THE MODIFICATION OF SOME AGROCHEMICAL SOIL INDICES UNDER THE INFLUENCE OF MINERAL FERTILIZATION

F. SALA, Isidora RADULOV, F. CRISTA, Adina BERBECEA

Banat's University of Agricultural Sciences and Veterinary Medicine, Faculty of Agricultural Sciences, Timisoara, Aradului Street, no. 119, RO-300645, Romania,
Corresponding author: florin_sala@yahoo.com

Abstract: *The aim of the research on which the present paper is based was to assess the way in which certain agrochemical indices of the soil are modified under the influence of mineral fertilization. Soil, the main means of production in agriculture, must be considered as a strategic natural resource, which is sustainable if exploited in a scientific way. It can bring its contribution to ensuring food supplies, and food safety. Exploiting agricultural areas by using incomplete or incorrect strategies has serious consequences, both from a quantitative and a qualitative point of view, on soil resources and also on agricultural yields, and the lack of fertilizers or improper use of fertilizers are elements of such a strategy. In our country, agriculture has undergone major changes after 1989. We are talking about a change in the form of ownership, a legislative system that is not a stimulus for farmers, the fact that many landowners are not properly prepared and trained in the matter of efficient use of land, poor endowment with equipment, lack of own financing, the incapacity to access investment funds, etc. The structure of crop plants has undergone quite large changes in Banat Plain, Timiş County, as it has in other parts of Romania. The area cultivated with leguminous plants (annual and perennial) has become much smaller. The predominant crop plants are wheat, maize and sunflower, and then come barley, two-row barley, soybeans, oil rape, sugar beet (less and less cultivated in recent years), with small impact in the realization of sustainable crop rotation. Under these conditions, people mostly use simple rotations wheat-maize or even monoculture, and fertilization is based almost exclusively on mineral fertilizers (in many cases unilateral with nitrogen), with high fluctuation from the point of view of the quantity of active substance from a plot of land to another. That is why the agrochemical characteristics of the soil undergo large modifications, with a negative impact on fertility. The paper presents the results of the research on the changes of the agrochemical indices represented by p*H, N, P, K in the context of an agricultural system based on field crops and a mineral fertilization system with variants which cover different situations met in the agriculture of the reference area, namely Banat Plain.*

Key words: *soil fertility, agrochemical indices, mineral fertilizers, fertilization system, vegetal agricultural systems, correlation*

INTRODUCTION

Data coming from FAO show that the yield increase due to fertilizers is 40 to 60%, with variations from one country to another; therefore fertilizers are an important factor in sustaining the agricultural production, SALA 2008.

In the context of the energetic problems the world is facing, after the maximum reached in 1980-1990 in respect to the quantity of fertilizers used, the present situation shows a global tendency towards decreasing the use of fertilizers, IFA, EFMA, 2007, RUSU et col. 2002.

Agriculture depends on the agricultural lands, and to a certain extent, the productive capacity of the land depends on the way in which agriculture makes use of these resources, namely the soils, DUMITRU 2002, HERA et col. 2002.

Fertilization systems are adapted to all types of agriculture; in the case of conventional agriculture, they are based almost exclusively on synthesis mineral fertilizers, in

correlation with pedo-climatic and technological factors, SALA 2002.

In the reference area, the structure of crop plants is reduced, and on extended areas people use simple wheat-maize rotations, sometimes sunflower as well. Moreover, monoculture is largely spread, which generates unilateral consumption of nutritious elements.

In many cases, fertilization was not correlated with the reserve in the soil, thus resulting unbalanced, sometimes unilateral, fertilization, using only nitrogen, many times the doses being less than the soil needed.

These causes have determined lack of balance in the state of soil fertility, some aspects being revealed by our research.

MATERIAL AND METHOD

During our research, we tested the influence of certain types of mineral fertilizers with basic macroelements (N,P,K), administered in various combinations and doses (unilateral nitrogen fertilization in the form of ammonia nitrogen used with phosphorus and potassium).

The experiences were bifactorial 4x5 in subdivided plots:

Factor A: phosphorus and potassium fertilization:
- $a_1 – P_0K_0$ – control
- $a_2 – P_{50}K_{50}$
- $a_3 – P_{100}K_{100}$
- $a_4 – P_{150}K_{150}$

Factor B: nitrogen fertilization:
- $b_1 – N_0$
- $b_2 – N_{50}$
- $b_3 – N_{100}$
- $b_4 – N_{150}$
- $b_5 – N_{200}$

Our research was carried out on crops of wheat, maize and sunflower, because these cover a significant part of the cultivated land in our area, according to the statistical data of DGA Timiş, using varieties of zonal hybrids for the west of our country.

The natural background for our experiments is specific for Banat Plain, The natural conditions for our experiment are specific to Banat Plain: the soil is cambic faeoziom (cambic chernozem), weakly gleyed, with neutral reaction (*p*H = 6.95-7.1), good supply of humus (H = 3.2), nitrogen index IN = 3.09, high base saturation level (over 85-87%), poor supply of mobile phosphorus (P_{AL} = 17.4 ppm) and average supply of potassium (K = 128 ppm).

The climatic conditions are characterized by average multiannual values of 603.3 mm precipitations and temperatures of 10.9°C. In the period when our research was carried out, the level of rainfall was within the multiannual average, but displayed lack of uniformity over years and decades. As for the temperature, the values we recorded were higher than the multiannual average; by association with droughty periods, in certain decades they resulted in periods of time that were not auspicious for crops.

RESULTS AND DISCUSSION

The fertilizers induce a series of changes in the soil, due to the intensification of physical, chemical and microbiological processes, to the change in consumption by crop plants and due to other processes and mechanisms which take place in the soil. Making use of some agro-physical indices and agrochemical characteristics, we tried to observe certain physical and chemical changes in the soil.

In this context, we determined: soil density (D), apparent density (DA), soil *p*H, total nitrogen content (N_t), mobile phosphorus content P_2O_5, assimilable potassium content K_2O.

The determinations made point to a weak differentiation of soil density after applying fertilizers with phosphorus and potassium.

We registered density values of 2.62 g/cm^3 at 0 to 20 cm in the soil, on unfertilized

land ($N_0P_0K_0$). Increasing the doses of phosphorus and potassium does not bring significant changes in soil density. The values characteristic for factor A are practically equal, between 2.58-2.59 g/cm^3, within the limit of accidental errors admitted.

Nevertheless, applying nitrogen fertilizers determines more obvious changes; in this case the differences between the gradations of factor B are significant. As a result of an increase in the root mass and organic wastes in the soil, especially in the arable layer, the density values decrease from 2.61 to 2.57 g/cm^3.

Apparent density is one of the characteristics which reflect most accurately the degree of soil settling and the organic matter content of the solid state. Any modification in the compactness or the contribution of organic wastes in the soil affects the values of apparent density.

In the surface horizon (0-20 cm), apparent density presents the smallest values, due to the works of energetic mobilization of soil, if we take into consideration the traditional system of land works being practiced (plowing, disking, harrowing, etc). If for the control variant (N_0) the values of the apparent density we registered were 1.25 g/cm^3 (P_0) and 1.27 g/cm^3 (P_{150}), we observed that the bigger the nitrogen doses, the smaller the apparent density values: down to 1.05 (N_{100}) and 1.08 (N_{200}) g/cm^3 respectively.

As for the reaction of soil to the mineral fertilization practiced, we noticed two situations. For the unilateral nitrogen ammonia fertilization, which is used at a large scale in production, we noticed a slight soil acidification, with *p*H values going down from 7.06 for the control variant to 6.80 – 6.84 for variants N_{100}, N_{200}.

In the case of balanced NPK fertilization (with phosphorus and potassium from 100 to 150 kg/ha active substance and the variation among the nitrogen doses from 50 to 200 kg/ha active substance), soil reaction is almost negligible, with *p*H values between 6.94 and 7.00.

The relatively small limits of pH modification both in the case of unilateral nitrogen fertilization and in the case of the balanced NPK fertilization prove good soil plugging capacity. Total nitrogen content N_t ranges from 0.114% for the control variant to 0.159% for variant $P_{150}K_{150}N_{200}$.

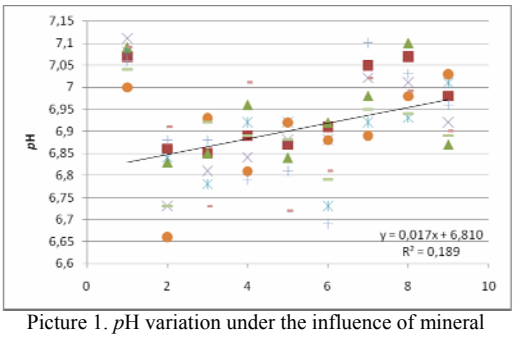
Phosphorus content classifies as among the average values of soil supplies, somewhat smaller in the case of the unilateral nitrogen fertilization (22.26 – 23.50 ppm) as compared to NPK fertilization (26.38 – 31.15 ppm).

Potassium content is within the limits of good soil supply for the control variant 154.56 ppm and oscillates between 166.21 – 178.77 ppm for variants $P_{100}K_{100}N_0$, and $P_{150}K_{150}N_{200}$ respectively.

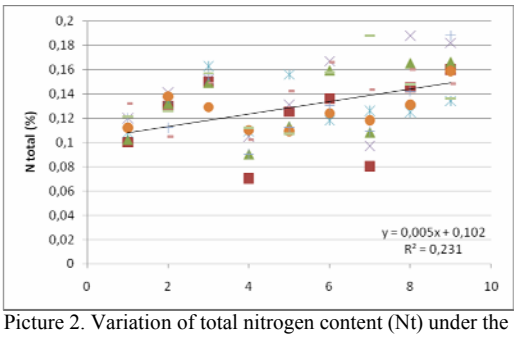
Table 4

The main agrochemical characteristics of gleyed cambic chernozem, observed in a fertilization system which uses chemical fertilizers (2006-2008)

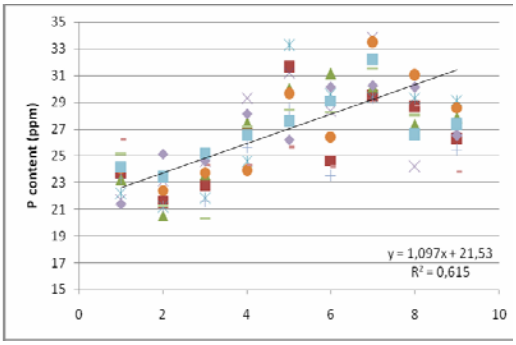
Index determined	Average values per fertilization variant								
	P_0K_0 N_0	P_0K_0 N_{100}	P_0K_0 N_{200}	$P_{100}K_{100}$ N_0	$P_{100}K_{100}$ N_{100}	$P_{100}K_{100}$ N_{200}	$P_{150}K_{150}$ N_0	$P_{150}K_{150}$ N_{100}	$P_{150}K_{150}N_{200}$
*p*H (in H_2O)	7.06	6.80	6.84	6.88	6.85	6.82	6.99	7.01	6.94
Total nitrogen (%)	0.114	0.127	0.150	0.098	0.124	0.144	0.121	0.150	0.159
P-AL (ppm)	23.50	22.26	23.25	26.38	29.20	27.52	31.15	28.40	26.89
K-AL (ppm)	154.56	155.26	158.40	166.21	169.92	167.21	170.32	171.02	178.77



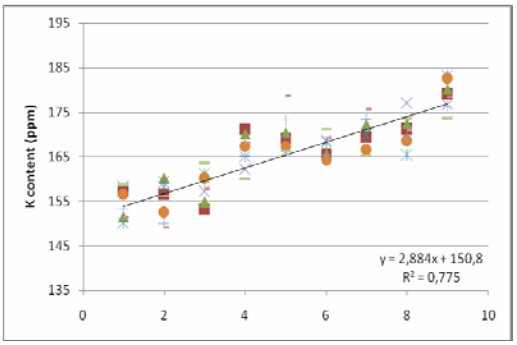
Picture 1. *p*H variation under the influence of mineral fertilization



Picture 2. Variation of total nitrogen content (Nt) under the influence of mineral fertilization



Picture 3. Variation of mobile phosphorus under the influence of mineral fertilization



Picture 4. Variation of assimilable potassium content under the influence of mineral fertilization

CONCLUSIONS

The research revealed the differentiated influence of types and doses of fertilizers (used in various combinations) on the main agrochemical characteristics of the cambic chernozem at TimiSoara Didactic Station.

Unilateral nitrogen administration in the form of nitrogen ammonia determines a slight acidification of the soil; this phenomenon can become even more obvious with the passing of time. We also registered a decrease in the supply of phosphorus and potassium in the soil, as well as lack of balance in plant nutrition and low yields.

Complex NPK fertilization maintains a high level of soil-plant balance regarding the consumption of nutritious elements and ensures balanced nutrition for crops.

BIBLIOGRAPHY

1. DUMITRU M., Mineral fertilizers and sustainable crop production in Romania, CIEC Proc. Suceava, Bucharest p. 63-75, 2002.
2. HERA Cr., SCHNUG E., DUMITRU M., DORNEANU A., Role of fertilizers in Sustainable Agriculture, Ed. CICEC, Bucuresti, 2002.
3. MULDER, J., CRESSER M.S, 1994, Soil and Soil Solution Chemistry in Biogeochemistry of small catchments: a tool for environmental research, pp 107-131, Ed.J.Wiley&Sons Ltd, USA.
4. RUSU M., MARILENA MARGHITAS, TODORAN A., BAIUTIU C., MUNTEANU V., OROIAN I., DUMITRAS ADELINA – Probleme ale optimizarii agrochimice a solurilor, Fertilizarea echilibrata a principalelor culturi in Romania, pag. 209-216, Ed. Agris, Bucuresti 2002.
5. SALA F., Introducere în sisteme de agricultură, Ed. Solness, Timişoara, 2002.
6. SALA F., Agrochimie, p. 51-62, Ed. Eurobit, 2008 Timişoara, ISBN 978-973-620-298-8.