

CHAPTER = 6

**SEEDLING
MORPHOLOGY**

SEEDLING MORPHOLOGY

Seedling is the juvenile stage of the plant and is produced from the seeds, in distinction to a plant propagated artificially, or a young plant so produced (Jackson, 1928). Early in botanical history, little attention was paid to seedling morphology (Caesalpinus, 1583). In 20th century occasional works has been done in this field but on temperate seedlings only. Some forest botanist made some works on tropical tree seedlings (Duke, 1965,1969; Burger, 1972). Many other workers (Naidu and Shah, 1981; Lodiges et al. 1981, 1984; Sampatkumar, 1982; Canne, 1983; Nemato and Ohashi, 1993; Kumilya and Paria, 1993, 1994) attempted to study the seedlings from the taxonomic view point. But no attempt has been made so far to study the seedling morphology of crop field weeds, to identify the weeds at their juvenile stage. Though Tiwari (1953-54) in Bihar observed that the weeds are more injurious in their early stage than the advance stages of the crop. So, in the present work attempt has been made to characterize and to identify the seedlings at their juvenile stage.

In the present work seedlings of 45 common dicotyledonous crop field weeds belonging to 20 families have been morphologically diagnosed on the basis of cotyledons or paracotyledons, eophylls (first few leaves) and hypocotyl characters.

6.1 KEY TO THE IDENTIFICATION OF SEEDLINGS

An artificial Key has been prepared for easy identification of the weed species at their juvenile stage.

- | | |
|---|-----------------------------|
| 1. First leaf compound ----- | 2 |
| 1. First leaf simple----- | 6 |
| 2. Leaflets obcordate----- | <i>Oxalis corniculata</i> |
| 2. Leaflets never obcordate ----- | 3 |
| 3. Paracotyledons narrowly lanceolate; leaflets deeply dissected ----- | <i>Fumaria indica</i> |
| 3. Paracotyledons oblong or rounded; leaflets entire ----- | 4 |
| 4. Terminal leaflet absent ----- | 5 |
| 4. Terminal leaflet rhomboid ----- | <i>Cleome viscosa</i> |
| 5. Leaflets sessile; rachis tip extended ----- | <i>Biophytum sensitivum</i> |
| 5. Leaflets petiolate; rachis tip not extended ----- | <i>Cassia sophera</i> |
| 6. First two leaves reduced into minute prophyll ----- | 7 |
| 6. First leaf not reduced but simple ----- | 8 |
| 7. Third to sixth leaves with two leaflets and increase in subsequent leaves ----- | |
| ----- | <i>Vicia angustifolia</i> |
| 7. Third and fourth leaf with four leaflets and increase in subsequent leaves ----- | |
| ----- | <i>Vicia hirsuta</i> |
| 8. Second and subsequent leaves compound ----- | 9 |
| 8. Second and subsequent leaves simple ----- | 10 |
| 9. Terminal leaflets of second leaf obcordate with few obscure serrations or almost entire ----- | |
| ----- | <i>Medicago lupulina</i> |
| 9. Terminal leaflet of second leaf rounded at tip, distantly crenate ----- | <i>Melilotus alba</i> |
| 10. Internode between cotyledonary node and next leaf suppressed ----- | 11 |
| 10. Internode between cotyledonary node and the first leaf never suppressed ----- | 19 |
| 11. Cotyledons obcordate (upto 1/3 part deep) ----- | <i>Hewittia scandens</i> |
| 11. Cotyledons not obcordate ----- | 12 |
| 12. Lamina of first four to six leaves reniform to slightly oblong-reniform ----- | 13 |
| 12. lamina of first few leaves or of mature leaves never reniform ----- | 14 |
| 13. Petiole of cotyledon 0.6-0.8 cm long; base of basal leaf lamina slightly cordate ----- | |
| ----- | <i>Leonurus japonicus</i> |
| 13. Petiole of cotyledon 0.1 cm long; base of all lamina deeply cordate -- | <i>Centella asiatica</i> |
| 14. Leaves exstipulate ----- | 15 |
| 14. Leaves stipulate ----- | 17 |
| 15. Margins of lamina, except cotyledons, deeply sinuate and spinous and with pinnate venation ----- | <i>Argemone mexicana</i> |
| 15. Margin of lamina never spinous ----- | 16 |
| 16. Cotyledons distinctly petiolate; lamina of first few leaf ovate to orbicular, entire and with pinnate veins ----- | <i>Rorippa indica</i> |

16. Cotyledons almost sessile, lamina of first leaf broader than long; irregularly serrate and with palmate veins ----- *Cucumis melo*
17. Seedling always produce two or more branches after the production of first leaf; second pair of leaf upto 0.45 cm long ----- *Euphorbia heyniana*
17. Seedling do not branch after the first leaf; normal stem with distinct internodes continues after the first leaf ----- 18
18. Stem densely woolly, serrations distant, broadest area for the lower half of lamina 1/3 part away from base ----- *Euphorbia hirta*
18. Stem shortly and sparsely woolly; serrations quite close set; broadest area for the lower half of lamina near the base ----- *Euphorbia indica*
19. Leaves except cotyledons alternate ----- 20
19. Leaves (in addition to paracotyledons), at least the first pair opposite ----- 35
20. Lamina deeply dissected ----- *Parthenium hysterophorus*
20. Lamina never dissected but entire/slightly lobed or variously serrate/dentate ----- 21
21. Veins three from base (palmate) ----- *Chrozophora rottleri*
21. Single vein from base ----- 22
22. Cotyledons shorter than the lamina of second leaf ----- 23
22. Cotyledons longer than lamina of second leaf, entire, narrowly lanceolate, lamina of other leaves entire, obtuse ----- *Digera muricata*
23. Leaves stipulate, sometimes stipules replaced by glands ----- 24
23. Leaves ex-stipulate ----- 27
24. Cotyledons and lamina of first few leaves obovate-oblong ----- 25
24. Cotyledons and lamina of the leaves never obovate; dwarf shoot never produced ----- 26
25. Dwarf shoot develop after second leaf ----- *Phyllanthus fraternus*
25. Dwarf shoot develop after 4-6 leaves ----- *Phyllanthus amarus*
26. Stem with no scales or stellate hairs ----- *Phyllanthus virgatus*
26. Stem scaly and with stellate hairs ----- *Croton bonplandianum*
27. Lamina entire at least of first few leaves ----- 28
27. Lamina dentate or sinuate or serrate ----- 31
28. Petiole absent; lamina linear lanceolate ----- *Sebastiania chamaelea*
28. Petiole always present ----- 29
29. Stem zigzag; lamina slightly obovate with rounded tip ----- *Evolvulus nummularius*
29. Stem erect ----- 30
30. Lamina ovate with notched tip ----- *Amaranthus viridis*
30. Lamina lanceolate with acute tip ----- *Celosia argentea*
31. Cotyledons minute, triangular ovate, lamina (of cotyledon) 0.12 cm long ----- *Scoparia dulcis*
31. Cotyledons more than 0.2 cm long, ovate or rounded ----- 32
32. Lamina of leaves of second and onwards broadly ovate ----- *Blumea lacera*
32. Lamina of leaves (except cotyledons) not obovate ----- 33
33. Paracotyledon narrowly lanceolate; leaves fleshy, ovate-lanceolate ----- *Chenopodium album*
33. Paracotyledons ovate ----- 34
34. Base of lamina slightly cordate or rounded ----- *Physalis minima*

34. Base of lamina narrowed to petiole, never cordate ----- *Solanum nigrum*
35. Margins of lamina not entire ----- 36
35. Margins of lamina entire or slightly and irregularly undulating ----- 41
36. Paracotyledons always more than 2.0 cm long; slightly ovate-lanceolate; lamina with cordate base ----- *Xanthium indicum*
36. Paracotyledons always less than 1.0 cm long, generally ovate or ovate-rounded; lamina never with a cordate base ----- 37
37. Lamina pinnately veined ----- 38
37. Lamina 3-veined from base ----- 39
38. Paracotyledons 0.07 cm long including petiole; lamina fleshy ----- *Phyllanthus nodiflora*
38. Paracotyledons 1.2 cm long including petiole; lamina not fleshy ----- *Leucas indica*
39. Hypocotyl over 2.0 cm long; lamina obscurely serrate ----- *Acalypha indica*
39. Hypocotyl less than 1.5 cm long; lamina distinctly dentate-serrate ----- 40
40. Base of lamina cuneate ----- *Ageratum conyzoides*
40. Base of lamina truncate ----- *Ageratum houstonianum*
41. Leaves sessile ----- *Anagallis arvensis*
41. Leaves petiolate ----- 42
42. Lamina rugose above ----- *Heliotropium indicum*
42. Lamina not rugose above ----- 43
43. Paracotyledons unequal, over 1.0 cm long; lamina gradually narrowed to petiole -----
----- *Alternanthera sessilis*
43. Paracotyledons equal, less than 1.0 cm long; lamina base otherwise ----- 44
44. Lamina strigose hairy above ----- *Eclipta alba*
44. Lamina glabrous ----- *Ludwigia perennis*

6.2 ENUMERATION

Enumeration of the seedling morphology has been made with families, genera and species of the weed flora arranged alphabetically.

Alternanthera sessilis

Germination epigeal, phanerocotylar.

Taproot 3.8-4.3 cm long, moderately thick, creamy white, lateral roots scarcely branched.

Hypocotyle straight, terete, 2.5-2.9 cm long, reddish.

Paracotyledons 2, unequal, opposite, persistent upto 8-10 leafed stage, exstipulate, petiolate; for smaller one petiole upto 0.7 cm, blade 0.8 x 0.55 cm, wide oblong, entire, base narrowed to petiole; for second one-blade ca. 0.9 x 0.7 cm entire, suborbicular, acute, base narrowed to petiole, reddish below; primary vein-1, secondary veins indistinct.

Internode straight, reddish, terete, 1st and 2nd internode 2.2 and 2.8 cm respectively.

First two leaves opposite, simple, exstipulate, petiolate; petiole 0.6-0.7 cm, blade ca. 1.7 x 0.95 cm, wide oblong, entire, obtuse, base narrowed to petiole, primary vein 1, secondary veins alternate.

Subsequent leaves opposite, petiole gradually shorter and other characters are same as that of first two leaves, branching also arises from the cotyledonary nodes.

Amaranthus viridis

Germination epigeal, phanerocotylar.

Taproot 3.4-4.0 cm long, thin, grayish, lateral roots profusely branched.

Hypocotyl straight, whitish green, terete, 0.9-1.1 cm long.

Paracotyledons two, opposite, fleshy, persistent upto 7-10 leaved stage, exstipulate, petiolate; petiole 0.4-0.6 cm, blade 0.7-0.8 x 0.2 cm, narrow elliptic, entire, obtuse, primary vein 1, secondary veins alternate.

Internode straight, terete, greenish-gray, 1st and 2nd internode 0.3-0.4 cm and 0.3-0.5 cm long respectively

First two leaves alternate, simple, exstipulate, petiolate; petiole 0.5-0.6 cm and 0.55-0.62 cm and blade 0.8-0.85 x 0.4-0.55 cm and 0.8-0.9 x 0.5-0.6 cm respectively, ovate, entire, emerginate, base obtuse; primary vein 1, secondary veins alternate.

Subsequent leaves alternate, exstipulate, petiolate and other characters are same as that of first two leaves except in size. [Plate 4, Fig.12]

Celosia argentea

Germination epigeal, phanerocotylar.

Taproot 8.4-10.2 cm long, moderately thick, white, lateral roots profusely branched.

Hypocotyl straight, terete, 1.2-1.4 cm long, violate, enveloped by petiolar sheath of paracotyledons.

Paracotyledons 2, opposite, entire, exstipulate, petiolate, persistent upto 10-12 leafed stage, sometimes found attached with mature plant; petiole 0.5 cm, blade 1.1 x 0.45 cm, fleshy, entire, lanceolate, acute, lower violate; primary vein 1, secondary veins indistinct.

Internode straight, light violate, 1st and 2nd internode 0.2 x 0.3 cm, respectively.

First two leaves semialternate, simple, green, dorsal violate near the midrib, fleshy, petiolate; petiole 0.9 and 1.4 cm, blade 1.8 x 0.9 cm and 2.9 x 1.4 cm respectively, entire, lanceolate, acute, base acute to acuminate; primary veins 1, secondary veins alternate.

Subsequent leaves alternate and other characters are same as that of first two leaves.

Digera muricata

Germination epigeal, phanerocotylar.

Taproot 7.4-7.6 cm long, white, lateral roots profusely branched.

Hypocotyle straight, 1.5-1.9 cm, lower reddish, upper green, enveloped by petiolar sheath of paracotyledons.

Paracotyledons 2, persistent upto 8-10 leafed stage, sometimes till branching, petiolate; petiole 1 cm, blade 3.8 x 0.4 cm, entire, linear, acute, base acute, primary veins 1, secondary veins indistinct.

Internode straight, 1st and 2nd internode 0.5 and 0.3 cm respectively.

First two leaves alternate, simple, exstipulate, petiolate; petiole 1.5 and 1.1 cm, blade 2.4 x 1.0 cm and 2.5 x 1.5 cm respectively, entire, ovate, acute, base acute; primary vein 1, secondary veins alternate.

Subsequent leaves alternate and others characters are same as that of first two leaves, branching also arises from the cotyladonary node. [Plate 3, Fig.4,18]

Centella asiatica

Germination epigeal, phanerocotylar.

Taproot 5.5-6.5 cm long, thin, creamy white, lateral roots profusely branched.

Hypocotyl straight, fleshy, 0.6-0.8 cm long, greenish.

Paracotyledons two, opposite, fleshy, persistent upto 8-12 leafed stage, exstipulate, petiolate; petiole ca. 0.1 cm, blade 0.5-0.6 x 0.45-0.5 cm, very wide ovate, entire, obcorded, base rounded, fleshy, primary vein 1, secondary veins indistinct.

Internode suppressed, leaves crowded at nodes.

First two leaves simple, fleshy, exstipulate, petiolate; petiole of first leaf 1.0-1.2 cm long, blade 0.7-0.9 cm; petiole of second one 1.5-1.7 cm, blade 0.9-1.0 x 1.6-1.7 cm, both blades reniform, crenate, lobed, primary veins 5 nerved from base.

Subsequent leaves crowded at nodes and other characters are same as that of first two leaves except in size. [Plate 3, Fig.1]

Ageratum conyzoides

Germination epigeal, phanerocotylar.

Taproot 3.0-3.8 cm long, thin, creamy white, lateral roots profusely branched.

Hypocotyl straight, 0.8-1.2 cm long, light reddish to green.

Paracotyledons 2, opposite, persistent upto 8-12 leafed stage, exstipulate, petiolate; petiole 0.15-0.18 cm long, blade ca. 0.25 x 0.22 cm, wide-ovate, entire, rounded, base rounded, primary vein 3 from base, secondary veins alternate.

Internode straight, terete, hairy, 1st and 2nd internode 1.1-1.9 cm and 1.7-2.8 cm long respectively.

First two leaves opposite, simple, exstipulate, petiolate; petiole 0.4-0.45 cm long, hairy, blade 0.7-0.8 x 0.5-0.55 cm, hairy, ovate, distantly serrate, acute, base cuneate, primary veins 3 from base, secondary veins alternate.

Subsequent leaves opposite, simple, exstipulate, petiolate, serrate and other characters are same as that of first two leaves except in size.

Ageratum houstonianum

Germination epigeal, phanerocotylar.

Taproot 4.0-5.0 cm long, thin white, lateral roots profusely branched.

Hypocotyle straight, terete, 0.4-0.6 cm long, reddish.

Paracotyledons 2, opposite, persistent upto 8-12 leafed stage, exstipulate, petiolate; petiole 0.1-0.16 cm long, blade 0.21 x 0.28 cm, oblate to very wide ovate, entire, rounded, base rounded, primary vein 3 from base, secondary veins alternate.

Internode straight, reddish, hairy, 1st and 2nd internode 0.7-1.3 cm and 0.5-0.9 cm long respectively.

First two leaves opposite, simple, exstipulate, petiolate; petiole 0.3-0.35 cm long, hairy, blade 0.6-0.7 x 0.5-0.55 cm, wide ovate, distantly serrate, acute, base truncate, hairy; primary veins 3 from base, secondary veins alternate.

Subsequent leaves opposite, simple, exstipulate, petiolate, serrate, base truncate and other characters are same as that of first two leaves except in size.

Blumea lacera

Germination epigeal, phanerocotylar.

Taproot 2.0-2.4 cm, thin, light brown, lateral roots profusely branched.

Hypocotyle straight, 0.25-0.4 cm, whitish green.

Paracotyledons 2, opposite, persistent upto 5-8 leafed stage, exstipulate, petiolate; petiole ca. 0.1 cm, blade 0.3 x 0.3 cm, wide ovate to orbiculate, entire, rounded, base rounded; primary and secondary vein indistinct.

Internode straight, green, hairy, 1st and 2nd internode 0.2 cm and 0.05-0.1 cm respectively.

First two leaves opposite, exstipulate, petiolate; petiole 0.1-0.2 cm, blade 0.6 x 0.5 cm and 0.7 x 0.5 cm respectively, wide ovate to suborbiculate, entire to dentate, obtuse, base obtuse; primary vein 1, secondary veins alternate.

Subsequent leaves form a rosette, sessile to sub sessile, exstipulate and other characters are same as that of first two leaves expect in size. [Plate 4 , Fig.4]

Eclipta alba

Germination epigeal, phanerocotylar.

Taproot 1.8-2.1 cm long, thin, brown, lateral roots are moderately branched.

Hypocotyle straightly curved, terete, greenish brown, 1.0-1.2 cm long.

Paracotyledons two, persistent upto 8-12 leafed stage, exstipulate, petiolate; petiole 0.2, blade ca 0.4 x 0.2 cm, narrow ovate, obtuse, entire, base obtuse rounded; primary vein one and secondary veins are indistinct.

Internode straight, terete, hairy, greenish brown, 1st and 2nd internode 0.5-0.6 cm and 0.5-0.1 cm respectively.

First two leaves are opposite, simple, exstipulate, petiolate; petiole ca. 0.1 cm, blade ca. 0.8 x 0.5 cm, ovate, obtuse, entire, base obtuse, primary vein one, secondary veins alternate.

Subsequent leaves are opposite decussate and other characters are same as that of first two leaves except in size. [Plate 3, Fig.15]

Parthenium hysterophorus

Germination epigeal, phanerocotylar.

Taproot 2.5-3.0 cm long, greenish, lateral roots profusely branched.

Hypocotyle straight, 1.1-1.3 cm, greenish gray, fleshy.

Paracotyledons two, opposite, persistent upto 6-11 leafed stage, fleshy, exstipulate, petiolate; petiole 0.2-0.3 cm, blade 0.4-0.45 x 0.3-0.35 cm, wide obovate, entire, rounded, base narrowed to petiole; primary vein 1, secondary vein indistinct.

Internode straight, hairy greenish-gray, fleshy, 1st and 2nd internode 0.25-0.3 cm and ca. 0.1 cm respectively.

First two leaves alternate, exstipulate, petiolate; petiole hairy, 0.6-0.7 cm and 1.0-1.3 cm respectively, 1st blade 0.7-0.75 x 0.35-0.4 cm, narrow ovate, entire, obtuse, base acute, primary vein 1, secondary veins indistinct, and 2nd one 0.9-1.1 x 0.4-0.45 cm, lanceolate above, pinnately lobed downwards, obtuse, base rounded, primary vein 3 nerved from base, secondary veins alternate.

Subsequent leaves alternate, exstipulate, petiolate, lanceolate above and pinnately lobed downwards, and other characters are same as that of second leaf except in size. [Plate 4, Fig.7]

Xanthium indicum

Germination epigeal, phanerocotylar.

Taproot 10.0-10.5 cm long, thick, creamy-white, lateral roots profusely branched.

Hypocotyle straight, terete, 4.8-5.5 cm, lower white upper reddish.

Paracotyledons two, persistent upto 6-8 leafed stage, opposite, exstipulate, petiolate; petiole ca. 0.8 cm, blade 2.7-2.9 x 0.8-0.85 cm, fleshy, entire, lanceolate, acute, yellowish-white, base narrowed to petiole, Primary veins 3 from base, secondary veins alternate.

Internode straight, terete, reddish, rough with short hairs, 1st and 2nd internode 1.2-1.4 cm and 0.4-0.45 cm respectively.

First two leaves opposite, simple, petiolate; petiole 2.2-2.4 cm, reddish, hairy, blade 4.2-4.4 x 3.4-3.6 cm, ovate to wide ovate, acute, rough with appressed hair on both sides; irregularly inciso-serrate, base asymmetrical, lobed; primary veins 3 from base, secondary veins alternate.

Subsequent leaves are opposite, and other characters are same as that of first two leaves. [Plate 4, Fig. 16]

Heliotropium indicum

Germination epigeal, phanerocotylar.

Taproot 2.9-3.2 cm, whitish-brown, moderately thick, lateral roots profusely branched.

Hypocotyl straight, terete, light green, 1.5-2.4 cm long, hairy.

Paracotyledons two, opposite, persistent upto 6-8 leafed stage, exstipulate, petiolate; petiole 0.4-0.5 cm, hairy, blade ca. 0.65 x 0.35 cm, ovate, entire, obtuse, base attenuate; primary vein 1, secondary veins indistinct.

Internode straight, terete, light green, hairy, 1st and 2nd internode 1.1-1.3 cm, and 0.3-0.5 cm respectively.

First two leaves opposite, simple, exstipulate, petiolate; petiole 0.7-0.85 cm, hairy, blade ca. 2.15 x 1.5 cm, narrow-ovate, entire, acute, base obtuse; primary vein 1, hairy from base to some extent, secondary veins alternate.

Subsequent leaves are opposite and other characters are same as that of first two leaves except in size. [Plate 3, Fig.27]

Rorippa indica

Germination epigeal, phanerocotylar.

Taproot 2.0-2.2 cm long, light brown, slender, lateral roots profusely branched.

Hypocotyl straight, ca. 0.2 cm long, fleshy, whitish-green.

Paracotyledons two, opposite, persistent upto 4-6 leafed stage, fleshy, exstipulate, petiolate; petiole 0.2-0.25 cm; blade 0.2-0.25 x 0.15 cm, wide-oblong, entire, rounded, base rounded; primary vein 1, secondary veins indistinct.

Internodes suppressed to form a basal rosette of leaves.

First two leaves also arise from the cotyledonary node, exstipulate, petiolate; petiole ca. 0.5 cm and 1.0 cm respectively; blade ca. 0.5 x 0.4 cm and 0.5 x 0.45 cm respectively, suborbiculate to orbiculate, entire to dentate, obtuse, base rounded; primary vein 1, secondary veins opposite.

Subsequent leaves alternate but in rosette, exstipulate, petiolate and other characters are same as that of first two leaves except in size. [Plate 4, Fig.19]

Cassia sophera

Germination epigeal, phanerocotylar.

Taproot 4.5-5.5 cm long, moderately thick, dark brown, lateral roots profusely branched.

Hypocotyl straight, terete, 6.0-6.5 cm, lower reddish upper green.

Paracotyledons two, opposite, persistent upto 6-10 leafed stage, exstipulate, petiolate; petiole about 0.1 cm, blade 1.2-1.3 x 1.0-1.1 cm, very wide oblong, entire, rounded, base cordate; Primary vein 5 nerved from base, secondary veins opposite.

Internode straight, terete, greenish gray, 1st and internode ca. 0.4 cm and ca. 0.2 cm respectively.

First two leaves alternate, pinnately compound, exstipulate, with a solitary dark gland near the base, petiolate; petiole 0.9-1.1 cm and 1.4-1.5 cm respectively; leaflets 4, petiolules ca. 0.1 cm, blade 1.1-1.3 x 0.6-0.7 cm, narrow obovate, entire, obtuse to rounded, base asymmetric.

Subsequent leaves alternate, leaflets became 3-5 pairs after 2-3 leafed stage, oblanceolate to narrow obovate, acute and other characters are same as that of first two leaves except in size. [Plate 3, Fig. 16; Plate 4, Fig. 10]

Chenopodium album

Germination epigeal, phanerocotylar.

Taproot 5.3 - 6.1 cm long, thin, grayish white.

Hypocotyle straight, terete, 2.8 - 3.0 cm long, reddish.

Paracotyledons 2 opposite, persistent upto 10-12 leafed stage, sometime till branching, exstipulate, petiolate; petiole 0.2-0.5 cm, blade 0.8-1.0 x 0.15-2.0 cm, linear to lanceolate, entire, fleshy, obtuse, base acute, veins are not distinct.

Internode straight terete, reddish, 1st and 2nd internode 0.5 and 0.7 cm respectively.

First two leaves opposite, simple fleshy, petiolate, petiole 0.45-0.7 cm, blade 1.0-1.2 x 0.25-0.45 cm, lanceolate-ovate, entire, obtuse, base obtuse; primary vein 1, secondary veins alternate.

Subsequent leaves are alternate, entire and other characters are same as that of first two leaves. [Plate 4, Fig. 2]

Cleome viscosa

Germination epigeal, phanerocotylar.

Taproot 3.0-3.5 cm long, slender, light brown, lateral roots moderately branched.

Hypocotyl straight, 1.5-1.7 cm long, grayish green.

Paracotyledons two, opposite, persistent upto 8-12 leafed stage, exstipulate, petiolate; petiole 0.3-0.4 cm, blade 0.45-0.5 x 0.25-0.3 cm, elliptic to oblong, entire, rounded, base rounded; primary vein 1, secondary veins indistinct.

Internode straight, light green, 1st and 2nd internode 0.7-0.8 cm and 0.4-0.5 cm respectively.

First two leaves opposite, exstipulate, trifoliolate, petiolate; petiole 0.9-1.0 cm, hairy; leaflets ovate to lanceolate, entire, obtuse, base cuneate, middle one largest, 0.8-0.9 x 0.5-0.6 cm, lateral two 0.65-0.7 x 0.3-0.35 cm; primary vein 1, secondary veins opposite.

Subsequent leaves opposite, trifoliolate upto 8 leafed stage, exstipulate, petiolate and other characters are same as that of first two leaves except in size. [Plate 4, Fig.9]

Evolvulus nummularius

Germination epigeal, phanerocotylar.

Taproot 3.0-3.5 cm long, moderately thick, whitish brown, lateral roots profusely branched.

Hypocotyl straight, terete, 1.0-1.2 cm, light green.

Paracotyledons two, opposite, persistent upto 6-10 leafed stage, exstipulate, petiolate; petiole 0.3-0.35 cm, blade 0.7-0.75 x 0.45-0.5 cm, wide oblong, entire, retuse, base obtuse; primary vein 1, secondary veins alternate.

Internode straight to slightly zigzag, light green, hairy, 1st and 2nd internode 0.4-0.5 cm, and 0.35-0.4 cm respectively.

First two leaves simple, alternate, exstipulate, petiolate; petiole hairy, 0.1-0.15 cm and ca. 0.15 cm respectively; blade 0.55-0.65 cm and 0.9-1.0 x 0.5-0.55 cm respectively, oblong, entire, retuse, base subcordate; primary vein 1, secondary veins alternate.

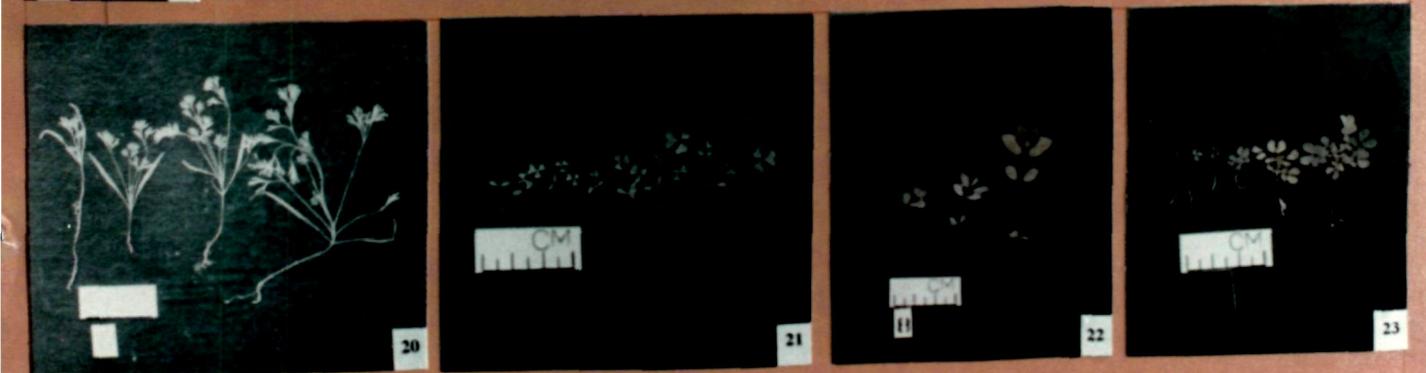
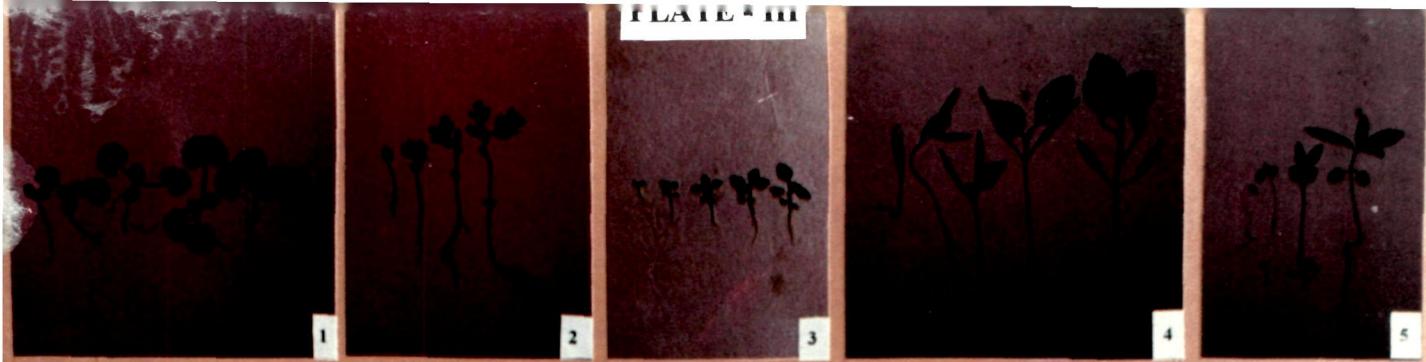
Subsequent leaves alternate, simple, exstipulate, petiolate and other characters are same as that of first two leaves except in size. [Plate 4, Fig.15]

PLATE - III
(SEEDLINGS)

Figure

1. *Centella asiatica*
 2. *Phyllanthus fraternus*
 3. *Scoparia dulcis*
 4. *Digera muricate*
 5. *Leucas indica*
 6. *Anagallis arvensis*
 7. *Vicia hirsuta*
 8. *V. angustifolia*
 9. *Hewittia scandens*
 10. *Medicago lupulina*
 11. *Physalis minima*
 12. *Argemone mexicana*
 13. *Leonurus japonicus*
- Fig. 14-19 Seedlings on seedbed and tub
14. *Vicia hirsuta*
 15. *Eclipta alba*
 16. *Cassia sophera*
 17. *Physalis minima*
 18. *Digera muricata*
 19. *Euphorbia hirta*
 20. *Fumaria indica*
 21. *Oxalis corniculata*
 22. *Euphorbia indica*
 23. *Biophytum sensitivum*
 24. *Phyllanthus amarus*
 25. *Croton bonplandianum*
 26. *Sebastiania chamaelea*
 27. *Heliotropium indicum*

PLATE III



Hewittia scandens

Germination epigeal, phanerocotylar.

Taproot 8.3-9.7 cm long, moderately thick, creamy white, lateral roots are profusely branched.

Hypocotyl straight to straightly-curved, terete, 2.6-2.9 cm long, lower white upper reddish.

Paracotyledons two, opposite, fleshy, persistent upto 10-14 leafed stage, exstipulate, petiolate; petiole 1.0-1.1 cm, blade 1.1-1.2 x 1.3-1.4 cm, cuneate to obcorded, entire, lobed, base obtuse to rounded; primary veins 3 nerved from base, secondary veins alternate.

Internode straight, 1st ca. 0.1 cm and 2nd suppressed.

First two leaves alternate, simple, exstipulate, petiolate; petiole 2.0-2.2 cm and 1.9-2.0 cm respectively; blade 2.2-2.3 x 1.5-1.6 cm and 2.3-2.4 x 1.5-1.6 cm respectively, ovate, acute to acuminate, cordate to lobed; primary vein 1, secondary veins alternate.

Subsequent leaves alternate, petiolate and other characters are same as that of first two leaves but sometimes variability in shape and other characters are also observed. [Plate 3, Fig.9]

Cucumis melo

Germination epigeal, phanerocotylar.

Taproot 5.0-5.8 cm long, moderately thick, creamy white, lateral roots profusely branched.

Hypocotyl straight, terete, light green, hairy, 2.8-3.6 cm long.

Paracotyledons 2, opposite, persistent upto 6-9 leafed stage, exstipulate, petiolate; petiole 0.2-0.25 cm long, blade 0.95-1.15 x 0.5-0.55 cm, elliptic, entire, retuse, base rounded, upper surface densely scabrous, margin hairy, primary vein 1, secondary vein alternate, midrib hairy.

Internode straight, ridged, prickly, 1st one very much reduced, 2nd one 0.2-0.25 cm long.

First two leaves alternate, simple, exstipulate, petiolate; petiole 2.2-2.4 cm and 3.0-3.2 cm long respectively, hairy, blade 1.7-1.8 x 1.9-2.1 cm and 2.3-2.5 x 2.5-2.6 cm respectively, very wide ovate, crenately dentate, acute, base lobed, surface hairy, primary 3-5 from base, secondary veins alternate.

Subsequent leaves alternate, exstipulate, petiolate and other characters are same as that of first two leaves except in size. [Plate 4, Fig.6]

Acalypha indica

Germination epigeal, phanerocotylar.

Taproot 4.5-5.0 cm, thin, grayish, lateral roots moderately branched.

Hypocotyle straight to straightly curved, terete, greenish-gray, 2.4-2.6 cm.

Paracotyledons 2, opposite, persistent upto 6-10 leafed stage, exstipulate, petiolate; petiole 0.2-0.25 cm, blade 0.55-0.6 x 0.35-0.4 cm, wide oblong, entire, rounded, base rounded, primary veins 3 nerved originated from base, secondary veins opposite.

Internode straight, greenish gray, 1st and 2nd internode 0.5-0.55 cm and 0.1-0.15 cm respectively.

First two leaves opposite, simple, exstipulate, petiolate; petiole 0.45-0.5 cm, blade 1.05-1.1 x 0.7-0.8 cm, wide obovate, shallowly serrate, acute, base obtuse, primary veins 3-nerved from base, secondary veins alternate.

Subsequent leaves alternate, petiolate, exstipulate and other characters are same as that of first two leaves except in size. [Plate 4, Fig.5]

Chrozophora rottleri

Germination epigeal, phanerocotylar.

Taproot 8.2-9.0 cm long, thin, white, lateral roots are profusely branched.

Hypocotyle straight, terete, lower creamy upper radish, 5.5-5.8 cm long.

Paracotyledons 2, opposite, entire, exstipulate, petiolate; petiole 0.7-0.8 cm, persistent upto 7-9 leafed stage, blade 1.2-1.3 x 0.5 cm, entire, elliptic to narrow elliptic, obtuse, base acute, primary vein 3 from base, secondary veins alternate.

Internode straight, terete, hairy, first internode ca. 0.4 cm, 2nd very much suppressed.

First two leaves alternate, simple, entire, hairy, petiolate; petiole of first leaf 2.0 cm, blade ca. 4.0 x 1.5 cm; petiole of 2nd leaf 1.7 cm, blade ca. 4.3 x 1.9 cm, lanceolate, acute, base obtuse, hairy on both sides, shallowly sinuate, primary veins 3 from base, secondary veins alternate.

Subsequent leaves alternate, ovate to wide ovate, obtuse, base obtuse and other characters are same as that of first two leaves except in size. [Plate 4, Fig. 18]

Croton bonplandianum

Germination epigeal, phanerocotylar.

Taproot 8.0-9.0 cm long, moderately thick, creamy white, lateral roots profusely branched.

Hypocotyle straightly curved, 2.8-3.6 cm long, brown, upper greenish.

Paracotyledons 2, persistent upto 5-8 leafed stage, opposite, exstipulate, petiolar; petiole with hairs, 0.6 cm long, blade fleshy, 1.5 x 0.55 cm, entire, linear-oblong, obtuse, base acute, primary veins 3 of which middle one thick extended, secondary veins inconspicuous.

Internode straight, green, hard, with dotted hairs, terete, 1st and 2nd internode are 1.0 cm and 1.1 cm respectively.

First two leaves alternate, simple, exstipulate, petiolar; petiole 1.2 cm, blade 2.0 x 1.5 and 2.0 x 1.9 cm respectively, serrate, ovate, acute, entire, dotted hairs on ventral side, yellowish green; primary vein 3-nerved from base, secondary veins alternate.

Subsequent leaves alternate, simple, exstipulate and other characters are same as that of first two leaves expect in size. [Plate 3, Fig. 25]

Euphorbia heyniana

Germination epigeal, phanerocotylar.

Taproot 2.1-2.7 cm long, thin, brownish, lateral roots profusely branched.

Hypocotyle straight to straightly curved, 0.5-0.7 cm, reddish.

Paracotyledons 2, opposite, persistent till branching, exstipulate; petiole ca. 0.1 cm, blade 0.2-0.25 x 0.1 cm, narrow ovate, lanceolate, entire, rounded, base rounded; primary and secondary veins are not distinct.

Internode 1st suppressed, 2nd 0.45-0.6 cm, terete, light reddish.

First two leaves opposite, simple, symmetric, stipulate, petiolate; stipule minute, setaceous; petiole ca. 0.1 cm, blade ca. 0.25 x 0.15 cm, narrow obovate, entire, rounded, base rounded, primary vein 1, secondary veins indistinct, first two leaves arranged at right angle with the paracotyledons; 2nd pair of leaves opposite, stipules indistinct, petiolate; petiole ca. 0.1 cm, blade ca. 0.35 x 0.2 cm, oblong, serrulate, round, base asymmetric, primary vein 1, secondary veins indistinct.

Subsequent leaves opposite, petiolate and other characters are same as that of 2nd pair of leaves except in size; branches arise from the cotyledonary node. [Plate 4, Fig. 8]

Euphorbia hirta

Germination epigeal, phanerocotylar.

Taproot 2.8-3.4 cm long, thin, grayish, lateral roots profusely branched.

Hypocotyle straight, terete, 0.6-0.7 cm, reddish.

Paracotyledons 2, opposite, persistent upto 10-14 leafed stage, exstipulate; petiolate; petiole ca. 0.05 cm, blade about 0.15 x 0.1 cm, wide elliptic, entire, obtuse, base obtuse to rounded, primary vein 1, secondary veins indistinct.

Internode straight, terete, gray, hairy; 1st internode suppressed, 2nd 1.6-1.7 cm long.

First two leaves opposite, simple, symmetric, arranged at right angle with the paracotyledons, stipulate, petiolate; stipule minute, subulate; petiole ca. 0.12 cm, blade ca.

0.3 x 0.22 cm, wide obovate, entire, rounded, primary vein 1, secondary veins indistinct; 2nd pair of leaves opposite, simple, exstipulate, petiolate, petiole about 0.1 cm, blade ca. 0.6 x 0.3 cm, elliptic oblong, serrate, acute, base asymmetric, hairy, primary vein 1, secondary veins indistinct.

Subsequent leaves opposite, oblong to narrow oblong, hairy and other characters are same as that of 2nd pair of leaves except in size. [Plate 3, Fig. 19; Plate 4, Fig. 1]

Euphorbia indica

Germination epigeal, phanerocotylar.

Taproot 3.5-4.1 cm long, moderately thick, grayish, lateral roots profusely branched.

Hypocotyle straight, terete, 0.6-0.8 cm, reddish-brown.

Paracotyledons 2, opposite, persistent upto 6-10 leafed stage, sometimes till maturity and flowering, stipulate; stipule minute, subulate; petiolate; petiole 0.05 cm, blade ca. 0.45 x 0.22 cm, symmetric, elliptic, entire, apex and base obtuse, primary vein 1, secondary veins indistinct.

Internode straight, terete, greenish gray, first internode suppressed, first two leaves arranged at right angle with the paracotyledons, second internode 1.4-1.8 cm.

First two leaves opposite, simple, stipulate, petiolate; stipule minute, subulate; petiole ca. 0.05 cm, blade ca. 0.6 x 0.35 cm, narrow obovate, entire, obtuse, base cuneate, primary vein 1, secondary veins opposite. 2nd pair of leaves opposite, simple, exstipulate, petiolate; petiole ca. 0.1 cm, blade ca. 0.9 x 0.4 cm, narrow oblong, serrate, acute, base asymmetric, primary vein 1, secondary veins alternate.

Subsequent leaves opposite and other characters are same as that of 2nd pair of leaves except in size. [Plate 3, Fig. 22]

Phyllanthus amarus

Germination epigeal, phanerocotylar.

Taproot 3.5-4.0 cm long, whitish gray. lateral roots are profusely branched.
Hypocotyle straight to straightly curved, 1.0-1.3 cm long, lower violate, upper grayish green.

Paracotyledons 2, opposite, persistent till branching, exstipulate, petiolate; petiole ca. 0.05 cm, blade ca. 0.45-0.15 cm, Lanceolate, obtuse, entire, base obtuse to rounded, lower violate, primary vein 1, secondary veins indistinct.

Internode straight, terete, 1st and 2nd internode 0.15 cm and 0.1 cm respectively.

First two leaves alternate, simple, stipulate, petiolate; stipule triangular - acuminate, ca. 0.01 cm long; petiole <0.05 cm both, blade ca. 0.5 x 0.2 cm and ca. 0.6 x 0.3 cm respectively, oblanceolate to narrow obovate, rounded, entire, base cuneate, primary vein 1, secondary veins opposite but not very distinct.

Subsequent leaves alternate, simple, exstipulate, petiolate, acuminate in branched leaves and other characters are same as that of first two leaves except in size; suppressed internode form a 5-6 leafed rosette like structure and branching arises after that stage. [Plate 3, Fig.24]

Phyllanthus fraternus

Germination epigeal, phanerocotylar.

Taproot ca 3.1-3.5 cm long, grayish white, lateral roots profusely branched.

Hypocotyle straight, 2.7-3.0 cm, greenish white.

Paracotyledons 2, opposite, persistent till branching, exstipulate, petiolate; petiole ca. 0.1 cm, blade 0.35 x 0.2 cm, ovate, obtuse, entire, base obtuse to rounded, primary vein 1, secondary veins alternate.

Internode straight, green, 1st and 2nd internode 1 cm and 0.25 cm respectively.

First two leaves alternate, simple, stipulate, petiolate; stipule minute, acuminate, petiole 0.1 cm both; blade 0.4 -0.45 x 1.5 cm and 0.6 x 0.3 cm respectively, oblanceolate to narrow obovate, rounded, entire, base cuneate, primary vein 1, secondary veins alternate

Subsequent leaves alternate, simple, exstipulate, petiolate and other characters are same as that of first two leaves except in size; branching arises from 2-3 leafed stage. [Plate 3, Fig.2]

Phyllanthus virgatus

Germination epigeal, phanerocotylar.

Taproot 7.5-8.7 cm long, brown, lateral roots profusely branched.

Hypocotyle straight, terete, 1.7-1.9 cm long, reddish green.

Paracotyledons 2, opposite, persistent upto 11-15 leafed stage, exstipulate, petiolate; petiole ca. 0.05 cm, blade ca. 0.7 x 0.15 cm, narrow oblong, entire, obtuse, base rounded, primary vein 1, secondary veins indistinct.

Internode straight, terete, reddish green, 1st and 2nd internode 5.0 cm and 2.0 cm respectively.

First two leaves alternate, simple, stipulate; stipule sagittate, reddish brown; petiolate; petiole 0.1 cm both, blade ca. 0.7 x 0.2 cm and 1.0 x 0.2 cm respectively, narrow oblong, acute, entire, base rounded, primary vein 1, secondary veins indistinct.

Subsequent leaves alternate, simple, exstipulate and other characters are same as that of first two leaves except in size. [Plate 4, Fig. 17]

Sebastiania chamaelea

Germination epigeal, phanerocotylar.

Taproot 5.2-8.3 cm long, whitish, moderately thick, lateral roots are scarcely branched.

Hypocotyle straight, terete, 4.5-6.5 cm long, greenish white.

Paracotyledons 2, persistent upto 10-14 leafed stage, sometimes till branching, exstipulate, sessile, blade 1.0-1.4 x 0.2-0.25 cm, lorate, entire, acute, base attached to the node, primary vein 1, secondary veins indistinct.

Internode straight, terete, 1st and 2nd internode 0.6-0.8 cm and 0.05-0.1 cm respectively.

First two leaves semialternate, simple, exstipulate, sessile, blade ca. 1.6-1.8 x 0.15-0.2 cm both, linear, entire, acute, base narrowed to the stem, primary vein 1, secondary veins indistinct.

Subsequent leaves are semialternate, sessile, simple and other characters are same as that of first two leaves except in size. [Plate 3, Fig.26]

Medicago lupulina

Germination epigeal, phanerocotylar.

Taproot 4.8-5.3 cm long, thin, creamy white, lateral roots are profusely branched.

Hypocotyle straight, terete, 0.5-0.7 cm long, reddish.

Paracotyledons 2, opposite, persistent upto 6-11 leafed stage, exstipulate, petiolate; petiole ca. 0.1 cm, blade 0.4-0.5 x 0.25- 0.28 cm, wide oblong, entire, obtuse, base obtuse; primary vein 1, secondary veins indistinct

Internode straight, terete, hairy, 1st and 2nd internode 0.2-0.3 cm and 0.1-0.15 cm long respectively.

First two leaves alternate, simple, stipulate, petiolate; stipule adnate, ca. 0.25 cm long; petiole 1.7-2.1 cm, hairy, blade 0.4-0.5 x 0.6-0.7 cm, lunate, dentate, mucronate, base obtuse to rounded, primary vein 1, secondary veins indistinct; 2nd leaf pinnately trifoliate, petiolate; petiole 2.5-2.7 cm long, hairy, stipule adnate, leaflets obovate, faintly incise-crenate, mucronate, base rounded, middle one 0.5-0.7 x 0.5-0.6 cm, lateral two 0.4-0.5 x 0.4-0.45 cm.

Subsequent leaves alternate and other characters are same as that of 2nd leaf except in size. [Plate 3, Fig.10]

Melilotus alba

Germination epigeal, phanerocotylar.

Taproot 8.0-11.3 cm long, brown, moderately thick, lateral roots are profusely branched.

Hypocotyle straight, terete, 2.0-2.4 cm long, lower white upper reddish.

Paracotyledons 2, persistent upto 6-8 leafed stage, exstipulate, petiolate; petiole 0.2-0.25 cm, blade 0.6-0.65 x 0.3 cm, narrow obovate, entire, obtuse, base obtuse to cuneate, flashy, veins indistinct.

Internode straight, terete, greenish, 1st and 2nd internode 1.7-2.1 cm and 1.6-1.7 cm respectively.

First two leaves alternate, stipulate; stipule adnate, ca. 0.2 cm long; 1st one simple, petiolate; petiole 1.2-1.4 cm, blade 0.9-1.0 x 1.1-1.4 cm, reniform, dentate, base rounded primary vein 1, secondary veins opposite; 2nd one pinnately trifoliolate, petiolate; petiole 1.3-1.4 cm; leaflet 0.6-0.7 x 0.5-0.6 cm, rounded, dentate, acuminate, base obtuse to rounded; petiolules 0.1-0.3 cm.

Subsequent leaves alternate, trifoliolate, petiolate, stipule adnate and other characters are same as that of 2nd leaf except in size. [Plate 4, Fig. 14]

Vicia angustifolia

Germination hypogeal, cryptocotylar.

Taproot 8.0-14.0 cm long, creamy white, lateral roots profusely branched.

Cotyledons 2, opposite, hard, dark brown, 0.4 x 0.35 cm.

Epicotyl straight to straightly curved, 0.8-1.2 cm long, light green.

Internode straight, green, first two nodes beard prophyll, 1st and 2nd internode 1.0-1.2 cm and 1.2-2.0 cm respectively; first two normal leaf bearing internodes 1.2-1.5 cm and 0.8-1.3 cm long respectively.

Prophyll 0.2-0.3 cm long, sessile, sobulate, entire, acuminate, green.

First two normal leaves alternate, peripinnate, rachis ending in a twisted tendril, stipulate, petiolate; stipule semi-sagittate, petiole 0.8-0.9 cm long in both; leaflets 2, subsessile, blade 2.0-2.15 x 0.2 cm, linear, entire, acute, base rounded, primary vein 1, secondary veins alternate.

Subsequent normal leaves alternate, leaflets 4-6 above and other characters are same as that of first two normal leaves except in size. [Plate 3, Fig. 8]

Vicia hirsuta

Germination hypogeal, cryptocotylar.

Taproot 6.0-10.0 cm long, thin creamy white, lateral roots profusely branched.

Cotyledons 2, opposite, hard, dark brown, 0.3 x 0.25 cm.

Epicotyle straight to straightly curved, 1.8-2.0 cm long, reddish.

Internode straight, reddish, first two nodes bear prophyll, 1st and 2nd internode 1.8-2.0 cm and 1.6-1.8 cm respectively; first two normal leaf bearing internodes 0.7-1.0 cm and 0.8-0.9 cm respectively.

Prophyll 0.15-0.2 cm long, sobulate, entire, acute, sessile, green.

First two normal leaves alternate, peripinnate, rachis ending in a twisted tendril, stipulate, petiolate; stipule semi-sagittate, petiole 0.6-0.7 cm long in both; leaflets 4, petiolulate; petiolule 0.04 cm long, blade lower 0.85 x 0.15 cm and upper 0.7 x 0.1 cm, linear, entire, mucronate, base obtuse-rounded, primary vein 1, secondary veins alternate.

Subsequent normal leaves alternate, leaflets 4-8 above and other characters are same as that of first two normal leaves except in size. [Plate 3, Fig. 7, 14]

Fumaria indica

Germination epigeal, phanerocotylar.

Taproot 6.0-7.3 cm long, creamy white, lateral roots are moderately branched.

Hypocotyle straight, terete, 3.4-4.1 cm long, reddish.

Paracotyledons 2, opposite, persistent upto 8-10 leafed stage, exstipulate, sessile, blade 2.8-3.5 x 0.18-0.2 cm, linear, entire, acute, base sheathing, primary vein 1, secondary veins 2, parallel to the primary one.

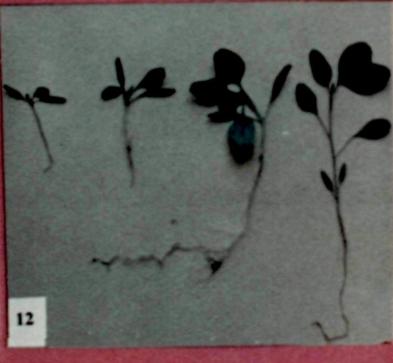
Internode straight with sheathing leaf bases, whitish green, 1st and 2nd internode 0.25-0.3 cm and ca. 0.1 cm long respectively.

PLATE - IV
(Seedling)

Figure

1. *Euphorbia hirta*
2. *Chenopodium album*
3. *Phyllanthus nudiflora*
4. *Blumea lacera*
5. *Acalypha indica*
6. *Cucumis melo*
7. *Parthenium hysterophorus*
8. *Euphorbia heyneana*
9. *Cleome viscosa*
10. *Cassia sophera*
11. *Ludwigia perennis*
12. *Amaranthus viridis*
13. *Solanum nigrum*
14. *Melilotus alba*
15. *Evolvulus nummularius*
16. *Xanthium indicum*
17. *Phyllanthus virgatus*
18. *Chrozophora rotteri*
19. *Rorippa indica*

PLATE - IV



First two leaves alternate, compound with narrow segments, exstipulate, petiolate; petiole 2.1-2.5 cm and 2.6-3.0 cm long respectively, leaf base sheathing, leaflets narrow, entire, acute, glabrous, reticulate, uncostate.

Subsequent leaves opposite and other characters are same as that of first two leaves except in size. [Plate 3, Fig.20]

Leonurus japonicus

Germination epigeal, phanerocotylar.

Taproot 4.2-5.0 cm long, thin, creamy white, lateral roots profusely branched.

Hypocotyle straight to straightly curved, terete, 1.0-1.25 cm long, reddish.

Paracotyledons 2, opposite, persistent upto 6-10 leafed stage, exstipulate, petiolate; petiole 0.65-0.8 cm long, hairy, blade 0.5-0.55 x 0.5-0.52 cm, orbiculate, entire, rounded, base lobed, primary vein 1, secondary veins alternate.

Internode straight reddish, hairy, 1st one 0.15-0.18 cm long, 2nd one suppressed.

First two leaves opposite, simple, exstipulate, petiolate; petiole 1.6-1.8 cm long, hairy, blade 1.6-1.7 x 1.4-1.5 cm, wide-ovate, serrate, rounded, base lobed, margin hairy, primary vein 1, secondary veins alternate.

Subsequent leaves opposite but suppressed internodes forms a rosette and other characters are same as that of first two leaves except in size. [Plate 3, Fig.13]

Leucas indica

Germination epigeal, phanerocotylar.

Taproot 3.8-4.3 cm long, thin, whitish brown, lateral roots are profusely branched.

Hypocotyle straight, terete, 2.7-3.0 cm long, greenish brown, hairy.

Paracotyledons 2, persistent upto 6-10 leafed stage, exstipulate, petiolate; petiole 0.4-0.5 cm long, blade 0.7-0.9 x 0.45-0.55 cm, wide elliptic, obtuse to emerginate, entire, base obtuse, primary vein 1, secondary veins indistinct.

Internode straight, terete, hairy, brownish green, 1st and 2nd internode 0.5-0.6 cm and 0.2-0.3 cm respectively.

First two leaves opposite, simple, exstipulate, petiolate; petiole ca. 0.3 cm, blade 1.5-1.6 x 0.5-0.6 cm, narrow elliptic, serrate, acute, base cuneate, primary vein 1, secondary veins alternate.

Subsequent leaves opposite, and other characters are same as that of first two leaves except in size. [Plate 3, Fig.5]

Ludwigia perennis

Germination epigeal, phanerocotylar.

Taproot 3.0-4.0 cm long, thin, white, lateral roots numerous and profusely branched.

Hypocotyle straight, fleshy, 0.7-1.0 cm long, light pink.

Paracotyledons two opposite, persistent upto 6-10 leafed stage, exstipulate, petiolate; petiole 0.25-0.3 cm; blade ca. 0.35 x 0.25 cm, sub orbiculate, entire, obtuse, base narrowed to petiole; primary vein 1, secondary veins indistinct.

First two leaves opposite, simple, exstipulate, petiolate; petiole 0.45-0.5 cm; blade 1.0-1.1 x 0.5-0.6 cm, glabrous, elliptic, entire, acute, base narrowed to petiole; primary vein 1, secondary veins alternate.

Subsequent leaves opposite, entire, petiolate and other characters are same as that of first two leaves expect in size. [Plate 4, Fig.11]

Biophytum sensitivum

Germination epigeal, phanerocotylar.

Taproot 1.3-1.5 cm long, brown, thin, lateral roots profusely branched.

Hypocotyle straight, terete, hairy, 0.9-1.4 cm long.

Paracotyledons 2, opposite, persistent upto 8-10 leafed stage, sometimes till maturity, exstipulate, petiolate; petiole ca. 0.1 cm; blade 0.25 x 0.15 cm, entire wide elliptic, obtuse, base rounded, primary veins 3, secondary veins indistinct.

Internode straight, very much reduced, ca. 0.1 cm hairy.

First two leaves opposite, compound, bifoliate, exstipulate, petiolate; petiole 0.15 -0.2 cm; leaflet rounded, 0.3 x 0.2 cm, bean shaped, rachis continued, primary vein 1, secondary alternate.

Subsequent leaves alternate on very suppressed internode, first 3 -4 leaves bifoliate, others compound peripinnate, number of leaflet 4 or more. [Plate 3, Fig.23]

Oxalis corniculata

Germination epigeal, phanerocotylar.

Taproot 2.7-3.0 cm long, thin, brown, lateral roots profusely branched.

Hypocotyle straight, terete, greenish brown, hairy, 0.6-0.8 cm long.

Paracotyledons 2, opposite, persistent upto 8-12 leafed stage, exstipulate, petiolate; petiole ca. 1.0 cm; blade 0.35 x 0.25 cm, wide elliptic, obtuse, entire, base obtuse; primary vein 1, secondary veins alternate.

Internode straight, very much reduced, <0.1 cm, greenish brown, hairy.

First two leaves opposite, compound, trifoliate, exstipulate, petiolate; petiole 0.8-0.85 cm, hairy; leaflet ca. 0.3 x 0.4 cm, emerginate, margins hairy, base acute; primary veins 3, secondary veins 2-4 not very distinct.

Subsequent leaves opposite and other characters are same as that of first two leaves except in size. [Plate 3, Fig.21]

Argemone mexicana

Germination epigeal, phanerocotylar.

Taproot 4.8-5.5 cm long, thin brown, lateral roots scarcely branched.

Hypocotyle straightly curved, 2.0-2.5 cm long, greenish white

Paracotyledons 2, opposite, persistent upto 6-8 leafed stage, exstipulate, sessile, blade 2.6 x 0.15 cm, entire, linear, attenuate, base sheathing the hypocotyle, primary veins indistinct.

Internode straight, 1st and 2nd internode much reduced ca. 0.1 cm

First two leaves alternate, simple, sessile, exstipulate, blade 2.0 x 0.55 cm and 2.0 x 0.5 cm respectively, oblanceolate, spiny, acute, base sheathing the internode; primary vein 1, secondary veins alternate.

Subsequent leaves alternate and other characters are same as that of first two leaves except in size. [Plate 3, Fig.12]

Anagallis arvensis

Germination epigeal, phanerocotylar.

Taproot 5.0-5.7 cm long, thin, creamy white, lateral roots are profusely branched.

Hypocotyle straight, terete, 1.4-1.7 cm long, lower white, upper light green.

Paracotyledons 2, opposite, persistent upto 8-14 leafed stage, sometimes till flowering, exstipulate, petiolate; petiole ca. 0.15 cm; blade 0.5-0.55 x 0.2-0.25 cm, elliptic, entire, acute, base narrowed to petiole; primary vein 1, secondary veins indistinct.

Internode straight, 1st and 2nd internode 0.7-0.8 cm and 1.0-1.1 cm long respectively.

First two leaves opposite, simple, sessile, exstipulate, blade 0.8-0.9 x 0.5 cm, narrow ovate, entire, obtuse, base cordate; primary vein 1, secondary veins indistinct.

Subsequent leaves opposite and other characters are same as that of first two leaves except in size. [Plate 3, Fig.6]

Scoparia dulcis

Germination epigeal, phanerocotylar.

Taproot 1.1-1.5 cm long, thin, creamy white, lateral roots profusely branched.

Paracotyledons 2, opposite, persistent upto 6-8 leafed stage, exstipulate, petiolate; petiole 0.06-0.08 cm long, blade 0.12-0.14 x 0.1 cm, wide ovate, entire, acute, rounded, primary vein 1, secondary veins indistinct.

Internode straight, 4-angled, reddish, 1st and 2nd internode 0.15-0.2 cm and 0.1 cm respectively.

First two leaves opposite, simple, exstipulate, petiolate; petiole 0.12-0.14 cm long, blade 0.18-0.2 x 0.12-0.14 cm, ovate, entire, distantly serrate, base attenuate, primary vein 1, secondary veins alternate.

Subsequent leaves opposite, exstipulate, ovate, distantly serrate to serrate and other characters are same as that of first two leaves except in size. [Plate 3, Fig.3]

Physalis minima

Germination epigeal, phanerocotylar.

Taproot 4.0-4.5 cm long, thin, creamy white, lateral roots profusely branched.

Hypocotyle straight, terete, 2.2-2.4 cm long, whitish green, hairy.

Paracotyledons 2, opposite, persistent upto 8-10 leafed stage, exstipulate, petiolate; petiole 0.4-0.45 cm long, hairy, blade 0.7-0.75 x 0.38-0.42 cm, narrow ovate, entire, acute, base rounded, hairy on midrib and lamina margin, primary vein 1, secondary veins opposite.

Internode straight, hairy, 1st and 2nd internode 0.2-0.25 cm and 0.3-0.35 cm long respectively.

First two leaves alternate, simple, exstipulate, petiolate; petiole 0.6-0.7 cm and 0.8-0.9 cm respectively, hairy, blade 0.9-1.1 x 0.75-0.8 cm, wide ovate, entire, obtuse, base obtuse to rounded, glabrous, margin hairy, primary vein 1, secondary veins lower opposite, upper alternate.

Subsequent leaves alternate, exstipulate, petiolate, ovate - narrow elliptic, distantly and shallowly serrate, acute, secondary veins alternate and other characters are same as that of first two leaves except in size. [Plate 3, Fig. 11, 17]

Solanum nigrum

Germination epigeal, phanerocotylar.

Taproot 8.5-9.3 cm long, creamy white, moderately thick, lateral roots are profusely branched.

Hypocotyle straight, hairy, terete, 1.8-2.0 cm long, whitish green.

Paracotyledons 2, opposite, fleshy, persistent upto 5-9 leafed stage, exstipulate, petiolate; petiole 0.4-0.5 cm; blade 0.8-0.85 x 0.4 cm, narrow ovate, entire, acute, base narrowed to petiole, Primary vein 1, secondary veins indistinct.

Internode straight, 1st and 2nd internode ca. 0.5 cm and 0.25 cm respectively.

First two leaves alternate, simple, glabrous, exstipulate, petiolate; petiole 0.7-0.8 cm; blade 1.0-1.2 x 0.7-0.8 cm and 1.55-1.6 x 1.2-1.3 cm respectively, ovate, entire, acute, base rounded; primary vein 1, secondary veins alternate.

Subsequent leaves alternate, petiolate and other characters are same as that of first two leaves except in size. [Plate 4, Fig. 13]

Phyla nodiflora

Germination epigeal, phanerocotylar.

Taproot 3.0-3.4 cm long, thin, brown, lateral roots moderately branched.

Hypocotyle straight, terete, 0.5-0.6 cm long, greenish.

Paracotyledons 2, opposite, persistent upto 6-8 leafed stage, exstipulate, petiolate; petiole 0.05 cm; blade ca. 0.2 x 0.15 cm, suborbiculate, obtuse, entire, base obtuse; primary vein 1, secondary veins indistinct.

Internode straight, terete, greenish, 1st and 2nd internode 0.5-0.6 cm and 0.7-0.8 cm respectively.

First two leaves opposite, simple, exstipulate, petiolate; petiole 0.25 cm; blade 0.45 x 0.25 cm, elliptic, acute, entire to serrate, base decurrent; primary vein 1, secondary veins indistinct.

Subsequent leaves opposite, serrate, narrow obovate and other characters are same as that of first two leaves except in size. [Plate 4, Fig.3]

6.3 RESULT AND DISCUSSION

It is evident from the key to the seedlings of these plants that they may be divided into two groups on the basis of first leaf character i.e. compound or reduced to prophyll or simple. The compound leaves are borne by 5 species viz. *Oxalis corniculata*, *Fumaria indica*, *Biophytum sensitivum*, *Cassia sophera* and *Cleome viscosa*. Again they are divided on the basis of leaflet characters. So, *Oxalis corniculata* can be identified by obcorded leaves; other seedlings with compound leaves again divided on the basis of paracotyledons and leaflet characters. *Fumaria indica* bears narrowly lanceolate paracotyledons and deeply dissected leaflets; opposite group is again divided on the basis of presence and absence of terminal leaflet. *Biophytum sensitivum* and *Cassia sophera* can be distinguished on the presence or absence of extended rachis, remaining one is *Cleome viscosa*, where there is a terminal rhomboid leaflet. Prophylls borne by *Vicia angustifolia* and *V. hirsuta* can be distinguished on the basis of leaflet number in subsequent leaves.

Another important group created in the key, where the first leaf simple but second and subsequent leaves are compounded as found in *Medicago lupulina* and *Melilotus alba* but they can be distinguished easily by the character of terminal leaflet.

In the third important group in the key, second and subsequent leaves are simple, and the group has been divided on the basis of internode characters. Internode between cotyledonary node and first leaf is suppressed found in 9 species. Among them only *Hewittia scandens* bears obcorded cotyledons. *Leonurus japonicus* and *Centella asiatica* bear reniform eophylls but can be distinguished on the basis of lamina base characters. Where eophylls are not reniform, different species can be distinguished by the presence or absence of stipule. Among 3 exstipulate species, *Argemone maxicana* is distinct with its spinous leaf margin where as *Rorippa indica* and *Cucumis melo* can be distinguished on the basis of venation pattern of first leaf. Among the stipulate species *Euphorbia heyneana* produces two or more branches after first leaf. Where as *Euphorbia hirta* and *E. indica* can be distinguished on the basis of woolly nature of stem, serration of leaf and position of the broadest part of the leaf-lamina.

Another major group of seedlings with simple leaves produce normal internode between cotyledonary node and the first leaf and can be further divided on the basis of phylotaxy of leaves (except cotyledons). Among 16 species with alternate leaf, lamina of *Parthenium hysterophorus* is deeply dissected. The other group (lamina not dissected) can be divided again on the basis of number of veins from the base of lamina. *Chrozophora rottleri* is borne 3 veins from base and other species can be subdivided on the basis of cotyledon and lamina characters. Cotyledons longer than the lamina of second leaf presents in *Digera muricata* where as opposite character bearing plants can be divided on the basis of cotyledon and lamina characters.

Phyllanthus fraternus and *P. amarus* though borne obovate-oblong cotyledon and lamina but development dwarf shoot took place after the production of first few leaves. The opposite characters is borne by *Phyllanthus virgatus* and *Croton bonplandianum* and they can be distinguished by the presence or absence of stellate hairs. The group with entire lamina of first few leaves is again divided on the basis of sessile or petiolate leaves. Leaves in *Sebastiania chamaelea* are sessile. Petiole bearing *Evolvulus numularius* bears zigzag stem where as erect stem bearing *Amaranthus viridis* possessed lamina with notched tips and *Celosia argentea* with acute tip. On the other hand lamina with serrate, dentate etc. bearing plant species can be categorised on the basis of minute cotyledons (in *Scoparia dulcis*) and cotyledons more than 0.2 cm long. The group with large cotyledon, again, shows variation in their lamina and paracotyledon characters. *Blumea lacera* bears broadly ovate lamina, where as seedlings with lamina other than ovate in shape can be subdivided on the basis of paracotyledons and the structure of the base of lamina. *Chenopodium album* produces narrowly lanceolate paracotyledons where as ovate paracotyledons are borne by *Physalis minima* and *Solanum nigrum*. While the former produces slightly cordate or rounded lamina base, the leaves of *Solanum nigrum* never produces a cordate lamina base.

The ten species which produce a pair of leaves (i.e. opposite phylotaxy) immediately after the cotyledons again have 6 species, where the margin of lamina is not entire. *Xanthium strumarium* bears more than 2.0 cm long lamina but others produce much smaller. Pinnately veined lamina bearing *Phyla nodiflora* has only 0.07 cm long paracotyledons. Paracotyledons in *Leucas indica* are 1.2 cm long and are pinnately veined. Seedlings with lamina 3-nerved from base can be divided on the basis of the length of hypocotyl. While *Acalypha indica* has hypocotyl over 2.0 cm long, *Ageratum conyzoides* and *A. houstonianum* has less than 1.5 cm long hypocotyl. While *A. conyzoides* has cuniate lamina, *A. houstonianum* has lamina with truncate base. On the other hand 5 species with entire or slightly irregularly undulating lamina are again divided on the basis of presence or absence of petiole. Leaves of *Anagallis arvensis* are sessile and among petiolate ones *Heliotropium indicum* have rugose lamina surface. Among the last three species *Alternanthera sessilis* has unequal paracotyledons but *Eclipta prostrata* and *Ludwigia perennis* have equal paracotyledons. Though they bear equal paracotyledons but the leaves in *Eclipta prostrata* are strigose above, but the leaves in *Ludwigia perennis* are glabrous.

So, we find, there is tremendous variation within the weed population of the district of Malda. And, this set of knowledge will be helpful in recognition of seedlings at their juvenile stage. It will also help the farmers to eradicate the weeds at their early stage when they are more dangerous.