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Research article

Usage values in landscape designs of *Anchusa azurea*, *Diplotaxis tenuifolia* and *Moltkia coerulea* (Tracheophyta) which have a natural distribution in the campus area of Niğde Ömer Halisdemir University

Sinem AKKAYA, Tülay EZER*

Niğde Ömer Halisdemir University, Faculty of Architechture, Department of Landscape Architecture, Niğde/Türkiye

*Corresponding author: tuezer@gmail.com; tezer@ohu.edu.tr

Abstract: In this study, the landscape use values of *Anchusa azurea* Mill., *Diplotaxis tenuifolia* (L.) DC. and *Moltkia coerulea* (Wild.) Lehm. species, which have a natural distribution in the Niğde Ömer Halisdemir University campus area, were investigated. These species were evaluated according to a total of 10 parameters, including showy flowers, flowering period, fragrance, flower colour, flowering duration, showy leaves, use as parterre plants, use on roadsides, use in rock gardens, and solitary use. As a result of these evaluations, species that meet five or more parameters were identified and their suitability for use in landscape design applications was determined. As a result of the study, it was determined that *Anchusa azurea* and *Moltkia coerulea* have showy characteristics of both flowers and leaves, while *Diplotaxis tenuifolia*, which has relatively small flowers, was found to have particularly showy leaves. And also, recommendations were also developed regarding the use of these plants in landscape architecture.

Keywords: *Anchusa azurea, Diplotaxis tenuifolia,* Landscape value, *Moltkia coerulea*, Natural species

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Introduction

Urbanisation, whether natural or anthropogenic, is one of the most dominant forms of land use worldwide today, and especially increasing population and unplanned urbanisation pose a significant threat to natural ecosystems and biodiversity. This situation caused by urbanisation has led to a gradual decrease in natural green areas, thus creating a need for urban open green areas that reflect the natural areas that establish a relationship between humans and nature (Çay, 2010; Smalwood & Wood, 2023; Tırnakçı & Aklıbaşında, 2023).

Plants, which are the most important component of natural ecosystems, are the most important element of these urban open green spaces due to their aesthetic and functional characteristics. Especially natural plants are one of the riches of our country, which has a floristic diversity that can compete with almost a continent, and it is very important to discover this richness and evaluate it in landscape desings according to their areas of use Aydoğdu, 2018; Tırnakçı & Aklıbaşında, 2023). These plants, which complement the geological structure, climate, soil and hydrological characteristics of the landscape in which they grow,

will not require any maintenance as they will continue to live in their own habitats and will be resistant to the ecological factors of the habitat. In addition, the use of these natural species will add aesthetic and functional value to landscape design. In particular, the colours, shapes and arrangements of the leaves, flowers and fruits of these natural species reveal their areas of use in designs and were considered important characteristics in the creation of effective compositions (Karahan & Yılmaz, 2001; Dönmez et al., 2016; Bozkurt, 2021).

Although university campus areas are subject to anthropogenic influences, the campus areas of universities with long-established structures can be considered areas where biological diversity is preserved (Ezer et al., 2021). The campus area of Niğde Ömer Halisdemir University attracts attention with a total of 405 plant taxa, 33 of which are endemic (Başköse et al., 2012). The present paper focuses on revealing the usage values in landscape design of *Anchusa azurea* Mill., *Diplotaxis tenuifolia* (L.) DC. and *Moltkia coerulea* (Wild.) Lehm. found on the campus area, which have not been studied in detail before.

Materials and Methods

Study area

The campus area, which covers approximately 3.5 km², is located between the provincial centre of Niğde and the district of Bor, 5 km south-west of the provincial centre. There are agricultural areas in the east, south and south-west of the study area. It is bordered by Bor district to the west and the Niğde-Bor highway to the north (Fig. 1).

Especially the aquatic habitats of the Akkaya Dam Lake and its surroundings, a large part of which is included in the campus area and was declared a "Wetland of International Importance" in 2005, have brought the area to a level that can be considered relatively rich in terms of phytodiversity.

Figure 1. Niğde Ömer Halisdemir University campus area (modified from Google Earth)

The climatic characteristics of Niğde province, where the study area is located, were determined using the climate data between 1991-2020 on the website of the General Directorate of Meteorology of the Niğde Meteorological Station (www.mgm.gov.tr). Accordingly, the annual average temperature is 11.7 °C and the month with the highest temperature is July with 23.2 °C. The month with the lowest temperature is January with 0.0 °C. The average annual rainfall is 349.9 mm, with May being the rainiest month with an average rainfall of 43.4 mm, while July is the driest month with an average rainfall of 5.5 mm. When the seasonal precipitation regime is examined, the study area is located within the semi-arid, very cold sub-Mediterranean climate and is located in the Eastern Mediterranean II variable in terms of precipitation regime (Akman, 2011).

The study area is geologically located within the Niğde Metamorphic Unit, also known as the Niğde Massif, and consists of carbonate-derived bedrock. In the massif, from bottom to top, there are Gümüşler, Kaleboynu, Aşıgediği and Çamardı formations. Niğde group metamorphics consist of white or bluish marbles, quartzite, amphibolite and gneisses (Atabey et al., 1990; Başköse et al., 2012).

The general vegetation type of the study area is steppe and the elements of the Irano-Turanian Phytogeographic Region, which includes the Central Anatolian steppes, are dominant. Members of the Asteraceae and Fabaceae in particular exhibit rich species diversity within the campus area. *Astragalus* L., an important characteristic of the Central Anatolian steppes, is the richest genus in the area in terms of taxonomic diversity (Başköse et al., 2012).

Data source

The main materials of the present study consists of the species *Anchusa azurea*, *Diplotaxis tenuifolia* and *Moltkia coerulea*, which occur naturally in the campus area of Niğde Ömer Halisdemir University. In addition, photographs taken during fieldwork and records of observations and measurements, together with relevant literature data, constitute the supporting materials for this study.

The method used to reveal the landscape use values of *A. azurea*, *D. tenuifolia* and *M. coerulea*, which are naturally distributed in the campus area and whose landscape use values have not been studied in detail before, was carried out under three general headings: 1. data collection, 2. synthesis of data, and 3. evaluation of results (Seyidoğlu Akdeniz & Zencirkıran, 2016).

Land studies were carried out in the study area in April, May, June, July, August, September, October and November of 2024, and generative and vegetative characteristics of the species, primarily showy flowers, were observed, photographs were taken and necessary data were noted, taking into account ground cover characteristics and population densities. In this context, the potential and possibilities of these species for use in landscaping desings were evaluated based on a total of 10 parameters, including showy flowers, flowering period, pleasant scent, flower colour, flowering duration, showy leaves, use as parterre plants, use on roadsides, use in rock gardens, and solitary use (Eroğlu et al., 2013; Sağlam & Önder, 2018; Çimen & Ulus, 2020; Bozkurt, 2021). As a result of these evaluations, species that meet five or more parameters have been identified and their suitability for use in landscape designs has been determined.

During the land studies, phenological observations of species were made without taking samples and without harming the plants in their natural habitats. The areas sampled during fieldwork and the areas where species are naturally distributed are shown in Fig. 2. *Diplotaxis tenuifolia* is widely spread throughout the campus area, including the main entrance of the Faculty of Education, the Conservatory Garden, the vicinity of the Faculty of Islamic Sciences, and the vicinity of the student cafeteria. *Moltkia coerulea* has been found on the library road, in the garden of the Fadımaana student dormitory, and around the Technopark building. *Anchusa azurea* has been found around the Faculty of Agricultural Sciences and Technologies, the Faculty of Science, and in the campus mosque garden.

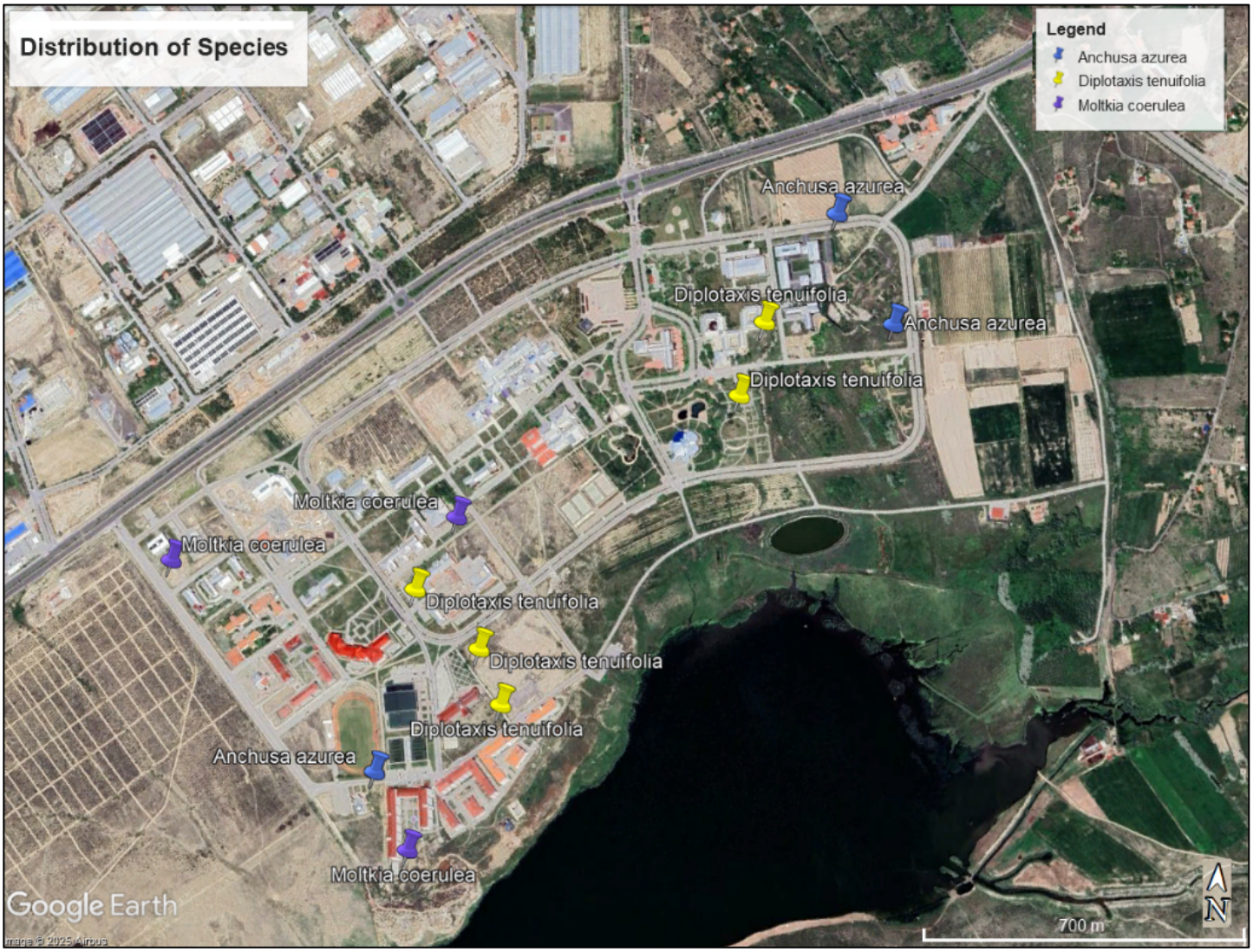

Figure 2. Representative morphological abnormalities: a) Micronucleus, b) Notched nucleus, c) Budding nucleus, d) Lobed nucleus, e) Binucleated nucleus

Results

Diplotaxis tenuifolia (L.) DC.

The plant is perennial and grows up to 70 cm tall, with a single or branched stem (Fig. 3).

The lower leaves are linear or spatulate. The leaves are flat, lobed or pinnatifid and approximately 10 cm long (Fig. 4).

The broad obovate petals are lemon yellow in colour and measure approximately 10 x 9 mm (Fig. 5).

The pedicels are erect and approximately 20-30 mm long, while the fruits are 20-45 mm long and 1.5-2 mm wide (Fig. 6).

The plant, which has a wide distribution in the study area, is generally found along roadsides and rocky slopes. It has formed large populations and clusters, especially on pavements and kerbs, under trees, and on vacant lots on the campus area. In addition, during land studies, different insect species were observed on the flower, and the presence of many different pollinators increased the plant's pollination potential and, consequently, its reproductive potential (Fig. 7).

Figure 3. General view of *Diplotaxis tenuifolia*

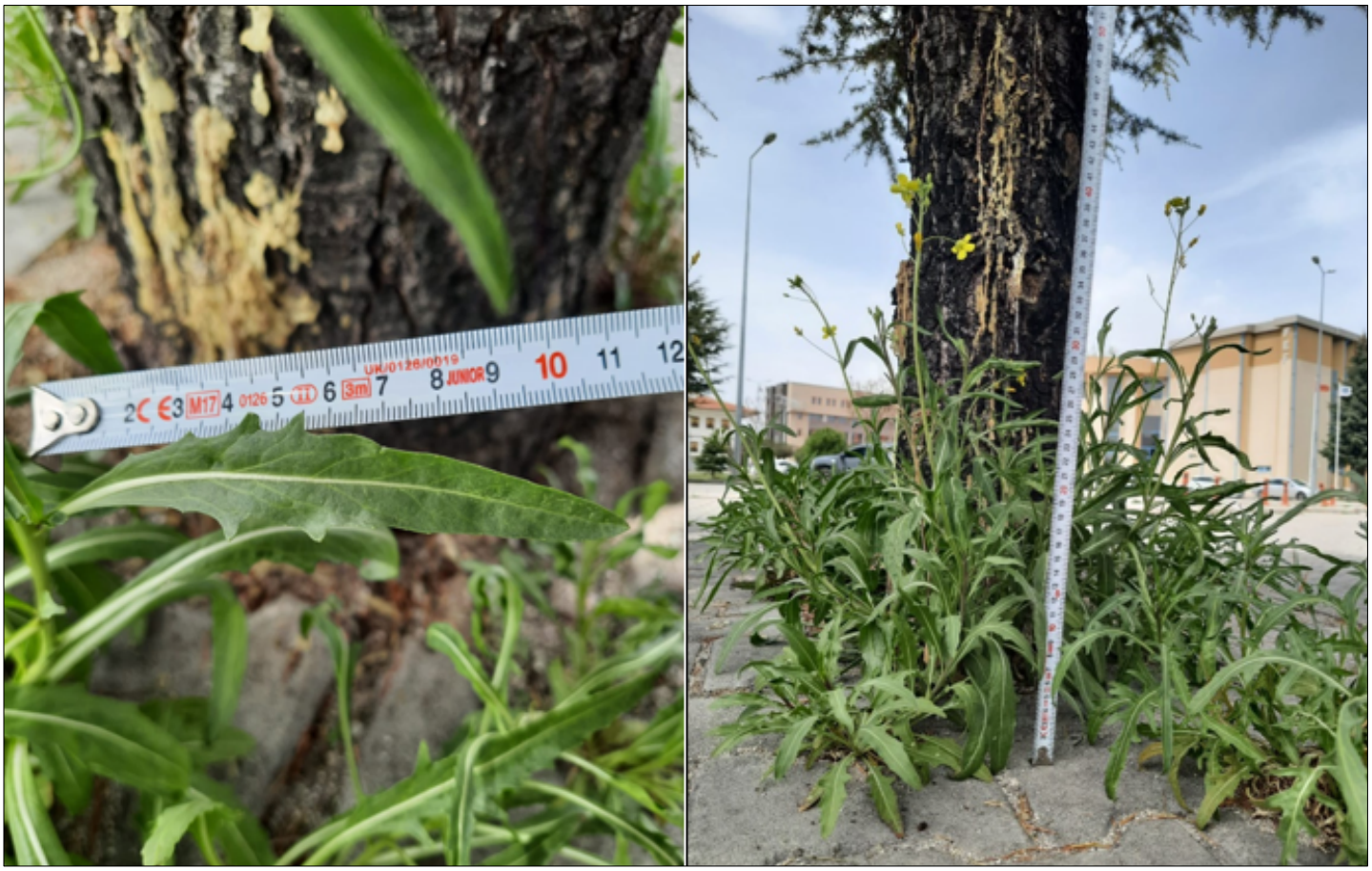

Figure 4. Leaves of *Diplotaxis tenuifolia*

Figure 5. Flowers of *Diplotaxis tenuifolia*

Figure 6. Leaves of *Diplotaxis tenuifolia*

Figure 7. The view from the kerbside and pollinator of *Diplotaxis tenuifolia*

***Moltkia coerulea* (Willd.) Lehm.**

The plant, covered with grayish sticky hairs, is perennial and the unbranched stems reach 10-20 cm in length (Fig. 8).

The inflorescence is 2-3 terminal cymoses. The corollas of the tubular flowers are dark blue and 10-12 mm long. Young flower buds are pink in color. The fruits have a hard shell and are 4 mm in size (Davis, 1978). Flowering starts in April and continues until the end of June, and pollination is carried out by insects (Fig. 9).

The species, which generally spreads in stony habitats, steppes, fields and field edges, was detected in the study area, especially in open areas relatively far from anthropogenic effects.

Figure 8. General view of *Moltkia coerulea*

Figure 9. Pollination of *Moltkia coerulea*

***Anchusa azurea* Mill.**

It is an erect, perennial, herbaceous plant with dense hair. The stem can grow up to 20-250 cm in height (Fig. 10).

The leaves are linear-elliptic, lanceolate or oblanceolate, 50-200x6-40 mm. Leaf margins entire or faintly undulate-crenate (Davis et al., 1988). Flowering begins in early April and continues until August. Corolla deep blue, 6-8 mm and lobes 5-7 mm. Stamens inserted at top of tube (Fig. 11).

Nutlets 6-8 x 2-3 mm, oblong and erect. It is generally distributed in fields and arid steppe areas.

Figure 10. Generel view of *Anchuza azurea*

Figure 11. Leaves and flowere of *Anchuza azurea*

Usage values in landscape designs of the species

Diplotaxis tenuifolia, *Anchusa azurea* and *Moltkia coerulea*, natural species in the Niğde Ömer Halisdemir University campus area, were evaluated according to their usability and possibilities in landscape architecture based on a total of 10 parameters (showy flowers, flowering period, pleasant scent, flower color, flowering period, showy leaf, use as parterre plant, use on roadsides, use in rock gardens, solitary use) (Table 1, 2).

Figure 8. Usage values in landscape designs of the *Diplotaxis tenuifolia*, *Anchusa azurea* and *Moltkia coerulea*. S.F.: showy flowers, P.S.: pleasant scent, F.C.: flower color, F.P.: flowering period, S.L.: showy leaf, P.P.: use as parterre plant, R.: use on roadsides, R.G.: use in rock gardens, S.: solitary use, m.: month.

Family	Species	Turkish name	S.F.	P.S.	F.C.	F.P.	S.L.	P.P.	R.	R.G.	S.
Brassicaceae	*Diplotaxis tenuifolia*	Türpenk		+		8 m	+	+	+	+	+
Boraginaceae	*Anchusa azurea*	Sığırdili	+	+		4 m	+	+	+	+	+
Boraginaceae	*Moltkia coerulea*	Mavikesen	+			3 m		+	+	+	+

Table 2. Flowering period of *Diplotaxis tenuifolia*, *Anchusa azurea* and *Moltkia coerulea*.

Species	January	February	March	April	May	June	July	August	September	October	November	December
Diplotaxis tenuifolia												
Anchusa azurea												
Moltkia coerulea												

Conclusion and Recommendations

As a result of the evaluations, *A. azurea* and *M. coerulea* were found to have showy characters in terms of both flower and leaf characteristics, while *D. tenuifolia*, which has relatively small flowers, was found to have showy leaves, especially when leaf characteristics were taken into consideration.

Diplotaxis tenuifolia, whose leaves form a green cover in the form of clusters at the base, can be used as an alternative to Poaceae members, which are used as grasses in landscaping designs and have high water requirements. Although it has the longest flowering period (8 months) compared to other species, the fragrance of its flowers is not dominant. It is therefore insufficient for creating fragrance gardens. On the other hand, *D. tenuifolia* is considered to be suitable for roadside use as it spreads along curbs and sidewalks. In addition, its green, strip-shaped leaves and yellow flowers will attract attention, especially in rock gardens. The fact that it spreads in harmony with other plant species in its area shows the possibility of its use as a parter plant. In the habitat where it grows, it is thought that it may be sufficient to create solitary designs in landscaping studies since its leaves spreading to the base form clumps. It can be said that the species is ideal to be used to create landscape designs at low cost due to its natural distribution in the area, producing a large number of seeds, not requiring much maintenance.

Moltkia coerulea, which attracts attention with the color of its flowers, remains flowering for 3 months. It is possible to use this species, which is seen to form clumps in the area where it is distributed, as a solitary. The species, whose flowers are odourless, can be used in rock gardens because it can grow in arid soils and does not require much maintenance. The species, which is observed to grow on roadsides in the study area, is ideal for roadside planting designs. Parterres can be created by combining them with different species, especially considering their attractive flowers. However, since the leaves were short (3-4 cm) and dull green in colour, they were considered as weak in terms of leaf characteristics.

Anchusa azurea, which attracts attention with its blue flowers, remains flowering for 4 months. The fact that it is a natural species that is resistant to drought and does not require much maintenance indicates that it is suitable for use in rock gardens. It can be used in herbaceous flower parterres with its flamboyant blue-pink flowers and leaves that attract attention in the designs. The species is fragrant, but since the scent is not intense, its suitability for use in scent gardens is questionable. In the study area, the species was generally found on road and kerb edges and was evaluated as suitable for use on roadsides. It is also an effective species with its flower colour and foliage, which makes it attractive for solitary use. It can be preferred in landscaping arrangements, especially in flower parterres, rock gardens, lawn areas and group plantings.

The use of plant species adapted to the ecological conditions of the region in the selection of plant material, which forms the basis of landscape planning, is one of the most important factors in the success of planting Works (Karahan & Yılmaz, 2001). As a result of the present study, it was revealed that *A. azurea*, *D. tenuifolia* and *M. coerulea*, which have natural distribution in Niğde Ömer Halisdemir University campus area, have landscape use value. Considering the geographical factors and climatic conditions of the area, it is very important to select plants that can survive in the face of harsh living conditions in landscape designs. The results obtained are very important in terms of both the introduction of natural species in our country, which has a plant diversity that can compete with almost a continent, as new plant material in landscape designs and the protection and sustainability of these species.

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Ethical Approval

No need to ethical approval for this study.

Conflict of interest

The authors have no conflict of interest.

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