

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Identification of some Dicot Weeds at Seedling Stage

Ajai Kumar Singh

Department of Botany, Udai Pratap College (Autonomous), Varanasi- 221 002, India

Manuscript Info	Abstract
<i>Manuscript History:</i> Received: 15 March 2015 Final Accepted: 18 April 2015 Published Online: May 2015	Comprehensive morphology of 15 common dicot weed seedlings have been recorded from winter season crop fields of Eastern Uttar Pradesh, India. The results showed that the germination is <i>Horsfieldia type</i> in <i>Lathyrus aphaca</i> and <i>Macaranga type</i> in the remaining weed seedlings. The relevant morphological attributes for distinction among reported weed seedling taxa
<i>Key words:</i> Weed, Seedling, Morphology, Identification	are seedling type, collet, paracotyledons, epicotyl and first leaf. Illustrations and key have been provided as an aid to the identification of weeds at seedling stage.
*Corresponding Author	
Ajai Kumar Singh	Copy Right, IJAR, 2015,. All rights reserved

INTRODUCTION

Identification of weeds at seedling stage is significant because it helps to choose suitable weed control measures before their establishment. Weed taxa vary in their response to weedicides, therefore it is important to select the correct weedicides to control a particular weed species and minimize environmental damage and wastage. Weed infestation is the major factor for lower agricultural production. Identification of weeds at seedling stage increases the weed control measures. This approach is also must because producing an adequate quantity of healthy food without polluting environment is a formidable challenge for agriculture in future. There are however, relatively few publications dealing with weed seedling identification (Kummer, 1951; Chancellor, 1959; Singh, 1963; Stucky, 1984; Singh and Singh, 1994; Anonymous, 2008; Singh and Sahu, 2010; Singh et al., 2011; Singh and Sahu, 2012 and Parkinson et al., 2013).

In the present study an attempt has been made to identify seedlings of dicot weeds listed in Table 1, common in winter season crop fields of Eastern Uttar Pradesh, India. Weed seedlings are described from morpho-taxonomic view point along with taxonomic key and illustrations to facilitate their identification.

1 Materials and Method

Seedlings of weeds (Table 1) have been collected from winter season crop fields of Eastern Uttar Pradesh (25⁰19⁻2612['] N & 82⁰05[']-83⁰58['] E), India during October, November, and December months of the year 2013. To ensure correct identification of seedling, seeds of all the reported weed species were also collected and grown next year in the green house after correct identification of mother plant with help of authentic literature. The different stages of development of each weed seedling were considered for preparing a complete description, out of ten individuals. All the reported specimens have been photographed and were documented in the form of herbarium sheets at different leaf stages, which have been deposited in the Herbarium, Department of Botany, Udai Pratap College (Autonomous), Varanasi, Uttar Pradesh, India. The gross morphological features of the seedlings were described following Burger (1972), Hickey (1973), Vogel (1980), Singh (2012) and Singh et al. (2014).

2 Results

2.1 Key to the seedlings:	
 Seedling hypogeal. Seedling epigeal. 	Lathyrus aphaca 2
2. Paracotyledons isocotylar	
2. Paracotyledons anisocotylar	
3. Epicotyl distinct	4
3. Epicotyl not distinct	9
4. First leaf two	5
4. First leaf one	
5. Paracotyledons acicular	Spergula falax
5. Paracotyledons oblong/orbicular/ovate	6
6. Epicotyl pubescent. Leaf blade base oblique	Euphorbia hirta
6. Epicotyl glabrous. Leaf blade base acute	7
7. Collet distinct. First leaf margins entire	Oldenlandia aspera
7. Collet not distinct. First leaf margins slightly serrate	Chenopodium album
8. Paracotyledons oblanceolate with distinct venation	Medicago polymorpha
8. Paracotyledons ovate without distinct venation	Melilotus indica
9. Paracotyledon blade linear with distinct venation	Argemone mexicana
9. Paracotyledon blade orbicular without distinct venation10. First leaf simple10. First leaf compound (trifoliate)	
 Paracotyledons ovate and pubescent Paracotyledons linear/lanceolate and glabrous 	Solanum nigrum 12
12. First leaf two	
12. First leaf one	
13. First leaf blade oblanceolate with hyphodromous venation	Alternanthera parenchioides
13. First leaf blade ovate with brochidodromous venation	Achyranthes aspera
14. Paracotyledons with hyphodromous venation	Digera muricata
14. Paracotyledons without distinct venation	Amaranthus viridis

2.2 Morphology of weed seedlings:

2.2.1. Achyranthes aspera L. (Amaranthaceae) (Figure 1A; Figure 2A)

Seedling epigeal; *Macaranga type*. Collet distinct, white, hairy and swollen. Hypocotyl pink-yellow, surface tuberculate, quadrangular in cross section. , 2.1 cm long at paracotyledon stage and 2.7 cm long at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, anisocotylar, foliaceous, exstipulate and petiolate. Petiole pink, glabrous, convexo-concave in cross section, 0.3 cm long. Blade lanceolate, base and apex acute, margins entire, adaxial surface dark green, abaxial surface pink, both surfaces glabrous. Venation hyphodromous. Epicotyl pink-green, pubescent, nearly terete in cross section, 6.0 cm long at 5th leaf stage. First leaves simple, two, opposite, exstipulate and petiolate. Petiole pink-green, pubescent, terete and channelled in cross section, 0.8 cm long. Blade ovate, base and apex acute, margins entire and pink, adaxial surface dark green, abaxial surface light green, both surfaces slightly hairy. Venation brochidodromous. Subsequent leaves same as that of first leaves except size.

2.2.2. Alternenthera parenchioides St. Hill. (Amaranthaceae) (Figure 1B; Figure 2B)

Seedling epigeal; *Macaranga type*. Collet distinct, white and glabrous. Hypocotyl pink, glabrous, terete in cross section, 0.5 cm long at paracotyledon stage and at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar,

anisocotylar, foliaceous, exstipulate and petiolate. Petiole pink, glabrous, convexo-concave in cross section, 0.2 cm long. Blade lanceolate, base attenuate, apex obtuse, margins entire and pink, adaxial surface dark green, abaxial surface light pink, both surfaces glabrous. Venation hyphodromus. Epicotyl distinct after 3rd leaf stage, light pink, slightly villose, terete in cross section, 0.7cm long at 5th leaf stage. First leaves two, simple, opposite, exstipulate and petiolate. Petiole same as paracotyledon petiole, 0.5 cm long. Blade oblanceolate, base attenuate, apex obtuse, margins entire, adaxial surface dark green, abaxial surface greyish green, both surfaces glabrous. Venation hyphodromous. Second and third leaves same as that of first leaves. Fourth and subsequent leaves villose. Other features same as that of first leaves except size.

2.2.3. Amaranthus viridis L. (Amaranthaceae) (Figure 1C; Figure 2C)

Seedling epigeal; *Macaranga type*. Collet distinct, white, hairy and slightly swollen. Hypocotyl pink, glabrous, terete in cross section, 1.2 cm long at paracotyledon stage and 1.5 cm long at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, anisocotylar, foliaceous, exstipulate and petiolate. Petiole pink, glabrous, convexo-concave in cross section, 0.3 cm long. Blade lanceolate, base attenuate, apex acute, margins entire, adaxial surface green, abaxial surface pink, both surfaces glabrous. Venation hyphodromous. Epicotyl light pink, sparsely hairy, terete in cross section, not distinct at first leaf stage, 2.0 cm long at 5th leaf stage. First leaf single, simple, exstipulate and petiolate. Petiole green-pink, sparsely hairy, convexo-concave in cross section, 0.8 cm long. Blade ovate, base cuneate, apex retuse, margins entire, both surfaces green and glabrous. Venation craspedodromous. Subsequent leaves same as that of first leaf except size and mucronate and retuse blade apex.

2.2.4. Argemone mexicana L. (Papaveraceae) (Figure 1D; Figure 2D)

Seedling epigeal; *Macaranga type*. Collet distinct, yellow-white, glabrous, slightly swollen. Hypocotyl light green, glabrous, terete in cross section, 0.7 cm long at paracotyledon stage, and at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, isocotylar, foliaceous, persistent up to 7th leaf stage, exstipulate and subsessile. Blade linear, base attenuate, apex acute, margins entire, both surfaces green and glabrous. Venation not distinct. Epicotyl not distinct. First leaf single, simple, exstipulate and petiolate. Petiole green, glabrous, slightly auriculate, plano-convex and winged in cross section, 0.6 cm long. Blade linear-oblanceolate, base attenuate, apex acute with mucro, margins lyrate and spiny, both surfaces green and glabrous. Venation eucraspedodromous. Subsequent leaves same as that of first leaf except size.

2.2.5. Chenopodium album L. (Chenopodiaceae) (Figure 1E; Figure 2E)

Seedling epigeal; *Macaranga type*. Collet not distinct. Hypocotyl purple/ purple-green, terete in cross section, 1.5 cm long at paracotyledon stage, and 2.2 cm long at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, isocotylar, foliaceous, persistent upto 6th leaf stage, exstipulate and petiolate. Petiole green/purple, glabrous, plano-convex in cross section, 0.3 cm long. Blade oblong, base attenuate, apex obtuse, margins entire, adaxial surface dark green, abaxial surface purple, both surfaces glabrous. Venation hyphodromous. Epicotyl purple, covered with powdery vesicles, terete in cross section, 2.6 cm long at 5th leaf stage. Internodes zig-zag after 4th leaf stage. First leaves two, opposite, simple, exstipulate and petiolate. Petiole purple-green, covered with powdery vesicles , terete and channeled in cross section, 0.8 cm long. Blade lanceolate, base acute, apex obtuse, margins slightly serrate, adaxial surface dark green, abaxial surface light green, both surfaces covered with powdery vesicles. Venation craspedodromous. Second and subsequent leaves same as that of first leaves but alternate.

2.2.6. Digera muricata (L.) Mart. (Amaranthaceae) (Figure 1F; Figure 2F)

Seedling epigeal; *Macaranga type*. Collet distinct, light pink, slightly swollen. Hypocotyl pink below and green above, scabrous, terete in cross section, 1.3 cm long at paracotyledon stage, and 1.9 cm long at 5^{th} leaf stage. Paracotyledons two, opposite, phanerocotylar, anisocotylar, foliaceous, persistent upto 5^{th} leaf stage, exstipulate and petiolate. Petiole pink-green, scabrous, plano-convex in cross section, 0.6 cm long. Blade linear, base attenuate, apex acute, margins entire, adaxial surface green, abaxial surface pink, both surfaces glabrous. Venation hyphodromous. Epicotyl green, scabrous, terete in cross section, 2.8 cm long at 5^{th} leaf stage. First leaf single, simple, exstipulate and petiolate. Petiole pink-green, scabrous or sparsly hairy, terete, channelled and winged in cross section, 0.7 cm long. Blade oval, base and apex acute, margins pink and entire, adaxial surface dark green, abaxial surface light green/pink, both surfaces glabrous. Venation craspedodromous. Second and subsequent leaves same as that of first leaf except size.

2.2.7. *Euphorbia hirta* L. (Euphorbiaceae) (Figure 1G; Figure 2G)

Seedling epigeal; *Macaranga type*. Collet distinct, white, glabrous. Hypocotyl pink, glabrous, terete in cross section, 0.5 cm long at paracotyledon stage and at at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar,

isocotylar, foliaceous, persistent upto 3rd leaf stage, exstipulate and petiolate. Petiole pink, glabrous, convexoconcave in cross section, 0.1 cm long. Blade oblong, base rounded, apex obtuse, margins entire, both surfaces green and glabrous. Venation not distinct. Epicotyl pink-green, pubescent, terete in cross section, 1.5 cm long at 5th leaf stage. First leaves two, opposite, simple, exstipulate and petiolate. Petiole light green, pubescent, convexoconcave in cross section, 0.1 cm long. Blade oval, base oblique, apex acute, margins serrate, both surfaces green and pubescent. Venation not distinct. Second leaves same as that of 1st leaves but blade margins serrate, both surfaces green and pubescent. Venation craspedodromous. Subsequent leaves same as that of second leaves except size.

2.2.8. Lathyrus aphaca L. (Fabaceae) (Figure 1H; Figure 2H)

Seedling hypogeal; *Horsfieldia type*. Collet and hypocotyl not distinct. Cotyledons two, opposite, secund, cryptocotylar, isocotylar, fleshy, persistent upto 6th leaf stage, exstipulate and sessile. Blade orbicular, base rounded, apex obtuse, margins entire, both surfaces light yellow and glabrous. Venation not distinct. Epicotyl white below, pink in the middle, and green above, appressed hairy below, and glabrous above, terete below and quadrangular above in cross section, 5.0 cm long at 5th leaf stage. First and second leaves prophyllous, simple, trilobed; each lobe linear, base broad, apex acute, margins entire, both surfaces green and glabrous, 0.2 cm long. Third leaf pinnately compound, peripinnate, alternate, stipulate and petiolate. Stipules lanceolate, base and apex acute, both surfaces green and glabrous, margins entire with one basal dentation on one side. Petiole green, glabrous, terete and channeled in cross section, 0.5 cm long. Leaflets simple and sessile. Blade lanceolate, base and apex acute, margins entire, both surfaces green and glabrous. Venation acrodromous. Stipules distinct after fourth leaf stage; ovate, base truncate and appendiculate, apex acute, margins entire, both surfaces green and glabrous. Venation campylodromous. Subsequent leaves same as that of third leaf except size.

2.2.9. Medicago polymorpha L. (Fabaceae) (Figure 1I; Figure 2I)

Seedling epigeal; *Macaranga type*. Collet distinct, white, glabrous. Hypocotyl white below and green above, glabrous, terete in cross section, 2.5 cm long at paracotyledon stage, and at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, isocotylar, foliaceous, persistent upto 6th leaf stage, exstipulate and petiolate. Petiole greygreen, glabrous, convexo-concave in cross section, 0.5 cm long. Blade oblanceolate, base attenute, apex obtuse, margins entire, both surfaces green and glabrous. Venation hyphodromous. Epicotyl light green, glabrous, terete in cross section, not distinct at 1st leaf stage, 1.5 cm long at 5th leaf stage. First leaf alternate, simple, stipulate and petiolate. Stipules linear, intrapetiolar, two, base truncate, apex acute, surface green and glabrous, 0.2 cm long. Petiole green, glabrous, terete and channeled in cross section, 2.8 cm long. Blade reniform, base cuneate, apex mucronate, margins entire in lower half but shallowly crenate in upper half, both surfaces green and glabrous. Venation craspedodromous. Second leaf compound, trifoliate, stipulate and petiolate. Stipules and petiole same as 1st leaf. Leaflets simple, petiolulate. Blade obovate, mean L/W 1.1, base cuneate, apex retuse, margins entire, other features same of 1st leaf. Subsequent leaves same as that of second leaf except size.

2.2.10. Melilotus indica (L.) All. (Fabaceae) (Figure 1J; Figure 2J).

Seedling epigeal; *Macaranga type*. Collet distinct, dirty white, glabrous, slightly swollen. Hypocotyl pink, glabrous, terete in cross section, 1.5 cm long at paracotyledon stage, and at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, isocotylar, foliaceous, persistent upto 4th leaf stage, exstipulate and petiolate. Petiole light pink, glabrous, convexo-concave in cross section, 0.2 cm long. Blade obovate-oblong, base acute, apex obtuse, margins entire, both surfaces green and glabrous. Venation not distinct. Epicotyl pink-green, glabrous, terete in cross section, 5.1 cm long at 5th leaf stage. First leaf alternate, simple, stipulate and petiolate. Stipules obliquely ovate, pink, base oblique, apex acute, margins entire, single nerved, glabrous, 0.4 cm long. Petiole green with pulvinate base and pink streaks, glabrous but sparsely hairy at tip, terete and channeled in cross section, 3.0 cm long. Blade reniform, base truncate-cineaste, apex mucronate, margins entire below, shallowly crenate above, both surfaces green and glabrous. Second and subsequent leaves compound, trifoliate, stipulate and petiolate. Stipules and petiolate same as 1st leaf. Leaflets simple, petiolulate. Central and lateral blades obovate, base cuneate. Other features same as that of 1st leaf except size.

2.2.11. Oldenlandia aspera DC. (Rubiaceae) (Figure 1K; Figure 2K)

Seedling epigeal; *Macaranga type*. Collet distinct, white, glabrous, slightly swollen. Hypocotyl light pink, glabrous, terete in cross section, 0.7 cm long at paracotyledon stage at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, isocotylar, foliaceous, persistent up to 3rd leaf stage, exstipulate and petiolate. Petiole light green, glabrous, convexo-concave in cross section, 0.1 cm long. Blade ovate, base attenuate, apex obtuse, margins entire, both surfaces green and glabrous. Venation not distinct. Epicotyl green, scabrous/glabrousent, quadrangular in cross

section, 5.1 cm long at 5th leaf stage. First leaves two, opposite, simple, stipulate and petiolate. Stipules green, deltoid, trilobed, base broad, apex acute, margins entire, glabrous, interpetiolar, 0.1cm long. Petiole light green, glabrouscent, plano-convex in cross section, 0.2 cm long. Blade elliptical, base attenuate, apex acute, margins entire, adaxial surface dark green, abaxial surface light green, both surfaces glabrous. Venation hyphodromous. Subsequent leaves same as that of first leaves except size.

2.2.12. Oxalis corniculata L. (Oxalidaceae) (Figure 1L; Figure 2L)

Seedling epigeal; *Macaranga type*. Collet distinct, light yellow-pink, hairy, slightly swollen. Hypocotyl pink, pubescent, terete in cross section, 0.6 cm long at paracotyledon stage, and at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, isocotylar, foliaceous, persistent upto 4th leaf stage, exstipulate and petiolate. Petiole pink, pubescent, convexo-concave in cross section, 0.2 cm long. Blade orbicular, base truncate, apex obtuse, margins entire and hairy, both surfaces pink-green and glabrous. Venation not distinct. Epicotyl not distinct. First leaf single, compound, trifoliate, exstipulate and petiolate. Petiole pink, pubescent, terete and channeled in cross section, 1.2 cm long. Leaflets simple, exstipulate and sessile. Blade obcordate, base cuneate, apex emarginate, margins entire, both surfaces green and glabrous. Venation hyphodromous. Subsequent leaves same as that of first leaf except size.

2.2.13. Parthenium hysterophorus L. (Asteraceae) (Figure 1M; Figure 2M)

Seedling epigeal; *Macaranga type*. Collet distinct, white, glabrous, slightly swollen. Hypocotyl grey-green, glabrous, terete in cross section, 0.8 cm long at paracotyledon stage, and 1.0 cm long at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, isocotylar, foliaceous, persistent upto 4th leaf stage, exstipulate and petiolate. Petiole white/grey, glabrous, convexo-concave in cross section, 0.3 cm long. Blade orbicular, base rounded, apex obtuse, margins entire, both surfaces green and glabrous. Venation not distinct. Epicotyl green, pubescent, terete in cross section, 1.1 cm long at 5th leaf stage. First leaf single, simple, exstipulate and petiolate. Petiole green, glabrous, convexo-concave in cross section, 0.7 cm long. Blade ovate, base attenuate, apex obtuse, margins entire, both surfaces green and pubescent. Venation craspedodromous. Second leaf elliptic, margins serrate, other features same as that of first leaf. Third and subsequent leaves except size and lyrate blade margins.

2.2.14. Solanum nigrum L. (Solanaceae) (Figure 1N; Figure 2N)

Seedling epigeal; *Macaranga type*. Collet distinct, light green, slightly swollen. Hypocotyl dark purple, villose, terete in cross section, 2.8 cm long at paracotyledon stage, and 3.1 cm long at 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, anisocotylar, foliaceous, persistent upto 6th leaf stage, exstipulate and petiolate. Petiole purple, villose, terete and channelled in cross section, 0.7 cm long. Blade ovate, base cuneate, apex acute, margins entire, adaxial surface dark green, abaxial surface green-purple, both surfaces pubescent. Venation hyphodromous. Epicotyl purple-green, villose, terete in cross section, 3.7 cm long at 5th leaf stage. First leaf single, simple, exstipulate and petiolate. Petiole green, glabrous, terete and channelled in cross section, 2.2 cm long. Blade ovate, base cuneate, apex acute, margins entire, adaxial surface dark green, abaxial surface dark green, both surfaces pubescent. Venation craspedodromous. Subsequent leaves same as that of 1st leaf except size

2.2.15. Spergula fallax L. (Fumariaceae) (Figure 1O; Figure 2O)

Seedling epigeal; *Macaranga type*. Collet distinct, white, glabrous. Hypocotyl green, glabrous, terete in cross section, 1.0 cm long at paracotyledon stage and at and 5th leaf stage. Paracotyledons two, opposite, phanerocotylar, isocotylar, foliaceous, long persistent, exstipulate and sessile. Blade acicular, base truncate, apex obtuse, margins entire, both surfaces glabrous. Venation not distinct. Epicotyl green, glabrous, terete in cross section, not much distinct at 1^{st} and 2^{nd} leaf stages, 2.6 cm long at 5^{th} leaf stage. First leaves two, opposite, simple, exstipulate and sessile. Blade acicular, base truncate, apex obtuse, margins entire, both surfaces glabrous. Venation not distinct. Subsequent leaves same as that of 1^{st} leaf except size.



Figure 1: Weed Seedlings and their parts. A. Achyranthes aspera; B. Alternenthera parenychioides; C. Amaranthus viridis; D. Argemone mexicana; E. Chenopodium album; F. Digera muricata; G. Euphorbia hirta; H. Lathyrus aphaca; I. Medicago polymorpha; J. Melilotus indica; K. Oldenlandia aspera; L. Oxalis corniculata; M. Parthenium hysterophorus; N. Solanum nigrum; O. Spergula fallax; Pct. Paracotyledon; Lf. First leaf.



Figure 2: Weed seedlings. A. Achyranthes aspera; B. Alternanthera parenychioides; C. Amaranthus viridis; D. Argemone mexicana; E. Chenopodium album; F. Digera muricata; G. Euphorbia hirta; H. Lathyrus aphaca; I. Medicago polymorpha; J. Melilotus indica; K. Oldenlandia aspera; L. Oxalis corniculata; M. Parthenium hysterophorus; N. Solanum nigrum; O. Spergula fallax.

Sr. No.	Species
1.	Achyranthes aspera L.
2.	Alternanthera parenchioides St. Hill.
3.	Amaranthus viridis L.
4.	Argemone mexicana L.
5.	Chenopodium album L.
6.	Digera muricata (L.) Mart.
7.	Euphorbia hirta L.
8.	Lathyrus aphaca L.
9.	Medicago polymorpha L.
10.	Melilotus indica (L.) All
11.	Oldenlandia aspera DC.
12.	Oxalis corniculata L.
13.	Parthenium hysterophorus L.
14.	Solanum nigrum L.
15.	Spergula fallax L.

Table 1: List of investigated weed species

3 Discussion

The seedling morphology of the investigated taxa exhibits some interesting diagonostic characters viz. seedling type, collet, shape and other morphological details of paracotyledons, epicotyl, phyllotaxy and shape of first leaves. Using these features the weed seedlings belonging to fifteen different genera can be distinguished from each other very easily.

It is remarkable to note that out of fifteen reported taxa, one taxon (*Lathyrus aphaca* L.) corresponds to the Horsfieldia type (Cotyledons remaining together within the testa and secund. The plumule is pushed free from the blocking testa by elongation of the cotyledonary petioles and develops into shoot before the cotyledons are shed, Figure 1H and Figure 2H) and remaining 14 to the Macaranga type (Cotyledons long persistent, leaf-like, free and spread in the air and have photosynthetic functions.) in the sense of Vogel (1980). In the Macaranga type, nine seedling taxa (Argemone mexicana, Chenopodium album, Euphorbia hirta, Medicago polymorpha, Melilotus indica, Oldenlandia aspera, Oxalis corniculata, Parthenium hysterophorus, and Spergula fallax) represent seedlings with isocotylar paracotyledons and remaining five (Achyranthes aspera, Alternanthera parenchioides, Amaranthus viridis, Digera muricata and Solanum nigrum) represent seedlings with anisocotylar paracotyledons. Among the nine seedlings with isocotylar paracotyledons, six are found to have distinct epicotyl (C. album, E. hirta, M. polymorpha, M. indica, O. aspera and S. fallax) and the remaining three (A. mexicana, O. corniculata and P. hysterophorus) are devoid of distinct epicotyl. Further, the six taxa with distinct epicotyl can be divided into two groups. One group with first leaf in pair (C. album, E. hirta, O. aspera, and S. fallax) and other with single first leaf (M. polymorpha and M. indica). The seedlings of M. polymorpha (Figure 1I; Figure 2I) and M. indica (Figure 1J; Figure 2J) can be distinguished from each other on the basis of shape and venation of paracotyledons. In the group of four taxa with first leaves in pair, S. fallax (Figure 10; Figure 20) appears to be isolated due to acicular paracotyledons whereas the remaining three have paracotyledons oblong/orbicular/ovate. Among these three, E. hirta (Figure 1G; Figure 2G) differs from other two taxa because of pubescent epicotyl and oblique base of first leaf. In O. aspera (Figure 1K; Figure 2K) collet was distinct and first leaf margins entire but in C. album (Figure 1E; Figure 2E) collet was not distinct and first leaf margins slightly serrate. The three taxa in which epicotyl was not distinct, can be further differentiated into two groups on the basis of shape and venation of paracotyledons. On the basis of linear paracotyledon blade with distinct venation the A. mexicana (Figure 1D; Figure 2D) is different from O. corniculata (Figure 1L, Figure 2L) and P. hysterophorus (Figure 1M; Figure 2M) and these two can be very easily recognized and differentiated from each other at first leaf stage by trifoliate compound leaf (O.corniculata, Figure 1L; Figure 2L) and simple leaf (P. hysterophorus, Figure 1M; Figure 2M).

In the second major group having seedlings with anisocotylar paracotyledons, the *S. nigrum* (Figure 1N; Figure 2N) can be isolated from the remaining four taxa due to pubescent and ovate paracotyledons. The remaining four taxa can be further grouped into two subgroups on the basis of phllotaxy. In *A. aspera* (Figure 1A; Figure 2A) and *A. parenchioides* (Figure 1B; Figure 2B) first leaves are in pair but they differ from each other in respect of shape and venation of leaves. The remaining two taxa *A. viridis* (Figure 1C; Figure 2C) and *D. muricata* (Figure 1F;

Figure 2F) are with single first leaf and can be distinguished from each other by the presence and absence of venation in paracotyledons.

4 Conclusion

The present study is an exploratory one, involving a limited number of weed taxa. From the results it is evident that characterization of weed seedlings from morpho-taxonomic view point can be exploited for their identification at seedling stage and in weed/crop management.

Acknowledgement

Thanks are due to Prof. N. D. Paria, Department of Botany, University of Calcutta, Kolkata, West Bengal, India, for encouragement and moral support.

References

Anonymous, (2008). Weed Seedling Identification Guide. Manitoba Agricultural Sustainability Initiative, Canada, pp. 25.

Burger, Hzn D. (1972): Seedlings of some tropical trees and shrubs mainly of South East Asia. Agricultural Publishing and Documentation (PUDOC), Wageningen, pp. 399.

Chancellor, R.J. (1959): Identification of seedlings of common weeds. Bulletin No. 179. Ministry of Agriculture, Fisheries and Food, London, UK.

Hickey, L.J. (1973): Classification of the architecture of dicotyledonous leaves. Amer. J. Bot., 60: 17-33.

Kummer, A.P. (1951): Weed Seedlings. University of Chicago Press, Chicago, pp. 306. Parkinson, H., Mangold, J. and Manalled, F. (2013): Weed Seedling Identification Guide for Montana and the Northern Great Plains. Montana State University Extension, pp. 160.

Singh, A.K. (2012): Seedling morphology of certain species of *Ocimum* L. (Lamiaceae) and their taxonomic significance. Bangladesh J. Plant Taxon., 19 (1): 89-92.

Singh, A.K. and Sahu, R.K. (2010): On the morphology of some medicinal weed seedlings of Uttar Pradesh. India. Indian J. Trop. Biodiv, 18(1): 59-66.

Singh, A.K. and Sahu, R.K. (2012): Seedling morphology of some rainy season weeds of Varanasi district. J. Econ Taxon. Bot., 36(1): 16-23.

Singh, A.K., Sahu, R.K., and Singh, S. (2011): Seedling morphology of a medicinal and aromatic weed-*Ocimum americanum* L. Journal of Non-Timber Forest Products, 18(1): 35-38.

Singh, A.K., Sahu, R.K. and Singh, S. (2014). Morpho-taxonomic studies on *Andrographis paniculat* (Burm. f.) Wall. ex Nees seedling – A medicinal plant. Indian Forester, 140(11): 1056-1060.

Singh, P.K. and Singh, S.K. (1994): On the identification of seeds and seedlings of poaceous crop weeds of Gorakhpur Division. Journal of Living World, 1(2): 180-183.

Singh, V.P. (1963): Seedling morphology of few weeds of U.P. Indian Journal of Forestry, 10 (2): 62-66. Stucky, J.M. (1984): Comparison of Two Methods of Identifying Weed Seedlings. Weed Science, 32: 598-602.

Vogel, E.T.de (1980): Seedlings of dicotyledons. Agricultural Publishing and Documentation (PUDOC), Wageningen, pp. 471.