

# ECOPHYSIOLOGICAL PROPERTIES OF TURKISH ENDEMIC *CENTAUREA CONSANGUINEA* DC.

Bulent Eskin<sup>1\*</sup>, Ibrahim Ilker Ozyigit<sup>2,3</sup>, Ilhan Dogan<sup>4</sup>, Goksel Demir<sup>5</sup>, Celal Yarci<sup>2</sup>, Memduh Serin<sup>2</sup>

<sup>1</sup>Aksaray University, Faculty of Economics and Administrative Sciences, Department of Political Science and Public Administration, 68100, Aksaray, Turkey

<sup>2</sup>Marmara University, Faculty of Science and Arts, Department of Biology, 34722, Istanbul, Turkey

<sup>3</sup>Kyrgyz-Turkish Manas University, Faculty of Science, Department of Biology, 72001, Bishkek, Kyrgyzstan

<sup>4</sup>Izmir Institute of Technology, Faculty of Science, Department of Molecular Biology and Genetics, 35430, Izmir, Turkey

<sup>5</sup>Kirklareli University, Faculty of Architecture, Department of Urban and Regional Planning, Kirklareli, Turkey

## ABSTRACT

This physiological and ecological study was performed on *Centaurea consanguinea* DC. to acquire information about certain characteristics (bioclimatic, edaphic, topographic, biotic etc.) of its habitat and distribution in Turkey, determine the requirements for germination, explore the soil-plant relations and obtain data on certain aspects of its population biology. Plant and co-located soil samples were collected from Amasya and Havza District (Samsun) in Turkey using standard methods. Various analyzes were employed for determining of physical, chemical and biological properties of the plant species and its co-located soils including pH, total protein and electrical conductivity (EC), soil texture, contents of mineral nutrition and other physical and chemical parameters and the results were presented. Nutrient amounts (in %) were found to be in the ranges of 0.01-0.007 for N, 0.0008-0.001 for P, 0.01-0.09 for K, 0.0002-0.0003 for Na in the soils and 2.25 for N, 0.0068 for P, 0.07 for K and 0.02 for Na in the plant, respectively. Also, it was observed that germination ratios of the seeds were depended on various factors.

## KEYWORDS:

Asteraceae family, *Centaurea consanguinea* DC., endemism, mineral nutrition

## INTRODUCTION

*Centaurea* also known as centaury, centory, starthistles, knapweeds and centaureas is a large genus in the Asteraceae family consisting of approximately 600 species distributed all around the world, particularly in the Middle East and surrounding regions [1,2]. A number of species from this genus are used in the treatment of rheumatism and gout and also utilized as anti-inflammatory, antipyretic, analgesic, diuretic, cytotoxic, antibacterial and tonic [3]. Compounds such as sesquiterpene lactones, acetylenes, triterpenes, as well as lignans

and flavonoids have been isolated from various species of *Centaurea* [4].

The genus *Centaurea* from which approximately 73% of these species are endemic comprising about 200 species in Turkey growing in particularly the south-western and eastern parts of the country [5-7].

*C. consanguinea* is endemic to Turkey and grows in Istanbul (Kartal), Bursa (Mudanya), Kastamonu, Corum (between Uzaykoy and Kuzkislala), Amasya (Kirkklar), Samsun (Havza), Samsun (Ladik), Sivas (Divrigi), Malatya, Erzincan (Kemaliye, Salihli), Tunceli (Ovacik), Elazig (between Firat and Elazig), Bingol (between Bingol and Mus), Gaziantep (between Aril and Gaziantep), and Diyarbakir [6-8]. *C. consanguinea* is a perennial species having 35–70 cm height, profusely branched from near base with spreading branches and purple flowers [9]. Period of flowering for *C. consanguinea* starts at the beginning of June and lasts until the end of August. The species shows distributions from sea level up to 1600 m around steps and dry and rocky slopes [8].

Species cannot be understood well without considering their habitats. Data about a habitat contributes for understanding of bioclimatic, terrestrial and biotic characteristics of a specific region and describes sum of the biotic and abiotic resources needed by an organism [10]. Regarding these points, this study was conducted to find out of ecophysiological properties of *C. consanguinea* by investigating its physical, chemical and biological parameters.

## MATERIALS AND METHODS

**Study area.** The city of Amasya (Figure 1) is located in the northern part of Turkey and stands in the mountains above the Black Sea coast, 40°39'12"N 35°49'59"E [11]. The population of the province is 321.977 [12]. Amasya has an area of 5,690 km<sup>2</sup>. The endemic species richness of the region is very high (206 species) [11].

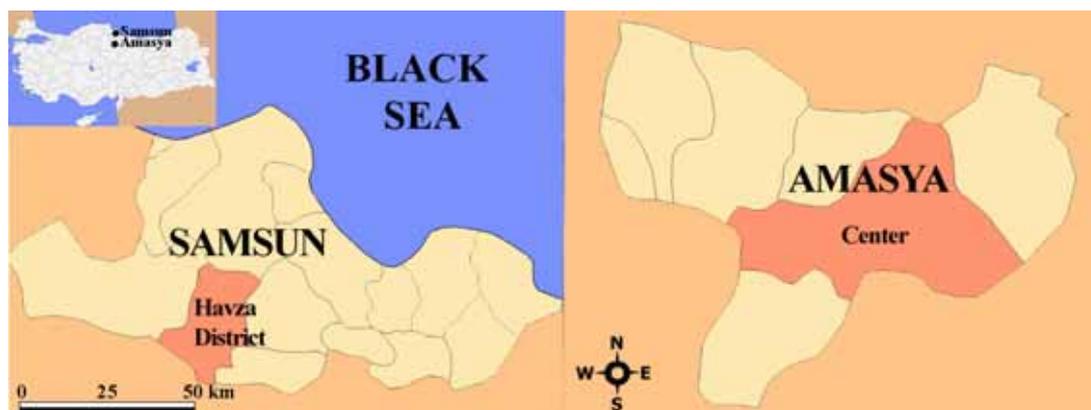


FIGURE 1

Map showing the study areas (Locations of Havza in Samsun and Center District in Amasya, Turkey).

TABLE 1  
Climate data for Amasya (Between 1975 - 2008).

| Months                             | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  | Year  |
|------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
| Average temperature (°C)           | 2.6  | 4.1  | 8.3  | 13.5 | 17.7 | 21.6 | 24.0 | 24.0 | 20.0 | 14.6 | 8.2  | 4.3  | 13.58 |
| Average high (°C)                  | 6.8  | 9.2  | 14.3 | 20.1 | 24.7 | 28.6 | 30.9 | 31.2 | 27.6 | 21.7 | 14.0 | 8.5  | 19.8  |
| Average low (°C)                   | -1.2 | -0.4 | 2.6  | 6.9  | 10.5 | 13.9 | 16.3 | 16.3 | 12.6 | 8.3  | 3.4  | 0.8  | 7.5   |
| Precipitation (kg/m <sup>2</sup> ) | 47.8 | 35.7 | 44.1 | 59.7 | 51.5 | 36.3 | 15.6 | 10.3 | 21.4 | 38.3 | 50.2 | 48.7 | 459.6 |

Samsun province (41°17'25"N 36°20'01"E) is located in the northern part of Turkey (Figure 2) and extends along the Black Sea coast between two delta rivers, Kizilirmak and Yesilirmak. The population of the province is 1,261,810. Samsun has an area of 9,579 km<sup>2</sup> [12]. Neighbors of the city are Sinop on the northwest, Corum on the west, Amasya on the south, Tokat on the southeast, and Ordu on the east [13]. Havza is a district of Samsun Province and it has an area of 788 km<sup>2</sup>. Havza is situated in a valley at an altitude of 675 m surrounded by mountains from three sides [14].

**Topography, Soil and Geology.** Amasya and surrounding regions comprising mostly complicated geological structures, including a number of mountains, plains, lakes, rivers, streams, valleys and plateaus contain rock groups belonging to the different geological periods (Quaternary, Neogene, Eocene and Cretaceous), hence having different evolution patterns. The rock groups in the regions were formed about 430 million years ago and as a result of metamorphoses, they can be seen in alluvial plain because of deposition [15]. Amasya is included in Tokat Massif placed into the Sakarya Zone of the Pontides [15, 16]. Amasya region is situated within a mountain belt called Pontide which extends along northern part of Turkey. The Black Sea mountain belt (Pontides) was started to take form about 29 million years ago and as a result of continued evolution of the mountain belt, the formation of the current geography of the region has been taken part (mountains, plains, lakes, rivers, streams, valleys and plateaus). Covering a large area around Amasya, the young basins (Suluova, Geldingen, Tasova and Aydinca plains) were

formed during this period and alluvial deposition is still ongoing within these areas [11].

There are two soil groups in the study area: bottom land and slope soils. The bottom land soils consisting of alluvial sediment soils are mostly seen around River Yesilirmak and its tributaries, where the streams flow into there. The soil texture varies from mild to severe within the slopes [11].

Silts are mainly found in the young delta plains but also old alluvial soils are seen along with terraces separated by steep slopes in Samsun. The transition zone to the south mountainous areas is covered by old clayey-chalky depositions. The coastal mountains are composed of Cretaceous lava. The clayey gravelly sediments are seen in the inner parts of the same mountains. Neogene sediments in the inner parts and the old and curly Cretaceous and Eocene flysch rocks are found in the south of the plains occasionally covered with alluvial soils. The volcanic formations are observed in the large areas. The Eocene, Cretaceous and Neogene dated formations are frequently seen around Samsun. The chestnut-colored and gray-brown podzolic soils are dominant in Havza, the district of Samsun [17].

**Climate.** The climatic conditions of Amasya are characterized by hot summers with drought periods and cold, rainy winters. Amasya features a kind of transition climate between the Oceanic climate and Continental Mediterranean climate. The mean annual temperature of this region ranges from 8 to 12°C. In the region, the annual precipitation is between 350-450 mm (Table 1). Despite the precipitation (as snow and rain), water deficiency effectively occurs during the summer period [18].

TABLE 2  
Climate data for Havza District (Samsun) (Between 1975 - 2008).

| Months                             | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  | Year  |
|------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
| Average temperature (°C)           | 7.0  | 6.7  | 8.0  | 11.2 | 15.3 | 20.2 | 23.3 | 23.5 | 20.0 | 16.0 | 11.9 | 9.0  | 14.34 |
| Average high (°C)                  | 10.7 | 10.6 | 12.0 | 15.2 | 18.6 | 23.5 | 26.5 | 27.0 | 23.9 | 20.0 | 16.1 | 12.7 | 18.07 |
| Average low (°C)                   | 4.0  | 3.5  | 4.7  | 7.7  | 11.7 | 16.0 | 19.1 | 19.6 | 16.4 | 12.8 | 8.6  | 6.0  | 10.84 |
| Precipitation (kg/m <sup>2</sup> ) | 61.4 | 51.8 | 56.8 | 57.5 | 49.4 | 47.4 | 31.6 | 37.0 | 52.5 | 88.2 | 84.2 | 73.3 | 691.1 |

A temperate climate prevails in Samsun. The total number of days at temperature below 0°C is lower than 20 days. Samsun has a typical Oceanic climate characterized by warm summer with humidity and cool and damp winter. The average temperature of the region ranges from 1 to 39°C. In the region, the annual precipitation is 691.1 mm [18]. Precipitation is the heaviest in late autumn and early winter (Table 2). Samsun has different climatic conditions depending on the parts of the region. Although, a typical Mediterranean climate is observed in the coastal region, an inland continental climate prevails along the inner parts of the region under influence of the mountains. While the precipitation in the coastal area is usually in the form of rain, inland areas are covered by snow for a number of days [13]. Our other study area (Havza) has a kind of transition climate between a temperate climate and an inland continental climate. The Oceanic climate is seen in some areas whereas the inland continental climate is observed in some other areas. Fog and snowfall occurs during the winter period [14].

**Collection, Preparation and Analyses of Samples.** The plant and co-located soil samples were collected from the center region of Amasya and Havza District (Samsun). Each of the soil samples (approximately 500 g) from study areas was taken from a depth of about 20 cm using a stainless steel shovel. After collection, they were left for air-drying and then passed through a 2-mm sieve. After sieving of the samples, the contents of N, P, K, Na, and CaCO<sub>3</sub> were determined by employing appropriate methods. Also, the fresh plant samples were collected from the study areas and the roots, branches and leaves of the plant samples were isolated and oven-dried at 80°C for 24 h, milled in micro-hammer cutter and fed through a 1.5-mm sieve. Then, the N, P, K and Na contents of the roots, branches and leaves of plant samples were determined. After all, statistical analyzes were conducted on the results recorded in our study.

The determination of electrical conductivities of soils from study areas were carried out according to Black (1968) [19]. An electronic pH-meter was utilized for the measurements of soil pH (in a 1:2.5 soil/water suspension). The CaCO<sub>3</sub> contents of soils was determined according to Tuzuner (1990) [20]. The total N content estimation in plant and soil samples was done using a modified Kjeldahl meth-

od [20]. Multi element stock solutions-1000 ppm (Merck) were used for preparing of the standard solutions employed for the measurement of K and Na in both plant and soil samples using Inductively Coupled Plasma Optical Emission Spectroscopy (Varian-Liberty Series II). Also, for the estimation of P contents of all samples, a method given by Olsen and Sommers (1982) [21] was utilized [20].

## RESULTS AND DISCUSSION

This research was carried out in the concept of understanding of the ecophysiological characteristics of *C. consanguinea* in particular soil-plant interactions and mineral nutrition status. *C. consanguinea* is an endemic species showing large-scale geographic distribution in Istanbul (Kartal), Bursa (Mudanya), Kastamonu, Corum (between Uzaykoy and Kuzkisla), Amasya (Kirkklar), Samsun (Havza), Samsun (Ladik), Sivas (Divrigi), Malatya, Erzincan (Kemaliye and Salihli), Tunceli (Ovacik), Elazig (between Firat and Elazig), Bingol (between Bingol and Mus), Gaziantep (between Aril and Gaziantep) and Diyarbakir in Turkey and adapted to the climates ranging from Mediterranean to inland continental climates [8].

The results of physical and chemical analyzes of the soil samples collected from the center of Amasya and Havza District (Samsun) are presented in Table 3. The results showed that the species is capable of growing in loamy, neutral and slightly alkaline soils, with average pH values of 7.43 for Amasya and 7.20 for Havza District (Samsun). The concentrations of CaCO<sub>3</sub> (in %) were 8.32 for Amasya and 10.62 for Havza District (Samsun). The data revealed that the plant has the ability to grow on medium (up to upper limit) calcareous soils. The data for electrical conductivity (in mS/cm) were 0.332 for Amasya and 0.262 for Havza District (Samsun) indicating compatibility of non-saline texture.

The chemical analyses of soils showed that N values (in %) were found to be in ranges of 0.032-0.068 (average 0.0518) for Amasya and 0.017-0.070 (average 0.039) for Havza District (Samsun) (Table 3). In general, N contents of mineral soils (in %) varies between 0.02 and 0.5, while the average value is 0.15 [22]. The data obtained from this work showed that N values (in %) were within normal ranges, however lower than the average in the soils

of study areas. Chemical analyzes of plant samples collected from study areas indicated that the average N values (in %) were 2.018 (1.95-2.1) in leaves, 2.21 (2.1-2.3) in stems and 2.376 (2.3-2.5) in roots for Amasya and 2.115 (2.01-2.2) in leaves, 2.204 (2.1-2.3) in stems and 2.618 (2.4-2.75) in roots for Havza District (Samsun) (Table 4). N content (in %) in plants generally varies between 0.2 and 6.0 [23]. According to our data, the N percentages in all plant parts of *C. consanguinea* were within normal limits. The levels of N contents were higher in the plants collected from both locations in comparisons with their co-located soils from both locations. It indicates that the plant is capable of taking required N amounts for itself from the soils. Average P values (in mg/kg) in the soils were found to be as 8.683 (8.13-9.585) (0.0008683%) for Amasya and 9.328 (8.17-10.44) (0.0009328%) for Havza District (Samsun) (Table 3). The average values of P (in %) in soils are in ranges of 0.0006 and 0.0009 [20]. The results showed that P contents of the soils in both locations were close to upper limits. The average P values of *C. consanguinea* (in mg/kg) were found to be as 64.55 (63.75-65.0) (0.006455%) in leaves, 64.95 (62.5-68.0) (0.006495%) in stems and 69.8 (68.5-71.0) (0.00698%) in roots for Amasya and 68.73 (67.5-69.75) (0.006873%) in leaves, 69.55 (66.0-71.25) (0.006955%) in stems and 73.85 (72.5-75.0) (0.007385%) in roots for Havza District (Samsun) (Table 4). Approximate P content of plants is 0.2% [24]. The results from our research showed that although the levels of P in soils were within normal limits, the levels of P in all plant parts were lower than normal. This indicates that the uptake of P by the plant was carried out sufficiently because the levels of P in the parts of plant ( $\geq 0.006455\%$ ) were higher than the levels of P in soils ( $\sim 0.001\%$ ) (Tables 3 and 4). This suggests that P requirement by the plant is lower than the average. Average K values (in mg/kg) in the soils were found to be as 219.26 (150.08-228.28) (0.0219%) for Amasya and 582.59 (254.08-913.95) (0.0582%) for Havza District (Samsun) (Table 3). Normal values (in %) of K

in soils lie between 0.013 (130 mg/kg) and 0.058 (580 mg/kg) and the average value (in %) for K is 0.0355 (355 mg/kg) [20]. Therefore, it can be concluded that K levels in the soils were within normal limit in Amasya and close to upper limit in Havza District (Samsun). Average K values (in mg/kg) of *C. consanguinea* were found to be as 570.98 (349.5-668.15) (0.0571%) in leaves, 541.0 (442.83-654.4) (0.0541%) in stems and 714.55 (513.95-898.4) (0.0714%) in roots for Amasya and 1074.74 (874.55-1300.4) (0.1074%) in leaves, 687.1 (613.4-796.8) (0.0687%) in stems and 921.5 (784.85-1083.9) (0.0921%) in roots for Havza District (Samsun) (Table 4). Epstein (1999) [24] reported that the level of K in plants is around 1%. Hence, our results were lower than the average. This implies that sufficient K uptake was carried out by the plant because the levels of K in the plant parts ( $\geq 0.05416\%$ ) were higher the levels of the soils from Amasya ( $\leq 0.0228\%$ ) and Havza District (Samsun) ( $\sim 0.0582\%$ ) (Tables 3 and 4). The average contents of Na (in mg/kg) in the soils were determined as 3.56 (3.125-3.875) ( $\sim 0.00036\%$ ) for Amasya and 2.128 (2.008-2.32) ( $\sim 0.000213\%$ ) for Havza District (Samsun). These values (Table 3) were in ranges of lower than normal limits in which are around 0.0046% [20]. The concentrations of Na (in mg/kg) in *C. consanguinea* were found to be as follows; 116.71 (87.71-148.88) (0.00116%) in leaves, 94.35 (64.54-129.56) (0.0094%) in stems and 206.68 (136.04-306.42) (0.00206%) in roots for Amasya and 413.24 (279.49-721.3) (0.00413%) in leaves, 272.6 (202.67-397.57) (0.0027%) in stems and 386.89 (284.1-446.22) (0.0038%) in roots for Havza District (Samsun) (Table 4). In plants, the levels of Na are around 0.001% [24]. Thus, it can be said that the concentrations of Na in *C. consanguinea* were higher than the normal limits. It suggests that the plant accumulates Na in its body due to the fact that the soils from the research areas contain lower Na contents than the average in both locations. This implies that the plant is adapted to live under such conditions; so that, its growth is promoted.

TABLE 3  
Physical and chemical analyses of the soil samples from the study areas.

| Locations             | Amasya center         |                   | Havza District (Samsun) |                   |
|-----------------------|-----------------------|-------------------|-------------------------|-------------------|
| Texture               | Loamy                 |                   | Loamy                   |                   |
|                       | Values<br>(Min.-Max.) | Average<br>Values | Values<br>(Min.-Max.)   | Average<br>Values |
| pH                    | 7.37-7.49             | 7.43              | 7.11-7.31               | 7.20              |
| N (%)                 | 0.032-0.068           | 0.0518            | 0.017-0.070             | 0.039             |
| P (mg/kg)             | 8.13-9.585            | 8.683             | 8.17-10.44              | 9.328             |
| K (mg/kg)             | 150.08-228.28         | 219.26            | 254.08-913.95           | 582.59            |
| Na (mg/kg)            | 3.125-3.875           | 3.56              | 2.008-2.32              | 2.128             |
| CaCO <sub>3</sub> (%) | 8.223-8.432           | 8.323             | 10.55-10.69             | 10.62             |
| *E.C. (µS/cm)         | 304.0-384.0           | 331.8             | 243.0-296.0             | 261.8             |
| **T.S.S. (mg/L)       | 254.0-292.0           | 276.8             | 392.0-437.0             | 411.4             |

\*E.C. = Electrical Conductivity, \*\*T.S.S. = Total Soluble Salt

**TABLE 4**  
**Chemical analyzes of the plant parts (leaf, branch and root) of *C. consanguinea* from the study areas.**

| Plant Parts             | Elements   | Leaf               |                | Stem               |                | Root               |                |
|-------------------------|------------|--------------------|----------------|--------------------|----------------|--------------------|----------------|
|                         |            | Values (Min.-Max.) | Average Values | Values (Min.-Max.) | Average Values | Values (Min.-Max.) | Average Values |
| Amasya                  | N (%)      | 1.95-2.1           | 2.018          | 2.1-2.3            | 2.21           | 2.3-2.5            | 2.376          |
|                         | P (mg/kg)  | 63.75-65.0         | 64.55          | 62.5-68.0          | 64.95          | 68.5-71.0          | 69.8           |
|                         | K (mg/kg)  | 349.5-668.15       | 570.98         | 442.83-654.4       | 541.0          | 513.95-898.4       | 714.55         |
|                         | Na (mg/kg) | 87.72-148.87       | 116.71         | 64.54-129.56       | 94.35          | 136.04-306.42      | 206.68         |
| Havza District (Samsun) | N (%)      | 2.01-2.2           | 2.115          | 2.1-2.3            | 2.204          | 2.4-2.75           | 2.618          |
|                         | P (mg/kg)  | 67.5-69.75         | 68.73          | 66.0-71.25         | 69.55          | 72.5-75.0          | 73.85          |
|                         | K (mg/kg)  | 874.55-1300.4      | 1074.74        | 613.4-796.8        | 687.1          | 784.85-1083.9      | 921.5          |
|                         | Na (mg/kg) | 279.49-721.3       | 413.24         | 202.67-397.57      | 272.6          | 284.1-446.22       | 386.89         |

Climate exerts forces for the formation of plant characters and distribution of plants in the world is related to climatic factors [25]. And, temperature is the main factor affecting the dormancy periods of seeds. In conjunction with this, it is an important factor for distribution of the plant species on earth. In the study areas, especially in inner parts, temperature commonly drops below freezing point during the winter months. Therefore, cold exposures in study regions affect the dormancy periods of seeds of *C. consanguinea*. Seed germination is related with time playing important roles for the continuity of a species [25]. Seed germination does occur depending on suitable environmental conditions for seedling. Under unsuitable conditions, the seeds can stay dormant for long time. Chemical inhibitors, hard and oxygen impermeable seed coat, period of darkness and light are some of the factors affecting the dormancy period [26].

After using the seeds stored in the refrigerator for planting, germination rates were recorded as follows: 90% on 1<sup>st</sup> and around 80% on 2<sup>nd</sup> planting (after 4 and 8 weeks), around 67% on 3<sup>rd</sup> and 57% on 4<sup>th</sup> planting (after 12 and 16 weeks). An ongoing decrease was observed between these intervals. After 24 weeks, the rate for germination was 38%. At the end of 28th week, the germination rate for the stored seeds of *C. consanguinea* at +4°C was increased to 52% (Figure 8). *C. consanguinea* is an endemic species and vulnerable to extinction. It should be protected and establishing a seed bank is one of the first tasks for the conservation of endemic *C. consanguinea* in future and the data obtained from this study should be applied for adjusting the storage conditions.

Previous studies showed that the water uptake rates of plant seeds are influenced by the temperature and the total water contents in which the seeds have during germination [26,27]. The highest and lowest water uptakes by the seeds of *C. consanguinea* obtained in our study were 0.009 g at 22°C and 35°C while 0.006 g. at -18°C and 5°C at the end of a 48 h period (Figure 3).

Accumulation of salt causing reducing of water uptake by seeds affects germination due lowered osmotic potential [27,28]. Progressive increase in

salt concentrations recorded in our experiments caused increasing reduction rates in seed germination. The seed germination rates of *C. consanguinea* were 10% in 0.1 M NaCl and 5% in 0.2 M NaCl, respectively while there was no germination in 0.3-0.5 M NaCl (Figure 6).

The seed germination does not take place when enough light exposure is not applied or vice versa. So, light conditions are very important for induction of the germination [29]. Our results showed that the rate of germination was ~65% in normal daylight whereas the rate of germination was only 30% in continuous light for *C. consanguinea* (Figure 7).

The availability of micro-elements is largely affected by soil pH [32]. At different levels of pH, some nutrients might be transformed into unavailable state while others might run into excessive levels causing toxicity [30]. In our study, optimum pH was 7.0 for the seed germination of *C. consanguinea*. At this point, the rate of germination was 50% whereas lower seed germination rates were observed at pH 5, 6 and 9 during a 15-day period (Figure 5).

The rates of water uptake of the seeds of *C. consanguinea* were determined by weighing them after leaving them in a range of 0.1-0.5 M NaCl solutions for 2, 4, 8, 24 and 48 hours. The lowest (0.003 g) and the highest (0.008 g) water uptakes were observed at 0.5 and 0.1 M NaCl solutions after 48 h. treatment for the seeds of *C. consanguinea*, respectively (Figure 4).

The levels of N, P, K and Na in *C. consanguinea* and the levels of N, P, K, Na, pH and CaCO<sub>3</sub> in the co-located soil samples collected from Amasya and Samsun were statistically evaluated showing regression and correlation co-efficient relationships between them. After the analyzing of data, relative positive correlations were seen between P and P; K and K; CaCO<sub>3</sub> and Na; CaCO<sub>3</sub> and K; CaCO<sub>3</sub> and P; CaCO<sub>3</sub> and N whereas relative negative correlations were obtained between Na and Na; N and N; pH and Na; pH and P; pH and K; and pH and N (Figure 9).

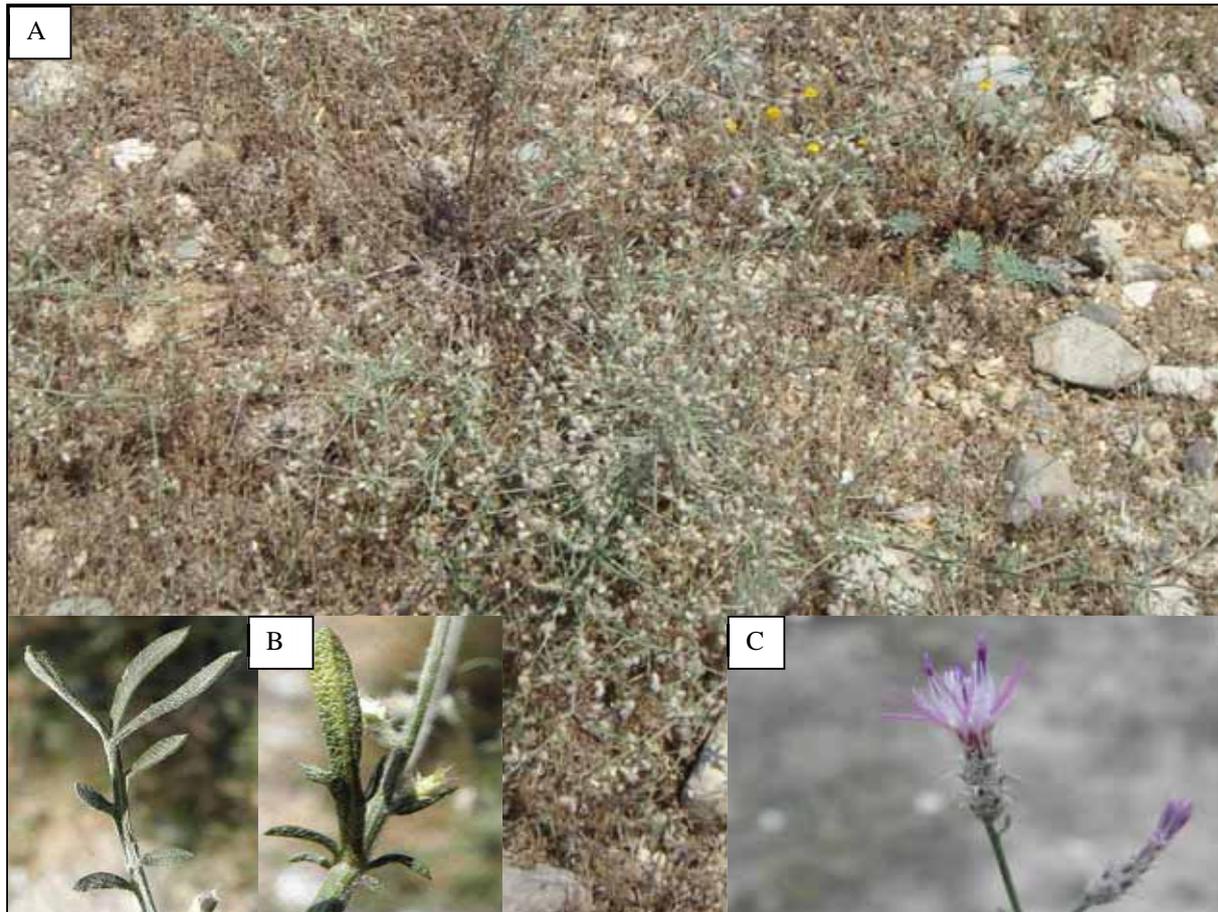


FIGURE 2

A-General habitat of *C. consanguinea*. B- Leaf structure. C- A branch with flower [33].

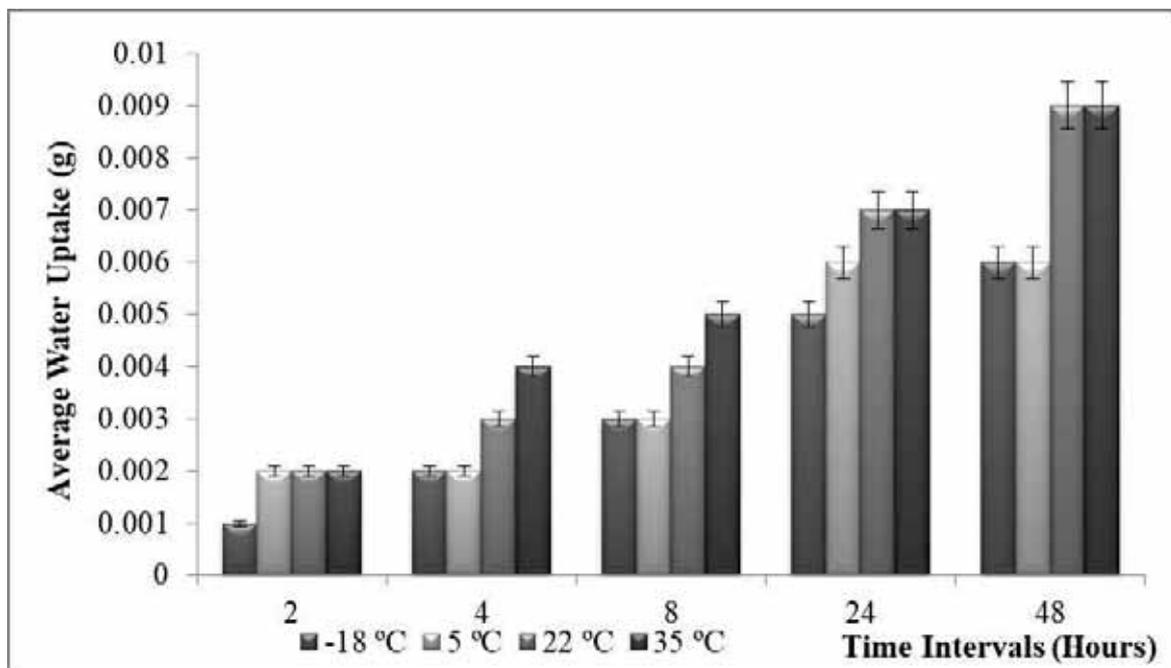


FIGURE 3

The effects of various temperatures on the water uptake of seeds of *C. consanguinea*

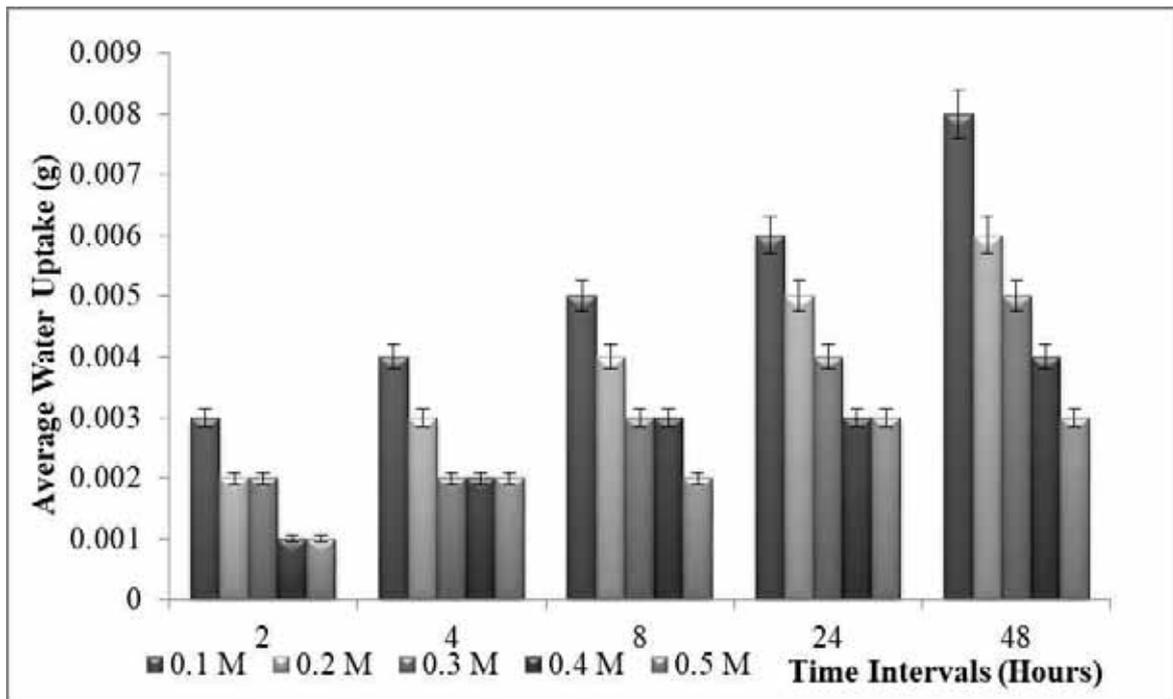


FIGURE 4

The effects of different salt (NaCl) concentrations on the water uptake of seeds of *C. consanguinea*

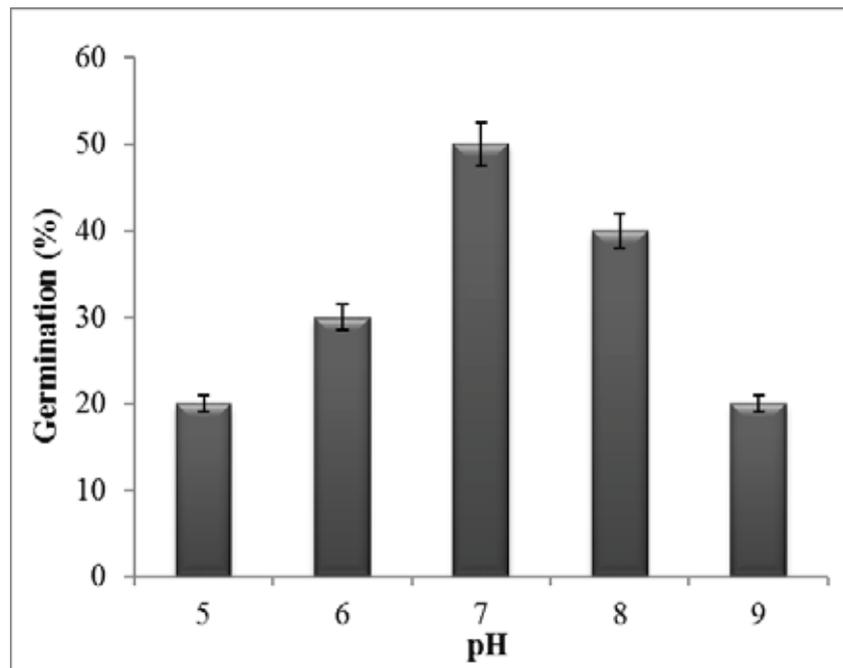


FIGURE 5

The germination of seeds of *C. consanguinea* at different pH values

The rate of water uptake by the roots of plant depends on salinity of the soil. In case of increase in the salinity of the soil causes decline in water uptake of the plant. Calcareous soils have very low solubility rates. Lime reacts with certain substances in the soil and thus low solubility compounds are produced. As a result, some substances cannot be taken up by the plants sufficiently. For the development of the plants, one of the most important

factors in the soils is the ratio of  $\text{CaCO}_3$  which relates indirectly with pH. The critical feature of the soil for plants is the pH of soil water. If pH is not within a certain range, existing elements in the soil cannot be taken up by the plants [31].

pH values were found to be in ranges of 7.37 to 7.49 (average 7.43) for Amasya and 7.11 to 7.31 (average 7.20) for Samsun. N, P, K and Na are taken up by the plants at most if the pH is in the

range of 6.5-7.5 [31]. Electrical conductivity (in mS/cm) was measured as 0.332 for Amasya and 0.262 for Havza District (Samsun). The data implies compatibility of non-saline texture for the soils. The concentrations of  $\text{CaCO}_3$  (in %) were 8.323 for Amasya and 10.62 for Samsun. The content of  $\text{CaCO}_3$  in the soils in research areas is not greater than 50%. The data revealed that the soil

types in research areas are having loamy, neutral and slightly alkaline features.

According to given information above, low solubility compounds are not produced and water uptake by the plants is not affected because of non-saline texture of the soils in the research areas. So, pH range and contents of  $\text{CaCO}_3$  in the research areas are suitable for taking up necessary amounts of N, P, K and Na by *C. consanguinea*.

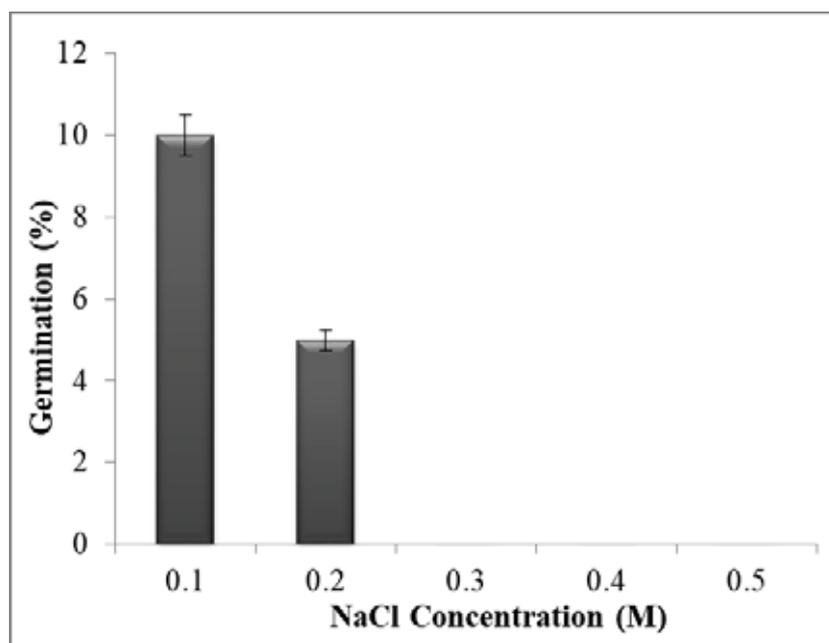


FIGURE 6

The germination of seeds of *C. consanguinea* at different salt (NaCl) concentrations

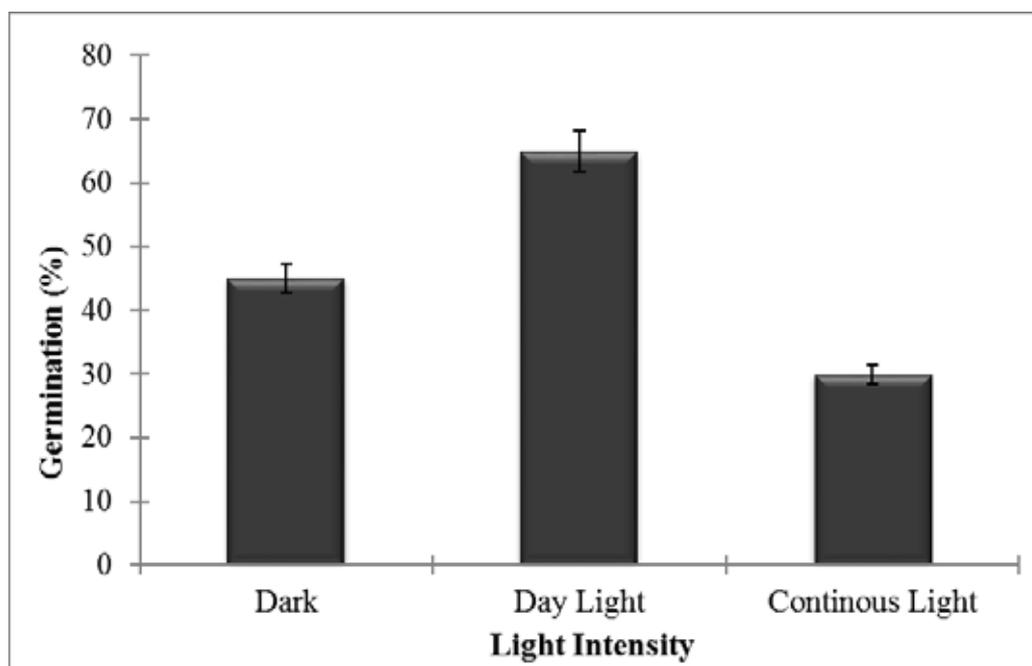
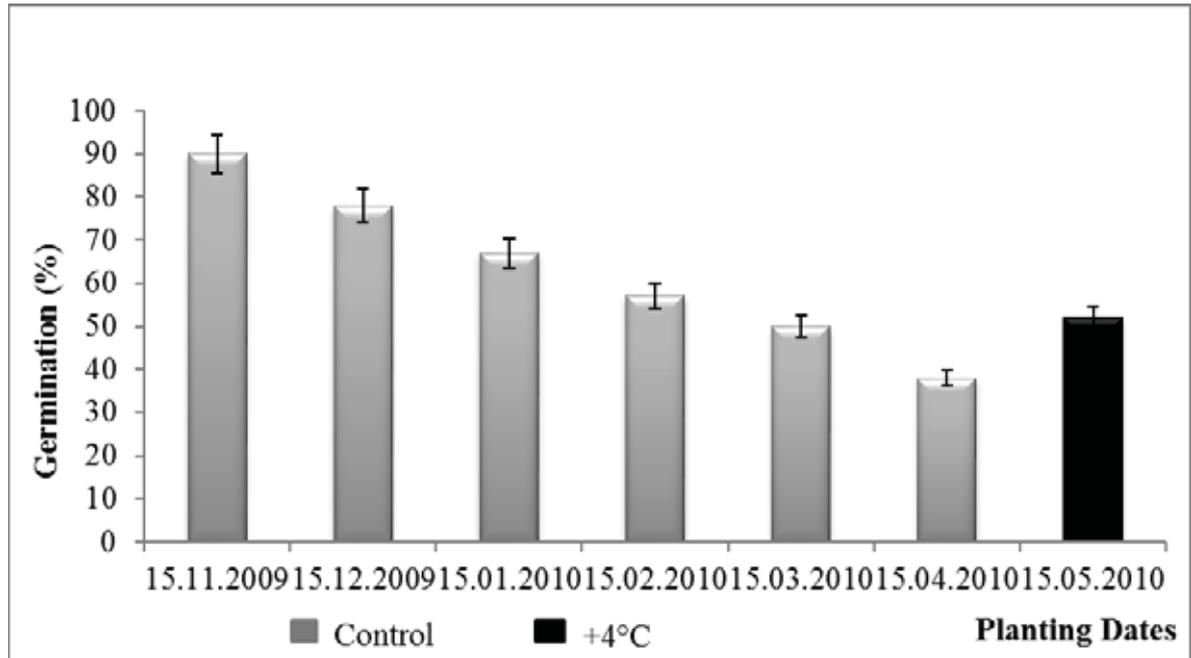
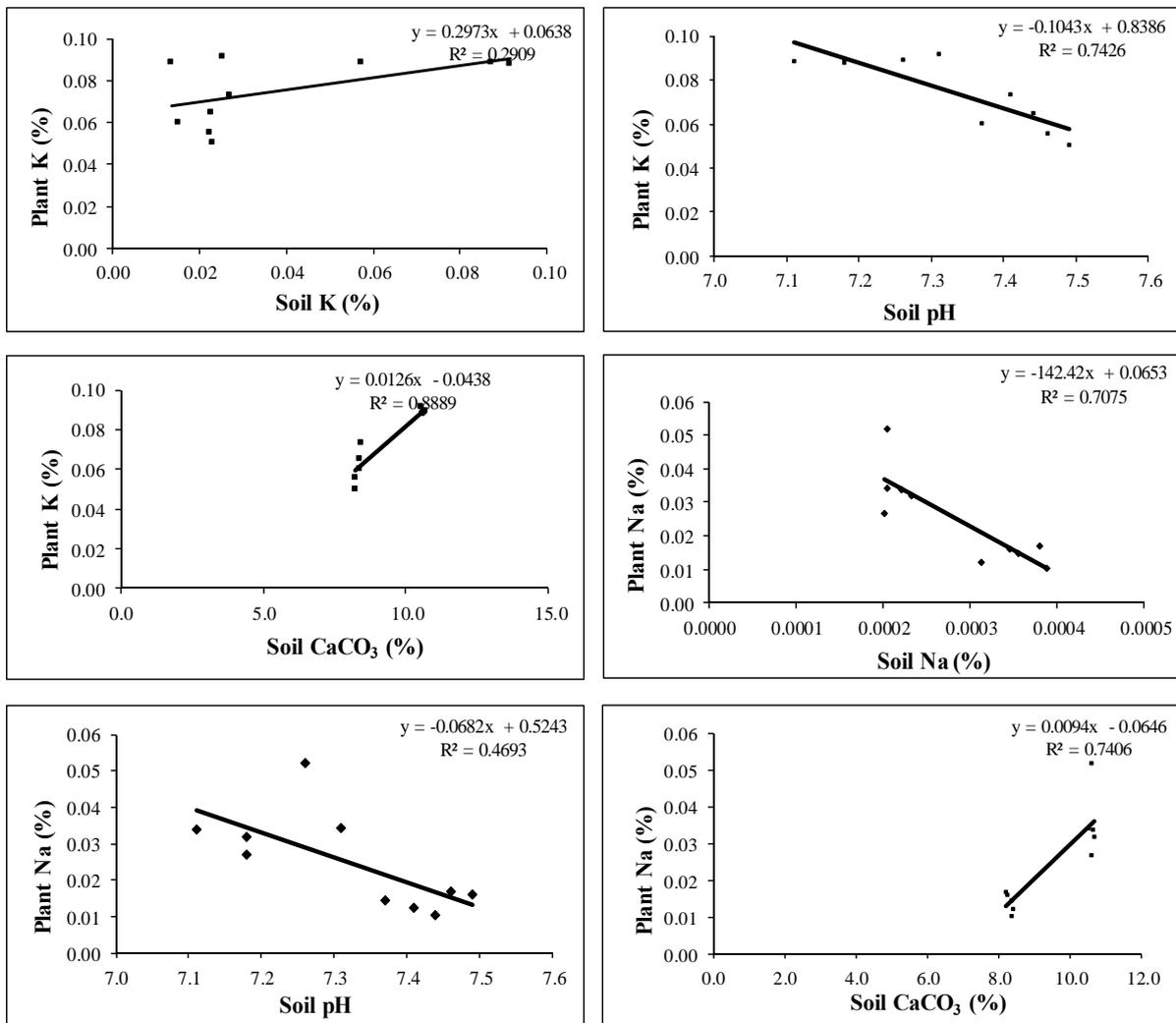


FIGURE 7

The effects of light on the germination of seeds of *C. consanguinea*



**FIGURE 8**  
The germination status of seeds of *C. consanguinea* at different dates



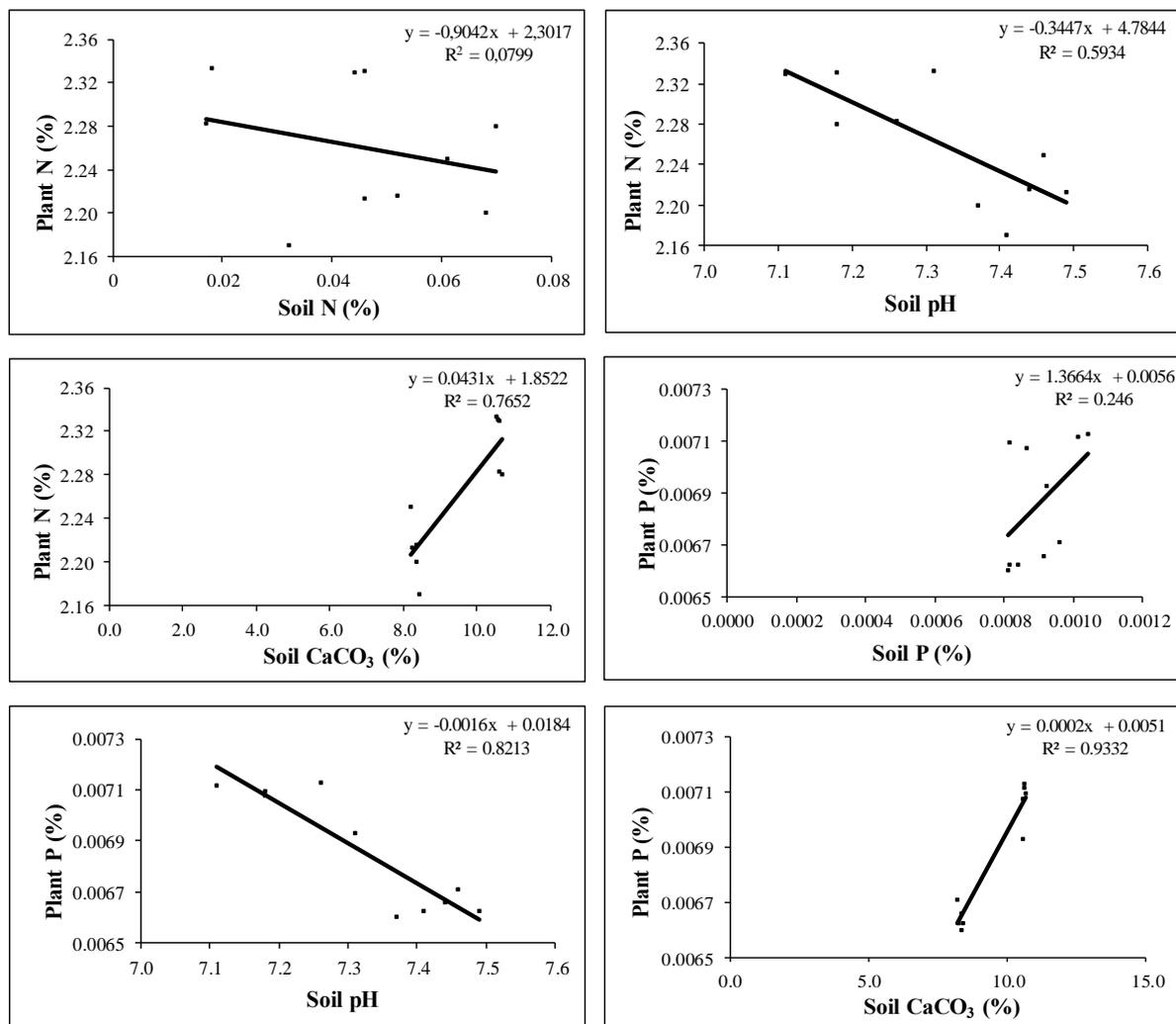


FIGURE 9

Statistical evaluation of *C. consanguinea* with the various elements and compounds in comparison with its co-located soils

## CONCLUSIONS

The present work focuses on *C. consanguinea* in order to enlighten its ecological characteristics in terms of soil-plant interactions on the background of physical, chemical and biological parameters, including pH, total protein and electrical conductivity, soil texture, contents of mineral nutrition and other physical and chemical parameters. The obtained results showed that the species is capable of growing in loamy and medium to upper limit of medium calcareous soils and according to the measurements of electrical conductivity, the structure of soil formations are in non-saline texture. Also, our findings indicated that the plant is capable of taking required amounts of N, P and K from the soils and accumulates Na in its body. In this work, the highest and lowest of water uptake by the seeds of the plant were observed in the ranges of 22-35°C and -18 and 5°C at the end of a 48 h period, respectively and excess salt concentrations caused more

reductions in the rates of seed germination. The germination rate of the plant was ~65% in normal daylight but only 30% in continuous light and optimum pH was found to be 7 for the seed germination.

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**Received: 31.01.2018**

**Accepted: 24.12.2018**

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#### CORRESPONDING AUTHOR

**Bulent Eskin**

Aksaray University,  
Faculty of Economics and Administrative Sciences,  
Department of Political Science and  
Public Administration,  
68100, Aksaray – Turkey

e-mail: bulenteskin@aksaray.edu.tr