Turkish Journal of Botany

Volume 25 | Number 3 Article 4

1-1-2001

A Study on the Autecology of Reseda lutea L. (Resedaceae) Distributed in Western Anatolia

YUNUS DOĞAN

Turk J Bot
25 (2001) 137-148

Research Article

A Study on the Autecology of *Reseda lutea* L. (*Resedaceae*) Distributed in Western Anatolia

Yunus DOĞAN
Dokuz Eylül University, Faculty of Education, Dept. of Biology, 35150-Buca, İzmir - TURKEY

Received: 25.11.1999
Accepted: 08.12.2000

Abstract: The aim of this study was to determine the autecological characteristics of *Reseda lutea* L. (*Resedaceae*) distributed in Western Anatolia. The chemical and physical analysis was carried out on soil and plant samples collected from 54 different localities in Western Anatolia. The results show that the plant generally prefers sandy-loam and sandy-clayey-loam textural soils, with a slightly alkaline or medium alkaline pH. They prefer non-saline, calcareous soils which are poor in potassium and phosphorus, but the nitrogen content of the soils was found to vary greatly. The soil and plant analysis results were evaluated statistically and correlations were established.

Key Words: *Reseda lutea*, Autecology, Distribution, Soil-plant relations

Batı Anadolu'da Yayılış Gösteren *Reseda lutea* L.'nın (*Resedaceae*) Otekolojisi Üzerine Bir Çalışma

Özet: Bu çalışmada, Batı Anadolu'da yayılış gösteren *Reseda lutea* L. (*Resedaceae*)'nın otekolojik özelliklerinin araştırılması amaçlanmıştır. Batı Anadolu'dan tesbit edilen 54 farklı lokaliteden toplanan toprak ve bitki örnekleri kimyasal ve fiziksel analizlere tabi tutulmuşlardır. Toprak analiz sonuçlarına göre; bitki, tekstür açısından genellikle kumlu tınlı ve kumlu killi; pH bakımında hafif alkali ve orta alkali toprakları tercih ettiği tesbit saptanmıştır. Yine bitkinin tuzluluk etkisinin olmadığı; çok kireçli, potasyum ve fosfor bakımdan yetersiz, azot bakımından her türlü toprakta yetişebildiği görülmüştür. Ayrıca toprak ve bitki analiz sonuçları istatistiksel olarak değerlendirilmiştir

Anahtar Sözcükler: *Reseda lutea*, Autekoloji, Yayılış, Toprak-bitki ilişkileri

Introduction

For an understanding of the biological characteristics of a species, it is important to have knowledge of its habitats. The number of studies on the ecology of plants in Turkey has increased remarkably. However the number of studies is still insufficient when the floristic richness of Turkey is taken into consideration (Doğan, 1998).

No ecological studies have been done on *Reseda lutea* L. (*Resedaceae*), a widespread species in Turkey.

Reseda lutea has great economical value in the Turkish carpet and kilim industry, where it is used as a natural dye source together with *R. luteola* (Eyüboğlu et al., 1983; Uğur, 1988; Anonymous, 1991). The yellow colour in dyes is principally obtained from *R. lutea* and *R. luteola* in Turkey (Anonymous, 1991). In spite of the fact that the best colour is obtained from the whole plant of *R. lutea,* collected before fruiting period (Eyüboğlu et al., 1983; Uğur, 1988), it has been reported that better colour can be obtained from the flowers and young shoots of *R. lutea* (Uğur, 1988; Anonymous, 1991; Öztürk and Özçelik, 1991). Dry or fresh plant material can be used for extraction of the dye.

According to one study carried out in Poland, thirty plant species have been used there for the improvement of apiculture (Jablonski et al., 1992). *R. lutea* is one of these, together with *R. luteola* L., *Centaurea scabiosa* L., *C. rhenana* Bor., *Circium oleraceum* (L.) Scop., *Solidago*

canadensis L., *S. serotina* Ait., *Scrophularia nodosa* L. and *S. alata* Gillib. The researchers recommended the use of these species on unfertile soils so as to increase nectar secretion.

In Australia and Iran, cattle breeders have been using *R. lutea* for grazing, as a dry food source in winter time and as a fresh food source in spring and summer (Moghaddam, 1977; Heap et al., 1995).

It has been reported that *R. lutea* is a harmful weed in carrot and potato fields in England and Scotland (Forbes and Mathews, 1985) and in crop fields in the United States, Iran, Australia and Poland (Bailey and Wicks, 1995; Abdallah and De Witt, 1978). It spreads easily through seeds, but can be reproduced vegetatively as well from pieces of root. The agricultural equipment used for the ploughing of cultivated fields breaks its roots into pieces and thus the plant spreads vegetatively. The weedy nature of this species sometimes causes a loss of 35% in crop fields (Heap et al., 1987).

The struggle to control this plant is especially difficult due to the fact that its long roots penetrate deep into the soil. The chemical combinations used against the weedy nature of *R. lutea* are numerous, but Metsulfuron has been found to produce successful results (Harris et al., 1995). According to Heap et al. (1995) Metsulfuron-methyl, Chlorosulfuron and Trialsulfuron can be successfully used against *R. lutea*, but Metsulfuron-methyl is the most economical of these. The following chemical herbicides are also used against *R. lutea*: Combinations of Metsulfuron and 2,4-D, and combinations of Dicamba, Glyphosate, Picloram and 2,4-D, Chlorimuron-ethyl, Tribenuron-methyl, Thifensulfuron, Dicamba/Bromoxynil/MCPA, Diflufenican, Clopyralid, Mecoprop/Dicamba, Imazethapyr, Fluroxypyr, Picloram/MCPA, Glyphosate, Picloram/2,4-D, Alloy and Glean (Heap et al, 1987; Harris et al.,1995).

Reseda lutea presents a potential threat to cucurbit crops in Australia and Iran because it is a potential host for watermelon mosaic virus (Heap et al., 1995; Amiri and Ebrahim-Nesbat, 1977). Watermelon mosaic virus occurs in South Australia as an economically damaging pest of several cucurbit crops and spreads through aphids (Heap et al., 1995). The pathogens and insects of *R. lutea* have been dealt with in detail by Bailey and Wicks (1995).

Pemberton and Irwing (1990) carried out studies on 47 species from 13 families distributed naturally in the United States and they investigated the elaiosomes and myrmecochory features in the seeds of *R. lutea*.

Gibbs (1974) recorded the existence of raffinose (carbohydrate), cyanogenic glycosides, glycobarbari from mustard-oil glucodes, gliconaturtiin m- carboxyphenyl-l-ananine, and leucoanthocyanins in the seeds and myrosin cells in *R. lutea*. Ferlay et al. (1993) reported the existence of lipids in the seeds and claimed that linolenic acid accounts for 60% of its fatty acid content.

This plant is also used to prevent erosion because of its fast growing roots which reach a depth of 80-100 cm or even 400 cm in very loose soils (Heap et al., 1995; Bruns and Jochimsen, 1989; Jochimsen and Janzen 1991). *R. lutea* has been used as a scatrizane, diuretic, sedative and sudorific (Bonnier, 1934). McIntryre et al. (1988) reported that the roots of this plant have diuretic and diarrheal properties.

The present study was undertaken in view of the economical potential of *R. lutea* as a natural source of dye in the kilim and carpet industry, as grazing material and a stock feeding source in cattle breeding, as a means of obtaining high nectar secretion in apiculture, and as the primary successional plant in the struggle against erosion and weedy nature, as outlined above.

For this purpose, *R. lutea* specimens collected from 54 different localities in Western Anatolia were investigated with regard to their autecological characteristics.

Material and Methods

The specimens of *R. lutea* were collected from 54 different localities in Western Anatolia and identified with the help of "Flora of Turkey and the East Aegean Islands" (Davis, 1965). All the specimens of *R. lutea* were deposited in the herbarium of the Biology Dept., Faculty of Education, Dokuz Eylül University under the code of Dogan. In addition to the plant samples, soil samples were also taken from the same localities. The sample area numbers of *R. lutea* in Western Anatolia, the grid-square numbers according to Davis (1965), and the localities, altitudes, the code of the herbarium records and collection dates are given in Table 1 and Figure 1.

Table 1. Localities of *Reseda lutea* in Western Anatolia, where the soil and plant samples were collected.

Çanakkale
1. A1 Ecebat, between Alçıtepe and Eceabat, 1.5 km to Eceabat, field border, 50 m, 24.06.1997, Dogan 239.
2. A1 Eceabat, near Yahyaçavuş Monument, wheat field, 60 m, 24.06.1997, Dogan 240.
3. B1 Ayvacık, Nusratlı Village, near the main road, 300 m, 23.06.1997, Dogan 241.
4. A1 Lapseki, 5 km to Şevketiye, 40 m, 25.06.1997, Dogan 242.
5. A1 Çanakkale, 10 km from the city centre, field border, 30 m, 24.06.1997, Dogan 243.

Balıkesir
6. B1 Ayvalık, city exit, side of Edremit-Çan road, 22.06.1997, Dogan 244.
7. B2 Bigadiç, 5 km from the city centre, field border, 350 m, 29.06.1997, Dogan 245.
8. B2 Bigadiç, Çağış Village, 170 m, 29.06.1997, Dogan 246.
9. B1 Balıkesir, entrance to the city centre, roadside, 80 m, 28.06.1997, Dogan 247.
10. B1 Savaştepe, Soğucak Village, field border, 400 m, 28.06.1997, Dogan 248.
11. A2 Bandırma, city entrance, roadside, 130 m, 27.06.1997, Dogan 249.
12. A1 Gönen, Taştepe Village, roadside, 70 m, 26.06.1997, Dogan 250.

Manisa
13. B1 Spil Mountain, around Atalanı, 1200 m, 04.06.1997, Dogan 251.
14. B1 Sabuncubeli slope, 470 m, 04.06.1997, Dogan 252.
15. B1 Centre, Dilşeker locality, base of a wall, 25 m, 04.06.1997, Dogan 253.
16. B1 Akhisar, 20 km from Akhisar, on the İzmir-İstanbul main road, 50 m, 04.06.1997, Dogan 254.
17. B2 Akhisar, 20 km from Gördes, field border, 720 m, 04.06.1997, Dogan 255.
18. B2 Gördes, Softalar locality, road side, 800 m, 05.06.1997, Dogan 256.
19. B2 Demirci, upper part of Klavuzlar Village, 760 m, 05.06.1997, Dogan 257.
20. B2 Kula, city entrance, on the Uşak-İzmir main road, 560 m, 06.06.1997, Dogan 258.
21. B2 Sarıgöl, near Sarıgöl-Buldan road, 225 m, 06.06.1997, Dogan 259.

İzmir
22. B1 Dikili, entrance to Salihler, near İzmir-Çanakkale road, in the field, 50 m, 17.06.1997, Dogan 260.
23. B2 Bergama, 5 km to Bergama, descent to Kozak plain, 50 m, 17.06.1997, Dogan 261.
24. B1 Gümüldür, Yeniköy exit, road side, 50 m, 19.06.1997, Dogan 262.
25. C1 Selçuk, city exit, towards Belevi, road side, 50 m, 19.06.1997, Dogan 263.
26. B1 Bornova exit, Manisa road, near MTA building, 200 m, 20.06.1997, Dogan 264.
27. B1 Seferihisar, Akkum, 50 m to sea side, 25 m, 19.06.1997, Dogan 265.
28. B1 Urla, Çeşmealtı, near the pine forest, 25 m, 20.06.1997, Dogan 266.
29. B1 Karaburun, Mordoğan, city centre, field border, 50 m, 20.06.1997, Dogan 267.
30. B1 Çeşme, around Boyalık, 50 m, 20.06.1997, Dogan 268.
31. B1 Konak, near Şirinyer old aqueduct, in the park, 60 m, 20.06.1997, Dogan 269.
32. B1 Aliağa, city centre, 40 m, 21.06.1997, Dogan 270.

Aydın
33. C2 Kuşadası, entrance to Kadınlar Plajı, 50 m, 31.05.1997, Dogan 271.
34. C2 Söke, 8 km to Söke, in the field, 260 m, 31.05.1997, Dogan 272.
35. C2 Ortaklar, city exit, towards İzmir, field border, 50 m, 03.06.1997, Dogan 273.
36. C2 Didim, Akbük cross-roads, roadside, 150 m, 31.05.1997, Dogan 274.

Denizli
37. B2 Güney, 19 km to Güney, near Sarıgöl-Güney road, 750 m, 07.06.1997, Dogan 275.
38. B2 Güney, between Güney and Çal, near Çal road, 800 m, 07.06.1997, Dogan 276.
39. B2 Çal, in Kabalar village, 830 m, 07.06.1997, Dogan 277.
40. C2 Denizli, between Denizli-Çal, Güzelpınar, field border, 1200 m, 08.06.1997, Dogan 278.
41. C2 Denizli, city centre, towards Tavas, 520 m, 08.06.1997, Dogan 279.
42. C2 Honaz Mountain, upper part of Kocapınar village, near the field, 1500 m, 09.06.1997, Dogan 280.
43. C2 Tavas, near Denizli-Tavas road, 1150 m, 09.06.1997, Dogan 281.
44. B2 Çal, entrance to Denizler town, 875 m, 10.06.1997, Dogan 282.
45. B2 Çivril, in Yamanlar Village, 850 m, 10.06.1997, Dogan 283.
46. C2 Baklan, in Hadım Village, 850 m, .06.1997, Dogan 284.
47. C2 Pamukkale, near the south gate of Pamukkale (Hierapolis), 340 m, 11.06.1997, Dogan 285.

Muğla
48. C2 Milas, exit of Ovabat Village, 500 m, 01.06.1997, Dogan 286.
49. C2 Yatağan, near Stratonikeia cross-roads, in the fallow field, 550 m, 01.06.1997, Dogan 287.
50. C2 Ula, Kızılağaç environs, road side, 700 m, 02.06.1997, Dogan 288.
51. C2 Muğla, city exit, upper part of Science-Art Faculty, near the new water tank, 700 m, 02.06.1997, Dogan 289.

Kütahya
52. B2 Şaphane, city exit, towards Gediz, 750 m, 12.06.1997, Dogan 290.
53. B2 Gediz, Abideler village exit, towards Gediz, 625 m, 12.06.1997, Dogan 291

Uşak
54. B2 Uşak, 20 km to city centre, Gediz-Uşak road side, near the field, 575 m, 11.06.1997, Dogan 292.

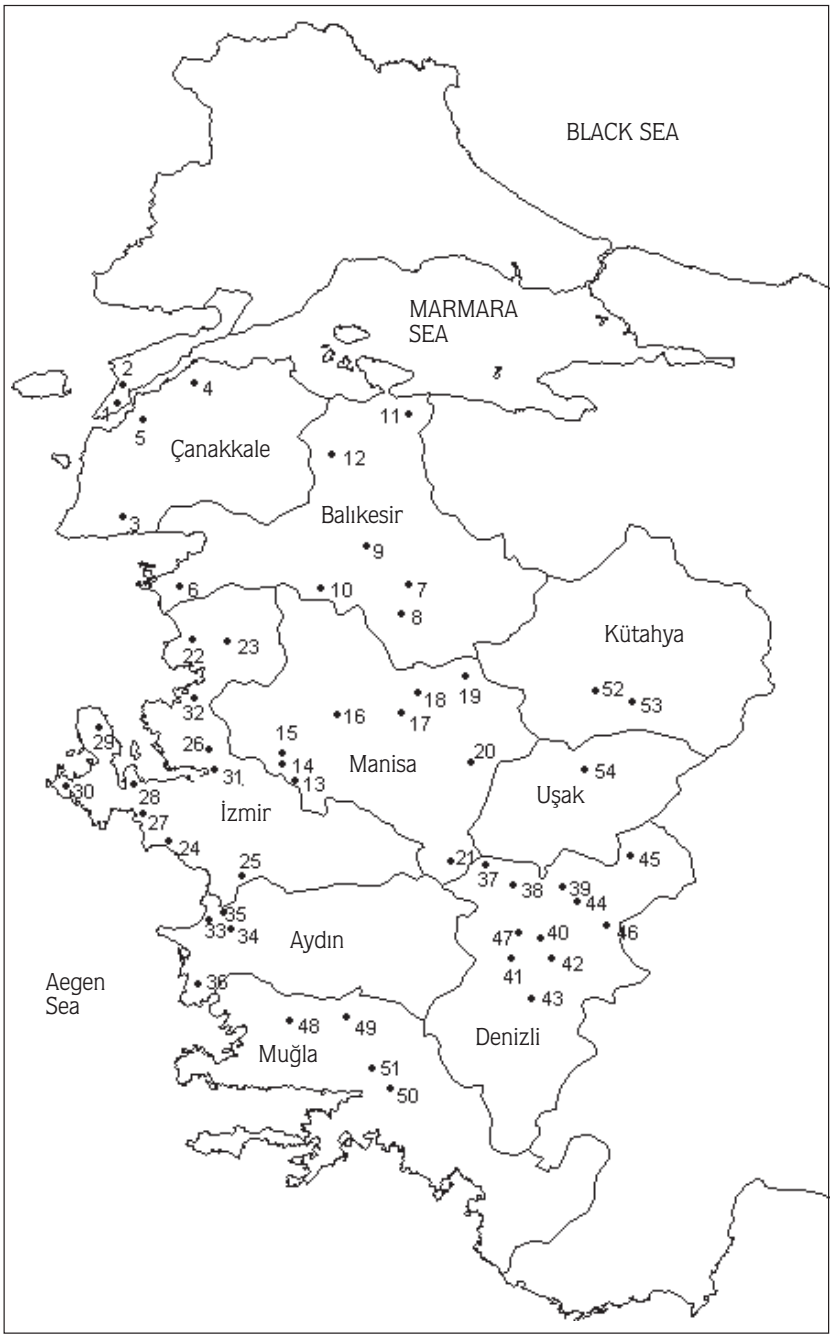

Figure 1. Map showing the collection sites of *R. lutea* from Western Anatolia.

The soil samples were collected from the localities given in Table 1 during the period June-July 1997. The litter on the surface of the soil was removed, and the soil samples were collected from a depth of 15-20 cm, put into polyethylene bags and brought immediately to the laboratory. They were left under laboratory conditions for air-drying. The dried samples were ground, passed through a 2-mm sieve and subjected to analysis. The textural classification, pH, total soluble salts, and calcium carbonate contents in the soils were determined by the methods outlined in detail by Öztürk et al. (1997). Total nitrogen was determined according to Bremner (1965) by the Kjeldahl method, phosphorus was determined according to Bingham (1949), and potassium was determined according to Pratt (1965). Phosphorus and potassium were read from a Spectrum 2000

Spectrophotometer and a Jenway Flame photometer respectively. The results for the soil structure were evaluated according to Bouyoucos (1955), with the pH according to Jackson (1958), CaCO3 according to Scheffer and Schactschabel (1956), total salt according to Anonymous (1951), nitrogen according to Loue (1968), phosphorus according to Bingham (1949) and potassium according to Pizer (1967).

The plant samples were collected from 54 different localities in the flowering and fruiting periods during of June-July, 1997. They were dried at 80° C in an air-blown oven for 24 hours, ground with a blender and subjected to analysis separately in two sets. In the first set all the various parts (root, stem, leaf and flower) of the plants were analysed, whereas in the second set the root, stem, leaf and flowers of plant samples from 10 localities, i.e., localities 1, 5, 6, 10, 13, 21, 24, 28, 36 and 47 were analyzed. Total nitrogen in the plants was determined according to Bremner (1965) using the Kjeldahl method, phosphorus was evaluated according to Lott et al. (1956) and read from a Spectrum 2000 spectrophotometer. The potassium and calcium values in the samples were read directly from a Jenway Flame photometer according to Kacar (1972). The nitrogen and potassium results were interpreted according to Kacar (1972), with the interpretation of phosphorus levels according to Johnson and Ulrich (1959) and calcium levels according to Chapman (1967).

The plant analysis results (nitrogen, phosphorus, potassium and calcium) and soil analysis results (pH, total soluble salts, calcium carbonate, total nitrogen, phosphorus and potassium) were subjected to statistical analysis using a multiple stepwise regression analysis. The results were interpreted according to Daniel and Terrell (1995), İkiz et al. (1996) and McClave et al. (1998).

Results and Discussion

Geographical Distribution

Reseda lutea is widely distributed throughout the various temperature zones of the world. The areas of distribution in the world are as follows: South, Western and Central Europe extending up to Finland, Norway, Sweden (Davis, 1965); England (Abdallah and De Witt, 1965; Abdallah, 1967); the Mediterranean basin, Asia Minor (Heap et al., 1995; Harris et al., 1995); Southwest Asia (Bonnier, 1934; Tutin et al., 1964; Bailey, 1947); Iran (Davis, 1965); and the former Soviet Union, Afghanistan, Chile, the United States (Harris et al., 1995), Australia, New Zealand, South and North Africa (Bonnier, 1934; Tutin et al., 1964; Bailey, 1947).

It is also widely distributed in Turkey. The localities recorded by Davis (1965) and during our field studies are as follows: A1: Çanakkale (Centre [5]; Eceabat [1]; Eceabat [2]; Lapseki [4]); Balıkesir (Gönen [12]); Takirdağ (Marmara Ereğlisi (Davis, 1965)). A2: Balıkesir (Bandırma [11]); İstanbul (Makriköy (Davis, 1965)); Kocaeli (İzmit (Davis, 1965)). A2/3: Bilecik (Centre (Davis, 1965)). A3: Sakarya (Gevye (Davis, 1965)). A4: Karabük (Safranbolu (Davis, 1965)). A5: Amasya (Centre (Davis, 1965)). A6: Samsun (Centre (Davis, 1965)). A7: Trabzon (Centre (Davis, 1965)); Gümüşhane (Torul (25.07.1997, Dogan 293)). A8: Artvin (Çoruh (Davis, 1965)). A9: Kars (Aras valley (Davis, 1965)). B1: Çanakkale (Ayvacık [3]); Balıkesir (Centre [9]; Ayvalık [6]; Savaştepe [10]); Manisa (Centre [15]; Spil Mountain [13]; Sabuncubeli [14]; Akhisar [16]); İzmir (Dikili [22]; Bergama [23]; Gümüldür [24]; Bornova [26]; Bornova (Davis, 1965); Seferihisar [27]; Urla [28]; Karaburun [29]; Çeşme [30]; Konak [31]; Aliağa [32]). B2: Balıkesir (Bigadiç [7]; Bigadiç [8]); Manisa (Akhisar [17]; Gördes [18]; Demirci [19]; Kula [20]; Sarıgöl [21]), Denizli (Güney [37]; Güney [38]; Çal [39]; Çal [44]; Çivril [45]); Kütahya (Şaphane [52]; Gediz [53]; Gediz to Uşak (Davis, 1965)); Uşak [54]. B3: Konya (Akşehir (Davis, 1965)). B4: Ankara (Tuz lake (Davis, 1965)). B5: Nevşehir (Ürgüp (12.08.1997, Dogan 294)). B6: Kahramanmaraş (Nurhak Mountain (Davis, 1965)). B7: Erzincan (Keşiş mountain (Davis, 1965)). B8: Erzurum (mountains between Ilıca and Tercan (Davis, 1965)). B9: Bitlis (Adilcevaz (Davis, 1965)). C1: İzmir (Selçuk [25]); Aydın (Kuşadası [33]; Söke [34]; Ortaklar [35]; Didim [36]); Muğla (Milas [48]). C2: Denizli (Centre [41]; Güzelpınar [40]; Honaz Mountain [42]; Tavas [43]; Baklan [46]; Pamukkale [47]); Muğla (Centre [51]; Yatağan [49]; Ula [50]); Afyon (Denizli to Çardak (Davis, 1965)). C3: Isparta (Sütçüler to Darıbükü (Davis, 1965)). C4: İçel (Mut-Silifke (06.04.1998, Dogan 295)); Antalya (Alanya (12.04.1998, Dogan 301)); Konya (Konya to Sille (Davis, 1965)). C5: Adana (highway (08.04.1998, Dogan 297); Adana exit (08.04.1998, Dogan 298)); İçel (Tarsus (07.04.1998, Dogan 296); Tarsus (Davis, 1965)); Hatay (Samandağ (11.04.1998, Dogan 300)). C6: Gaziantep (Nizip (09.04.1998, Dogan 299)); Adana (Seyhan-

Haruniye (Davis, 1965)). C8: Siirt (Centre (Davis, 1965)). C9: Hakkari (Zab (Davis, 1965)). C10: Hakkari (Cilo Mountain (Davis, 1965)). The geographical distribution given above clearly shows that the ecological amplitude of *R. lutea*, as a cosmopolite species, is very wide.

Ecological Distribution

Reseda lutea occurs at roadsides, and in fallow fields, field borders, ditches, waste places, old buildings, walls, rocky slopes, open stony hillsides, fields, cultivated and disturbed ground in Western Anatolia. This plant was observed as being mainly a ruderal species in our study area. These results are in agreement with the results of Davis (1965) and Heap et al. (1995).

In terms of altitude, it occurs from 25 m to 1500 m in Western Anatolia according to our field observations (Table 1). However, Davis (1965) reported that the plant can grow at up to 2000 m, and Moghaddam (1977) reported that this plant can grow at 300-1900 m in Iran. Özçelik and Öztürk (1991) stated that the plant can grow at up to 2300 m in Turkey. According to Moghaddam (1977), *R. lutea* grows well between -25 and 50° C, under a yearly precipitation varying from 100 to 400 mm. In Turkey, the plant grows at up to 2300 m in Eastern Anatolia. This shows that the plant can live at higher altitudes than those reported by Moghaddam (1977). Bolle (1936) and Abdallah (1967) stated that the plant has some xeric features such as a deep and wide root system and tracheids on the leaf margins, which contain water-storage cells. These features suggest that this plant can adapt to drought easily.

Reseda lutea is adapted to light conditions. This is clear from the sample areas and the habitats it occupies, which are open and have sparse vegetation. This shows that *R. lutea* is a heliophytic plant. The roots go very deep into the soil and spread out; thus giving it a chance to draw water from deeper sources, thus avoiding drought. Heap et al. (1995) reported that the plant roots can reach a depth of 4 m of soil, but we observed 2-m-deep roots in loose soils. Moghaddam (1977), Bruns and Jochimsen (1989) and Jochimsen and Janzen (1991) reported that this plant is one of the best soil binders and can be used in the prevention of erosion, in mined areas and along spoiled banks. In this respect, our observations were in accordance with those of the authors named above.

Reseda lutea is not found in pure communities in Western Anatolia. It grows mainly in small groups or individually. However, it has been found to form communities in carrot and potato fields in England and Scotland (1985), and in crop fields in Hungary, the U.S.A. and Australia (Heap et al., 1995; Abdallah and De Witt, 1978; Heap et al., 1987), where it results in crop loss. No such behaviour has yet been observed or reported from cultivated areas in Turkey, with the exception that Özgökçe et al. (1999) encountered it growing as a weed in some wheat fields.

Physical Analysis of the Soils

The physical analysis of the soils taken from 54 different localities of *R. lutea* revealed that 44.4% of the soils were sandy-loam; 27.75%, sandy-clayey-loam; 9.25%, clayey-loam; 9.25%, loamy; 5.55%, loamy-sand; 1.85%, clay; and 1.85% were silty-loam in texture (Bouyoucos, 1955). This suggests that the plant generally prefers sandy-loam and sandy-clayey-loam soils (Table 2). Heap et al. (1995) stated that *R. lutea* grows on a wide range of soils from sandy Mallee soils to red-brown clayey loam soils in South Australia and that this is very similar to our results. The pH of soils supporting *R. lutea* in Western Anatolia varies from 7.17 to 8.3: 5.55% of the soils were found to be neutral, 64.75% were slightly alkaline and 29.60% were moderately alkaline in nature (Table 2), indicating that this plant usually prefers slightly alkaline to moderately alkaline soils. Heap (1994) and Heap et al. (1995) reported that this plant largely prefers slightly alkaline soils in South Australia. Our results thus concur with those of Heap (1994) and Heap et al. (1995). The soluble salt content in the soils was found to vary from 0.030% to 0.050% (Table 2). None of these soils exhibited a salinity effect according to the classification given for salinity (Anonymous, 1951). *R. lutea* appears to be a glycophyte, but this was not reported by Heap (1994), Heap et al. (1995) or Harris et al. (1995), who investigated this species botanically in detail. In the present study, it was determined that the $CaCO_3$ content of the soils varied from 0.408% to 40.800% (Table 2). These results showed that 20.35% of the soils were poor in $CaCO_3$, while 3.70% were medium, 12.95% were rich and 62.90% were very rich in $CaCO_3$ (Scheffer and Schactschabel, 1956). It can be seen that this plant generally prefers calcareous soils, but can live on poor and medium calcareous soils as well. Abdallah and De Witt (1978) stated that *R. lutea* is

Table 2. Physical analysis of the soils of *Reseda lutea*.

Loc.	Sand (%)	Clay (%)	Silt (%)	Structure	pH	Salinity (%)	$CaCO_3$ (%)
1	58.16	23.84	18	Sandy-clayey-loam	7.70	0.03	7.749
2	62.16	17.84	20	Sandy-loam	7.96	0.03	14.68
3	60.16	21.84	18	Sandy-clayey-loam	7.96	0.03	8.970
4	52.16	27.84	20	Sandy-clayey-loam	7.65	0.03	2.450
5	44.16	29.84	26	Sandy-clayey-loam	8.00	0.03	27.33
6	74.16	17.84	8	Sandy-loam	7.75	0.03	9.790
7	52.16	27.84	20	Sandy-clayey-loam	7.57	0.03	17.950
8	64.16	21.84	14	Sandy-clayey-loam	7.79	0.03	31.820
9	62.16	19.84	18	Sandy-loam	7.64	0.03	14.680
10	28.16	17.84	51	Silty-loam	7.70	0.03	40.800
11	72.16	13.84	14	Sandy-loam	8.02	0.03	24.470
12	72.16	17.84	10	Sandy-loam	7.39	0.03	0.816
13	66.16	17.84	16	Sandy-loam	7.88	0.03	11.420
14	86.16	9.84	4	Loamy-sand	8.30	0.03	15.500
15	62.16	17.84	20	Sandy-loam	7.54	0.03	36.710
16	70.16	13.84	16	Sandy-loam	7.84	0.03	11.420
17	72.16	21.84	6	Sandy-clayey-loam	7.65	0.03	0.408
18	36.16	37.84	26	Clayey-loam	7.64	0.05	34.260
19	68.16	19.84	12	Sandy-loam	7.89	0.03	33.450
20	78.16	9.84	12	Sandy-loam	7.79	0.03	0.816
21	78.16	7.84	14	Loamy-sand	7.81	0.03	3.260
22	64.16	25.84	10	Sandy-clayey-loam	7.89	0.03	40.800
23	81.44	8.56	10	Loamy-sand	7.17	0.03	0.816
24	41.44	32.56	26	Sandy-clayey-loam	7.50	0.03	1.220
25	71.44	8.56	20	Sandy-loam	7.44	0.03	29.780
26	45.44	34.56	20	Sandy-clayey-loam	7.72	0.03	23.660
27	41.44	30.56	28	Clayey-loam	7.71	0.03	2.860
28	55.44	18.56	26	Sandy-loam	7.92	0.03	35.080
29	61.44	22.56	16	Sandy-clayey-loam	7.68	0.03	40.800
30	53.44	24.56	22	Sandy-clayey-loam	7.77	0.03	11.420
31	55.44	18.56	26	Sandy-loam	7.75	0.03	7.750
32	61.44	18.56	20	Sandy-loam	8.10	0.03	22.840
33	37.44	28.56	34	Loamy	7.72	0.03	40.800
34	47.44	22.56	30	Loamy	7.70	0.03	16.310
35	59.44	16.56	24	Sandy-loam	7.82	0.03	25.290
36	49.44	18.56	32	Loamy	7.19	0.03	2.450
37	45.44	22.56	32	Loamy	7.95	0.03	40.800
38	31.44	38.56	30	Clayey-loam	7.50	0.03	40.800
39	61.44	14.56	24	Sandy-loam	7.95	0.03	34.260
40	57.44	18.56	24	Sandy-loam	7.82	0.03	5.710
41	43.44	24.56	32	Loamy	7.88	0.03	30.590
42	57.44	24.56	18	Sandy-clayey-loam	7.65	0.03	40.800
43	51.44	18.56	30	Sandy-loam	7.76	0.03	1.630
44	51.44	28.56	20	Sandy-clayey-loam	7.46	0.05	17.560
45	47.44	30.56	22	Sandy-clayey-loam	8.06	0.03	16.320
46	61.80	18.56	20	Sandy-loam	8.05	0.03	36.710
47	67.80	14.56	18	Sandy-loam	7.96	0.03	36.710
48	69.80	12.56	18	Sandy-loam	8.06	0.03	15.500
49	23.80	32.56	44	Clayey-loam	7.75	0.03	40.800
50	31.80	28.56	40	Clayey-loam	7.56	0.03	1.220
51	69.80	14.56	16	Sandy-loam	7.79	0.03	2.450
52	71.80	14.56	14	Sandy-loam	8.10	0.03	6.530
53	53.80	18.56	28	Sandy-loam	8.06	0.03	8.970
54	27.80	42.56	30	Clay	8.02	0.03	35.890
Min					7.17	0.030	0.408
Max.					8.30	0.050	40.800
Mean					7.776	0.031	19.701
S.D.					0.226	0.0049	14.569
S.E.					0.031	0.0007	1.983

distributed mostly on calcareous and to some extent on non-calcareous. Clapham et al. (1962) and Grubb (1976) stated that it is distributed especially in calcareous areas. The results of Abdallah and De Witt (1978), Clapham et al. (1962) and Grubb (1976) thus support our findings.

Chemical Analysis of the Soils

Chemical analysis of the *R. lutea* soils showed that the total nitrogen content varied from 0.028 to 0.644% (Table 3). These soils can be classified as follows: 16.65%, poor; 40.70%, medium; 12.95%, sufficient; and 18.50%, very rich in nitrogen (Loue, 1968). The plant thus seems to show no preference as to nitrogen content. When the results for soil phosphorus are examined, it can be seen that the values varied from 0.00002 to 0.00060% (Table 3). Bingham's classification (1949) for phosphorus content in soils reveals that the soils of all 54 different localities were poor in phosphorus. The potassium content of the soils varied from 0.080% to 0.780% (Table 3). All the soils were below the limit of deficiency according to the potassium classification of Pizer (1967).

Chemical Analysis of the Plants

The plant samples of *R. lutea* collected from 54 localities in Western Anatolia showed that the nitrogen contents varied from 1.246% to 3.318%. It has been reported that total nitrogen content varied from 0.2 to 6.0% on a dry-weight basis (1972). The nitrogen content of this plants lies between these values (Table 4). Harris et al. (1995) and Davis et al. (1993) reported that this plant contains nitrate at a high level. It has been determined that *R. lutea* is a very desirable food for farm animals, and the level of nitrate is 2.5-3.1% from the first leaves up to the first flowering. Although this nitrate level is high, it has not been found to cause injury or death in farm animals (Davis et al., 1993). The nitrate level obtained in the present study varied in the range of 1.246-3.318%, which is similar to the results of Davis et al. (1993) and Harris et al. (1995). Again, in our area, no negative effects of this high nitrate level on farm animals were observed. The phosphorus percentage in these plant samples varied from 0.054 to 0.340% (Table 4). These values lie within the limits of Johnson and Ulrich (1959), 0.01-1.0% on a dry-weight basis. The potassium content in the *R. lutea* plant samples varied from 2 to 7% (Table 4). According to Kacar (1972), the potassium contents of plants vary from 0.2 to 11%, so the results of potassium analysis in these samples lie within the limits given by

Table 3. Chemical analysis of the soils of *Reseda lutea*.

Loc.	N (%)	P (%)	K (%)
1	0.070	0.00036	0.053
2	0.077	0.00007	0.019
3	0.098	0.00007	0.013
4	0.126	0.00011	0.028
5	0.070	0.00004	0.020
6	0.049	0.00004	0.019
7	0.161	0.00050	0.074
8	0.084	0.00007	0.064
9	0.077	0.00030	0.041
10	0.133	0.00013	0.018
11	0.028	0.00002	0.008
12	0.091	0.00040	0.030
13	0.091	0.00011	0.023
14	0.028	0.00002	0.020
15	0.154	0.00025	0.046
16	0.126	0.00023	0.072
17	0.042	0.00015	0.025
18	0.049	0.00010	0.025
19	0.084	0.00007	0.050
20	0.070	0.00025	0.062
21	0.070	0.00036	0.047
22	0.056	0.00004	0.047
23	0.105	0.00046	0.029
24	0.070	0.00002	0.025
25	0.168	0.00060	0.039
26	0.266	0.00011	0.072
27	0.336	0.00020	0.068
28	0.119	0.00013	0.047
29	0.049	0.00002	0.044
30	0.126	0.00004	0.076
31	0.119	0.00043	0.060
32	0.035	0.00002	0.032
33	0.098	0.00004	0.039
34	0.133	0.00010	0.034
35	0.273	0.00010	0.025
36	0.644	0.00016	0.072
37	0.042	0.00002	0.029
38	0.056	0.00002	0.031
39	0.140	0.00025	0.051
40	0.063	0.00011	0.050
41	0.119	0.00004	0.027
42	0.133	0.00002	0.031
43	0.161	0.00046	0.078
44	0.090	0.00012	0.060
45	0.056	0.00004	0.024
46	0.063	0.00002	0.025
47	0.042	0.00002	0.010
48	0.056	0.00013	0.021
49	0.084	0.00004	0.010
50	0.329	0.00011	0.030
51	0.245	0.00016	0.039
52	0.105	0.00004	0.033
53	0.105	0.00010	0.026
54	0.070	0.00002	0.029
Min	0.028	0.00002	0.0080
Max.	0.644	0.00060	0.0780
Mean	0.117	0.00025	0.0383
S.D.	0.1009	0.00015	0.0191
S.E.	0.0137	0.00002	0.0026

Table 4. Chemical analysis of the plant samples.

Loc.	N (%)	P (%)	K (%)	Ca (%)
1	2.240	0.086	7.0	0.97
2	3.234	0.156	2.7	1.48
3	2.814	0.080	4.6	0.62
4	2.310	0.216	4.3	0.89
5	2.030	0.188	2.9	1.40
6	1.806	0.130	4.2	0.94
7	2.002	0.146	6.5	1.10
8	2.926	0.090	3.7	1.25
9	2.898	0.074	3.6	1.20
10	2.842	0.254	6.7	1.56
11	1.946	0.120	4.7	1.26
12	1.652	0.088	2.7	0.79
13	3.318	0.188	4.6	1.20
14	2.072	0.090	4.7	0.97
15	2.576	0.080	4.2	0.52
16	2.282	0.106	4.1	1.06
17	2.590	0.180	3.6	1.40
18	2.506	0.162	3.8	1.02
19	1.708	0.078	2.6	0.97
20	2.086	0.202	3.8	1.33
21	2.702	0.124	2.1	0.94
22	2.394	0.120	4.1	1.10
23	3.164	0.340	4.5	1.24
24	2.758	0.130	4.4	1.59
25	2.450	0.118	4.5	0.96
26	2.842	0.108	3.7	1.79
27	1.694	0.166	3.5	0.78
28	2.702	0.056	5.6	1.01
29	2.170	0.108	3.1	1.24
30	2.324	0.162	4.0	1.69
31	2.114	0.202	2.3	1.39
32	1.806	0.146	3.8	1.11
33	1.750	0.070	2.8	1.21
34	2.086	0.108	3.5	0.83
35	2.422	0.066	2.0	1.10
36	2.632	0.054	4.5	1.46
37	3.024	0.140	4.1	0.88
38	2.730	0.226	4.4	1.67
39	2.800	0.134	2.9	1.16
40	1.820	0.216	4.8	1.62
41	2.814	0.202	3.3	1.26
42	2.324	0.144	3.1	1.38
43	1.246	0.194	3.8	1.37
44	2.436	0.078	3.4	0.78
45	2.086	0.102	2.6	0.99
46	2.800	0.140	3.2	0.69
47	2.618	0.188	3.2	1.42
48	2.086	0.216	3.8	1.24
49	3.080	0.113	4.0	1.56
50	2.352	0.216	2.7	1.26
51	2.758	0.170	3.3	1.36
52	1.974	0.146	3.5	1.01
53	2.674	0.144	4.0	1.16
54	2.226	0.248	5.3	1.21
Min	1.246	0.054	2	0.52
Max.	3.318	0.340	7	1.79
Mean	2.4018	0.1446	3.8519	1.1740
S.D.	0.4577	0.0587	1.0570	0.2838
S.E.	0.0623	0.0080	0.1438	0.0386

Kacar (1972). The calcium values in our plant materials were found to vary from 0.520% to 1.790% (Table 4). Chapman (1967) stated that the level of calcium deficiency in plants is around 0.93% . was observed that 4.86% of the *R. lutea* plant samples were below this level, but 95.14% were above it.

The root, stem, leaf and flowers of plant samples from 10 sites were collected and subjected to separate analysis (Table 5). The following results were obtained from the chemical analysis. Nitrogen varied in the ranges of 1.358-1.778% in the roots, 0.930-2.030% in the stems, 2.003-3.290% in the leaves and 2.534-3.276% in the flowers; phosphorus varied within the ranges of 0.016-0.038% in the roots, 0.022-0.049% in the stems, 0.040-0.062% in the leaves and 0.080-0.146 in the flowers; potassium varied in the ranges of 1.2-3.3% in the roots, 2.3-3.9% in the stems, 2.3-3.8% in the leaves and 2.1-4.4% in the flowers; and calcium varied in the ranges of 0.40-1% in the roots, 0.78-1.13% in the stems, 0.99-1.59% in the leaves and 0.60-1.86 in the flowers.

The data from the chemical analysis of the root, stem, leaf and flower of *R. lutea* are within the limits of the chemical analysis results of the whole plant. It can be seen that the nitrogen, phosphorus, potassium and calcium contents of the root, stem, leaf and flower are all within the range of values reported by Kacar (1972) for nitrogen and potassium, Johnson and Ulrich (1959) for phosphorus. However, some of the results are lower than the values reported by Chapman (1967) for calcium (Table 5). In terms of the mean values, it can be seen that root and stem are below the given values, whereas leaf and flower are above the limits given by Chapman (1967).

A comparison of the nitrogen, phosphorus, potassium and calcium contents of the root, stem, leaf and flower of the plant samples collected during the reproductive period (April-September) in June-July verifies that: the nitrogen content is highest in the flower (mean 2.961%), and lowest in the root (mean 1.5458%), as is the case with phosphorus content, which is highest in the flower (mean 0.0975%) and lowest in the root (mean 0.0272%). Potassium accumulates mostly in the stem (3.34%), and is at a low level in the root (mean 2.00%). Calcium accumulates mostly in the leaf (mean 1.3880%), while the lowest level is again in the root. Statistical evaluations revealed that the lowest accumulations of

nitrogen, phosphorus, potassium and calcium are in the root, while the highest accumulations of nitrogen and phosphorus are in the flower, the highest accumulation of potassium is in the stem and the highest accumulation of calcium is in the leaf (Table 5). The minerals taken from the soil are accumulated in the plant during the reproductive period. We concluded that during this period, ion transportation is faster, so there is a higher level of minerals in the above-ground parts of the plant. The levels of nutritional elements in plants vary between different plant species and between different organs of a plant species (Kacar, 1977; Kacar and Katkat, 1998). Kacar and Katkat (1998) reported that the amount of minerals in the root region of a plant species is smaller than the amount of minerals present in the above-ground part of the species. According to Kovancı (1985), the amount of nitrogen and phosphorus is smaller in the roots of the plants. Similarly, Kacar (1977) and Fink (1991) reported that the amount of calcium is smaller in the roots of the plants. In Pirdal's study (1989) on *Asphedolus aestivus* L. distributed in Western Anatolia, the results for the nitrogen, phosphorus and potassium contents of the root and rhizome are lower than for the above-ground parts of the plant. Kacar (1977), Pirdal (1989) and Kacar and Katkat's results (1998) were in agreement with our results.

Statistical Evaluation of the Soil and Plant Analysis Results

Statistical analysis of the results of the physical and chemical analyses of the plants and soils on a multiple-stepwise basis showed that the plant elements nitrogen, phosphorus, potassium and calcium are dependent variables, and such characteristics of the soils as pH, total soluble salts, calcium carbonate, total nitrogen, phosphorus, potassium and the interactions between these are independent variables. In addition to the individual effects of the soil characteristics on the plant elements, the interactions between soil characteristics that represent joint impacts were also considered. The regression models in this study were double logarithmic in form, and any significant estimator is an elasticity coefficient, which is the percentage change in a dependent variable by the percentage change in an independent variable (Daniel and Terrell, 1995; İkiz et al., 1996; McClave et al., 1998).

Through statistical analysis, significant relationships were determined between the following parameters: plant nitrogen and soil potassium (R2: 0.05, R: 0.24); plant phosphorus and the interaction between soil calcium carbonate and soil potassium (R2:0.09, R:0.31); and

Table 5. Statistical evaluation of chemical the analysis results of the root, stem, leaves and flowers of *Reseda lutea*.

	Min.	Max.	Mean	S.D.	S.E.
N (%) root	1.358	1.778	1.5428	0.1887	0.0844
N (%) stem	0.930	2.030	1.4012	0.4203	0.1880
N (%) leaf	2.003	3.290	2.5678	0.5308	0.2374
N (%) flower	2.534	3.276	2.961	0.3687	0.1844
P (%) root	0.016	0.038	0.0272	0.0097	0.0043
P (%) stem	0.022	0.049	0.0336	0.0111	0.0049
P (%) leaf	0.040	0.062	0.0502	0.0097	0.0043
P (%) flower	0.080	0.146	0.0975	0.0323	0.0162
K (%) root	1.2	3.3	2.00	0.7842	0.3507
K (%) stem	2.3	3.9	3.34	0.7436	0.3326
K (%) leaf	2.3	3.8	3.04	0.5550	0.2481
K (%) flower	2.1	4.4	3.00	1.0033	0.5017
Ca (%) root	0.40	1.00	0.6960	0.2133	0.0964
Ca (%) stem	0.78	1.13	0.8720	0.1458	0.0652
Ca (%) leaf	0.99	1.59	1.3880	0.2421	0.1083
Ca (%) flower	0.60	1.86	1.1625	0.5207	0.2603

plant potassium and the interaction between soil pH and soil phosphorus (R2: 0.06, R:0.24) (Table 6). Correlation coefficients, R, of the regression models show that there exists a weak and negative relationship in the factors referred to here (Daniel and Terrell, 1995; İkiz et al., 1996; Mc Clave et al., 1998). When the low R and R2 values are examined - Başlar and Mert (1999) also found low values for *Rubia tinctorum* and *Chrosophora tinctoria* in the same area - it is possible to state that a lack of factors affecting soil productivity prevents the development of the expected relationship between plant and soil.

These studies on *R. lutea* should prove helpful in future studies and a better understanding of *R. lutea*.

Acknowledgements

This paper is a part of my PhD thesis. I am grateful for the financial support provided by the Research Fund of Dokuz Eylül University (Project No: 0922.97.01.45).

Table 6. Double-logarithmic regression models.

	Dependent variable				
	Plant nitrogen		Plant phosphorus		Plant potassium
Constant	0.561460		-2.109678		-0.159948
	(0.171775)		(0.066942)		(0.160318)
Soil potassium	-0.087103*	Soil $CaCO_3$	-0.100237*	Soil pH and	-0.040491*
	(0.049982)	and potassium interaction	(0.041894)	phosphorus interaction	(0.021933)
Significant F	0.08		0.02		0.07
R^2	0.05		0.09		0.06
R	0.23		0.31		0.24
Standard Error	0.19779		0.39841		0.025414

*Significant for α= 0.1, Sig. F: Probability value for F, R^2: Determination coefficient,
R: Correlation coefficient. The value in parenthesis shows the standard error of estimator.

References

Abdallah MS (1967). The *Resedaceae - A Taxonomical Revision of the Family*. Mededelingen Landbouwhogeschool Wageningen. (Veenman H. and Zonen N. V., Wageningen).

Abdallah MS, De Witt HCD (1978). The *Resedaceae - A Taxonomical Revision of the Family*. Mededelingen Landbouwhogeschool Wageningen. (Veenman H. and Zonen N. V., Wageningen).

Amiri J, Ebrahim-Nesbat F (1977). *Reseda lutea* L. and *Fumaria asepala* Boiss. the Natural Hosts of Watermelon Mosaic Virus in the Mashed Areas. *Iranian J Plant Pathology* 13: 51-52.

Anonymous (1951). *Soil Survey Staff*. Washington: Soil Survey Manual U. S. D. A. Handbook 18.

Anonymous (1991). *Bitkilerden Elde edilen Boyalarla Yün Liflerinin Boyanması*. Ankara: Sanayi ve Ticaret Bak. Küçük Sanatlar ve San. Böl. ve Siteleri Gen. Müd. Yay.

Bailey LH (1947). *The Standard Cyclopedia of Horticulture*, III. New York: Mac Millan Company.

Bailey PT, Wicks TJ (1995). Biological control of *Reseda lutea* L. (*Resedaceae*), a weed of cereal crops in South Australia. Thirteenth Int. Plant Protection Cong., The Hague, 2-7 July 1995, Abstract No. 1410, *European J Plant Pathology* Supplement.

Başlar S, Mert HH (1999). Studies on the Ecology of *Chrozophora tinctoria* (L.) Desf. and *Rubia tinctorum* L. in Western Anatolia. *Turk J Bot*, 23: 33-44.

Bingham FT (1949). Soil Tests for Phosphate. California: *Agriculture* 3: 11-14.

Bolle F (1936). *Resedaceae*. In: Enger A, Prantl K (eds.) *Die Natürlichen Pflanzenfamilien*, Volume 17b Berlin: pp. 659-692.

Bonnier G (1934). *Flore Complete Illustree en Couleurs de France Suiss et Belgique*, Tome III. Paris.

Bouyoucos GJ (1955). Hydrometer Method Improved for Making Particle Size Analysis of Soil, *Agr J* 54: 3.

Bremner MM (1965). Total Nitrogen. In: Black CA (ed) *Methods of Soil Analysis*, Part II. pp.1149-1178. Madison: Amar. Soc. of. Agr. Inc. Pub.

Bruns D, Jochimsen M (1989). Der Einfluß unterschiedlich behandelten Bergematerials auf das Wurzelwachstum ausgewählter Pionierpflanzen. *Verhandlungen Gesellschaft fur Okologie* 18: 73-78.

Chapman HD (1967). Plant Analysis Values Suggestive of Nutrient Status of Selected Plants. *Soil Testing and Plant Analysis* II: 77-91.

Clapham AR, Tutin TG, Warburg EF (1962). *Flora of the British Isles*. Cambridge: Cambridge University Press.

Daniel WW, Terrell JC (1995). *Business Statistics (For Management and Economics)* Seventh Edition. Boston: Houghton Mifflin Comp.

Davis ES, Wichman PR, Harris JD (1993). Yellow Mignonette Biology and Control. *Proc. West Soc. Weed Sci.* 46: 89-90.

Davis PH (1965). *Flora of Turkey and East Aegean Islands*, I. Edinburgh: Edinburgh Univ. Press.

Doğan Y, Mert HH (1998). An Autecological Study on the *Vitex agnus-castus* L. (*Verbenaceae*) Distributed in West Anatolia. *Turkish J Botany* 22: 327-334.

Eyüboğlu Ü, Okaygün İ, Yaras F (1983). *Doğal Boyalarla Yün Boyama*. İstanbul: Uygulamalı Eğitim Vakfı Yayınları, Özkur Basımevi.

Ferlay V, Malley G, Masson A, Ucciani E, Grubber M (1993). Composition en acides gras des huiles graines d'especes spontanees du sud-est Mediterranean. *Oleagineux* 48: 91-97.

Fink S (1991). The micromorphological distribution of bound calcium in needles of Norway spruce (*Picea abies* (L.) Karst). *New Phyt.* 119: 33-40.

Forbes GR, Mathews PR (1985). Pre-emergence R-40244 for early weed control in potatoes and carrots. *Br. Crop Prot. Conf. Weeds*, 3: 747-804.

Gibbs RD (1974). *Chemotaxonomy of Flowering Plants*, 1, 3. Montreal: McGill-Queen's Univ. Press.

Grubb PJA (1976). Theoretical Background to the Conservation of Ecologically Distinct Groups of Annuals and Biennials in the Chalk Grassland Ecosystem. *Biology and Conservation* 10: 53-76.

Harris JD, Davis ES, Wichman, DM (1995). Yellow Mignonette (*Reseda lutea*) in the United States. *Weed Technology* 9: 196-198.

Heap JW (1994). *Biology and control of Reseda lutea L. (Cutleaf mignonette)*. Masters Thesis. Dept. Crop Protection and Plant Science, University of Adelaide, Waite Agricultural Research Institute, Adelaide, South Australia.

Heap JW, Wilcocks, MC, Kloot, PM (1995). *Reseda lutea* L. In: Groves RH, Shepherd RCH. and Richardson RG (eds.), *The Biology of Australian Weeds* Volume I. Melbourne: R. G. and F. J. Richardson Pub.

Heap JW, Willcooks MC, Kloot P M (1987). The Biology of Australian Weeds. 17. *Reseda lutea* L. *Plant Protection Quarterly* 2:179-185.

Hegi G (1958). *Illustrierte Flora von Mittel-Europa*, IV/I. München: Carl Hanser Verlag.

İkiz F, Püskülcü H, Eren S (1996). *İstatistiğe Giriş*, 4. Baskı. İzmir: Ege Üniv. Basımevi.

Jablonski B, Koltowski Z, Dabska B (1992). Nectar Secretion and Honey Efficiency of Important Plants in Poland Conditions, Part VII. *Pszczelnicze Zeszyty Naukowe* 36: 54-64.

Jackson ML (1958). *Soil Chemical Analysis*. New Jersey: Prentice Hall.

Jochimsen M, Janzen D. (1991). Structure and phytomass production of a pioneer community. In: Easer G, Overdieck D (eds.) *Facets of Modern Ecology* pp. 39-69 Amsterdam: Elsevier Science.

Johnson CM, Ulrich A (1959). Analytical Methods for Use in Plant Analysis. California: *Agricultural Experiment Station Bulletin* 766.

Kacar B (1972). *Bitki ve Toprağın Kimyasal Analizleri. II, Bitki Analizleri*. Ankara: Ankara Üniv. Zir. Fak. Yay. 453, Uygulama Klavuzu: 155, Ankara Üniv. Basımevi.

Kacar B (1977). *Bitki Besleme*. Ankara: Ankara Üniv. Ziraat Fakültesi Yayınları: 637, Ankara Üniv. Basımevi.

Kacar B, Katkat AV (1998). *Bitki Besleme*. Bursa: Uludağ Üniv. Güçlendirme Vakfı Yayınları:127, Vipaş Yayınları.

Kovancı İ (1985). *Toprak Verimliliği ve Bitki Besleme*. İzmir: Ege Üniv. Ziraat Fak. Teksir No: 107-11.

Lott L, Nery JP, Gello JR, Medcaff JC (1956). Leaf Analysis Technique in Coffee Research. *IBEC. Res. Inst.* II. 9: 21-24.

Loue A (1968). Diagnostic Petiolaire de Prospection, Etudes sur la Nutrition et la Fertilisation Potossiques de la Vigne. *Societe Commerciole des Potosses d'Alsace Services Agronomiques* 31-41.

McClave JT, Benson PG, Sincich T (1998). *Statistics for Business and Economics*, Seventh Edition. Prentice Hall International Inc.

McIntryre M, Michael P, Stevens J (1988). *New Herbal*. London: Penguin Books.

Moghaddam M.R. (1977). *Reseda lutea*: Multipurpose Plant for Arid and Semiarid Lands. *J Range Manage* 30: 71-72.

Özgökçe F, Behçet L, Tel AZ (1999). Özalp (Van) İlçesi Hububat Tarlaları Üzerinde Yabancı Otların Paryodisiteleri ve Hayat Formları Üzerinde Bir Araştırma. 1st International Symposium on Protection of Natural Environment & Ehrami Karaçam (Pinus nigra Arn. ssp. pallasiana (Lamb.) Holmboe. var. pyramidata (Acat.)Yaltırık), Kütahya 23-25th September 1999, *1st International Symposium on Protection of Natural Environment & Ehrami Karaçam* Announcement book pp. 420-429, Kütahya: Dumlupınar Üniv. Çevre Sor. Araş. ve Uyg. Merk. Yay. No: 1.

Öztürk M, Özçelik H. (1991). *Doğu Anadolu'nun Faydalı Bitkileri (Useful Plants of East Anatolia)*. Ankara: SİSKAV.

Öztürk M, Pirdal M, Özdemir F (1997). *Bitki Ekolojisi Uygulamaları*. İzmir: Ege Üniv. Fen Fak. Kitaplar Serisi No: 157, Ege Üniv. Basımevi.

Pemberton RW, Irwing DW (1990). Elaiosomes on Weed Seeds and the Potential for Myrmecochory in Naturalised Plants. *Weed Science* 38: 615-619.

Pirdal M (1989). *Asphodelus aestivus* Brot.'un Autekolojisi Üzerinde Bir Araştırma. *Doga Tu Botanik Dergisi* 13: 89-101.

Pizer NH (1967). Some Divisory Aspects Soil Potassium and Magnesium. *Tech. Bull.* 14:184.

Pratt PF (1965). Potassium. In: Black CA (ed.) *Method of Soil Analysis*, Part II. Madison: Amer. Soc. of Agron. Inc. Pub.

Scheffer F, Schactschabel P (1956). *Lehrbuch der Agrikultur Chemie und Bodenkunde*. Stuttgart: Ferdmant Ecke Verlag.

Seçmen Ö, Gemici Y, Leblebici E, Görk G, Bekat L (1986). *Tohumlu Bitkiler Sistematiği*. İzmir: Ege Üniv. Fen Fak. Kitaplar Serisi No: 116.

Tutin TG et al. (eds) (1964). *Flora Europe*, I. Cambridge: Cambridge Univ. Press.

Uğur G (1988). *Türk Halılarında Doğal Renkler ve Boyalar*. Ankara: Türkiye İş Bankası Kültür Yay. 289.