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THE SEED ATLAS OF PAKISTAN-I. AIZOACEAE

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Abstract

Seed morphology of 8 species distributed in 7 genera, belonging to the family Aizoaceae, was examined using light and scanning electron microscopy (SEM). Seed morphology was found useful to strengthen the generic and specific delimitation of the family Aizoaceae. The present paper shall be a part of "Seed atlas of Pakistan" which may be ultimately used by the agriculturist, in seed bank and conservation studies.

Introduction

The family Aizoaceae comprises 127 genera and 1860 species distributed in tropics and sub-tropics of S. Africa and rarely in Australia (Mabberley, 1997). In Pakistan it is represented by 9 species included in 8 genera viz., *Aizoon* L., *Corbichonia* Scop., *Gisekia* L., *Mesembryanthemum* L., *Limeum* L., *Sesuvium* L., *Trianthema* L. and *Zaleya* Burm. f. (Nasir, 1973).

The seed morphology has played an important role in the taxonomy of the family Aizoaceae. Hartmann (1993), Dequan & Hartmann (2004) and Vivrette *et al.*, (2004) studied the seeds of the family Aizoaceae and emphasized the importance of shape, size and surface pattern. Similarly, Hassan *et al*., (2005) also studied the seeds of 26 species for this family and found that the seed shape and surface pattern were diagnostic characters for generic as well as specific delimitation. In the present report the taxa of the family Aizoaceae were studied for their seed morphology to design a Seed Atlas of Pakistan.

Materials and Methods

Mature seeds of 8 species belonging to 7 genera of the family Aizoaceae were collected from herbarium specimen (Appendix I) and seed morphological characters were examined under light microscope (Nikon Type 102) and scanning electron microscope (JSM-6380A). For scanning electron microscopy dry seeds were directly mounted on metallic stubs using double adhesive tape and coated with gold for a period of 6 minutes in a sputtering chamber and observed under SEM. The terminology is used in accordance to Bergreen (1981) and Stearn (1983) with slight modifications. The following characters of seed were studied: Presence or absence of aril, colour, shape, size, surface (testa), position of hilum and presence or absence of strophiole on hilum (Table 1).

General seed characters of the family Aizoaceae

Seeds with or without aril, reniform, retortiform, elliptic pyriform or transversely cuneate, colour varies from cream, dark brown-black, shiny or unshiny, 0.6-2x0.4-2 mm, surface psilate or non-psilate, ribbed or non-ribbed, rugose, reticulate or areolate, or ridged, hilum sub basal or central-sub central, strophiolate or non-strophiolate.

Appendix I. List of voucher specimens.

Taxa	Collector, number & herbarium.
Aizoon canariense	*M. Qaiser et al*., 802,770 (KUH); *Tahir Ali* 795 (KUH)*; Sultan-ul-Abedin & Abrar Hussain* 6218,6238(KUH); *S.I. Ali et al*., 1142 (KUH); *M. Ahmed* s.n. (KUH).
Corbichonia decumbens	*S.I. Ali et al*., 200,511 (KUH)*; M. Qaiser & A. Ghafoor* 3952 (KUH); *Abrar Hussain* s.n. (KUH); *Sultan-ul-Abedin* 5207 (KUH).
Gisekia pharnaceoides	*M. Qaiser et al*., 3662,549 (KUH); *S.I. Ali et al*., 731(KUH); *S.M. Zaidi* 101 (KUH); *Sultan-ul-Abedin* 5154 (KUH); *M. Qaiser* 2590 (KUH).
Limeum indicum	*Razia Ahmad* 83 (KUH)*; M. Qaiser et al*., 702, 630 (KUH)*; S.I. Ali et al*., 1430 (KUH)*; S.M. Jafri* 1073 (KUH)*; Ahmad Ali* s.n. (KUH).
Sesuvium sesuvioides	*A.Ghafoor & S. Omer* 1614 (KUH); *S.M. Jafri* 3782 (KUH); *S.I. Ali et al*., 240 (KUH); *J.R. Kazmi* s.n. (KUH).
Trianthema portulacastrum	*S.A. Farooqi and M. Qaiser* 2984 (KUH); *Mushtaq Hussain* s.n. (KUH*)*; *Sultan-ul-Abedin* 8266,3996 (KUH); *A. Qureshi* s.n. (KUH).
T. triquetra	*S.M.Jafri* 3781,1542 (KUH)*; M. Tasnif* s.n. (KUH); *M. Qaiser et al*., 3889 (KUH); *Sultan-ul-Abedin* 3966, 5601 (KUH); *M. Qaiser & A. Ghafoor* 4192 (KUH).
Zaleya pentandra	*M.Qaiser* 245 (KUH); *Sultan-ul-Abedin* 355 (KUH); *S.M. Jafri* 847 (KUH); *S.A. Farooqi & M. Qaiser* 2184 (KUH).

Key to the genera

1. \+ Seeds transversely cuneate ……..…….…… *Trianthema*
   \- Seeds reniform, retortiform, or elliptic pyriform ...…..……..…… 2

2. \+ Seed surface psilate ……..…….…… 3
   \- Seed surface other than psilate …..…… 4

3. \+ Seeds elliptic pyriform, black, hilum sub-basal, strophiolate …… *Gisekia*
   \- Seeds reniform, cream, hilum central, non-strophiolate ……....…….... *Limeum*

4. \+ Seeds ribbed, dark brown-black ……..……..……... 5
   \- Seeds non-ribbed, ridged or rugose, black ……..……..…… 6

5. \+ Seeds retortiform with compactly arranged many ribs, strophiolate ……...
   ……. *Corbichonia*
   \- Seeds reniform with loosely arranged 8-10 ribs, non-strophiolate ……..… *Aizoon*

6. \+ Seeds areolate, rugose ……..……...……. *Zaleya*
   \- Seeds non areolate, with transverse and longitudinal ridges ...……...… *Sesuvium*

***Aizoon* L.**

It is represented by a single species viz., *A. canariense* L. Seeds without aril, reniform, dark brown and shiny, 0.6-0.7x0.4-0.6 mm, surface with concentric loosely arranged 8-10 ribs with longitudinal slight ridges, hilum sub central, non-strophiolate (Table 1; Fig. 1A-B).

***Corbichonia* Scop.**

It is represented by a single species viz., *C. decumbens* (Forsk.) Exell. Seeds without aril, retortiform, black and shiny, 0.9-1.25x0.6-1 mm, surface with concentric compactly arranged many ribs with porous surface, hilum sub central, strophiolate (Table 1; Fig. 1C-D).

***Gisekia* L.**

It is represented by a single species viz., *G. pharnaceoides* L. Seeds without aril, elliptic pyriform, black and shiny, 1.1-1.2x0.9-1 mm, psilate surface with slight punctation at hilum, hilum sub basal, strophiolate (Table 1; Fig. 1E-F).

***Limeum* L.**

It is represented by a single species viz., *L. indicum* Stocks. Seeds without aril, reniform, cream and shiny, 1.8-2x1-1.15 mm, psilate surface, dorsally convex and ventrally hollow, hilum central, non-strophiolate (Table 1; Fig. 2A-B).

***Sesuvium* L.**

It comprises a single species viz., *S. sesuvioides* (Fenzl.) Verdc. Seeds with aril, elliptic pyriform, black and shiny 0.8-0.95x0.7-0.8 mm, transversely and longitudinally ridged, slightly depressed centrally, hilum sub central, non-strophiolate (Table 1; Fig. 2C-D).

***Trianthema* L.**

It is represented by two species viz., *T. portulacastrum* L., and *T. triquetra* Rottl. & Willd. Seeds with or without aril, transversely cuneate, black , 0.8-1.7x0.8-2 mm, rugose or ribbed, reticulate-areolate, hilum sub-central, strophiolate or non-strophiolate (Table 1; Figs. 2E-F, 3A-B).

Key to the species of *Trianthema*

1. \+ Seeds ribbed and reticulate ..... *T. triquetra*
   \- Seeds non-ribbed, rugose and areolate ..... *T. portulacastrum*

***Zaleya* Burm. f.**

It comprises a single species viz., *Z. pentandra* (Linn.) Jeffrey. Seeds without aril, elliptic pyriform, black, 1.6-1.8x1.5-1.6 mm, surface rugose, areolate, hilum sub central, non-strophiolate (Table 1; Fig. 3C-D).

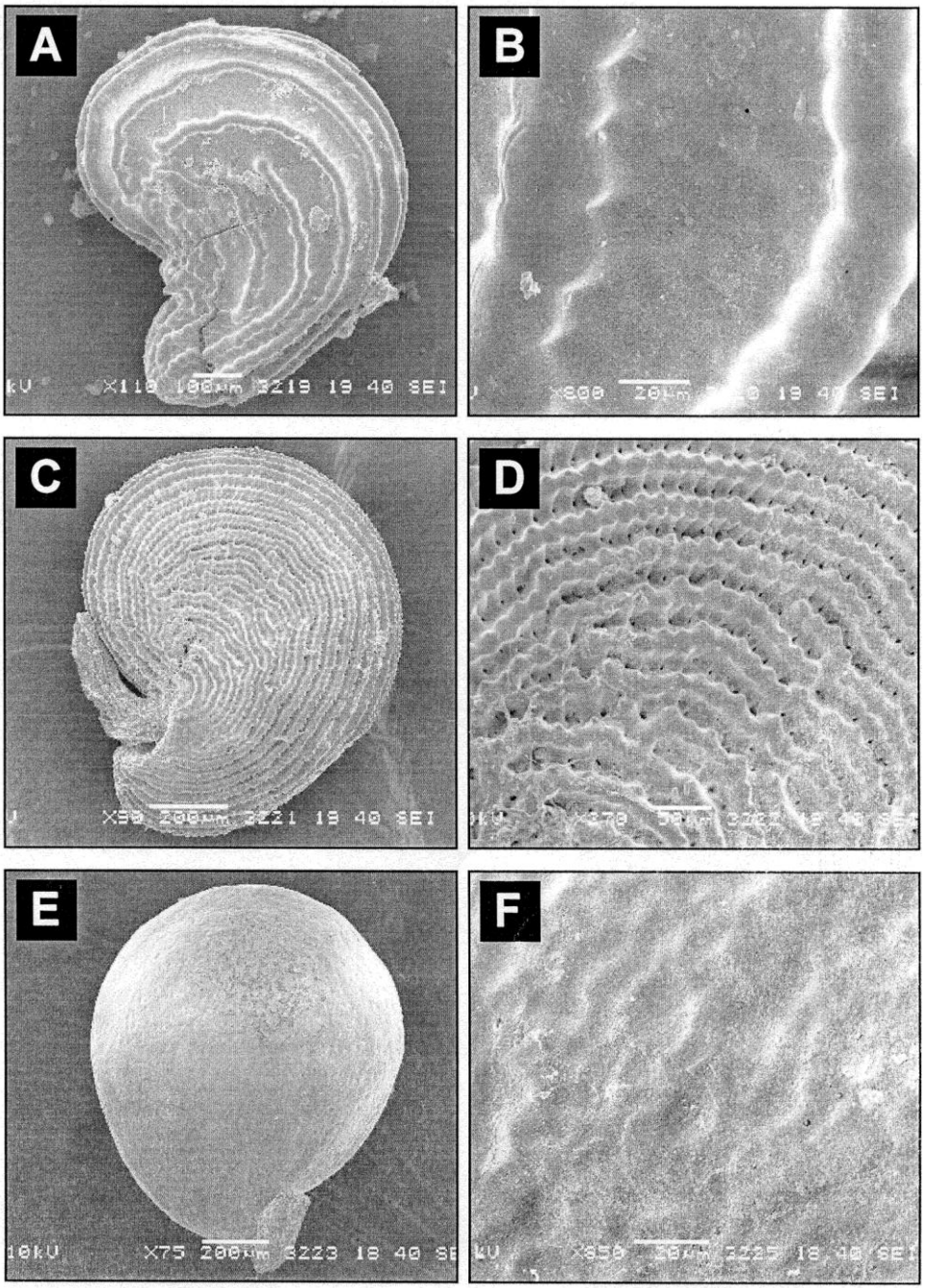

Fig. 1. Scanning electron micrographs. *Aizoon canariense*: A, seed; B, surface. *Corbichonia decumbens*: C, seed; D, surface. *Gisekia pharnaceoides*: E, seed; F, surface (Scale bar: A=100 µm; B, F=20 µm; C, E=200 µm; D,50 µm).

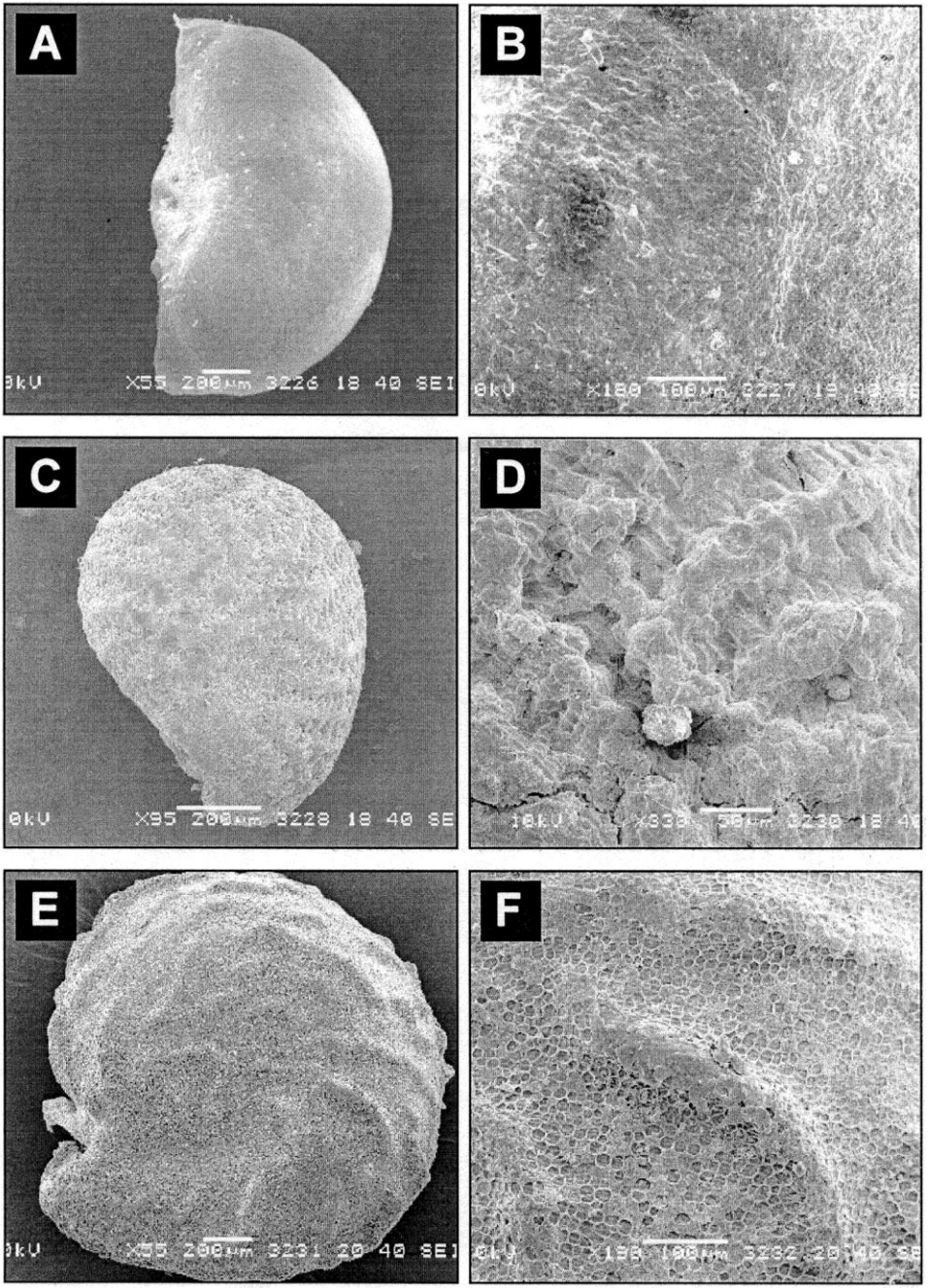

Fig. 2. Scanning electron micrographs: *Limeum indicum*: A, seed; B, surface. *Sesuviun sesuvioides*: C, seed; D, surface. *Trianthema portulacastrum*: E, seed; F, surface (Scale bar: A, C, E=200 µm; B, F=100 µm; D=50 µm).

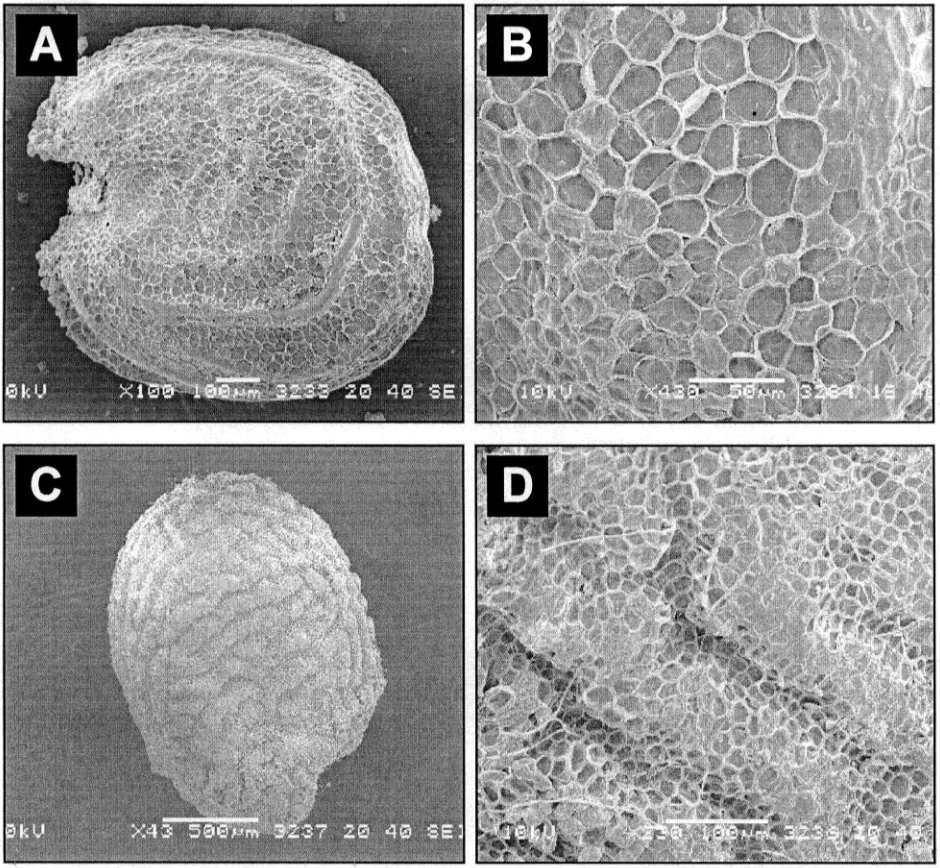

Fig. 3. Scanning electron micrographs: *T. triquetra*: A, seed; B, surface. *Zaleya pentandra*: C, seed; D, surface (Scale bar: A, D=100 µm; B=50 µm; C=500 µm).

Result and Discussion

Family Aizoaceae has diverse seed characters (Hartmann, 1993; Kirkbride *et al*., 2006) which may be significantly used to evaluate the taxonomic decisions, as the genus *Trianthema* could be easily distinguished by having transversely cuneate seeds, while remaining genera having reniform, retortiform or elliptic pyriform seeds. Further more, the genera *Limeum* and *Gisekia* are grouped by the presence of psilate seed surface, while in the remaining genera seed surface is non-psilate. Similarly *Limeum* remains distinct from rest of the genera of the family Aizoaceae by the absence of pigmentation (Behnke *et al*., 1983) and due to this exclusive character *Limeum* occupied uncertain taxonomic position in the family Aizoaceae (Cuenoud *et al.*, 2002; Hassan *et al*., 2005). Similarly, in the genus *Gisekia* the presence of punctation towards the hilum makes it different from rest of the genera and the present findings are also supported by the studies of Hassan *et al*., (2005). The genera *Corbichonia* and *Aizoon* are further grouped by the presence of ribbed seeds, but these two genera still remain distinct with each other by having concentric, compactly arranged numerous ribs with porous surface and loosely arranged,

8-10 ribs with slightly longitudinal ridged surface in *Corbichonia* and *Aizoon* respectively. The rest of the two genera viz., *Sesuvium* and *Zaleya* are distinguished by having rugose surface in *Zaleya* and a specific pattern of thick longitudinal and transverse ridged surface is found in *Sesuvium*.

Hassan *et al*., (2005) reported smooth seed surface in *Sesuvium sesuvioides*, whereas Nasir (1973) observed rugose seed surface in the same species. However, present studies do not support the earlier findings of Nasir (1973) and Hassan *et al*., (2005) as ridged seed surface has been observed.

Similar to that of the generic delimitation, seed morphology has also been found useful to distinguish the species of *Trianthema*, as the *T. triquetra* is characterized by having 3-6 ribbed and reticulate surface, while in *T. portulacastrum* seed surface is rugose.

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