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Determination the Effects of the Post-Afforestation Elapse on Soil Properties and Nitrogen Mineralization (Giresun-Şebinkarahisar Case)

Mehmet KÜÇÜK[1*], Sinan AKÇAY[2]

[1]Artvin Coruh University, Faculty of Forestry, Department of Forest Engineering, Artvin, TURKEY
[2]İzmir Forest Enterprise Directorate, Armutlu Forest Sub-district Directorate, İzmir, TURKEY
[*]Corresponding Author: mkck61@artvin.edu.tr

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Abstract

Aim of study: In this study, it is aimed to reveal the effects of time on some soil properties and nitrogen mineralization potential in scotch pine afforestation areas.

Material and methods: The study was carried out in the afforestation areas in Şebinkarahisar Forest Management Directorate. Soil samples were taken from two depth levels (0-15 cm and 15-30 cm Soil samples were taken from afforestation areas (afforested 1, 5 and 20 years ago) and adjacent unforested(control) areas. Some physical and chemical analyzes as well as nitrogen mineralization measurements were done in the soil samples.

Main results: It was determined that the period after afforestation has a statistically significant effect on the change of soil properties. Thus, while the sand and C / N ratio decreased with afforestation, clay, bulk density and pH increased. The difference in the effect of the time passed over planting times in terms of net mineralization data in nitrogen mineralization was found to be statistically insignificant. Equal incubation conditions prevented the difference in planting time.

Highlights: With the study, changes in soil properties have been revealed through afforestation studies in areas that are sensitive to erosion and the necessity of improving potential erosion sites has emerged.

Keywords: Afforestation, Nitrogen Mineralization, Erosion, Şebinkarahisar.

Ağaçlandırma Çalışmaları Üzerinden Geçen Zamanın Toprak Özellikleri ve Azot Mineralizasyonu Üzerindeki Etkilerinin Belirlenmesi (Giresun-Şebinkarahisar Örneği)

Öz

Çalışmanın amacı: Bu çalışmada, sarıçam ağaçlandırma sahalarında zamanın bazı toprak özelliklerine ve azot mineralleşme potansiyeline olan etkilerinin ortaya konması amaçlanmıştır.

Materyal ve yöntem: Çalışma, Şebinkarahisar Orman İşletme Şefliğinde ağaçlandırma sahalarında gerçekleştirilmiştir. Toprak örnekleri, ağaçlandırma faaliyeti yapılmamış sahadan(kontrol) 1, 5 ve 20 yıllık ağaçlandırılmış alanlardan iki derinlik kademesinden (0-15 cm ve 15-30 cm) alınmıştır. Toprak örneklerinde bazı fiziksel ve kimyasal analizler ve bunun yanında azot mineralizasyon ölçümleri yapılmıştır.

Temel sonuçlar: Ağaçlandırma sonrası geçen sürenin, toprak özelliklerinin değişimi üzerinde istatistik olarak önemli düzeyde etkili olduğu belirlenmiştir. şöyleki, kum ve C/N oranı ağaçlandırma ile azalırken, kil hacim ağırlığı ve pH ise artmıştır. Net mineralleşme verileri bakımından dikim zamanı üzerinden geçen sürenin etkisi istatistik düzeyde önemsiz çıkmıştır. İnkübasyon koşullarının eşit olması dikim zamanındaki farklılığı engellemiştir.

Araştırma vurguları: Bu çalışma ile birlikte hem erozyona duyarlı alanlardaki ağaçlandırma çalışmaları sonucunda toprak üzerindeki değişimler ortaya konulmuş hem de potansiyel erozyon sahalarının iyileştirilmesinin gerekliliği ortaya çıkmıştır.

Anahtar Kelimeler: Ağaçlandırma, Azot Mineralizasyonu, Erozyon, Şebinkarahisar.

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Introduction

Afforestation increases terrestrial biomass along with the transformation of non-forested lands into forests and contributes to the ecosystem restoration, wood and fiber production, and climate change. Afforestation studies have increased rapidly in recent years. As of 2015, 278 million ha were grown as planting areas, including afforestation, which corresponds to 7% of global forestry (Keenan et al., 2015; Payn et al., 2015). Turkey's forest lands have increased by 15 million decares in the past 15 years. Across the country, forest lands, which were 20.8 million ha in 2002, reached 22.3 million ha in 2017 (Anonim, 2018).

Afforestation has multiples objectives water and soil preservation, soil erosion control, landscape conservation, services for humankind (Villacís et al., 2016, Cerdà, et al., 2017, Nunes et al., 2018). pH, temperature, water content, texture, C:N ratio, microbial biomass, and other available nutrients are significantly affected by afforestation (Deng et al., 2016; Lauber et al., 2013; Li et al., 2012). The main purpose of rehabilitation works is to enrich the soil with nutrients (Deng & Shangguan, 2017) and thus provide favorable conditions for plant development (Agegnehu et al., 2017).

Nitrogen is the most essential nutrient for plant nutrition (Ouyang et al., 2013; Wan et al.,2017). Nitrogen plays an important role in diameter and height increase in plant development (Qin et al., 2016, Chen et al., 2020). Nitrogen mineralization or nutritional supplement with artificial fertilization is required for the absorption of nitrogen by plants.

The ability to absorb nitrogen from the soil is the most important indicator of the quality of the soil. "Nitrogen mineralization" refers to the release of inorganic nitrogen from soil organic matter. Nitrogen mineralization is controlled by processes such as the nature of the organic matter in the soil, the amount of microbial biomass, the level of microbial activity, soil temperature, and moisture (Pramanik et al., 2017; Waldrop et al., 2017). The rate of nitrogen mineralization in the soil can be done in the laboratory or by the plants that determine nitrogen intake (Knoepp et al., 2000). Environmental factors, plants, animals and other microscopic creatures in the soil structure have significant effects on the formation of mineral nitrogen.

Microorganisms that provide the decomposition of organic matter affect nitrogen mineralization by increasing the activity at suitable soil pH. Indeed, Curtin et al. (1998) showed that nitrogen mineralization increased significantly when the pH of acidic soils was increased. While nitrate is formed in slightly acidic and slightly alkaline (pH 6.0-8.0) soils, an increase in ammonium is observed due to increasing acidity (Runge, 1974).

The nitrogen content of plants varies by species. For example, nitrogen concentration content is higher in chestnut and Scotch pine litter compared to spruce litter (Sariyildiz T., 2003). The average amounts of nitrogen are 369.0 - 941.3 kg.ha^{-1} in the litter and 35-40 kg.ha^{-1} in annual deciduous leaves. Nitrogen and other nutrients added to the soil through annual defoliation play a major role as fertilizers only in terms of forest nutrition (Dündar, 1988).

Afforestation practices play an important role in the proper use of lands. However, afforestation has a great impact in terms of soil conservation and sustainability. In addition, afforestation prevents soil loss and allows elements such as nitrogen and carbon to be kept and stored in the soil. (Keesstra et al., 2018; Visser et al., 2019).

This study aimed to determine the change in soil properties and nitrogen mineralization potential in Scotch pine afforestation areas in the vicinity of Yeniyol village in Şebinkarahisar district of Giresun province under laboratory conditions.

Material and Methods

Research Area

The study was carried out in experimental plots within the borders of Yeniyol village in Şebinkarahisar district of Giresun province. The study area is between 465768 m-4453481 m north latitudes and 4454023 m-466501 m east longitudes, and its average elevation from sea level is 1850 m. The slope of the land is around 15% on average. The areas are generally located in sunny aspects (Figure 1 and 2).

Figure 1. Location of the research area in Turkey

The semi-arid Central Anatolian climate and humid Black Sea climate characteristics are observed in Şebinkarahisar. While the average temperature value was 9.0 C°, the maximum and minimum temperature values were determined to be 39.6 C° and – 23.5 C°, respectively. The average amount of precipitation is 572.2 mm.


Figure 2. General view of study area.

The most common soil types in the land within the boundaries of Şebinkarahisar district are brown soils, brown forest soils, non-calcareous brown forest soils, and high mountain meadow soils. Apart from them, bare rocks and debris, gray-brown podzolic soils in a narrow area, and alluvial and colluvial soils are observed (Anonim, 2013).

Method

In the study, the number of sampling areas was determined to be 20 (control x 5, 1-year x 5, 5-year x 5, 20-year x 5) in 4 different planting areas. A total of 40 soil samples, including 10 samples from each of the sampling areas selected, were taken from two depth levels. Soil sampling was performed using a 15x15x15 cm steel cube cylinder. Soil samples were taken in May 2016. After the soil samples taken from the sampling areas in the research areas, transfered to the laboratory were air-dried, and passed through a 2 mm sieve, so they were prepared for analysis. Texture analysis was performed on these samples using the Bouyoucos hydrometer method. The pH values of soil samples in the soil-pure water mixture with an acidity of $½_{.5}$ were measured by a digital pH meter. While the amount of organic matter was determined using the updated Walkley - Black wet digestion method, the total amount of nitrogen was determined using the Kjeldahl wet digestion method (Kacar, 2009). While the carbon-nitrogen ratio was determined based on the principle of the ratio of organic carbon and organic nitrogen measured in percent to each other, bulk density analyses were performed by dividing the oven-dry weight of the soil samples taken from the land with a soil bulk density cylinder by cylinder volume (Gülçur, 1974; Kacar, 2009). Bulk density sampling was performed only in the 0-15 cm depth, as only volume cylinders were used for nitrogen mineralization. For nitrogen mineralization analysis, 100 grams of soil was taken from 2 mm sieved air-dry soil and placed in polyethylene bags. 60 ml of distilled water was added to keep the soils at 60% water holding capacity. Nitrogen mineralization was performed by the micro-distillation method after being kept during a 63-day incubation period under laboratory conditions (Bremner & Keeney, 1965; Öztürk et al., 1997). SPSS 16.0 version was used on the data obtained. The Kolmogorov-Smirnov test was performed to check the normal distribution of the data. The one-way analysis of variance (one-way ANOVA) was performed to determine the difference between planting time. and control site.

Results

General Soil Properties

The results in Table 1 were obtained as a result of the analyses performed with the soil samples taken from the control areas and the areas where 1-year, 5-year, and 20-year plantings were done.

Table 1. Average values of soil properties in soil samples taken by planting time and the letters through which the difference according to the analysis of variance is shown

Soil Properties	Depth Level (cm)	Control	1-Year Planting	5-Year Planting	20-Year Planting
Sand (%)	0-15	67.1a	61.1ab	51.4b	54.3b
	15-30	67.5a	65.2a	55.8a	56.1a
Clay (%)	0-15	12.8a	15.1ab	18.9ab	22.6b
	15-30	15.2a	13.7a	19.3a	22.9a
Silt (%)	0-15	20.1a	23.8ab	29.7b	23.1ab
	15-30	17.3a	21.1a	24.9a	21.0a
pH	0-15	7.64a	7.90b	7.86ab	7.66ab
	15-30	7.77a	7.76a	7.76a	7.70a
Organic Matter (%)	0-15	2.70a	1.67a	2.18a	1.95a
	15-30	1.63a	1.25a	1.14a	1.47a
Total Nitrogen (%)	0-15	0.090a	0.066a	0.096a	0.078a
	15-30	0.066a	0.052a	0.060a	0.060a
C/N ratio	0-15	17.9b	13.9ab	13.6a	14.7ab
	15-30	13.4a	12.7a	11.1a	14.0a
Bulk Density (g/cm^3)	0-15	1.18a	1.13a	1.25a	1.50b

According to these data, the highest values depth of 0-15 cm were determined in the sand amount in the control areas (67.1), in the clay amount in the 20-year planting area (22.6), and in the silt amount in the 5-year planting area (29.7). The lowest values were determined in the 5-year planting area (51.43), the control area (12.8), and also the control area (20.1), respectively (Table 1). At a depth of 15-30 cm, the values in terms of sand amount were found to be like those at a depth of 0-15 cm. While the highest clay amount (22.9) was found in the 20-year planting area, it was found to be the lowest (13.7) in the 1-year planting area (Table 1). A ranking like at a 0-15 cm depth also appeared in silt values (Table 1). As a result of the analysis of variance, while the effect of planting time on sand, clay and silt values was significant at a depth of 0-15 cm ($p<0.05$), this effect was found to be insignificant at a depth of 15-30 cm.

The change in pH values measured in the planting areas and control areas was found to be irregular. While the highest values were found in the 1-year planting areas (7.90) at a depth of 0-15 cm, pH values in all areas were found to be close to each other at a depth of 15-30 cm. They were found to be the lowest (7.64) in the control areas at a depth of 0-15 cm (Table 1). According to the measurement results, it was found that the area had slightly alkaline characteristics in terms of pH values. As a result of the analysis of variance, while the effect of the time passed over planting times on pH values was found to be significant at a depth of 0-15 cm ($p<0.05$), this effect was found to be insignificant at a depth of 15-30 cm.

The organic matter content of the soils was found to be higher at both depth levels in the control areas compared to the planting areas. The lowest values were found in the 1-year planting areas (1.67) at a depth of 0-15 cm and in the 5-year planting areas (1.14) at a depth of 15-30 cm. When it was evaluated over the averages, it was observed that the area was not at a very high level in terms of organic matter (Table 1). As a result of the analysis of variance, the difference between the effect of the time passed over planting time was found to be insignificant at both depth levels in terms of organic matter content ($p>0.05$).

The total amount of nitrogen was found to be the highest in the 5-year planting area at a depth of 0-15 cm (0.096) and in the control area at a depth of 15-30 cm (0.066). The lowest values were found in the 1-year planting areas (0.066-0.052) at both depth levels (Table 1). As a result of the analysis of variance, the effect of the time passed over planting times was determined to be insignificant in terms of nitrogen amount ($p>0.05$).

According to the data in Table 1, the carbon-nitrogen ratio was found to be higher in the control area (17.9) at a depth of 0-15 cm compared to the planting areas. At a depth of

15-30 cm, this ratio was found to be the highest by (14.0) in the 20-year planting area. As a result of the analysis of variance, the effect of the time passed over planting times was observed to be significant in terms of the carbon-nitrogen ratio ($p<0.05$).
The values of the bulk density are presented in Table 1. According to these data, an increase in bulk density was generally observed (20-year planting area=1.50) as the time passed over 0-15 cm planting time increases. The result of the variance analysis on bulk density data, while the effect of the time passed over planting times was determined to be insignificant between the control, 1-year and 5-year planting times ($p>0.05$), it was found to be statistically significant in the 20-year planting areas ($p<0.05$).

Nitrogen Mineralization

The data obtained as a result of the analyses performed with the soil samples taken from the study area are as follows:

Table 2. t0 and t63 mineralization values (kg.ha-1) according to planting times, the letters through which the difference according to the analysis of variance is shown (t0: initial mineralization, t63: net mineralization after 63 days, kg.ha-1: kilogram value per hectare)

Mineralization	Unit	Control	1-Year Planting	5-Year Planting	20-Year Planting
t_0 NH_4	$kg.ha^{-1}$	16.6a	16.8a	17.6a	22.3b
t_0 NO_3	$kg.ha^{-1}$	17.2a	19.3ab	23.4b	23.3b
t_0 NH_4+NO_3	kg.ha-1	33.8a	36.1a	41.0ab	45.6b
t_{63} NH_4	$kg.ha^{-1}$	7.6a	7.9a	7.7a	11.5a
t_{63} NO_3	$kg.ha^{-1}$	23.8a	26.6a	29.9a	21.9a
t_{63} NH_4+NO_3	$kg.ha^{-1}$	31.4a	34.5a	37.6a	33.4a

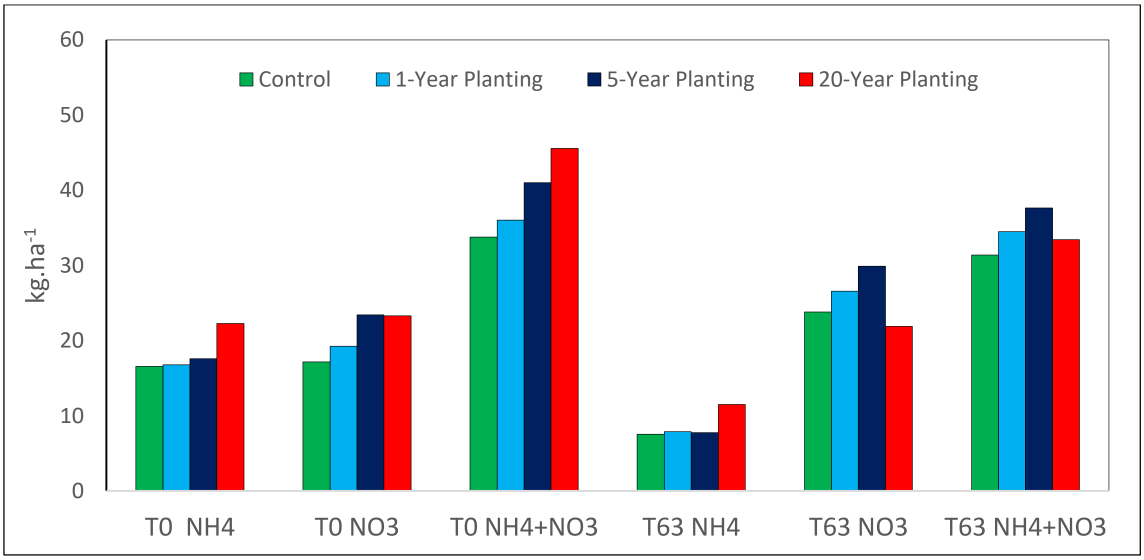

Figure 3. Change graph of t_0 and t_{63} mineralization values (kg.ha-1)

In terms of the initial mineralization data on a hectare basis, while ammonium, nitrate and total mineralization data were found to be the lowest (16.6-17.2-33.8) in the control area, they were found to be the highest in the ammonium and total mineral nitrogen value in the 20-year planting area and high in nitrate in the 5-year planting areas. According to the result of the variance analysis on the initial mineral nitrogen data, the effect of the time passed over planting times on a hectare basis was observed to be statistically significant in terms of both ammonium, nitrate, and total mineralization data ($p<0.05$). The average initial mineralization values are presented in Table 2, and their changes are presented in Figure 3.

In terms of 63-day net mineralization yields on a hectare basis, while ammonium, nitrate, and total mineralization data were found to be the lowest in the control area, they were found to be the highest in the ammonium and total mineral nitrogen value in the 20-year planting area and high in nitrate in the 5-year planting areas (Figure 3). According to the result of the variance analysis on 63-day net mineralization data, it was determined that the effect of the time passed over planting times was not found to be statistically significant on a hectare basis (p>0.05).

Discussion

General Soil Properties

According to the analyses, in terms of the amount of sand, statistically significant differences were found between the times passed over planting times. Significant decreases were observed in the amount of sand as time passed. As the reason for it, it can be said that the seedlings created the degree of cover and canopy as the time passed, precipitation ensured the direct cessation of the soil's abrasive effect, especially in rainy periods, and thus, the transport of soil was blocked. In terms of vegetation in the area, the presence of the tree and bush layer instead of the herbaceous layer plays a role in reducing the amount of sand (Ekinci, 2016). In some studies, it was concluded that afforestation studies had a reducing effect on the amount of sand (Özel, 2008; Tolay et al., 1982; Korkanç, 2014; Akdağ, 2016; Küçük et al., 2019). Küçük et al., (2019), for example, attributed higher sand and lower clay content in planting areas to having little or no protective vegetation and removal of clay by erosion cover in open areas.A significant increase was observed in the amount of clay in 1, 5, and 20-year afforestation areas compared to control areas. Along with the root spread of seedlings in the soil, clay and silt contents were retained, especially by the roots, and thus, the transport of clay was prevented. In some studies, afforestation activities had an increasing effect on the amount of clay (Özel, 2008; Özalp et al., 2015; Yüksek et al., 2010). They support the results we obtained in our study.

In terms of the amount of silt, a high amount of silt content was found at all planting times compared to control areas. In some studies, it was concluded that planting activities played a role in increasing the amount of silt (Ekinci, 2016; Akdağ, 2016).

Concerning pH values, pH values were higher in planting areas compared to control areas. In many studies, it was concluded that afforestation studies increased the soil pH value in some cases and decreased it in other cases (Kara & Bolat, 2008, Grerup et al., 2006; Balesdent et al., 2000), which may vary according to the variety of the plant species and stand composition.

There was no significant differences according to afforestation activities in terms of organic matter content... In many studies, it was stated that afforestation studies played a role of increasing organic matter (Göl, 2002; Tüfekçioğlu et al., 2002; Atmaca & Tuluhan, 2006). No significant differences were observed by afforestation. However some researchers reported increasing amount of total nitrogen after afforestations (Göl, 2002; Özkan, 2004; Akdağ, 2016). The decomposition rate of the litter also has a significant effect on organic matter. Compared to other species (chestnut and oak), scotch pine litter decomposition rate is slower than other species (Sariyildiz et al., 2008).

When carbon-nitrogen ratio values were examined, the carbon-nitrogen ratio was found to be lower in planting areas than that in control areas.. This result leads to the conclusion that especially afforestation activities provide favorable conditions for microorganisms and nutrients.In particular, the use of nutrients and organic matter in the soil immediately after the planting of seedlings is considered to play an essential role in reducing the carbon-nitrogen ratio.

The C:N ratio was found to be low in the soils under legumes where nitrogen fixation is efficient, in organic soils with rapid carbon decomposition, and in arid soils (Zinn et al., 2018). In another study, it was reported that the C / N ratio increased by 16.9% at a soil depth of 0–10 cm and by 14.5% at a soil depth of 10–20 cm in afforested areas (forest and bushes) compared to control areas. In afforestation areas with intense tree species, the C / N ratio was found to be higher in the lands with a soil depth of less than 40 cm compared to control areas (Shi et al., 2015).

In general, the reasons why afforestation activities increased bulk density could be the retention of clay and the fact that machine tillage led to soil compaction during afforestation activities. In most of the studies conducted to determine the effect of afforestation on bulk density, it was reported that bulk density decreased with afforestation studies (Küçük, 2013; Korkanç, 2014; Shi et al., 2015; Özalp et al., 2015).

The results obtained in the presented study revealed that it has a significant effect on the change of soil properties with afforestation, as well as both controlling soil quality and increasing soil fertility. In literature studies, it is seen that afforestation studies increase soil fertility (Alcañiz et al., 2020; Parhizkar et al., 2020). Sariyildiz et al., (2017) reported that, the convention of a forest area to agriculture land-use can significantly reduce the soil quality and soil organic C and total N stock capacities.

Mineralization

When the initial mineralization data were evaluated, it was observed that there was a significant increase in values per hectare in terms of both ammonium, nitrate and total mineralization values and in active mineralization data as the planting time passed. It was observed that this increase became more apparent, especially in the 20-year planting areas and. A difference of between 2.5 $kg.ha^{-1}$ and 12 $kg.ha^{-1}$ was found in terms of total mineralization between control and planting areas, and this difference varied between 0.1 $kg.ha^{-1}$ and 6 $kg.ha^{-1}$ in ammonium mineralization and between 2 $kg.ha^{-1}$ and 6 $kg.ha^{-1}$ in nitrate mineralization.

Considering 63-day net mineralization data, it was found that the planting time did not have a significant effect on both ammonium, nitrate, and total mineralization. It can be primarily considered that the reason why no difference occurred there was that the study was carried out under laboratory conditions because soil moisture and temperature and moisture conditions under 1-year-old seedlings are expected to be different from those under 5 and 20-year-old vegetation, which will lead to a significant difference in mineralization values. It was already found that this difference had an effect on initial mineralization. However, since moisture and temperature are constant under laboratory conditions, low differences in organic matter and nitrogen caused the amount of net mineralization to be statistically insignificant. The region's semi-arid climate caused this difference to be low. Indeed, it was stated in a study that soil temperature and moisture had significant effects on nitrogen mineralization. In their study, Anggria et al. (2012) found nitrate content in dry and hot soils higher compared to moist soils. Yu et al., (2014) stated that, nitrate form in dry storage and ammonium in wet storage are dominant in nitrogen accumulation. In this study, it is observed that the pH value was found to be high, indicating that nitrate mineralization was higher than ammonium mineralization. Generally, the nitrification value increases with increasing pH (Bergamasco et al., 2019). Some researchers indicated that nitrification was found to be near neutral and more in basic soils (Nadelhoffer et al., 1991; Robinson et al., 1995). On the other hand, it was stated that the process of taking nitrogen as ammonium and nitrate can continue in the range of 5.5 and 10 soil pH and adapt to these pH conditions in microorganisms (Nugrogho et al., 2007). Under high acidity conditions ($pH < 5.0$), nitrification occurs in reduced rates (Sahrawat, 2008), although Gubry-Rangin et al., (2010) reported nitrification in soils with a pH of 4.5. Nitrate yield is expected to be higher in areas where the pH value is close to neutral. A significant relationship was determined between pH and NO_3 formation in the soils in agricultural areas, and it was stated that the optimum pH value for NO_3 formation should be between 6.6 and 8.0 (Paul & Clark, 1996; Ramos et al., 2017). Since the soil reaction affects the number and activities of microorganisms living in the soil, the conversion of organic nitrogen to inorganic nitrogen is also affected (Kacar, 1977; Groffman & Fisk, 2011).

The decomposition of organic matter in the soil is an expected result in active mineralization values along with the formation of nitrogen content and with the emergence of suitable living conditions for microorganisms. Organic matter decomposition increased since the amount of mineralization was high over time, the accumulation of organic matter was high and favorable living conditions were provided for microorganisms (Zhai et al., 2019). Thus, there was an increase in the amount of mineralization as time passed. The fact that the carbon-nitrogen ratio was found to be low in planting areas appears to support the accuracy of this idea.

Furthermore, the amount and quality of debris in the soil are also thought to be effective on mineralization because many researchers indicated that the structure, functions, and species diversity of plant communities might affect inorganic nitrogen levels in the soil (Naeem et al., 1994; Tilman et al., 1996; Hooper & Vitousek 1997). However, nitrogen utilization levels may also affect the structure of the plant community (Inouye & Tilman, 1995; Mamolos et al., 1995).

In this study, the total mineralization value was 33 to 45 kg.ha-1, which is within the limit ranges in the literature. While Kücük & Yener (2019) reported that value as 35 $kg.ha^{-1}$ at 0-15 cm soil depth and 42.5 $kg.ha^{-1}$ at 15-30 cm soil depth for hornbeam-chestnut mixed stands, Rehder (1971) reported it as 10 and 90 kg ha^{-1} stated that the annual mineral nitrogen in pasture communities varied between for pasture communities.. Gökçeoğlu (1988) found that net mineralization was 75 kg ha^{-1} $year^{-1}$ in grassland and 28 kg ha^{-1} $year^{-1}$ in forest lands. Güleryüz & Gökçeoğlu (1994) found that mineral nitrogen was 25 kg ha^{-1} $year^{-1}$ in Juniperus communities and 26 kg ha^{-1} $year^{-1}$ in Festuca communities. The reason for low nitrogen mineralization in the mentioned study may be due to the high altitude of the study area and the low annual average temperature. Indeed, Ünver (2007) found that net mineralization was 59 kg ha^{-1} $year^{-1}$ in the Plantago community, 53 kg ha^{-1} $year^{-1}$ in the Juniperus community, and 43 kg ha^{-1} $year^{-1}$ in Alyssum soils.

Conclusion

As a result of afforestation works, it was observed that they caused significant changes in the general soil properties of sand, clay, silt, pH, C/N ratio, and bulk density. Likewise, it was determined that they were also effective in initial mineralization values (NH_4, NO_3). It is considered that the effect of afforestation studies will appear on organic matter and nitrogen after many years. Due to the equal temperature and moisture values under laboratory conditions in mineralization measurements, the fact that no difference was found in net mineral nitrogen values was one of the expected results. An increase, though partial, was determined in net mineral nitrogen values with afforestation studies.

According to the result of this study, it was determined that the planting of Scotch pine in semi-arid areas yielded positive results in improving soil properties. In particular, since the region is semi-arid, it may be recommended to make the soil better by bringing herbaceous or leafy species to the field, which may be organic matter supplement, along with afforestation and to provide better development of these seedlings. The preference of Scotch pine, mainly because it is a contented species, in the afforestation of semi-arid areas makes it a species that can be recommended to practitioners based on our results.

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