

## Seed Morphology of Ten Common Aquatic Weeds of Transplanted Rice

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**ABSTRACT** Seed is one of the most important organs of weeds for persistence in the crop field. The importance of seed morphology is increasing along with the increasing interest on plant quarantine and soil seed bank. Seed morphology of ten most common weeds of transplanted rice viz., *Aeschynomene indica*, *Cyperus iria*, *Echinochloa crusgalli*, *Ludwigia linifolia*, *Monochoria vaginalis*, *Oryza rufipogon*, *Paspalum scrobiculatum*, *Sacciolepis interrupta*, *Scirpus juncoides* and *Scirpus maritimus* have been studied under 100 to 200 times magnification and measured with the help of software BIOPLSS-22 and ocular scale. Seed length of all the species, except *O. rufipogon* was less than 4 mm. Test weight (1000 seed weight) of the species, varied from 0.08 g (*S. interrupta*) to 10.00 g (*A. indica*). Presence of raphe in naked seeds of *Z. linifolia* separated the species from other species. Very prominent hilum was noticed only in *A. indica* and *S. maritimus*. The present findings on seed morphology were contribution for taxonomic operations of the weed flora and also were helpful in identifying seeds for plant quarantine activities, weed seed bank determination as well as for seed certification programmes.

**Key words:** Seed morphology, aquatic weed, crop-weed contamination, plant quarantine

Seed is one of the most important organs of weeds for persistence in the crop fields. The crop seed contamination by the competitive weeds is the easiest means of association between crops and weeds. The accumulation of dormant seeds in the soil is another way of appearance of many cropland weeds in the field year after year. Seed, therefore is not only an unit to produce new generation of plants, but also an efficient device of dispersal, multiplication as well as to escape from the common weed management practices.

In biology, study of weeds, generally a little weightage is given to the seeds. But, the importance of seed morphology is increasing along with the increasing interest on plant quarantine and soil seed bank. Moreover seed morphology, being a "stable" character, bears tremendous significance in taxonomic operations.

Transplanted rice in Asia, cultivated in lowland to medium lowland situations, was found to be associated with certain weed species. Seed morphology of some of such most common weed species was studied with an aim to depict the structural details with the possible variations, so that, such characters can help in easy identification of the species.

### MATERIALS AND METHODS

Seeds of ten most common and dominant aquatic weed species of transplanted rice have been taken into account for the present study. The weed species were viz., *Aeschynomene indica*, *Cyperus iria*, *Echinochloa crusgalli*, *Ludwigia linifolia*, *Monochoria vaginalis*, *Oryza rufipogon*, *Paspalum scrobiculatum*, *Sacciolepis interrupta*, *Scirpus juncoides* and *Scirpus maritimus*. Seed morphology was studied under 100

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to 200 times magnification. The image of each seed was transferred to the PC with the help of CCD camera. For each character, observation was recorded from nearly 20 seeds collected from different individuals of the same species. Measurements were recorded in the PC with the help of the software BIOPLSS-22 and were compared with the data recorded with the help of ocular scale. The mean data was presented along with the standard deviation to show the range of variation. As many as 13 morphological characters have finally been selected for taxonomic characterization. The achenes of Cyperaceae and grains or caryopsis of Poaceae members have also been referred as seed in this work to reduce the confusion.

## RESULTS AND DISCUSSION

### *Aeschynomene indica* L.

Seeds triangular to trapezoid or sometimes to reniform in lateral view and ellipsoidal in view from hilum side; size  $2.24 (\pm 0.24) \times 1.25 (\pm 0.19) \times 0.74 (\pm 0.11)$  mm; blackish in colour after maturity. Wall smooth, aril and raphe absent. Hilum ellipsoidal, blackish in colour, with a ring of  $0.60 (\pm 0.05) \times 0.35 (\pm 0.03)$  mm around hole of  $0.45 (\pm 0.05) \times 0.23 (\pm 0.05)$  mm. Funicle persistent, brownish in colour,  $0.21 (\pm 0.07)$  mm in length. The special feature of the species is its tomentose seed surface. Thousand seed weight 10.00g. (Fig. 1: 1).

### *Cyperus iria* L.

Seeds triangular in view from hilum side and ovoid in lateral view;  $1.64 (\pm 0.13) \times 0.90 (\pm 0.12) \times 0.43 (\pm 0.11)$  mm in size, reddish black to brown in colour after maturity. Wall smooth, seed surface having three prominent ridges, aril and raphe absent. Hilum indistinct, funicle absent. Thousand seed weight 1.58 g. (Fig. 2: 5a&b).

### *Echinochloa crusgalli* (L.) P. Beauv.

Seeds triangular in view from hilum side and ovoid to ellipsoidal in lateral view:  $2.67 (\pm 0.13) \times 1.27 (\pm 0.14) \times 0.84 (\pm 0.09)$  mm in size, yellowish brown in colour after maturity. Wall smooth, glossy, aril and raphe absent. Hilum indistinct, funicle absent. Thousand seed weight 1.40 g. (Fig. 2: 8a&b).

### *Ludwigia linifolia* (Vahl) Rolla Rao

The species have two kinds of seeds in the same fruit. Upper seeds are naked and seeds of lower part of the fruit are endocarp coated. Both naked and encoated seeds of this species have been studied.

#### *Naked seed*

Seeds spherical in view from hilum side and ellipsoidal in lateral view;  $0.60 (\pm 0.04) \times 0.39 (\pm 0.05) \times 0.28 (\pm 0.04)$  mm in size, light brown after maturity. Wall smooth, seed surface black striped, aril absent and raphe ridged, brown in colour and as long as the seed  $0.46 \pm 0.02 \times 0.06 \pm 0.03$  mm. Hilum indistinct, funicle persistent or caducous and very short [ $0.21 (\pm 0.05)$  mm in length]. Thousand seed weight 0.09 g. (Fig. 1: 4a-c).

#### *Encoated seed*

Seeds pentangular,  $0.84 (\pm 0.09) \times 0.85 (\pm 0.06) \times 0.30 (\pm 0.08)$  mm in size, brown in colour after maturity. Coating surface rough, ridged and furrowed; aril, raphe, hilum and funicle indistinct. Thousand seed weight 0.30 g. (Fig. 1: 4d).

### *Monochoria vaginalis* (Burm.f.) Presl.

Seeds spherical in view from hilum side and ellipsoidal in lateral view;  $0.77 (\pm 0.04) \times 0.44 (\pm 0.04) \times 0.18 (\pm 0.03)$  mm in size, dark brown in colour after maturity. Wall glossy, ridged and furrowed, aril and raphe absent. Hilum indistinct, funicle persistent,  $0.17 (\pm 0.03)$  mm in length. The special feature of the species was the laterally furrowed seed surface. Thousand seed weight 0.24 g. (Fig. 1: 2a&b).

### *Oryza rufipogon* Griff.

Seeds spherical in view from hilum side and fusiform from lateral side;  $5.3 (\pm 0.41) \times 1.91 (\pm 0.22) \times 0.99 (\pm 0.17)$  mm in size, radish brown in colour after maturity. Wall smooth or ridged and furrowed, aril and raphe absent. Hilum indistinct, funicle absent. Thousand seed weight 5.14 g. (Fig. 2: 9).

### *Paspalum scrobiculatum* L.

Seeds ellipsoidal in view from hilum side and

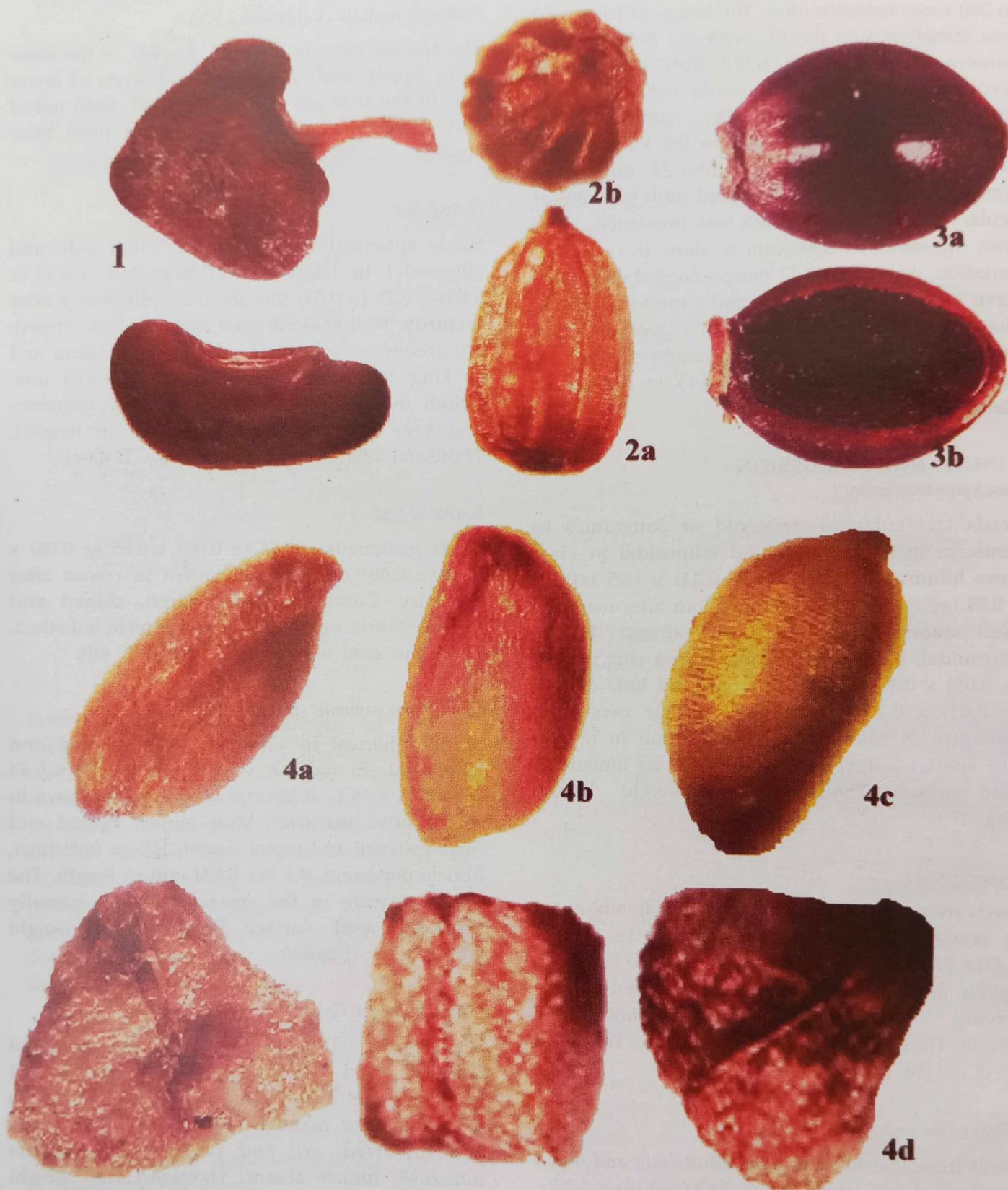
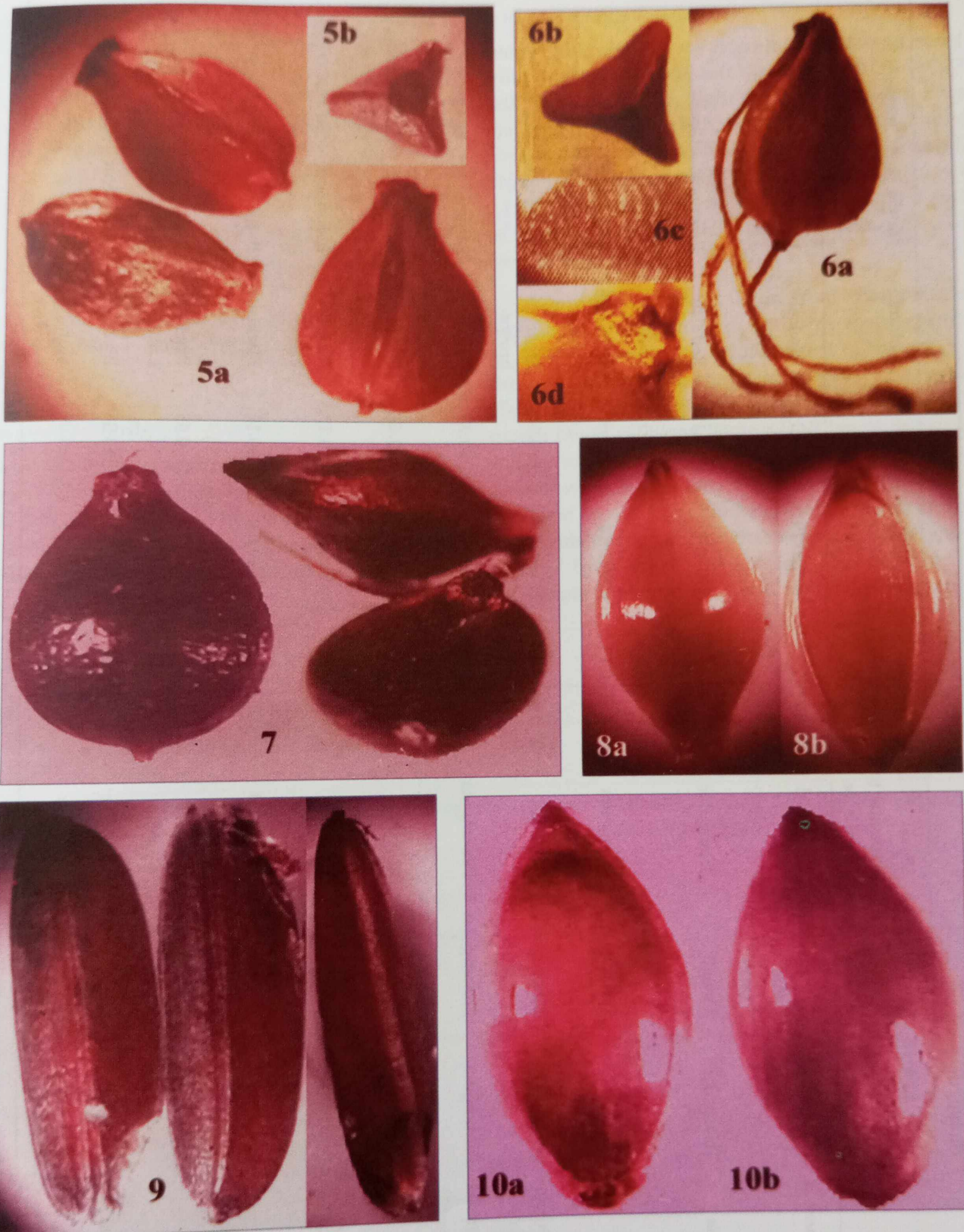


Fig. 1.: 1. *Aeschynomene indica* L. (seeds with and without funicle); 2. *Monochoria vaginalis* (Burm.f.) Presl. (a: lateral view; b: the hilum); 3. *Paspalum scrobiculatum* L. (a: lemma side; b: palea side); 4. *Ludwigia linifolia* (Vahl) Rolla Rao (a: named seed lateral view; C; naed seed - view opposite to hilum side; d: endocarp coated seeds from different angles)



Figs. 5-10. *Cyperus iria* L. (a: lateral view; b: the glume); 6. *Scirpus maritimus* L. (a: lateral view; b: view from hilum side; c: surface reticulation; d: the hilum); 7. *Scirpus juncooides* Roxb. (view from different angles); 8. *Echinochloa crusgalli* (L.) P. Beauv. (a: palea side; b: lemma side); 9. *Oryz rufipogon* Griff. (view from different angle); 10. *Sacciolepis interrupta* (Willd.) Stapf. (a: lemma side; b: palea side)

Table 1a. Shape, size, colour, nipple and integument characters of the seeds of weed species

Species	Shape/outline		Size (mm)				Nipple	Integument	
	View from hilum side	Lateral view	View opposite to hilum side	Length	Breadth	Width			Colour
<i>Aeschynomene indica</i>	Ellipsoidal	Triangular to trapezoid or reniform	Ellipsoidal	2.24±0.24	1.25±0.19	0.74±0.11	Blackish	Indistinct	Smooth
<i>Cyperus iria</i>	Triangular	Ovoid	Triangular	1.64±0.13	0.90±0.12	0.43±0.11	Reddish black to Brown	Emergent	Smooth
<i>Echinochloa crusgalli</i>	Triangular	Ovoid	Triangular	2.67±0.13	1.27±0.14	0.84±0.09	Yellowish brown	Prominent	Smooth, Glossy
<i>Ludwigia limifolia</i> (Naked seed)	Spherical	Ellipsoidal	Spherical	0.60±0.04	0.39±0.05	0.28±0.04	Light brown	Prominent	Rough
<i>Ludwigia limifolia</i> (Encoated seed)	Pentangular	Pentangular	Pentangular	0.84±0.09	0.58±0.06	0.30±0.08	Brown	Absent	Rough
<i>Monochoria vaginalis</i>	Spherical	Ellipsoidal	Spherical	0.77±0.04	0.44±0.04	0.18±0.03	Dark brown	Indistinct	Glossy, Ridged & Furrowed
<i>Oryza rufipogon</i>	Spherical	Fusifiform	Spherical	5.30±0.41	1.91±0.22	0.99±0.17	Reddish brown	Indistinct	Smooth, ridged & furrowed
<i>Paspalum scrobiculatum</i>	Ellipsoidal	Ovoid	Ellipsoidal	2.39±0.16	1.75±0.09	0.97±0.11	Blackish	Indistinct	Rough, glossy
<i>Sacciolepis interrupta</i>	Spherical	Fusifiform	Spherical	2.08±0.06	0.98±0.07	0.44±0.05	Blackish brown	Emergent	Smooth
<i>Scirpus juncooides</i>	Triangular	Ovoid	Triangular	1.86±0.04	0.94±0.25	0.25±0.04	Black	Prominent	Glossy, rough
<i>Scirpus maritimus</i>	Triangular	Ovoid	Triangular	1.54±0.11	0.94±0.08	0.33±0.09	Light brown	Elongate	Smooth, glossy

ovoid from lateral side;  $2.39 (\pm 0.16) \times 1.75 (\pm 0.09) \times 0.97 (\pm 0.11)$  mm in size, blackish in colour after maturity. Wall rough on palea side while smooth and glossy on lemma side, aril and raphe absent. Hilum indistinct, funicle absent. Thousand seed weight 1.33 g. (Fig. 1: 3a&b).

*Sacciolepis interrupta* (Willd.) Stapf.

Seeds spherical in view from hilum side and fusiform from lateral side;  $2.08 (\pm 0.06) \times 0.99 (\pm 0.07) \times 0.44 (\pm 0.05)$  mm in size, blackish in colour after maturity. Wall smooth, aril and raphe absent. Thousand seed weight 0.08 g. (Fig. 2: 10a&b).

*Scirpus juncooides* Roxb.

Seeds triangular in view from hilum side and ovoid in lateral view;  $1.86 (\pm 0.04) \times 0.94 (\pm 0.25) \times 0.25 (\pm 0.04)$  mm in size, blackish in colour after maturity. Wall smooth, glossy, aril and raphe absent. Hilum indistinct, funicle absent. Thousand seed weight 0.45 g. (Fig. 2: 7).

*Scirpus maritimus* L.

Seeds triangular in view from hilum side and ovoid from lateral side;  $1.54 (\pm 0.11) \times 0.94 (\pm 0.08) \times 0.33 (\pm 0.09)$  mm in size, light brown in colour after maturity. Wall smooth, glossy, aril and raphe absent. Hilum rhomboid to square shaped, brownish in colour, with a ring of  $0.19 (\pm 0.04) \times 0.15 (\pm 0.02)$  mm and hole of  $0.13 (\pm 0.01) \times 0.11 (\pm 0.02)$  mm size; funicle absent. Thousand seed weight 0.35 g. (Fig. 2: 6a-c).

A wide range of variation from triangular to trapezoid or sometimes to reniform was recorded in *Aeschynomene indica*, while in rest of the species these variations in shape was not remarkable (Table 1a). Seeds of all the species were very small except *Oryza rufipogon* having seed length between 4 mm to 6 mm, while the seeds of rest of the species were of less than 4 mm in length. Presence of raphe in *Ludwigia linifolia* (naked seed) is the distinguishing character that separated this weed species from rest nine species. Hilum with its prominent hole and ring was found to be distinct

**Table 1b. Depression and hilum characters of the seeds of weed species**

Species	Depression		Hilum					
	Kind	Shape	Position	Shape	Ring diameter	Hole diameter	Ring colour	Hole colour
<i>Aeschynomene indica</i>	Sub-apical	Rounded	Central	Ellipsoidal	$0.60 \pm 0.04$ (L) $0.35 \pm 0.03$ (B)	$0.45 \pm 0.05$ (L) $0.23 \pm 0.05$ (B)	Blackish to brownish	Blackish
<i>Cyperus iria</i>	Absent	Absent	Inconspicuous					
<i>Echinochloa crusgalli</i>	Sub-apical	Rounded	Inconspicuous					
<i>Ludwigia linifolia</i> (Naked seed)	Absent	Absent	Inconspicuous					
<i>Ludwigia linifolia</i> (Encoated seed)	Absent	Absent	Inconspicuous					
<i>Monochoria vaginalis</i>	Apical or sub apical	Rounded	Inconspicuous					
<i>Oryza rufipogon</i>	Absent	Absent	Inconspicuous					
<i>Paspalum scrobiculatum</i>	Apical	Rounded	Inconspicuous					
<i>Sacciolepis interrupta</i>	Absent	Absent	Inconspicuous					
<i>Scirpus juncooides</i>	Apical	Rounded	Inconspicuous					
<i>Scirpus maritimus</i>	Absent	Absent	Basal	Rhomboid to square	$0.19 \pm 0.04$ (L) $0.15 \pm 0.02$ (B)	$0.13 \pm 0.01$ (L) $0.11 \pm 0.02$ (B)	Brownish	Whitish

Table 1c. Wall reticulation and funicle characters of the seeds of weed species

Species	Wall reticulation							Funicle
	Types	Pattern	Fields	Wall type	Wall thickness	Wall shape	Wall height	
<i>Aeschynomene indica</i>	Primary & secondary	Irregular	Closed	Double	Thick	Inconspicuous	Inconspicuous	Persistent
<i>Cyperus iria</i>	Inconspicuous							Absent
<i>Echinochloa crusgalli</i>	Inconspicuous		Absent					
<i>Ludwigia linifolia</i> (Naked seed)	Primary & secondary	Inconspicuous	Closed	Inconspicuous	Thick	Inconspicuous	Inconspicuous	Absent
<i>Ludwigia linifolia</i> (Encoated seed)	Primary & secondary	Inconspicuous	Closed	Inconspicuous	Thick	Inconspicuous	Inconspicuous	Absent
<i>Monochoria vaginalis</i>	Primary	Irregular	Open	Single	Thin	Straight	Bold	Present
<i>Oryza rufipogon</i>	Primary	Regular	Open	Double	Thin	Straight	Inconspicuous	Absent
<i>Paspalum scrobiculatum</i>	Primary	Regular	Open	Single	Thin	Straight	Inconspicuous	Absent
<i>Sacciolepis interrupta</i>	Primary	Inconspicuous	Open	Inconspicuous	Thin	Straight	Line	Absent
<i>Scirpus juncooides</i>	Primary	Regular	Open	Single	Thin	Straight	Line	Absent
<i>Scirpus maritimus</i>	Primary	Irregular	Open	Single	Thin	Inconspicuous	Inconspicuous	Absent

in only two species viz., *Aeschynomene indica* and *Scirpus niaritinnts* (Table 1b). Presence of hilum distinguished *Scirpus maritimus* from *S. juncooides* where hilum was indistinct. They can also be distinguished on the basis of colour differences and wall type of the seeds. Only two species exhibited persistent funicle that is *Aeschynomene indica* and *Monochoria vaginalis*, while in naked seeds of *Ludwigia linifolia* sometimes semi persistent funicle having length of  $0.21 \pm 0.05$  mm was also observed (Table 1c). A little bit depression was also observed in *Aeschynomene indica*, *Echinochloa crusgalli*, *Monochoria vaginalis*, *Paspalum scrobiculatum* and *Scirpus juncooides*. The position of such depressions was apical or sub-apical and shape was shallowly rounded (Table 1b). In other species the depression was very indistinct or absent. The test weight of the species varied from 0.08g (*Sacciolepis interrupta*) to 10.00 g (*Aeschynomene indica*).

Out of ten most commonly associated weed species of transplanted rice, six were highly competitive weeds. Their seeds were usually found

to spread, as contaminant of crop seeds. The seeds of sedges viz. *Cyperus iria*, *Scirpus juncooides* and *S. maritimus*, however, found to contaminate the rice seeds occasionally, more particularly the semi dwarf varieties cultivated as autumn and winter crop. The seeds of *Monochoria vaginalis* usually did not contaminate the rice seeds but was a major component of soil seed bank of low land and medium low land paddy fields, along with all other studied weed species.

The present findings on seed morphology were contribution, for taxonomic operations of the weed flora and also were helpful in identifying seeds for plant quarantine activities, weed seed bank determination as well as for seed certification programmes.

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