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INFLUENCE OF FERTILIZATION ON SOIL FERTILITY AND PRODUCTION ON LAND AFFECTED BY DEGRADATION

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Abstract

Soil fertilization and fertility are terms that reflect some of the most influential factors on agricultural production. Corollary to this principle, the paper is intended to be a preliminary study focusing on the use of fertilizers in different doses and reports for agricultural crops in order to improve soil fertility and produce high yields. The experience organized on areas affected by soil degradation took place over two years, and the results obtained prove that the fertilization and modification decision was one scientifically correct and led to superior production in comparison to the unfertilized sample.

Key words*: fertilization, fertility, fertilizer, degraded soil.*

INTRODUCTION

The soils in Romania as well as those from different European countries are in a continuous process of degradation. Worldwide, the decline in soil fertilization can be noticed, 60% of the soils having low or very low fertility, 29% moderate fertility and only 11% high fertility (Hera, 2002). The decline in soil fertility is produced over time as a result of different phenomena and anthropogenic factors. One of the soil degradation factors in Romania is soil reaction. Particularly, the acidic reaction of soils present in our country's soils is considered to be of strong pH or moderate acid, spreading on 28% of the agricultural area. In the case of strong acid pH, at values below 5.8, in these soils there is also aluminum, often above the limit of phytotoxicity (Davidescu, 1981).

The soils affected by degradation, under the influence of acid reaction, are deficient in macro-elements. They undergo different processes (fixation and relegation) and the mobile forms become totally insufficient for normal plant nutrition.

The paper presents the results of a field experience on a soil surface affected by phenomena of acidification, as a result of the fertilizations, on the one hand analysing their impact on the state of ensuring the soils with nutrients and on the other hand being interested in their effect on the production.

MATERIALS AND METHODS

In order to analyse the impact of fertilizers on the soil fertility status, in 2016, an experience on degraded chernozem cambic soil was organized in a site belonging to a family association in Letcani, Iasi County.

The territory under analysis has an area of 20.7 ha and the soil under analysis has a pH between 5.4 and 5.8, respectively, a strongly acidic reaction. The initial soil condition was poor for assimilable nitrogen but also for phosphorous and assimilable potassium.

For fertilizations there were used urea (46.6% a.s.) as nitrous fertilizer, fractionally administered, concentrated superphosphate (45% a.s.) as a phosphate fertilizer and 50% potassium salt as potassium fertilizer.

The fertilizer doses have been set according to the expected harvest and soil condition with the three macro elements, namely IN, P-AL and K-AL.

Experience has been carried out over two years, in a wheat-maize rotation.

For the maize crops, the nitrogen factor N had graduations: 50, 100, 150, 200 kg/ha, phosphorus factor - P - 40, 90, 140, 190 kg/ha, and potassium - 60, 110, 160, 210 kg/ha. At the

wheat culture, the graduations were: N - 40, 80, 120, 160, for P - 30, 70, 110, 150 and for K - 50, 100, 150, 200 kg/ha a.s.

In the autumn of 2015, 60 t/ha of manure were handled and the calcareous fining was done using 120 t/ha of $CaCO_3$.

At the laboratory dosages there were determined: pH, potentiometric method, ammoniacal forms - colorimetric method with Nessler reagent and nitric form, colorimetric method with phenol 2.4 disulfonic acid, phosphorus - colorimetric determination with $SnCl_2$ and accessible potassium, flame photometry method.

RESULTS AND DISCUSSIONS

In the climatic conditions of Letcani-Iasi, the optimization of vegetation factors at wheat and maize was considered appropriate to be done by a balanced fertilization system, which would lead to the improvement of soil fertility status, but also to the obtaining of stable productions.

From the analysis of data regarding the fertilizer application, on the state of insurance with mobile forms of soil nutrients in wheat culture (Table 1), it is found that they increase in relation to the dose and the association of fertilizers. Applied unilaterally, the nitrogen yields increases from 18 ppm in the unfertilized control variant to 41 ppm for the N_{160} variant, which is optimal (Davidescu, 1980). In combination with phosphate fertilizers, the nitrogen evolves to 47 ppm for the $N_{160}P_{150}$ variant, while the phosphorus increases from 12 ppm P-AL unfertilized variant to 35 ppm, the $N_{160}P_{150}$ variant, a value considered by the specialized literature as the optimal assurance, for field crops.

Fertilizing with nitrogen, phosphorus and potassium makes significant increases in soil macronutrient content, assimilable forms. Thus, with the maximum dose of $N_{160}P_{150}K_{200}$, there is an increase of up to 49 ppm for nitrogen - over optimal, 37 ppm P-AL - slightly over optimal and 204 ppm K-AL - optimal.

For the maize crops (Table 2), the fertilizer doses used improve the soil nutrient assurance condition even more than at the wheat culture. Nitrogen increases from 45 ppm $NH_4^+ + NO_3^-$ - N_{200} variant (normal content) at 52 ppm for the variant in combination with phosphate and potassium fertilizers in doses of $N_{200}P_{190}K_{210}$.

Table 1. The impact of fertilization on the mobile forms of nutrients in the wheat culture

Doze of fert. kg a.s./ha	$NH_4^+ + NO_3^-$ ppm	P-AL ppm	K-AL ppm
N_0	18	12	77
N_{40}	25	13	67
N_{80}	28	14	78
N_{120}	36	13	79
N_{160}	41	15	79
N_0P_0	18	12	77
$N_{40}P_{30}$	29	18	71
$N_{80}P_{70}$	38	22	78
$N_{120}P_{110}$	42	29	79
$N_{160}P_{150}$	47	35	80
$N_0P_0K_0$	18	12	77
$N_{40}P_{30}K_{50}$	33	25	85
$N_{80}P_{70}K_{100}$	40	27	159
$N_{120}P_{110}K_{150}$	43	32	179
$N_{160}P_{150}K_{200}$	49	37	204

The assimilable phosphorus grows in the same way, in relation to the dose administered and in complexation with the nitrogen and potassium fertilizers. There are highlighted progressive increases of this macronutrient of 12 ppm P-AL - unfertilized variant to 39 ppm for binary variants. $N_{200}P_{190}$ and ternara - $N_{200}P_{190}K_{210}$, exceed the optimal concentration by 4 ppm.

Table 2. Impact of fertilizations on the assimilable forms of nutrients in maize cultures

Doze of fert. kg a.s./ha	$NH_4^+ + NO_3^-$ ppm	P-AL ppm	K-AL ppm
N_0	18	12	77
N_{50}	27	12	77
N_{100}	30	13	78
N_{150}	35	13	79
N_{200}	45	14	79
N_0P_0	18	12	77
$N_{50}P_{40}$	30	17	78
$N_{100}P_{90}$	38	34	80
$N_{150}P_{140}$	44	38	79
$N_{200}P_{190}$	49	39	80
$N_0P_0K_0$	18	12	77
$N_{50}P_{40}K_{60}$	33	20	90
$N_{100}P_{90}K_{110}$	45	28	149
$N_{150}P_{140}K_{160}$	48	33	190
$N_{200}P_{190}K_{210}$	52	39	221

The potassium fertilizer used to raise soil concentration from 77 ppm K-AL - unfertilized variant at 80 ppm - $N_{200}P_{190}$

variant, low soil concentration at 221 ppm K-AL - variant $N_{200}P_{190}K_{210}$, value which surpasses the optimum by 21 ppm.

From the analysis of the results it is clear that, at both wheat and maize crops, the limits of normal concentration of nitrogen, phosphorus and potassium, accessible forms are reached, in the intermediate variants, which explains the synergy between them.

The application of fertilizers, especially those of nitrogen and phosphorus, is one of the most important means of increasing agricultural production. In particular, on these soils affected by acidification processes, an optimal fertilization system implies dependence on pedoclimatic conditions, but also the calculation of optimal economic dosages, leading to high and stable production. Equally, establishing fertilizer assortment and balance fertilizer ratios represent objective necessities, id we take into consideration the deterioration of the fertility status of these soils and a series of unfavourable physical-chemical attributes of these soils, such as a degree of high compaction, an inadequate water capacity, poor aeration porosity, etc.

Analysing the results obtained from fertilizations, we could notice their contribution as a limiting factor, to the order of the size of the crops.

In the two years of the analysis and taking into account the different climatic conditions of the area, the average production obtained without application of fertilizers was at the level of 1520 kg/ha in wheat and 1950 kg/ha in maize culture (Tables 3, 4)

The administration of singular nitrogen has led to relatively small increases at the wheat culture (Table 3). These increases have progressively increased up to a dose of 120 kg/ha a.s., when the production flattens. In combination with phosphorus, the nitrogen leads to higher yields of 120 kg/ha N and 110 kg/ha P, providing a yield of 695 kg/ha harvest. The relationship of inter-conditionality and synergism of the three fertilizing elements, nitrogen, phosphorus and potassium, results in 120 kg/ha N, 110 kg/ha P and 150 kg/ha K, to produce maximum yields of 2375 kg/ha, with a crop yield of 855 kg/ha. However, the highest production yield kg/kg of administered fertilizer a.s. can be noticed at the unilateral application of nitrogen, of 4.46 kg gain/kg of fertilizer in the case of 120 kg/ha a.s.

Table 3. Impact of fertilization on yields of wheat crops

Variant	Production kg/ha	Difference + kg/ha	Production gain Kg/kg s.a
N_0	1520	-	-
N_{40}	1595	75	0.93
N_{80}	1860	340	4.25
N_{120}	2056	536	4.46
N_{160}	1935	415	2.59
N_0P_0	1520	-	-
$N_{40}P_{30}$	1645	125	1.78
$N_{80}P_{70}$	1954	434	2.89
$N_{120}P_{110}$	2215	695	3.02
$N_{160}P_{150}$	2134	614	1.98
$N_0P_0K_0$	1520	-	-
$N_{40}P_{30}K_{50}$	1854	334	2.78
$N_{80}P_{70}K_{100}$	1986	460	1.84
$N_{120}P_{110}K_{150}$	2375	855	2.25
$N_{160}P_{150}K_{200}$	2200	650	1.27

At the maize crops, there is somewhat the same trend. The maximum yields are obtained with the dose of 200 kg/ha and 2518 kg/ha, but also with the variants of $N_{150}P_{140}K_{160}$ and $N_{200}P_{190}K_{210}$, where the production yields are of 649 and 740 kg/ha respectively.

Table 4. Impact of fertilization on productions of maize crops

Variant	Production kg/ha	Difference + kg/ha	Production gain kg/kg a.s.
N_0	1950	-	-
N_{50}	1975	25	0.50
N_{100}	2025	75	0.75
N_{150}	2289	339	2.26
N_{200}	2518	568	2.84
N_0P_0	1950	-	-
$N_{50}P_{40}$	2044	94	1.04
$N_{100}P_{90}$	2090	140	0.73
$N_{150}P_{140}$	2547	597	2.05
$N_{200}P_{190}$	2425	475	1.21
$N_0P_0K_0$	1950	-	-
$N_{50}P_{40}K_{60}$	2167	217	1.46
$N_{100}P_{90}K_{110}$	2220	270	0.90
$N_{150}P_{140}K_{160}$	2599	649	1.44
$N_{200}P_{190}K_{210}$	2690	740	1.23

It is important the fact that, just like at the maize culture, the fertilizing elements can increase the effect, and lead to higher harvests than when single nitrogen is administered.

If another indicator is considered, kg gain/kg of a.s. administered in the wheat culture, the N_{120} variant results in an increase of 446 kg/kg of

a.s., while in maize cultures the administration of 200 kg/ha of nitrogen leads to an increase of 2.84 kg/kg of fertilizer a.s.

CONCLUSIONS

Corollary of the study, it can be stated that in the case of soils with acidification tendency, along with calcareous finishing and organic fertilization, chemical fertilization plays a decisive role in the equilibrium nutrient balance in soil, leading to optimal levels in soils and to obtain relatively stable production.

The administration of singular nitrate fertilizers leads to the production of similar or even higher productions than the administration of fertilizers in the NP relationship. However, it is avoided raising the threshold of nitrogen fertilizers, knowing their action in the sense of acidification of the soil solution.

The export of nutrients with the crops and the adequate non-fulfillment of nutrient requirements according to the specific consumption of the species, causes the crops to flatten after a certain dose of fertilizers.

For wheat production, production is flattened after administration of $N_{120}P_{110}K_{150}$, but the most effective harvest gain kg/kg of fertilizer a.s. administered, the variant $N_{120}P_{110}$, respectively, 3, 08 kg/kg 1 kg a.s.

For corn crops, the maximum yield is obtained with the $N_{200}P_{190}K_{210}$ variant, but the production gain kg/kg of fertilizer a.s. is at the $N_{150}P_{140}$ variant, ie 2.05 kg gain/kg of NP a.s.

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