



SEM study of some allied species of *Cyperus* L. from Khandesh region of Maharashtra, India

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ABSTRACT

The nut morphology of 08 allied species of *Cyperus* L. from Khandesh region of Maharashtra was examined under LM and SEM. The nuts exomorphic characters that is diagnostic at species level are, nut shape, size, dimensions, colour and nuts surface sculpture in different species. SEM studies at high magnification show different types of surface patterns like papillate, reticulate, with different anticlinal and periclinal walls. The nut exomorphic characters from LM and SEM investigation facilitate the construction of an artificial key for the allied species of *Cyperus* L.

Keywords: *Cyperus* L., LM, SEM, Allied species, Nut surface

INTRODUCTION

The family Cyperaceae has received relatively meagre attention due to its economic insignificance, small inconspicuous flowers with complicated morphology and difficulties in their identification. Among other different characters, the morphology of fruit or nut be safely relied on as diagnostic for the identification of different genera and species. Various attributes of nuts includes size, shape, colour, particularly surface patterns. Different genera of sedges can be identified in most cases with the help of these features.

The typical fruit is one of the distinguishing features of the family Cyperaceae. It develops from a bi or tricarpeal, syncarpous, unilocular ovary with one basal ovule. The pericarp of this one-seeded fruit is free from the testa. The caryopsis of the closed allied family Poaceae differs from it in having the fruit-wall and nut-coat inseparably fused together.

The Cyperaceous fruit should be designated as "achene" in preference to the usually employed term "nut". The latter connotes stony texture of the fruit-wall, where as in most species of the Cyperaceae the pericarp is scarcely hard. Achene, *sensu stricto*, should denote a simple fruit developed out of a

single carpel (Jackson, 1928). But as Eames (1961) points out, "No morphological line separates an achene from "nut". The term "achene" has already been employed by some authors (Lowrence, 1951; Esau, 1953) without reference to the number of carpels. It is, therefore, preferred to "nut" on account of its more comprehensive characters.

The genus *Cyperus* L. is dominant in family Cyperaceae with over 550 species in the world. It is well represented in India by near about 100 species whereas in Khandesh (41-*Cyperus*). Hence the present genus is selected for the study. Most of the species prefer moist situations such as banks of rivers, streams, margins of ponds, wet fields etc.

MATERIALS AND METHODS

Review of literature shows that, Heywood (1971), Khan T. A. and Chaudhari G.S. (2015), Brisson and Pterson (1977) drew attention to the importance and impact of Scanning Electron Microscope in the study of systematic problems. Recently the application of LM and SEM in the study of seed coat has become widespread. (Trivedi *et al.*, 1979, 1980; Blatter 1943; Murthy and Sanjappa, 2002; Mohamed *et al.*, 2004; Jaime *et al.*, 2004; Reza shaikh Akbari and Dina Azizian, 2006; Wadoodkhan M.A. 2015). Similarly, Murthy and Sanjappa (2002) studied the seed surface characters of approximately 51 species of *Indigofera* and made a key to delimit the taxa. Hence during present work attempt is being made to study the macro and micro-morphological features of nut using Light and Scanning electron microscopy.

MATERIALS AND METHODS

Nuts of 8 species of *Cyperus* L. were collected from the field of Khandesh region. The collected species were identified with the help of Dr. M. A Wadood Khan and by the matching with herbarium specimens of Botanical Survey of India, Pune- Maharashtra, India. Only mature and dry nuts were taken for investigation. Dry nuts were cleaned, and examined under light microscope to observe the different exomorphic parameters viz., shape, dimensions, colour and nut surface texture. Five nuts of each species were taken to cover the range of variations.

For SEM investigation, dry nuts were mounted on metal stubs and examined using Philips XL 30 ESEM with EDAX at the Sophisticated Instrumentation Center for Applied Research and Testing (SICART), Vallabh Vidyanagar, Gujarat, India. The whole surface of each nut was examined under the SEM and photographs were taken at two magnifications: lower magnification to show whole nut and higher magnification to show fine surface details. The terms used for describing the nut coat patterns have been adopted according to Stearn (1966).

Nut morphology (LM and SEM):

Cyperus alulatus Kern.

Nut trigonous, obovoid, 1.5-1.8 mm long, shining dark brown, mucronate at apex. SEM studies indicate that the nut surface pattern is reticulate-minutely papillate. The anticlinal walls are narrow. The periclinal walls are shallow depressed with minute central papillae or tubercles.

Cyperus iria L.

Nut triquetrous, obovoid, as long as the glumes, broadly stipitate, 1-1.5 x 0.5-0.8 mm, minutely apiculate at apex, shining dark brown to gray black. SEM studies indicate that the nut surface pattern is reticulate, reticulum more prominent at lower and upper side of nut, surface reticulate, anticlinal and periclinal wall not prominent. Tangential walls have convex portion raised at their center with smooth prominent papillae/tubercles.

Cyperus rotundus L.

Nuts trigonous, oblong-obovoid to, ellipsoid, 1.3-1.5 x 0.4-0.7 mm, apiculate, brown. SEM observation indicate that the nut surface pattern is reticulate with prominent anticlinal and periclinal wall, and having raised smooth prominent papillae/ tubercles at center.

Cyperus esculentus L.

Nuts trigonous, obovoid to oblong-obovoid, obtuse at apex, hardly apiculate 1.2-1.5 x 0.8-1 mm, grayish-black. SEM studies reveal that the nut surface pattern is reticulate with regular polygonal surface. The radial walls are the most prominent feature of nut coat surface. The tangential walls have no papillae at their centre (colliculate).

Cyperus squarrosus L.

Nuts trigonous, narrowly oblong or oblong-obovate, 0.7-1 x 0.2-0.4 mm, smooth or obscurely dotted, dark

grayish-brown. SEM observation show that the nut surface pattern is reticulate with more or less prominent radial wall. papillae smooth and not much raised.

***Cyperus maderaspatanus* Willd.**

Nuts trigonous, narrowly oblong, slightly curved, 0.8-1.3 x 0.2-0.3 mm, punctulate, apiculate, reddish-brown. SEM observation indicate that the nut surface pattern is reticulate with centrally placed raised papillae. Papillae show interconnection from adjacent by prominent narrow line.

***Cyperus pumilus* L.**

Nuts biconvex, narrowly obovoid, upto 0.5 mm long, laterally compressed, not exposed from the glumes, brownish, punctulate with isodiametrical epidermal cells, truncate apex, apiculate. SEM observation indicate that the nut surface pattern is reticulate with distinct polygonal cells. Each is distantly arranged from its adjacent cells anticlinal and periclinal wall prominent deeply depressed. Central portion is raised with smooth prominent papillae which are more or less interconnected.

Table 1: Morphological characters of nut surface studied as revealed by LM and SEM

Sr. No.	Species	Shape	Colour	Seed surface	Dimensions in mm
1.	<i>Cyperus alulatus</i>	Obovoid	Shining dark brown	Reticulate-minutely papillate	1.5-1.8 x cm ca 1 mm
2.	<i>Cyperus iria</i>	Obovoid	Shining dark brown to gray black	Reticulum more prominent at lower and upper side of nut, with smooth prominent papillae.	1-1.5 x 0.5-0.8 mm
3.	<i>Cyperus rotundus</i>	Obovoid-ellipsoid	Brown	Reticulate with prominent anticlinal and periclinal wall, and having raised smooth prominent papillae.	1.3-1.5 x 0.4-0.7 mm
4.	<i>Cyperus esculentus</i>	Obovoid to oblong-obovoid	Grayish-black	Reticulate with regular polygonal surface, no papillae at their centre (colliculate)	1.2-1.5 x 0.8-1 mm
5.	<i>Cyperus squarrosus</i>	Narrowly oblong	Dark grayish-brown	Reticulate with more or less prominent radial wall. papillae smooth and not much raised.	0.7-1 x 0.2-0.4 mm
6.	<i>Cyperus maderaspatanus</i>	Narrowly cylindrical oblong	Reddish-brown	Reticulate with centrally placed raised papillae. Papillae show interconnection from adjacent by faint narrow line.	0.8-1.3 x 0.2-0.3 mm
7.	<i>Cyperus pumilus</i>	Narrowly obovoid	Brownish	Reticulate with distinct polygonal cells, smooth prominent papillae which are more or less interconnected.	0.5-0.6 x 0.3-0.4 mm
8.	<i>Cyperus punctatus</i>	Oblong- ovate, or obovoid	Brownish-black	Reticulate with distinct polygonal cells. Each cell is distantly arranged from its adjacent cell, anticlinal and periclinal wall prominent with smooth prominent papillae which are interconnected by narrow lines	0.8-0.9 x 0.4-0.5 mm

Cyperus punctatus Roxb.

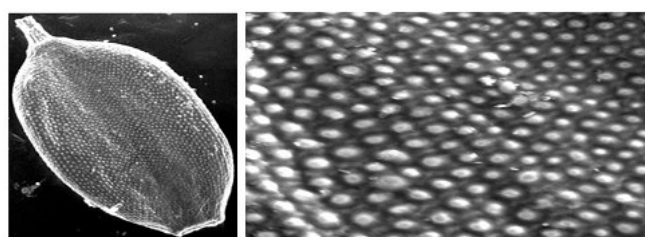
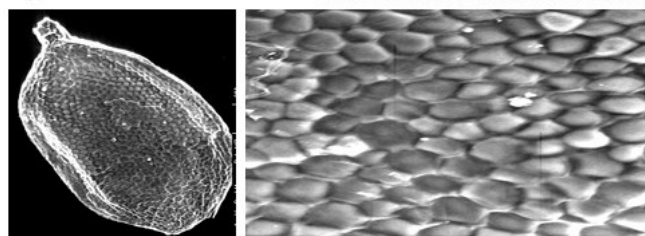
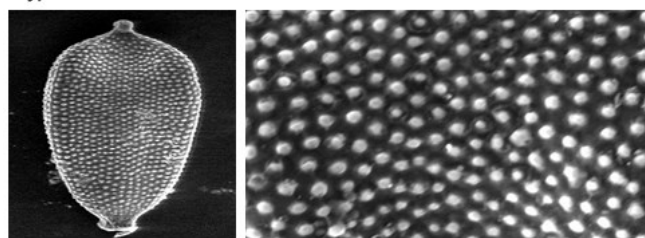
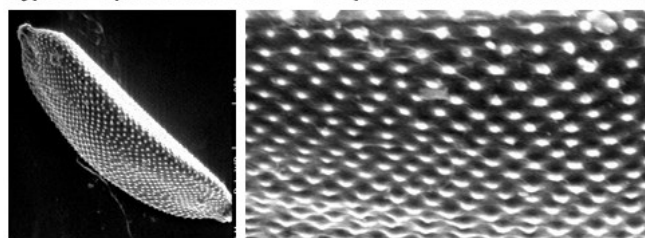
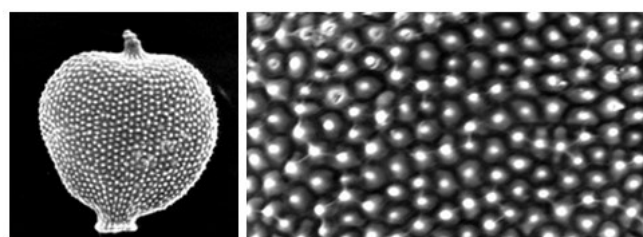
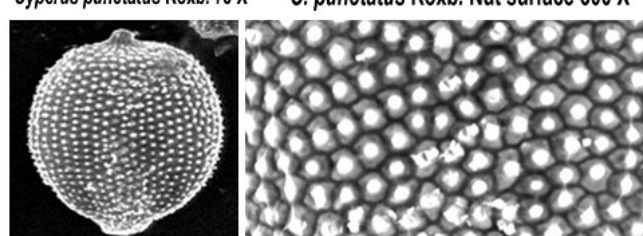
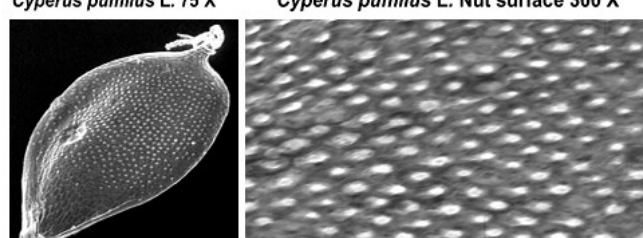
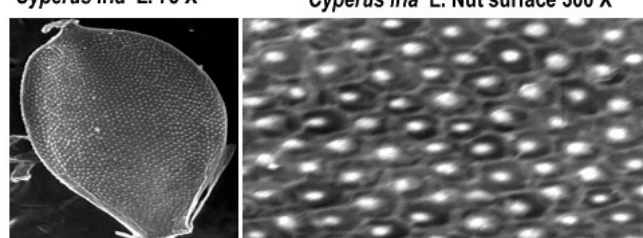
Nut elliptic, oblong- ovate, or obovoid, 0.8-0.9 x 0.4-0.5 mm, brownish-black, densely granulate, shining, usually rounded at apex, minutely apiculate. SEM studies reveal indicated that the nut surface pattern is reticulate with distinct polygonal cells. Each cell is distantly arranged from its adjacent cell anticlinal and periclinal wall prominent. Central portion is raised with smooth prominent papillae which are interconnected by narrow lines.

RESULTS AND DISCUSSION

Cyperus L. is one of the dominant genera in family Cyperaceae it is easily distinguishable from other by its various morphological features, there is intricacy regarding the treatment of species like, *Cyperus*

esculentus L., *Cyperus rotundus* L., *Cyperus squarrosus* L., *Cyperus maderaspatanus* Willd., *Cyperus punctatus* Roxb., *Cyperus pumilus* L., *Cyperus iria* L. and *Cyperus alulatus* Kern. The floral structure resembles with each other hence many people are misidentify at species level. LM and SEM studies is a reliable tool in elucidating taxonomic confirmation of species.

The *Cyperus esculentus* L. and *Cyperus rotundus* L. are closely related species in SEM studies very outstanding differences. The nut surface of *Cyperus esculentus* L. as well as *Cyperus rotundus* L. is of reticulate type however the presence of prominent small smooth papillae in the center of *Cyperus rotundus* L. make it distinct than *Cyperus esculentus* L. (Plate-I) where the papillae or tubercles are absent and instead, the radial and tangential walls are much prominent forming the colliculate surface.

*Cyperus esculentus* L. 75 X*C. esculentus* L. Nut surface 300 X*Cyperus rotundus* L. 75 X*C. rotundus* L. Nut surface 300 X*Cyperus squarrosus* L. 75 X*C. squarrosus* L. Nut surface 300 X*C. maderaspatanus* Willd. 75 X*C. maderaspatanus* Willd. Nut Surface 300X**Plate I***Cyperus punctatus* Roxb. 75 X*C. punctatus* Roxb. Nut surface 300 X*Cyperus pumilus* L. 75 X*Cyperus pumilus* L. Nut surface 300 X*Cyperus iria* L. 75 X*Cyperus iria* L. Nut surface 300 X*Cyperus alulatus* Kern 75 X*Cyperus alulatus* Kern Nut Surface 300X**Plate II**

There is controversy regarding the treatment of *Cyperus squarrosus* L. and *Cyperus maderaspatanus* Willd. However, the SEM study of their nut surface show similarities as well as differences. Both species have reticulate nut surface with more or less prominent radial wall and smooth centrally placed papillae but *Cyperus maderaspatanus* Willd. differs from *Cyperus squarrosus* L. in having interconnection between adjacent papillae which is marked by faint narrow line as shown in (Plate-I). *Cyperus punctatus* Roxb. resembles *Cyperus pumilus* L. but can be identified by its SEM study of nut surface patterns. *Cyperus punctatus* Roxb. nut shows the reticulate with distinct polygonal cells. Each cell is distantly arranged from its adjacent cell, anticlinal and periclinal wall prominent with smooth prominent papillae than the *Cyperus pumilus* L.

Similarly SEM studies of nut surface reveal significant differences in 2 species of *Cyperus*, viz. *Cyperus iria* L. and *Cyperus alulatus* Kern where although the both nuts have reticulate surface while papillae there are different which can be observed only under SEM (Plate-II). In *Cyperus iria* L. reticulum are more prominent at lower and upper side of nut, anticlinal and periclinal walls not prominent, papillae are minute, centrally placed and not smooth. In *Cyperus alulatus* Kern the anticlinal walls are narrow, periclinal walls are shallow depressed but prominent while papillae are minute smooth and centrally placed.

Thus, the surface pattern revealed by SEM can help in delimiting the taxa. On the basis of the information cited above it can be said that nut morphology along with nut surface pattern is the conservative trait and can be of great value in taxonomic delimitations and in hybridization as a genetic and species marker. The present investigation also reaffirms the significance of LM and SEM studies as a reliable tool in elucidating taxonomic and phylogenetic relationships.

CONCLUSION

Light and scanning electron microscopy reveals that nut surface pattern varies in the allied species of *Cyperus* L. hence LM and SEM study helps to identify the allied species of *Cyperus* L.

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