An Autecological Investigation on Endemic Alkanna Haussknechtii Bornm. (Boraginaceae) Critically Endangered in Turkey

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Abstract: Autecological properties of Alkanna haussknechtii Bornm. (Boraginaceae), a critically endangered endemic in the vicinity of Amasya are presented and discussed. The analysis of N%, P% and K% in the below-ground and above-ground parts of the plant in generative growth period have been determined. In addition, soil samples have been collected from different localities and their physical and chemical aspects have been analyzed. During generative growth period macroelement contents of the below ground parts of the plant are higher than those of the above ground parts due to the “top senescences”. It grows loamy, neutral and slightly alkaline soils with high water holding capacity, type of soil medium level calcareous, with low saline soils.

Key words: Alkanna haussknechtii, Endemic, Rare plant, Autecology, Top senescences.

INTRODUCTION

The family Boraginaceae is found throughout temperate and subtropical areas of the world. Alkanna Tausch is a genus of herbaceous and it is represented by 34 species in Turkey. Twenty-six (76.4 %) of them are endemic to Turkey[7,12]. Some Alkanna species are used as potherbs, emanagog and for dye. Alkanna tinctoria is used to stain wood and marble and to colour medicines, wines and cosmetics[1,16]. A red dye is obtained from the roots of Alkanna orientalis and Alkanna lehmanii Tineo[21].

Alkanna haussknechtii is an endemic taxon to Turkey and Irano-Turanian phytogeographic region elements. This species is perennial plant and its length is 11-28 cm with few branches, glandular and eglandular hairy. Basal and cauline leaves linear to oblong-lanceolate. Bracts as long as calyx. Calyx 4-8 mm in flower, 6-10 mm in fruit, lobes linear-lanceolate. Corolla 7.5-10 mm, glabrous out side, limb sulphur-yellow 5-lobed. Nutlet 4-6 mm in diameter, tuberculate[1] (Photo.1 and Fig. 1).

This plant grows on steppe, forest clearings, grassy plains and vineyards. Its altitudinal range varies between 400-1300 m (30-50 m2 areas). This species is not grown outside of its natural ecologic area. Due to the construction works around Amasya, the annual cleaning of vineyards and biotic factors such as agriculture, grazing, forest exploitation, this species is under a great threat. Therefore, according to IUCN endangered categories, Alkanna haussknechtii distributing only in the vicinity of Amasya is in the CR (critically endangered) category[8].

The aim of this paper is to determine the macroelement contents of this species in below and above ground parts during generative growth period and its natural distribution in the vicinity of Amasya and to discuss the causes of threat to this species.

MATERIAL AND METHODS

The soil and plant samples of A. haussknechtii were collected from 6 different localities in vicinity of Amasya during flowering and fruiting. The localities where plant samples were collected are; A5 Amasya: High School, road side and shrub areas (cultivated areas near), at 450 m., on 10 May 2001, Kandemir, with the collection number 610, (30 m2) (Fig. 2).

A5 Amasya: Education Faculty district, open areas (cultivated areas near), at 400 m., on 20 May 2001, Kandemir, with the collection number 611, (30 m2) (Fig. 2).

A5 Amasya: Karaman Mountain, road side and open areas, at 500 m., on 30 May 2001, Kandemir, with the collection number 612, (50 m2) (Fig. 2).

A5 Amasya: Centre district (Şehycui), vineyard field (cultivated areas near), at 400 m., on 12 June 2001, Kandemir, with the collection number 613, (40 m2) (Fig. 2).

A5 Amasya: Direkli-Yassıcal Village, steppe areas, at 1300 m., on 26 June 2001, Kandemir, with the collection number 614, (50 m2) (Fig. 2).

A5 Amasya: Yukari Kale Village, vineyard field (cultivated areas near), at 600 m., on 5 July 2001, Kandemir, with the collection number 615, (30 m2) (Fig. 2).

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Soil samples were taken in depths of 0-25 cm during the generative period. The soil samples were cleaned after the collection, put into polyethylene bags and taken immediately to the laboratory. They were air-dried under laboratory conditions. The dried soil samples were passed through a 2 mm sieve and analyzed for different physico-chemical characteristics. The soil texture, water holding capacity, total salinity, calcium carbonate (CaCO₃), organic matter and pH have determined according to the standart methods. All of the samples were digested in a mixture of nitric and perchloric acids with the exception of the samples taken for N analysis, which were digested with sulphuric acid and selenium, using Kjeldahl apparatus. P contents were determined using the ammonium-molybdate-stannous chloride method. K contents were determined with a Perkin Elmer 2280 atomic absorption spectrophotometer. The below ground (root) and above ground parts (stem, leaves, flowers, fruit and seed) of the plants were dried in an oven at 70°C for 36 hours, ground with a commercial blender and prepared for analysis. Nitrogen has been determined by the semimicro Kjeldahl metod with a Kjeltec Auto 1030 Analyser. P has been determined by using Jenway spectrophotometer and K has been determined by Petracourt PFP-1 flame photometer.

The results of soil and plant analysis have been explained according to Allen et al. [2].

Fig. 1: A. General appearance of Alkanna haussknechtii, b. Corolla and stamens, c. Fruit, d. Seed

Fig. 2: Distribution of Alkanna haussknechtii in Turkey.
•:Alkanna haussknechtii
RESULTS AND DISCUSSION

Phenological Observations: The leaf development and primary shoot time of plant is at the beginning of April. The flowering period of *A. haussknechtii* starts in the middle of May. Flowering period is rather long. Fruit ripening is in the end of June. Seed maturation time is at the beginning of July. The phenological development of the species may vary somewhat according to habitat and altitude.

Climatic Observations: Following Emberger’s classification, Amasya has East Mediterranean precipitation regime first variant (W.Sp.A.Sm) and Direkli-Yassical Village has East Mediterranean precipitation regime second variant (Sp.W.A.Sm). According to the pluviothermic quotient values (Q) it is determined that Amasya is in the Semi-dry Mediterranean Bioclimatic zone; and Direkli-Yassical Village is in the Light-rainy Mediterranean Bioclimatic zone (Figs 3, 4).

Physical and Chemical Characteristics of the Soil Samples: As can be seen from table 1, *A. haussknechtii* grows on loamy, neutral and slightly alkaline soil (pH values of 7.20-7.80). Salinity values of *A. haussknechtii* soils vary from 0.05 to 0.07 %. CaCO₃ contents are quite high such as 1.43 %-3.07 %.

The percentage of water holding capacity (WHC) ranges from 40.7 to 50 %. It is seen from table 1 that the organic matter contents of these soils vary from 1.16 to 3.61 %. The nitrogen content of *A. haussknechtii* soils is between 0.250 %-1.304 %. The phosphorus content of soil varies from 0.0015 to 0.0088 %. Soil potassium values range 0.68- 2.12 %.

Chemical Analysis of the Plant Samples (Above and below Ground Parts): Macroelement contents (N, P and K) of above and below ground parts of *A. haussknechtii* during generative growth period are shown in table 2. In the below ground parts, the total N, P, and K contents vary within the ranges; 0.83-2.42 %, 0.08-0.257 %, 1.16-2.86 %. On a dry weight basis, the percentages of the total N, P and K contents in the above ground vary between 0.40-2.07 %, 0.035-0.144 %, 1.71-2.34 respectively.

This species is critically endangered (CR) and its distribution area is continuously limited, and the population densities are decreasing (Table 3). The factors threatening the population density of the species are environmental e.g. pollution, extreme drought, annual cleaning and agrochemical treatment of vineyards. The species is affected extremely by these factors as it occurs predominantly in cultivated areas.

According to our observations in 2001-2002 years, the seeds of *Alkanna haussknechtii* need special environmental conditions to sprout. Unfortunately, seed have not sprouted for some two years due to extreme temperatures and cold in the vicinity of Amasya. Therefore, this species has not been studied in terms of chromosome numbers and morphology. There is no certain knowledge about the economic importance of this species. However, it has been supposed to be useful for medical and dye industry like the other members of Boraginaceae family.

*A. haussknechtii* is adapted to clear areas. It is clearly seen from the samples areas that it occupies the localities which have sparse vegetation. This means that *A. haussknechtii* is a heliophytic plant and it grows mainly in small groups or individually. In the study area, different geological and lithological structure are seen in Figure. 2. Soil structures in the study area are determined by lithological characteristic. Generally, in the study area, various volcanic and calcareous rock of mesozoic origin are dominant.

Therefore, in the natural habitat of our study area Mediterranean climatic conditions are dominant, winters are warm and rainy and summers are dry and hot.

According to climatic observations, an arid period can not be seen in the Direkli-Yassical Village. In our investigations, we determined that the pH and CaCO₃ values of the soil samples taken from these localities are lower than those taken from other localities. This result might be because of the increase of rain. According to the pluviothermic quotient values (Q), *A. haussknechtii* are densely distributed in the Semi-dry Mediterranean and Light-rainy Mediterranean Bioclimatic zone (Figs 3, 4).

From the Table 1, it is seen that the plant prefers loamy, neutral and slightly alkaline soils with high water holding capacity. Total salinity is too low in all of the localities. CaCO₃ contents are at moderate to low, soil organic matter ranges from moderately rich to very rich, contents K in soil are quite high as well. Soil N is quite high. The content P in soil has shown deficiency at all localities in the generative growth periods. We also observed that *Alkanna haussknechtii* generally grows in soil with poor contents P (Table 2).

This is due to the fact that in alkaline (pH>7) soils pH effects the nutrient elements of plants. That is, in such soils CaCO₃ contents increase and this increase cause the low contents P.

In all localities macroelements contents in below ground parts of *A. haussknechtii* are higher than above ground parts during the generative growth period, due to the top senescence (Table 2). Leopoldi is distinguished from various senescence types in different plants. In such plants the above-ground parts
senescence completely and new shoots appear at the beginning of the next season. The reserves in the vegetative storage organs allow a rapid growth during the initial period\cite{4}. Senescence must be considered as an important process in the adaptation of higher plants to environmental conditions and optimum usage of macroelements is an important part of the adaptation to environmental conditions\cite{13}. This is a well controlled process and it is not a passive decay of a plant\cite{11}. The reason behind high contents of N, P and K in below ground parts of plant in the generative periods is the transportation and position of nutrient elements from drying above ground part to deposition organs at the end of the vegetation period, aiming for the survival of the plant with its below ground part up to the next vegetation period.

Similar results have also been observed in ecological studies obtained from various other plant species such as *Iris pseudacorus* L., *Sternbergia lutea* (L.) Ker-Gawl. ex Sprengel and *Narcissus tazetta* L. subsp. *tazetta*, *Iris histrioides* Foster, *Iris taochia* Woronow Ex Grossh. and *Erysimum amasianum* Hausskn.& Bornm.\cite{10,18,14,15,6}.

a. Station, b. Altitude, c. Temperature period, d. Precipitation period, e. Mean annual temperature (0C), f. Mean annual precipitation (mm), g. Rainy period, h. Dry period, i. Temperature curve, k. Precipitation curve, l. Freezing months, m. Possible freezing months, n. The lowest temperature average for the coldest month, p. Absolute minimum temperature.

Fig. 3: Climatic diagram belonging of Amasya meteorological station

Fig. 4: Interpolated climatic diagram of Direkli-Yass?cal village
Table 1: Physical and chemical analysis results on the soil samples of *A. haussknechtii* growing places

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Extreme values</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.20-7.80</td>
</tr>
<tr>
<td>Total salinity(%)</td>
<td>0.05-0.07</td>
</tr>
<tr>
<td>CaCO3 (%)</td>
<td>1.43-3.07</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>1.16-3.61</td>
</tr>
<tr>
<td>Water holding capacity (%)</td>
<td>40.7-50</td>
</tr>
<tr>
<td>N (%)</td>
<td>0.250-1.304</td>
</tr>
<tr>
<td>P (%)</td>
<td>0.0015-0.0088</td>
</tr>
<tr>
<td>K (%)</td>
<td>0.68-2.12</td>
</tr>
</tbody>
</table>

Table 2: N, P and K contents in above and below ground parts of *A. haussknechtii* in generative growth period

<table>
<thead>
<tr>
<th>Plants parts</th>
<th>Elements</th>
<th>Extreme values</th>
<th>Mean values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above ground</td>
<td>N</td>
<td>0.40-2.07</td>
<td><em>1.06±0.60</em>*</td>
</tr>
<tr>
<td>Below ground</td>
<td>N</td>
<td>0.83-2.42</td>
<td>1.05±0.48</td>
</tr>
<tr>
<td>Above ground</td>
<td>P</td>
<td>0.035-0.144</td>
<td>0.079±0.039</td>
</tr>
<tr>
<td>Below ground</td>
<td>P</td>
<td>0.080-0.257</td>
<td>0.161±0.071</td>
</tr>
<tr>
<td>Above ground</td>
<td>K</td>
<td>1.71-2.34</td>
<td>2.02±0.24</td>
</tr>
<tr>
<td>Below ground</td>
<td>K</td>
<td>1.16-2.86</td>
<td>2.07±0.67</td>
</tr>
</tbody>
</table>

*Generative growth period **Standard deviation

Table 3: The population density in localities of *A. haussknechtii* for two years in localities from where samples were collected

<table>
<thead>
<tr>
<th>Locality</th>
<th>Plant number ( per 100 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amasya-High School</td>
<td>6</td>
</tr>
<tr>
<td>Amasya-Education Faculty district</td>
<td>5</td>
</tr>
<tr>
<td>Amasya-Direkli-Yassical Village</td>
<td>10</td>
</tr>
<tr>
<td>Amasya-Karaman Mountain</td>
<td>5</td>
</tr>
<tr>
<td>Amasya-Centre district (Şehycui)</td>
<td>6</td>
</tr>
<tr>
<td>Amasya-Yukan Kale-Village</td>
<td>7</td>
</tr>
<tr>
<td>Amasya-Centre district (Şehycui)</td>
<td>6</td>
</tr>
<tr>
<td>Amasya-Yukan Kale-Village</td>
<td>7</td>
</tr>
</tbody>
</table>

Conclusions: In this study, the phenological and ecological properties of *A. haussknechtii* have been investigated. Top senescence is an important strategy to the adaptation of higher plants to environmental conditions. Also, ecological studies on *A. haussknechtii*, which could well serve as a source of dye for carpets, kilims and textiles in Amasya are of great importance.

REFERENCES


