



Aesthetic and ecological characteristics of *Prunus Taxa* in landscape design: A Study in eastern and southeastern provinces of Türkiye

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Abstract

Plants play a crucial role in landscape design and are at the heart of landscape design. Climate change's purposeful plant choices could improve landscape design. In this study, it is tackled using some native Subgen *Amygdalus* taxa in the landscape to make the natural environment flexible against global climate change, as some species are indispensable elements of plant breeders and gardens, which have adapted to the arid habitat and Türkiye is among the gene centers. The research was carried out in rural areas, afforestation areas and gardens in the provinces of Adıyaman, Hakkâri, Malatya, Şanlıurfa and Van and detected taxa were recorded on form through on-site observation, photographing and collected in accordance with the herbarium technique later to identify according to Browicz (1972) and Yazbek (2010). After field studies, the aesthetic and ecological characteristics of each of Subgenus *Amygdalus* were evaluated based on plant design. In the course of study fields, it was determined that *P. dulcis*, *P. orientalis* and *P. arabica* are used in afforestation and erosion control areas, *P. dulcis* in almond orchard plant, *P. arabica*, *P. orientalis* and *P. spinosissima* are used as hedge plants, and some taxa are used as rootstock and they grow in different ecological areas with outstanding visual effect. In this study, it is aimed to determine Subgen *Amygdalus* growing naturally in study area, their aesthetic and ecologic features and the roles they can undertake in the landscape against climate crisis and to be introduced.

Keywords: Landscape design, Natural Plants, Biodiversity, Prunus subgen *Amygdalus*

Introduction

Due to the increasing environmental problems with global climate change, the issue of making the cities and landscapes of the future more resilient gain importance day by day. However, also in order to create an urban landscape that is adaptable to environmental effects, it is extremely important to prefer native species that can resist adverse environmental conditions throughout the city and can easily adapt to the environment in plant applications (Erduran and Günel, 2012). Because the use of local native species offers various advantages in terms of ecological, functional and economic aspects in the creation, protection and improvement of natural environments in and outside the city. Some of this advantages are following;

- ✚ Provide natural habitat for birds and wildlife,
- ✚ Sustain populations of pollinators and attract a variety of other beneficial insects,
- ✚ Control storm runoff and erosion,

- ✚ Develop a strong relationship with soil fungi and other native microorganisms,
- ✚ Sustain a spiritual, recreational, educational, and cultural heritage,
- ✚ Supporting local ecosystems,
- ✚ Improve the resilience of an ecosystem,
- ✚ Provide sustainability,
- ✚ Contribute to essential environmental services and improve environmental quality,
- ✚ Contribute to rural-urban connectivity,
- ✚ Reduces the pressure of urban structures on natural habitats.

All these advantages are an effective strategy to protect local biodiversity, use water resources more efficiently and support natural habitats.

When it comes to climatical assessments, the first thing to consider is the use of natural species. Increasing water demand, especially against drought caused by climate change; dictates the use of natural plants that are compatible with environmental conditions and resistant to natural events in landscape designs (Atabeyoğlu and Bilge, 2019; Çimen and Ulus, 2020). Although natural species are so important, applications for the selection of suitable plants in both urban green space arrangements and private areas are not sufficiently carried out in Türkiye. One of the important reasons for this situation is that the intense demand for exotic species in urban and rural landscapes restricts the effective use of natural plant species, and the other is that it does not cope with the negative effects of drought and drought-resistant plants and it is the lack of knowledge and awareness about climate change, drought (Dilaver 2014).

On the other hand, in landscape arrangements, selection of plant species is so important. Because each plant has a different features that are great importance and used in design and to fulfill ecological/engineering, architectural and aesthetic functions in the landscape. These features are; size, form, strength and opacity in architecture; improving air and water quality, providing erosion control and impact on climate in ecology/engineering and size, form (shape), color and texture in aesthetic (Booth, 1996). Along with the principles of design, the these characteristics of plants should also be taken into account. For a successful functions undertake in the design, it is important to know each plant that makes up the composition well and to highlight its effective properties (Robinson, 2004).

In terms of all these features, there are suitable plant materials that can be used in rural landscape studies as a response to the climate crisis in Türkiye's flora. One of these plant materials is "*Prunus* subgen *Amygdalus* L." genus.

This genus encompasses a little range of species high ornamental, but also ecological values. Thanks to these features, much of them offers an alternative to conventional landscapes when being independently grown or blending with ornamentals into existing yards and gardens into aesthetically pleasing designs. However, only a limited range of species finds common use as landscaping plants. As an example, *P. dulcis* is traditionally cultivated for its fruit, while *P. orientalis* has been employed for erosion control in Türkiye. Additionally, certain species within this genus possess medicinal value.

One of the main reasons for researching taxa of this genus is that Türkiye is among the gene centers, and the other is that high ornamental and ecological values offer potential for both urban and rural sustainable landscapes. However, presently they occupy a very specific and limited space in the landscape and ornamental plants industry. Because, most of the research on this genus is genetics, breeding, anatomy and palynology, and the ethnobotanical characteristics and studies aimed at

benefiting more from their fruits. As there is very limited available data about them in landscape and ornamental plants industry, it is necessary to reveal the possibility of using these taxa by studying their ecological demands and visual characteristics both in the adaptation process to climate change and sustainable gardening practices.

The primary objective of this paper is to assess the current utilization of Subgen *Amygdalus* within the study area, focusing on its aesthetic and ecological characteristics. Furthermore, this study aims to identify the potential roles that these native species can fulfill within the landscape. Ultimately, the research aims to propose the use of these native species as a means to enhance the resilience of urban landscapes in the face of the climate crisis while simultaneously contributing to their visual appeal and fragrance.

Material and Methods

The main material of this study is *Prunus* L. subgenus *Amygdalus* L. which are naturally distributed in eastern Türkiye (Table 1) and (Fig. 1).

Table 1. Collection localities of Subgenus *Amygdalus* taxa

The name of taxa	Endanger status	Endemism	Localities	Ecological features of localities
<i>Prunus dulcis</i> (Mill.) D.A. Webb			Adiyaman, Hakkari, Malatya, Sanliurfa, Van	Orchards, Cultivated and Afforestation areas
<i>P. fenziiana</i> Fritsch	DD		Hakkari (Esendere)	Creek slope, Steppe
<i>P. trichamygdalus</i> (Hand.-Mazz.) var. <i>trichamygdalus</i>			Adiyaman (Nemrut Mountain) Between Hakkari-Yüksekova	Sloping hillsides
<i>P. trichamygdalus</i> (Hand.-Mazz.) var. <i>elongata</i>	NT	+	Hakkari (Between Hakkari-Yüksekova)	Sloping hillsides
<i>P. orientalis</i> (Lam) Redh.	DD		Adiyaman, Elazığ, Malatya	Sloping hillsides, Steppe
<i>P. kotschy</i> (Boiss. & Hohen.) Nab.	VU		Hakkari (Between Yüksekova-Esendere)	Sloping hillsides, Openings in Oak Forest
<i>P. carduchorum</i> Bornm.			Hakkari (Between Yüksekova and Şemdinli, Derecik Umurlu)	Steppe, Sloping hillsides
<i>P. arabica</i> var. <i>arabica</i> (Olivier) Meikle.	NT		Adiyaman (Kahta and Tut) Hakkari (Çukurca)	Steppe, Sloping hillsides, Openings in Oak Forest
<i>P. lycioides</i> (Spach) Schneider			Adiyaman (Nemrut mountain), Malatya (Beydağı)	Rocky slopes
<i>P. spinosissima</i> (Bunge) Franch.			Şanlıurfa	Steppe

Subgenus *Amygdalus* is a small group within *Prunus*, containing approximately 24 species, which is tree or shrub with spreading or upright crown. Branches thornless or thorny; Leaves glabrous or pubescent; petioles sessile to 30 mm long; blades color variable, shape variable, margin usually toothed; Inflorescences usually fascicled on short shoots; petals color variable base mostly tapering, apex usually notched, stamens 10 – 35; style length relative to stamens is variable. Fruits usually with short pedicels, glabrous or pubescent; drupes usually green, sometimes reddish on exposed side (Yazbek, 2010).

Subgenus *Amygdalus* is the earliest deciduous fruit and nut tree to bloom in spring. With the stone fruits, the beauty of flowers and decorative leaves and they perform multiple functions, such as for food, flavor,

and ornamental appearance in landscape. Also, they receive a great deal of attention, especially from plant breeders and horticulturists, usually to assess the potential for their use in cultivar improvement (Socias and Felipe, 1987; Socias I Company 1998; Gradziel et al., 2001).

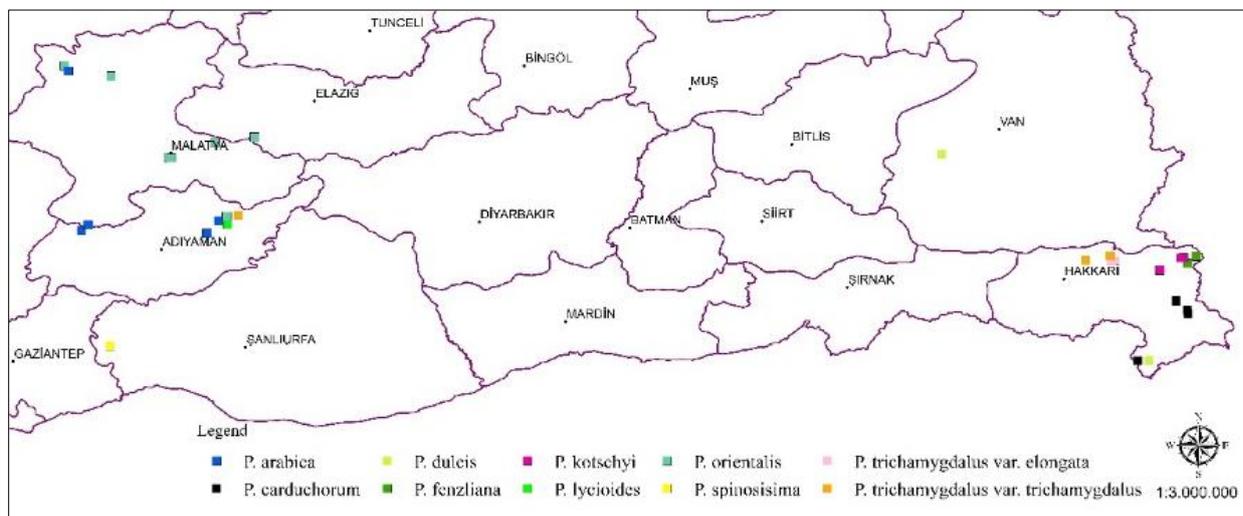


Figure 1. The map where Subgenus *Amygdalus* were collected in study

The majority are distributed in Iran and eastern Türkiye with a few in southeastern Europe, the Mediterranean region, and east into Mongolia and western China, a distribution pattern referred to as the Irano-Turanian distribution (Browicz 1989). Members of subg. *Amygdalus* are deciduous shrubs or small trees that are important components of northern temperate forests in Asia and Europe, mostly occurring in mountainous areas, often between 1,000 and 2,500 m in elevation. They occur in a variety of environments, but mainly in relatively dry habitats, and sometimes in deserts [e.g., *P. arabica* (Oliv.) Meikle]. Those in Türkiye grow at the marginal areas, poor, rocky and stony, and calcareous soils (Kaşka et al., 1999).

The study areas are characterized by a continental type of climate with very cold winters and hot summers. However, the southeast experiences a steppe climate with very hot summers, severe aridity and winters hardly experience frost but severe dry winds dominate the summer season. The precipitation in the form of snow is a regular feature in winter, and rains are common in spring and autumn. The elevation decreases from east to west and southwest. The average annual temperature increases from east to west and southwest, but the average annual precipitation decreases. The area of saline and degraded soils in the region is increasing. The factors responsible for this are over-irrigation practices, and salt accumulation due to evaporation (Öztürk et al, 2008).

The harsh climatic conditions in the region result in higher mechanical than chemical weathering of parent material, as such soils are pebbly in nature. Main soil types within the area are: alluvial, colluvial, chestnut, brown, regosols, basaltic, organic, and arid soils (Öztürk et al, 2004; Öztürk et al, 2006).

Methods

In the study, on-site observation, measurement and photography methods were used in the field studies based on Flora of Turkey and Systematics Of *Prunus* Subgenus *Amygdalus* Monograph And Phylogeny (Yazbek, 2010) records. During field studies, the one hand while determined the locations of the Subgenus *Amygdalus* samples via GPS to obtain digital map, the other hand samples were collected in accordance with the herbarium technique to identify according to Browicz (1972) and Yazbek (2010). Also, some features of each taxa such as form/habitus, leaves, flowers and fruits color, texture and

habitat were noted on form through on-site observation and they have been photographed to evaluate view of seasonal throughout year.

In the obtained data analysis phase, endemism, endangered status and noted and photographed the aesthetic and ecological characteristics of each of Subgenus *Amygdalus* were evaluated based on the principles and elements of plant design (Table) 2 and the roles these taxa can play in design are explained.

Table 2. Basic principles of plant design (Both, 1996; Robinson, 2004; Korkut et al., 2010).

Aesthetic		Functional
Principles of Visual Composition	Visual Properties	Design principles
Harmony and Contrast	Form	Visual control (Light, Screening, Emphasis)
Balance	Line	Motion control (Orientation, Circulation)
Emphasis and Accent	Texture	Physical Environment control (Climate, Noise, Air pollution, Erosion)
Sequence	Color	Space Creation
Scale		
Movement and Viewing Angles		

Results

Each of 10 subg. *Amygdalus* taxa that grow naturally under different ecological condition has different traits with extraordinary flower color, fruit and decorative leaves, form and texture. When these taxa are considered separately; *P. dulcis*; Trees up to 8-12 m tall, with spreading crown. Bark is brown, young shoot is green and tornless. Leaf blades is green, ovate-lanceolate or elliptic, when mature, it is glabrous and leathery. Drupes green, surface densely pubescent; mesocarp splits at maturity, seed is sweet or bitter (Table 3 and Fig. 2).

Table 3. Morphological features of *Prunus dulcis*

Inflorescence	Pedicel (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Petioles (mm)	Fruit (mm)	Fruting
Fascicled or 1-2	10 - 50	30 - 50	March - April	20-120 x 25-30	10 – 35	40-50 x 30	Aug - Sept



Figure 2. Stands, habitat, form, flower, leaf, fruit and stone of *P. dulcis*

Habitat and Distribution: In oak and cedar forest, in abandoned orchards or orchard borders, open shrub lands and among rocks where sheltered, on dry slopes, with limestone and metamorphic rocks. Native and naturalized. Growing at elevations between 150 – 2000 m (Yazbek, 2010).

It spreads to S.W. and C. Asia, and in addition cultivated in S. Europe (Yazbek, 2010). In Türkiye, every region except the coastal parts of the Eastern Black Sea and very high plateaus (Küden, 2016).

Landscape function: It is a famous tree with the white-pink flowers, a very strong fragrance during early spring bloom and economically valuable and edible fruit that are a good food source.

Whereas nowadays it is cultivated as a fruit tree in temperate regions all over the world and Türkiye (Fig. 3), in England it is never likely to be valued in gardens for good eatable nuts and it is for its beauty of flower alone that it is cultivated (Url 1). However, being exposed to spring late freezes, unlike usually cultivated for its fruit, it is planted as a border plant in gardens (Fig. 4) and for afforestation in barren areas in Central Anatolia or rainfed areas (Kaşka et al., 1999; Küden and Küden, 2000). Also it was used in avenue in German (Fig. 5), (Url 3).



Figure 3. *P. dulcis* in cultivated for fruit in Malatya



Figure 4. *P. dulcis* in gardens in Derecik (Hakkâri) and as a border plant in Golbasi (Adiyaman)



Figure 5. *P. dulcis* in cultural landscape in Germany

Its beauty of flowers makes a stunning specimen for garden or park in spring exploding into masses of white flowers. So it is often naturalized as an ornamental tree in gardens in the north of the Mediterranean region (Url-2).

Needs optimum temperature 24 °C, is better in full sun and generally grows light, fertile, deep and well-drained soils in a wide variety of from sandy to clay soils and pH is 6.5 (Verma and et al., 2010).

P. fenzliana; Shrubs or small tree up to 2 (4) m tall, with divaricate branches. Bark is grey, shoots is subspinescent, one year old twigs green, reddish on exposed side, older twigs grey peeling to shown brown, glabrous; Leaf is green and leathery. Inflorescences solitary, fascicled on short shoots; petals pink; drupe greenish with yellowish pubescence (Browicz, 1989; Yazbek, 2010), (Table 4 and Fig. 6).

Table 4. Morphological features of *Prunus fenzliana*

Inflorescence	Pedicel (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Leaf petioles (mm)	Fruit (mm)	Fruting
solitary, fascicled	-	15 x 20	March - April	80 x 20	10 - 15	25 x 15	Aug - Sept



Figure 6. Flower, leaf and fruit, form and stone of *P. fenzliana* in Hakkâri

Habitat and Distribution: In forests and shrub lands, mostly on rocky slopes and cliffs, and frequently in ravine. Growing at elevations between 1400 – 3500 m (Yazbek, 2010).

It is distributed in Armenia, the western regions of Azerbaijan and Northwest Iran (Kester and Asay, 1975; Ladizinsky, 1999), Turkmenistan (Yazbek, 2010) and Türkiye. Distribution in Türkiye is Erzurum, Kars and Hakkâri provinces.

Landscape function: This taxa is not used in landscape or in cultivated area in Türkiye. But it belongs to the primary gene pool of *P. dulcis* and the secondary gene pool of peach (*P. persica*). So it has the

potential for use as a gene donor for crop improvement (Url-4) and it is used as a rootstock in almond breeding for late blooming to be easily hybridized (Graselly, 1976, Ladizinsky, 1999).

Thrives in a well-drained moisture-retentive loamy soil (Bean, 1981; Huxley, 1992). Prefers some lime in the soil but is likely to become chlorotic if too much lime is present (Chitdendon, 1951). Succeeds in sun or partial shade though it fruits better in a sunny position (Bean, 1981; Huxley, 1992). Most members of this genus are shallow-rooted and produce suckers if the roots are damaged (Bown, 1995). The plants tolerate temperatures down to -18°C (Url-5).

P. trichamygdalus; Shrubs 2-3 m tall, with spreading crown. Bark is braun, branches thornless; one year old twigs greenish, glabrous or pubescent; older twigs brown to grey-brown, leaf blade is green, elliptic, rarely lanceolate or oblanceolate, abaxially sparsely pubescent, adaxially glabrous and subleathery, petals pink, drupes green, surface short velutinous (Yazbek, 2010), (Table 5 and Fig. 7 and 8). Has two variety and var. *elongata* is endemic.

Table 5. Morphological features of *P. trichamygdalus*

Inflorescence	Pedichel (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Petioles (mm)	Fruit (mm)	Fruting
Solitary or Fascicled	5	30 - 50	April	40-45 x 10-15	5 - 10	21 x 15 25-27 x 15-18	June - Aug



Figure 7. Habitat, form, flower, leaf and stone of *P. trichamygdalus* var. *trichamygdalus*



Figure 8. Habitat, form, flower, leaf fruit and stone of *P. trichamygdalus* var. *elongata*

Habitat and Distribution: On limestone and igneous soils, on cliffs and rocky places, particularly along gorges. Growing at elevations between 950-2500 m (Yazbek, 2010).

Distribution is Eastern Anatolia in Türkiye, and nearby areas of Iran. In Türkiye, Adıyaman, Malatya, Bitlis, Elazig, Erzincan, Hakkâri province (Yazbek, 2010).

Landscape function: This taxa, too, is not used in landscape in Türkiye. However, sweet form of *P. trichamygdalus* is cultivated in Diyarbakır - Eğil (Meydan, 2019). Crops need full sun, plant requires deep and well-drained soil.

P. orientalis; Shrubs 0.5 - 3 m tall, with erect or spreading crown, Bark brown or grey. Branches thorny; one year old twigs white tomentose, older twigs grey - brown, pubescent, glabrous or glabrescent; Leaves blade silvery white because of the pubescence, elliptic, lanceolate, and less often obovate, oblanceolate or spatulate, when young or mature abaxially and adaxially white tomentose. Petals pink to pale pink, drupe silvery white because of pubescence and surface densely silvery-white tomentose; mesocarp splitting at maturity (Table 6 and Fig. 9).

Table 6. Morphological features of *P. orientalis*

Inflorescence	Pedicel (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Petioles (mm)	Fruit (mm)	Fruting
Solitary	1-3	12-16	March	20-44 x 15 -21	5 - 8	15-25 x 10-15	Aug - Sept



Figure 9. Habitat, form, flower, leaf and fruit of *P. orientalis*

Habitat and Distribution: Common in open grazed oak forest, open sunny niches, on rocky limestone slopy hillsides, also on dry silt and on steep river stream banks. Growing at elevations between 500 - 2000 m., but most frequently between 800 and 1200 m altitudes (Browicz 1972), (Yazbek, 2010). In Anatolia, it generally spreads in arid, calcareous and stony areas. The annual rainfall in the areas where it grows is between 250 mm and 450 mm (Grasselly, 1976).

Its distributions is in the mountains of Iraq, the Syrian desert, Lebanon and western Iran to the interior of Türkiye (Kester and Asay, 1975). It has a wide distribution area over central, southern and eastern Anatolia in Türkiye (Browicz 1989), in the provinces of Adıyaman, Ankara, Antalya, Bitlis, Çankırı, Elazığ, Erzincan, İçel, Kayseri, Kahramanmaraş, Konya, Malatya, Mardin, Niğde, Şırnak and Uşak.

Landscape function: Although it is almost never used in parks and garden in Türkiye as a ornamental plant, it has been used to control soil erosion and to stabilize water flows in arid and semi-arid areas in Iran and as a rootstock in semi-desert areas (Mortazavi, 1986, Madam et al., 2011). It was also used in afforestation area to control soil erosion in Kuluncak district of Malatya province and it has been using as a border plant around vineyards and pistacio orchards in Adıyaman and Şanlıurfa provinces (Fig. 10). And it is among the recommended species for green belt and wind screen in areas close to the water source and the road in Konya (Uysal et al., 2016).

P. kotschy; Multi-stemmed dense shrubs up to 1.2 m tall, with spreading crown. Bark is brown-grey, Branches somehow thorny; young shoots whitish pubescent, later glabrous. blade green but looks grayish because of pubescence, lanceolate, oblong-lanceolate, rarely slightly oblanceolate, when young or mature densely yellowish grey-tomentose or floccose on both surfaces. Petals pink; drupes green but looks grey because of pubescence (Table 7 and Fig. 11).



Figure 10. *P.orientalis* in erosion control areas and hedge plant at fields edge

Grows in clay loam structure and especially in soils with high lime content and high pH value. Since it is a typical plant of sunny southern aspects, it has a high demand for light.

Table 7. Morphological features of *P. kotschy*

Inflorescence	Pedicel (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Petioles (mm)	Fruit (mm)	Fruting
usually fascicled in pairs	1 - 5	15 - 20	April - May	40x 15	1 - 2	25 x 17 x 14	June - July



Figure 11. Habitat, form, flower, leaf and fruit of *P. kotschy*

Habitat and Distribution: Oak forest and woodlands, growing on rocks on limestone slopes and mountain ridges, at the upper edges of the Oak and Pistacia steppe forest zone, growing at elevations between 1400 – 2450 m.

It is restricted to a small area in northern Iraq, eastern Iran and south-east Türkiye (Socias et al, 2017). It shows a narrow distribution within the Siirt and Hakkâri provinces in Türkiye.

Landscape function: It draws attention with stunning pink flowers blossing in late spring and yellowish pubescent leaf and shots but it is almost never to be used anywhere in Türkiye. It grows in light and medium textured soil and needs full sunlight.

***P. carduchorum*;** Multi-stemmed dense shrubs 0.5– 1.2 m tall, with spreading crown. Bark brown or grey-brown. Branches thornless, but very rigid, leaf blade green, linear-lanceolate, less often lanceolate, or rarely oblanceolate, when young abaxially and adaxially pubescent, when mature, glabrous or pubescent on both surfaces. petals pink, drupe green, surface with velutinous-grey pubescence (Table 8 and Fig. 12).

Table 8. Morphological features of *P. carduchorum*

Inflorescence	Pedicel (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Petioles (mm)	Fruit (mm)	Fruting
Solitary	1 - 2	1-1.5	April - May	6,5 x 7	1 - 2	20-23 x 16 x 12	June - July



Figure 12. Habitat, form, flower, leaf and fruit of *P. carduchorum*

Habitat and Distribution: On rocky slopes with limestone or metamorphic rocks, in *Astragalus* zones or open degraded forest. Growing at elevations between 1500 - 3000 m.

N. Syria, N. Iraq, N.W. Iran and E. Türkiye. It shows a narrow distribution within the provinces of Hakkâri in Türkiye (Yazbek, 2010).

Landscape function: Although it is one of the most beautiful indigenous delicate shrub with pink flowers, it is used nowhere in Türkiye like *P. kotschy*. Grows in almost any soil except wet; full sun, adaptable to many soil conditions.

***P. arabica*;** Broomlike shrub 0.75 - 2 m tall, with upright (ascending) crown, Bark brown. Branches angled and thornless; twigs green, glabrous. Leaf blade green, narrow-lanceolate, narrow-elliptic to linear, sometimes narrow-oblongate, abaxial surface sparsely pubescent on midvein, adaxial surface glabrous, petals white, pale pink, or pink, as drupe matures surface glabrescent (Yazbek, 2010), (Table 9 and Fig. 13).

Table 9. Morphological features of *P. arabica*

Inflorescence	Pedice (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Petioles (mm)	Fruit (mm)	Fruting
Soliter	1-3	15-18	March - April	29 x 7	6	14-20x8-13x10	May - June



Figure 13. Habitat, form, flower, leaf and fruit of *P. arabica*

Habitat and Distribution: In arid and semi arid regions, on limestone and volcanic rocky slopes, mountains and savannas; often along riversides, and gorges, dry gullies and ravines, open degraded forest and on eroded slopes (Fig. 14). Growing at elevations between 500 - 2700 m (Yazbek, 2010).



Figure 14. *P. arabica* on eroded slopes in Hakkâri

Lebanon, Syria, S. Türkiye, N. Jordan, N. Iraq, E. Iran (Yazbek, 2010). It spreads within the provinces of Adıyaman, Gaziantep, Maraş, Urfa, Mardin, Siirt and Hakkâri in the southeast region in Türkiye.

Landscape function: It draws attention with stiff, long, permanently green, glabrous, angled branches and often leafless. These features can create a stunning display for any garden and parks and can make the landscape more interesting. But it is only grown as a hedge plant in the vineyard and field edges around Maraş (Yaltrık, 1971). Grows light (sandy) and heavy (clay) on dry or moist soils, although it is shade tolerant, it needs full sunlight.

***P. lycioides*;** Very dense shrub 0.6-1.2 m tall, with spreading crown. Bark grey. Branches very thorny, leaf blade green, linear, linear-lanceolate, or linear-oblongate, abaxial surface glabrous, rarely sparsely pubescent on midvein, adaxial surface glabrous. Petals pink to deep pink, fruit surface is glabrescent; mesocarp splitting at maturity (Yazbek, 2010), (Table 10 and Fig. 15).

Table 10. Morphological features of *P. lycioides*

Inflorescence	Pedice (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Petioles (mm)	Fruit (mm)	Fruting
Fascicled	0 - 1,5	10	Late Jan - Early May	13.5-20.2 x 5.1-7	1 - 3	10-15 x 10-12	Late Mar-Mid July

Figure 15. Habitat, form, flower, leaf and fruit of *P. lycioides*



Habitat and Distribution: In dry and semiarid areas, on limestone, clay, gravelly, rocky slopes and hillsides. Sometimes near rivers. Growing at broad elevation ranges of between 450 - 2200 m.

Widely spreads throughout Iran and Türkiye, with few records in N. Syria. Its distribution area in Türkiye is Southern Anatolia.

Landscape function: It has an outstanding flowers and dense thorny, however, it is never used in parks and garden in Türkiye, either. But in Central and West Asia where it distributed plays an important role in preventing and controlling soil erosion (Cavalloro and et al, 2020).

Although it is shade-tolerant, it needs full sunlight and grows loam or loamy clay soils.

P. spinosissima; Shrubs (0.5) 1 - 2 m tall, with spreading crown. Bark grey, branches very thorny, petals pink to deep pink, leaf blade green, spatulate, obovate, elliptic or lanceolate. Drupes reddish from one side and green from the other, pubescent (Table 11 and Fig. 16). Seeds are a little bitter but can edible in fresh. It is morphologically similar to *P. lycioides*.

Table 11. Morphological features of *P. spinosissima*

Inflorescence	Pedicel (mm)	Flower Diam. (mm)	Flowering	Leaf (mm)	Petioles (mm)	Fruit (mm)	Fruting
Fascicled	1	-	Late Feb Late Apr	18- 29 x 8	5-7	15 x 9 x 8- 10	Early May Mid Aug



Figure 16. Habitat, form, flower, leaf and fruit of *P. spinosissima*

Habitat and Distribution: In semi arid regions, on clay, limestone and volcanic rocky mountain slopes. Growing at elevations between 700 – 1900 m.

Its distribution; Afghanistan, Eastern Iran, Tacikistan South Turkmenistan and Türkiye. Its distribution area in Türkiye is Southern Anatolia (Browicz ve Zohary, 1996).

Landscape function: It has an attractive and fragrant flowers blooming and attracting birds, butterflies, and pollinators in late spring and it grows naturally or is grown as a edge plant of pistachio orchards in the Southeastern Anatolia region. It grows primarily in the temperate biome.

Discussion

According to the results obtained in the research, *P. dulcis* and *P. orientalis* are used currently in afforestation and erosion control areas in Türkiye. *P. dulcis* also is used in the (commercial) orchard and as a (naturalized) ornamental plant (in garden/in avenue), *P. arabica*, *P. orientalis* and *P. spinosissima* are used as hedge plants and all taxa but *P. kotschyi* and *P. carduchorum* are used as a rootstock. But each Subgen *Amygdalus* taxa in study area have a various ecological/engineering, architectural and aesthetic features (Table 12).

Table 12. Aesthetic, architectural and ecologic features of subgen *amygdalus*

Taxa Name	Aesthetic				Architectural				Ecological			
	Texture	Form (Shape)	Scale	Color	Form	Height (m)	Spread (m)	Resistance to drought	Desire Temperature	Resistance to Coldness	Light	
<i>P. dulcis</i>	F/M	Sp	H	H	T	4-12	2,5-6	M	H	M	FS	
<i>P. fenzliana</i>	F/M	Sp	M	H	T/Sh	2-4	1-2	M/H	M	H	S/PSh	
<i>P. trichamygdalus</i>	F/M	Sp	M	H	T/Sh	2-3	1-3	H	M	M	S/PSh	
<i>P. kotschyi</i>	M	Sp	L	H	Sh	0.5-1.2	0.5-1	M	L	H	S	
<i>P. carduchorum</i>	F	Sp	L	H	Sh	0.5-1.2	0.5-1	H	L	M	S/PSh	
<i>P. arabica</i>	F/M	U	M	H	Sh	0.75-2	0.5-1	H	L	M	S/PSh	
<i>P. orientalis</i>	M	Sp	M	H	Sh	1-3	0.5-2	H	L	H	S	
<i>P. lycioides</i>	M	Sp	L	H	Sh	0.6-1.2	0.5-1	H	L	M	S/PSh	
<i>P. spinosissima</i>	M	Sp	M	H	Sh	(0.5) 1-2	0.5-1.5	H	L	M	S/PSh	

F; Fine, FS; Full Sun, H; High, I; Irregular L; Low, M; Medium, PSh; Partly Shade, S; Sun, Sh: Shrub, Sp;

Spreading, T; Tree, U; Uprigt

According to table 12, Subgen. *Amygdalus* taxa are tree or shrub that have not only aesthetic features, but also ecological features is valuable. With these traits including from white to (deep)pink flowers blooming in spring that has strong fragrance that some has, edible fruit or nuts, resistance to drought and many pests and diseases and being rootstock, they can play an important rol in landscape (Table 13).

When each of Subgen *Amygdalus* is evaluated separately in table 13;

'*P. dulcis*' is suitable for home gardens, shopping centre precincts and urban parks. Can be planted at the garden edge away of swimming pools or close walls and paving and at street, but should be considered that fruit drop may be a minor nuisance in pedestrian and paved areas. Should not be planted near nature reserves, creeks or watercourses. The other hand, despite a fully deciduous species and losing all its leaves in winter, when it reaches full maturity, it can be considered a perfect shading tree in summer and to enjoy sun in winter. The bright leaves turning yellow in autumn can add interest to landscape, Nevertheless, in order to optimize the tree's aesthetic potential, it is recommended to place it in a sunny location with evergreen trees as a backdrop.

As well as because of the distribution of *P. dulcis* in Asian mountain systems with high erosion rates and native and naturalized in abandoned orchards or orchard borders, it is reasonably drought-resistant and resistant to many pests and diseases. While these traits make it a great low-maintenance tree for garden, park and rural areas, its adventitious roots are suitable to increase the stability of slopes and mitigate erosion on dry slopes (Kaşka et al., 1999). It has high potential both for food forests and for bird parks such as *Nycticorax nycticorax* Linne (Durmuş, 2008). Also, it produces good nectar which attracts bees (*Anthophora plumipes* Pallas ve *A. orientalis* Morawitz) and insects (Grace, 2010). Also, *P. dulcis* can act as a safety barrier to prevent land abandonment, to control forest fires and to mitigate the consequences of climate change on lands at risk of climate change other than horticulture due to playing an important role in the agricultural economy. But as the phenological stages is affected by insufficient chill accumulation, heat waves, drought, irregular rainfall, and spring frost and orchards

sustainability is susceptible to climate conditions (Guillamón et al, 2022; Thomas, 2019; Alonso et al, 2005).

Table 13. Use of subgen *amygdalus* taxa in landscape architecture

Taxa Name	Aesthetic			Architectural						Functional					
	Evergreen/Dedicou	Seasonal interest	Color/Feature	Creating Space	Screening	Privacy	Climate control	Noise Control	Erosion Control	Traffic Control	Wildlife	Rock Garden	Roof-terrace Garden	Rootstock	Agroforestry
<i>P. dulcis</i>	D	Spring-Summer, Fall	fragrant white or pink flowers, yellowy orange fall color	L Sh	W/S	X	X	X	X	X	X		X	X	
<i>P. fenzliana</i>	D	Spring-Summer, Fall	pink flowers	L	W/S	X	X	X	X	X	X		X	X	X
<i>P. trichamygdalus</i>	D	Spring-Summer, Fall	White or pink flowers	L	W/S	X	X	X	X	X	X		X	X	
<i>P. kotschyi</i>	D	Spring-Summer-Fall	pink flowers yellowish grey-tomentose or floccose foliage, fruit	E	W		X	X		X		X			X
<i>P. carduchorum</i>	D	Spring - Summer	Pink flowers, Fine texture	E	W		X	X		X		X			
<i>P. arabica</i>	D	All Season	white, pale pink, or pink flowers evergreen shoots	E	W/S		X	X		X	X		X	X	
<i>P. orientalis</i>	D	Spring - Summer-Fall	White or pink flowers, Silvery-green foliage	E	W/S		X	X		X	X		X	X	
<i>P. lycioides</i>	D	Spring - Summer	Pink-deep pink flowers	E	W		X	X		X	X	X	X	X	
<i>P. spinosissima</i>	D	Spring - Summer	Pink-deep pink flowers	E	W/S		X	X		X			X		

E; Enclosure, L; Limitation, S; Sun, Sh; Shading, W; wind.

'*P. fenzliana*' with small-sized fruit and pink flowers blooming in late spring and being small tree stands out. Its masses of white flowers that provide ample colour and attract a host of insects and birds and its resistance of reasonably coldness and to many pests and diseases and low-maintenance is to make it an invaluable wonderful landscape subject.

By and large since this taxa can be a popular choice for small garden and parks and also for narrow spaces or in border. Because it is a deciduous tree, its open and airy structure creates light shade underneath the canopy and can be used as a small shading tree/shrub at the garden edge in summer. This species has a non-aggressive root system so, it is safe to plant alongside paving or retaining walls. In the other with its fine texture it can be used as a soliter or in groups in gardens, parks or sandy cliffs. As it is adaptation to moist soil, though it might need watering in arid regions, but may be a preferred option for the colonization of in colder regions. It is an ideal replacement for the exotic *Prunus* taxa especially in colder regions. Though fruit and sweet or slightly bitter seed are edible as raw or cooked, if the seed is too bitter, this plant are mildly toxic to humans. Plants in this genus are notably susceptible to honey fungus (Huxley, 1992). As low humidity and high temperatures protect it from fungal diseases, climate change may affect it positively.

'*P. trichamygdalus*' with medium-sized fruit and attractive whitish-pink flowers blooming on short shoots before emerging leaves in mid spring can be cultivated in gardens for its beauty of flower alone. It is an ideal replacement for the exotic *Prunus* shrubs especially in drought areas.

Due to its open, airy structure it is suitable to create light shade underneath its canopy in summer like *P. fenzliana*. It is ideal for hedges and for over lawns and rock gardens as a soliter or in groups. It is qualified for edge of walls at the garden due to the small size or to create a wall effect in a line for separating areas. Also its leathery leaves turning yellow in autumn add interest to landscape. As growing up particularly along gorges, it has a high capacity to tolerate drought and cold conditions, so it provides possibility to increase the stability of slopes and mitigate erosion on dry slopes and it can be planted in wastelands. As medium-sized fruit and non-bitter forms of *P. trichamygdalus* is cultivated in orchard, it can be a potential for food forests because the phenological stages may not be affected so much adverse conditions. Moreover since providing likely food and habitat for wildlife and can be suitable and for bird parks.

P. orientalis with white tomentose leaves and fruits throughout the vegetation season and pinkish blooming in mid spring before leaves emerge is to stand out. Also, that its flowers show very high frost resistance (Grasselly, 1976), needing too low-watering and its resistance to salt and drought-tolerant makes it a perfect shrub. Therefore, it can be alternative to exotic shrubs needing watering. It is qualified as a snow and wind curtains or hedge plant due to thorny dense form and for xeriscape design. It can be pruned formal shapes to create backgrounds in flowerbed or to contrast. Also it has been using to control soil erosion and to stabilize water flows in arid and semi-arid areas and as a rootstock.

Since *P. orientalis* seeds are a little bitter but can be edible in fresh, its fruits can help to feed wildlife living in rural and urban areas and flowers provide important benefits for bees it can be suitable potential both for agroforestry and for bird parks.

'*P. kotschyi*' can be preferred as an ornamental plant with small yellowish pubescent fruit, foliage and outstanding pink flowers in parks and gardens in cold city to create positive effects on the urban landscape, because it tolerance to abiotic stresses such as drought, low winter temperature, snowfall and frost. It can provide a beautiful background with its flowers, to define and separate spaces or to form a

low hedge or to control car light in narrow refuge due to its thorny, dense low stem. It can be used for decorative purposes in a groups or solitary in parks or in roof-terrace gardens. It is ideal to use in mountain steppes to mitigate erosion or to establish green belt along roads. Moreover it can be used in cut floristry and be pruned to shape if need. Seeds are bitter and not edible but fruit and nectar are good source for wildlife. Since providing food and habitat for wildlife, it can be as an insect and bird-attracting garden subject. It can be an excellent alternative to the exotic *Chaenomeles japonica*.

'*P. carduchorum*' explosion of pink flowers in mid spring can provides a stunning display for any garden and parks and it can be an excellent substitute for against the exotic plants or alternative to *Chaenomeles japonica*.

It can play an active role in in the resilient of urban landscape, for it is reasonably drought-resistant and is resistant to many pests and diseases and need low maintenance. Since it often grows on roadsides slope and shallow soils, it can be tolerant of exhaust gas emissions and be used roadside planting and in urban open areas or to create green belts along roads in city or mountain steppes. Also, often growing under the quercus canopy as well, it can be an excellent choice for creating a kind of mini-forest in the gardens and parks. Due to its non-aggressive root system, it is safe to plant next to sidewalks or retaining walls as a ornamental plant. It can be partly pruned for hedge. Seeds are bitter and not edible but nectar attracts bees and insects who pollinate its flower. Fresh fruit attracts small mammals. So it provides wildlife habitats and can be used in insect and bird-attracting garden.

'*P. arabica*' with white or pale pink blooming during early spring and attractive green twigs can play a special rol in landscape to create stuning space. For exmple its upright form and green dense twigs make it an outstanding screening shrub and an effective hedge or a focus plant. It is qualifed as a snow and wind curtains or hedge plant due to thorny dense form or for xeriscape design. When espicially it is used as an ornamental plant in stony or rocky backgrounds in arid areas in continental climate, it can be succed interesting landscape.

As it shows great tolerance to abiotic stresses such as drought, salinity, low soil fertility and low winter temperatures, it can be used for afforestation along with *Pinus brutia* (Yaltırık, 1971), and can plays a valuable role to combat desertification, to stop dunes, to control soil erosion and to stabilize water bodies in arid and semi-arid mountains. Also it is suitable candidate for green belts of cities especially on infertile soils in arid and semi-arid areas (Mozaffarian, 2005). It capables of providing favorable conditions and microclimate for other species by coping with unfavorable conditions in rock debris and slopes. It can be used in road slope and it can good substitute for exotic plants or maybe for *Spartium junceum* L.

Although *P. arabica* fruit is not an economically important plant, is eaten by local people in some places and sold in the market (Meikle 1966; Browicz and Zielinski 1984). Even it is not suitable for food forests, it can be cultivated for multi purposes including food and habitat for wildlife and an insect and bird-attracting garden subject. On the other hand, seeds and seedlings may present an important genetic resource to be used in breeding programs to generate new cultivars and rootstocks that are more adapted to climate change.

'*P. lycioides*' can be one of favourite shrubs with an attractive flowers in early spring in small garden for decorative purpose. For example, it can be designed as a decorative bush or screening hedge in garden and parks, in rrefuge or on the roadside, be planted in pots in homes or gardens, in xeriscape garden, even in roof-gardens. Moreover as this species is preferred to build nest by some birds (Aghanajafizadeh and Heydari, 2020), it can be used for bird parks. It is highly adapted to environmental

stresses such as drought and lack of annual precipitation and unfavorable soil conditions, it can be used to control soil erosion and to create wooded pastures in dry areas.

Seeds are bitter and not edible but it is traditionally used as a antidiabet antiinflammation, antibacterial and laxative agent (Abbaslou and et al, 2014; Ziarati and Alaedini, 2014). So it can be used as a medical-aromatic plant. In addition, as it have been used directly as rootstocks for almond usually for non-irrigated conditions (Khadivi-Khub and Anjam, 2016), can be used in breeding programs to generate new cultivars and rootstocks that are more adapted to climate change as a genetic resource.

'*P. spinosissima*' can play a vital rol in landscape as a a small shrubs that have an abundance of pink flowers in early spring and is native to dry areas. It can be used in lanscape as a hedge or border plants and as an ornamental plant in arid areas in continental climate or in xeriscape gardens due to adaptation to many soil types. It is excellent for massing on embankments or naturalized areas with attractive shape and for soil conservation operations on steep slopes. It can be pruned for a natural look or to raise the canopy.As its salted almonds is eaten as dry fruits by population, it can contribute to food forest ecosystem. Also, used in the Iranian folk medicine (Sajadi, et al, 2021) and having different biological properties including antibacterial, anticancer, antioxidant, antidiabetic, antiemetic, antihypertensive, hypoglycemic, hypolipidemic (Encyclopaedia Iranica, 2019), it can be used as a medical-aromatic plant. It is important as a rootstock or and as a genetic resource for growing sweet almonds, peaches, plums and apricots in arid regions due to its resistance to drought conditions (Açar et al, 2001).

Conclusion

Climate change has led to an increased frequency and severity of heat waves, droughts, and heavy precipitation events (IPCC. Climate Change 2023). Nevertheless in the Mediterranean-type climate regions, where an important fraction of subgen *Amygdalus* grows, that the mean annual precipitation tends to decrease may result in harmful effect on all biodiversity, it stands out that subgen amygdalus taxa show a high capacity to tolerate drought conditions.

Therefore, it is imperative to support and utilize these taxa, which offer a higher resistance to pests, diseases, and the challenges posed by climate change, which can be contributed to food forest ecosystem, including carbon sequestration, and require minimal maintenance.

Moreover, apart from the cultivation of *Prunus* taxa for use as rootstock, it is also necessary to develop them in a way that overcomes the homogenization pressure brought by globalization in the ornamental plants market, creates a difference and responds to the evolving needs (Alp et al, 2020).

Additionally, it is crucial to consider the conservation of certain taxa, such as *P. trichamygdalus* var. *elongata*, which is endemic, as well as *P. kotschyi* and *P. carduchorum*, due to their limited distribution areas. Special attention should be given to relieving the pressures exerted by land use on these taxa. Policies and scientific projects aimed at promoting landscape sustainability and protecting both the taxa and their habitats have been developed to address these concerns.

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