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Research Article

Study of Ecological Characters of *Ziziphora Clinopodioides* L. Medicinal Plant in North East Rangelands of Iran

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ABSTRACT

Ziziphora clinopodioides L. (Lamiaceae) is one of the most important medicinal plants had been used in traditional medicine in natural sites of mountainous areas of Iran. This study aimed to investigate the main autecological characteristics of plant. In this site, different parameters such as climate characters, vegetation studies, physical and chemical analysis of the soil were determined. The results showed that *Ziziphora clinopodioides* could be adapted in regions with arid cold climate, annual rainfall average of 295 mm and annual average temperature of 11.28 °C. *Ziziphora clinopodioides* have dispersed in northern, south and north east slope and altitude 1200- 1875 m of sea level in area. It was observed that this plant generally prefers Loamy texture, lime, alkaline pH and non-saline soils. The content of organic matter is rich in its habitat. Individual plants height varies from 21 to 40 cm with canopy diameter of 25 to 75 cm. Mean canopy cover was 17% in the habitat. According to the results of the vegetation studies, average of the current yield was 241.27 kg/ha and 11500 species per hectare was estimated as average of the density of *Ziziphora clinopodioides*.

Key words: Autecology, *Ziziphora clinopodioides*, Rangeland, Iran

INTRODUCTION

Iran with about 1.65 million square kilometer area is a large country and after Turkey is the richest country of plant diversity in the Middle East (Jafari and Akhani, 2008). Iran is one of the major centers of endemism in the world. This country is rich in plant diversity; topographic factors have created a very diverse microclimate and edaphic conditions that caused growth around 8000 plant species (Haghighi and Mozafariyan, 2011).

Medicinal plants have been used in folk medicine for therapy of many diseases. The results of scientific researches of medicinal plants for remedying several diseases, including infectious diseases (Moradi *et al*., 2011, Khalili dehkordi *et al*., 2011), diabetes (Asgary *et al*., 2011), cancer (Shirzad *et al*., 2011), atherosclerosis (Rafieian-Kopaei *et al*., 2011), gastrointestinal disorders (Shahrani *et al*., 2007, Rahimian *et al*., 2010), burns (Asadi *et al*., 2013), and neurological difficulties (Akhlaghi *et al*., 2011) have been very promising.

Lamiaceae family, a large and diverse family of about 200 genera and 3,200 species is distributed in world (Zargari, 1997). The Ziziphora genus belongs to Lamiaceae family, with more than 15 species, mainly distributed in the Mediterranean mountainous regions of Europe, Asia and Africa. This plant with the Persian name of Kakuti, consists of four species including *Ziziphora clinopodioides*, *Ziziphora tenuior*, *Ziziphora capita* and *Ziziphora persica* is found in mountainous regions of Iran (Rechinger, 1980; Mozaffarian, 1996).

Many investigators *et al.* have been studied on the antioxidant, antibacterial and antifungal activities of the plants. It has been indicated in Iranian and many Asian traditional medicines, such as Turkey, that the infusions of Ziziphora species, especially Ziziphora clinopodioides, have been used as antiseptic, carminative and sedative agent to treat cold, flu, cough, stomach ache and diarrhea (Salehi, 2005; Zargari, 1997; Soltani *et al*., 2013).

In relation to the phytochemical qualities of Ziziphora genus, many researchers stated that the Ziziphora species are rich in monoterpenoides and phenolic compounds such as thymol, pulegone, piperitenone and p-menth-3-en-8-ol, which can have antioxidant and antimicrobial activity against many infectious diseases and pathogens (Aliakbarlu and Farnaz Shameli, 2013; Sajadi *et al.*, 2003; Thuille *et al.*, 2003).

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Autecological studies are essential to get basic information requisite for the species management. The main problem in plant study is knowledge of plant ecological condition in order to assemble favorite condition for planting. There are many medicinal plants in Iran but there is lack of enough information about plants condition and their application. The purpose of this study is to investigate some autecological characteristics of *Ziziphora clinopodioides* to specify its ecological requirements and successful establishment.

MATERIALS AND METHODS

The study area

The study area was chosen in arid rangelands of Bojnourd city in North East of Iran (North Khorasan Provinces). This region is situated between 37° 23' to 37° 36' North latitude and 57° 7' to 57° 15' East longitudes. The area is approximately 5300 hectares with elevation ranging from 1020 m to 1875 meter. The means of precipitation is 295mm/year that maximum and minimum of precipitation occur in April and July respectively. The mean of annual temperature is 11.28° C. The average maximum temperature is 26.1° C in July and minimum temperature is -6.8° C in January. The climate of this region with using of Emberger method is cold arid. The embrothermic diagram show that drought period is for five months of year and wet season start in November and continues until May (Fig.1).

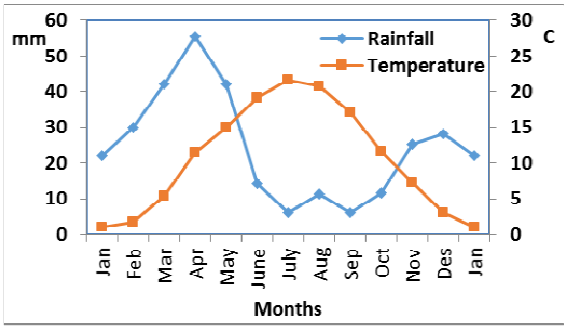

Fig. 1: Embrothermic curve in the study area.

Method of investigation

The climatic (temperature, rainfall), topographic and edaphic (physical and chemical) properties of the habitat were determined. Meteorological data including rainfall and temperature were obtained from Bojnourd meteorological station. Five soil profiles were randomly dug at area. Soil samples were analyzed for OC, EC, pH, CEC, N, Na, K, P, Ca, HCO_3, Cl, Mg, SO_4, Gravel, $CaCO_3$, $CaSO_4$ and texture. Plant height, density, abundance, canopy cover and yield of *Ziziphora clinopodioides* were directly measured in the field using transect and quadrate method (Mannetje, 1978). Ten 50 meter transects were established, 80 plots by the average of 1m ×1m were selected. To determine phenology and growth duration, from the beginning of growing season, the plant growth area was visited biweekly and vegetative stages of plant growth were recorded in related forms. Rooting depth was also measured in each soil profile.

RESULTS AND DISCUSSION

The habitat of a species is the most important part of its life cycle. Therefore, there is a need to understand the habitat for an evaluation of the biological features of a species which is also critical for the wildlife management. Habitat of a species is informative about bioclimatic, edaphic, topographic, biotic characteristics of a specific area, it describes sum of the biotic and abiotic factors required by an organism (Thomas, 1979).

Climate is one of the most important factors in the plant development (Vallejo *et al*., 1998). In Irano-Turanian zone, fall and winters are cold, rainy and snowy, and summers are dry and hot, are covered by sclerophylleous species that need quite little water and high temperatures (Dogan, 2003). Using the Emberger climate classification (Alizadeh *et al.*, 1995), the habitat of *Ziziphora clinopodioides* was categorized as cold arid. The mean annual rainfall and temperature were about 295 mm and 11.28°C for the habitat, respectively, with the bulk of the rains concentrated in March, April and May. The results showed that *Ziziphora clinopodioides* grows at altitudes of 1200- 1875 m above sea level.

The Flora of study area is rich composed of annual and perennial plants. Vegetation survey showed that *Thymus transcaspicus*, *Poa bulbosa* and *Ziziphora clinopodioides* are the dominant species of the region and it grows with several different types of species. Some of these species are listed in Table 1.

Plant characteristics

In table 2, vegetative characteristics of *Ziziphora clinopodioides* were shown in the study area. Based on these accomplished studies, this plant is distributed on the northern slopes, calcareous places and altitude of 1200-1875 m. The average canopy cover of *Ziziphora clinopodioides* was 17% across the habitat. Height of individual plants varies from 21 to 40 cm with a crown diameter of 39 to 42 cm. The density of plants in habitat was counted as 11500 per hectare. Product of this plant in areas is 241.270 Kilograms per hectare. Germinating capacity of seeds was 95% in laboratory conditions. Like any other plants, growth and survival of *Ziziphora clinopodioides*, during the different stages of growth need different amounts of moisture. The root system was in surface soils. *Ziziphora clinopodioides* have horizontal and vertical roots. The main roots penetrate to a depth of 25 to 30 cm depending on the soil texture and moisture and then spread horizontally.

Phenology

The obtained results of phenological observations in the plant habitat shows that *Ziziphora clinopodioides* depended on the rain condition of the area in that year from late March starts the plant growth and continues until late June. Flowers of this plant appear at the beginning of July to mid- September. Seed formation occurs in August and September is seed maturity time. From the beginning of October seeds start to fall and to the early November the plant begins to wilt and the stems are dried and crushed. Due to weather conditions, plant winter dormancy period begins in November and will continue until late March (Table 3).

Table 1: Some of the Companion species that growing along with *Ziziphora clinopodioides* in the study areas.

Scientific name	Scientific name
Acer monspessulannum L.	*Hordeum bulbosum* L.
Achillea micrantha Willd	*Hordeum glaucum* Stand.
Adonis flammea Jacq.	*Hulthemia persica* mich.
Aegilops crassa Boiss.	*Hypericum perforatum* L.
Aegilops cylindrica Host.	*Inula oculus- Christi* L.
Aegilops ovata L.	*Iris songarica* Schrenk.
Agropyron intermedium (Host) P. Beauv	*Iris kopetdaghensis* (Vved) Mathew & Wendelbo
Agropyron trichophorum (Link) Richter.	*Lappula microcarpa* (Ledeb.) Gurke
Allium caspium (Pall.) M.B.	*Lepidium draba* L.
Allium monophyllum Vved.	*Medicago sativa* L.
Alyssum linifolium Steph et Willd.	*Medicago radiata* L.
Arum orientale M.B	*Medicago polymorpha* L.
Asperula arvensis L.	*Melica persica* Kunth subsp. *persica*
Asperula setosa Jaub. et Spah	*Melilotus officinalis* (L.) Lam.
Astragalus brachycalyx Syn.	*Nonea lutea* (Desri) Reichenb.
Astragalus grammocalyx Boiss. et Hoh.	*Onobrychis transcaspica* V.Nikitn
Astragalus microcephalus Maass & Mozaff.	*Onosma bulbotrichum* DC.
Astragalus mollis M.B.	*Onosma koschyi* Boiss.
Astragalus vanilla Boiss.	*Orobanche alba* Stephan
Berberis integerrima Bunge.	*Perovskia abrotanoides* Karel.
Berberis khorasanica Browicz & Zielinski	*Phlomis persica* Boiss.
Boissiera squarrosa (Banks et soland) Nevski	*Plantago lagopus* L.
Bongardia chrysogonum (L.) Boiss.	*Plantago lanceolata* L.
Bromus briziformis Fisch. et C.A.Mey.	*Poa bulbosa* L.
Bromus danthoniae Trin.	*Polygonum aviculare* L.
Bromus tectorum L.	*Potentilla recta* L.
Bromus tomentellus Boiss.	*Phuopsis styloso* (Trin) Hook.F.
Capsella bursa-pastoris (L.) Medicus	*Pyrus boissieriana* Buhse
Carex stenophylla Wahlenb.	*Ranunculus arvensis* L.
Centaurea aucheri (DC.) Wagenitz.	*Rosa beggeriana* Schrenk
Centaurea depressa M.B.	*Rosa canina* L.
Centaurea virgata Lam.	*Rosa lutea* Mill.
Cerasus incana (Pall.) Spachr	*Rubia florida* Boiss.
Cerasus microcarpa (C.A . mey) Boiss	*Rubia tinctorum* L.
Ceratocephallus falcatus (L.) Pers	*Rumex acetosella* L
Consolida regalis S.F.Gray	*Salvia chloroleuca* Rech. F. et. Aell.
Coronila varia L.	*Salvia nemorosa* L.
Cotoneaster multiflora Bge	*Salvia reuterana* Boiss.
Dactylis glomerata L.	*Salvia sclarea* L.
Dianthus orietalis Adams	*Sanguisorba minor* Boiss. et Hausskn.
Dracocephalum kotschyi Boiss.	*Scutellaria orientalis* L.
Echinops ritrodes Bunge.	*Stachys turcomanica* Trautv.
Eminium alberti (Rgl.) Engl	*Stipa barbata* Desf.
Ephedra procera Fisch. & Mey.	*Thalictrum minus* L.
Eremostachys laevigata Bge.	*Thymus kotschyanus* Boiss. et Hohen.
Thalictrum foetidum L.	*Thymus transcaucasicus* Ronniger
Eremurus olgae Regel.	*Trigonella monantha* C.A.Mey.
Euphorbia humilis C.A. Mey. et Ledeb	*Vicia monantha* Retz.
Festuca ovina L.	*Vaillantia hispida* L.
Galium humifusum Bieb.	*Verbascum songaricum* Schrenk ex Fisch.
Galium verum L.	*Veronica biloba* Schreb.
Geum kokanicum Regel et Schmalh.	*Zataria multiflora* Boiss.
Glycyrrhiza glabra L.	*Ziziphora clinopodioides* Lam.
Hedysarum kopetdaghi Boriss.	*Ziziphora tenuior* L.
Heteranthelium piliferum (Banks et Soland.) Hochst.	

Table 2: The vegetative characteristics of *Ziziphora clinopodioides* in the study area

Germination %	Abundance %	product per hectare (kg)	Density (per hectare)	canopy diameter average (cm)	Canopy cover (%)	Rooting depth (cm)	Minimum height (cm)	Maximum height (cm)	Mean height (cm)
95	69.7	241.270	11500	37.58	17	30	21	40	29.55

Table 3: Phenological stages of *Ziziphora clinopodioides*

Vegetative stages	March	April	May	June	July	August	September	October	November	December	January	February
Vegetative growth												
Flowering												
Seed production												
Winter dormancy												

Table 4: The analysis results of soil in the habitats of *Ziziphora clinopodioides*

Parameters	Key area		
	1	2	3
Sand (%)	49	47	51
Silt (%)	36	37	34
Clay (%)	15	16	15
Gravel%	14.85	14.67	16.56
EC (ds/m)	1	0.92	0.99
pH	7.83	7.77	7.91
CEC(CMol/kg)	11.8	12.5	11.5
Organic Carbon (%)	2.07	1.93	2.14
Bulk density(gr/cm^3)	1.46	1.45	1.44
Particle density(gr/cm^3)	2.65	2.65	2.65
CaCO3 (%)	26.56	25.52	29.81
CaSO4 (%)	0.88	0.87	0.89
N (%)	0.105	0.089	0.082
Saturation moisture (%)	36	35	35
P (ppm)	0.8	0.8	0.8
K (ppm)	130	128	120
Na (mmol/lit))	1.3	1.7	1.5
Ca(mmol/lit	2.5	2.2	2.7
$HCO3^-$(mmol/lit)	3	2.8	2.95
CL(mmol/lit)	1.2	1.1	1.3
Mg(mmol/lit)	1.5	1.1	1.3
SO4(mmol/lit)	1.2	1.15	1.2

The physical and chemical results of the soil analysis

The results of physical and chemical analysis of the soil samples collected from the distribution area of *Ziziphora clinopodioides* have been presented in Table 4. As can be seen from Table 4, the species grows on loamy soils. Soil texture has a large influence on controlling soil moisture and nutrients available to plants (Jafari *et al.*, 2006). The minimum and maximum electrical conductivity are 0.92 and 1ds/m, respectively, indicating the soils with low salinity. The soil pH values range from 7.77 to 7.91, which are related to alkaline class. Soil pH is a major factor influencing the availability of elements in the soil for plant uptake (Marschner, 1995). Among the effects of pH, the most important is mainly on the solubility of nutrients and their ionic forms (Ronen, 2007). Some nutrients might become unavailable while others might reach high concentrations leading to deficiency or toxicity, respectively, at different levels of pH (Ronen, 2007). In our study, pH range is optimum. Saturation moisture ranges were between 36 and 38(%) in the habitats. The Cation exchange capacity of these soils varies from 11.5-12.5cmol/km. Concentration of CaSO4 is worthless. The calcium carbonate content of the soils of *Ziziphora clinopodioides* varies from 25.52- 29.81%. It can be seen that this plant generally prefers calcareous soils.

The nitrogen contents of the soils of *Ziziphora clinopodioides* varies from 0.082- 0.105% (Table 4). In general, percentage N contents of mineral soils varies are between 0.02 and 0.5, while the average value is 0.15 (Kacar & Katkat, 2010; Bruce and Rayment 1982). Our results indicated that values are within normal range, but lower than average. The organic carbon of these soils varies from 1.93-2.14%. These soils contain rich in organic carbon. Average P values in the soils were 0.8 (ppm) for area. The average value for soil P is between 0.0006 and 0.0009% (Eskin *et al*., 2013). The results showed that soil P for locations is low. Average K values were 120-130 ppm in area. Normal values of K in soil lie between 130 and 580 ppm and the average value is 355 ppm (Eskin *et al*., 2013). Therefore, it can be concluded that K levels in the soils of *Ziziphora clinopodioides* are lower than the average. The average of soil Na in mmol/lit were measured as 1.3-1.7 (mmol/ lit) in the habitats of *Ziziphora clinopodioides*. These values are lower than normal limits lying around 46 mmol/lit (Eskin *et al*., 2013). The calcium, magnesium, bicarbonate, chlorine and sulfate contents have been found to be 2.2-2.7, 1.1-1.5, 2.8-3, 1.1-1.3 and 1.15-2 mmol/lit in the soil, respectively.

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