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Research Article

An Autecological Study on the *Vitex agnus-castus* L. *(Verbenaceae)* Distributed in West Anatolia

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Abstract: This study covers the investigation of the soil-plant relations of *Vitex agnus-castus* L. *(Verbenaceae)*, a typical element of Mediteranean macchia vegetation. Soils collected from 38 different localitis in West Anatolia were analysed together with the *V. agnus-castus* plants from the same localities. This plant was observed to generally prefer loamy-textured, neutral and slightly alkaline soils, poor in calcium carbonate, containing varying amounts of organic matter, being rich or very rich in nitrogen, rich in phosphorus and deficient in potassium. They grow on nonsaline soils. The relations between the results of soil and plant analysis were tested statistically, and correlation coefficient and regression curves determined.

Key Words: *Vitex agnus-castus,* Autecology, Soil.

Batı Anadolu'da Yayılış Gösteren *Vitex agnus-castus* L. (*Verbenaceae*) Üzerinde Autekolojik Bir Çalışma

Özet: Bu araştırmada Akdeniz-maki vejetasyonunun tipik elementi olan *Vitex agnus-castus* L.'un*(Verbenaceae)* toprak-bitki ilişkilerinden elde ettiğimiz sonuçlar değerlendirilmiştir. Batı Anadolu'da tesbit edilen 38 farklı lokaliteden, *V. agnus-castus* bitki örnekleriyle beraber, üzerinde yaşadığı toprak örnekleri toplanmış ve analize tabi tutulmuştur. Bu bitkinin genellikle tınlı bünyeli, nötr ve hafif alkali, kireçce fakir, tuzluluk etkisinin olmadığı, değişen miktarlarda organik madde içeren, azotlu ve azotça zengin, fosfor bakımından zengin, potasyumca eksik toprakları tercih ettiği tespit edilmiştir. Çalışma materyelimizin toprak ve bitki analizlerine ait sonuçlar arasınaki ilişkinin varlığı istatistiksel olarak araştırılmış, korelasyon katsayıları ve regresyon eğrileri tesbit edilmiştir.

Anahtar Sözcükler: *Vitex agnus-castus,* Autekoloji, Toprak.

Introduction

Turkey is divided into three main phytogeographical regions, namely, the Mediterranean, the Irano-Turanian and the Euro-Siberian. Of these, the Mediterranean region is typically characterized by macchia vegetation, one of the most important elements of which is *Vitex agnus-castus* L. Only a few studies have been done on this plant so far. Saden-Krehula and Kustrak (1) have reported the existence of progesterone and 17 a-hydroxyprogesterone hormones in the this species, whereas Wollenveber and Mann (2) have studied the flavonoids of this plant. Varma *et al.* (3) and Crouch & Van Staden (4) conducted investigations on the in vitro culture of *V. agnus-castus.* Lal et al. (5) studied the oxytoxic and antifertility effects of the seeds of *V. agnus–castus* on albino rats. However, no autecological studies have been done on this plant, in spite of the fact that is has great economical value, being used either for medicinal purposes or as dyeing material. The aim of this paper was to evaluate the soil-plant relations of this species following its natural distribution in West Anatolia.

Materials and Methods

Soil and plant samples of *V. agnus-castus* were collected from 38 different localities in Western Anatolia during Flowering (Table 1, Figure 1).

Soil samples were collected from 0-20 cm depth, brought to the laboratory, air-dried and sieved using 2 mm mesh. Texture, pH, total soluble salts, calcium carbonate and organic matter content determinations were made according to the methods detailed by Öztürk *et al.* (6). For nitrogen, phosphorus and postassium determination in soils samples were prepared using the Kjeldahl method and percentage content determined on a Spectronic-2 Bausch & Lomb spectrophotometer and Flame photometer, 655, respectively (7).

Table 1. List of localities from where soil and plant samples were collected.

1.	Manisa; Centre, Süngülü Village
2.	Manisa; Kırkağaç, Soma road side
3.	Manisa; Soma, Turgutalp Town exit, road side
4.	Manisa; Demirci, Yeşildere Village, old stream bed
5.	Manisa; Salihli, Demirköprü power plant environs, 2 km to Yeni Sindel Village
6.	Balıkesir; Savaştepe, Karaçam Village, near field
7.	Balıkesir; Ayvalık, Altınova, next to cemetery
8.	Balıkesir; Burhaniye, Karaağaç Town, naked fallow field
9.	Balıkesir; Edremit, City exit, olive field
10.	Balıkesir; Manyas, Entrance of Kızıksa, stream bank
11.	Balıkesir; Susurluk, City exit, next to military zone
12.	Çanakkale; Ayvacık, Süleymanköy
13.	Çanakkale; Bayramiç, old cemetery,
14.	Çanakkale; Ortaca Village, in the village
15.	Çanakkale; Lapseki, 3 km after Adatepe exit
16.	İzmir; Beydağ, Ova road, hill slope
17.	İzmir; Tire, Gökçen Town entrance
18.	İzmir; Bayındır, Yakacık Village cemetery
19.	İzmir; Menemen, Türkeli Village, peach field
20.	İzmir; Aliağa, Kalabak Village, İncirbükü environs
21.	İzmir; Selçuk, Çamlık, Aydın slope
22.	İzmir; Kınık, City entrance
23.	İzmir; Bergama, Bakırçay, near field
24.	Muğla; Bodrum, Turgutreis, City entrance
25.	Muğla; Yatağan, Maden, tobacco field
26.	Muğla; Ula, 4 km to Ula, near field
27.	Muğla; Köyceğiz, Doğuşbelen Village exit, corn field
28.	Muğla; Göcek, Göcek pass
29.	Denizli; Honaz, Town exit
30.	Denizli; Buldan, 9 km west
31.	Denizli; Sarayköy, Town exit, near field
32.	Aydın; Nazilli, Durasallı Village
33.	Aydın; Yenipazar, Ortaasya around
34.	Aydın; Sultanhisar, 3 km from city exit
35.	Aydın; Köşk, Baklaköy
36.	Aydın; Koçarlı, 7 km to Koçarlı, road side
37.	Aydın; Germencik, Neşetiye, fig field
38.	Aydın; Söke, 5 km to Ağaçlı Village

The above-ground parts of the plant (stem, leaves, flowers) were collected during flowering period for plant analysis. Plants were dried in an oven at 80 °C for 24 hours and milled. Total nitrogen was determined according to the Kjeldahl method (8), phosporus was determined by spectrophotometer (9), and potassium, calcium and sodium were determined by flame photometre according to the methods outlined in detail by Kacar (7).

Results of soil and plant samples were statistically tested, and regression curves and correlation coefficients obtained (10).

All the specimens were deposited in the herbarium at the Biology Dep., Buca Faculty of Education, Dokuz Eylül University.

Results

General Distribution

V. agnus-castus is a typical Mediterranean element and is widely distributed in the world. The main areas include the Mediterranean (13), Southern Europe, West Asia, Crimea, Caucasus (Azerbaijan, Georgia, Armenia) (12), Iran, Africa boreals (12), from Central Asia to India (1, 14), and in sheltered positions in New-York (11).

The distribution areas of this species in Turkey are as follows: Thrace, Outer Anatolia, Antakya, Maraş, Amanus and Western and Southern Anatolia (12, 13, 15). The localities we have recorded follow: (B1) Manisa: Süngüllü village (DEBB 216), Kırkağaç (DEBB 217), Soma-Turgutalp (DEBB 218); Balıkesir: Savaştepe-Karaçam

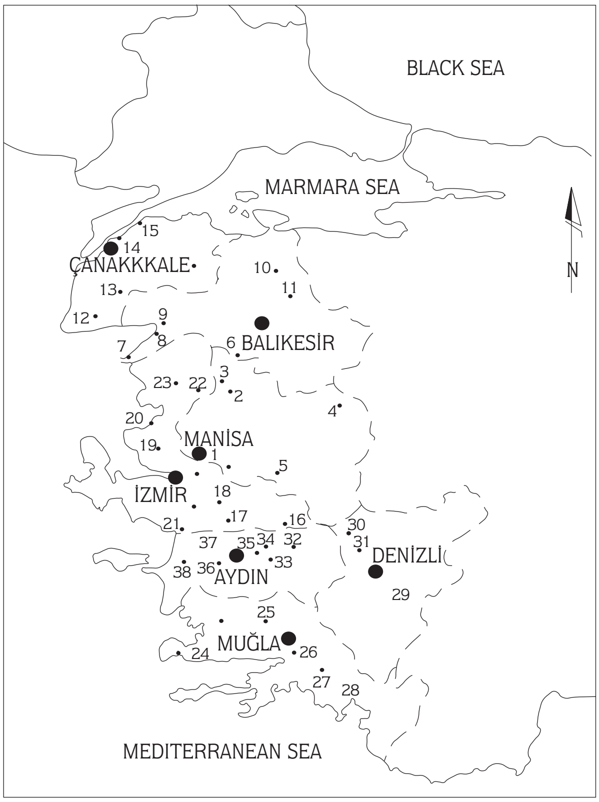

Figure 1. Map showing collection sites of *V. agnus castus* in West Anatolia.

village (DEBB 221), Ayvalık-Altınova (DEBB 222), Burhaniye-Karaağaç town (DEBB 223), Edremit (DEBB 224), Manyas-Kızıksa (DEBB 225), Susurluk (DEBB 226); Çanakkale: Ortaca village (DEBB 229), Ayvalık-Süleymanköy (DEBB 227), Bayramiç (DEBB 228), Lapseki-Adatepe (DEBB 230); İzmir: Tire-Gökçen (DEBB 202, Bayındır-Yakacık village (DEBB 203), Menemen-Türkeli village (DEBB 204), Aliağa-Kalabak village (DEBB 205), Kınık (DEBB 207), Bergama-Bakırçay (DEBB 208). (B2) Manisa: Demirci-Yeşildere village (DEBB 219); Salihli-Yeni Sindel village (DEBB 220), İzmir: Beydağ (DEBB 201); Denizli: Buldan (DEBB 237). (C1) İzmir: Selçuk-Çamlık (DEBB 206); Muğla: Bodrum-Turgutreis (DEBB 231); Aydın: Koçarlı (DEBB 213), Germencik-Neşetiye (DEBB 214), Söke-Ağaçlı village (DEBB 215). (C2) Muğla: Yatağan-Maden (DEBB 232), Ula (DEBB 233), Köyceğiz-Doğuşbelen village (DEBB 234), Göcek (DEBB 235); Denizli: Honaz (DEBB 230), Sarayköy (DEBB 238); Aydın: Durasallı village (DEBB 209), Yenipazar (DEBB 210), Sultanhisar(DEBB 211), Köşk-Baklaköy (DEBB 212).

Ecological Distribution:

V. agnus-castus generally grows alongside the banks of streams and in valleys, damp places, on littoral habitats, mostly on sandy soils, parched alluvial soils, rocky areas near the sea, also on limestone slopes, and on sunny and hot places and in ditches. The distribution area of the plant extends into innermost western Anatolia, parallel to the sea, particularly the areas in which Mediterranean climate is dominant.

It grows along the Mediterranean and Aegean coasts penetrating inwards up to approximately 250 km and between altitudes from sea level to 750 m. However, Boissier (12) has reported its existence up to 1200 m.

Soil Analysis:

Soil supporting *V. agnus-castus* generally has clayey loam, loamy or silty texture. According to the results presented in Table 2, pH, total soluble salts, calcium carbonate, organic matter, nitrogen, phosporus and potassium values range between 6.28-7.98, 0.006-0.187%, 0.1-29.29%, 0.31-5.8%, 0.102-1.304%, 0.001-0.0095% and 0.0036-0.0934% respectively.

Plant Analysis:

The results of the analysis of plants collected during flowering season are presented in Table 3. On dry weight basis nitrogen, phosphorus, potassium, calcium and sodium values vary between 0.734,1.980%, 0.007-0.204%, 0.62-1.44%, 0.18-0.90% and 0.04-0.22% respectively.

Statistical Analysis:

Statistical analysis of results presented above reveals that a correlation exists between soil pposphorus and plant phosphorus, (Fig. 2); soil phosphorus and plant pottassium, (Fig. 3); soil potassium and plant potassium, (Fig. 4); and soil calcium carbonate and plant sodium (Fig. 5). Other results gave neither a positive nor a negative correlation.

Discussion

Soil texture results show that 57.90% are loamy, 36.85% clayey loam and 5.26% silty in nature, thus indicating that this plant grows mainly on loamy soils. It has been reported by various researchers that plants such as *Ceratonia siligua* L. *(Caesalpiniaceae)*, *Inula graveolens* (L.) Desf. (*Asteraceae)* and *Asphodelus aestivus* L. (*Liliaceae*), which, like *V. agnus-castus,* are Mediterranean elements, generally prefer loamy soils (16-18).

Table 2. Physical and chemical analysis results of the soils.

Locality	Texture	pH	T.S. Salts %	CaCO3 %	Org. Mat. %	N %	P %	K %
1	Loamy	7.47	0.060	0.79	1.44	0.130	0.0020	0.0156
2	Loamy	7.90	0.067	26.39	2.28	0.964	0.0043	0.0174
3	Silty	7.46	0.053	23.38	5.80	0.692	0.0039	0.0183
4	Loamy	7.17	0.006	0.40	1.10	0.118	0.0006	0.0036
5	Clayey-loam	7.34	0.020	0.89	1.48	0.862	0.0002	0.0441
6	Clayey-loam	7.45	0.142	9.13	2.40	0.104	0.0039	0.0268
7	Clayey-loam	7.52	0.157	23.20	2.28	0.102	0.0014	0.0314
8	Clayey-loam	7.77	0.102	5.94	1.10	0.156	0.0016	0.0351
9	Loamy	7.72	0.033	4.83	0.31	0.108	0.0037	0.0105
10	Loamy	7.37	0.068	1.67	3.68	0.324	0.0021	0.0318
11	Loamy	7.62	0.017	2.46	1.32	0.254	0.0001	0.0059
12	Clayey-loam	7.40	0.187	2.14	1.84	0.706	0.0089	0.0748
13	Silty	7.30	0.186	27.53	5.52	0.254	0.0084	0.0300
14	Clayey-loam	7.14	0.129	1.43	2.28	0.706	0.0027	0.0200
15	Clayey-loam	7.40	0.133	29.29	1.72	0.254	0.0001	0.0092
16	Loamy	7.66	0.062	3.07	2.28	0.108	0.0003	0.0060
17	Clayey-loam	7.30	0.074	0.97	3.44	0.134	0.0034	0.0250
18	Clayey-loam	7.37	0.053	1.62	3.24	0.142	0.0095	0.0290
19	Loamy	7.30	0.082	1.53	1.84	0.150	0.0034	0.0699
20	Loamy	6.28	0.079	0.10	3.92	0.680	0.0022	0.0150
21	Clayey-loam	7.42	0.053	2.87	1.66	0.586	0.0021	0.0124
22	Clayey-loam	7.28	0.133	9.29	4.72	0.624	0.0033	0.0934
23	Loamy	6.75	0.020	0.10	0.57	0.148	0.0015	0.0171
24	Loamy	7.38	0.063	1.36	2.24	0.996	0.0016	0.0166
25	Clayey-Loam	7.50	0.114	22.58	3.00	0.126	0.0010	0.0392
26	Loamy	7.07	0.063	1.20	1.76	0.148	0.0017	0.0131
27	Loamy	7.88	0.068	4.95	2.88	0.122	0.0004	0.0036
28	Clayey-loam	7.33	0.078	1.20	2.52	0.132	0.0001	0.0107
29	Loamy	7.18	0.028	3.99	2.27	0.138	0.0033	0.0124
30	Loamy	7.60	0.019	2.00	1.20	1.304	0.0005	0.0048
31	Loamy	7.66	0.039	9.18	0.46	0.112	0.0010	0.0083
32	Loamy	7.98	0.045	0.48	0.31	0.892	0.0065	0.0300
33	Clayey-Loam	7.39	0.095	1.12	1.56	0.118	0.0089	0.0387
34	Loamy	7.48	0.057	0.64	0.63	0.102	0.0011	0.0076
35	Loamy	7.25	0.024	0.40	1.00	0.632	0.0011	0.0055
36	Loamy	7.48	0.034	3.91	0.57	0.154	0.0035	0.0152
37	Loamy	7.59	0.038	5.59	1.10	0.132	0.0027	0.0076
38	Loamy	7.23	0.060	2.15	3.24	0.840	0.0021	0.0071
Min.		6.28	0.006	0.10	0.31	0.102	0.0001	0.0036
Max.		7.98	0.187	29.29	5.80	1.304	0.0095	0.0934
Mean		7.405	0.072	6.310	2.131	0.395	0.0027	0.0249
S.D.*		0.304	0.047	8.776	1.351	0.352	0.0026	0.0227
S.E.**		0.049	0.008	1.424	0.219	0.057	0.0004	0.0037

* Standart Deviation

** Standart Error

Table 3. Chemical analysis results of the plant samples.

Locality	N %	P %	K %	Ca %	Na %
1	1.648	0.078	0.92	0.56	0.04
2	1.540	0.108	1.16	0.78	0.06
3	1.244	0.088	1.24	0.76	0.04
4	1.302	0.080	1.08	0.48	0.04
5	0.918	0.072	1.38	0.46	0.10
6	1.688	0.044	0.82	0.50	0.16
7	1.980	0.042	0.88	0.70	0.08
8	1.645	0.092	0.94	0.48	0.10
9	1.526	0.106	1.02	0.54	0.12
10	1.630	0.150	0.98	0.60	0.04
11	1.660	0.100	1.02	0.58	0.14
12	1.514	0.064	0.82	0.56	0.10
13	1.218	0.060	1.14	0.42	0.06
14	1.676	0.044	0.92	0.52	0.08
15	1.916	0.026	0.92	0.76	0.16
16	0.734	0.078	1.06	0.18	0.04
17	1.156	0.007	1.04	0.42	0.04
18	1.044	0.104	1.24	0.46	0.08
19	1.498	0.092	1.10	0.60	0.06
20	1.204	0.108	1.44	0.42	0.10
21	1.414	0.072	1.04	0.54	0.04
22	1.680	0.076	1.34	0.72	0.06
23	1.778	0.072	1.16	0.90	0.06
24	1.330	0.108	0.74	0.54	0.22
25	1.638	0.020	0.92	0.72	0.06
26	1.414	0.116	0.90	0.66	0.04
27	1.470	0.080	0.62	0.42	0.06
28	1.120	0.016	0.94	0.42	0.04
29	1.638	0.076	1.16	0.60	0.04
30	0.882	0.080	1.06	0.36	0.04
31	1.680	0.108	1.04	0.66	0.04
32	1.400	0.204	1.34	0.42	0.06
33	1.638	0.156	1.08	0.66	0.04
34	1.890	0.024	0.96	0.54	0.04
35	1.162	0.056	1.14	0.48	0.04
36	1.428	0.072	0.88	0.60	0.08
37	1.918	0.116	1.26	0.66	0.04
38	1.190	0.032	1.06	0.48	0.08
Min.	0.734	0.007	0.90	0.18	0.04
Max.	1.980	0.204	1.99	0.90	0.22
Mean	1.458	0.080	1.275	0.557	0.072
S.D.*	0.300	0.041	0.317	0.139	0.042
S.E.**	0.049	0.007	0.051	0.023	0.007

* Standart Deviation

** Standart Error

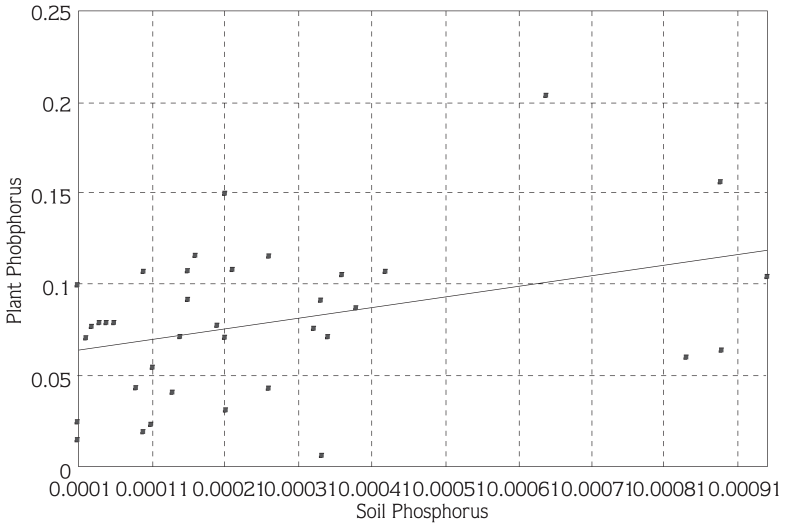

Figure 2. Regression analysis graph of soil phosphorus and plant phosphorus.

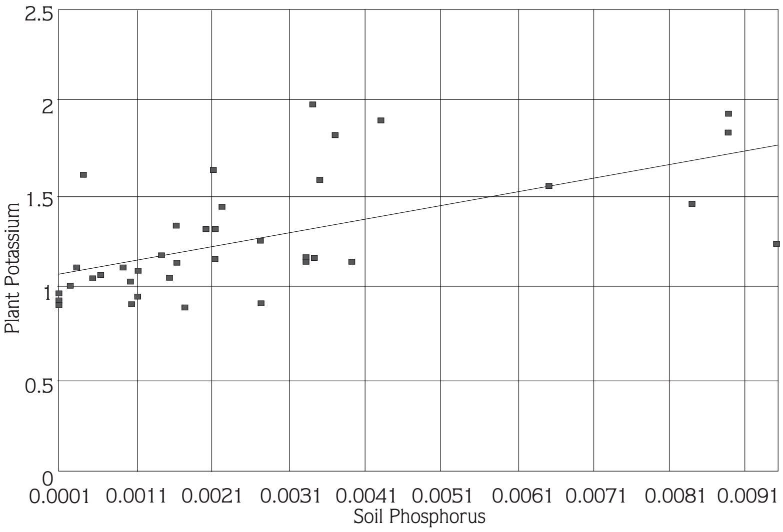

Figure 3. Regression analysis graph of soil phosphorus and plant potassium

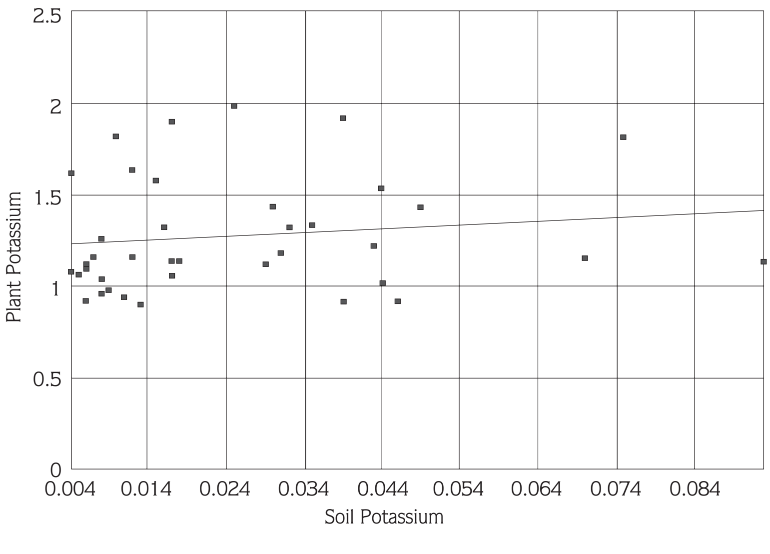

Figure 4. Regression analysis graph of soil potassium and plant potassium

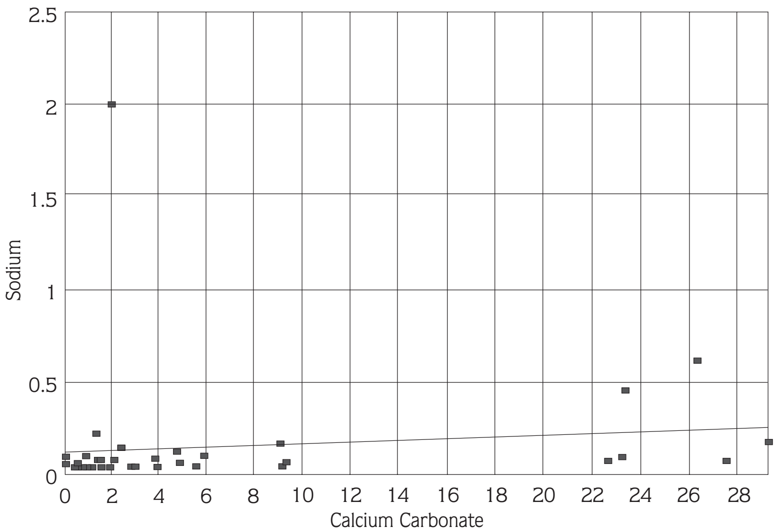

Figure 5. Regression analysis graph of calcium carbonate and plant sodium.

The pH of the soils varied between 6.28-7.98, accordingly 2.63% of the soils were weakly acidic, 44.74% neutral, 47.38% slightly alkaline and 5.26% moderately alkaline. It hes been observed that mediterranean plants such as *Myrtus communis* L. (*Myrtaceae*) (20), *Inula graveolens* (17), W *Inula viscosa* (L.) Aiton (*Asteraceae*) (21), *Pistacia lentiscus* L. (Anacardiaceae) (22), *Asphodelus aestivus* (18), *Vicia sativa* L. (*Fabaceae*) (19) and *Capparis ovata* Desf. (Capparaceae) (23) prefer neutral or slightly alkaline soils, as does *V. agnus-castus.*

Soil salinity values varied between 0.40-29.29%, and in 92.12% of the soils salinity effect was very rare but in 7.90% it was rare. From this it is clear than our plant grows in soils where very little salinty effect is observed. It has been reported that *Asphorelus aestivus,Vicia sativa, Capparis spinosa* L. (*Capparaceae*) and *C. ovata,* prefer soils where the salinity effect is negligible, as does *V. agnus-castus* (18, 19, 23). From this, it is may be concluded that *V. agnus-castus* can be included in the glycophyte group.

The $CaCO_3$ content of the soils was between 0.40-29.29%. In accordance with this, 52.63% of these soils were poor, 18.42% medium, 15.79% rich and 13.16% very rich in $CaCO_3$, depicting the fact that *V. agnus-castus* prefers soils poor in $CaCO_3$. Species such as *Pistacia lentiscus* (22), *Asphodelus aestivus* (18), *Vicia sativa* (19), *Capparis spinosa* and *C. ovata* (23), distributed in Western Anatolia, have been reported to prefer soils poor in $CaCO_3$. We can thus conclude that a major part of the typical Mediterranean elements prefer soils poor in $CaCo_3$. An increase in the $CaCO_3$ content in the soils results in e decrease in the growth behaviour of *V. agnus-castus.*

The organic matter content of the soils varies between 0.31-5.80%; accordingly, 31.58% of the soils were very poor, 2.63% poor, 34.22% moderately rich, 23.67% rich and 7.90% very rich in organic matter. *V. agnus-castus* grows on all knids of soils. On the other hand, it has been reported that *Pistacia lentiscus* (22), *Inula viscosa* (21) and *Capparis ovata* (23), distributed in Western Anatolia, prefer soils moderately rich and rich in organic matter content, while it has been observed that *Myrtus communis* (22), *Asphodelus aestivus* (18) and *Vicia sativa* (19) grow in soils poorer in organic matter.

Of the samples studied 50% were sufficient in nitrogen content and 50% were in it. This indicates that this species prefers nitrogenous soils. *Capparis* species growing in West Anatoila have also been reported to prefer nitrogen-rich soils (23).

23.69% of the soils supporting *V. agnus-castus* were poor in phosphorus while 26.32% were moderate and 50% rich in this element. This reveals that this plant prefers soils rich in phosphorus rather than those poor and moderately rich. It has been reported that mediterranean plants such as *Pistacia lentiscus, Capparis ovata* and *Capparis spinosa,* distributed in this region, prefer soils rich in phosphorus (22, 23), but that *Asphodelus aestivus,* which also grows in this region, prefers soils poor in phosphorus (18).

As for potassium content, 44.74% of the soils were deficient, 13.16% low, 7.90% sufficient, 13.16% high and 21.10% very high in this element. From this it can be concluded that *V. agnus-castus* generally prefers soils deficient in potassium. Species such as *Asphodelus aestivus, Capparis ovata* and *Capparis ovata* and *Capparis spinosa,* likewise prefer soils poor in potassium, while *Pistacia lentiscus,* a plant of the same region, prefers soils sufficient in pottasium, as reported by Pirdal (18), Öztürk & Ataç (22) and Özdemir & Öztürk (23).

Since *V. agnus-castus* is a naturally growing plant species, it was not possible to determine ranges for elemental analysis in plant samples, which are avaliable for cultivated species only.

The regression curves and the correlation coefficients were obtained by statistical examination of the results. According to the data, the relation between soil phosphorus and plant phosphorus was weak (r: 0.3626), but medium between soil phosphorus and the plant potassium (r:0.5769), soil potassium and plant potassium (r:0.6469), and soil calcium carbonate and plant sodium (r:5173). All these relations were positive. The highest relation was observed between soil potassium and plant potassium. Neither a negative nor a positive relation was found in the other analysis data.

Very few ecological studies have been conducted on plants growing in Turkey which are used as dye source are quite limited. As such, ecological studies on *V. agnus-castus,* which is a source of dye for carpets, kilims and textiles in Western Anatolia is of great importance. This plant is also used in pharmaceuticals, apiculture and landscape architecture arrangements, further augmenting the importance of this plant.

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