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MODELING OF THE NITRIFICATION PROCESS IN A SOIL IN CĂLĂRAŞI COUNTY

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Abstract

Quantifying the best possible the nitrification of nitrogen in the soil remains an important issue for the sustainable agriculture and for the environmental protection. The aim of the study was to evaluate in the laboratory the influence of some factors: temperature, humidity and amount of manure incorporated in the process of nitrification in a soil mainly in Călăraşi county, on a cambic chernozem. The results of the laboratory analyses were statistically processed by the analysis of variation. In the experimental model, the nitrogen dose increase, given to the soil, had no effect on the nitrification capacity. However, the humidity of 100 % nitrification was stimulated even in the case of the sample test, which has not received the ammonium nitrate. Such an observation could be the basis of the observation that in the irrigated fields, the processes of mineralization of organic substance are always high, especially at high doses of mineral fertilizer. It was noticed that the nitrification process was subject to a seasonal dynamics. The nitrification is more intense in autumn, when the conditions are optimal for this process. As a conclusion, the fertilization system has a great influence on the nitrogen nitrification in the soil.

Key words: *ammonium nitrate, cambic chernozem, humidity, nitrification, temperature*

INTRODUCTION

The crop is the main factor depleting soil mineral nitrogen solution [4].
The fertilization with organic and mineral fertilizers are an important way of increasing the content and quality of soil organic substance [11].
The mineral fertilizers rose over time problems, especially on the processes of mineralization (ammonification) and nitrification of nitrogen in the soil. The nitrogenous fertilizers were used in larger and larger amounts in order to increase the production, but they led over time to the increase of the amount of nitrate in the soil, agricultural products and hence water. [6].
Since the soil organic substance can provide the plant with the mineralization processes large amounts of nitrogen, it increasingly requires further research on finding ways to optimize the nitrogen regime in order to ensure a greater efficiency of the mineral fertilization [5].
The transformation in the soil of nitrogen fertilizers, the nitrogen passes from one chemical form to another can result in assimilable mineral nitrogen losses and changes in soil reaction, likely to reduce the effectiveness of these fertilizers [10].
The conversion of nitrogen compounds in the soil is made by means of soil population [9].
The nitrates are the only natural source of nitrogen available for relatively neutral p_H soils in Călăraşi. In optimal conditions for the flora nitrification, the ammonia nitrogen in mineral and organic fertilizers introduced in the soil is rapidly converted to nitrate.
For the pollution control and prevention with mineral nitrogenous substances, directives were adopted both at European and national level, which aim to oriented to a sustainable agriculture and a national code of best agricultural practices for all Romanian farmers [2].

MATERIALS AND METHODS

This research aimed to assess the dynamics nitrification that occurs in a cambic chernozem with increasing doses of mineral nitrogen. I chose this type of soil, because in Călăraşi county, the chernozem occupies 80 % of the agricultural area.

The soil studied was a cambic chernozem with good fertility: 2.6-2.9 % in irrigated soil 2.9-3.1 % in non-irrigated soil; 0.11 to 0.12 % total nitrogen. The soil reaction is characterized by a neutral p_H (6.3 to 7), with small differences in the profile. The buffering capacity of the soil is good. The soil nitrification potential is high, being favored by agrophytotechnical works performed in optimal period, by altering the termo-hidric regime of the soil.

In order to estimate the nitrification process, Waksman incubation method was used of soil incubation in the laboratory under controlled temperature and humidity, eliminating the possibility of loss by leaching of nitrates. Soil samples, collected from the 0-20 cm layer, the three repetitions of the field, were mixed in a mixed sample of the experimental variant and incubated for 21 days in the laboratory [8]. The soil samples were studied in model according to the following scheme [7]:

A.Temperature of incubation, with the following graduations: a_1, 5^0C (early spring); a_2, 20^0C (in spring), a_3, 30^0C (in summer).

B.Capacity of filed for water - C.F.W. (humidity %), with the graduations: b_1 – 40%, b_2 – 80%, b_3 – 100%.

C.Dosis of nitrogenous fertilizer (ammonium nitrate NH_4NO_3, N active substance) with the graduations: N_0, N_{60}, N_{120}, N_{160}, N_{240}, respectively c_1-c_5.

The determination of the nitrate content was made by colorimetric method. The nitrate extraction was done with a solution of K_2SO_4. Nitrate dosing was phenol-disulphuric acid, by which nitrates are bound to nitro-acid phenol-disulphuric, coloured in yellow in alkaline medium. The colour intensity obtained depended on the concentration of nitrates. The maximum extinction was at 410 nm.

The results obtained following the analyses were processed statistically by the analysis of variation.

RESULTS AND DISCUSSIONS

The determinate nitrate amounts are found in tables 1, 2 and 3.

The letters before the numbers separate in alphabetical order the significant decrease of the values in the column, based on the limit difference (L.D.), and those placed after the numbers separate in alphabetical order the significant decrease of the values in the line based on limit difference (L.D.).

Table 1. Influence of incubation temperature of the soil samples depending on humidity (40% C.F.W. – factor B) and chemical fertilizers with nitrogen on the nitrification potential

C/A N	5°C a_1	20°C a_2	30°C a_3	X_c
0 c_1	c -1.23 c	b 1.06 b	c 1.69 a	c 0.51
60 c_2	c -1.28 c	a 1.52 b	b 2.78 a	a 1.01
120 c_3	b -0.98 c	b 1.11 b	a 3.18 a	a 1.10
160 c_4	d -1.6 c	c 0.71 b	a 3.31 a	b 0.81
240 c_5	a -0.67 b	a 1.67 a	c 1.77 a	b 0.92
X_a	-1.15 c	1.21 b	2.55 a	**0.87 c average B**

L.D. A 0.1% = 0,18 L.D. CxA 0.1% = 0,20
L.D. B 0.1% = 0,13 L.D. AxC 0.1% = 0,20
L.D. C 0.1% = 0,11 X_a= average A; X_c= average C

At 40% capacity of field for water (table 1), it was found out: the unique influence of factor A determined the increase of nitrate amounts found in the soil sample in the experimental model, while increasing the temperature of incubation (-1.15 c to 5°C; 1.21 b to 20°C; 2.55 a to 30°C). Value -1.15mg NO_3/ 100g soil means that at 5°C a nitrate consume was made, under a low nitrification process.

Table 2. Influence of incubation temperature of the soil samples depending on humidity (80% C.F.W. – factor B) and chemical fertilizers with nitrogen on the nitrification potential

C/A N	5°C a_1	20°C a_2	30°C a_3	X_c
0 c_1	c-1.34 c	e 1.09 b	d 1.69 a	e 0.48
60 c_2	b-1.12 c	d 2.23 b	c 3.10 a	d 1.40
120 c_3	a-0.52 c	c 2.65 b	b 4.28 a	c 2.14
160 c_4	c-1.42 c	a 5.56 a	a 5.07 b	a 3.07
240 c_5	a-0.49 c	b 3.79 b	a 4.97 a	b 2.76
X_a	-0,98 c	3.06 b	3.82 a	**1.97 b average B**

L.D. A 0.1% = 0,18 L.D. CxA 0.1% = 0,20
L.D. B 0.1% = 0,13 L.D. AxC 0.1% = 0,20
L.D. C 0.1% = 0,11 X_a= average A; X_c= average C

As regards the separate influence of the factor C (nitrogen fertilizer dose), there were no significant changes in the concentration of nitrates in the soil sample after the incubation.
The positive influence of the temperature of incubation on the nitrification process was observed in all nitrogen doses administered.
The ammonium nitrate administered in the soil subject to incubation did not cause significant changes in the nitrification process.
At 80% capacity of field for water (table 2), the following were found out:
The simple influence of factor A determined, as in the case of 40% in the capacity of field for water, an increase of the nitrate amounts made in the process of nitrification such as: - 0.98 c to 5°C, 3,06 b to 20°C, 3,82 a to 30°C.
The separate influence of factor C (nitrogen fertilizer dose) did not determine significant changes of the intensity of the nitrification process.
The increase of the temperature of incubation proves to be favourable to the nitrification process, regardless the increase of nitrogen fertilizer dose administered to the model.
The influence of increasing the nitrogen dose, regardless the temperature of incubation, of nitrification, was insignificant.
At 100% capacity of field for water (table 3), it was found out that the influence of factors A and C were insignificant. In this case, the influence of temperature on the dose of the fertilizer was also insignificant. The same can be said for the influence of fertilizer amounts to each of the three temperatures of incubation.
In particular, we see that at 100% capacity of field for water, the nitrification process did not vary in intensity depending on the two influence factors. It is possible that the discriminate factor is only insufficient oxygen, knowing that nitrifying bacteria have the role to oxidize the ammonia and that in the conditions of its deficiency, the nitrification process is limited.
As the nitrogen dose decreases, from N_{240} to N_0, the potential for nitrification increased.
This is the proof of the depressive effect of the mineral fertilization with ammonium nitrate on the nitrification process.

Table 3. Influence of incubation temperature of the soil samples depending on humidity (100% C.F.W.– factor B) and chemical fertilizers with nitrogen on the nitrification potential

C/A N	5°C a_1	20°C a_2	30°C a_3	X_c
0 c_1	c 2.67 b	d 4.17 a	e 1.59 c	c 2.81
60 c_2	d 2.57 b	c 4.67 a	d 2.54 b	b 3.26
120 c_3	a 4.19 b	a 5.47 a	b 3.59 c	a 4.42
160 c_4	c 2.84 b	e 3.86 a	c 3.06 b	b 3.25
240 c_5	b 3.41 b	b 4.96 a	a 5.06 a	a 4.48
X_a	3.14 b	4.63 a	3.17 b	**3.64 a average B**

L.D. A 0.1% = 0,18 L.D. CxA 0.1% = 0,20
L.D. B 0.1% = 0,13 L.D. AxC 0.1% = 0,20
L.D. C 0.1% = 0,11 X_a= average A; X_c= average C
Average factor B: 0,87 c (40% C.F.W.); 1.97 b (80% C.F.W.); 3.64 a (100%C.F.W.)

The increased nitrogen dose administered, decreased soil p_H (a soil acidification occurred due to the acidifying effect of this fertilizer). This acidification prevents the nitrification process.

CONCLUSIONS

As a general conclusion on the nitrification process depending on the moisture content of the soil - aerating soil samples during incubation, there is a clear increase from 40% to 100% C.F.W. (0.87 to 40 %; 1.97 to 80 % ; 3.64 to 100 %).
From the data obtained, we can see that the amount of nitrogen fertilizer influenced the nitrification potential. The amount of nitrate increased with the dose of nitrogen fertilizer. The correlation is particularly close to 100% of capacity of field for water. These findings confirm several previous data [3] and they provided the basis of the finding that the capacity of mineralization-nitrification is the most adequate index to assess the nitrogen need for the crops [1].
The nitrates resulting from the oxidation of the ammonia in the soil and of the one added as a mineral fertilizer represent on the one hand, elements of nutrition for other organisms, as well as waste of the nitrification process. In anaerobic conditions produced in

the version of reaching the ceiling of 100 % of field capacity for the soil water, the nitrates existing or produced in the soil can be a source of oxygen for the anaerobic respiration of the microflora, known as the reduction of nitrate and denitrification.

From the experimental data, we observe that at the humidity of 100%, the nitrification was stimulated even in the case of the witness sample, which did not receive the ammonium nitrate. Such an observation could be the basis of the finding that in irrigated fields, the processes of mineralization of the organic substance are always higher, especially at high doses of mineral fertilizer.

From our data we can see that the fertilization system has a great influence on the nitrogen nitrification of the soil.

As we found out, there were no anaerobic conditions or they lasted very little, because there is an increase of nitrate with increasing the capacity of field for water, which probably facilitated the development of various species of soil microflora and with it releasing into the environment easily assimilated organic substances.

As I remarked in my study, the nitrifying bacteria grow and nitrify best when the humidity is between 60-80% of field capacity.

Depending on the local environment conditions, the nitrification processes are subject to seasonal dynamics. The vegetable residues which accumulate in the soil at the end of the growing season are only partially decomposed, due to the low temperature of the soil in this season. The disintegration processes are lower in the winter months. Only at the beginning of the growing season, an increase in nitrification may be expected. The process culminates in early summer, being interrupted only during the periods of drought. The soil works have a key influence on this dynamics. The nitrification is more intense in autumn (when favorable conditions of temperature and humidity are met).

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