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STUDY OF SEEDLING MORPHOLOGY OF SOME SPECIES COLLECTED FROM GADAP TOWN, KARACHI (PAKISTAN)

Nabeela Mehmood[1], Muhammad Imran[2*] and Sahar Zaidi[1]

[1]*Department of Botany, Federal Urdu University of Arts, Science and Technology (FUUAST) Gulshan-e- Iqbal Campus, Gulshan-e- Iqbal (Karachi), Pakistan.*
[2]*Govt. Degree Boys College, Gulzar-e-Hijri, Karachi.*
*Corresponding author E-mail: imranbotanist@gmail.com

ABSTRACT

The study of seedling morphology provides quite useful data in concern of classification of plant species. This is a very preliminary study in which we study about 25 species belong to 16 families in 3 orders collected from Gadap town, Karachi. The seedling morphology is found to be helpful in separating the taxa on the basis of their morphological characters. The artificial key is made for different families belonging to same orders and different species of the same families.

Key-words: Seedling morphology, vegetative characters, Gadap Town.

INTRODUCTION

Morphological characterization of seedlings of flowering plants now gives an alternate way for the identification of plants in the field of phytotaxonomy. The study of the seedlings morphology plays a significant role in the recognition of taxa like the floral characters do. Seedling is the juvenile life stage of a plant. Seedlings are different than their mature plant stage in their size, shape, appearance and anatomy. Seedling morphology is a part of plant taxonomy. In present days, study of vegetative characters is setting a new trend for the identification and characterization of plant species. The work on seedling morphology has been done on the floras of different countries that is Europe (Lubbock, 1892), South East Asia (Burger, 1972), Puerto Rico (Duke, 1965), North Western Europe Lowland (Muller, 1978), Malaysia (Vogel, 1980), Africa (Hladik and Miqual., 1990), Finland (Welling and Laine., 2000) etc. Some scientists work on the individual families like members of family Cyperaceae (Didrichsen, 1894; Jacques-Fleix, 1989), Annonaceae (Garword, 1995) and dicotyledonous plants (Ye, 1983). Beltrati (1978) explored the significant importance of seedling morphology in concern of recognition of plants at their vegetative stage. Rodrigues and Azevedo Tozzi (2008) studied systematic relevance of seedling morphology in *Acosium*, *Guianodendro* and *Laptolubium* (Leguminosae, Papilionoidae). Seedlings provide great contribution in concern of plant identification through their morphology (Gaertner, 1791; De Candolle, 1825; Klebs, 1881). The data that produced due to seedling morphology has significant impact on classification of species (Ahmed and Paria, 1996). Beltrati (1981) found the importance of seedling morphology in field of plant taxonomy. Seedling characters play principal role in recognition of plant species (Andreata and Pereira, 1990). Das and Mukherjee (1997) classified *Ipomoea* on the basis of seedling morphology. Hwang and Conran (2000) worked on seedling morphology of taxa of family Casuarinaceae which deals with the species recognition at their early stages. Rodrigues *et al*., (2014) differentiated two Amazon species of *Eutada* (Leguminosae) on the basis of seedling morphology. The study of seedling morphology reveals the differences that we found in seedlings but not in adult plants. Feitoza *et al*., (2014) explored the characteristic morphological features of seedling stage as a systematic tool to solve the problems that come during identification, ecological attributes as well as phytogenetics. The young plants are sometimes found to be very different from their adult stages that it is hard to correlate the seedlings with adult plants (Sanyal and Paria., 2015). Seedling characters provide knowledge that is helpful in recognition of plants at their young life stage (Boss and Paria, 2015). The seedling characters have importance in the identification of each group of flora as they have large diversity (Sanyal and Paria, 2015).

Present study deals with the morphological study of seedling from Gadap town, Karachi. Gadap town is situated in the North Western part of Karachi along the Hub River. Gadap town covered large area of Karachi. It lies on the geographical coordinates of 29°22' 35" N, 66°29' 4" E. It is a very dry, hot area and has an arid climate. This area is selected because it consists of a large part of Karachi and vast numbers of species are found in that area. In Pakistan, no work has been done on the seedling morphology of flora of a selected area but some work on the seedling characteristics of some local species has been described by Khan *et al*. (2014, 2015a, b; 2017) and Khan and Zaki (2016) so this attempt is made to study the morphological study of seedlings.

MATERIALS AND METHODS

Periodical field trips were arranged in pre and post monsoon season of the study area i.e. Gadap town, Karachi from August, 2015 to Dec, 2016. The mature seeds of 25 species in 16 families of angiosperms were collected from different localities in brown paper envelopes. In the laboratory, the seeds were rubbed with sand paper and soaked in water for 4-5 hours. Then 10to 20 seeds of each plant were placed in their respective pots and after germination, morphology of their cotyledons and initial leaves was studied. Voucher specimen was collected in each case for correct identification. The morphological characters that studied are from cotyledons to 3 to 4 leaf stages and they include color, division of lamina, phyllotaxy, stipulate or exstipule, petiolate or sessile (if petiolate then all characters of petiole are studied like shape, color, size, about surface that is hairy or glabrous), shape of cotyledon and leaf, base, apex, margin, surface, venation. These studied characters were matched with the voucher specimens that were collected from study area along with seeds. Photographs of each seedling were also taken with the help of Nikon D3200. In the present study, we examined the seedling morphology of 25 species belong to 16 families found in Gadap town.

OBSERVATIONS AND RESULTS

1. Family Aizoaceae

i) *Zaleya pentandra* (L.) Jeffery

Germination type: Epigeal

Cotyledons: two, opposite, green in color, lower surface is reddish, horizontal, exstipulate, petiolate (reddish green, round, erect, soft, size is about 0.2 cm to 0.3 cm), lamina orbicular, apex and base obtuse, margin entire, distinct midrib, surface is smooth. **Internodes** greenish, round, erect, glabrous, distance is very less among internodes distance 0.3 cm to 0.5 cm. **First two leaves** simple, opposite, vertical, ventral surface is green whereas dorsal surface is red, exstipulate, petiolate (green, round, soft, angled, size 0.2 cm to 0.3 cm), blade obcordate, apex retuse, base cuneate, margin entire, surface glabrous, distinct midrib. **Subsequent leaves** simple, two, opposite, slightly vertical, , ventral surface is green whereas dorsal surface is red, exstipulate, petiolate (green, flat, smooth, size 0.3 cm to 0.5 cm), blade obovate, apex mucronate, base cuneate, margin entire, surface glabrous, distinct midrib with arcuate venation.

2. Family Amaranthaceae

i) *Amaranthus viridis* L.

Germination type: Epigeal

Hypocotyle light green in color, soft, delicate, round, glabrous, size 0.8 cm to 1 cm. **Cotyledons** two, opposite, horizontal, green, exstipulate, petiolate (green, flat, soft, green, glabrous, size 0.1 cm to 0.2 cm), lamina orbicular, apex and base obtuse, margin entire, suface glabrous, midrib indistinct. **Internodes** green, glabrous, round, fleshy, internodal distance 1 cm to 2 cm. **First two leaves** simple, two, opposite, green, horizontal, exstipulate, petiolate (light green, round, soft, delicate, size 0.3 cm to 0.5 cm), lamina ovate, apex and base obtuse, margin entire, surface glabrous, distinct midrib. **Subsequent leaves** simple, two, alternate, horizontal, exstipulate, green, surface glabrous, petiolate (green, round, smooth, size 0.6 cm to 1 cm), lamina ovate, apex acute, base obtuse, margin entire, distinct midrib with pinnate venation.

ii) *Digera muricata* (L.) Mart.

Germination type: Epigeal

Hypocotyle dark green, round, fleshy, size is about 1 cm. **Cotyledons** two, opposite, horizontal, green, exstipulate, petiolate (green, flat, glabrous, size 0.2 cm to 0.3 cm), lamina oblong, apex acute, base obtuse, margin entire, surface glabrous, midrib distinct. **Internodes** green, round, fleshy, glabrous, internode distance 1 cm. **First two leaves** two, opposite, horizontal, green, exstipulate, petiolate (greenish white, round, glabrous, size is about 0.2 cm to 0.4 cm), lamina ovate, apex acute, base obtuse, margin entire, surface smooth, distinct midrib with pinnate alternate venation. **Subsequent leaves** simple, two, opposite, horizontal, exstipulate, green, surface glabrous, petiolate (purplish green, round, fleshy, glabrous, size is about 1 cm to 2 cm), lamina ovate, apex acute, base obtuse, slightly wavy margin, distinct midrib with pinnate alternate venation.

3. Family Asteraceae

i) ***Launaea procumbens*** (Roxb.) Ramayya & Rajagopal
Germination type: Epigeal.
Hypocotyle green, soft, round, glabrous, fleshy, size is about 0.5 cm to 0.6 cm. **Cotyledons** two, opposite, green, horizontal, exstipulate, petiolate (green, round, delicate, glabrous, size is about 0.1 cm to 0.3 cm), smooth surface, blade obovate, apex obtuse, base obtuse, margin entire, indistinct midrib. **Internodes** green, round, fleshy, glabrous, internode distance 0.2 cm. **First two leaves** two, opposite, green, horizontal, exstipulate, petiolate (green, round, glabrous, size is about 0.6 cm to 0.8 cm), smooth surface, blade obovate, apex obtuse, base obtuse, margin serrate and pointed, distinct midrib with arcuate venation. **Subsequent leaves** simple, two, opposite, horizontal, exstipulate, green, surface glabrous, petiolate (green, round, thick, smooth, size 1.5 cm to 2 cm), lamina ovate, apex acute, base cuneate margin serrate, distinct midrib with arcuate venation.

ii) ***Pluchea lanceolata*** (DC.) C. B. Clarke
Germination type: Epigeal.
Hypocotyle green, soft, round, glabrous, internode distance 1.5 cm to 2 cm. **Cotyledons** two, opposite, green, horizontal, exstipulate, sessile, smooth glabrous, blade obovate, apex obtuse, base obtuse, margin entire, indistinct midrib. **First two leaves** simple, single, vertical, light green, exstipulate, sessile, lamina ovate to lanceolate, apex obtuse, base attenuate, margin entire to serrate, surface smooth, distinct midrib. **Subsequent leaves** simple, alternate, exstipulate, sessile, shape lanceolate, apex obtuse, base attenuate, surfaces glabrous, margin dentate, distinct midrib with pinnate opposite venation.

4. Family Boraginaceae
i) ***Heliotropium crispum*** Desf.
Germination type: Epigeal
Hypocotyle green, erect, round, pubescent, internode distance 0.6 cm to 0.7 cm. **Cotyledons** two, opposite, dark green, horizontal, exstipulate, sessile, blade obovate, apex retuse, base cuneate, margin entire, suface has pubescent hairs, distinct midrib. **First two leaves** simple, two, opposite, dark green, succulent, horizontal, exstipulate, sessile, blade lanceolate, apex retuse,base cuneate, margin entire, suface has strigose hairs, distinct midrib.

5. Family Caesalpinniaceae
i) ***Senna holosericea*** (Fres.) Greuter
Germination type: Epigeal.
Hypocotyle whitish green in color, erect, round, soft, fleshy, size is about 1.2 cm to 1.5 cm. **Cotyledons** two, opposite, dark green, horizontal, exstipulate, petiolate (green, round, soft, glabrous, size 0.2 cm to 0.3 cm), shape obcordate, apex retuse, base obtuse, margin entire, smooth and glabrous surface, distinct midrib. **Internodes** green, round, hard, glabrous, internode distance 0.6 cm to 0.7 cm. **First two leaves** compound, peripinnate, opposite, green, erect, stipulate, free-lateral stipule, petiolate (green, curved, round, soft, glabrous, size 0.5 cm to 0.6 cm). **Leaflets** opposite, green, horizontal, exstipulate, petiolate (green, round, glabrous, size 0.1 cm to 0.2 cm),shape obovate, apex obtuse, base obtuse, margin entire, surface glabrous, distinct midrib, opposite pinnate veination.

6. Family Capparaceae
i) ***Cleome viscosa*** L.
Germination type: Epigeal.
Hypocotyle dark green, round, fleshy, size is about 1 cm. **Cotyledons** two, opposite, green, horizontal, exstipulate, petiolate (green, round, glabrous, size is about 0.3 cm to 0.4 cm), smooth surface, blade obovate, apex obtuse, base obtuse, margin entire, indistinct midrib. **Internodes** light green in color, round, surface is covered with pubescent hairs; internode distance is about 0.4 cm to 0.5 cm. **First two leaves** compound, palmate, trifoliate, alternate, exstipulate, petiolate (green, round, hard, pubescent hairs, size is about 0.8 cm to 1.3 cm). **Leaflets** green, exstipulate, sessile, shape obovate, apex rounded, base cuneate, margin entire, surface has pubescent hairs, distinct midrib with alternate venation.
ii) ***Gynandropsis gynandra*** (L.) Briq.
Germination type: Epigeal.
Hypocotyle yelloish green, round, hard, surface has pubescent hairs, size is about 1 cm. **Cotyledons** two, opposite, green, horizontal, exstipulate, petiolate (green, round, pubescent, size is about 0.3 cm to 0.6 cm), pubescent surface, blade obovate, apex obtuse, base obtuse, margin entire, distinct midrib. **Internodes** light green, round, surface is covered with pubescent hairs; internode distance is about 0.5 cm to 0.7 cm. **First two leaves** compound, palmate,

trifoliate, alternate, exstipulate, petiolate (green, round, hard, pubescent hairs, size is about 0.8 cm to 1.3 cm). **Leaflets** green, exstipulate, sessile, shape obovate, apex rounded,base cuneate, margin entire, surface has pubescent hairs, distinct midrib with alternate venation. **Subsequent leaves** compound, palmate, pentafoliate, opposite, exstipulate, petiolate (green, round, hard, pubescent hairs, size is about 1cm to 1.5 cm). **Leaflets** green, exstipulate, sessile, flat, shape obovate, apex rounded, base cuneate, margin entire, surface has pubescent hairs, distinct midrib with alternate venation.

7. Family Chenopodiaceae

i) *Chenopodium murale* L.

Germination type: Hypogeal

Epicotyle purple-red in color, soft, delicate, glabrous, size is about 2 cm to 3 cm. **Cotyledons** two, opposite, horizontal, reddish, exstipulate, sessile, shape oblong, apex obtuse, base obtuse, margin entire, surface glabrous, indistinct midrib. **Internodes** green, round, fleshy, smooth, internode distance 2 cm to 3 cm. **First two leaves** simple, two, opposite, horizontal, olive green in color, exstipulate, petiolate (green, flat, glabrous, size is about 0.2 cm to 0.3 cm), shape ovate, apex obtuse to acute, base obtuse-truncate, margin serrate, surface smooth, distinct midrib. **Subsequent leaves** simple, two, opposite, horizontal, deep green in color, exstipulate, petiolate (green, flat, glabrous, size is about 1.5 cm to 2 cm), shape lanceolate to ovate, apex obtuse to acute, base attenuate to truncate, margin serrate, surface smooth, distinct midrib with alternate pinnate venation.

8. Family Convolvulaceae

i) *Convolvulus glomeratus* Choisy

Germination type: Epigeal

Hpocotyle green, hard, smooth, size is about 1 cm. **Cotyledons** simple, two, opposite, horizontal, green in color, exstipulate, petiolate (green, round, glabrous, size is about 0.2 cm to 0.3 cm), shape obovate, apex retuse,base cordate, margin entire, surface smooth, distinct midrib, multicostate. **Internodes** green, round, smooth, internode distance 2 cm to 2.5 cm. **First two leaves** simple, alternate, green, exstipulate, petiolate (green, round, glabrous, size is about 0.3 cm to 0.5 cm), shape lanceolate,apex acute, base obtuse, margin ciliate, distinct midrib with pinnate opposite venation. **Subsequent leaves** simple, alternate, green, exstipulate, petiolate (green, round, glabrous, size is about 1 cm to 1.5 cm), shape lanceolate, apex acute, base obtuse, margin undulate, distinct midrib with pinnate opposite venation.

ii) *Merremia aegyptia* (Linn.) Urban

Germination type: Epigeal

Hypocotyle green, hard, smooth, size is about 4 cm to 5 cm. **Cotyledons** two, opposite, horizontal, green in color, exstipulate, petiolate (whitish, soft, circular, pubescent, size is about 0.3 cm to 0.5 cm), shape obcordate, apex emarginate,base cordate, inter-petiolar stipule, margin undulate, surface glabrous, multicostate venation. **Internodes** olive green, round, surface has pubescent hairs, straight, internode distance 1.5 cm to 1.7 cm. **First two leaves** opposite, compound, pentafoliate, green, exstipulate, petiolate (green, round, pubescent, size is about 0.5 cm to 0.7 cm), surface pubescent. **Leaflets** green, lamina narrow elliptic, apex acute, base obtuse, margin entire, surface pubescent, distinct midrib with pinnate opposite venation.

iii) *Merremia hederacea* (Burm. f.) Hall. f.

Germination type: Epigeal

Hypocotyle green, hard, smooth, size is about 4 cm to 4.3 cm. **Cotyledons** two, alternate, horizontal, green in color, exstipulate, petiolate (green, soft, circular, pubescent, size is about 1 cm to 1.3 cm), shape obcordate, apex emarginate, base cordate, margin entire, surface pubescent, multicostate venation. **Internodes** green, round, fleshy, surface has woolly hairs, straight, internode distance 0.7 cm to 1.2 cm. **First two leaves** opposite, compound, palmately trifoliate, green, exstipulate, petiolate (green, circular, fleshy, woolly surface, size is about 0.5 cm to 0.7 cm), surface woolly. **Leaflets** dark green, lamina ovate, incision of lamina sect, apex acute, base cordate, margin entire, surface woolly, alternate pinnate venation.

9. Family Euphorbiaceae

i) *Andrachne aspera* Sprang.

Germination type: Epigeal

Hypocotyle green, hard, smooth, size is about 2 cm to 3 cm. **Cotyledons** two, opposite, horizontal, green in color, exstipulate, petiolate (green, soft, circular, glabrous, size is about 0.2 cm to 0.3 cm), shape orbicular, apex obtuse, base obtuse, margin entire, surface glabrous, distinct midrib with multicostate venation. **Internodes** green, round,

smooth surface, erect, internode distance 0.2 cm to 0.3 cm. **First two leaves** simple, alternate, green, herbacious, exstipulate, petiolate (green, circular, fleshy, smooth surface, size is about 0.3 cm to 0.4 cm), surface glabrous, shape orbicular to renifom, apex obtuse, base cordate, margin ciliate, smooth surface, distinct midrib with arcuate venation.

10. Family Malvaceae

i) *Abutilon indicum* (Linn.) Sweet

Germination type: Epigeal

Hypocotyle green, pubescent, size is about 1.5 cm to 1.8 cm. **Cotyledons** two, opposite, horizontal, green in color, exstipulate, petiolate (green, soft, circular, pubescent, size is about 0.3 cm to 0.4 cm), shape cordate, apex obtuse, base cordate, margin entire, surface smooth, distinct midrib. **Internodes** green, round, fleshy, smooth surface, straight, internode distance 0.5 cm to 0.6 cm. **First two leaves** simple, alternate, green, horizontal, adnate stipule about 2 cm, petiolate (olive green, circular, smooth surface, size is about 1 cm to 1.5 cm), surface has woolly hairs, shape cordate, apex acute, base cordate, margin serrate, distinct midrib with palmate venation.

ii) *Abutilon pannosum* (Forst.f.) Schlecht

Germination type: Epigeal

Hypocotyle elongate, green, pubescent on surface, size is about 1.5 cm to 2 cm. **Cotyledons** two, opposite, horizontal, green in color, exstipulate, petiolate (olive green, soft, circular, pubescent, size is about 0.5 cm to 0.7 cm), shape cordate, apex obtuse, base cordate, margin entire, surface smooth, distinct midrib. **Internodes** green, circular, smooth surface, straight, internode distance 0.8 cm to 1 cm. **First two leaves** simple, alternate, green, horizontal, adnate stipule about 2 cm, petiolate (green, circular, pubescent surface, size is about 1 cm), surface has woolly hairs, shape cordate, apex acute, base cordate, margin serrate, distinct midrib with palmate venation.

11. Family Menispermaceae

i) *Cocculus pendulus* (J.R. & G. Forst.) Diels

Germination type: Epigeal

Hypocotyl green, hard, glabrous surface, size is about 2 cm to 2.5 cm. **Cotyledons** two, opposite, horizontal, green in color, exstipulate, petiolate (green, flat, pubescent, size is about 0.3 cm to 0.5 cm), shape oblong, apex obtuse,base cuneate, margin entire, surface glabrous, distinct midrib. **Internodes** green, circular, hard, smooth surface, internode distance 0.4 cm to 0.8 cm. **First two leaves** simple, alternate, green, horizontal, shruby, exstipulate, petiolate (green, circular, pubescent surface, size is about 0.6 cm to 1 cm), shape orbicular to peltate, lamina has incision, apex acute, base hastate to truncate, margin entire, surface glabrous, distinct midrib with palmate venation.

12. Family Oxalidaceae

i) *Oxalis corniculata* L.

Germination type: Epigeal

Hypocotyl green, soft, delicate, glabrous surface, size is about 0.2 cm to 0.3 cm. **Cotyledons** two, opposite, horizontal, green in color, exstipulate, petiolate (green, round, pubescent, size is about 0.1 cm to 0.2 cm), shape obovate, apex obtuse, base obtuse, margin entire, surface glabrous, indistinct midrib. **Internodes** olivegreen, circular, soft, pubescent surface, internode distance 1.5 cm to 2 cm. **First two leaves** compound, palmately trifoliate, green, horizontal,astipulate, petiolate (purplish green, circular, delicate, pubescent surface, size is about 1 cm). **Leaflets** green in color, flat, petiolate (green, round, hairy, size is about 0.8 cm to 1 cm), shape orbicular, apex emarginated, base cuneate, margin entire, surface has pubescent hairs, distinct midrib, shiny leaf surface.

13. Family Papilionaceae

i) *Rhynchosia minima* (Linn.) DC.

Germination type: Epigeal

Hypocotyl green, glabrous surface, size is about 1 cm to 1.3 cm. **Cotyledons** two, opposite, horizontal, green in color, free lateral stipule(2 pairs), petiolate (green, round, fleshy, pubescent, size is about 0.7 cm to 1.2 cm), shape orbicular, apex obtuse, base cordate, margin entire, surface glabrous, distinct midrib with multicostate venation. **Internodes** green, circular, pubescent surface, internode distance 0.3 cm to 0.6 cm. **First two leaves** compound, palmately trifoliate, alternate, green, horizontal, green free lateral stipule(2 pairs), petiolate (green, fleshy, glabrous surface, size is about 0.2 cm to 0.3 cm). **Leaflets** green, exstipulate, petiolate 0.5 cm to 0.8 cm, shape rhomboid, apex obtuse,base cuneate, margin entire, surface glabrous, distinct midrib with multicostate venation.

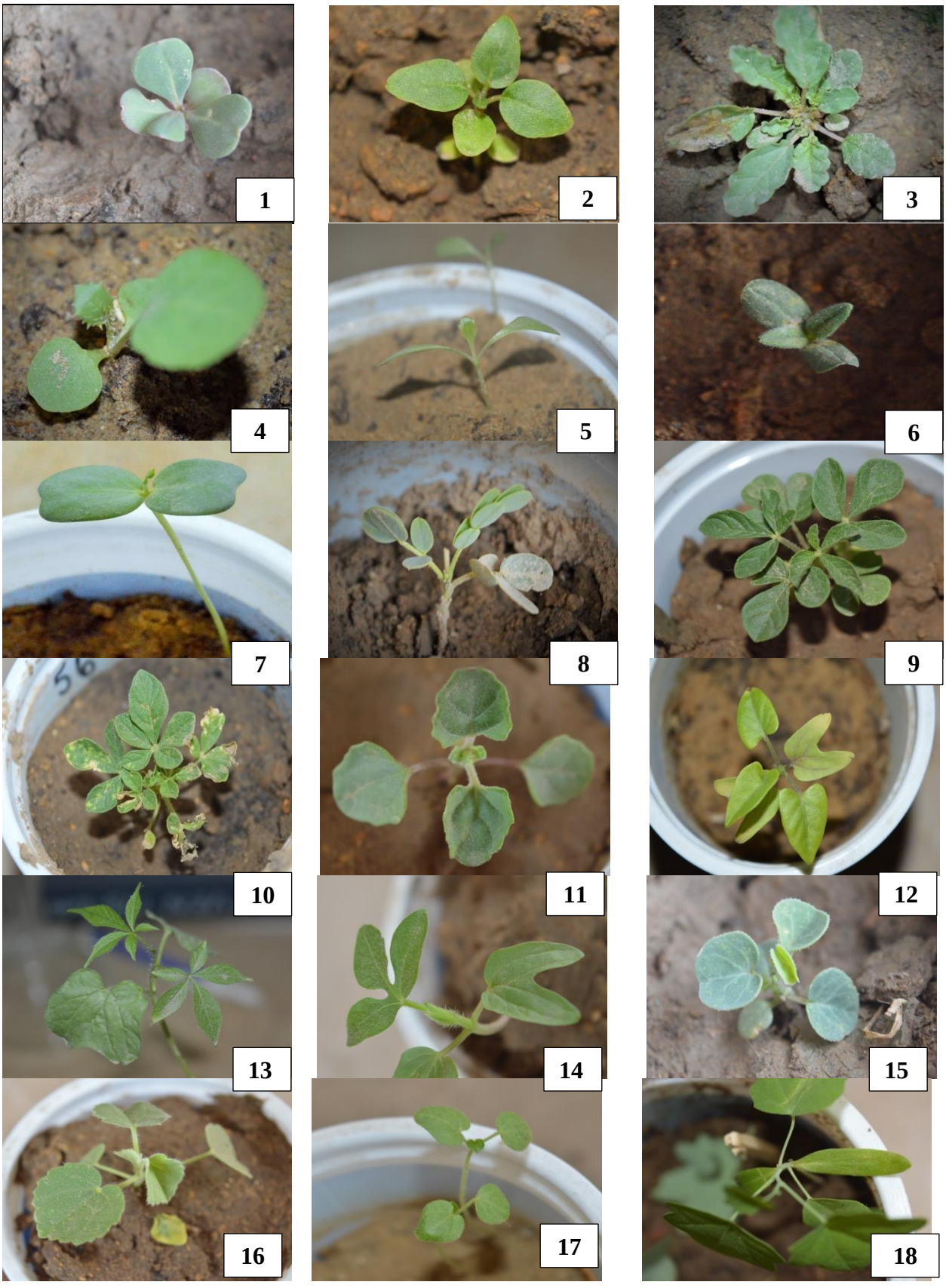
ii) *Tephrosia subtriflora* Baker
Germination type: Epigeal
Hypocotyl green, hard, glabrous surface, size is about 1 cm. **Cotyledons** two, opposite, vertical, green in color, exstipulate, petiolate (green, round, glabrous, size is about 0.1 cm to 0.2 cm), shape obovate, apex obtuse,baseobtuse, margin entire, surface glabrous, distinct midrib with pinnate opposite venation. **Internodes** green, circular, pubescent surface, internode distance 0.3 cm to 0.6 cm. **First two leaves** compound, pinnate, alternate, green, horizontal, stipulate, petiolate (green, circular, pubescent surface, size is about 0.7 cm to 1 cm). **Leaflets** green, imperipinnate, sessile, shape oblong- obovate, apex obtuse, base obtuse, margin entire, surface glabrous, distinct midrib with pinnate venation, 7-9 in number.

iii) *Tephrosia uniflora* (Blatter & Hallberg) Gillett & Ali
Germination type: Epigeal
Hypocotyl light green, hard, circular, glabrous surface, size is about 0.6 cm to 0.7 cm. **Cotyledons** two, opposite, herbaceous, horizontal, light green in color, exstipulate, petiolate (green, round, fleshy, glabrous, size is about 0.2 cm to 0.3 cm), shape oblong, apex obtuse, base obtuse, margin entire, surface glabrous, distinct midrib. **Internodes** green, circular, hard, pubescent surface, internode distance 0.8 cm to 1cm. **First two leaves** compound, imperipinnate, opposite, green, horizontal, herbaceous, green free lateral stipules (2 pairs), petiolate (green, hard, glabrous surface, size is about 0.4 cm to 1cm). **Leaflets** green, petiolate o.1 cm to 0.2 cm, usually 5 in number, shape oblanceolate, apex mucronate, base cuneate, margin entire, surface glabrous, distinct midrib with pinnate opposite venation.

14. Family Poaceae
i) *Echinochloa colona* (L.) Link
Germination type: Hypogeal
Epicotyl: white, straight, circular, glabrous surface, size is about 2 cm to 3 cm. **Cotyledons:** single, straight, horizontal, light green in color, exstipulate, sessile, shape linear, apex acute, base sheathing, margin entire, surface glabrous, parallel venation. **Internodes:** green, circular, hollow, pubescent surface, internode distance 1 cm to 2 cm. **Subsequent leaves:** simple, alternate, erect, green, exstipulate, sessile, vertical, surface smooth, shape oblong, apex acute, base sheathing, margin entire, distinct venation.

15. Family Portulacaceae
i) *Portulaca oleracea* L.
Germination type: Epigeal
Hypocotyl green, straight, circular, fleshy, glabrous surface, size is about 0.5 cm to 0.6 cm. **Cotyledons** two, opposite, horizontal, green in color, astipulate, petiolate (redish green, circular, fleshy, size 0.6 cm to 0.7 cm), shape lanceolate, apex obtuse, base cuneate, margin entire, surface glabrous and shiny, indistinct midrib. **Internodes** green, circular, fleshy, pubescent surface, internode distance 0.7 cm to 1cm. **First two leaves** simple, opposite, purplish, horizontal, succulent, astipulate, sub-sessile, shape obovate, apex obtuse, base cuneate, margin entire, surface glabrous and shiny, distinct midrib. **Subsequent leaves** simple, opposite, green, horizontal, succulent, astipulate, sub-sessile, shape obovate, apex obtuse-truncate, base cuneate, margin entire, surface glabrous and shiny, distinct midrib.

16. Family Rhamnaceae
i) *Ziziphus jujube* Mill.
Germination type: Epigeal
Hypocotyl olive green, straight, circular, fleshy, pubescent surface, size 1.5 cm to 1.8 cm. **Cotyledons** two, opposite, horizontal, green in color, exstipulate, petiolate (light green, circular, curved, fleshy, surface has pubescent hairs, size 0.6 cm to 1 cm), shape orbicular, apex obtuse, base obtuse, margin entire, surface glabrous, distinct midrib with multicostate venation. **Internodes** green, circular, fleshy, pubescent surface, internode distance 1.5 cm to 2 cm. **First two leaves** simple, opposite, green, horizontal, free lateral stipule about 0.6 cm, petiolate (green, circular, erect, pubescent surface, size is about 0.3 cm to 0.4 cm), shape ovate, apex acute,base obtuse, margin serrate, surface smooth, distinct midrib with multicostate venation.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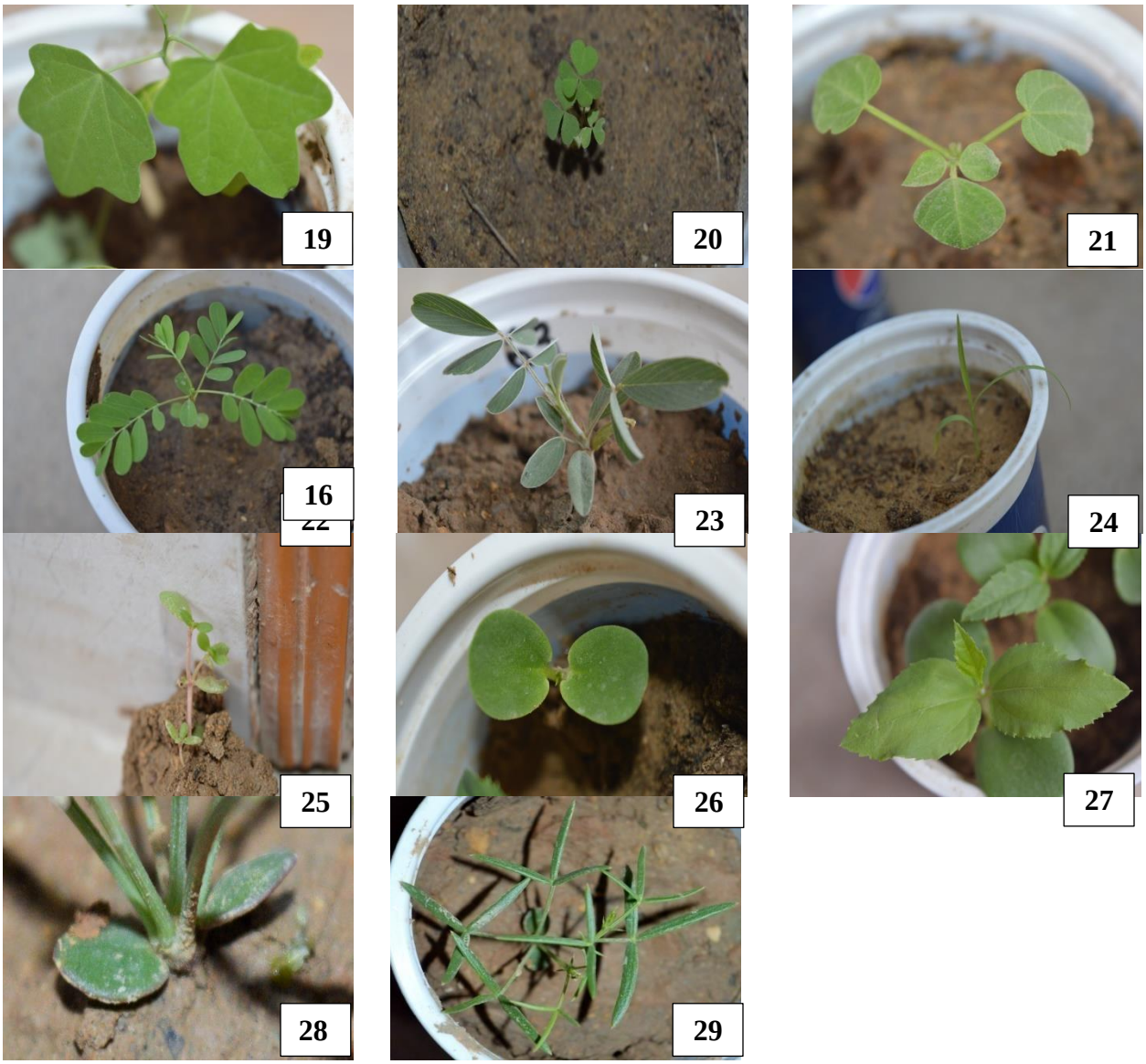

Fig. 1-29.

1. *Zaleya pentandra*, 2. *Amaranthus viridis*, 3. *Digera muricata*, 4. *Launaea procumbens*, 5. *Pluchea lanceolata*, 6. *Heliotropium crispum*, 7. *Senna holosericea* (cotyledons), 8. *Senna holosericea* (subsequent leaves), 9. *Cleome viscosa*, 10. *Gynandropsis gynandra* 11. *Chenopodium murale*, 12. *Convolvulus glomeratus*, 13. *Merremia aegyptia*, 14. *Merremia hederacea*, 15. *Andrachne aspera*, 16. *Abutilon indicum*, 17. *Abutilon pannosum*, 18. *Cocculus pendulus* (cotyledon), 19. *Cocculus pendulus* (subsequent leaves), 20. *Oxalis corniculata*, 21. *Rhynchosia minima*, 22. *Tephrosia subtriflora*, 23. *Tephrosia uniflora*, 24. *Echinochloa colona*, 25. *Portulaca oleracea*, 26. *Ziziphus jujube* (cotyledons), 27. *Ziziphus jujube* (subsequent leaves), 28. *Fagonia cretica* (cotyledons), 29. *Fagonia cretica* (subsequent leaves).

17. Family Zygophyllaceae
i) *Fagonia cretica* L.
Germination type: Epigeal

Hypocotyl green, circular, hard, surface glabrous, size 0.3 cm to 0.5 cm. **Cotyledons** two, opposite, horizontal, green in color, succulent, exstipulate, sessile, shape obovate, apex obtuse,base obtuse, margin entire, surface glabrous, indistinct midrib. **Internodes** green, circular, hard, surface glabrouse, internode distance 1.5 cm to 2 cm. **First two leaves** compound, palmately trifoliate, opposite, green, vertical, exstipulate, petiolate (green, long, hard, glabrous surface, size is about 2 cm). **Leaflets** green, exstipulate, sessile, shape linear, apex acute, base obtuse, margin entire, surface glabrous, distinct midrib.

Key of the studied taxa

1. **Order Asterales**

1) **Family Asteraceae:** *Launaea procumbens*, *Pluchea lanceolata*.

Key to the investigated species

\+ Cotyledons petiolate, first two leaves opposite, blade obovate, base obtuse ……..… *Launaea procumbens*

\- Cotyledons sessile, first two leaves alternate, blade ovate to lanceolate, base attenuate ……..… *Pluchea lanceolata*

2. **Order Capparales**

1) **Family Capparaceae:** *Cleome viscosa*, *Gynandropsis gynandra.*

\+ Cotyledons glabrous, first two leaves and subsequent leaves are trifoliate ……..….. *Cleome viscosa*

\- Cotyledons pubescent, first two leaves trifoliate, subsequent leaves pentafoliate ……..…… *Gynandropsis gynandra*

3. **Order Caryophyllales**

Key to the investigated families

1+ Cotyledonspetiolate, orbicular or oblong, first two leaves obcordate or ovate……2

1- Cotyledon sessile, oblong or lanceolate, first two leaves ovate or obvate…….3

2+ Cotyledon orbicular, first two leaves obcordate, subsequent leaves obovate, apex retuse …….Aizoaceae

2- Cotyledon oblong, first two leaves ovate, apex obtuse……....Amaranthaceae

3+ Cotyledons reddish, oblong, first two leaves olive green, ovate, Petiolate …… ……..……..Chenopodiaceae

3- Cotyledon green, lanceolate, first two leaves purplish, obovate, sessile ---------- …….Portulacaceae

1) **Family Amaranthaceae**

Key to the investigated species

\+ Cotyledon apex obtuse, first two leaves petiole light green and subsequent leaves petiole is green……..… *Amaranthus viridis*

\- Cotyledon apex acute, first two leaves petiole greenish whitish and subsequent leaves petiole is purplish……..…….. *Digera muricata*

4. **Order Cyperales**

Family Poaceae

Echinochloa colona

5. **Order Euphorbiales**

Family Euphorbiaceae

Andrachne aspera

6. **Order Fabales**

Key to the investigated families

\+ Cotyledon alternate, dark green, obcordate, obtuse……Caesalpinniaceae

\- Cotyledon opposite, green to light green, obovate-orbicular……Papilionaceae

1) Family Caesalpinniaceae

Senna holosericea

2) Family Papilianaceae

Key to the investigated species

1- Cotyledons obovate or oblong, base obtuse, leaves pinnately compound…….2

1+ Cotyledons orbiculor, base cordate, leaves palmately compound ....……*Rhynchosia minima*

2+ Cotyledons obovate, leaflets oblong-obovate, apex obtuse, 7-9 in number

……..……. *Tephrosia subtriflora*

2- Cotyledons oblong, leaflets oblanceolate, apex mucronate, 5 in number…
……*Tephrosia uniflora*

7. **Order Geraniales**
   Family Oxalidaceae
   Oxalis corniculata
8. **Order Lamiales**
   Family Boraginaceae
   Heliotropium crispum
9. **Order Ranunculales**
   Family Menispermaceae
   Cocculus pendulus
10. **Order Rosales**
    Family Rhamnaceae
    Ziziphus jujube
11. **Order Sapindales**
    Family Zygophyllaceae
    Fagonia cretica
12. **Order Solanales**
    Family Convolvulaceae

Key to the investigated species

1+ Cotyledons green, glabrous, obovate, apex retuse, margin entire, first two leaves alternate, simple…….. *Convolvulus glomeratus*

1- Cotyledons white or green, pubescent, obcordate, apex retuse, margin entire or undulate, first two leaves opposite, compound…… 2

2+ Cotyledon whitish, margin undulate, first two leaves pentafoliate, pubescent, leaflet green, narrow elliptic, base obtuse, opposite pinnate venation……..…….*Merremia aegyptia*

2- Cotyledon green, margin entire, first two leaves trifoliate, wooly surface, Leaflets dark green, ovate, base cordate, alternate pinnate venation……..*Merremia hederacea*

DISCUSSION

The study of seedling morphology provides quite useful data. This is a very preliminary study in which we study 25 species belong to 16 families in 13 orders. The number of species we studied was very less in number that's why only 25 different species we found and with the exception of 1 or 2, all belong to different families. But still they were found to be helpful in separating the taxa on the basis of their morphological characters. The keys were made for different families belonging to same orders and different species of the same families. As the sample size increases these morphological differences were found to be more useful. From taxonomic point of view the seedling morphology is now going important throughout the world. There is a need to work on this field in our country too and the present work is the initial work of this pattern.

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