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Investigation of Litters and Some Soil Properteis under Umbrella Pine (*Pinus Pinea* L.) Plantations at Terkos-Durusu, Istanbul

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Abstract: *A field experiment was conducted in Terkos (Durusu) dune forest plantation to investigate carbon accumulation under umbrella pine (Pinus pinea L.) plantation at Istanbul, Turkey. 60 sample plots were established in the field of study. Sample lots were divided into Four tree density based to tree diameter at breast height (DBH) normally a > 8 m, b= 8-20 m, c= 20-36 m and cd < 36 m in the area planted with umbrella pine. Each group of density was consist 15 plots. In all sample plots litters and soil samples were collected. Litters samples were taken from 20x20 cm area. Soil samples were taken from 6 different layers such as (0-5 cm, 5-15 cm, 15-30 cm, 30-50 cm, 50-70 cm and 70-100 cm) depth to determine sand, silt and clay percentages, soil acidity (pH), organic carbon contents and organic carbon masses. Results obtained shows that there is an effect on soil organic carbon in (0-5 cm) depth and therefore, sand dunes movement were stabilized accordance to the organic matter decomposition, while soil acidity values are decreased and soil nutrients are increased on subsoil layers.*

Keywords: *Coastal dunes, Umbrella pine, plantation, litters, organic carbon*

1. Introduction

The forests consume much CO_2 more than other terrestrial ecosystems and keep carbon for a long time in the bodies. Forests have an important role in the terrestrial ecosystems. Forest ecosystems cover larges part of the terrestrial land surface and are the major components of the terrestrial carbon cycle. Most important, forest ecosystems accumulate organic compounds with long carbon residence times in vegetation, detritus and in particular, the soil by the process of carbon sequestration. Trees, the major components of forests, absorb large amounts of atmospheric carbon dioxide (CO_2) by photosynthesis, and forests return an almost equal amount to the atmosphere by auto and heterotrophic respiration (Lorenz and Lal, 2010).

Forests play a major role in the exchange of CO_2 between atmosphere and biosphere, being an important natural restraint to climate change. Land use changes such as forest clearing, cultivation and pasture/grassland conversion are known to result in changes in soil carbon (Houghton, 1999).

It has been estimated that approximately 123 Pg of carbon were released to the atmosphere between 1850 and 1990 due to land-use change (Houghton, 1999). Changes in soil carbon after conversion of forests to pasture and grassland vary greatly among sites. Differences in carbon storage between pasture, grassland and forest sites are attributed to variations in vegetation type, tree stand age and physical properties of soils (Osher *et al.,* 2003).

The emissions of greenhouse gases in Turkey were observed to increase from 170.06 Tg CO_2 in 1990 to 312.31 Tg CO_2 in 2005, representing an increase of 83.06% (*National Inventory Report* Turkey 2007). A great portion of the greenhouse gas emissions originates from the energy sector, 77.30 % of total greenhouse gas emissions. In Turkey, during the period of 1990- 2005, sectors other than forestry have caused greenhouse gas emissions (NIR Turkey 2007).

The magnitude of the carbon pool in forest depends on soil properties, climate, and anthropogenic activities. The ability of soil to stabilize soil organic matter and the relationship between soil structures are key elements in soil carbon dynamics (Six *et al.,* 2002). Physical properties as in silt and clay content or the microaggregation of soil are considered to protect organic matter from decomposing organisms (Oades, 1988; Torn *et al.*, 1997; Kaiser & Guggenberger, 2003).

Plantation is one of the effective ways for connecting to the atmospheric carbon in the biomass and soil. Durusu forest is the one of the sand dunes forest plantation in Terkos (Durusu), Istanbul. Durusu forest is also the one of the industrial forest plantations in Northern region in Turkey. Durusu sand dunes forest was planted with maritime pine and umbrella pine species.

While, the desertification and drought have been threatening to every kind of lands, and natural resources of many countries, a large number of studies have been carried out in various countries on soil. These studies have increased in recent years. One of these studies is sand dunes plantation that made on the 3350 ha of coastal dune in Terkos-Durusu northern Turkey. In this study, some soil properties changes and litters decomposed were investigated in 60 plots that afforested of umbrella pine species in Durusu coastal dune plantation.

2. Materials and Methods

2.1. Description of Research Area

Terkos (Durusu) Lake, which gives its name to Istanbul's drinking water, is 40 km northwest of city center. Terkos Lake is a coastal set lagoon separated from the Black Sea by sand dunes whose wdith ranges from 250 m to 5 km and whose average width is 2 km. Sand dune fields start 25 km from the west of Bosphorus and span in an area of 30 km along the coast of black sea (Köken, 1991, Aygün, 1994, Baylan and Karadeniz, 2006). Terkos sand dunes, which represent the biggest and most important sand systems located nearby Istanbul, has an international significance due to its inclusion of endemic plan species for the region (Figure 1). The climate in the black sea region is always raining, average raining each year is 990 mm, temperature average is 14 ^{0}C. Minimum temperature degrees is -11.9 ^{0}C with maximum 39.1 ^{0}C. Terkos Lake has a several types of soils such are; brown forest soils dominate in the southern part of the region. Acidic brown soils, rendzina, alluvial, hydromorphic alluvial, reddish-yellow podzolic and vertisol soils are other main soil types occurring in the Terkos part of the region.

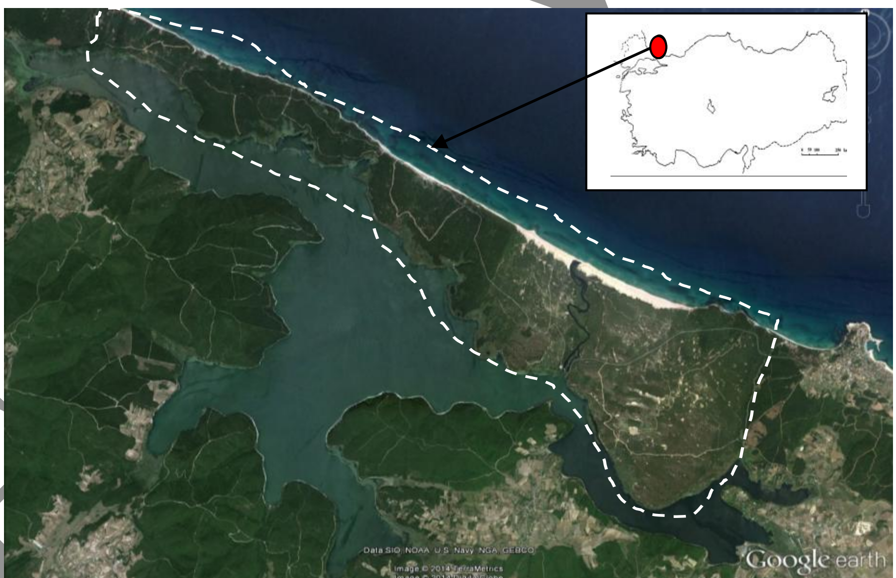

Figure 1. *Location of research.*

Terkos Lake consist many different species as; *Pinus pinaster*, *Pinus pineal*, *Pinus contorta* Dougl., *Pinus ponderosa* Laws., *Pinus radiata* D. Don., *Cupressus arizonica* Greene.,..act (Özcan, 2002). *Pinus pinaste* used in Turkey at Terkos dune plantation in 1880. It's growing especially in the north region of Turkey. In Turkey *Pinus radiata* had a serious insect problem and *Pinus pinaster* had some snow/wind damage and displayed many broken branches due to the weight of early snowfalls (Özcan, 2002). İt was determined that *Pinus pinaster* provenance from (Corsica and Morocco) grows successfully in Marmara, Blacksea Region and that it is more resistant to insect, disease, snow and wind damages.

2.2. Methods

Four development stages normally a, b, c and cd under umbrella pine were sellected. Each stages were divided into 15 plots with size 20x20 m. In each sample plot, tree diameter DBH (1.30 m) were measured (Figure 1). Forest floor samples were collected from (20x20 cm) area randomly. One soil pit was dug in each sample plot. Soil samples were taken using a cylindirical steel soil corers (1 dm^3) from six different soil depths (0-5, 5-15, 15-30, 30 -50, 50-70 and 70-100 cm) in to the soil profile. The peculiar arrangement and placement of the plots were made base on the distribution of umbrella pine species to provide the relationship between site variables and sand dune under dryland rain forest.

Collected samples were brought to the laboratory for analysis. Soil samples were air-dried and hand sorted to remove stones and root materials. Samples were passed through 2 mm sieve screen before analysis.

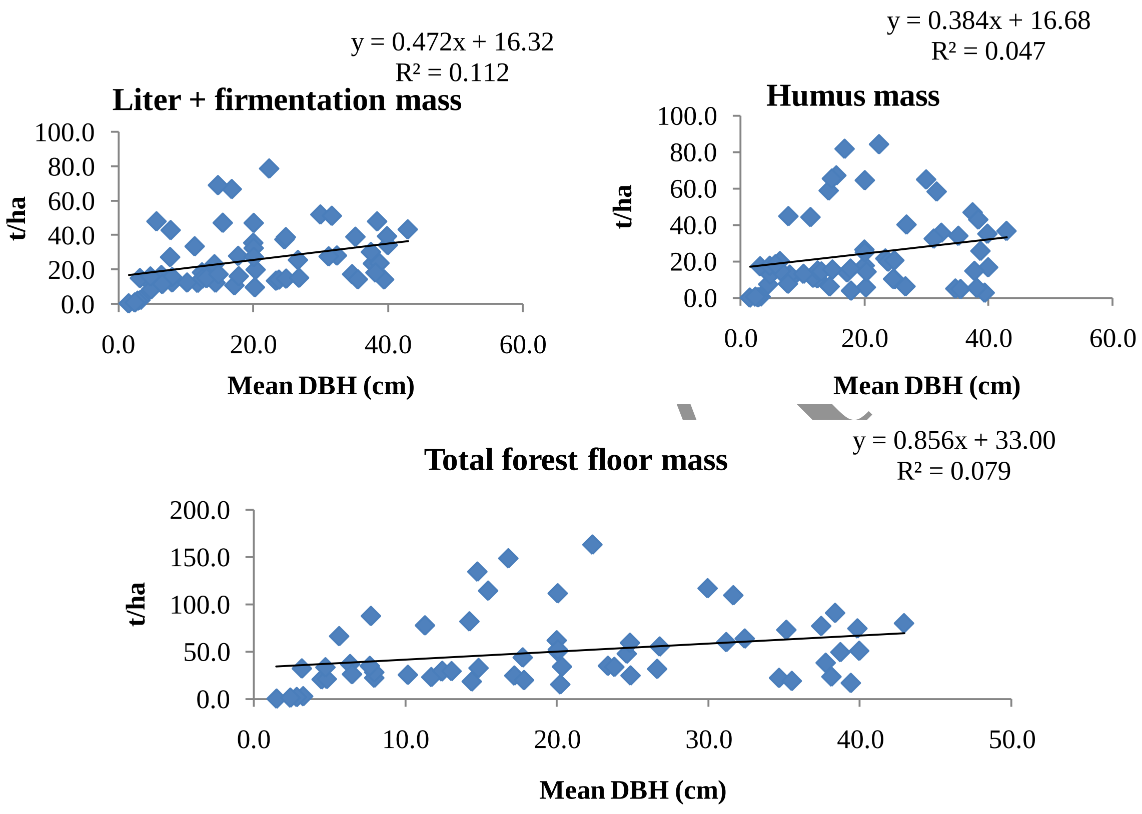

Figure 2. *DBH regression line to forest floor mass.*

Sand, silt and clay of samples were found using Bouyoucos hydrometer method. Actual acidity was determined by a pH meter with glass electrodes in 1/2.5 distilled water. Soil organic carbon was determined in accordance with Walkley -Black (WB) titration method. Forest floor samples were dried at 70 ºC for 24 h until constant weight. Each forest floor sample was divided into three layers (litter + fermentation and humus layers). Stored forest floor samples ground and passed through a 1 mm mesh screen before analysis. These samples were analyzed for total carbon using LECO Truspec 2000 instrument. Organic matter amounts of forest floor samples were found by loss on ignition method after grinding and burning at 550 ºC (Karaoz 1992). The values found for umbrella pine were compared statistically at 0.05 significance level using SPSS statistically evaluated methods.

3. Results and Discussions

Soil and forest floor samples analysis were evaluated according to four different development stages of umbrella pine species. Results were discussed by comparing each groups of different development stages namely (a, b, c and cd) of umbrella pine planted species.

Height, diameter 0.3 m, diametere 1.30 m and tree density per hectar were shown in (Table 1). Average of tree density per hectar was found to be 1281 and tree height was 7.25 m per hectar. Meanwhile, tree diameter (0.3 m) was founded to be 25.54 cm and average of tree diameter (1.30 m) was 19.8 cm (Table 1).

Table 1. *Mean height, diameter and tree numbers under umbrella pine sample plots.*

Tree Density	Heighet (m)	Diameter Ø 0.3m (cm)	Diameter Ø 1.30 m (cm)	Tree number (ha)
a	2.44 ± 0.27	10.11 ± 0.7	5.0 ± 0.5	2856 ± 548
b	5.53 ± 0.34	19.01 ± 0.7	14.5 ± 0.6	1385 ± 245
c	8.33 ± 0.52	28.91 ± 1.3	22.9 ± 0.8	671 ± 104
cd	12.72 ± 0.35	44.14 ± 0.9	36.9 ± 0.9	213 ± 25
Average	**7.25**	**25.54**	**19.8**	**1281**

Total forest floor mass under umbrella pine per hectare was 50.02 ton/ha, thus 25.71 ton/ha clarified litters & fermentation mass layers, and 24.31 ton/ha clarified humus mass layers (Table 2). Umbrella pine forest floor is dominated by pine needles. Mean masses of litter & fermentation layers under umbrella pine forest floor among groups were 15.49, 26.42, 30.18 and 30.74 ton/ha respectively, while, mean masses of humus layers under umbrella pine forest floor among groups were found to be 12.44, 29.28, 28.92 and 26.62 ton/ha namely. There was a significant different among groups masses. Humus mass layers were significantly lowest than litters layers under umbrella pine spices. Statistically, humus layers were not significantly different among groups at 0.05 levels, while total masses of forest floor were statistically different at 0.05 levels among groups. Humus masses depend to litter decomposition. Litter decomposition and the formation of humus are processes that are dependent on vegetation and the quality and quantity of its litter production (Table 2).

Table 2. *Some forest floor properties under umbrella pine species.*

Tree Density	Litter mass (t/ha)	Humus mass (t/ha)	Total mass (t/ha)
a	15.49 d ± 3.67	12.44 ns ± 2.95	27.93 d ± 6.22
b	26.42 c ± 5.02	29.28 ns ± 6.49	55.70 c ± 11.50
c	30.78 a ± 4.49	28.92 ns ± 6.20	59.70 a ± 10.43
cd	30.14 b ± 3.10	26.62 ns ± 4.49	56.77 b ± 7.32
Average	**25.71**	**24.31**	**50.02**
P	**0.048***	**0.092 ns**	**0.022***

Values are mean. Values within columns followed by the same letter are not statistically different at 0.05 significance levels. NS: non-significant. Each entry is mean, n = 15

The result demonstrated that lower tree density is playing role on effecting forest floor mass under umbrella pine species due to less litter fall. Umbrella pine of coastal dune plantation forest floor has higher organic carbon content (Table 3). Organic carbon contents of litter layers changed between 35.57 % under low tree density development stage and 45.79 % under high tree density development stage. While, under humus layer changed between 18.47 % low tree density and 16.69 % higher tree density. Terkos (Durusu) forest floor layer carbon amount was determined by ton per hectare. Total mean carbon of forest floor under umbrella pine species was 12.13 ton/ha. Mean carbon ratios of litter and humus layers were 10.00 ton/ha and 4.20 ton/ha respectively. The lowest organic carbon amount was found to be 5.61 ton/ha under low tree density group and 17.51 ton/ha under high tree density development stage (Table 3). Statistical levels for organic carbon contents and carbon mass ton per hectare of litter and humus layers were significantly different at 0.05 levels, while investigating mean of carbon mass of humus layers show non significance different at 0.05 levels (Table 3).

Table 3. *Some forest floor properties under umbrella pine species.*

Tree Density	Litter layers % C_{org}	Humus layers % C_{org}	Litter layers C (t/ha)	Humus layers C (t/ha)	Total C (t/ha)
a	35.57 d ± 1.93	18.47 a ± 0.49	4.88 d ± 1.08	2.21 b b ± 0.49	5.61 d ± 1.47
b	36.65 c ± 1.61	18.16 b ± 0.46	9.27 c ± 1.68	5.38 b b ± 1.25	11.30 c ± 2.76
c	38.99 b ± 1.93	16.96 c ± 0.57	11.89 b ± 1.88	4.91 b b ± 1.14	14.08 b ± 2.75
cd	45.79 a ± 0.96	16.69 d ± 0.46	13.95 a ± 1.59	4.30 b b ± 0.71	17.51 a ± 2.22
Average	**39.25**	**17.57**	**10.00**	**4.20**	**12.13**
P	**0.000*****	**0.029***	**0.001*****	**0.102 ns**	**0.011*****

Values are mean. Values within columns followed by the same letter are not statistically different at 0.05 significance levels. NS: non-significant. Each entry is mean, n = 15

We conclude that quantity storage of organic carbon under surface is clarified to the amount of organic matter masses. Great forest floor accumulation on Terkos-Durusu coastal dune plantation surface, predominating fermentation layer, low and high organic matter mass, organic carbon contents, and organic carbon mass of umbrella pine demonstrated that decomposition rate was occurred. Parallel to this overview, Filcheva *et al.* (2000) found litter accumulation under pine (*Pine nigra* Amold.) was 7.68 ton/ha compared to 12.13 ton/ha under umbrella pine on coastal dune plantation in Istanbul. They described also that litter originating from the deciduous (broad leaved) species undergoes more rapid humus decomposition and mineralization than that from the conifers. This underlines the importance of nutrient recycling by decomposition of organic matter which is a key process for the re-vegetation of Durusu coastal dunes.

According to soil properties under umbrella pine species, results were compared among 4 development of tree density namely a, b, c and cd. Fine soil fractions among tree densities changed between 1303.79 g/l at 0-5 cm soil depth under (cd) high tree density stage and 1439.81 g/l at 70-100 cm soil depth under (a) low tree density development stage (Table 4). Results determined that fine soil fractions weights were lower in high density tree development stage, while soil organic matter masses and organic carbon masses were highest. These clarified that soil sample weights in surface and depths depend to amount of organic matter on forest floor. Parallel to this, fine soil fraction only at 0-5 cm depth under higher tree density of umbrella pine species lower than other density groups (Table 4). Sand rates in all soil depth layers have a significantly different among groups. Meanwhile, silt and clay rates have no any important difference among groups under umbrella pine (Table 4). This result can be interpreted that soil particle size distribution (soil texture) under umbrella pine it is sandy dunes soil. Accordance to significant levels among density groups, fine soil fractions for (a) and (cd) densities were not different statistically at 0.05 levels, while, (b) and (c) densities groups were significantly difference at 0.05 levels. Meanwhile, sandy, silt and clay percentages were shown no significant different among density groups at 0.05 levels (Table 4).

Table 4. *Soil properties under umbrella pine species.*

Tree Density	Soil Depths (cm)	Fine soil fraction (g/l)	Sand %	Silt %	Clay %
a	0-5	1417.88 a ± 18.30	95.397 a ± 0.4	1.60 a ± 0.2	2.10 a ± 0.4
	5-15	1391.42 a ± 17.95	96.396 a ± 0.4	1.61 a ± 0.2	1.91 a ± 0.4
	15-30	1418.49 a ± 13.37	96.399 a ± 0.6	1.51 a ± 0.2	2.20 a ± 0.5
	30-50	1423.79 a ± 8.51	96.319 a ± 0.6	1.50 a ± 0.2	2.21 a ± 0.5
	50-70	1418.94 a ± 10.14	96.000 a ± 0.8	1.52 a ± 0.3	2.52 a ± 0.6
	70-100	1439.81a ± 10.24	95.900 a ± 0.9	1.51 a ± 0.3	3.10 a ± 0.7
P		**0.593 ns**	**0.986 ns**	**0.978 ns**	**0.999 ns**
b	0-5	1373.19 c ± 12.11	94.833 a ± 0.4	1.71 a ± 0.2	2.91 a ± 0.3
	5-15	1396.72 b ± 7.99	94.806 a ± 0.5	1.90 a ± 0.2	3.02 a ± 0.4
	15-30	1406.86 a ± 9.81	95.500 a ± 0.6	1.71 a ± 0.2	2.83 a ± 0.5
	30-50	1426.19 a ± 13.27	95.801a ± 0.5	1.72 a ± 0.3	2.51 a ± 0.4
	50-70	1421.69 a 8.70	96.200 a ± 0.5	1.50 a ± 0.3	2.20 a ± 0.3
	70-100	1422.62 a ± 11.06	96.300 a ± 0.4	1.31 a ± 0.2	2.40 a ± 0.4
P		**0.005*** **	**0.287 ns**	**0.559 ns**	**0.907 ns**
c	0-5	1381.99 b ± 7.19	93.555 a ± 0.4	2.45 a ± 0.3	3.10 a ± 0.3
	5-15	1405.59 a ± 10.01	95.563 a ± 0.5	1.82 a ± 0.2	2.80 a ± 0.3
	15-30	1407.55 a ± 9.37	94.510 a ± 0.8	2.43 a ± 0.3	3.22 a ± 0.7
	30-50	1429.86 a ± 10.47	94.110 a ± 0.6	2.35 a ± 0.4	2.75 a ± 0.4
	50-70	1437.20 a ± 12.40	94.700 a ± 0.9	2.21 a ± 0.5	3.10 a ± 0.5
	70-100	1430.50 a ± 15.21	96.800 a ± 1.1	4.41 a ± 0.5	3.11 a ± 0.7
P		**0.006*** **	**0.944 ns**	**0.635 ns**	**0.930 ns**
cd	0-5	1303.79 a ± 12.46	90.777 a ± 1.0	4.00 a ± 0.4	6.01 a ± 0.7
	5-15	1314.53 a ± 13.75	89.511 a ± 1.1	4.00 a ± 0.4	6.50 a ± 0.8
	15-30	1353.30 a ± 80.82	90.318 a ± 1.3	3.41 a ± 0.6	6.32 a ± 0.8
	30-50	1337.24 a ± 20.30	88.109 a ± 3.7	4.42 a ± 1.2	7.51 a ± 2.6
	50-70	1350.19 a ± 18.78	89.500 a ± 2.4	2.11 a ± 0.6	6.11 a ± 1.8
	70-100	1350.32 a ± 18.19	89.400 a ± 2.4	4.11 a ± 0.5	6.52 a ± 2.1
P		**0.405 ns**	**0.949 ns**	**0.747 ns**	**0.896 ns**

Values are mean. Values within columns followed by the same letter are not statistically different at 0.05 significance levels. Each entry is mean, n = 15

In all soil layers, soil organic content under umbrella pine was found to be lower except under high density tree was significantly different. Therefore, soil organic carbon masses were lower in all soil depth layers except for high density tree. The organic carbon content of the depth layers (Ah) ranged between 0.847 and 0.026 % (Table 5). The highest mass of organic carbon was 11.043 g/l in 0-5 cm depth layer under (cd) high tree density group, while the lowest was 0.369 g/l in 70-100 cm depth layer under (a) low tree density group. In general, the highest organic carbon masses were founded in 0-15 cm soil depth layers under umbrella pine species at Terkos (Durusu) coastal dune plantation. Organic carbon contents and carbon mass values within density groups were significantly different among density groups at 0.000 levels. For the whole soil profiles, the carbon ratio decreased with depths. The natural vegetation in the area is dominated by dune or coastal forest. Soil in the region consists mainly of fine and medium grained sand and have a low silt and clay content. Terkos (Durusu) vegetated dunes, the soil profile consist of litter on an A horizon underlain by sand which described as the sandy dunes soil form. We determined that carbon accumulation under umbrella pine species were clearly affected by quantity of organic matter and litter (pine needles) decomposition of the site. Du to this transformation, umbrella pine forest floor resulted in larger quantities of organic carbon masses in upper soil layers.

Table 5. *Some soil properties under umbrella pine species.*

Tree Density	Soil Depths (cm)	Organic C Content (%)	Carbon Mass (g/l)	pH Values
a	0-5	0.132 a ± 0.016	1.872 b ± 0.213	7.93 b ± 0.044
	5-15	0.075 b ± 0.009	1.044 c ± 0.119	7.98 b ± 0.034
	15-30	0.055 b ± 0.007	0.780 a ± 0.093	7.98 b ± 0.033
	30-50	0.040 a ± 0.005	0.570 a ± 0.069	8.01 a ± 0.035
	50-70	0.031 b ± 0.003	0.440 a ± 0.043	8.08 a ± 0.031
	70-100	0.026 b ± 0.003	0.369 a ± 0.040	8.09 a ± 0.029
P		**0.000*** **	**0.000*** **	**0.008*** **
b	0-5	0.185 a ± 0.020	2.540 b ± 0.273	7.84 b ± 0.042
	5-15	0.112 a ± 0.012	1.564 c ± 0.161	7.95 b ± 0.037
	15-30	0.071 b ± 0.006	0.999 d ± 0.079	7.96 b ± 0.039
	30-50	0.050 b ± 0.005	0.713 d ± 0.078	8.00 a ± 0.034
	50-70	0.037 b ± 0.005	0.526 a ± 0.067	8.06 a ± 0.030
	70-100	0.030 b ± 0.004	0.427 a ± 0.059	8.06 a ± 0.026
P		**0.000*** **	**0.000*** **	**0.000*** **
c	0-5	0.312 a ± 0.049	4.312 d ± 0.656	7.29 a ± 0.183
	5-15	0.176 b ± 0.027	2.474 c ± 0.356	7.44 a ± 0.187
	15-30	0.125 b ± 0.017	1.759 b ± 0.221	7.43 a ± 0.196
	30-50	0.085 c ± 0.012	1.215 b ± 0.167	7.51 a ± 0.190
	50-70	0.065 c ± 0.010	0.934 a ± 0.144	7.54 a ± 0.176
	70-100	0.057 c ± 0.010	0.815 a ± 0.142	7.53 a ± 0.176
P		**0.000*** **	**0.000*** **	**0.936 ns**
cd	0-5	0.847 a ± 0.083	11.043a ± 1.062	6.15 a ± 0.136
	5-15	0.445 b ± 0.041	5.850 b ± 0.524	6.18 a ± 0.152
	15-30	0.260 c ± 0.026	3.259 c ± 0.388	6.25 a ± 0.141
	30-50	0.197 d ± 0.012	2.634 d ± 0.161	6.28 a ± 0.133
	50-70	0.144 d ± 0.009	1.944 d ± 0.104	6.39 a ± 0.123
	70-100	0.137 d ± 0.008	1.850 d ± 0.102	6.41 a ± 0.132
P		**0.000*** **	**0.000*** **	**0.832 ns**

Values are mean. Values within columns followed by the same letter are not statistically different at 0.05 significance levels. NS: non-significant. Each entry is mean, n = 15

Soil organic carbon is the main source of energy for soil microorganisms. The ease and speed with which soil organic carbon becomes available is related to the soil organic matter fraction in which it resides. İn this respect, soil organic carbon can be partitioned into fractions based on the size and breakdown rates of the soil organic matter in which it is contained. İt is one of the most important constituents of the soil due to it is capacity to affect plant growth as both a source of energy and trigger for nutrient availability through mineralization. This study indicates that amount of organic carbon on research site associated to tree species. İn the soil profile under 50 years umbrella pine afforested, organic carbon concentrations were recorded 0-15 cm depth layer. However, organic accumulation at the surface being greater on more immature sites. Typically, coastal dune plantation dose not contain organic carbon. Therefore, the potential to increase the carbon capital in sandy dune soil is not significalt.

Soil pH in all soil depths under umbrella pine was significantly different among lower density levels. Soil pH values were changed between acid and alkalin. Results were significantly different among depth layers. Soil pH mean average among tree density were found to be 8.01, 7.97, 7.45 and 6.27 respectivily. Meanwhile, (a) tree density group was determined as alkalin soil with 8.09 mean average in 70-100 cm depth and (cd) tree density group was classified as acidic soil with 6.15 mean average in 0-5 cm depth layer (Table 5). According to results, soil of Terkos (Durusu) dune plantation under umbrella pine it is changed between acidic and alkalin. Here, likely forest floor plays a key role in soil surface. Possible organic matter decomposition products with higher pH decreased the acidity under forest soil species. Decomposition products enrich the substrate with carbon and moderate the pH values in Durusu dune plantation, Istanbul. Organic matter increased exponentially with decreasing pH. The acidity of the soil has a major influence on soil processes. Some field site show the expected pattern of acidification under vegetation cover in coastal dunes. Most typical dry dune plant species are adapted to fluctuating, extreme temperatures, drought and frequent soil moisture changes. The more stabilized conditions, which prevail during organic matter accumulation, support the growth of umbrella pine species. Soil under umbrella pine have more acidic pH degrees (Table 5). These pH scores under umbrella pine were indicative of the presence of organic acids from decomposed pine forest floor increased acidity in dune soil.

4. Conclusion

Costal dunes are classified as semi natural ecosystem in whic succession is initiated by fixation and driven by the complex of soil formation (humus accumulation) and vegetation succession. Coastal dune plants are subjected to natural multiple stresses and vulnerable to global change. Some changes associated with global change could interact in their effects on vegetation. As vegetation plays a fundamental role in bulding and stabilizing dune systems, effective coastal habitat management requires a better understanding of the combined effects of such changes on plant populations.

Soil organic matter is mainly composed of carbon, hydrogen and oxygen but also has small amounts of nutrients such as nitrogen, phosphorus, sulphur, potassium, calcium and magnesium contained within organic residues. Organic matter makes up just 2-10% of the soil mass but has a critical role in the physical, chemical and biological funtion of soils.carbon is a measureable component of soil organic matter.

Our results showed that umbrella pine species were able to grow and coverd the area by reducing sand dune movements and fertiled the research area with organic matter. This indicates that this species are adopted and an inherent ability to respond to Terkos-Durusu that is consistent with its role of primary colonizer of dune areas of high sand movement. İn conclusion, the present study suggests that increased nutrient availability may interact in their effects on dune plant perfomance, thus their combined effects may be not predicted by knowing the individual effects. This study elucidate the impact of low loads of carbon deposition on coastal dunes.

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