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Nitrogen Mineralization in the Soils of the Conifer Forest Communities in the Eastern Mediterranean

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Abstract
The nitrogen mineralization rates in the soils of three coniferous forest communities (*Pinus nigra* subsp *pallasiana*, *Abies cilicica* subsp *cilicica*, *Cedrus libani*) in the middle Taurus Mountains (Turkey) were investigated. N mineralization was determined by the standard incubation method under laboratory conditions at 20ºC and 60 %WHC. Mineral nitrogen (NH_4^+-N ve NO_3^--N) was analyzed in the beginning, 21st and 63rd days of incubation by micro-distillation. Net mineral nitrogen accumulations were calculated for the 63-days (mg N_{min} / 100 g dry-soil / 63-days). Needle-leaf forest communities were cross-examined based on their mineral nitrogen and soil parameters. The relationships between the mineral nitrogen production and soil factors were analyzed by a simple correlation test. Mineral nitrogen production in the soils of these communities is strongly related to the total nitrogen rate. The highest total nitrogen mineralization rates were determined in the soils of the *Abies cilicica* community. The nitrogen mineralization in the soils of three closely related needle-leaf forest communities in the Eastern Mediterranean phyto-geography region were found to be different.
Keywords: Nitrogen, mineralization, nitrification, mediterranean forest.

Doğu Akdeniz Bölgesi İğne Yapraklı Orman Topluluklarının Topraklarında Azot Mineralleşmesi

Özet
Orta Toros dağlarından üç iğne yapraklı orman ağacı (*Pinus nigra* subsp. *pallasiana*, *Abies cilicica* subsp *cilicica*, *Cedrus libani*) topluğunun topraklarında azot mineralleşme oranları araştırılmıştır. N mineralleşmesi 20ºC ve %60 MSK laboratuar koşullarında standart inkübasyon yöntemiyle belirlenmiştir. Mineral azot (NH_4^+-N ve NO_3^--N) inkübasyonun başlangıcı, 21ci günü ve 63cü gününde mikro-destilasyon yöntemiyle tayin edilmiştir. Net mineral azot birikimleri 63 gün için hesaplanmıştır (mg N_{min} / 100 g kuru toprak / 63 gün). İğne yapraklı orman ağacı toplulukları mineral azot ve toprak parametrelerine göre karşılaştırılmış, mineral azot üretimi ile toprak etmenleri arasındaki ilişkiler basit korelasyon testi ile analiz edilmiştir. Araştırılan toplulukların topraklarında mineral azot üretiminin toplam azot oranıyla kuvvetli ilişkili olduğu saptanmış, en yüksek toplam azot ve mineralleşme oranları *Abies cilicica* topluluğunun toprağında belirlenmiştir. Doğu Akdeniz bitki coğrafyası bölgesindeki birbiriyle ilişkili üç iğne yapraklı orman ağacı topluluğunun toprağında azot mineralleşmesinin farklı olduğu belirlenmiştir.
Anahtar Kelimeler: Azot, mineralleşme, nitrifikasyon, akdeniz ormanı.

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INTRODUCTION

Anatolia being approximately 20.7 million ha (26.8% of the country) and covered with forests is rich in biodiversity (Kaya and Raynal, 2001). Three endemic *Abies* communities [*A. bornmuelleriana* Mattf., *A. nordmandiana* (Steven) Spach, *A. cicilica* (Ant. & Kotschy) Carr.], and the old climax forests formed by the *Cedrus libani* communities are of great importance to Turkey.

The mineralization rate of nitrogen is important to determine the productivity of an ecosystem. Nitrogen availability is a common indicator of soil quality (Keeney, 1980; Gökçeoğlu, 1988; Knoepp et al., 2000; Güleryüz et al., 2008). Forest soils generally contain insufficient nitrogen which limits development and productivity (Knoepp and Swank, 1998). The major sink for N in mature forests is usually found in the soil organic material

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(Nadelhoffer et al., 1999a, 1999b). However, because of the low pH of the needle-leaf forests, either the nitrification rate is very low or the nitrate production cannot be realized. Therefore, the main source of the biologically receivable nitrogen is ammonium which is set free through the decomposition of the organic substance (Vitousek and Matson, 1985).

Soil organic matter is readily accumulated in the forest ecosystems. The amount of organic matter produced by plants and their decomposition rates show great variations among plant types (Van Cleeve et al., 1983; Nadelhoffer et al., 1983; Gökçeoğlu, 1988; Scott and Binkley, 1997; Lovett et al., 2004). The quality and the amount of soil organic matter is accepted as a main soil characteristic (Runge, 1983; Köhler et al., 1995; Paul and Clark, 1996; Chapin, 2003). However, Lovett et al., (2004) points out that the three species can exert a strong control on the N cycling in the forest ecosystems that appears to be mediated through the quality of soil organic matter which they produce. But, they also suggested that the control mechanisms are to be more complex than the simple litter and soil characteristics such as litter lignin:N ratio and/or soil C:N ratio. It is a generally accepted view that organic matter containing high levels of nitrogen has more power to mineralize the nitrogen than one containing low levels (Chapin, 2003).

N mineralization in the soil is generally used as an indicator of the area productivity and forest development (Keeney, 1980) and is determined in the field or under controlled laboratory conditions (Knoepp et al., 2000). In this study, the nitrogen mineralization rates were determined under controlled conditions (20 ^{o}C and %60 WHC) in the soils of *Abies cicilica* (Ant. & Kotschy) Carr., *Pinus nigra* Arnold subsp. *pallasiana* (Lamb.) Holmboe and *Cedrus libani* A. Rich. forest communities which are dominant in the humid orogenic zone of the Taurus Mountains and the interrelated communities.

MATERIAL AND METHOD

Study Area

The 1300 km long Taurus Mountains chain is located on the south side of Anatolia, between Iraq and the Aegean region. These mountains are formed by the closure of the ocean calyx of the south arm of the Neotethys Ocean and they form a considerable part of the Alp-Himalaya mountain ranges which passes along the south and east of Anatolia (Şengör, 1980).

The Bolkar Mountains, in Southern Anatolia, extend approximately 150 km in the east zone of the middle Taurus Mountains. While, in most places, they do not exceed 2500 m in the west zone, the Bolkar Mountains pass over 3000 m in the east, and reach 3524 m at Medetsiz Hill. In the middle zone, there is Dümbelek Plateau (pastured area), a wide Plateau at 2200 m. Our research area (Çamlıyayla) is a district that has a rough structure including valleys and hills in the south. Cehennem Stream and Kadıncık Valleys which are the branches of the Tarsus (Berdan) Creek surround this region (Gemici, 1994). A large area of the mount is composed of calcareous substratum. Red, brown and reddish-brown forest soils are widespread on the southern side of the Bolkar Mountains while on the northern side the brown step soils are widespread (Gemici, 1994). Our research sites lies on the southern side of Bolkar Mountains (Figure 1).

The yearly amount of rain is between 624.4 and 1068.5 mm and the relative humidity is 64-72 % in the region. The minimum temperature is between 0.3-5.5^{o}C, while the maximum temperature is between 30.7-34.6^{o}C. The highest temperatures were recorded in August (Anonymous, 1974).

The Mediterranean mountain layers are formed by *Pinus brutia*, *P. nigra*, *Cedrus libani*, and *Abies cilicica* forests and, are related to the mountain layers on the middle and east Taurus Mountains (Akman, 1995; Atalay, 1994). *P. nigra*, *P. brutia*, *Cedrus libani*, and *Abies cilicica* form in these forests both as mixed and pure communities. Another wide-spread forest group in the region is *Juniperus exelsa* and *J. drupaceae* which are mainly located in the posture area, and J. oxycedrus which is located beneath the red-pine forests. The most wide-spread *Quercus coccifera*, is mostly found at *Q. cerris* and *Q. infectoria* (Gemici, 1994). Rarely found types are *Cerasus mahalep*, *Sorbus torminalis*, *Alnus glutinosa*, *Tilia plathyphyllos*, *Acer platanoides*, *A. monspessilanum* and *Ulmus glabra*.

Sampling and Analytical Methods

Our study material consists of the 0-10 and 10-30 cm soil layers taken from *Abies cilicica*, *Cedrus libani*, and *Pinus nigra* forest communities of the Çamlıyayla district.

Three sampling sites (5x10 m^2) for each community from different areas were selected. The floristic properties of the sampling sites belonging to

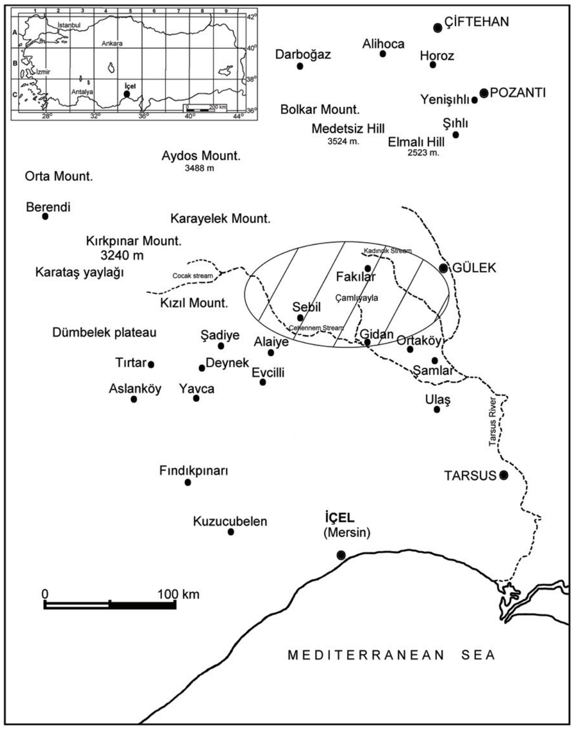

Fig 1. Investigation area (redrawn from Gemici 1994).

each community are given in Table 1.

Soil samples were taken from three sampling sites for each community. Volumetric soil samples were taken from the surface down to 30 cm depth with a container of 15x15x30 cm and the soil cores were divided into two layers of 0-10 and 10-30 cm after splitting into two different layers, the soil core was separated from their stone and plant parts by sifting with a standard 4 mm sieve. Approximately 300-400 g of each sifted sample was contained and then put into nylon bags.

The soil samples were dried naturally in the air and then put into paper bags to be archived. The WHC%, pH, organic C, total N analyses and standard incubation procedures were performed on the air-dry soils.

The Water Holding Capacity (% WHC) of the soil samples were calculated using the differences between the fresh and dry weights of the materials, which were saturated and then dried at 80 oC until a constant weight was obtained. The WHC% values of the samples were taken into consideration by calculating the amount of water needed for each sample to be watered-down to 60% WHC by unit.

The total soil nitrogen (%) was calculated by the Kjeldahl method using salicylic-sulfuric acid and selenium (Steubing, 1965) and the organic carbon (%) content was calculated using the wet incineration method (digestion with concentrated sulfuric acid and titration by $K_2Cr_2O_7$) (Steubing, 1965). The soil pH was determined in mud saturated with distilled water (20 g soil, 50 ml distilled water) using a pH-meter.

Standard Incubation

The 100 g of air-dried soil were put into polyethylene bags and humidified with distilled water to reach 60% WHC. Samples were then placed into an incubator set at 20°C for 63 days.

The mineral nitrogen was analyzed by the micro-distillation method (Bremner and Keeney, 1965; Gerlach, 1973) and was calculated as mg N_{min} / 100 g dry-soil.

The mineral nitrogen analyses (NH_4^+-N and NO_3^--N) were made in the beginning, at the 21st and 63rd days of incubation. The incubation period was divided into two main periods: 21-days (0-21 days) and 42-days (21-63 days). The net mineral nitrogen was calculated for 63-days (mg N_{min} / 100 g dry-soil / 63-days) using the difference between 0 and the 63rd day (Güleryüz et al., 2007).

Statistical Analyses

The differences among communities was tested with a variance analysis for the total nitrogen (%), organic carbon (%), C/N ratio, pH, WHC %, soil water contents at 60 % WHC, and mineral nitrogen values using a one-way ANOVA. The significance among means was determined by the Tukey HSD test. Also, the relationship between net mineral nitrogen production and the soil characteristics was analyzed by a simple correlation test. All of the tests were performed at the significance level of ?; 0.05 using Statistica Ver 6.0 (StatSoft Inc. 1984-1995) packet program.

RESULTS

Soil Characteristics

The soil characteristics of the forest communities are given in Table 2. The difference among communities was found to be significant ($P<0.05$) for the total N (%), C/N rate and pH in the layer of 0-10 cm. However, the difference was not significant regarding the organic C (%) and WHC (%). Considering all of the characteristics at the 10-30 cm layer, there was no significant difference ($P>0.05$) except for the pH.

In the 0-10 cm layer of soil, the total nitrogen amount of the *Abies cilicica* community was about 4

Table 1. The general properties of the plots [Cited taxon names are given according to Davis (1965-1985)].

***Abies cilicica* subsp *cilicica* community (AC)**

AC I

Ç ıkrıcak Site, cover 80%, limestone, slope 45% NE, 1258 m, sampling date: 3.7.2003

Quercus coccifera Juniperus oxycedrus, J. exelsa, Pinus nigra subsp pallasiana, Paliurus spina-christi, Campanula psilostachya, Dactylis glomerata, Prunus spinosa, Galium aperine, Ostrya carpinifolia, Daphne sericea, Viola alba, Silene aegyptiaca, Teucrium chamaedyrs, Acinos rotundifolius, Galium verum, Scabiosa argentea, Potentilla recta, Globularia trichosantha

AC II

Atdagı Site, Cover 60%, limestone, slope 45% NE, 1400 m, sampling date: 25.8.2003

Juniperus exelsa, Quercus coccifera, Prunus spinosa, Celtis australis, Rosa canina, Achillea millefolium, Silene italica, Geum urbanum, Cynodon dactylon, Bunium microcarpum, Euphorbia kotschana

AC III

Kozaağacı Site, Cover 25%, limestone, slope 5% NE, 1100 m, sampling date: 22.8.2003

Juniperus exelsa, Salvia tomentosa, Rosa canina, Viola cilicica, Centaurea urvillei, Medicago varia ssp. varia, Alcea pallida

***P. nigra* subsp. *pallasiana* community (PN)**

PN I

Tanzit Site, Cover 50%, limestone, slope 45% NE, 750 m, sampling date: 3.7.2003

Cedrus libani, Viola sieheana, Juglans regia, Silene italica, Vicia cracca ssp. stenophylla, Lotus corniculatus, Galium aparine, Daphne oleoides, Dactylis glomerate, Asphodeline taurica

PN II

Mercimek Site, Cover 60%, limestone, slope 20% NE, 700 m, sampling date: 22.8.2003

Cedrus libani, Xeranthemum annuum, Salvia tomentosa, Carpinus orientalis, Galium verum, Bromus tomentollus

PN III

Göpter Site, Cover 25%, limestone, slope 30 % NE, 1100 m, sampling date: 23.7.2003

Juniperus exelsa, Prunus spinosa, Rosa canina, Oryzopsis coerulescens, Geum urbanum, Psorolea bituminosa, Cynodon dactylon, Hypericum perforatum, Calamintha betulifolia, Agrimonia eupotaria, Hypochoeris glabra

***Cedrus libani* community (CL)**

CL I

Ç ıkrıcak Site, Cover 80%, limestone, slope 30% NE, 1572 m, sampling date: 3.7.2003

Prunella lacinata, Convolvulus lineatus, Galium verum, Salvia tomentosa, Cynoglottis chetikiana, Sedum alba, Hieracium pannosum, Polygala anatolica, Brachypodium sylvaticum, Centaurea kotschyana

CL II

Göpter Site, Cover 5%, limestone, slope 30% SW, 1100 m, sampling date: 22.8.2003

Juniperus drupaceae, Celtis austrialis, Pinus brutia, Pyrus amgdaliformis, Rosa canina, Dianthus orientalis, Medicago sativa, Stachs cretica, Melissa officinalis, Daucus corata, Hypochoeris glabra, Galium verum

CL III

Kozağacı Site, Cover 25%, limestone, slope 20% SW, 1000 m, sampling date: 22.8.2003

Juniperus exelsa, Q. coccifera, Cistus creticus, Coronilla varia, Lotus aegeus, Dactylis glomerata, Anemone blanda

times higher than that of the other communities. The organic C contents in the soils were similar. The highest C/N ratio was found in the *P. nigra* community and there was a significant difference among the pH of the groups (slightly alkali). The Water Holding Capacity in the soil at 0-10 cm was relatively high in the *A. cilicica* community but, this was not a significant difference when compared with other groups (Table 2).

Nitrogen Mineralization

The nitrogen mineralization of the two different layers was examined using the standard incubation method and is given in Fig 2. Except for the initial NH_4^+-N at the 0-10 cm soil layer, the differences among the communities were found to be significant in other periods ($P<0.05$). While the highest NH_4^+-N was on the 21st day, it was lowest on day 63 in the P. nigra community. The highest NO_3^--N was found in the soil of the *A. cilicica*

Table 2. The organic C, total N, C/N ratio, WHC (%), and pH means of the two soil layers of *A. cilicica*, *C. libani*, and *P. nigra* communities and the significant levels for the differences among the means [$F_{\alpha:0.05,\ (2)6}$:5.14] and difference groups among communities

Soil Layers	*A. cilicica*	*C. libani*	*P. nigra*	*F*	*P*
0-10 cm					
Organic C (%)	$2.5^{a} \pm 0.1$	$2.7^{a} \pm 1.1$	$3.4^{a} \pm 0.3$	*1.56*	*0.285*
Total N (%)	$0.7^{a} \pm 0.2$	$0.2^{b} \pm 0.1$	$0.2^{b} \pm 0.1$	*16.52*	*0.004*
C/N ratio (%)	$3.7^{b} \pm 0.7$	$13.5^{ab} \pm 6.5$	$19.8^{a} \pm 5.7$	*7.92*	*0.021*
WHC (%)	$110.2^{a} \pm 28.5$	$78.9^{a} \pm 14.1$	$77.8^{a} \pm 14.6$	*2.48*	*0.164*
pH ($H_2 0$)	$7.3^{b} \pm 0.2$	$7.8^{ab} \pm 0.3$	$7.9^{a} \pm 0.1$	*6.60*	*0.030*
10-30 cm					
Organic C (%)	$2.3^{a} \pm 0.1$	$2.7^{a} \pm 0.9$	$2.9^{a} \pm 0.4$	*0.79*	*0.495*
Total N (%)	$0.4^{a} \pm 0.1$	$0.3^{a} \pm 0.1$	$0.2^{a} \pm 0.1$	*2.32*	*0.179*
C/N ratio (%)	$6.0^{a} \pm 1.8$	$10.3^{a} \pm 2.1$	$16.0^{a} \pm 8.1$	*3.08*	*0.120*
WHC (%)	$80.8^{a} \pm 12.1$	$81.3^{a} \pm 22.3$	$77.0^{a} \pm 15.4$	*0.06*	*0.945*
pH ($H_2 0$)	$7.5^{b} \pm 0.1$	$7.9^{ab} \pm 0.2$	$7.9^{a} \pm 0.1$	*7.68*	*0.022*

(Values represent a means of 3-replicate for each community; ±Standard Deviation).

community at all periods. While 0 and the 21st day NO_3^--N values in *A. cilicica* soil were found to be relatively close to *P. nigra*, it then increased to the 63rd day. The initial NO_3^--N decreased on the 21st day, and the latter increased remarkably in the *C. libani* soil. The highest NO_3^--N value was found at the initial period in the *P. nigra* community, and then a decrease was observed in the incubation period (Figure 2).

A different N-mineralization process was observed in the 10-30 cm layer (Figure 2). The differences among the communities were significant ($P<0.05$) in all cases except the NO_3^--N on the 21st day (Table 2). On the first day, the lowest NH_4^+-N was in the *C. libani* community and, created a relatively distinct group among others. On the 21st and 63rd days of the incubation in the *A. cilicica* soil, the NH_4^+-N was higher than the others. In all groups, the NH_4^+-N increased till day 21, then decreased till day 63 (Figure 2). The highest NO_3^--N was measured in the *A. cilicica* community on days 0 and 63, and was found relatively close to the others on the 21st day. While there is an increase in the *A. cilicica* and *C. libani* communities on day 63 compared with day 21, it remained the same in *P. nigra* (Figure 2).

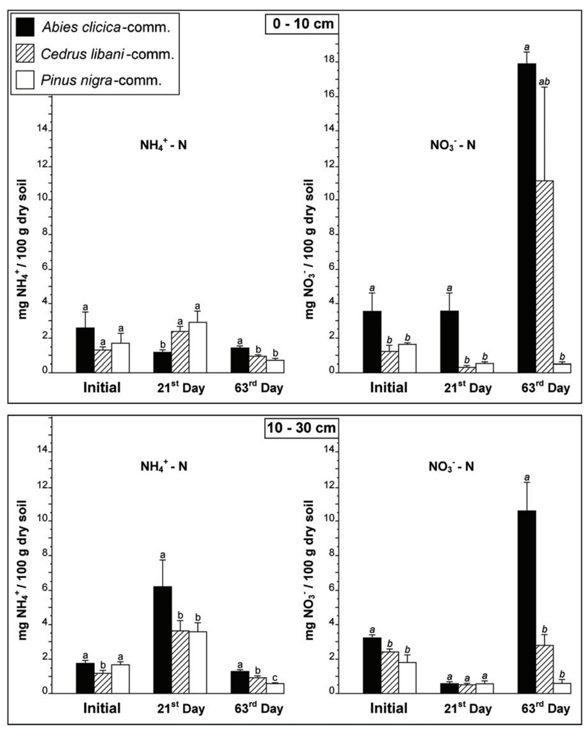

Fig 2. The comparison of forest communities regarding the nitrogen mineralization at the initial, 21st and 63rd days of soil incubation. [Difference groups among communities shown by the normal letters for ammonium and the italic letters for nitrate Different letters represent the difference groups among sample sites ($P<0.05$)].

Mineral Nitrogen Production

The differences among the communities regarding the net mineralization rate was found to be significant and the cross-examination of the communities is given in Figure 3. The NH_4^+-N accumulation was negative in the 0-10 cm layer of soils. The difference among the groups was not found to be significant ($P>0.05$). As to the NO_3^--N

Table 3. The correlation coefficients between the net mineral nitrogen production (mg N_{min} /100 g dry soil 63 d^{-1}) and soil characteristics in the 0-10 cm layer of soil, significance levels and regression equities [n=9, α;0.05]

Parameters	*r*	*P*	$Y = a + bx$
NH_4^+-N			
Organic C (%)	-0.263	0.494	NH_4^+ - N = -0.1723 - 0.2349 x Org C (%)
Total N (%)	-0.546	0.128	NH_4^+ - N = -0.3719 - 1.276 x Total N (%)
C/N ratio	0.138	0.722	NH_4^+ - N = -0.9703 + 0.01032 x C/N
pH (H_2O)	0.488	0.183	NH_4^+ - N = -7.591 + 0.88221 x pH
WHC (%)	-0.455	0.219	NH_4^+ - N = 0.21058 - 0.0118 x WHC (%)
NO_3^--N			
Organic C (%)	-0.273	0.476	NO_3^- - N = 16.222 - 2.988 x Org C (%)
Total N (%)	0.721	0.029	NO_3^- - N = 0.0764 + 20.594 x Total N (%)
C/N ratio	-0.703	0.035	NO_3^- - N = 15.573 - 0.6412 x C/N
pH (H_2O)	-0.714	0.031	NO_3^- - N = 128.44 - 15.79 x pH
WHC (%)	0.445	0.230	NO_3^- - N = -4.930 + 0.14181 x WHC (%)
NH_4^++ NO_3^--N			
Organic C (%)	-0.297	0.438	Total N_{min} = 16.049 - 3.223 x Org C (%)
Total N (%)	0.680	0.044	Total N_{min} = -0.2955 + 19.319 x Total N (%)
C/N ratio	-0.696	0.037	Total N_{min} = 14.603 – 0.6309 x C/N
pH (H_2O)	-0.678	0.045	Total N_{min} = 120.85 – 14.90 x pH
WHC (%)	0.410	0.273	Total N_{min} = -4.719 + 0.12996 x WHC (%)

P<0.05 significant correlation

and total N_{min} (NH_4^++ NO_3^--N) accumulation rates, the difference among communities was found to be significant (P<0.05) in the same layer. While the highest nitrate and total mineral nitrogen accumulation rate was obtained in the *A. cilicica* community, the accumulation was negative in the *P. nigra* community (Figure 3).

The NH_4^+-N accumulation was negative in the 10-30 cm layer of soil, and the difference among the communities was found to be significant (P<0.05). In the *P. nigra* community, a considerably higher NH_4^+-N loss took place. A significant difference among the communities was observed for NO_3^--N and total N_{min} (NH_4^++ NO_3^--N) accumulation rates (P<0.05). It was observed that the *A. cilicica* community had the highest production rate. Although the *C. libani* community had a positive accumulation, it was located in the same difference group together with the *P. nigra* community with a negative accumulation (Figure. 3).

Correlation between soil characteristics and mineral nitrogen accumulation

The correlation between the net mineral nitrogen production and soil characteristics was tested only in the 0-10 cm layer of groups and the simple correlation coefficients, significance levels and regression equations are given in Table 3. While the correlation between NH_4^+-N production and soil characteristics was not significant (P>0.05), the correlation between NO_3^--N production and total nitrogen was significantly positive, and between the pH and C/N rate was significantly negative (P<0.05). The correlation between the total N_{min} and soil characteristics showed similarity with the NO_3^--N results (Table 3).

DISCUSSION

Terra-rosa soils due to the suitable climate conditions are widespread in the Mediterranean region. Generally, the soils are neutral, low alkali, and with low acidic characteristic. However, due to

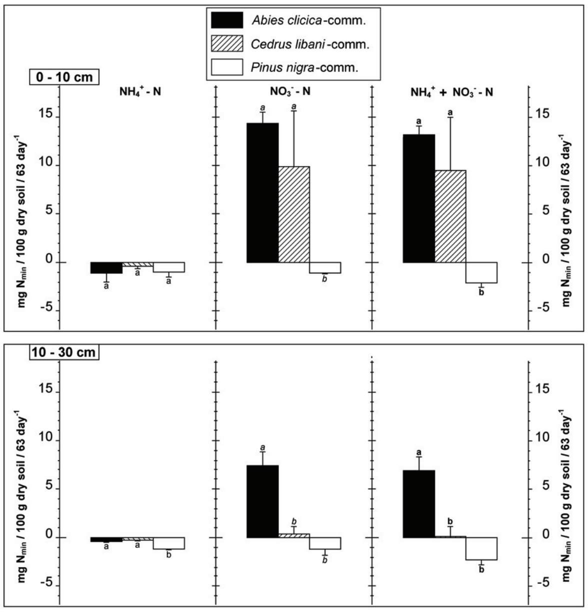

Fig 3. Comparison of the forest communities regarding the net mineral nitrogen accumulation for the 63 days incubation period. [Difference groups among communities shown by the normal letters for ammonium and the italic letters for nitrate and the boldface for total N_{min}. Different letters represent the difference groups among sample sites ($P<0.05$)]

the increased amount of rain towards to higher altitudes, acid soils have become more common (Atalay, 1994). In our research areas, the average soil pH was noted as nearly neutral (pH 7.3-7.9). As a result of the relatively fast decomposition, organic mater is low (Atalay, 1994). Even in the 0-10 cm layer of soils, the organic C amount was found take very low. However, the organic C amount was higher in the *P. nigra* community. Conversely, the total nitrogen rate of the *Abies cilicica* community was higher than the others.

Ammonium accumulation is negative in all the communities due to the transformation of ammonium to nitrate. Especially at the 0-10 cm layer of the soil, the *Abies cilicica* and *Cedrus libani* communities have shown a similarity and the mineral nitrogen production of the *P. nigra* remained negative. The surface layer of the soil is important since it reflects the vegetation characteristics. As a matter of fact, N_{min} production in the 0-10 cm layer was not observed at the 10-30 cm layer. While the nitrate production in the *Abies cilicica* community was higher than the others it was close to zero in the *Cedrus libani* community, and was negative in the *P. nigra* community.

Mineral nitrogen production in these communities was strongly related to the total amount of nitrogen. The *Abies cilicica* (rich in nitrogen) has shown itself in net mineral nitrogen production (Table 2; Figure 3). As to composition and quality of the remnants, it is widely accepted that remnants containing high levels of nitrogen has more power to mineralize nitrogen (Chapin, 2003).

The dominant plant types are as effective as the abiotic factors in controlling the ecosystem production (Berendse, 1990; Wedin and Tilman, 1990; Van Vuuren et al., 1992). The amount of organic matter produced by plants and its decomposition ability show a great change in each different plant type (Aber et al., 1990; Berendse et al., 1989; Van Vuuren et al., 1992; Lovett et al., 2004; Zengin et al., 2008). However, Lovett et al., (2004) have also claimed that control mechanisms are more complex than the simple litter and soil characteristics such as litter lignin:N ratio and polyphenolic concentration or the soil C:N ratio.

Our results indicated that N mineralization in the soils of the three closely related needle-leaf forest communities located in the Eastern Mediterranean phyto-geography region are different. In addition, this results supports the general opinion that organic matter containing high levels of nitrogen has more power to mineralize the nitrogen than the organic matter containing low levels of nitrogen.

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