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Autecology of *Cephalaria taurica* Szabó, A Narrow Endemic from Turkey: Plant-Soil Interactions

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Abstract: *In this study, some autoecological characteristics of Cephalariataurica were investigated. In this context, plant and soil samples were collected from two different elavations(loc. 1, 1100 m and loc. 2, 200 m) of Kızıldağ in Amanos Mountains, Hatay/Turkey. Mineral element distribution in soil and plant samples were measured, and physical and chemical properties of soil, including texture, pH, electrical conductivity (EC), saturation, salinity, and $CaCO_3$ contentwere determined.*

Keywords:*Autecology,plant-soil interactions,endemics, Antakya,Turkey.*

I. Introduction

Genus *Cephalaria,* whichbelongs toCaprifoliaceaefamily,contains approximately 94 species.The species of this genus are mainly distributed in South Africa, MediterraneanRegion, Balkan Peninsula, South Ukraine, Caucasia, Iran, West China and Middle East[1-4]. While genus *Cephalaria* has 94 species around the world, in Turkey thegenus is representedby39 species, and 23out of which are endemic[1, 5-7].

Cephalaria species have economical and medicinal importance.*C.gigantea*is used for dying the wool in carpet business [1].*C.syriaca*is usedas awheat additive material to improve the rheological properties of dough[8, 9]. *Cephalaria* species are also usedfor medicinal purposes such ashypothermal, alleviative, relaxantanti-infective, uretic and menstruation regulator activities, and in the treatment of rheumatism, lung and cardiac diseases[4].*Cephalaria* species also contain a very diverse group of biologically active secondary metabolites including, triterpenoid,saponin,iridoid glycosides, essential oil, fatty acid, antioxidants, flavonoid glycosides, andalkaloids.Some of thesesubstances have antimicrobial, antifungal and cytotoxic effects [1, 2, 5, 6, 10-14].

Although many *Cephalaria* species have been studied for their ecological, botanical and phytochemical importance, *C.taurica* has not been extensively studied.Therefore,this study aims to investigate the some of the autoecological properties of the endemic species, soil-plant interactions and mineral nutrition status.

II. Materials And Methods

2.1. Study Area

Study area is located attwo different elevations (loc. 1, 1100 m and loc. 2, 200 m) of Kızıldağ inAmanos Mountains, Hatay/Turkey(Fig.1).Kızıldağ is bordered by the Mediterranean Sea in the west, Samandağ in the south, Iskenderun bay in the southwest and Dörtyol in the north.Hatay province has formations of all geological periods, from Cambrian to the present day. In the formations of Precambrian and Paleozoic periods, schist, quartzite, shale, limestone and rocks are frequently observed. Lands Mesozoic period show a distribution particularly in south Amanos and along the Amanos Mountains, and in an area of west and southwest of Kuseyr Plato between Yayladağ and Samandağ. Lands of Mesozoic-Tertiary period have a distribution mainly in the middle Amanos starting from the northwest of Kırıkhan to the north and northwest area of Hassa. Lands of Quaternary era constitute the youngest unit of lands within the provincial boundaries. These lands have distribution primarily in the Amik plain, the Asi river delta, coastal plains of Iskenderun Gulf, and valley floors of rivers. Since Hatay and its neighboring provinces have become exposed to intense tectonic movements, it shows variations in terms of geomorphic shapes, and mountains, plateaus, plains and graben areas form the main geomorphic shapes [15].Amanos Mountains have five different types of soils: (1) eroded soils on marl bedrock, (2) red mediterranean soils, (3) brown calcareous soils, (4) brown forest soils and (5) alfisols[16].In the study area, climate type is typical Mediterranean with warm and rainless summers, and moderately warm and rainy winters. Average highest temperature is 23.2^{o}C and average lowest temperature is 14.0^{o}C, with an annual average of 18.3^{o}C. Annualtotal precipitation is 1120.7mm [17, 18], and annual average relative humidity is around 69% as seen in Table 1[19]. Total evapotransprationin the region for the last 50 year was 1278 mm [20, 21].

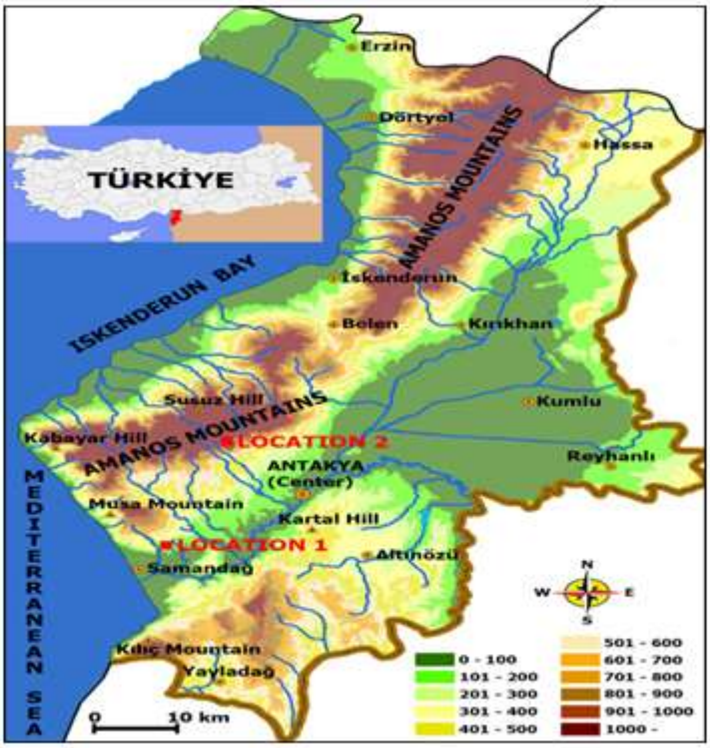

Figure 1. Map showing the study area - Hatay/Türkiye.

Table 1. Climate data for Hatay (1954-2013)
*Prepared using the data of General Directorate of Meteorology [19].

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average temperature (°C)	8.3	9.8	13.2	17.2	21.2	24.8	27.2	27.8	25.5	20.7	14.2	9.6	18.3
Average high (°C)	12.2	14.4	18.3	22.5	26.4	29.2	31.1	31.9	31.0	27.5	20.2	13.7	23.2
Average low (°C)	4.7	5.7	8.5	12.3	16.3	20.8	23.9	24.5	21.1	15.2	9.4	5.9	14.0
Precipitation (mm)	182.9	164.8	143.0	109.9	86.5	22.4	8.2	5.1	39.6	67.3	103.2	187.8	1120.7 (total)

2.2. Plant and Soil Analysis

Plant (root, stem and leaf) and soil samples were collected from two different localities in Kızıldağ.Plant samples (root, stem,and leaf) were oven-dried at 80°C for 48 hours, milled in micro hammer cutter and passed through 1.5-mm sieve. 0.5 g of samples were weighed and transferred into Teflon vessels and then 8 ml 65% HNO_3 was added. Then, samples were mineralized in microwave oven at 145°C for 5 min., at 165°C for 5 min. and at 175°C for 20 min. After cooling, samples were filtered by Whatman filters and made up to 50 ml with ultrapure water. Standard solutions were prepared by using multi element stock solutions-1000 ppm (Merck) and K and Na measurements were conducted by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES).N and P were determined by the methods outlined in detail in Kacar&Katkat[22].

500 g of soil samples were taken from a depth of 30 cm in both localities. The pH was determinedby Hanna 211pH meter; total soluble salt (TSS) and conductivity values weremeasured by Hanna E.C. 211 conductivity meter; soil texture was determined with Bouyoucos Hydrometer; $CaCO_3$ was measured byScheiblercalcimeter; modified Kjeldahl method was used for total N analysis; Pconcentration was determined by using Olsen method;all measurements were taken according to the methods outlined in detail in Oztürk et al. [23]K and Na concentrations were measured by using ICP-AES.

III. Results And Discussion

Soil analysis showed that*C. taurica*prefers loamy soils (Table 2).The pH valueswere measured as 8.10 for location 1 and8.09 for location 2, indicating that *C. taurica*well adopted to grow on moderatealkaline soils. $CaCO_3$ concentrations were determined as 8.247% in location 1 and 8.351% in location 2.This showed that*C.taurica*prefers moderate levels of $CaCO_3$.Average total soluble salt (TSS) weredetermined as 0.0256% in location 1 and 0.0273% in location 2, indicatingthat *C. taurica*prefersnon-saline soils.Electrical conductivity value wasmeasured as 0.119 mS/cm in location 1 and 0.172 mS/cm inlocation 2,supporting that study area has non-saline soil type. This is also attributable to the improved soil drainage conditions since the year 1975 to control runoff flows and salinity levels in the region [18]. The soil survey conducted in the region in 1962 showed that the TSS ranged from 0.054 to 0.321% [18]. On the other hand, our results showed the TSS was between 0.0256 and 0.0273%, indicating a large portion of TSS was leached away from the region.

Table 2. Physical analysis of the soils supporting *C. taurica*.

	Location 1 (1100 m)	Location 2 (200 m)
Texture	Loamy (L)	Loamy (L)
$CaCO_3$ (%)	8.247	8.351
EC (mS/cm)	0.119	0.172
TSS (%)	0.0256	0.0273
pH	8.10	8.09
N (%)	0.04	0.035
P (%)	0.000194	0.00022
K (%)	0.0186	0.05213
Na (%)	0.0041	0.0084

N amount of soil was measured as 0.04% at location 1 and 0.035% at location2 (Table 2).In plant parts,N amount was measured as 1.96% in root, 1.54% in stem and 1.35% in leaf at location 1,and1.67% in root, 1.83% in stem and 1.61% in leaf at location 2 (Table 3).Tuzuner[29] reported that percentage of N in soilsis between 0.1% and 0.15%. Therefore, soil type in both locations represented the characteristics of nitrogen-poor soils. On the other hand, the soils of the Amik Plain that are undergone intensive agriculture have 0.000138% or (1.38 ppm) total N in the 0 to 20 cm depth of the surface soil all over the Plain [17].According to Ozdemir&Ozturk[24], average N content in plant parts is within normal ranges, implying that *C. taurica* is capable of taking required N from the nitrogen-poor soil.

Soil nitrogen availability depends on the location and seasonal factors such as precipitation, temperature, wind, soil type and pH [25], and uptake of this nitrogen by plant strongly supported by adaptability of plant in its environment. In addition, mycorrhizal fungal activity enhances N uptake and its translocation by acquiring nitrate(NO_3^-), ammonium (NH_4^+) and amino acids for its host species [26-28]. Therefore, availability of required N by *C. taurica* from nitrogen-poor soil can be explained by either adaptation mechanisms favoring in the way of high accumulation of N or presence of mycorrhizal fungal activity.

Table 3. Chemical analysis of plant parts in *C. taurica*

	Location 1			Location 2		
Plant Parts	**Root**	**Stem**	**Leaf**	**Root**	**Stem**	**Leaf**
N (%)	1.96	1.54	1.35	1.67	1.83	1.61
P (%)	0.005253	0.01724	0.006717	0.007561	0.024626	0.02761
K (%)	0.48	1.1819	0.6598	1.1760	1.4687	1.6583
Na (%)	0.01773	0.020068	0.022325	0.066893	0.038634	0.078221

P content in soilwas measured as 0.000194%in location 1 and 0.00022% in location2.According to Tuzuner[29], average P concentration varies between 0.0006% and 0.0009%. Therefore, percentage of P in study area shows phosphorus-poor soil characteristics. In plant parts, P concentrationwas measured as0.005253% in root, 0.01724% in stem and 0.006717%in leaf at location 1, and0.007561% in root, 0.024626% in stem and 0.02761% in leaf at location 2.Average P content in plants is usually accepted as 0.2%[30].Although P uptake and accumulation of*C. taurica*were lower than usual, it is able to sufficiently form healthy populations in its restricted habitat.

K concentration insoil was measured as 0.0186% and 0.05213% in location 1and 2respectively. In plant parts, concentration of K was measured as 0.48% in root, 1.18% in stem and 0.6598% in leaf samples at location 1, and1.176%in root, 1.469% in stem and 1.658% in leaf samples at location 2.According to Tuzuner[29], accepted valueof K percentage in soil lie between 0.013% and 0.058%.Therefore, average K concentrationsin both locations are within the normal ranges.Epstein[30] reported that average K content in plants is around 1%. Our findings are slightly higher than this limit.

Soil Na concentrationwas measuredas0.0041% at location 1 and 0.0084% at location 2. In plant parts, Na concentrationswere measured as 0.0177% in root, 0.0200% in stem, and 0.0223% in leaf at location 1and0.0669% in root,0.0386% in stem, and 0.0782% in leaf at location 2.

Studies indicated that soils of *C. taurica* were mainly salt-free (0.1%<Na) and this is also supported with EC values of 0.119 and 0.172 mS/cm[22, 31]. Na concentration in*C. taurica*is withinthe accepted values[22, 30]. This shows that *C. taurica* may have a higher Na accumulation capacity in salt-free soils. Akis[18] reported soil salinity decreased and texture got coarser as the elevation increased in the Amik Plain.

*C. taurica*shows most of the attributes of narrow endemicsincluding narrow geographical range, a few population, small and declining population size, need for specialized ecological niches, and stable and constant growing environment[32]. Soil properties, altitude, climate, precipitation and temperature of *C. taurica*'shabitat, and obtained plant-soil mineral element distribution resultssupport the general attributes of narrow endemics earlier mentioned in this study. Since endemic species are much more vulnerable to extinction at much higher rates than other species, they must be given priority, and monitored carefully in order to preserve the genetic diversity of these species. In addition, ecological studies about these endemic species should be supported with comprehensive physiological and molecular studies.

This study showed that soil properties, altitude, climate, precipitation and temperature of *C. taurica*'s habitat, and obtained plant-soil mineral element distribution supported the general attributes of narrow endemics. Akis[20] determined moisture characteristics of the soils in the landscape of the studied area. The soils showed no more than 3.8 kPa negative pressure to utilize soil water by plants and soil matric potential values ranged from 3.8 to 16 kPa for the 30 cm thickness of the surface soil. In a simulation study of the soil moisture content of the same study area, matric potential ranged from zero negative pressure (saturation with water) to 23 kPa pressure [21]. Therefore, *C. taurica*, being a narrow endemic, must be given priority, and monitored carefully in order to preserve the genetic diversity of this species since endemic species are much more vulnerable to extinction at much higher rates than other species. In addition, ecological studies about these endemic species should be supported with comprehensive physiological and molecular studies to promote the understanding about these narrow endemics.

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