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A study of the soil-plant interactions of *Pistacia lentiscus* L. distributed in the western Anatolian part of Turkey

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This study was undertaken with the aim of illuminating the soil-plant interactions of *Pistacia lentiscus* L., which is a Mediterranean sclerophylleous coastal zone plant in the Western Anatolian part of Turkey. The soil analysis data showed that this plant grows on different kinds of soils such as sandy-clayey-loam, clayey-loam, sandy-loam and loamy texture. Soils are not saline, with pH moderately and slightly alkaline. This species prefers soils with low phosphorus and potassium contents, but with different calcium carbonate and nitrogen contents. Three negative linear correlations were observed between plant calcium and soil pH, plant nitrogen and soil calcium carbonate, plant potassium and soil calcium carbonate.

Key words: *Pistacia lentiscus*, autecology, Anatolia.

Introduction

Pistacia lentiscus L. (Anacardiaceae) is a small Mediterranean species, with a height of up to 8 m; it appears as an evergreen tree or shrub, distributed up to 800 m a.s.l. It appears in dry open woods and scrublands in the Mediterranean Region (extending to Portugal and Canary Islands), and in garrigues, maquis on sandy soils and dry rocky slopes. In Turkey, it is distributed throughout the Aegean and Mediterranean geographical regions (DAVIS 1966).

P. lentiscus has an economic value as it is the source of a traditional medicinal agent "gum" mastic, an oleoresin traditionally used in the perfume industry and as a chewing gum in many cultures, and used in pharmaceuticals, dental adhesives, and in high grade varnishes for protecting pictures. Mastic is composed of resinous exudates obtained from the stem and the main leaves of *P. lentiscus*. It is used as a food ingredient in the Mediterranean region. It has been discovered that mastic gum has been proved to kill the carcinogenic bacteria *Heliobacter pylori* which is responsible for peptic ulcers, very effectively (AL-SAID et al. 1986, MARONE et al. 2001). Therefore, clinically, mastic has been effective in the treatment of benign gastric ulcers (HUWEZ and AL-HABBAL 1986) and duodenal ulcers (AL-HABBAL et al. 1984).

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There have been various studies of *P. lentiscus*, especially after the discovery of the antimicrobial activity of its essential oils (TASSOU and NYCHAS 1995, IAUK et al. 1996, ALI-SHTAYEH and ABU GHDEIB 1999). Methanol extracts of *P. lentiscus* and *Thymus maroccanus* were very active against the virus *Herpes simplex* (MOUHAJIR et al. 2001).

There are also some studies about insecticidal effects of this species (TRABOULSI et al. 2002). The oils of *P. lentiscus* were more efficient against the eggs of the pest (LAMIRI et al. 2001). Insecticidal effects were detected when extracts of *P. lentiscus, Genista umbellata* and *Cachrys sicula* where mixed with the insect diet (PASCUAL-VILLALOBOS and ROBLEDO 1998).

There are also some studies about the chemical characteristics of this species. Young leaves of *P. lentiscus* were richer in nitrogen and tannins but poorer in carbohydrate contents, as compared to mature leaves (MARAKIS and DIAMANTOGLOU 1990). The essential oils of individual plants of *P. lentiscus* from Corsica, such as myrcene, limonene, terpinen-4-ol, alpha-pinene, beta-pinene, alpha-phellandrene, sabinene, p-cymene and gamma-terpinene were found to be the main constituents (CASTOLA et al. 2000).

SAWIDIS et al. (2000) investigated the distribution, anatomy and development of the resin duct system responsible for the resin exudation in *P. lentiscus* var. *chia*. They found that resin ducts were present in the stem, leaf and root located only in the phloem of the vascular bundles.

Pistacia lentiscus is well adapted to the semiarid Mediterranean basin. However, it is negatively affected by tourism, fire, degradation and deforestation of the region for plantation (especially for olive tree plantation) or for making secondary houses, etc. As a result of this pressure on the species, the number of individuals representing the species in the region has been reduced. To our knowledge, no detailed study of the soil and plant characteristics of *P. lentiscus* in our study area has been published. The aim of this study, then, is to find out some of the physical and chemical characteristics of soils supporting this species in the coastal zones of Western Anatolia, some of the chemical characteristics of the aerial parts of the plant, with materials collected from the study area, and the statistical relations between results of the analysis of soil and plant samples.

Investigated area

This study was carried out in the vicinity of five cities (Canakkale, Balikesir, Izmir, Aydin and Mugla) in the coastal region of West Anatolia in Turkey (Fig. 1). In West Anatolia, different geological and lithological structures can be seen. The structure of the study area, generally, is Palaeozoic metamorphic schist-gneiss, mica schist; alluvion, quaternary; Neogene marl, sand stone, soft limestone; Mesozoic limestone, flysch and ophiolite. Related to this structure, soils of the region, generally, are red Mediterranean soil--Alfisol, brown forest soil– Inceptisol, and alluvial soil (ATALAY 1994).

Meteorological data about drought level and other climatic conditions of the study area were obtained from the local meteorology stations of the five cities, and EMBERGER's formula was applied (NAHAL 1981) (Tab. 1). In EMBERGER's climate classification, the following climatic elements are used, taking into consideration the fact that plants are active between certain temperatures: the mean minimum temperature for the coldest month

Fig. 1. Map showing the plant and soil sample collection localities from West Anatolia.

Tab. 1. Meteorogical data obtained from the local meteorology stations of cities. P: annual precipitation, M: the mean maximum temperature for the hottest month, m: the mean minimum temperature for the coldest month, and Q: pluviothermic quotient values.

City	P (mm)	M (°C)	m (°C)	Q
Canakkale	628.5	30.2	2.8	78.2
Balikesir	594.8	30.7	1.5	70.4
Izmir	695.2	32.7	5.5	87
Aydin	670.1	35.1	4.2	73
Mugla	1209.2	32.8	1.6	133.5

(m), the mean maximum temperature for the hottest month (M), annual precipitation (P) and pluviothermic quotient values (Q). The study area is classified into humid and sub-humid bioclimatic zones, among six Mediterranean bioclimatic zones.

Material and methods

Collection of specimens

Plant specimens of *P. lentiscus* were collected at 20 localities along the West Anatolia in June 2000 (Fig. 1):

Izmir:	1. Gumuldur-Yenikoy, 2. Bornova-Ciceklikoyu, 3. Seferihisar-Akkum, 4. Cesmealti-Guvendik, 5. Karaburun-Mordogan, 6. Cesme, 7. Aliaga.
Aydin:	8. Didim-Akbuk, 9. Ortaklar, 10. Pamucak, 11. Davutlar-National Park, 12. Soke.
Balikesir:	13. Burhaniye, 14. Ayvalik, 15. Altinoluk.
Mugla:	16. Milas, 17. Bodrum-Gundogan, 18. Fethiye, 19. Marmaris-Ilicalar.
Canakkale:	20. Ezine-Geyikli.

Collected plants were identified according to DAVIS (1966). All the specimens were stored in a personal herbarium. For chemical analysis, the above-ground parts (stem, shoots, leaves, flowers) of the specimens were also collected. In this collection procedure, in each locality three sets of samples – at least one branch from top and bottom, and from four sides of the middle of the tree – each totally containing six branches, are collected. They are then, dried in an oven at 80 °C for 24 hours and milled.

Soil samples of *P. lentiscus* are taken from the same localities where the plant samples are collected. The litter on the surface of the soil is removed, and soil samples are collected from a depth of 15–20 cm, put into polyethylene bags and brought to the laboratory. They are left under laboratory conditions for air-drying. They are then passed through a 2 mm sieve and stored for analysis.

Physical chemical analysis

Total nitrogen in the soil and the plant is determined according to BREMNER (1965) by using the Kjeldahl method, phosphorus in the soil is determined according to BINGHAM (1949) and in the plant according to LOTT et al. (1956), using a Spectrum 2000 Spectrophotometer, potassium and calcium in the soil and the plant are determined according to PRATT (1965), using a Jenway Flame Photometer. Each measurement is repeated three times and the mean values of these measurements are presented as a result.

Data analysis

Regression models were developed for each effective factor through which the relationship between each factor of the soils (values obtained in this study about pH, calcium carbonate, total soluble salts, nitrogen, phosphorus and potassium) and the aerial parts of plant samples (nitrogen, phosphorus, potassium and calcium) are investigated. The estimators in the models are tested by t -test and the overall regression model by F-test at the significant level of 0.10. Moreover, R's of the models are discussed. All the regression models are obtained in the computer by using SPSS (Statistical Package for Social Sciences) statistical package.

Results

Pistacia lentiscus grows on sandy-clayey-loam, sandy-loam, clayey-loam and loamy soils. The pH, total soluble salts, calcium carbonate, nitrogen, phosphorus and potassium values of our soil samples range between 7.90–8.06, 0.030–0.111%, 1.220–40.800%, 0.042–2.114%, 0.00002–0.00050% and 0.020–0.074%, respectively (Tabs. 2, 3).

The nitrogen content values of the aerial materials of *P. lentiscus* range from 0.0882–1.4840%, phosphorus values lie between 0.068–0.980%, potassium content values fluctuate between 0.72 to 1.860%, and calcium contents of this species vary between 0.36 and 0.92% (Tab. 4).

Tab. 2. The results of physical analysis of the soils of *Pistacia lentiscus*. Loc.-locality number, S.D. -standard deviation, S.E.- standard error

Loc.	Sand %	Clay %	Silt %	Texture	PH	Salts %	$CaCO_3$ %
1	41.44	32.56	26	Sandy-clayey-loam	7.50	0.030	1.220
2	44.16	29.84	26	Sandy-clayey-loam	7.71	0.030	23.800
3	36.16	37.84	26	Clayey-loam	7.72	0.030	2.860
4	62.16	17.84	20	Sandy-loam	7.82	0.030	34.800
5	64.16	21.84	14	Sandy-clayey-loam	7.71	0.046	40.800
6	51.44	28.56	20	Sandy-clayey-loam	7.75	0.048	8.970
7	61.80	18.56	20	Sandy-loam	8.06	0.030	34.260
8	37.44	28.56	34	Loam	7.19	0.030	2.450
9	51.44	18.56	30	Sandy-loam	7.75	0.030	22.840
10	43.44	24.56	32	Loam	7.77	0.030	40.800
11	51.44	18.56	30	Sandy-loam	7.76	0.030	1.220
12	45.44	22.56	32	Loam	7.82	0.030	40.800
13	31.80	28.56	40	Clayey-loam	7.77	0.104	4.830
14	62.16	17.84	20	Sandy-loam	7.70	0.030	11.420
15	49.44	18.56	32	Loam	7.74	0.033	3.570
16	53.80	18.56	28	Sandy-loam	8.05	0.030	7.750
17	47.44	22.56	30	Loam	7.60	0.105	3.190
18	41.44	30.56	28	Clayey-loam	7.46	0.084	1.940
19	69.80	14.56	16	Sandy-loam	7.82	0.030	2.450
20	31.80	28.56	40	Clayey-loam	7.56	0.111	3.070
				Max:	8.06	0.111	40.800
				Min:	7.19	0.030	1.220
				Mean:	7.713	0.046	14.6520
				S.D.:	0.1919	0.029	15.4353
				S.E.:	0.043	0.0064	3.4514

Tab. 3. The results of chemical analysis of the soils of *Pistacia lentiscus.*

Loc.	N %	P %	K %
1	0.070	0.00002	0.025
2	0.266	0.00011	0.072
3	0.334	0.00020	0.068
4	0.117	0.00011	0.046
5	0.051	0.00002	0.039
6	0.119	0.00004	0.072
7	0.042	0.00002	0.034
8	0.612	0.00012	0.074
9	0.245	0.00010	0.025
10	0.090	0.00004	0.039
11	2.114	0.00012	0.050
12	0.119	0.00010	0.032
13	0.084	0.00004	0.010
14	0.049	0.00004	0.020
15	0.273	0.00010	0.025
16	0.056	0.00010	0.021
17	0.133	0.00050	0.039
18	0.336	0.00020	0.072
19	0.329	0.00020	0.039
20	0.321	0.00020	0.030
Max:	2.114	0.00050	0.074
Min:	0.042	0.00002	0.020
Mean:	0.2875	0.00012	0.043
S.D.:	0.4542	0.00011	0.0186
S.E.:	0.1016	0.00002	0.0042

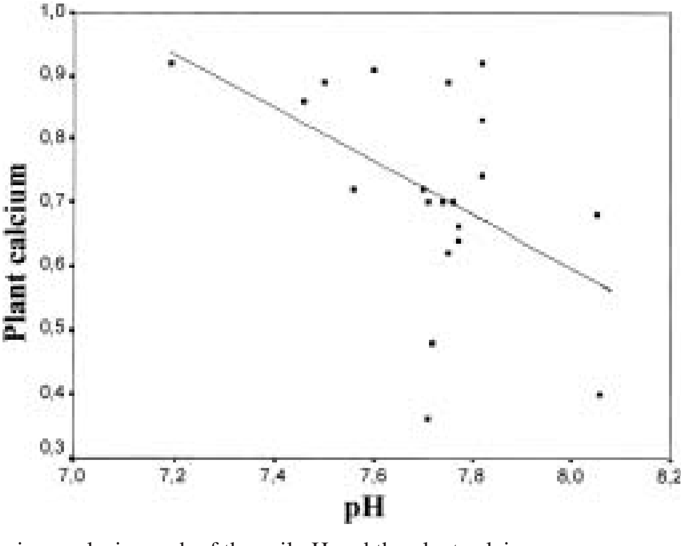

Fig. 2. Regression analysis graph of the soil pH and the plant calcium.

Tab. 4. The results of chemical analysis of the plant samples of *Pistacia lentiscus*.

Loc.	N %	P %	K %	Ca %
1	1.260	0.118	1.60	0.89
2	1.120	0.142	1.60	0.70
3	1.330	0.068	1.60	0.48
4	1.170	0.098	1.70	0.83
5	1.358	0.640	1.03	0.36
6	1.484	0.098	1.70	0.89
7	1.162	0.480	0.92	0.40
8	1.372	0.110	1.70	0.92
9	0.882	0.118	1.60	0.62
10	0.938	0.600	0.72	0.64
11	1.264	0.402	0.82	0.70
12	1.112	0.300	0.74	0.74
13	1.218	0.108	1.80	0.66
14	1.344	0.140	1.72	0.72
15	1.474	0.210	1.86	0.70
16	1.358	0.270	1.80	0.68
17	0.924	0.104	1.50	0.91
18	1.010	0.620	0.80	0.86
19	1.302	0.980	0.84	0.92
20	1.452	0.226	1.78	0.72
Max:	1.484	0.980	1.860	0.92
Min:	0.882	0.068	0.72	0.36
Mean:	1.2267	0.3357	1.3913	0.7170
S.D.:	0.1834	0.2891	0.4287	0.1652
S.E.:	0.0410	0.0646	0.0959	0.0369

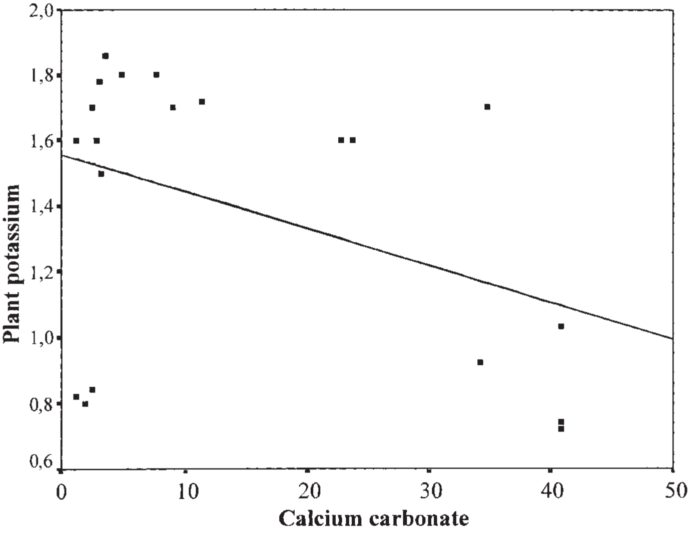

Fig. 3. Regression analysis graph of the soil calcium carbonate and the plant nitrogen.

Correlation coefficients and regression curves showed that three negative correlations exist between soil pH and plant calcium (R: 0.49) (Tab. 5, Fig. 2); soil calcium carbonate and plant potassium (R: 0.41) (Tab. 6, Fig. 3) and soil calcium carbonate and plant calcium (R: 0.49) (Tab. 7, Fig. 4).

Tab. 5. The results of regression analysis of the soil pH and the plant calcium in *Pistacia lentiscus*.

Model Summary

Model	R	R squared	R squared	Std. Error
1	0.489	0.239	0.197	0.1480

a Predictors: (Constant). pH

ANOVA

Model		Sum of squares	df	Mean square	F	p
1	Regression	0.124	1	0.124	5.649	0.029
	Residual	0.394	18	2.191E-02		
	Total	0.518	19			

a Predictors: (Constant). pH
b Dependent Variable: Plant calcium

Coefficients

Model		Unstandardized coefficients B	Std. Error	Standardized coefficients Beta	t	p
1	(Constant)	3.961	1.365		2.901	0.010
	PH	–0.421	0.177	–0.489	–2.377	0.029

a Dependent Variable: Plant calcium

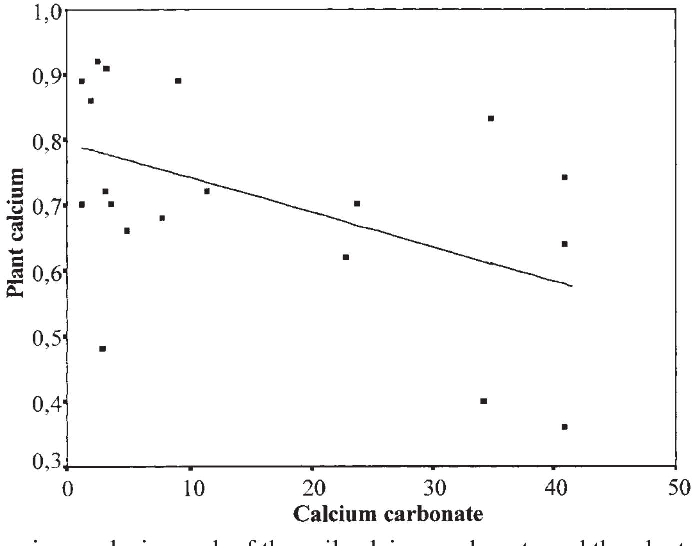

Fig. 4. Regression analysis graph of the soil calcium carbonate and the plant calcium.

Discussion

Climate is one of the most important factors in the plant development (VALLEJO et al. 1998). In western Anatolia, winters are warm and rainy, and summers are dry and hot, are covered by sclerophylleous tree and maquis species that need quite little water and high temperatures (TEMUCIN 1993). According to the pluviothermic quotient value and annual precipitation value that identified the general drought level, our study area can be classified into humid (Mugla) and sub-humid (Balikesir, Izmir, Aydin, Canakkale) bioclimatic zones, among the six Mediterranean bioclimatic zones. As a result of our study, we found in our study area that the species is most densely distributed in the sub-humid zone.

According to the mean minimum temperature for the coldest month in the Mediterranean bioclimatic zone, *P. lentiscus* is distributed in cool (Canakkale, Balikesir, Mugla) and temperate (Izmir, Aydin) variants. It was observed that *P. lentiscus* is distributed in a mixed form with some Mediterranean elements like C*istus* sp. L. (Cistaceae) and *Arbutus* sp. L. (Ericaceae), *P. terebinthus* L. (Anacardiaceae)*, Spartium junceum* L. (Fabaceae) and *Quercus coccifera* L. (Fagaceae) or in an individual *P. lentiscus* group. It is interesting to compare the results of this study and those for *P. terebinthus* subsp. *palaestina* (Boiss.) Engler (BASLAR et al. 1999), *S. junceum (*MERT et al. 1996), on *C. creticus* L. and *C. salviifolius*. L. (BASLAR et al. 2002a), *Arbustus unedo* L. and *A. andrachne* L. (BASLAR et al. 2002b) carried out in our study area, *Quercus cerris* L. var. *cerris* and *Phillyrea latifolia* L. (KUTBAY and KILINC 1994), *Q. cerris* L. (BUSSOTTI et al. 2000), *Q. ilex* L (BUSSOTTI et al. 2000, RAPP et al. 1992 and CANADELL and VILÀ 1992), and *Q. suber* (OLIVEIRA et al. 1996) carried out in the rest of Mediterranean area.

From the physical analysis of the soils, it was found in this study that *P. lentiscus* grows on sandy-clayey-loam (20%), sandy-loam (35%), clayey-loam (20%) and loamy (25%) soils. Similar soil characteristics are reported by BASLAR et al. (2002b) in their study on *A. unedo* and *A. andrachne*. On the other hand, *S. junceum* (MERT et al. 1996), *C. creticus* and *C. salviifolius* (BASLAR et al. 2002a) and *P. terebinthus* subsp. *palaestina* (BASLAR et al. 1999) generally prefer clayey-loam soils.

Soil analysis show that 90% of our soil samples are slightly alkaline and 10% are moderately alkaline, according to JACKSON's (1958) soil-pH classification. Similar preferences of alkaline soils are reported by some other researchers who studied in the same area. For example, BASLAR et al. (2002a) reported that 70% of their *C. creticus* and *C. salviifolius* samples prefer alkaline soils and BASLAR et al. (2002b) reported that soils of *A. unedo* and *A. andrachne* are slightly alkaline. On the other hand, *P. terebinthus* subsp. *palaestina* generally prefers neutral soils (BASLAR et al. 1999).

According to SCHEFFER and SCHACTSCHABEL (1956), 25% of our soils are poor in calcium carbonate content, 25% are moderate, 10% are rich and 40% are very rich. In other studies, it was reported that *S. junceum* (MERT et al. 1996), *C. creticus* and *C. salviifolius* (BASLAR et al. 2002a), *A. unedo* and *A. andrachne* (BASLAR et al. 2002b) and *P. terebinthus* subsp. *palaestina* (BASLAR et al. 1999) live in soils with various calcium carbonate concentrations.

With respect to soil salinity content (ANONYMOUS 1951), our soil samples are non-saline. In other studies analyses were carried out on *A. unedo* and *A. andrachne (*BASLAR et al. 2002b), *P. terebinthus* subsp. *palaestina* (BASLAR et al. 1999), *S. junceum* (MERT et al. 1996), *C. creticus* and *C. salviifolius* (BASLAR et al. (2002a).

According to soil nitrogen classification (LOUE 1968), it was found that 10% of our soils are poor, 20% moderate, 20% sufficient and 50% rich in nitrogen. KUTBAY and KILINC (1994) reported that the mean nitrogen concentrations of soils of *Q. cerris* var. *cerris* are 31% and of *P. latifolia* are 27%. Considering the results of this study (mean 28%), their results show some parallels with ours. A comparison of our data with those of BASLAR et al. (1999, 2002a) reveals that *C. creticus, C. salviifolius, A. unedo* and *A. andrachne* distributed in the same area live in soils with various nitrogen concentrations.

According to BINGHAM (1949) all of our soils are very deficient (less than 0.003%) in phosphorus. It was reported that *C. creticus* and *C. salviifolius* (BASLAR et al. 2002a), and *A. unedo* and *A. andrachne* (BASLAR et al. 2002b) are distributed in soils with similar phosphorus content characteristics with our soils. The mean phosphorus value of soils of *Q. cerris* var. *cerris* is reported as 0.002% and of soils of *P. latifolia* is reported as 0.004% (KUTBAY and KILINC 1994). Since the mean phosphorus value of our soils is 0.00012%, our results are well below those of KUTBAY and KILINC (1994). On the other hand, *S. junceum* (MERT et al. 1996), *P. terebinthus* subsp. *palaestina* (BASLAR et al. 1999) are reported to live in soils with various phosphorus concentrations.

Soils in West Anatolia are deficient (less than 0.35%) in potassium (PIZER 1967). Phosphorus is deficient in many Mediterranean soils, especially in terra rossa soils (HENKIN et al.1998). Similarly, it was reported that *S. junceum* live in soils with deficient potassium (MERT et al. 1996). On the other hand, all *P. terebinthus* subsp. *palaestina* (BASLAR et al. 1999), *C. creticus* and *C. salviifolius* (BASLAR et al. 2002a), and *A. unedo* and *A. andrachne* (BASLAR et al. 2002b) prefer soils with deficient potassium concentrations. The mean potassium value of our soils is 0.043%. If we compare this result with the results of *Q. cerris* var. *cerris* (mean 0.77%) and of *P. latifolia* (mean 0.35%) (KUTBAY and KILINC 1994), it is understood that our soils are relatively deficient, as well.

With respect to mineral content, the soils collected from our study area have the characteristics of the semi-arid Mediterranean basin, with infertile, nutrient-poor soils (PERRY et al. 1987). It was reported that evergreens tend to occur in such kinds of soil (SCHULZE 1982 in. KNOPS et al. 1997). Similarly, MONK (1966) stated that low level of phosphorus and potassium in the soil is the factor related to the distribution of evergreen species. Since *P. lentiscus* is an evergreen species, low level soil mineral values found in this study are the results expected.

Chemical analysis of the above-ground parts of *P. lentiscus*, a Mediterranean sclerophylleous species, showed that the mean nitrogen concentration of our plant samples is 1.226%. BASLAR et al. (2002b) reported that the mean nitrogen values of aerial parts of *A. unedo* and *A. andrachne* are 0.972% and 1.050%, respectively. Similarly, BASLAR et al. (1999) reported this value for *P. terebinthus* subsp. *palaestina* as 1.263%. BUSSOTTI et al. (2000) studied the nitrogen values of the leaves of *Q. cerris* and *Q. ilex* during three years, and they found that the value increases each year. The mean nitrogen value for the three years is reported as 2.01% and 1.36%, respectively, and the first year's results are 1.83% and 1.23%, respectively (BUSSOTTI et al. 2000). Both RAPP et al. (1992), and CANADELL and VILÀ (1992) studied *Q. ilex* and both authors reported that the mean nitrogen value of the aerial parts of the species is 1.02%. The same value for the leaves of *Q. suber* (OLIVEIRA et al. 1996), *Q. cerris* var. *cerris* and *P. latifolia* (KUTBAY and KILINC 1994) is reported as 1.08%, 1.38% and 1.41%, respectively.

From these results it can be understood that the mean nitrogen value of *P. lentiscus* found in this study is lower than those of deciduous *P. terebinthus* subsp. *palaestina* and *Q. cerris* and *evergreen Q. ilex* and *P. latifolia,* but higher than those of the evergreen *A. unedo*, *A. andrachne* and *Q. suber.* BUSSOTTI et al. (2000) declared that nitrogen values of leaves of *Q. ilex* and *Q. cerris* are relatively low. The leaves of sclerophyllous species from Mediterranean forests and maquis have a low concentration of nitrogen.

In this study, the mean phosphorus value of the aerial parts of *P. lentiscus* is found to be 0.336%. This value for the aerial parts of *A. unedo* has been reported as 0.551%, of *A. andrachne* as 0.522% (BASLAR et al. 2002b), of *P. terebinthus* subsp. *palaestina* as 0.040% (BASLAR et al. 1999), of *Q. ilex* as 0.120% (RAPP et al. 1992) and as 0.10% (CANADELL and VILÀ 1992), and the leaves of *Q. cerris* as 0.09% (BUSSOTTI et al. 2000), of *Q. ilex* as 0.08% (BUSSOTTI et al. 2000), of *Q. suber* as 0.14% (OLIVEIRA et al. 1996), of *Q. cerris* var. *cerris* as 0.002%, of *P. latifolia* as 0.004% (KUTBAY and KILINC 1994).

The mean phosphorus content of the species mentioned above are comparable with the mean phosphorus content of *P. lentiscus* and *A. unedo* and *A. andrachne*. Although our value is higher than the values of the rest of the Mediterranean species, in absolute terms it is low. According to BUSSOTTI et al. (2000), the phosphorus values of leaves of sclerophyllous species of Mediterranean forests and maquis have a low concentration of phosphorus, and LOVELESS (1962) suggested that the low level of phosphate intake in sclerophyllous and mesophytic leaves might be an important clue in the interpretation of sclerophylly. Similarly, many authors hypothesize that in evergreen Mediterranean vegetation, sclerophylly is a phenomenon of phosphorus deficiency (RICKLEFS and MATTHEWS 1982, COWLING and CAMPBELL 1983, RUNDELL 1988). Since *P. lentiscus* is a sclerophyllous evergreen Mediterranean species, the low level of phosphorus value found in this study is an expected result.

The mean content of potassium is found to be 1.391% in *P. lentiscus*. This value for some species distributed in the same study area is reported as 0.712 % in *A. unedo* and 0.521% in *A. andrachne* (BASLAR et al. 2002b), 0.630% in *P. terebinthus* subsp. *palaestina* (BASLAR et al. 1999). The same value for some other Mediterranean plants is determined as 0.87% in *Q. cerris* var. *cerris* and 0.55% in *P. latifolia* (KUTBAY and KILINC 1994), 1.01% in *Q. cerris* (BUSSOTTI et al. 2000), 0.35% *Q. suber* (OLIVEIRA et al. 1996), and in *Q. ilex* this value reported as 0.60% by BUSSOTTI et al. (2000), 0.88% by RAPP et al. (1992) and 0.65% by CANADELL and VILÀ (1992). Although our value seems to be low, in comparison to those of others listed above, our value is the richest.

The mean value of the calcium content of the above-ground parts of *P. lentiscus* is found to be 0.717% in this study. This value is reported by some authors studying in the same study area but on different taxa as being 1.34% in *P. terebinthus* subsp. *palaestina* (BASLAR et al. 1999), 0.684% in *A. unedo* and 0.887% in *A. andrachne* (BASLAR et al. 2002b). The same value for other Mediterranean elements is reported as 0.91% in *Q. cerris* (BUSSOTTI et al. 2000), as 0.41% in *Q. suber* (OLIVEIRA et al. 1996), and in *Q. ilex* it is stated as 0.54% by BUSSOTTI et al. (2000), as 0.98% by RAPP et al. (1992) and as 0.67% by CANADELL and VILÀ (1992). From the above cited literature, the mean calcium contents of the mentioned taxa vary between 0.41% (in *Q. suber*) and 1.34% (in *P. terebinthus* subsp. *palaestina*). Since the adequate limit of calcium content of plants is 0.93% (CHAPMAN 1967), our value is below the adequate limit but between the values of the above mentioned studies.

We determined three negative, weakly significant, linear correlations between nitrogen, phosphorus, potassium, pH, total soluble salts and calcium carbonate contents of the soils, and the aerial parts of plants. Regression curves and correlation coefficients showed that a negative correlation exists between soil pH and plant calcium (R: 0.49); between soil calcium carbonate and plant calcium (R: 0.49); and between soil calcium carbonate and plant potassium (R: 0.41). As seen from Tab. 5 and 7, the probability values of the soil pH and plant calcium, and soil calcium carbonate and plant calcium are less than 0.05, but that of the soil calcium carbonate and plant potassium is just above 0.05 (Tab. 6).

Since there is a direct relationship between the plant nutrient content and soil properties (KIZILGOZ et al. 2001), the reason of this weakness can be explained by relating these results with the physical characteristics of the region. The semiarid Mediterranean areas where this species is distributed are naturally characterized by long dry periods and scarce, rainfall (PERRY et al. 1987), resulting in the erosion of soils and specific contents of nitrogen and phosphorus (ARHONDITSIS et al. 2000). In the Mediterranean region, phosphorus is concentrated mainly in the top few centimetres of the soil (HENKIN et al. 1998). Mineral substances in open fields are washed away and the soil becomes thin (BASLAR et al. 2002a) and infertile (PERRY et al. 1987). Due to the thin soil layer and the transportation of mineral substances to the underground, plant roots do not penetrate sufficiently deep and plants cannot take in adequate amounts of minerals (DOGAN and MERT 1998, BASLAR et al. 2002a, 2002b). Similar results were previously reported by some authors who studied in the

Tab. 6. The results of regression analysis of the soil calcium carbonate and the plant potassium in *Pistacia lentiscus*.

Model Summary

Model	R	R square	Adjusted R square	Std. Error of the Estimate
1	0.407	0.165	0.119	0.4024

a Predictors: (Constant). Calcium carbonate

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	0.578	1	0.578	3.568	0.075
	Residual	2.914	18	0.162		
	Total	3.492	19			

a Predictors: (Constant). Calcium carbonate
b Dependent Variable: Plant potassium

Coefficients

Model		Unstandardized coefficients B	Std. Error	Standardized coefficients Beta	t	Sig.
1	(Constant)	1.557	0.365		2.901	0.010
	Calcium carbonate	–1.130E-02	0.177	–0.489	–2.377	0.029

a Dependent Variable: Plant potassium

Tab. 7. The results of regression analysis of the soil calcium carbonate and the plant calcium in *Pistacia lentiscus*.

Model Summary

Model	R	R square	Adjusted R square	Std. Error
1	0.494	0.244	0.202	0.1475

a Predictors: (Constant). Calcium carbonate

ANOVA

Model		Sum of squares	Df	Mean Square	F	p
1	Regression	0.127	1	0.127	5.822	0.027
	Residual	0.392	18	2.175E-02		
	Total	0.518	19			

a Predictors: (Constant). Calcium carbonate
b Dependent variable: Plant calcium

Coefficients

Model		Unstandardized coefficients B	Std. Error	Standardized coefficients Beta	t	p
1	(Constant)	0.795	0.046		17.258	0.000
	Calcium carbonate	–5.289E-03	0.002	–0.494	–2.413	0.027

a Dependent variable: Plant calcium

Aegean region of Turkey, with respect to some deciduous and evergreen sclerophyllous taxa (DOGAN and MERT 1998, BASLAR et al. 2002a, 2002b) and herbaceous species (BASLAR and MERT 1999, DOGAN 2001). On the other hand, this species is well adapted to the region.

Pistacia lentiscus is a low-growing shrub, well adapted to water-stress conditions (BAREA et al. 1992), and suitable for the fight against erosion, which is the one of the main factors in the desertification of semiarid Mediterranean ecosystems.

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