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SEEDLING MORPHOLOGY OF SOME MEDICINAL PLANTS OF CONVOLVULACEAE OF TRIPURA, NORTH-EAST INDIA

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Seedling morphology of six medicinal plants of Convolvulaceae were studied from different parts of Tripura, North-East India. Seedling characters are important and promising from the taxonomic as well as evolutionary point of view. Seedling morphology of six species of Convolvulaceae has been investigated on the basis of their germination pattern, position of cotyledon, hypocotyl, epicotyl, and paracotyledon and eophylls development. An artificial key has been constructed for easier identification of plants in their juvenile stage. Phenogram has been prepared to investigate the correlation between the investigated taxa.

Keywords: Convolvulaceae, Seedling Morphology, Taxonomy.

Seedling is young plant sporophyte. Seedling is a critical phase in life cycle of an individual (Harper 1977). The term *seedling* can be used loosely to cover very young individuals (Burger 1972). Seedling characters are as reliable as floral one. Critical examination of correlation between group of characters of both the adult as well as the juvenile plant has repeatedly shown results in better understanding of taxonomically difficult taxa. (Bokdam 1977). The study of seedling morphology, which had been a less explored field in flowering plants, particularly in angiosperms, has now emerged as an essential discipline for taxonomic research at present. Moreover, the world-wide loss of biodiversity is a symptom of indiscriminate human exploitation of natural resources and developing land for human use (Savard *et al.* 2000). So, proper studies on seedling and their morphology will be helpful for their early identification and conservation of natural resources which in turn shall help in conservation of biodiversity. Seedling morphology is a less explored work in India, so in this study an attempt has been made to study seedling morphology of some medicinal plants of family Convolvulaceae. In this study six medicinal plants of family Convolvulaceae has been selected for the seedling morphological study. These are *Argyreia argentea* (Roxb.) Sweet, *Ipomoea carnea* Jacq., *Ipomoea hederifolia* L., *Ipomoea quamoclit* L., *Merremia umbellata* (L.) Hallier f. and *Merremia vitifolia* (Burm. f.) Hallier f. which are variously used as medicine in different treatments. *Argyreia argentea* is used in the treatment of tumour, marasmus, paralysis (Uddin *et al.* 2010). *Ipomoea carnea* is anti-diabetic, hepatoprotective, anti-inflammatory, anxiolytic, sedative and wound healing, anti-HIV activities (Kumar and Priyanka 2018). *Ipomoea hederifolia* reported to possess oxytocic, anticancer, anti-psychotic, anti-inflammatory, anti-oxidant and anti-microbial properties according to indigenous systems of medicine in India (Pandurangan and Rana, 2015). *Ipomoea quamoclit* used in treatment of physical weakness, abnormal behaviour, sinking of voice, bleeding from cuts and wounds, piles, snakebites (Paul and Sinha 2016). *Merremia umbellata* has been widely used in folk remedies. Poultice of leaf is applied on burns and sours (Ganjir *et al.* 2013) *Merremia vitifolia* used to treat eczema; fresh leaf paste is applied to affected areas 3-4 times daily (Rahman 2006).The key prepared in the present study is completely a new initiative for the early identification and conservation of the studied taxa. The phenogram presented in this study is the first report of implication of seedling morphological character in phenetic

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analysis of the members of the family Convolvulaceae found in Tripura.

MATERIALS AND METHODS

Study area: Tripura is a state in North-East India and considered as a biodiversity hotspot. (http://www.bsienvis.nic.in/). It borders Bangladesh, Mizoram and Assam. Tripura is surrounded by Bangladesh on its north, south and west: the length of its international border is 856 km (84% of its total border). The state lies between 22° 56' to 24° 32' North latitudes and 91° 09' to 92° 20' East longitudes with an aerial extent of 10,491.69 sq. km.(Fig. 1).

Methodology: The mature seedling specimens of *Argyreia argentea*, *Ipomoea carnea*, *Ipomoea hederifolia*, *Ipomoea quamoclit*, *Merremia umbellata* and *Merremia vitifolia* were collected from different localities of Tripura. The specimens were photographed and documented in the form of herbarium sheets. They were compared and identified with the help of seedling raised from identified seeds. At least eight to ten specimens of each growth form were studied from various habitats. Morphological observation and description of seedlings were done according to Duke (1965), Burger (1972), Bokdam (1977), Vogel (1980) and Paria (2014). Artificial keys were prepared for the identification of investigated taxa in juvenile stage. Phenogram were prepared based on UPGMA method in PAST software. Soil pH, electrical conductivity (Soil survey staff, 2004), organic carbon (Walkley and Black 1934), available phosphorus (Olsen and Sommers 1982, Bray and Kurtz 1945) and available potash (Hanway and Heidel 1952) has been calculated to correlate soil properties with seedling.

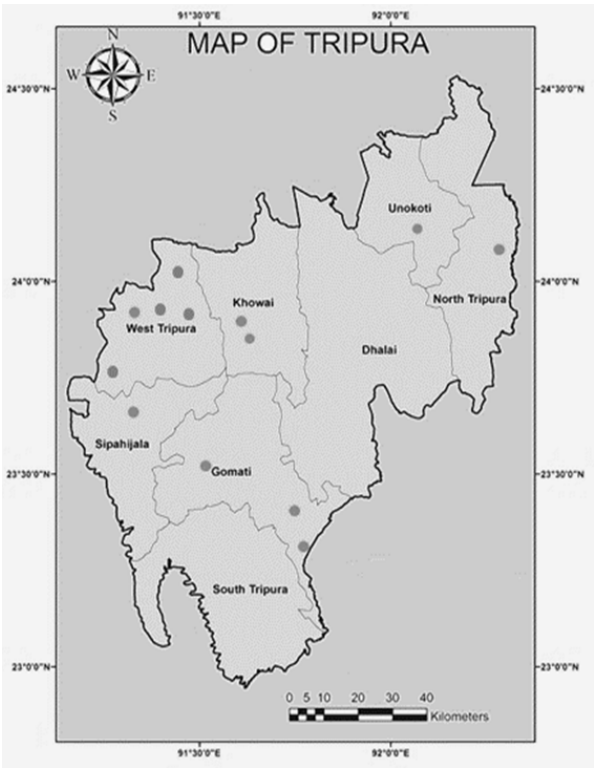

Figure 1: Map of Tripura showing the different areas visited during the field survey.

RESULTS

Diagnoses and key to identification of the investigated taxa.

1. *Argyreia argentea* Arn. Ex Choisy, Convolv. or. 36. 1834 & in DC. Prodr.9:330.1845. (Plate 1 A-D).

Seedling Morphology: (Up to 10th leaf stage) *Seedling* PEF. *Roots* tap, elongating. *Hypocotyl* epigeous, reduced, *Paracotyledon* epigeous, unequal, petiolate, glabrous, exstipulate, leaf obovate/elliptic, ±4.0-5.0×±7.0-8.0 cm, apex emarginate, margin entire, base sagittate/auriculate, venation pattern palmate, venation distinct, surface of blade glabrous both surface. *Epicotyl* hairy, ±6.0-7.5×±0.2-0.3 cm. *Eophylls* simple, alternate, stipulate, petiolate, leaf ovate, ±4.0-5.0×±3.0-4.5 cm, base truncate/auriculate, apex acute, margin entire, venation pattern pinnate, surface of blade glabrous both side. *Next leaves* simple, alternate, ovate, other characters more or less same as that of first two leaves except measurements.

***2. Ipomoea carnea* subsp. *fistulosa* (Martius ex Choisy) D. F. Austin, Taxon. 26: 237. 1977. (Plate 1 E-H).**

Seedling Morphology: (Up to 10th leaf stage)

Table1: GPS data of the site of sample collection

S.NO.	Voucher number	Species	Locality	GPS location	
				Latitude	Longitude
1.	TUH 2171	*Argyreia argentea*	Khayerpur	23.8469	91.3418
2.	TUH 2156	*Ipomoea carnea*	Dukli	23.7861	91.2818
3.	TUH 2179	*Ipomoea hederifolia*	Gakulnagar	23.7241	91.2673
4.	TUH 2169	*Ipomoea quamoclit*	Dukli	23.7861	91.2818
5.	TUH 2231	*Merremia umbellata*	Suryamani Nagar	23.7622	91.2618
6.	TUH 2237	*Merremia vitifolia*	Suryamani Nagar	23.7622	91.2618

Seedling PEF. *Roots* tap, reduced. *Hypocotyl* epigeous, elongating. *Paracotyledon* epigeous, equal, petiolate, exstipulate, leaf bilobed, ±2.0-3.5×±1.0-2.0 cm, apex obtuse, margin entire, base obtuse, venation pattern palmate, surface of blade glabrous. *Epicotyl* glabrous, ±4.0-9.5×±0.1-0.2 cm. *Eophylls* simple, alternate, stipulate, petiolate, leaf ovate, ±2.0-4.5×±1.5-2.5 cm, base obtuse/oblique, apex mucronate, margin entire, venation pattern pinnate, surface of blade glabrous. *Next leaves* simple, alternate, ovate, other characters more or less same as that of first two leaves except measurements.

***3. Ipomoea hederifolia* Linnaeus, Syst. Nat. ed. 10. 925. 1759. (Plate 1 I-L).**

Seedling Morphology: (Up to 10th leaf stage) *Seedling* PEF. *Roots* tap, reduced. *Hypocotyl* epigeous, elongating. *Paracotyledon* epigeous, equal, petiolate, leaf obovate, ±1.5-3.0×±0.6-3.5 cm, apex lobed, margin entire, base auriculate, venation pattern palmate, surface of blade glabrous both surfaces. *Epicotyl* glabrous, ±0.5-1.2×±0.2-0.3 cm. *Eophylls* simple, alternate, exstipulate, petiolate, leaf ovate, ±1-2.5×±1.0-2.0 cm, base cordate, apex acute, margin entire/ dentate, venation pattern pinnate. *Next leaves* simple, alternate, ovate, cordate, apiculate. *Subsequent leaves* simple, alternate, other characters more or less same as that of first two leaves except measurements.

***4. Ipomoea quamoclit* Linn., Sp. Pl. 159. 1753. (Plate 1 M-P).**

Seedling Morphology: (Up to 10th leaf stage) *Seedling* PEF. *Roots* tap, elongating. *Hypocotyl* epigeous, elongating. *Paracotyledon* epigeous, equal, petiolate, exstipulate, leaf bilobed, ±3.5-5.0×±0.3-0.6 cm, apex acute, margin entire, base cordate, venation pattern palmate, green, surface of blade glabrous both surfaces. *Epicotyl* glabrous, ±0.6-1.5×±0.1-0.2 cm. *Eophylls* simple, alternate, exstipulate, petiolate, leaf pectinate, ±2.0-3.5×±1.4-3.5 cm, base cuneate, apex acute, base balance symmetric, margin lobed, venation patternpinnate. *Next leaves* simple, alternate, other characters more or less same as that of first two leaves except measurements.

***5. Merremia umbellata* (Linn.) Hall. f. subsp. *Orientalis* (Hall. F.) Oostr. In van Steenis, Fl. Males. 1.4(4) :449.1953. (Plate 1 Q-T).**

Seedling Morphology: (Up to 10th leaf stage) *Seedling* PEF. *Roots* tap. *Hypocotyl* epigeous, elongating. *Paracotyledon* epigeous, equal, petiolate, leaf bilobed, ±1.2-1.8×±1.2-1.8cm, apex obovate, base cuneate, margin entire, venation pattern palmate. *Epicotyl*, glabrous, ±0.2-0.6×±0.1-0.2 cm. *Eophylls* simple, alternate, exstipulate, petiolate, leaf ovate, ±3-3.6×±1.4-1.8 cm, , apex acute, base cordate, margin sinulate, venation pattern pinnate. *Next leaves* simple, ovate, alternate, other characters

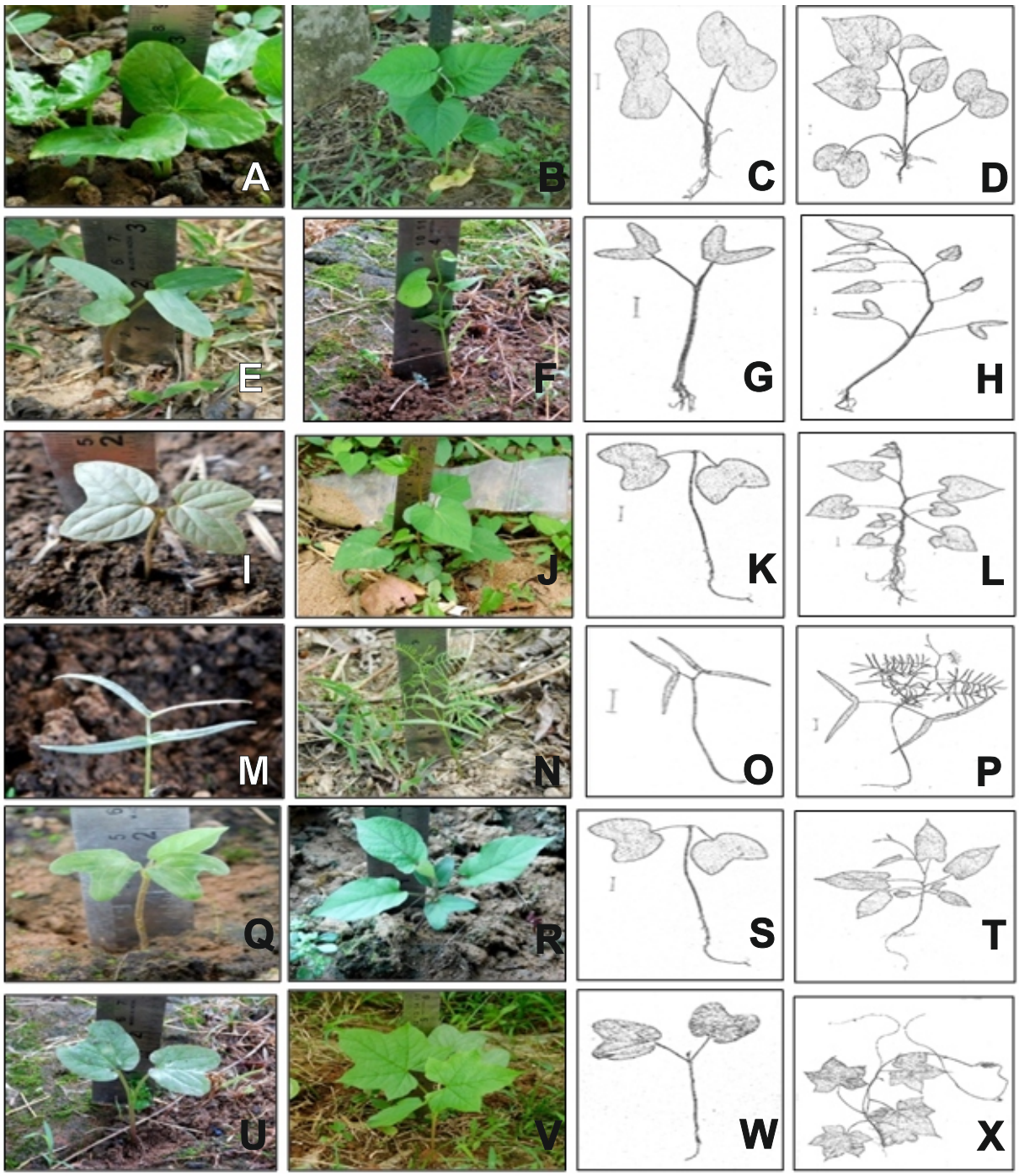

Plate 1 (A-X): (A-D). *Argyreia argentea* **A.** Paracotyledon **B.** Mature seedling **C&D.** Sketches of seedling. **E-H.** Ipomoea carnea **E.** Paracotyledon **G&H.** Mature seedling **G-H.** Sketches of seedling. **I-L.** Ipomoea hederifolia **I.** Paracotyledon **H-J.** Mature seedling **K&L.** Sketches of seedling. **M-P.** *Ipomoea quamoclit* **M.** Paracotyledon **N.** Mature seedling **M-P.** Sketches of seedling. **Q-T.** *Merremia umbellata* **Q.** Paracotyledon **R.** Mature seedling **S&T.** Sketches of seedling. **U-X.** *Merremia vitifolia* **U.** Paracotyledon **V.** Mature seedling **W-X.** Sketches of seedling.

more or less same as that of first two leaves except measurements.

***6. Merremia vitifolia* (N. L. Burman) H. Hallier, Bot. Jahrb. Syst. 16: 552. 1893. (Plate 1 U-X).**

Seedling Morphology: (Up to 10th leaf stage) *Seedling* PEF. *Roots* tap, short elongating. *Hypocotyl* epigeous elongating. *Paracotyledon* epigeous, unequal, petiolate, leaf obovate, ±2.5-3.5×±2-3.6 cm, apex lobed, base auriculate, margin entire, venation pattern palmate, *Epicotyl* ±0.5-0.8×±0.2-0.4 cm. *Eophylls* simple, alternate, exstipulate, petiolate, leaf ovate, ±4-9×±4-9 cm, base cordate, apex acute/ acuminate, margin lobed, venation pattern palmate. *Next leave* simple, alternate, other characters more or less same as that of first two leaves except measurements.

List of abbreviations used in table:

Alt: Alternate; **Ex**: Exstipulate; **Lob**: Lobed; **Obov**: Obovate; **Opp:** Opposite; **Ov**: Ovate; **Pal**: Palmate; **Pec**: Pectinate; **PEF:** Phanerocotylar epigeal foliaceous; **Pin**: Pinnate; **Sim**: Simple; **St:** Stipulate.

Key to the investigated taxa:

1a.Hypocotyl reduced……. ***Argyreia argentea***

b. Hypocotyl elongating……...….2

2a.(1)Epicotyl hairy…….. ***Merremia vitifolia***

b. Epicotyl glabrous…….……3

3a. (2) Eophylls pectinate……***Ipomoea quamoclit***

b. Eophylls ovate……..……4

4a.(3) Eophylls leaf apex mucronate..***Ipomoea carnea***

b. Eophylls leaf apex acute…….5

5a.(4) Eophylls venation pattern bronchiodromous……***Ipomoea hederifolia***

b. Eophylls venation pattern actinodromous……***Merremia umbellata***

DISCUSSION

In this investigation, six medicinal plants of family Convolvulaceae has been described based on seedling morphological characters. These seedling characters can serve as marker character for identification of taxa. All six studied taxa showed Phanerocotylar Epigeal Foliaceous (PEF) type of germination. PEF type of germination is advantageous over other types of germination as they generally grow faster than when exposed to increased light (Pooma and Bongers 1988). Multivariant phenetic analyses have been used in classifying many plants and interpreting results of taxonomic studies (Sneath and Sokal 1973). Seedling features are often distinctive at the species level and correlate well with the data from other source with regard to sectional and sub sectional placement of species with genus

Table 2: Some major seedling characteristics of the investigated taxa

Taxa	Seedling type	Stipules		Nature		Phyllotaxy		Shape			Venation pattern		
		(Para) cot	Eophyll	Eophyll	Metaphyll	Eophyll	Metaphyll	(Para)cot	Eophyll	Metaphyll	(Para)cot	Eophyll	Metaphyll
Argyreia argentea	PEF	Ex	St	Sim	Sim	Alt	Alt	Obov	Ov	Ov	Pal	Pin	Pin
Ipomoea carnea	PEF	Ex	St	Sim	Sim	Alt	Alt	Lob	Ov	Ov	Pal	Pin	Pin
I. ederifolia	PEF	Ex	Ex	Sim	Sim	Alt	Alt	Obov	Ov	Ov	Pal	Pin	Pin
I. quamoclit	PEF	Ex	Ex	Sim	Sim	Alt	Alt	Lob	Pec	Pec	Pal	Pin	Pin
Merremia umbellata	PEF	Ex	Ex	Sim	Sim	Alt	Alt	Obov	Ov	Ov	Pal	Pin	Pin
M. vitifolia	PEF	Ex	Ex	Sim	Sim	Alt	Alt	Obov	Ov	Ov	Pal	Pal	Pal

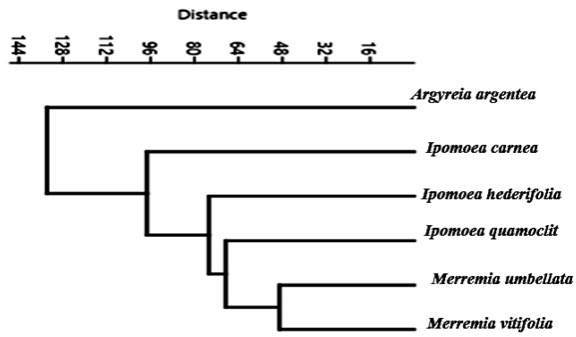

Figure 2: Phenogram based on Seedling morphological data (UPGMA method) to draw affinities between the studied genera in family Convolvulaceae.

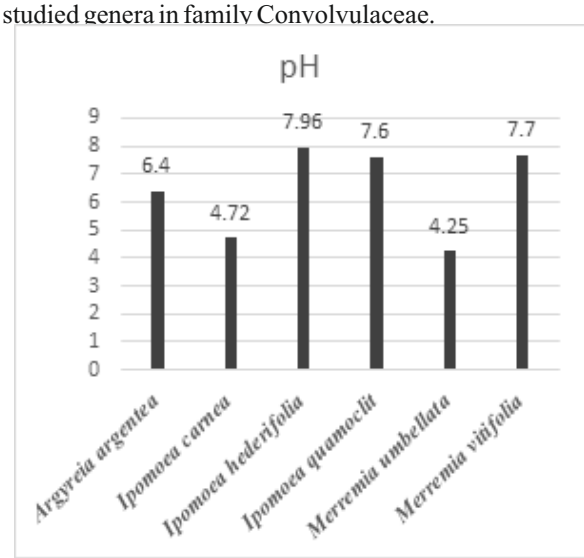

Figure 3: Graph showing soil pH in which seedlings are found.

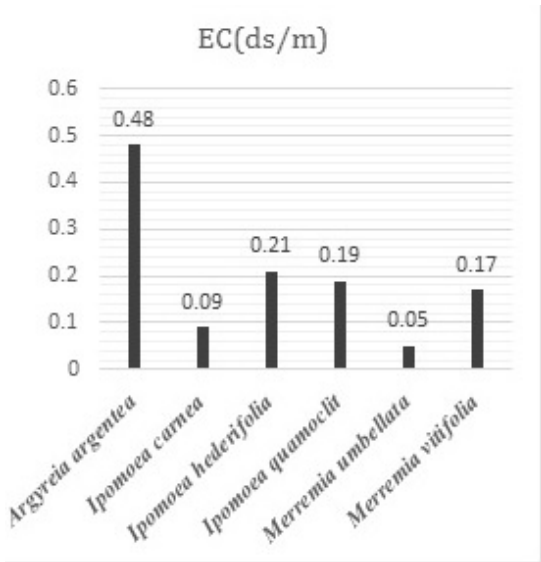

Figure 4: Graph showing soil EC in which seedlings are found.

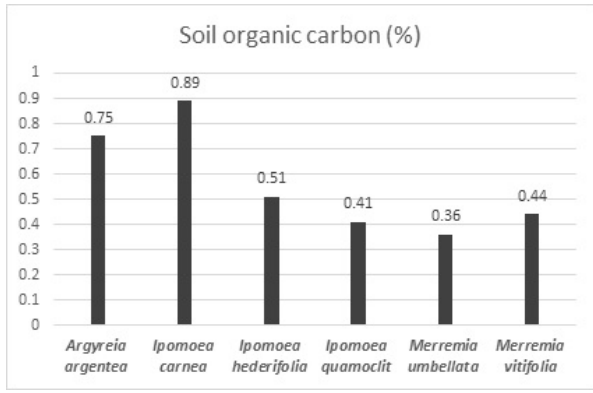

Figure 5: Graph showing soil organic carbon (%) in which seedlings are found.

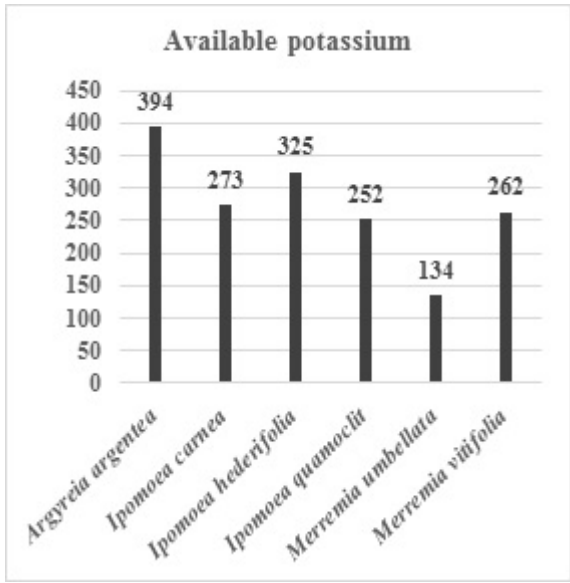

Figure 6: Graph showing soil available potassium in which seedlings are found.

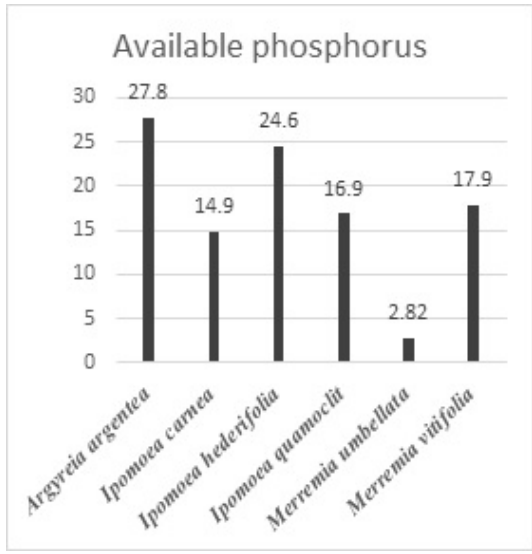

Figure 7: Graph showing soil available potassium in which seedlings are found.

(Cane 1983). Seedling characters like germination pattern, nature of root, hypocotyl, shape, size, color, apex, base, margin of paracotyledons and eophylls has been considered in this investigation. Root of *Ipomoea hederifolia* is short elongating while rest five species have elongating roots. Hypocotyl of *Argyreia argentea* was reduced while rest five species have elongating hypocotyl. All investigated taxa have bilobed paracotyledons. Eophylls of *Ipomoea quamoclit* has pectinate leaves while rest investigated taxa have ovate leaf. Based on these seedling characters artificial key has been constructed for the easier identification of plants in their juvenile stage. A phenogram has been constructed using UPGMA method to draw correlation between the taxa. Phenogram includes two cluster. Cluster 1A contains *Argyreia argentea* which may be because *Argyreia* had reduced hypocotyl. Cluster 1B contains two sub cluster. Sub cluster 2A contains *Ipomoea carnea* and 2B contains two sub clusters. 3A contains two sub cluster. 4A contains *Ipomoea hederifolia* and 4B contains *Ipomoea quamoclit* which may be based on pectinate leaf. Both *Merremia* species are clustered in same sub cluster. This phenogram shows that seedling characters are very reliable in identification of species in juvenile stage. *Ipomoea hederifolia, Ipomoea quamoclit* and *Merremia vitifolia* are growing in alkaline soil while *Argyreia argentea, Ipomoea carnea* and *Merremia umbellata* are growing in acidic soil. All taxa have been growing in low soil salinity. Soil organic carbon of *Ipomoea hederifolia* was medium and *Argyreia argentea, Ipomoea carnea* was found to be growing in high soil organic carbon but rest three species has been growing in low soil organic carbon. An increase in SOC can increase soil aggregate stability, water retention capacity, water infiltration, plant available water, soil microbial and macro fauna biomass and activity, and cation exchange. *Argyreia argentea* has highest available phosphorus while rest four species were growing in low available phosphorus and. Deficiency of P in soil severely affects the plant metabolism and in turns their yields. *Merremia umbellata* has lowest available potassium and *Argyreia argentea* and *Ipomoea hederifolia* has highest availbale potassium. Potassium is extremely important in many ways to the productivity of plant. It improves nitrogen use efficiency.

CONCLUSION

This work shows that seedling character of Convolvulaceae plant is related to each other and the artificial key is extremely useful for early identification and restoration of plants. Seedling morphological studies of medicinal plants help to restore the wild medicinal plants in early stage of their life cycle. These types of study are extremely useful for safeguarding of biodiversity and to draw the evolutionary relationship among medicinal properties of plants.

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