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Considerations Regarding a Comparative Economic Approach on Corn and Wheat Crops on a Representative Soil in Romania

Abstract. The research refers on the production results obtained on corn crops (Turda STAR Variety) and wheat crops (Dumbrava variety) (cultivated following corn crops) conducted on an argyle chernozem soil in Cluj County, Romania. The study exhibits the differentiated fertilization systems (the effect of the nitrogen-phosphorous interaction) involved in obtaining high productions of wheat and corn in the reference area. For corn crops the rate of return, as a mean of all the values that derive from all nitrogen-phosphorous combinations was at a very high level, 80%, with a maximum of the individual values reached at the fertilizing combination N200P160, at which the value of the production increase due to the applied dose, reached the maximum value (6041kg/ha).. For wheat crops the rate of return, as a mean of all the values that derive from all nitrogen-phosphorous combinations was at a medium level, 58%, with a maximum of the individual values reached at the fertilizing combination N200P80, at which the value of the production increase due to the applied dose, reached the maximum value (2658kg/ha). Corn is not as sensitive as wheat to an imbalanced nitrogen-phosphorous (NP) ratio and responds to this through high productions even for nitrogen (N) overdoses that can sustain high and economic corn grain productions per surface unit.

Key words: corn crops, economic optimization, fertilization systems, nitrogen-phosphorous interaction, wheat crops.

Introduction

Sustainable agriculture attracts the application of principles that lead to agriculture technologies which are both technically and economically productive, providing effective solutions for protecting the environment and the consumers. They also insure the productivity of the factors involved and also an optimization of the production components. The production data are obtained from these experiments that target the economic efficiency of differentiated fertilizations on corn and wheat productions and their quality. In this study was tracked the effect of the nitrogen-phosphorous interaction in achieving corn and wheat productions. The production data are obtained from experiments, framed in the "long term experiments system" from ASAS-ICDCPT Fundulea network, which target both the effect and efficiency of differentiated fertilizations on productions and also the impact of fertilizers on the soil fertility evolution, on the quality of the productions obtained (Poruțiu et al., 2013). Economic approaches dedicated to ensure real management of

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fertilizing resources on agricultural crops are going through stages of scientific evidence on the economic efficiency of fertilizer application and then developing a substantiation framework for the optimization of fertilization. These approaches involve first of all defining the concepts and objectives of establishing relevant indicators expressing fertilization efficiency and optimization in order to disseminate the results obtained in the delimitation of differentiated fertilization systems (Otiman, 1979; Otiman, 1987; Toader et al., 2013). In the context of the optimization of soil-plant system, an important scientific and practical role is played by the agrochemical optimization alternatives that harmonize the fertilizing components of the soil with the demands of the vegetal species that can exploit better the production capacity of the soil and genotypes cultivated in order to obtain high vegetal productions that are consumable in large quantities, having superior quality indices, in terms of maintaining an equilibrium in the environment and determining food safety and security (Rusu et al., 2005, Borlan et al., 1994; Hera, 2008). Economic and fertilization optimization objectives were related to investigating by economic analysis, the efficiency indicators in experimental variants, which, based on net revenues (of the increase of production) and their unitary costs assess the rates of return of the technical effect and also on researching on economic efficiency research results supported the appropriateness of performing further studies regarding programming technologies of fertilizer application, that includes based on maximizing net income, detailing specific indicators for the optimization of calculating the NP doses, of their programming the establishment of fertilizer assortment and relevant recommendations related to the rational application of fertilizers (Porutiu, 2014).

Material and methods

The experimental approaches were performed under SCDA-Agricultural Research and Development Station Turda conditions, using the experimental protocol of long term experiences, first located in the agricultural year 1966/1967, for wheat-corn-soy rotation (Haş, 2006).

The varieties of wheat and corn used for the experiments were Dumbrava wheat variety and corn hybrid Turda STAR.

The field experience which underpins the achievement of objectives is a bi-factorial structure that tracks the effect of the NP interaction on wheat: A factor - phosphorus doses (kg P_2O_5/ha): 0; 40; 80; 120; 160, with annual application to wheat; B factor - nitrogen doses (kg N/ha): 0; 50; 100; 150; 200, with annual application to wheat after corn;

Soil from the nutrient experiences: according to soil mapping, pedological and agrochemical study and from the soil quality monitoring results, this soil fits the argic chernozem type, in the pedological class of cernisoils.

Fertilizer used in the experiments: complex fertilizer 20-20-0 is a solid, granulated nitrophosphate, which holds when applied, the effect of the interaction of the two elements from its composition (N·P), here in balanced concentrations and reports (1:1:0) (Hera, 2008).

When harvesting the wheat, production results were collected and for these the absolute increases due to phosphorus application as a fertilizer were calculated.

The processing and interpretation of the data was conducted using the production curves according to polynomial models and they were graphically represented in this study.

When harvesting the corn and wheat, production results were collected and for these the absolute increases due to phosphorus application as a fertilizer were calculated. The economic indicators tracked and studied were economic efficiency indicators: Production increase per surface unit (ha) (ΔQ); Value of the production increase per surface unit (ha) (V_S); Additional costs per surface unit (ha) (Cs); Value of the production increase per 1 leu additional costs (V_S/1 leu Cs) (Otiman, 1987; Chiş and Merce, 1999).

RESULTS

Wheat crops respond positively to the NP levels applied to the soil in the experience, the production effects are at the level of 3-6 tons grains per surface unit (ha) with production differences (increases) that are very distinctly significant for all nitrogen-phosphorous combinations applied (Figure 1, Figure 2).

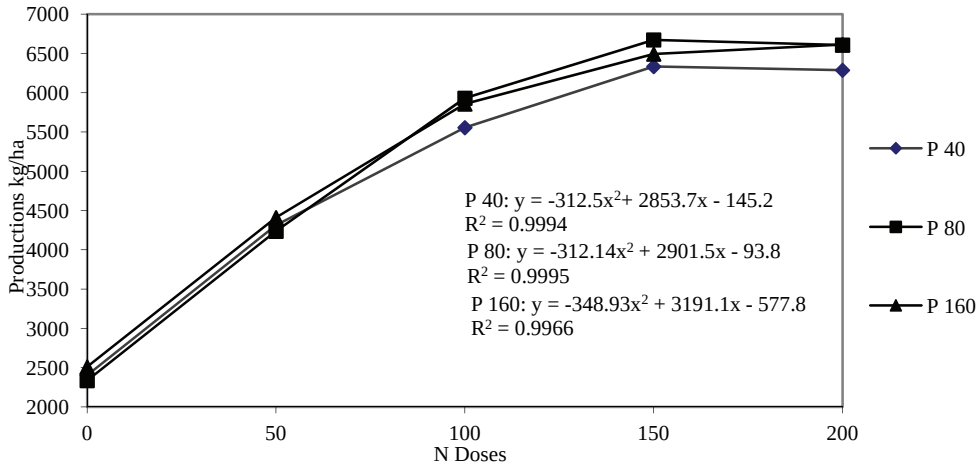

Fig. 1. Effect of differentiated fertilization (NP) on the production of grain (kg/ha) obtained from wheat grown after corn in 2011

Source: own calculation.

The results obtained during 2011 exhibit Dumbrava wheat's variety feature to harness well the nutrients applied, from the small to the medium and to the high NP doses, with capping tendencies of the grain production and of fertilizing increases, at over 100 – 150 kg N/ha for wheat grown after corn.

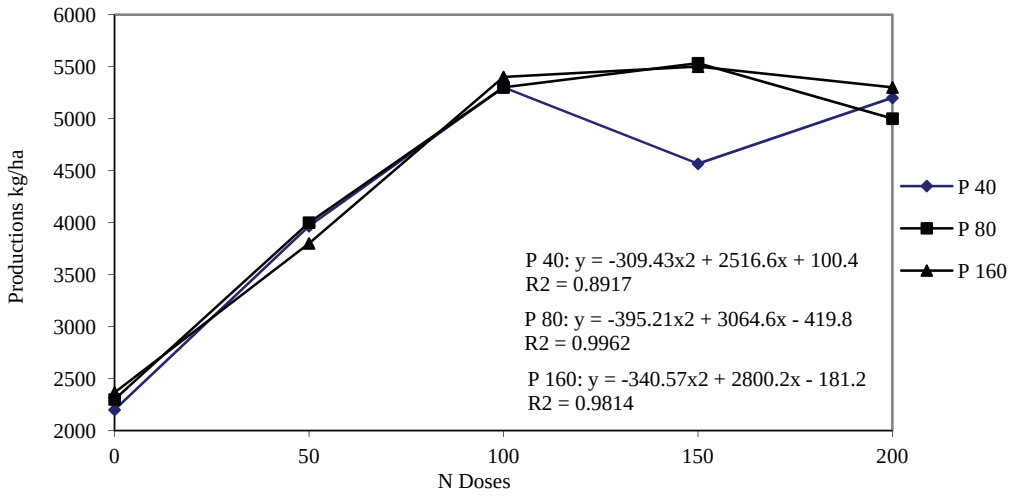

Fig. 2. Effect of differentiated fertilization (NP) on the production of grain (kg/ha) obtained from wheat grown after corn in 2013

Source: own calculation.

The complex application of the NP combinations exhibits multiple possibilities of obtaining productions of 5,5 - 7 t grains/ha for wheat grown after corn, at 100 – 200 kg N/ha and 40 – 160 kg P/ha insured at the same time.

Wheat production results in the experimental years 2011 and 2013 allow a synthesis of their analysis regarding some production effective approaches through differential fertilizing systems based on the NP complex effect, a high priority and often used technology (Table 1).

Table 1. Report on production and maximum increases to the content of a. s./hectare (N+P)

Year	Crop	Maximum production (kg/ha)	NP Dose	Dose sum N+P	Production/NP dose	Prod. Dif. (M)/NP dose
2011	Wheat after corn	5533	N150P80	230	24	6,1
2013	Wheat after corn	6945	N150P120	270	26	5,2
Mean	Wheat after corn	6239	N150P100	250	25	5,6

Source: own calculation.

Technical results obtained as the mean of the years 2011 and 2013 prove the possibility of obtaining maximum yields of wheat, Dumbrava variety, of 6945 kg/ha using N150P106 fertilizer effort (crop after corn). Corn crops have a much differentiated response to the effect of applying fertilizers than wheat. First, only the results in 2011 confirm regularities in the influence of NP factor on the grain production or significant influences of the N and P factors (Figure 3, Figure 4).

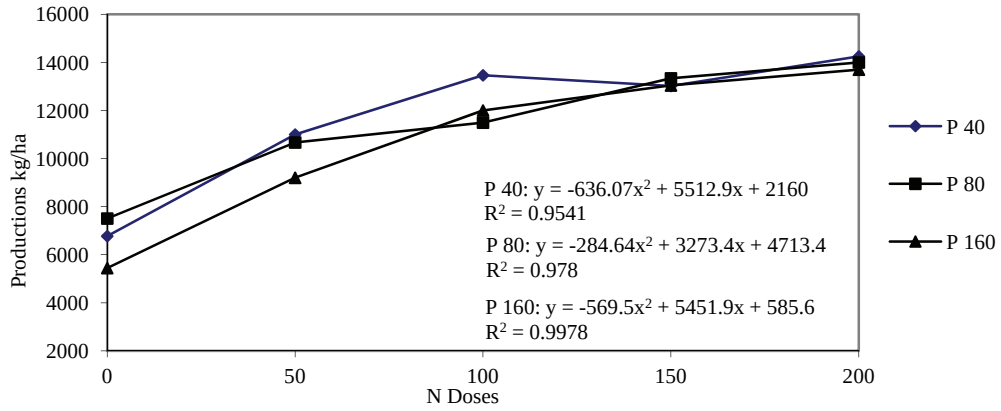

Fig. 3. Effect of differentiated fertilization (NP) on the production of grain (kg/ha) obtained from corn grown after wheat in 2011

Source: own calculation.

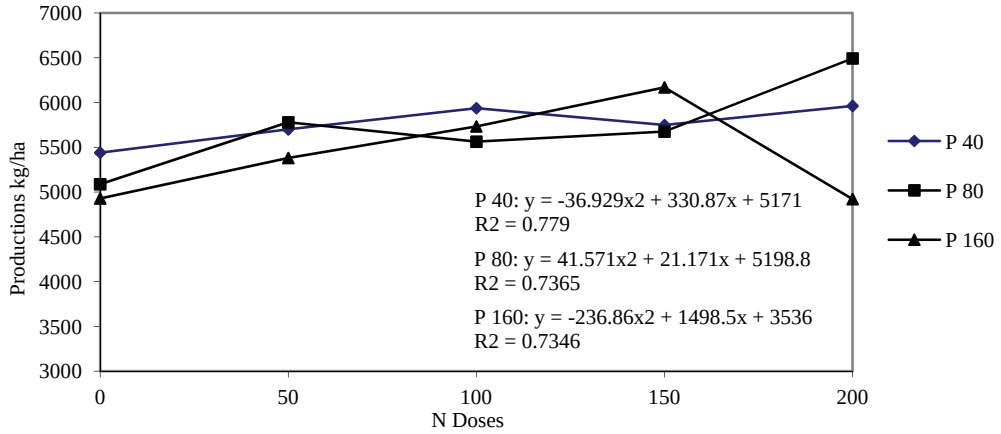

Fig. 4. Effect of differentiated fertilization (NP) on the production of grain (kg/ha) obtained from corn grown after wheat in 2013

Source: own calculation.

Table 2. Report on production and maximum increases to the content of a. s./hectare (N+P)

Year	Crop	Maximum production (kg/ha)	NP Dose	Dose sum N+P	Production/NP dose	Prod. Dif./NP dose
2011	Corn	13696	N200P160	360	38	2,0
2013	Corn	6493	N200P80	280	23	2,5
Mean	Corn	10093	N200P120	320	31	2,2

Source: own calculation.

Table 3. Economic efficiency indicators for wheat grown after corn in 2011(Vs; Cs; Vs/1 leu Cs) (lei)

N	Economic efficiency indicators	P →	0	40	80	120	160	Mean
0	Vs							
	Cs	–	–	–	–	–	–	–
	Vs/1 leu							
50	Vs		900	1766	1700	1300	1433	1420
	Cs		644	943	1100	1752	1390	1166
	Vs/1 leu		1.39	1.87	1.54	0.74	1.02	1.31
100	Vs		1500	3100	3000	2700	3033	2667
	Cs		920	1235	1424	1571	1759	1382
	Vs/1 leu		1.63	2.51	2.1	1.71	1.72	1.93
150	Vs		1800	2366	3233	2700	3133	2646
	Cs		1158	1414	1660	1801	2034	1613
	Vs/1 leu		1.65	1.67	1.94	1.49	1.54	1.66
200	Vs		2166	3000	2700	2166	2933	2593
	Cs		1402	1663	1844	1987	2252	1829
	Vs/1 leu		1.72	1.8	1.46	1.09	1.3	1.47
Mean	Vs		1592	2558	2658	2217	2633	2332
	Cs		1031	1314	1507	1778	1859	1498
	Vs/1 leu		1.6	1.96	1.76	1.26	1.39	1.59
	Rate of return (Vn; Rr) (lei; %)							
0	Vn							
	Rr		–	–	–	–	–	–
50	Vn		256	823	600	- 452	43	254
	Rr		40	87	54	- 26	3	32
100	Vn		580	1865	1576	1129	1274	1285
	Rr		63	151	110	71	72	93
150	Vn		642	952	1573	899	1099	1033
	Rr		55	67	95	49	54	64
200	Vn		764	1337	856	179	681	763
	Rr		54	80	46	9	30	44
Mean	Vn		561	1244	1151	439	774	834
	Rr		53	96	76	26	40	58

Source: own calculation.

Actually, corn grain production (Turda STAR hybrid) are very variable from year to year, the quantitative results in 2013 are less than half of the productions obtained in 2011. Climate disorders slashed the production of those years. The synthesis of the production results obtained for corn linked to the NP fertilization proves specificity due to this crop and especially a real dependency to the favorable climatic condition of that agricultural year (Table 2).

Based on technical analysis, consistent with the average production results obtained in 2011 and 2013, with all the high variability of the grain production, it is possible to obtain maximum yields of 8128 kg/ha at a complex dose of N183P93. Large differences in production from year to year and the production increases per active substance unit prove the influence of the years (with climatic effects) on the effectiveness of applying fertilizers to corn. From this point of view, only the results in 2011 can be conclusive for a correct technical and economic analysis. For wheat crops efficiency indicators calculated for 2011 and 2013 show levels that prove a higher efficiency of the NP doses (Table 3, Table 4).

Table 4. Economic efficiency indicators for wheat grown after corn in 2013 (Vs; Cs; Vs/1 leu Cs) (lei)

N	Economic efficiency indicators	P →	0	40	80	120	160	Mean
0	Vs	–	–	–	–	–	–	–
	Cs							
	Vs/1 leu							
50	Vs		1053	1373	1368	1231	1368	1279
	Cs		703	840	1111	1244	1416	1063
	Vs/1 leu		1.49	1.63	1.23	0.99	0,97	1.26
100	Vs		1794	2268	2587	2448	2408	2301
	Cs		967	1224	1444	1605	1762	1400
	Vs/1 leu		1.85	1.85	1.79	1.52	1.37	1.68
150	Vs		2337	2828	3121	3154	2867	2861
	Cs		1242	1468	1685	1875	2056	1665
	Vs/1 leu		1.88	1.92	1.85	1.68	1.39	1.74
200	Vs		2541	2795	3074	3026	2952	2878
	Cs		1469	1683	1900	2086	2287	1885
	Vs/1 leu		1.72	1.66	1.61	1.45	1.29	1.55
Mean	Vs		1931	2316	2538	2465	2399	2330
	Cs		1095	1304	1535	1703	1880	1503
	Vs/1 leu		1.74	1.77	1.62	1.41	1.26	1.56
	Rate of return (Vn; Rr) (lei; %)							
0	Vn		–	–	–	–	–	–
	Rr							
50	Vn		350	533	257	- 13	- 48	216
	Rr		49	63	23	- 1	- 3	26
100	Vn		827	1044	1143	843	646	901
	Rr		85	85	79	52	37	68
150	Vn		1095	1360	1436	1279	811	1196
	Rr		88	92	85	68	39	74
200	Vn		1072	1112	1174	940	665	993
	Rr		72	66	61	45	29	55
Mean	Vn		836	1012	1003	762	530	827
	Rr		74	77	62	41	26	56

Source: own calculation.

For corn crops were taken into consideration the efficiency parameters and indicators for 2011 when the productions were constantly of 12-14 tons of grains/ha and annual production increases of 3-7,5 tons grains/ha. For corn, the quantification of the economic efficiency indicators was developed with reference to the framework technology parameters for this crop (according to data from SCDA-Agricultural Reasearch and Development Station Turda) (Tab. 5).

Table 5. Economic efficiency indicators for corn grown in 2011 (Vs; Cs; Vs/1 leu Cs) (lei)

N	Economic efficiency indicators	P →	0	40	80	120	160	Mean
0	Vs	–	–	–	–	–	–	–
	Cs							
	Vs/1 leu							
50	Vs		3653	4014	3004	3695	3571	3587
	Cs		3068	3068	3068	3068	3068	3068

	Vs/1 leu	1.19	1.3	0.97	1.2	1.16	1.16
100	Vs	5289	6357	3786	6407	6232	5614
	Cs	3068	3068	3068	3068	3068	3068
	Vs/1 leu	1.72	2.07	1.23	2.08	2.03	1.83
150	Vs	4813	5929	5540	6049	7220	5910
	Cs	3068	3068	3068	3068	3068	3068
	Vs/1 leu	1.57	1.71	1.8	1.97	2.35	1.88
200	Vs	6275	7099	6167	7579	7141	6853
	Cs	3068	3068	3068	3068	3068	3068
	Vs/1 leu	2.04	2.31	2.01	2.47	2.55	2.28
Mean	Vs	5008	5850	4624	5933	6041	5491
	Cs	3068	3068	3068	3068	3068	3068
	Vs/1 leu	1.63	1.85	1.5	1.93	2.02	1.43
	Rate of return (Vn; Rr) (lei; %)						
0	Vn	–	–	–	–	–	–
	Rr						
50	Vn	585	946	- 64	627	503	519
	Rr	19	30	- 2	20	16	17
100	Vn	2221	3289	718	3339	3164	3546
	Rr	72	107	23	108	103	83
150	Vn	1568	2861	2472	2981	4152	2807
	Rr	51	93	80	97	135	91
200	Vn	3207	4031	3099	4511	4773	3924
	Rr	105	131	101	147	155	128
Mean	Vn	1895	2782	1556	2865	3148	2449
	Rr	62	90	40	93	102	80

Source: own calculation.

Production and economic results for corn crops from 2011 are reference for the ones obtained in 2013 (climatically unfavorable) stating that due to thermic excess the results from 2013 were not significant regarding the fertilization effect. Corn grain production obtained in 2013 did not even represent 50% of the ones registered in 2011.

The research on the situation of optimum doses show that on an argic chernozem type of soil, the essential and recommended element is nitrogen. Corn crops responded to the application and even overdosage of nitrogen – which can sustain high and economical productions per surface unit.

Summary

It was proven to be essential the effect of nitrogen-phosphorous interaction for corn and wheat crops, followed by the individual action of nitrogen and less of the phosphorus. The variation and variability of the effect of the factors (x_1-P and x_2-N) were at a high level, production results being much different between 2011 and 2013. The most favorable year in terms of climate was 2011, and in 2013 excess heat (during the decisive pheno-phases of crops) caused lower results. In the set of the mentioned alternatives of fertilization with the mentioned doses, grain yields can be obtained of 5,5-6,5 t/ha for wheat crops, Dumbrava

variety, on an argic chernozem. In 2011, Turda STAR hybrid responded with grain yields of 12-14 t/ha, with increases in NP interaction accounted for only ½ and over half of the grain production. This hybrid harnessed the NP interaction, at average and high doses of both nutrients. In 2013 were reported some effects of fertilizers, but exhibited erratically and without statistical support. Economic analysis of the results of differentiated fertilization highlights high economic variability of the combinations of x_1 (P doses) and x_2 (doses of N). This variability occurs based on the level of production, the level and value of production increases obtained, equally important and essential, from the amount of additional costs due to fertilization. The rates of return of fertilization on corn and wheat crops in 2011, show a high efficiency of complex measures of NP and even of the primarily application of nitrogen. With high levels of production of 12-14 t grains/ha and increases of 4-6 t/ha due to the application of some NP combinations, the rates of return are very high and positive feedback justifies such activities. Optimum doses insure and forecast the production levels that stood of the productions that have derived from the results and technical analysis of corn productions. The economic analysis, in which some calculations that show numerical and percentage indicators of this field were made, is capable of also differentiating the technologies that can be applied to prevent fertilization formulas, such as „widespread formulas" and can bind technological efforts, by costs and results, to the rational technical and economic feature.

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