Investigations on Nitrogen Dynamics in Red Mediterranean Soils of Greece

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Abstract
Understanding the N dynamics in the soil-plant system is essential to successful N management. Red Mediterranean Soils (RMS) occupy a great part of the soils resources in Greece. However, there is still little information on the N fluxes in these soils. Surface samples were selected from 14 sites of N. Greece to represent RMS differing in culture history and soil characteristics. N mineralization potentials of these soils were measured, as well as N plant uptake was calculated in order to establish whether laboratory measurements of available N in soil were correlated with yields of unfertilized crops and with crop response to N fertilizer. In spite of the difference in No values among the soils tested, rates of mineralization were similar. Ammonium fixation is a property of many soils and a factor to be considered in practical agriculture. The C/N ratio alone is insufficient to predict the decomposability of the soil organic matter.

Key Words
N mineralization, Ammonium Fixation, C/N ratio

Introduction
Nitrogen is the key element to plant production and modern farming systems require an ample supply of N fertilizer necessary for maximum crop yield. Soil N dynamics is characterized by a series of transformation processes between organic and inorganic forms of N and the response of the N dynamic system to any stress such as N removal by crops and/or N fertilizer addition to soil.

Under normal soil conditions, inorganic N derived by mineralization process and the quantity of N fertilizer required for maximum yield, without leaving excesses that may be lost by leaching or other means, depends on an accurate estimation of the capacity of the soil to mineralize organic nitrogen. The relationship between total N and mineralized N has been widely studied (Cambell and Keeney 1982), but entirely different conclusions have often been reached. Native fixed ammonium is involved in the N dynamics of soil and may be an important component of the N fertility status of some agricultural soils ((Scarpf and Weier 1981). Carbon to nitrogen soil organic ratio is an indicator of the decomposing ability of soil organic matter and consequently of the N supplying potential of the soil (Xiaoping *et al.* 2007).

Greek soils have a wide range of mineralization potentials (Simonis and Setatou 1992) and native fixed ammonium was found to be the dominant N form in some soils (Setatou and Simonis 1994).

Red Mediterranean Soils occupy a great part of the soil resources in Greece. However there is still little information on the N fluxes in these soils. The purpose of this investigation is to study the N dynamics in representative RMS in Northern Greece.

Methods
Surface samples (0-30) were selected from 14 sites of N. Greece, to represent RMS differing in culture history and soil characteristics, measured by the standard procedures (Jackson 1958; Bremner 1965).Soil total N and inorganic N was determined according to the method of Stanford and Smith 1972.
In three of the soils the mineral status was determined by three different methods and in a pot experiment with ryegrass, three doses of ammonium sulfate (0 75, 150 mg/pot) were tested. Plant N uptake was calculated in order to establish whether laboratory measurements of available N in soil were correlated with yields of unfertilized crops and with crop responses to N fertilizer and to assess the value of such measurements for advisory purposes.

Results
Some basic characteristics of the soils tested are shown in Table 1. Total N of the soils ranged from 670 to 1820 ppm, while inorganic N varied from 60 to 128 ppm. Fixed ammonium ranged from 56 to 123 ppm and constituted 5.0 to 15.7 percent of the total N content of the soils tested. The distribution of C_{org}/N_{tot} ratios varied from 5.3 to 22.2. This suggests considerable variability in the quality of soil organic materials in

contrast that all soil humus in mineral soils is of essentially the same composition stabilizing at a C/N ratio near 10:1.

Cumulative N mineralized during the incubation period followed the same general trend for all soils. The rate of mineralization was rapid at the beginning, then declined with the length of the incubation period (Figure 1). The cumulative N mineralized was linearly proportional to the square root of time ($t^{1/2}$), throughout the 30 weeks of intermittent incubations. The cumulative N mineralized – time curves found with the soils studied, were of similar shape to those obtained by other investigations working with RMS (Mattar *et al.* 1991).

The dry matter and N uptake by ryegrass grown in the pot experiment with the three soils were highly correlated with mineral N content of fresh soil (Min-N_f) and the increase in mineral content of re-wetted air-dry soils (MinN_{ad}).

Table 1. Some characteristics and N parameters of the soils tested.

Soil	Texture	pH 1:1	Org.N ppm	Org.C %	Total N ppm	Fixed NH_4-N ppm	Inorg N ppm	Exch NH_4-N ppm	Cumul N miner ppm	Fix NH_4-N total N	C/N
1	SCl	7.2	891	0.65	980	85	89	4	109.5	8.7	6.6
2	SCl	6.8	1741	0.97	1820	73	79	6	121.4	4.0	5.3
3	SCl	7.4	1050	1.15	1110	56	60	4	109.8	5.0	10.4
4	L	6.7	994	1.04	1090	90	96	6	112.0	8.3	9.5
5	SCl	6.7	734	0.82	810	73	76	3	148.0	9.0	10.1
6	SCl	6.2	652	0.88	780	123	128	5	107.0	15.8	11.2
7	SCl	7.0	504	0.55	610	100	106	6	118.6	16.4	9.0
8	SCl	6.0	1696	3.76	1820	111	124	13	108.8	6.1	20.6
9	SCl	7.2	560	1.49	670	104	110	6	113.4	15.5	22.2
10	CL	6.8	743	0.94	860	98	117	19	117.5	11.4	10.9
11	L	7.0	732	0.87	840	105	108	3	90.1	12.5	10.4
12	SCl	7.2	830	0.87	840	85	92	5	95.3	10.2	10.4
13	SCl	6.2	1195	1.28	1520	93	75	7	83.5	6.1	8.4
14	L	5.7	2125	2.60	2480	65	105	15	105.5	4.6	10.5

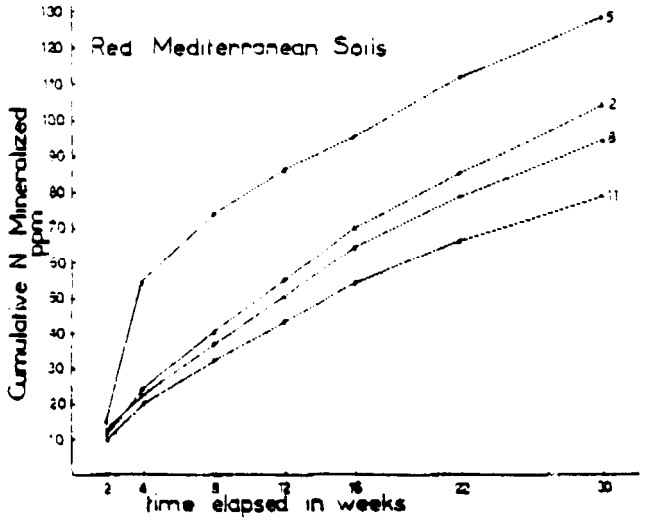

Figure 1. Cumulative N-mineralized with time for selected soils.

Conclusions

In spite of the difference in No values among the soils tested, rates of mineralization were similar. This suggests that the forms of organic N contributing to the mineralizable forms of N in Greek environments among soils are similar. Ammonium fixation is a property of many soils and a factor to be considered in practical agriculture. The C/N ratio alone is insufficient to predict the decomposability of the soil organic matter. Min-N_f and Min-N_{ad} can be used to predict available N for advisory purposes.

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