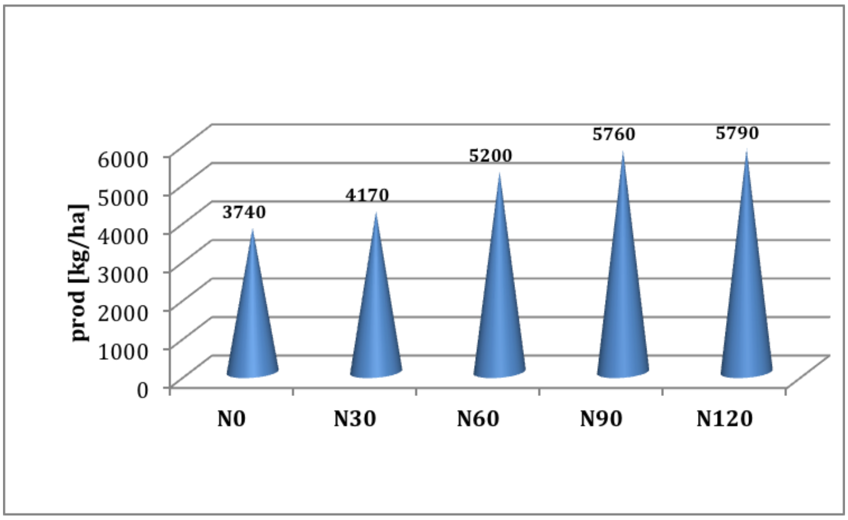

Figure 1. Average grain production per hectare for winter wheat variety Ciprian in the year 2016

Table 1

Analysis of variance for the nitrogen fertilization on grain production
of winter wheat variety Ciprian in 2016

Source of Variation	DF	SS	MS	F test	
				Value	Significance
Replications	2	937240	468620		
Nitrogen N	4	10485240	2621310	3.2743	
Error	8	10485240	800570		
Total	14	17827040			

The analysis of varince for the data collected in the year 2016, presented in the Table 2 above, returned a variation coefficient (vc) of 18.14%, placing the experimental data in moderate variation (10% < vc > 20%), also, the F-test shows that among the 5 nitrogen graduations studied there are no significant differences.

The Student test, Table 2. below, shows that statistically there are significant differences for the variants fertilized with nitrogen levels of 120 kg/ha active substance, which gained 55% more grains versus the control, folowed very closely by the variant with a nitrogen level of 90 kg/ha active substance with 54% gain in grains versus the control.

Table 2

The influence of nitrogen fertilization on grain production
of winter wheat variety Ciprian in 2016 (Student test)

N Graduation	Yield		Difference (kg/ha)	Significance
	Kg/ha	%		
N_0	3740	100.0	-	
N_{30}	4170	111.5	430	
N_{60}	5200	139.0	1460	
N_{90}	5760	154.0	2020	*
N_{120}	5790	154.8	2050	*

DL 5% = 1685 kg/ha; DL 1% = 2451 kg/ha; DL 0.1% = 3683 kg/ha.

For the year 2017, the calculated grain productions (Figure 2) ware greater overall compared to the previous year for al the variants studied, ranging from 6857 kg per hectare for the control to 8438 kg per hectare for the variant fertilized with 120 kg per hectare nitrogen active substance.

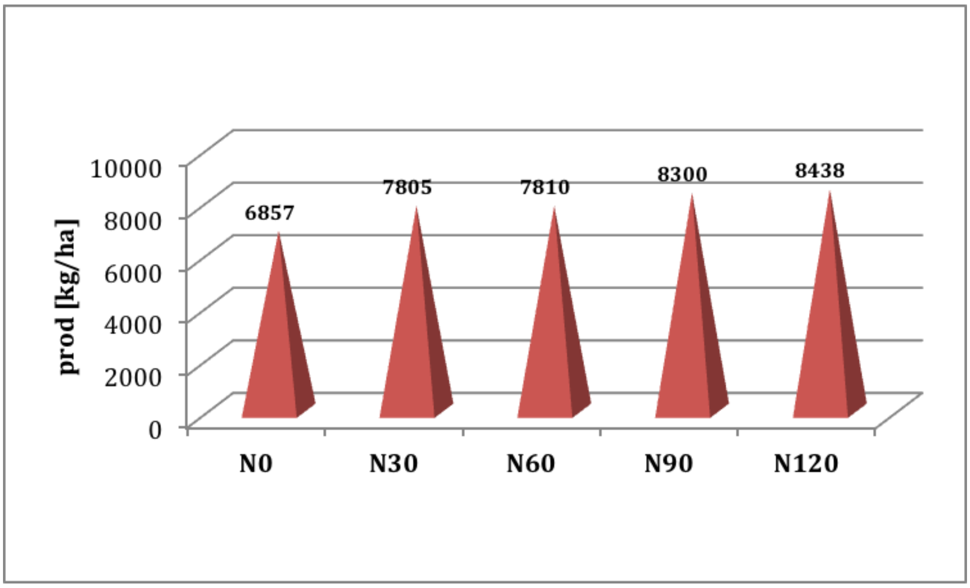

Figure 2. Average grain production per hectare for winter wheat variety Ciprian in the year 2017

Again, there is a positive correlation between the dose of applied nitrogen and the levels of grain production.

Table 3

Analysis of variance for the nitrogen fertilization on grain production
of winter wheat variety Ciprian in 2017

Source of Variation	DF	SS	MS	F test	
				Value	Significance
Replications	2	8604422.933	4302211.467		
Nitrogen N	4	4612932.400	1153233.100	4.5225	*
Error	8	2039998.400	254999.800		
Total	14	15257353.733			

The analysis of variance (Table 3) for the data gathered in the year 2017 returned a variation coeficient (vc) of 6.44% meaning that the experimental data analyzed had a low variation, vc < 10%. The F test for the 5 variants studied also shows that there are significant differences between results.

Table 4

The influence of nitrogen fertilization on grain production
of winter wheat variety Ciprian in the year 2017

N Graduation	Yield		Difference (kg/ha)	Significance
	Kg/ha	%		
N_0 (control - unfertilized)	6857	100.0	-	-
N_{30} (30 kg/ha N a.s.)	7805	113.8	948	
N_{60} (60 kg/ha N a.s.)	7810	113.9	953	*
N_{90} (90 kg/ha N a.s.)	8300	121.0	1443	**
N_{120} (120 kg/ha N a.s.)	8438	123.3	1581	**

DL 5% = 951 kg/ha; DL 1% = 1383 kg/ha; DL 0.1% = 2078 kg/ha.

By analyzing the Student test, presented in Table 4 above, we can state that, versus the control, most prominent result yielded the variant that received 120 kg/ha nitrogen active substance with an increase of 23.3% over the control, followed closely by the variant that received 90 kg/ha active substance nitrogen with 21.0% gain versus the control, both statistically assured as distinctly significant. The variant fertilized with a dose of 60 kg/ha active substance nitrogen had an increase in production of 13.9% versus the control and is statistically assured as significant.

The yields for every studied variant in 2017 are consistent with those of the year before. Also we could draw the conclusion that for higher doses of nitrogen the grain production return is not always significant and further more the differences gained probably do not justify the higher input of nitrogen, like the case of N_{90} and N_{120} variant, where the differences ware very close, for every year studied.

As shown in Figure 3 below, there is a strong pozitive corelation between grain yield and the unilateral application of the nitrogen based fertilizers and this is statistically assured by the values of the calculated coefficients.

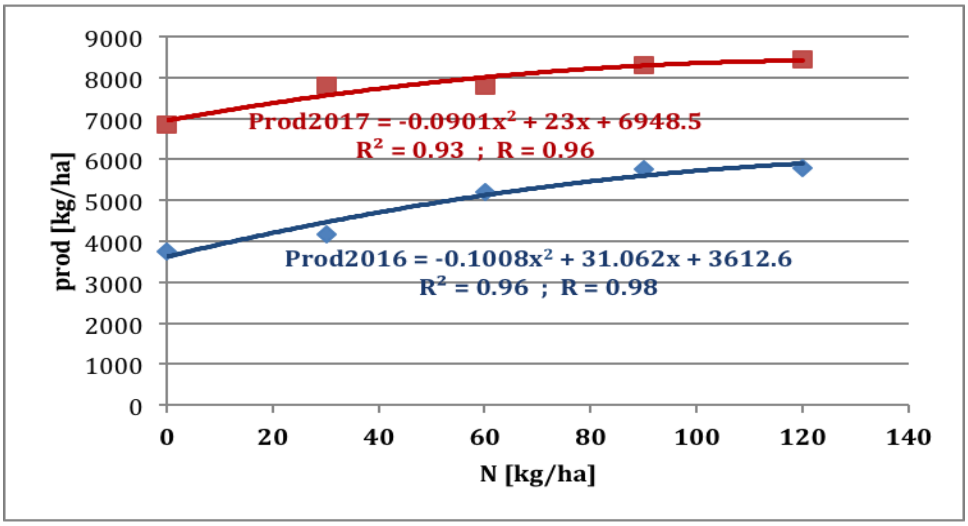

Figure 3. The corelation between nitrogen dose and grain production for the years 2016 and 2017

The noticeable difference in grain production between the studied years is due to the fact that 2016 was an exceptionally wet year with above average rainfall both in quantity and frequency, resulting in a lower exposure to direct sun radiation and ripe conditions for many pathogens and an average production of 4932 kg/ha, whilst 2017 had a considerable precipitation deficit, as a matter of fact, by the time of the harvest, the soil of the experimental plots reached pedological drought, but as it seams, the Ciprian variety managed well use of the water reserve averaging at 7842 kg/ha.

If we factor in this differences we can analyze the interactions between vegetation conditions of the years that our experiment took place wich will become Factor A and the fertilization levels of the nitrogen aplied, Factor B:

Table 5

Analysis of variance for the interaction between nitrogen fertilization and vegetation conditions on grain production of winter wheat variety Ciprian

Source of Variation	DF	SS	MS	F test	
				Value	Significance
Replications	2	1966227.467	983113.733		
Factor A (The year)	1	1966227.467	983113.733	527784.900	
Error (a)	2	7575435.467	983113.733		
Factor B (Nitrogen N)	4	13802570.200	3450642.550	527784.900	**
AB	4	13802570.200	323900.550	0.6137	
Error (b)	16	2039998.400	527784.900		
Total	29	13802570.200			

The two way ANOVA from the Table 5 above returned a variation coefficient (vc) of 11.37% stating that analyzed data had a moderate variation (10% < vc < 20%).

The F values for the A and B factors ware deducted dividing the variations of A and B factors to the variations of their respective errors (a) and (b). The F value for the AB interaction was deducted by dividing the mutual interaction variation with the variation of the (b) error. According to the F test we can state that the vegetation conditions of the experimental year (Factor A) and the interaction between the year and fertilization dose (AxB) have an insignificant action over the grain production in Ciprian variety, and also, we can state that the nitrogen fertilization level has a distinctly significant action over it.

Considering that the main difference between the two experimental years was the level of precipitation, there is a hole suite of factors that derive from this and even if this study did not include them all, we can confidently state that they have a major implication in the process of grain production in the studied winter wheat variety, as it's clearly shown in the Student test presented in Table 6 below:

Table 6

The influence of vegetation conditions on grain production of winter wheat variety Ciprian in the year 2017

Factor A (experimental year)	Grain production yield		Difference in kg/ha	Signification
	Kg/ha	%		
A1 – 2016	4932	100	Control	-
A2 – 2017	7842	159.0	2910	***

DL 5% = 3058 kg/ha; DL 1% = 7053 kg/ha; DL 0,1% = 22455 kg/ha.

The difference in year over year gain in yield is of 59% in 2017 versus 2016 which is statistically assured as very significant, but regardless, if we analyze the productions gained applying a Student test on the data gathered (Table 7) we can conclude that no matter the climatic conditions, for the variant fertilised with N_{60} (60 kg/ha N a.s.) there atre statisticaly assured significant results with a 22.8% gain in grain production, as for the variants with the nitrogen graduations of N_{90} (90 kg/ha N a.s.) and N_{120} (120 kg/ha N a.s.) there ware very significant results at 132.7% and 134.3%, but fairly close to each other, making the highest dose of nitrogen aplied probably not economically feasible.

Table 7

The influence of nitrogen fertilization levels on grain production of winter wheat variety Ciprian in the years 2016 and 2017

Factor B (N graduations)	Yield		Difference in kg/ha	Signification
	Kg/ha	%		
N_0 (control - unfertilized)	5299	100	Control	
N_{30} (30 kg/ha N a.s.)	5988	113.0	689	
N_{60} (60 kg/ha N a.s.)	6505	122.8	1207	*
N_{90} (90 kg/ha N a.s.)	7030	132.7	1732	***
N_{120} (120 kg/ha N a.s.)	7114	134.3	1816	***

DL 5% = 889 kg/ha; DL 1% = 1225 kg/ha; DL 0,1% = 1684 kg/ha.

Furthermore, the interactions between the climatic conditions and increases in production gains caused by the unilateral application of nitrogen based fertilizers maintains its positive correlation trends regardless of climatic or vegetative conditions, assured by the calculated coefficient values, graphically described in the Figure 4,

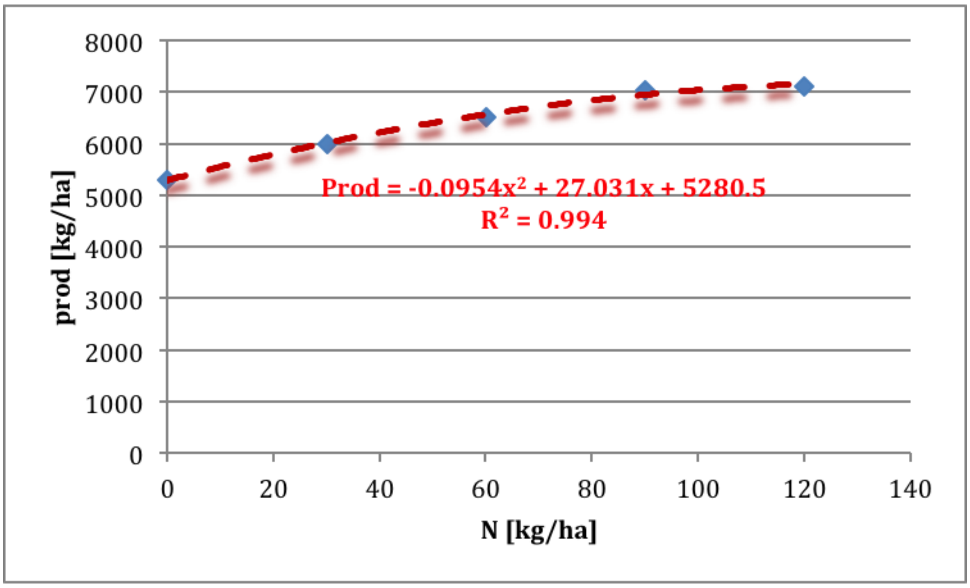

Figure 4. The interaction between nitrogen dose, climatic conditions and grain production for the years 2016 and 2017

and, the interaction between nitrogen level of fertilization and climatic conditions needed for the grain production in Ciprian wheat variety as derived from the Student test applied on the studied data (Table 8),

Table 8

The interaction of nitrogen fertilization levels and vegetative conditions on grain production of winter wheat variety Ciprian in the years 2016 and 2017

AxB interactio		Grain production		Difference	Signification
		Kg/ha	%		
A1	B1 – N0	3740	75.8	mt	
	B2 – N30	4170	84.5	430	
	B3 – N60	5200	105.4	1460	*
	B4 – N90	5760	116.8	2020	**
	B5 – N120	5790	117.4	2050	**
A2	B1 – N0	6857	100	mt	
	B2 – N30	7805	113.8	948	
	B3 – N60	7810	113.9	953	
	B4 – N90	8300	121.0	1443	*
	B5 – N120	8438	123.1	1581	*

DL 5% = 1257 kg/ha; DL 1% = 1733 kg/ha; DL 01% = 2382 kg/ha.

shows that distinctly significant and significant gains in yield ware achieved for the variants with N_{90} (90 kg/ha N a.s.) and N_{120} (120 kg/ha N a.s.), while for the N_{30} (30 kg/ha N a.s.) in both instances proved unsignificant and statistically unasured. We could also draw the conclusion that when the conditions for vegetation are less suitable, the higher nitrogen doses are more meaningfull.

CONCLUSIONS

Based on the gathered data and its statistical interpretation, we can comfortably draw the following conclusions regarding the grain production in Ciprian winter wheat variety:

- Nitrogen is one of the decisive elements in production processes of grain yields for Ciprian winter wheat variety;
- There is a positive corelation between the quantieties of nitrogen based fertilizers and the grain production levels returned;
- Higher doses of nitrogen return significant results in grain yields gains for the Ciprian variety;
- Highest doses of nitrogen N_{90} (90 kg/ha N a.s.) and N_{120} (120 kg/ha N a.s.) are not justified from an economical standpoint, the differences between them being unsignificant;
- Nitrogen fertilization level has a distinctly significant action over grain production in Ciprian variety regardless of the vegetation conditions, but they are crucial in the production process and yield levels.

BIBLIOGRAPHY

BÎLTEANU, GH., 2003 - Fitotehnie, volume I, Ceres, Bucharest, Romania.

CRISAN AND COLABORATORS, 1975 – Metodologia elaborări planurilor de fertilizare cu calculatoarele electronice, Bucharest, Romania.

IMBREA, F., PIRSAN, P., DAVID, GH., BOTOS, L., DURAU, C., 2008 – Influence of fertilizing on yield and grain quality in main wheat cultivars in the Western Plain, Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, ISSN 1843-5246, 65(1), Cluj-Napoca, Romania.

IMBREA F., 2014 - Tehnologii Integrate, vol. I Cereale şi leguminoase pentru boabe, Eurobit, Romania, Timişoara, pp: 57.

POP, G., 2007 – Tehnologii Agricole, Agroprint, Timisoara, Romania, pp: 126-127

ROMAN GH., V., ION, V., EPURE, L.I., 2006 - Fitotehnie – Cereale şi leguminoase pentru boabe. CERES, Bucuresti, Romania.

SĂULESCU, N.A., SĂULESCU, N.N., 1967 – Câmpul de experienţă, Ed. Agrosilvică, Bucureşti, Romania.

WWW.FAO.ORG - Statistics Devision, 2016

WWW.STATIUNEALOVRIN.RO/soiuri_si_hibrizi/