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Research Article

Nitrogen Mineralization in the Soils of Some Grassland Communities in the Alpine Region of Uludağ in Bursa-Turkey

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Abstract: Nitrogen mineralization was investigated in controlled conditions (60% WHC, 20ºC) in the soil of some alpine grassland communities. A significant correlation was found between the mineralization of nitrogen and certain soil factors (pH, WHC, Total Nitrogen and Organic Carbon). It was concluded that ammonification takes place at higher rates in grasslands which are dominated by *Nardus stricta* L. *(Poaceae)* plant species, whereas nitrification occurs at a higher rates in grasslands which are dominated by *Festuca cyllenica* Boiss. et Heldr. and *F. punctoria* Sm. *(Poaceae).*

Key Words: Mineralization, Nitrogen, Grassland

Uludağ Alpin Bölgesinde Bazı Otlakalan Topluluklarının Toprağında Mineral Azot Oluşumu

Özet: Bu çalışmada, mineral azot oluşumu bazı alpin otlakalan topluluklarının toprağında kontrollü şartlarda (toprağın % 60 Maksimum Su tutma Kapasitesinde ve 20ºC sıcaklıkta) araştırıldı. Mineral azot oluşumu ile bazı toprak etmenleri (pH, MSK, Toplam Azot ve Organik Karbon) arasındaki ilişki anlamlı bulundu. Amonifikasyonun *Nardus stricta* L. *(Poaceae)* bitki türünün egemen olduğu otlaklarda daha yüksek, Nitrifikasyonun ise *Festuca cyllenica* Boiss. et Heldr. ve *F. punctoria* Sm. *(Poaceae)* bitki türlerinin egemen olduğu otlakalanlarda daha yüksek olduğu sonucuna varıldı.

Anahtar Sözcükler: Mineralleşme, Azot, Otlakalan

Introduction

Mineralization in soil and the absorption by plants of nitrogen are important indicators of the productivity and dynamism of ecosystems. It has been explained that the nitrogen form in grassland ecosystems is a factor to be checked with a nitrogen-flow model (1).

The mineralization of organic compounds takes place as biological activity. Consequently, mineral nitrogen productivity is controlled by the chemical and munities investigated in this study (4,5). In this study, nitrogen mineralization was investigated in controlled conditions in the some plots of the same grassland communities. Furthermore, a correlation between mineralization and various socl factors was tested.

Materials and Methods

Mineralization was examined in air-dried soil samples taken from 5 plots previously studied for phytomass distribution and productivity (5). Soils collected

From each sample, 100 g soil was taken and placed in polyethelene bags. The samples were then moistened with water until the WHC value reached 60%. The moistened samples were incubated in a biotron apparatus (Heraeus Vötsch, HPS500) at a temperature of 20ºC for 9 weeks. Mineral nitrogen was analysed twice in each soil sample. These analyses were carried out at the end of the third and ninth weeks of the incubation period. The values obtained on these two dates were used to determine the net mineral nitrogen productivity (mg Nmin/100 g dry soil/6 weeks). The mineral nitrogen of the soil was determined by Microdistillation (7).

The total nitrogen and organic carbon contents were measured in an analysis of homogenized dry matter with an automatic nitrogen analyzer (Mod. 1400) from CARLO ERBA. This method is explained in detail in a previous paper (4). The pH of the air-dried soil samples was measured with Beckman pH Meters in saturated mud.

The differences between the plots were identified by an analysis of variance. Difference groups were determined using the Tukey test. In addition, a correlation between mineralization and soil factors was investigated. All statistical analyses were performed at a significance level of 0.05 (8).

"Flora of Turkey and the East Aegean Islands" was referred to for the names of the taxa cited in the text (9, 10). The cover and abundance of plant species in the plots were determined according to the method of Braun-Blanquet (11). The determination of the cover and abundance of species in the plots has been discussed at length in previous papers (4, 5, 12).

Results and Discussion

The species combinations of the plots are shown in Table 1. The differences between the plots in terms of soil factors was tested by an analysis of variance.

Table 1. Cover and abundance of dominant plant species in the plots (5).

Plot number	1	2	3	4	5
Cover (%)	60	75	100	100	100
Festuca punctoria	3	1			
Festuca cyllenica	1	4			
Thymus bornmuelleri	2	2			
Cruciata taurica	2	1			
Ranunculus dissectus	2	1			
Trifolium repens	2	1			
Nardus stricta			5	5	3
Deschamsia caespitosa			1	1	4
Ranunculus constantinopolitanus			1	3	1
Carex nigra			1	2	1
Plantago gentianoides				3	+
Crepis alpestris			1	2	+
Anthoxanthum odoratum			2	+	1

Table 2. Difference groups with regard to soil factors (*)

	Plot Numbers				
	1	2	3	4	5
Total N (%)	0.274 ± 0.027^{B}	0.304 ± 0.038^{B}	0.680 ± 0.207^{A}	0.425 ± 0.053^{B}	0.320 ± 0.098^{B}
Organic C (%)	3.595 ± 0.349^{B}	4.624 ± 0.753^{B}	10.002 ± 2.932^{A}	5.555 ± 0.711^{B}	3.318 ± 0.859^{B}
C/N ratio	13.14 ± 0.33^{A}	15.72 ± 0.76^{A}	14.76 ± 0.37^{A}	13.06 ± 0.36^{AB}	10.68 ± 2.86^{B}
pH-values	5.660 ± 0.029^{A}	5.472 ± 0.084^{B}	4.538 ± 0.164^{C}	4.492 ± 0.049^{C}	5.446 ± 0.084^{B}
WHC (%)	71.44 ± 7.50^{B}	73.08 ± 9.72^{B}	115.57 ± 40.09^{A}	82.90 ± 12.16^{AB}	64.74 ± 16.81^{B}

(*) The difference between the plots is significant for all soil factors

plots dominated by *Festuca cyllenica* Boiss. & Heldr. and *F. punctoria* Sm. The C/N ratio was highest in the plots dominated by *Nardus stricta* (plot number 3) and *Festuca cyllenica*. (plot number 2) (Figure 1).

Mineralization was investigated for a WHC of 60% and temperature of 20ºC. These values were chosen according to the data of previous papers (2, 13). The mineralization rate of nitrogen was determined over a given incubation period. This period is usually 6 weeks

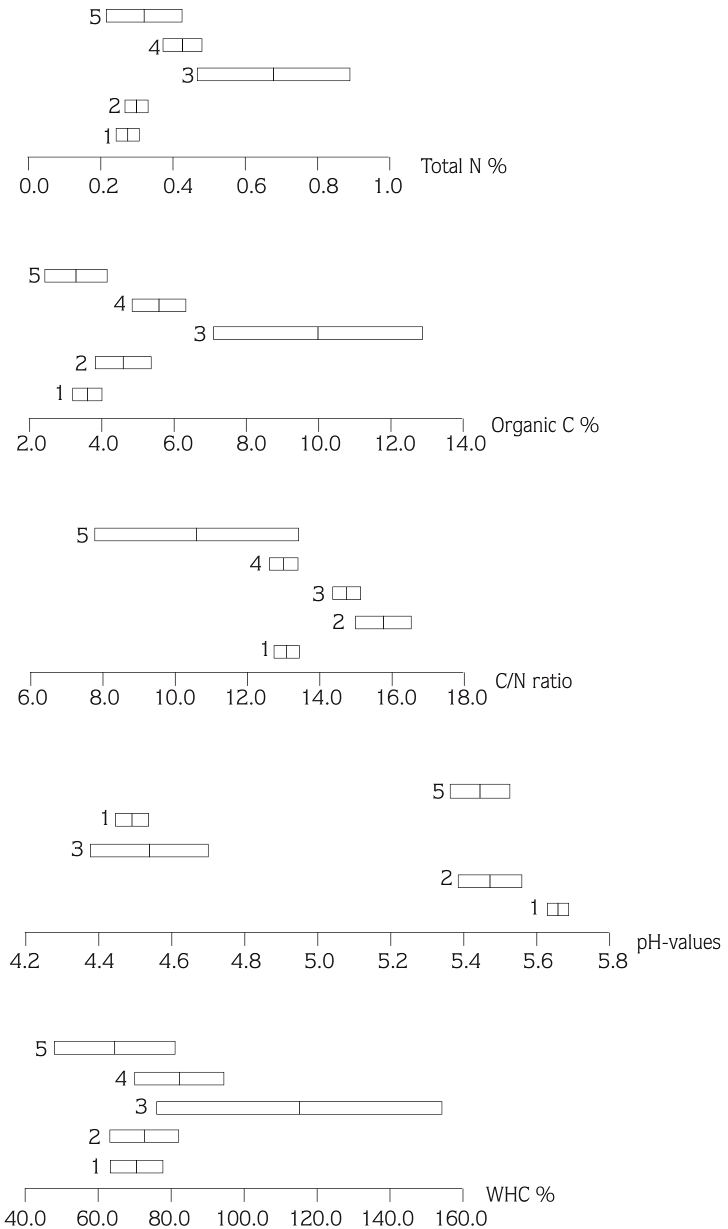

Figure 1. Comparison of plots with regard to soil factors (The plot numbers are shown to the left side of the relevant diagrams)

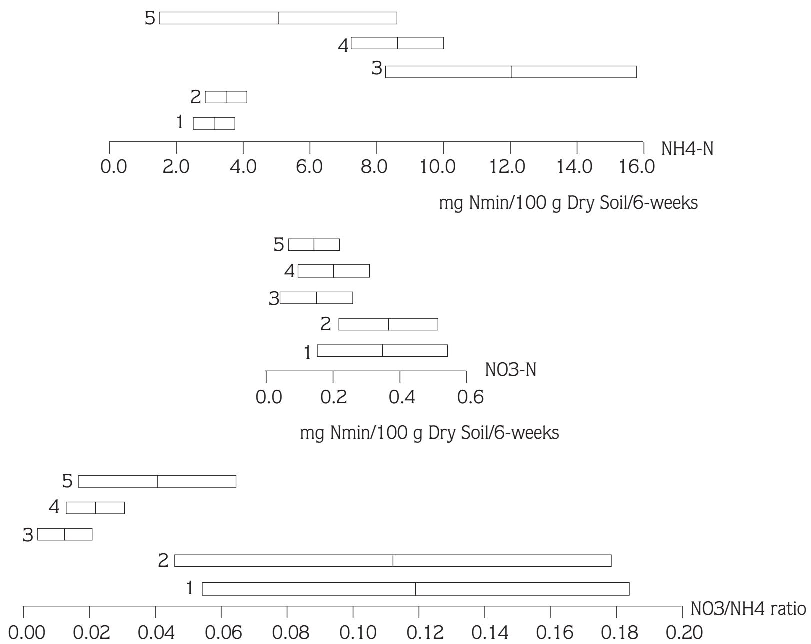

Figure 2. Comparison of plots with regard to net mineral nitrogen productivity (The plot numbers are shown to the left of the relevant diagrams)

Table 3. Difference groups with regard to mineral-nitrogen productivity (mg Nmin/100 g dry soil/6 weeks) (*)

	Plot Numbers				
	1	2	3	4	5
NH_4^+ -N	3.160±0.676B	3.523±0.604AB	12.154±3.759A	8.718±1.375AB	5.096±3.563AB
NO_3^- -N	0.354±0.199AB	0.367±0.151A	0.154±0.107AB	0.203±0.106AB	0.146±0.074B
NH_4^+ + NO_3^- -N	3.514±0.647BC	3.890±0.512BC	12.308±3.781A	8.921±1.476AB	5.242±3.557B
NO_3^- / NH_4^+	0.119±0.065A	0.112±0.066AB	0.013±0.008BC	0.022±0.008BC	0.041±0.024B

(*) The difference between the plots is significant for all soil factors

work carried out by Güleryüz and Gökçeoğlu (4), who reported that NH_4^+ - N and NO_3^- - N productions were highest in the *Nardus* community and *Festuca* between NH_4^+ -N production and WHC (r=0.511), total nitrogen content (r=0.703) and organic carbon content (r=0.691) in the soil. The correlation between NO_3^- -N production and soil factors was not found to be significant. It is interesting that a positive correlation was found between NO_3^- - N production and pH-values of soil, although the correlation between NH_4^+ - N production and pH values was negative. This result agrees with the general rule that increasing acidity results in the predominance of NH_4^+ - N, whereas slight alkalinity and slight acidity (pH 8.0-6.0) leads to the formation of NO_3^- -N (3, 18). Moreover a correlation between organic carbon content and WHC and pH-values was sought. The correlation was found to be significant; r=0.799 (for WHC) and r= -0.693 (for pH

Table 4. Simple correlation coefficients between net mineral nitrogen production and soil factors (n=25; p<0.001 significant, p>0.001; not significant; Sr: standard error) (8)

PARAMETER	r	r^2	$Sr = \sqrt{\frac{1-r^2}{n-2}}$	$t_{0.05\ (2)\ 23}$	$t = \frac{r}{Sr}$	H0; p=0	y= a+ bx
NH_4 and pH	-0.732	0.535	0.142	2.069	5.155	p<0.001	y=36.483-5.848x
NH_4 and WHC	0.511	0.261	0.179	2.069	2.855	p<0.001	y=0.012+0.0799x
NH_4 and Total N(%)	0.703	0.494	0.148	2.069	4.750	p<0.001	y=0.072+16.133x
NH_4 and Organic C(%)	0.691	0.478	0.151	2.069	4.576	p<0.001	y=1.001+1.020x
NH_4 and C/N	0.242	0.059	0.202	2.069	1.198	p>0.001	y=-0.055+0.493x
NO_3 and pH	0.394	0.155	0.192	2.069	2.052	p>0.001	y=-0.369+0.120x
NO_3 and WHC	0.017	0.0003	0.208	2.069	0.082	p>0.001	y=0.237+0.0001x
NO_3 and Total N(%)	-0.335	0.112	0.196	2.069	1.709	p>0.001	y=0.362-0.292x
NO_3 and Organic C(%)	-0.232	0.054	0.203	2.069	1.143	p>0.001	y=0.315-0.013x
NO_3 and C/N	0.319	0.102	0.198	2.069	1.611	p>0.001	y=-0.085+0.025x
pH and Organic C (%)	-0.693	0.480	0.150	2.069	4.620	p<0.001	y=5.815-0.128x
WHC and Organic C (%)	0.799	0.638	0.125	2.069	6.392	p<0.001	y=40.728+7.533x

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