Study of the Ammonium-N and Nitrate-N Contents of Different Soils During Incubation

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The investigation of the transformation processes of different elements in the root zone is very important not only for the purpose of following the fate of a certain element, but also for formulating equations describing these processes. Such equations are essential for modelling the element cycles in the root zone, and in the case of nitrogen: to develop a nitrogen transformation submodel.

The N supply provided by the soil could be characterized by the N mineralization of soil humus and by the mineral-N accumulated in a certain soil layer (NÉMETH & SZEBENI, 1987; SZEBENI & NÉMETH, 1987). There are several biological (incubation) and chemical methods for forecasting the rate of mineralization during the growing season. Using biological methods several researchers have investigated the incubation of remoistened soils during various lengths of time, at different temperatures and under aerobic and anaerobic conditions (ADDISCOTT, 1983; DENDOOVEN et al., 1987; KOWALENKO & CAMERON, 1976).

Material and Methods

A 6-month incubation experiment was carried out to study the effect of soil moisture content, temperature, added nitrogen and two different plant residues (maize and alfalfa) on the mineral nitrogen (NH_4-N and NO_3-N) content and dynamics of different Hungarian and Egyptian soils.

Soil samples were collected from a non-fertilized field at the Experimental Station of RISSAC (Hungary) and from El-Marashda (Egypt). The basic soil analysis data are shown in Table 2. By applying the SITOBI programme it was easy to make an interactive design of multifactorial orthogonal experimental plans (Table 1) and to statistically analyse the data.

The mineral nitrogen content (exchangeable ammonium and nitrate) of the soil was measured 10 times during the first 84 days of the incubation. Sampling was carried out more frequently (5 times) in the first two weeks.

In this presentation the first results (nitrate-N dynamics) of the incubation of two calcareous sandy soils (one from Hungary and one from Egypt) are summarized.

Table I
Treatments of the incubation experiment

Treatment Code	Factors				
	Tempera-ture, °C	MWC %	Nitrogen mg/kg	Alfalfa g/100 g	Maize g/100 g
1.	15	80	225	3	3
2	35	80	225	3	1
3.	15	40	225	3	1
4.	35	40	225	3	3
5.	15	80	75	3	1
6.	35	80	75	3	3
7.	15	40	75	3	3
8.	35	40	75	3	1
9.	15	80	225	1	1
10.	35	80	225	1	3
11.	15	40	225	1	3
12.	35	40	225	1	1
13	15	80	75	1	3
14	35	80	75	1	1
15.	15	40	75	1	1
16.	35	40	75	1	3
17.	45	60	150	2	2
18.	5	60	150	2	2
19.	25	100	150	2	2
20.	25	20	150	2	2
21.	25	60	300	2	2
22.	25	60	0	2	2
23.	25	60	150	4	2
24.	25	60	150	0	2
25.	25	60	150	2	4
26.	25	60	150	2	0
27.	25	60	150	2	2
28.	25	60	150	2	2
29.	25	60	150	2	2
30.	25	60	150	2	2
31.	25	60	150	2	2
32.	25	60	150	2	2
33.	25	60	150	2	2
34.	25	60	150	2	2
35.	25	60	150	2	2
36.	25	60	150	2	2

Table 2

Results of soil analysis of the Hungarian and Egyptian calcareous sandy soil

Sampling depth , cm	$CaCO_3$ %	Organic matter, %	pH (H_2O)	pH (KCl)
Őrbottyán				
0 - 10	1.5	0.68	8.04	7.44
10 - 20	1.3	0.74	8.06	7.44
25 - 35	1.1	0.56	8.05	7.55
45 - 55	0.5	0.37	7.93	7.32
70 - 80	16.1	0.20	8.33	8.03
100 - 110	16.3	0.14	8.41	8.27
El-Marashda				
0 - 30	10.4	0.10	8.04	7.67

Results and Discussion

Fig. 1A and 1B show the effect of soil moisture content and temperature on the nitrate-N content in a calcareous sandy soil from Hungary during the period investigated.

As regards the soil moisture content (Fig. 1A) it can be seen that the initial nitrate-N content decreased in the first 14 days in all treatments. After this period, in the 20-80% MWC range the nitrate-N concentration increased due to nitrification and mobilization. (The ratio of mobilization and immobilization can be calculated, but these data are not given in the present paper.) At 100% MWC not only the surplus, but also the initial nitrate-N content disappeared due to denitrification.

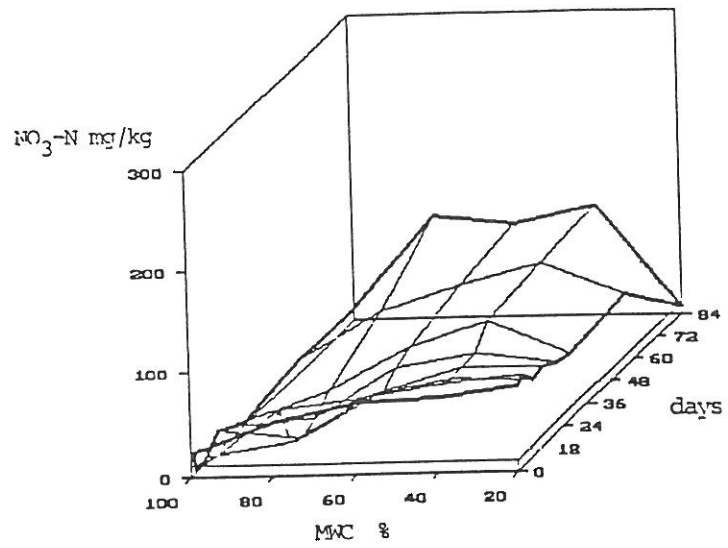
The results of different incubation temperatures (Fig. 1B) on the nitrate-N content show that in low (5 °C) temperature environments the nitrate-N content of the samples remained close to the initial values. The highest nitrate-N content could be detected at 35 °C.

Fig. 2A and B illustrate the influence of soil moisture content and temperature on the nitrate-N content in a calcareous sandy soil in Egypt during the period investigated.

The nitrate-N results of this poorly supplied sandy soil show that the optimum range of nitrate-N accumulation is narrower (around 60% MWC) than in the case of the Hungarian soil. In a dry environment the nitrate-N concentration remained at the initial value, while in a wet environment a significant decrease was observed in the nitrate-N content (Fig. 2A).

On this sandy soil the incubation temperature range optimum from the point of view of nitrate-N accumulation was between 25 °C and 35 °C.

A.



B.

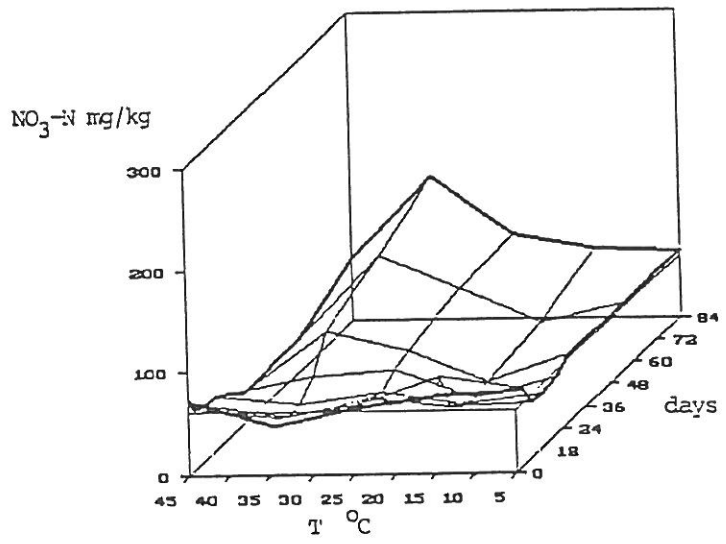
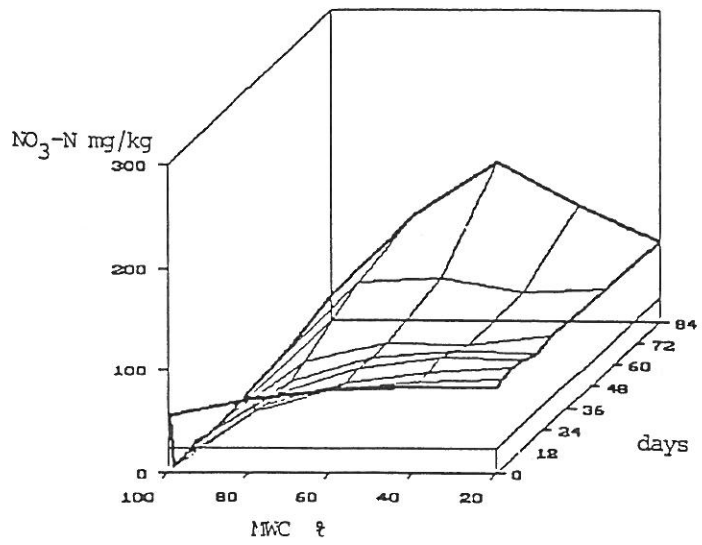


Fig. 1
Effect of soil moisture (A) and incubation temperature (B) on the nitrate-N content of the calcareous sandy soil of Őrbottyán

A.



B.

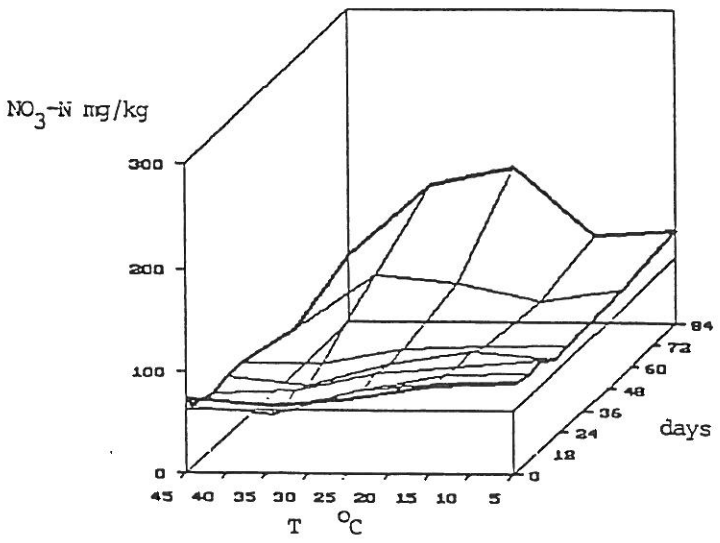


Fig. 2
Effect of soil moisture (A) and incubation temperature (B) on the nitrate-N content of the calcareous sandy soil of El-Marashda

Summary

In a 6-month incubation experiment the dynamics of the mineral nitrogen content of a Hungarian and an Egyptian soil was investigated.

As shown by the results obtained on two poorly supplied calcareous sandy soils, there is a certain range of soil moisture and incubation temperature that is suitable for nitrate-N accumulation. the results of nitrate-N analysis, together with other processes (mobilization, immobilization, denitrification) which can also be calculated and/or measured in this type of experiment, provide a good opportunity to formulate the equations necessary for the description of nitrogen transformation.

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