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WEED SEED EPIDERMAL ANATOMY OF WHEAT AND COTTON FIELDS FROM DISTRICT KHAIRPUR, SINDH, PAKISTAN

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ABSTRACT

The anatomy of seeds of weed species of wheat and cotton fields of district Khairpur, Sindh, Pakistan were carried out through scanning electron microscope (SEM). From the studied seeds, there was a wide range of seed shapes ranging from orbicular, ovate, elliptic, oblong to reniform topentagonous. The surface of seeds revealed the difference in epidermal structures from smooth to reticulate and glandular. This paper highlits diversity of epidermal stucture of studied seeds that can be used for proper identification of seeds of important weeds in Pakistan.

Key words: Epidermal anatomy, SEM, Weed seeds.

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INTRODUCTION

Weeds are unwanted plant species growing in the domesticated crops and often described as plants damaging crop production system. As predominance of a weed species is the result of high capacity for reproduction and efficient mechanism for dispersal, survival, adaptation and competition. Seed structure and shape are the key determinants in this respect. Comprehensive information about the morphological characters of the seeds of weed propagules, such as shape, surface structure and attachment point will be of great value in establishing efficient techniques of weed management in crop husbandry.

The ability to recognize weeds, always important in farming, has become even more essential in modern agriculture. Of no less importance, however, is the identification of weed seeds, which

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account for the loss of millions of dollars (Martin and Barkley, 1961) and undesirable seeds that contaminate seeds for food or industrial use, lower the grade and value of the farm products.

The seed morphology is essential for reference in identifying seeds, since published botanical descriptions of plants rarely include the necessary morphological details of the seed. It is observed that the mature seeds are usually not present in the herbarium specimens. The herbarium sheets are preferably prepared at the time when plant specimens are in flowering. The distinguishing features between the species of a genus may be fairly similar. The differences often being minute or obscure, therefore, a high magnification resolution under Scanning Electron Microscope is essential for viewing their finer surface features .

The use of SEM has witnessed remarkable contribution from exploring the nutlet/seed morphology in recent time. Hussain *et al.* (1990) found SEM investigation of seed/nutlet a useful character with the combination of other characters in separating closely allied genera in the tribe Saturejeae (Lamiaceae). External morphology of three groups of *Opuntia ficus-indica* (Cactaceae) seeds, and the ultra structure of the seed testa for their possible use as plant taxonomic characters under SEM technique was assessed by Degano *et al.* (1997). Jonsell (1986) and Koul *et al.* (2000) investigated the seed coat morphology and microsculpturing seed coat in certain genera of Brassicaceae and provided evidence for the close relationships among various genera. Machado *et al.* (2003) observed the pattern of longitudinal ribs and verrucose coat of four species of *Phyllanthus* L. (Euphorbiaceae) under SEM. Khanki (2003) carried out SEM study of fruits and seeds of all Iranian taxa of *Fritillaria* subgenus *Fritillaria* (Liliaceae). Zeng *et al.* (2004) found reticulate and blister type patterns during the development of seeds in the six species of *Brassica* i.e. *B. rapa*, *B. oleracea*, *B. nigra, B. carinata*, *B. napus* and *B. juncea* under SEM and concluded that the variation in the patterns of seed coat development could be used to provide a new and more effective way to analyse the close relationship among amphidiploids and their ancestral parents. Kanwal *et al.* (2009) and Ather *et al*. (2009) examined seed morphology of 8 species of family Aizoaceae and 20 taxa belonging to the subfamily Grewioideae respectively, using light and scanning electron microscopy. They found it useful to support the taxa both at the generic and specific levels and for designing a Seed Atlas of Pakistan. Moreover, to demarcate the taxa at specific level seed morphology of 8 species of the genus *Cuscuta* which is a single genus of family Cuscutaceae was investigated by Kanwal *et al.* (2010).

Present study aims to determine the anatomy of seed characteristics among wide range of weed taxa collected from both the crops in question which will be helpful in identification of seeds.

MATERIALS AND METHODS

Mature Seeds of 20 weed species were collected from wheat and cotton fields and examined under scanning electron microscope (SEM) to determine their shape and epidermal structure. These were air dried and fixed to specimen stubs with an adhesive tape and placed on the revolving discs of JFC-110 ion sputter coater for 10-12 minutes. The examination was carried out and photographed using 5 KV with working distance of 20 mm through Jeol JSM-T100 SEM at National Agriculture research centre, Islamabad. The photomicrographs were taken at different magnifications. The terms used by Stearn (1992) were adopted in order to describe the seed coat pattern.

RESULTS AND DISCUSSION

The following is a description of seed morphology of each weed species with reference to seed shape and surface ornamentation (Table-1 and Fig. 1 and 2).

Seed shape

A wide range of seed shapes have been observed which include orbicular, ovate, obovate, linear, elliptic, oblong and reniform (Table-1). *Chenopodium album* (Fig. 1I)*, Chenopodium murale* (Fig. 1M) and *Dactyloctenium aegyptium* (Fig. 2I) possessed orbicular shaped seeds. In the case of *Cleome viscosa* (Fig. 1E) and *Trianthema portulacastrum* (Fig. 1A), the seed shape was orbicular, however, there was beak at their attachment points, while, *Chenopodium ficifolium* (Fig. 1K) and *Physalis peruviana* (Fig. 2O) had sub-orbicular shape.

The seed shapes of *Euphorbia serpens* (Fig. 1S), *Phalaris minor* (Fig. 2K), *Melilotus indica* (Fig. 2C), *Polypogon fugax* (Fig. 2M) and *Vaccaria hispanica* (Fig. 1G) were ovate, whereas *Convolvulus arvensis* (Fig. 1O) had irregular ovate shaped seeds. have widely ovate shaped seeds. In the case of *Bergia aestivosa* (Fig. 1Q), narrowly oblong shaped seeds identified. The widely elliptic and elliptic shaped seeds have been observed in *Amaranthus virdis* (Fig. 1C) and *Vicia sativa* (Fig. 2E), respectively. Two species viz., *Corchorus tridens* (Fig. 2S) and *C. aestuans* (Fig. 2Q) have truncate and widely truncate shaped seeds, respectively. Reniform shaped seeds have been found in the species of *Atylosia platycarpa* (Fig. 2A). Grass *Avena fatua* (Fig. 2G) only possessed lanceolate shape along with slightly groove towards its distal end.

Seed surface

SEM study of the seed surface reveals different types of seed epidermal structure. The basic types are smooth, reticulate and tuberculate. Each type has a range of variations within it.

Smooth

A smooth surface of seeds has been observed in *Vicia sativa* (Fig. 2 H) and *Polypogon fugax* (Fig. 2N).

Smooth with pusticulate

The seeds of *Phalaris minor* had sparsely shallow elevations on smooth surface (Fig. 2L).

Puncticulate

Atylosia platycarpa had tiny scattered dots on the smooth surface (Fig. 2B). This type of feature is called puncticulate.

Aculeate

In this type of surface, seeds had small pointed projections. This type is found in *Dactyloctenium aegyptium* (Fig. 2J).

Pitted with aculeate

Corchorus tridens (Fig. 2T) has small pointed projections present on pitted surface of seed.

Reticulate with aculeate

In this type of surface the seeds had a raised reticulate network of angled lines in addition to small pointed projections. This type is observed in *Convolvulus arvensis* which is densely reticulate with aculeate (Fig. 1P) and *Cleome viscosa* having parallel ridges reticulate within, with aculeate surface (Fig. 1F).

Tuberculate with aculeate

In *Melilotus indica* small pointed projections are present on tuberculate surface (Fig. 2D).

Pitted with tuberculate

The seeds of *Vaccaria hispanica* (Fig. 1H) had small projections on the pitted surface.

Tuberculate and verrucate

In *Chenopodium murale* (Fig. 1N) tuberculate and veruccate (with irregular projections or knobs) type of seed surface is present.

Ruminate

In this type the surface is penetrated by irregular channels running in different directions, showing eroded features. This type of features are observed in *Physalis peruviana* (Fig. 2P) and *Euphorbia serpens* (Fig. 1T).

Densely reticulate with rugose

The seed surface of *Trianthema portulacastrum* (Fig. 1B) is densely reticulate with rugose texture (irregular elevation running in one direction and making up the wrinkles on seed surface).

Densely reticulate within patch

The surface of *Corchorus aestuans* seed is densely reticulate within patch. In this type of seed surface the reticulation has been formed by a densely well developed raised network of angled lines on a smooth surface within patch (Fig. 2R). This form is regular and geometric from the regular spacing of the cells. There is a flate appressed patch on the surface of seed.

Reticulate with spiral compact and elongated ridges

In this type of seed surface the reticulation has been formed by a well developed raised network of spiral compact and elongated ridges. This type is present in *Bergia aestivosa* (Fig. 1R).

Irregular ridges

This type of epidermal surface has been observed in seed of *Amaranthus virdis* (Fig. 1D).

Lineate with setose trichomes

The seed surface of *Avena fatua* is lineate which is covered with unicellular setose trichomes (Fig. 2H).

Cup like glands

Chenopodium ficifolium (Fig. 1L) is covered with compact cup like glands, there are ridges radiating from the attachment point.

Ocellate glandular

Eye-like glands are present on the seed surface of *Chenopodium album* (Fig. 1N).

The SEM study has brought remarkable findings regarding the epidermal structure of weed species of wheat and cotton crops. It has been observed that most of the characteristics of seed surface have been ignored or recorded inappropriately. At the same time there are number of species with some features indicated by various Scientists, but not matching with the present findings. For example, Cope (1982) described seed surface of *Dactyloctenium aegyptium* as rugose, where as in present study an aculeate epidermal surface has been observed. Similarly, Nasir (1975) and Kanwal *et al*. (2009) found rugose surface in *Trianthema portulacastrum*, on the other hand a densely reticulate surface has been found in addition to rugose surface under SEM (Fig. 5F and 7D).

The seed surfaces of species of genus Chenopodium such as *C. album, C. ficifolium and C. murale* (Fig. 3 B, D & F) are found with ocellate glands, compact cup like glands and tuberculate-verrucate respectively.

Freitag *et al.* (2001) are of opinion that the difference between two subspecies (named subsp. *ficifolium* from Europe-Siberia and an other subsp. *blomianum* from Indian subcontinent) stands no certain without confirming seed characters. In fact, the present findings confirm that the material examined was collected from the study area, belongs to subsp. *blomianum*. Moreover, present findings highlighted the epidermal structure of seeds more clearly having suborbicular seed shape with compact cup like glands on surface. No material was examined from Europe-Siberia.

The present study reveals that the species of *Chenopodium ficifolium* has cup like glands on the its seeds. They might be spherical at their early stage and encourages the seed dispersal by ants (myrmecochory). Bouman and Meeuse (1992) have mentioned the commonness of myrmecochory in the family Labiatae. In this family the ovary in some of the taxa is covered by spherical or ball like glands which became cup like on the nutlets. Perhaps they are nectories which have ceased to function at the time of dispersal having lost their contents and invaginating. So the formation of cup like glands on seeds of above weed species could be the similar phenomenon as that of Labiateae.

CONCLUSION

It is concluded from the results of present study that epidermal anatomical characters of seeds are considered diagnostic at the generic and specific level of weed species amongst the wide range of taxa. Hence, such distinct features have been proved as good taxonomic characteristics and also a potential add in taxonomic description of these species.

Table-1. Epidermal anatomical characters of seeds of wheat (W) and cotton (C) weeds examined by SEM

S.No	Name of weed species	Family	Shape	Epidermal structure	Crop
1.	*Trianthema portulacastrum* Linn.	Aizoaceae	Beaked orbicular	Densely reticulate with aculeate	C
2.	*Amaranthus virdis* Linn.	Amaranthaceae	Widely elliptic	Irregular ridges with pitted surface	C
3.	*Cleome viscosa* Linn.	Capparidaceae	Beaked orbicular	Parallel ridges reticulate within, with aculeate projection	C
4.	*Vaccaria hispanica* (Miller) Rauschert.	Caryophylaceae	Widely ovate	Pitted with tuberculate	W
5.	*Chenopodium album* Linn.	Chenopodiaceae	Orbicular	Ocellate glandular	W
6.	*Chenopodium ficifolium* subsp.*blomianum* (Aellen) Aellen.	Chenopodiaceae	Sub-orbicular	Compact cup like glands, ridges radiating from attachment point	W
7.	*Chenopodium murale* Linn.	Chenopodiaceae	Orbicular	Tuberculate and verrucate	W
8.	*Convolvulus arvensis* Linn.	Convolvulaceae	Irregular ovate	Densely reticulate with aculeate projections	W/C
9.	*Bergia aestivosa* Wight & Arn.	Elatinaceae	Narrowly oblong, curved	Reticulate with spiral compact elongated ridges	C
10.	*Euphorbia serpens* Kunth.	Euphorbiaceae	Ovate with acute apex	Ruminate	C
11.	*Atylosia platycarpa* Benth.	Papilionaceae	Reniform	Smooth with puncticulate and strophiolate	C
12.	*Melilotus indica* (L.) All.	Papilionaceae	Widely ovate	Tuberculate with aculeate	W
13.	*Vicia sativa* Linn.	Papilionaceae	Elliptic	Smooth	W
14.	*Avena fatua* Linn.	Poaceae	Lanceolate, slightly grooved towards distal end.	Lineate covered with setose trichomes	W
15.	*Dactyloctenium aegyptium* (Linn.) Willd.	Poaceae	Orbicular	Aculeate	C
16.	*Phalaris minor* Retz.	Poaceae	Ovate with acute apex	Smooth with sparse shallow pusticulate	W
17.	*Polypogon fugax* Nees ex Steud	Poaceae	Ovate	Smooth	W
18.	*Physalis peruviana* Linn.	Solanaceae	Sub orbicular	Ruminate	C
19.	*Corchorus aestuans* Linn.	Tiliaceae	Widely truncate	Densely reticulate within patch	C
20.	*Corchorus tridens* Linn.	Tiliaceae	Truncate	Pitted with aculeate	C

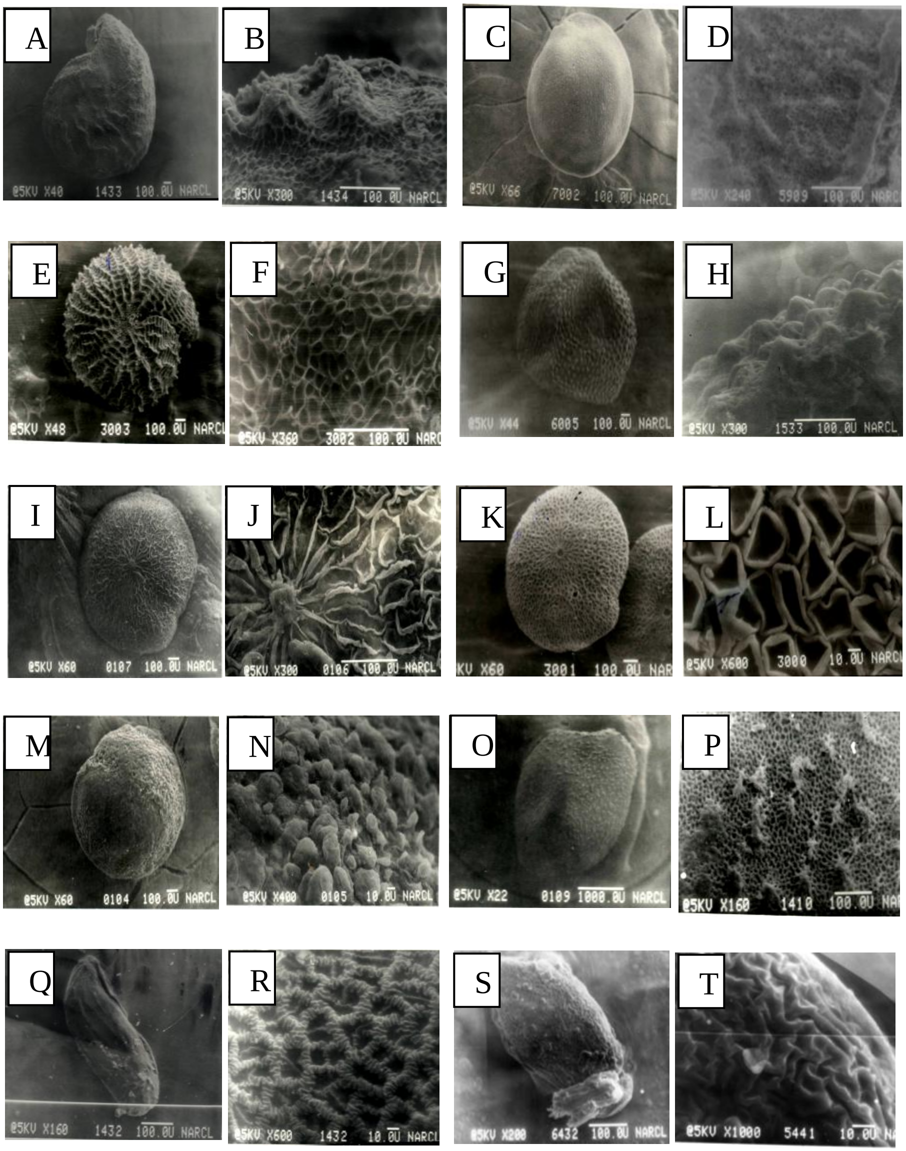

Figure 1. Scanning Electron Micrographs of seeds showing whole seed & seed surface. A&B: Trianthema portulacastrum. C&D: Amaranthus virdis. E&F: Cleome viscosa. G&H: Vaccaria hispanica. I&J: Chenopodium album. K&L: Chenopodium ficifolium subsp.blomianum. M&N: Chenopodium murale. O&P: Convolvulus arvensis. Q&R: Bergia aestivosa. S&T: Euphorbia serpens. (Scale on

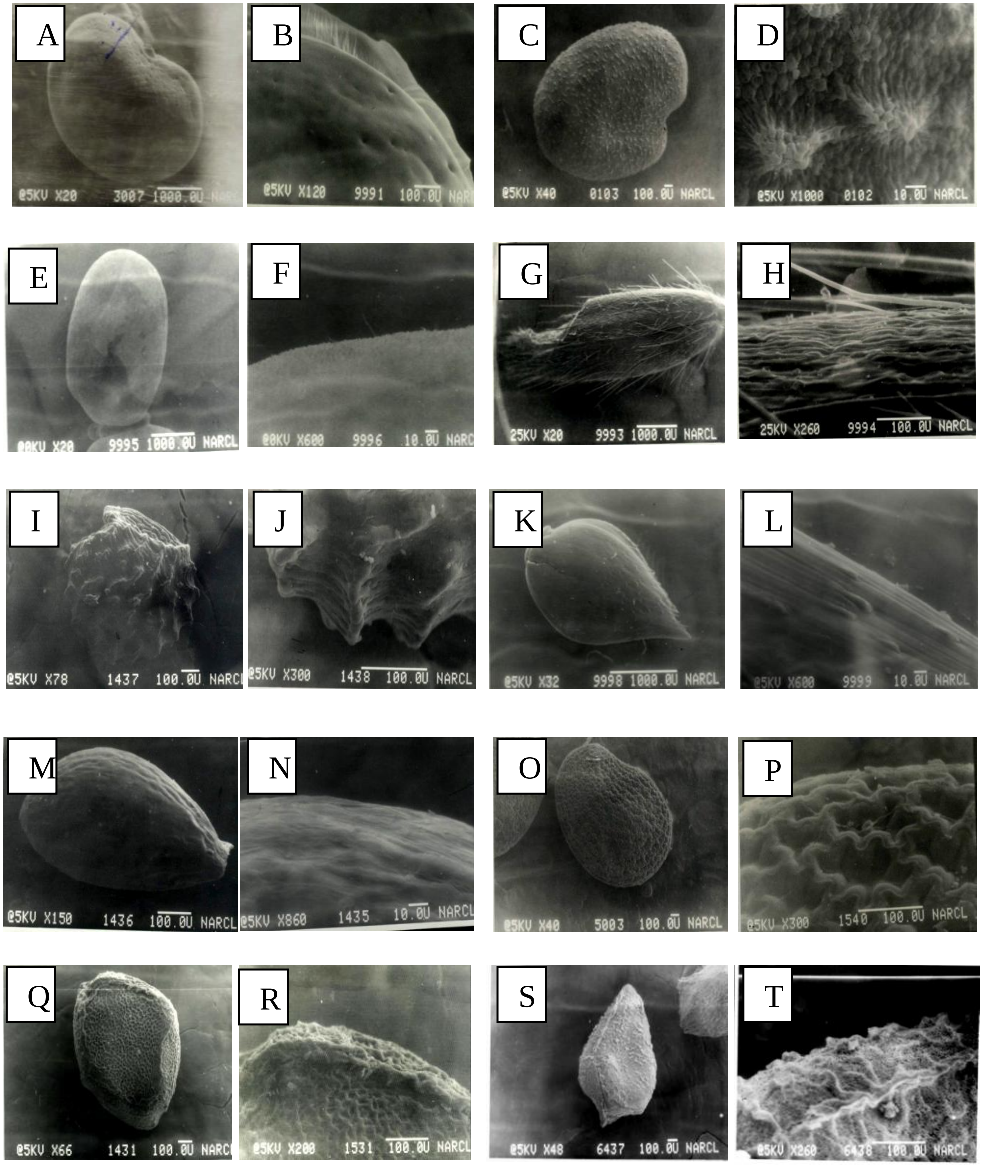

Figure 2. Scanning Electron Micrographs of seeds showing whole seed & seed surface. A&B: Atylosia platycarpa. C&D: Melilotus indica. E&F: Vicia sativa. G&H: Avena fatua. I&J: Dactyloctenium aegyptium. K&L: Phalaris minor. M&N: Polypogon fugax. O&P: Physalis peruviana. Q&R: Corchorus aestuans. S&T: Corchorus tridens. (Scale on each micrograph).

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