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A Critical Analysis of the Morphometry of Two Endangered Medicinal Plants – "*Bacopa monnieri* L. and *Centella asiatica* L."

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Both the plants *Bacopa monnieri* L. and *Centella asiatica* L. are known for their medicinal values for many years. These plants are being used to cure various diseases such as - ulcer, tumor, eczema and anemia etc. Most important use of these plants is as memory vitalizer. So, there is a need to analyse the morphometry of both the plants in their natural state. In the present study the morphometry of plants were recorded and soil test was done to know the quality of soil of different areas of Hazaribag, where these plants naturally grows. Result shows that plants has different morphometry in terms of plant length, root length, number of nodes, distance between nodes, number of leaves and area of leaves etc.

Keywords: Bacopa monnieri; Centella asiatica; edaphic factors; memory vitalizer; morphometry.

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1. INTRODUCTION

Bacopa monnieri L. is a small creeping, glabrous, succulent herb belonging to the family *Plantaginaceae*. It is an ancient and renowned medicinal plant with legendary system of Indian medicine (Ayurveda). It is classified as Medhya Rasayana, a drug, which is supposed to counteract the effect of mental stress and improve intelligence and memory function. It is found to be effective in case of anxiety and neurosis. It possesses anti-inflammatory, analgesic and antipyretic activity [1]. It is also used as a diuretic, appetitive and cardio tonic [2].

Centella asiatica L. is a clonal, perennial herb with creeping stolons belonging to the family *Apiaceae*. It has been used in Ayurvedic medicine since centuries [3]. The preparations of this plant have been used in wound healing and memory enhancement [4]. The extract and some fraction of the plant have also been reported to possess several other medicinal uses against rheumatism, syphilis, leprosy, ulcers and eczema [5] Visweswari, et al. 2010, Won, et al., 2010).

Soil is vitally important for plant growth and development. The plants are supplied with the water and nutrients from soil, it requires for its development. An effect of soil structure on growth performance of *Salix caprea* and *Prunus padus* has been reported previously [6]. Edaphic factors such as pH, electrical conductivity, salinity, moisture content, organic carbon and nutrients affect the plant growth. Thus, vegetation zones are often linked with edaphic variations, including changes in soil salinity, nutrient availability, etc. [7]. The present study is to investigate the impact of these edaphic factors on the growth of these two medicinal plants *Bacopa monnieri* L. and *Centella asiatica* L. and analyse their morphological features, collected from the different areas of Hazaribag.

2. MATERIALS AND METHODS

Twenty fresh plants each of *Bacopa monnieri* L. & *Centella asiatica* L. were collected from different ecological habitats of Hazaribag in the month of March, 2017. The areas for the sample collection were -

1. Collection of *Bacopa monnieri* from - V.B.U Campus, Sindoor, Indrapuri, Kolghatti.
2. Collection of *Centella asiatica* from - Nawabganj, Lake road, Kolghatti, V.B.U Campus.

To see the impact of edaphic factor on plants, various morphometric parameters such as- plant length, root length, number of nodes, distance between nodes, number of leaves and area of leaves were studied. For the purpose of measurement of length of the sample plants, meter scale was used. Area of leaves were taken through graph paper.

Measurement of area of leaves of *Bacopa monnieri*:

No. of full smallest square = 1 mm^2
No. of half and greater than half small square = 1 mm^2
No. of less than half small square= ignored

Measurement of area of leaves of *Centella asiatica*:

No. of full square = 1 cm^2
No. of half and greater than half squares =1 cm^2
No. of less than half squares = ignored

The leaf surface area was calculated using equation:

Leaf Area = NGS X OGA

Where, NGS is the number of grid squares inside the leaf outline and OGA is the area of single square grid [8].

Along with plant samples, the soil from different study areas were also taken from the depth of 1-15 cm and soil test was done. A comparison was done.

2.1 Soil Test

In order to know the condition of the soil where study plants grow naturally, different parameters were taken and tests were performed to analyse the pH, water content, salinity, electrical conductivity, organic carbon and minerals (NA, Ca & K).

2.1.1 Methods of soil tests

Moisture content by oven dry method (Standard method): First of all non-corrodible containers were cleaned and dried and weighed, mass of each container (M1) were noted. Number of each container were also noted down along with its weight.

Then, container was filled up with 10 g of soil sample and weighed and their mass (M2) were noted down.

Containers were placed into hot air oven (HAO-293), Temperature was arranged to 15ºC and allowed them to dry for 24 hours.

After 24 hours, oven was turned off and containers were taken out using tongue and after the cooling of the containers mass (M3) of each container were noted down.

Calculation of moisture content by oven dry method: From the data collected during the test, water content of given soil samples were calculated by the formula:-

$$W = M2\text{-}M3 \times 100 / M3\text{-}M1$$

Where

M1= mass of empty containers.
M2= mass of the containers with wet soil
M3 = mass of the containers with dry soil

pH, EC and salinity test using modern systronic 371: The spoon was used to weigh out about 10 gm of the soil samples into the containers. Then 50 gm of distilled water was added to the soil samples. Solutions of 1:5 of soil & water were prepared. Then containers were shaken for about 1-3 minutes, now mixed solutions were allowed to stand for 10-20 minutes. When soil samples got dissolved electrodes (i.e. pH, EC and salinity electrodes) of modern systronic 371 were used one by one, to measure pH level, EC and salinity of the soil samples respectively. Electrodes were dipped into the solution above the soil and reading was noted by display. Electrodes were rinsed with distilled water between each use [9].

Organic carbon by loss-on ignition: FOR the organic carbon of the soil, 5 gm of the soil samples without moisture (dried at 105ºC) were placed in the non-corrodible containers and combust in a programmer muffle furnace at 850ºC for 2 hours. Soil organic carbon was calculated as the weight loss [10].

$$SOC_{LOI}\ (gKg^{-1}) = ((weight_{105^oC} - weight_{850^oc}) \times 100) / Weight_{105^oC}$$

Determination of Na, Ca, & K by flame photometer: For the determination of Na, Ca and K, solution of the soil samples was prepared by digestion through Nitric-Perchloric acid digestion method [11]. For this purpose 1 gm of soil samples were placed in a 250 ml digestion tube and 10 ml of concentrated HNO_3 was added. Then mixture was boiled gently for 30-40 minutes to oxidize all easily oxidizable matters. After cooling, 5 ml of 70% $HCLO_4$ was added in tube and was boiled gently until dense white fumes appeared. After cooling 20 ml of distilled water was added and it was boiled further to release any fumes. The solutions were cooled, further filtered through Watman No. 42 filter paper and transferred to quantitatively to 250 ml flask by adding distilled water.

The solution thus prepared was then used to determine Na, Ca and K by flame photometer 128.

- On the basis of soil test of all study stations different parameters of soil condition i.e. pH, moisture content, EC, salinity, organic carbon and minerals such as Na, Ca and K, were recorded.

3. RESULTS

The result reflects the variation in morphology of the plants concerning plant length, root length, number of nodes, distance between nodes, number of leaves and area of leaves. It clearly showed significant differences in their morphological features.

Morphometric analysis of *Bacopa monnieri* L. were shown that, plant length, root length, number of nodes, number of leaves represents the highest value in V.B.U campus area and on the other hand Indrapuri area recorded less value in plant length, root length, number of nodes and number of leaves (Table 1).

In case of *Centella asiatica* L., morphometric analysis shown that growth parameters such as plant length, root length, number of nodes, distance between nodes, number of leaves and area of leaves were highest in Lake road area. And in Kolghatti area plant length, distance between nodes, number of leaves and area of leaves were lowest (Table 3).

The result of soil test of different study site of *Bacopa monnieri* L. and *Centella asiatica* L. showed greater variation in edaphic factors such as moisture content, pH, electrical conductivity, salinity, organic carbon and nutrients like Na, Ca & K (Tables 2 and 4).

Tables shows the morphological features and edaphic factors of *Bacopa monnieri* and *Centella asiatica* in different study station.

4. DISCUSSION

The growth of *Bacopa monnieri* L. was highest in V.B.U campus area and lowest in Indrapuri area. High growth in V.B.U pond may be because of low electric conductivity, low salinity, normal amount of Na, Ca &K and high moisture content.

Low growth in Indrapuri may be because of acidic pH, high electrical conductivity, high salinity, soil salinity represents one of the most serious threats to the growth of the plants [12] and very high calcium content. Also no. of nodes of *Bacopa monnieri* L. in V.B.U campus is high and distance between nodes is low along with high no. of leaves. So V.B.U campus is most suitable for the growth of *Bacopa monnieri* L. But area of leave shows reverse trend. It was lowest in V.B.U campus and highest in Indrapuri.

In case of *Centella asiatica* L. plant growth was highest in Lake road area and lowest in Kolghatti area. Growth in Lake road can be attributed to normal moisture content, low electrical conductivity low salinity, good amount of organic carbon, and good concentration of nutrients like K in Lake road. Low growth in Kolghatti may be attributed to high phosphorus and calcium. It shows that soil quality have affects the morphometry of these plants.

Table 1. Morphometry of *Bacopa monnieri* in different study sites of Hazaribag

Stations	Plant length (cm)	Root length (cm)	No. of nodes	Distance between nodes (cm)	No. of leaves	Area of leaves (mm^2)
V. B. U. Campus	54.03±10	10.13±02	21±05	1.83±01	74±10	32.18±03
Sindoor	41.72±10	6.85±02	15±05	2.65±05	60±10	43.23±05
Indrapuri	35.08±10	3.96±01	13±05	3.13±01	50±08	44±02
Kolghatti	50.75±10	8.58±02	17±05	2.93±07	64±10	40.71±05

Table 2. Soil test result of study sites of *Bacopa monnieri* L.

Stations	Moisture content (%)	pH (mol/L)	EC (µS/cm)	Salinity (ppt)	Organic carbon (g/kg)	Na (ppm)	Ca (ppm)	K (ppm)
V. B. U. Campus	17.49	7.25	0.20	0.22	71.15	7.36	17.62	4.39
Sindoor	06.28	08.4	0.60	0.37	30.50	9.83	25.23	11.92
Indrapuri Chowk	20.62	06.90	1.80	1.39	41.05	11.59	29.19	12.69
Kolghatti	08.56	08.14	0.80	0.66	11.51	9.43	20.94	6.45

Table 3. Morphometry of *Centella asiatica* in different study sites of Hazaribag

Stations	Plant length (cm)	Root length (cm)	No. of nodes	Distance between nodes (cm)	No. of leaves	Area of leaves (cm^2)
Nawabganj	27.5±05	3.13±02	6±02	4.10±02	08±02	3.20±01
Lake road	50±10	12±02	10±05	8.50±08	18±04	15.17±05
Kolghatti	28.2±08	8.86±01	10±05	6.03±02	10±05	1.6±01
VBU Campus	45±08	5.47±02	08±03	6.06±02	13±05	4.57±02

Table 4. Soil: Soil test result of study site of *Centella asiatica* L.

Stations	Moisture content (%)	pH (mol/L)	EC (µS/cm)	Salinity (ppt)	Organic carbon (g/kg)	Na (ppm)	Ca (ppm)	K (ppm)
Nawabganj	14.01	7.53	8.20	7.19	28.04	17.85	48.84	11.08
Lake road	08.13	7.10	1.10	0.64	25.47	07.58	07.58	21.50
Kolghatti	01.94	7.91	1.40	1.34	17.08	10.89	35.52	15.56
VBU Campus	03.22	7.47	1.10	0.83	10.33	10.38	26.82	12.68

5. CONCLUSION

From the present study it has been concluded that edaphic variations such as pH, water content, salinity, electrical conductivity, organic carbon and nutrient availability in different study sites had effects on the morphology of these plants and plants had variation in their morphometric features. Thus, edaphic factors play an important role in morphology as well as on growth of *Bacopa monnieri* L. and *Centella asiatica* L. On the other hand soil salinity had adverse effect on the growth of these plants. A number of factors must be responsible for their uneven growth. Further research needs to be done to quantify the result.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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