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SYSTEMATIC RELATIONSHIPS AMONG SOME SPECIES OF *SOLANUM* L. SECT. *MELONGENA* L. -- EVIDENCE FROM SEED CHARACTERS

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Solanum incanum L. and *S. insanum* L., two Indian wild and weedy forms of spinous Solanums, are closely related to *S. melongena*, the cultivated eggplant or brinjal. Evidence from light and scanning electron microscopy of the seed supports their close phylogenetic relationship. The three are nearly identical in the shape and size of the seed, the hilum and the seed epidermal cells. Seeds of "*S. melongena* var. *potangi*" on the other hand, have distinctly different morphology. This form of disputed taxonomic validity and uncertain identity is probably not available among the phylogenetically close relatives of eggplant.

Key words : *Solanum melongena, S. insanum, S. incanum, "S. melongena* var. *potangi"*, seed, scanning electron microscopy, systematic relationships

Section *Melongena* L. of genus *Solanum* L. comprises six spinous species including *S. melongena*, the cultivated eggplant or brinjal. Eggplant is suggested to have originated in South Asia, probably India, where besides numerous cultivars, some wild and weedy forms known as *S. incanum* L. and *S. insanum* L. are also found. There is consensus that *S. incanum* is the progenitor of eggplant (Bhaduri, 1951; Narsimha Rao, 1979; Lester and Hasan, 1991). But disagreement exists regarding the relationships of *S. insanum*, this species has been regarded as either an ancestor or a weedy derivative of cultivars (Prain, 1903; Bhaduri, 1951; Lester and Hasan, 1991). Another plant, morphologically similar to eggplant and given the epithet "*S. melongena* var. *potangi*" (Mital, 1950), has been sugested as one of the progenitors of eggplant (Bhaduri, 1951). The identity of this form and the validity of its nomeclature have, however, been brought into question (Khan, 1979; D.B. Deb - Pers. comm.)

Several workers have used seed coat characters for the identification and taxonomic treatment of Solanaceae (Souèges, 1907; Wojciechowska, 1972; Gunn and Gaffney, 1974; Whalen, 1979; Lester and Durrands, 1984). Besides seed shape and colour, surface features like form and dimensions of epidermal

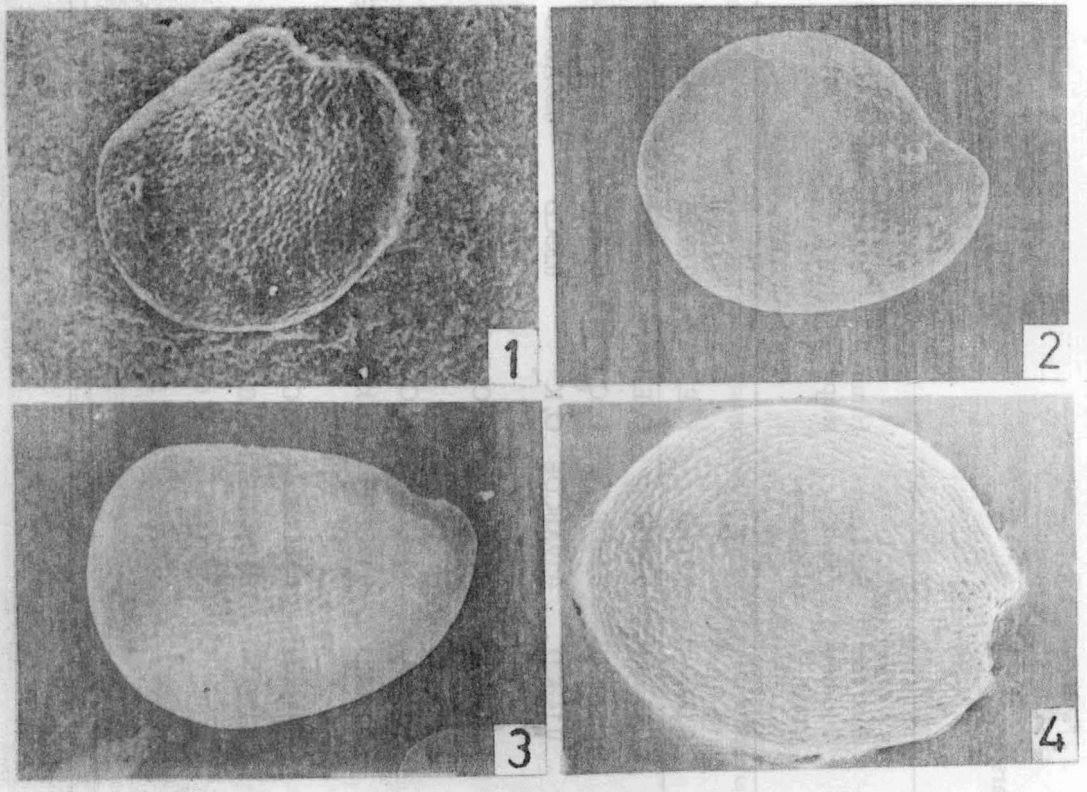
cells and patterns made by anticlinical wall thickenings have been used to differentiate numerous Solanaceaous species. Earlier studies demonstrated the usefulness of seed surface microstructural features in resolving the systematic relationships of *S. melongena* and some related taxa (Karihaloo and Malik, 1992). In the present paper, detailed studies on the macro- and micromorphology of the seed and seed surface in several accessions of *S. melongena, S. incanum, S. insanum* and *"S. melongena* var. *potangi"* are reported.

MATERIALS AND METHODS

Seeds of nine cultivars (including named cultivars and landraces) of *Solanum melongena,* five accessions of *S. insanum* and one accession of *S. incanum* (Table 1), collected from different locations in India, were used for the present study. In addition, seeds from the original collection of *"S. melongena* var. *potangi"* (Mital, 1950) located in NBPGR were also investigated. Ten seeds of each accession were observed for their external morphology: overall seed shape and size (macromorphology) and shape and size od epidermal cells (micromorphology). The macromorphological features were studied under a dissecting stereomicroscope mounted with an ocular micrometer. Micromorphology of the seed epidermis was observed by scanning electron microscopy (SEM). Dry, untreated and enzyme treated seeds were used for the purpose. For enzyme treatment, the seeds were soaked in 1 per cent cellulase (Sigma c-7377) solution for 16 hr. Later, the seeds were thoroughly washed with distilled water and dried in an oven at 32°C for 18 hr. The seeds were mounted on brass stubs and coated uniformly with a thin gold layer in a JFC-1100 ion sputter. Scanning of the seed surface was done at an accelerated voltage of 25 KV by SEM model Jeol JSM 840 A. Measurements of cells and other components were made from enlarged photographs. Terminologies of Gunn and Gaffney (1974) and Barthlott (1981) were used for describing seed and seed surface structures. Statistical comparisons of the numerical data were made by Duncan's multiple range test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The seeds of the presently investigated Solanums are light to dark-brown mostly C-shaped but also oblong and obovate (Table 1, Figs. 1-4). The hilum is marginal, key-hole shaped or rarely oblong, elliptical, linear and obovate. The seed length ranges between 2.31 mm and 3.61 mm, width between 2.03 mm and 3.15 mm and thickness between 0.76 mm and 0.94 mm. Hilum length among the accessions varies between 0.35 mm and 0.75 mm and breadth between 0.11 and 0.58 mm. Persual of Table 1 reveals that the average seed size of *S melongena* is greater than that of the other three taxa. Since *S melongena* has larger fruits than those of its putative progenitors, *S. insanum* and



Figs. 1-4. Scanning electron micrographs of the seeds of *Solanum melongena* (Fig. 1). *S. insanum* (Fig. 2), *S. incanum* (Fig. 3) and "*S. melongena* var. *potangi*" (Fig. 4). × 14.

S. incanum, it is probable that the genetic changes responsible for increasing the fruit size of the cultivars have also affected the size of their seeds. Table 1 also shows that there exist large and often significant differences in seed morphometry among the accessions in both *S. melongena* and *S. insanum*. Consequently, most characters show wide in ranges within species variations and these ranges overlap across species. Thus on the basis of the seed macromorphological characters, none of the investigated taxa can be distinguished as a distinct entity.

The morphometric details of the epidermal cells of the 16 investigated accessions are presented in Table 2. The epidermal cells are mostly isodiametric (Figs. 5-8), those towards the seed edges being tangentially elongated. The cell length ranges between 131.6 µm and 234.4 µm, and the cell breadth between 97.2 µm and 155.2 µm. The number of undulations varies between 7.4 and 15.0 per cell while the length of undualtions ranges between 30.2 µm and 71.7 µm. As is evident from Table 2, overlapping ranges of variation in

Table 1. Seed characters of *Solanum* species and cultivars/accessions

Species and Cv./accession	Seed Outline shape*	Seed length (mm)	Seed breadth (mm)	Seed thickness (mm)	Seed coat thickness (mm)	Seed coat /seed thickness	Hilum shape**	Hilum length	Hilum breadth
S. melongena									
SM 85	C	3.36B	3.03AB	0.81C	0.17A	0.21AB	K, E, O	0.69AB	0.48AB
CA 172	C	3.61A	3.15A	0.94A	0.15ABC	0.16DE	O, E, K	0.67AB	0.44ABC
Arka Shirish	C	3.00C	2.50BE	0.88B	0.14BCD	0.16DE	O, C, K	0.53CDE	0.41ABC
West Coast Round	C	2.59DE	2.25GHI	0.74D	0.14BCD	0.19ABCDE	O, K	0.55CD	0.39ABCD
Pusa Purple Cluster	C, O	3.36B	2.89BC	0.88B	0.14CD	0.16DE	K, O, E, C	0.75A	0.41AB
Manjari Gota	C	3.30B	2.80CD	0.88B	0.15ABC	0.17CDE	K, O	0.52CDE	0.30BCDE
Pusa Purple Round	C	3.01C	2.64DE	0.82C	0.14BCD	0.17CDE	O, K	0.66AB	0.38ABCDE
IC-89823	C	2.90C	2.38FG	0.78CD	0.14BCD	0.18CDE	K, O	0.48DE	0.30BCDE
IC-89834	C	2.56DEF	2.28FHG	0.67E	0.12D	0.18BCDE	K, O	0.35F	0.22BCDE

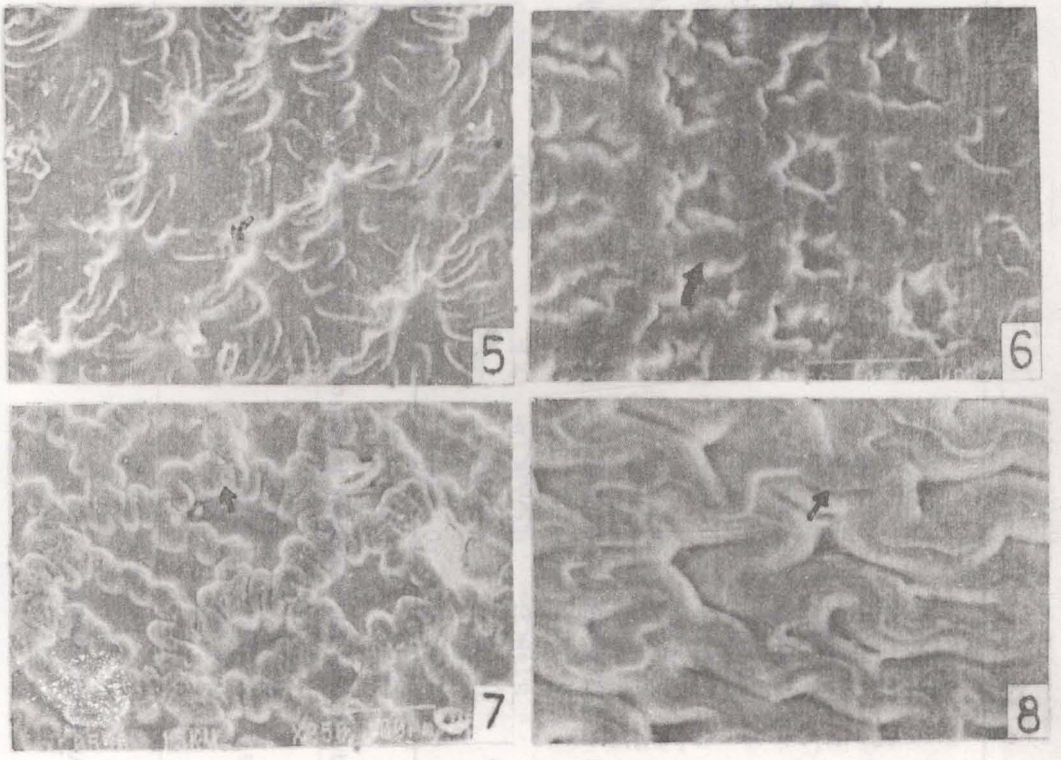
(*Contd. from p. 15*)

S. insanum									
JL-58	C, O	2.44EF	2.07IJ	0.88B	0.16AB	0.20ABC	K, O, E	0.51CDE	0.58A
JL-62	C, O, Ob	2.31IF	2.03J	0.79CD	0.15ABC	0.19ABCD	K, O, L	0.47DE	0.20BCDE
JL-39	C, O	2.36F	2.07IJ	0.68E	0.13CD	0.19BCDE	K, O	0.43EF	0.19CDE
IC-3253	C, O	2.55DEF	2.05IJ	0.68E	0.13CD	0.19ABCD	K	0.44DEF	0.20BCDE
IC-111404	C, O	2.79CD	2.36FG	0.73D	0.16AB	0.22A	K	0.52CDE	0.25BCDE
S. incanum									
JL-64	C, O, Ob	2.75CD	2.14HIJ	0.75CD	0.15ABC	0.20AB	K	0.44DEF	0.14DE
"S. melongena var. *potangi"*	C, O, Ob	2.84C	2.47EF	0.75CD	0.12D	0.16DE	L, O	0.61BC	0.11E

*C : C-shaped; O: Oblong; Ob : Obvate

**K: Keyhole-shaped; E: elliptical; O: oblong; C: circular; L: linear

The different seed and hilum shapes of an accession have been arranged in order of their frequencies. In each column, figures followed by the same letter are not significantly different.



Figs. 5-8. Scanning electron micrographs of the seeds surface of *S. melongena* (Fig. 5), *S. insanum* (Fig. 6), *S. incanum* (Fig. 7) and "*S. melongena* var. *potangi*" (Fig. 8). Note the bead-like structure of cell margins in Figs. 5-7 and the thin line of depositions in Fig. 8 × 160

the epidermal cell characters exist among *S. melongena, S. incanum* and *S. insanum*. "*S. melongena* var. *potangi*", however, stands out from these in having significantly fewer number of undulations per cell, shorter undulations and thinner cell margins than all the other taxa. Thus, the epidermal cell characters distinguish "*S. melongena* var. *potangi*" as a distinct form whereas the other three taxa are nearly identical with each other.

The appearance of the cell margins is another feature of taxonomic interest in the present materials. In all the accessions of S. *melongena, S. insanum* and *S incanum*, the cell boundaries are dotted with bead-shaped structures (Figs. 5-7). Our earlier studies on single accessions of *S melongena* and *S. insanum* had also revealed the bead-like appearance of cell boundaries (Karihaloo and Malik 1992). Identical structures in more accessions of these taxa indicate that

beading of the seed epidermal cell margins is a uniform character in these species. In *"S. melongena* var. *potangi"*, the cell boundaries bear a structurally and chemically different kind of deposition. It is in the form of a thin raised line (Fig. 8) which unlike bead-shaped structures of the other taxa, is eroded by cellulase treatment.

Table 2. Seed epidermal cell characters of *Solanum* species and cultivars/accessions

Species and Cv./ accession	Cell length (μm)	Cell breadth (μm)	Number undulation/ cell	Length undulations (μm)	Cell margin thickness (μm)
S. melongena	108.3BC	140.6ABC	13.7AB	68.6A	14.5B
SM 85	178.4BC	154.2A	13.4ABC	71.4A	12.6B
CA 172	169.8CDE	138.8ABC	12.8ABC	47.2CDEF	7.6EF
Arka Shirish	169.8CDE	138.8ABC	12.8ABC	47.2CDEF	7.6EF
West Coast Round	188.0BC	142.8ABC	14.0AB	39.2FG	8.0DEF
Pusa Purple Cluster	171.2CDE	131.6ABCD	12.6ABC	55.6BC	13.8B
Manjari Gota	234.4A	140.2ABC	13.8AB	54.2BCD	14.8B
Pusa Purple Round	154.2EF	126.OCDE	15.OA	51.4CDE	8.8CDE
IC-89823	270.8D	155.2A	13.8AB	52.0CDE	15.4B
IC-89834	168.0CDE	126.6CDE	11.2CD	48.2CDEF	13.8B
S. insanum					
JL-58	159.0CDE	97.2F	13.0ABC	41.8EF	12.2BC
JL-62	131.6F	108.4DEF	13.4ABC	45.0DEF	11.6BCD
JL-39	163.8CDE	120.9CDE	12.9ABC	52.3CDE	14.6B
IC-3253	157.2DEF	128.6BCDE	11.2CD	60.6AB	15.4B
IC-111404	184.4BCD	153.0AB	10.2D	46.6CDEF	20.2A
S. incanum					
JL-64	177.0CDE	105.BEF	10.2D	48.6CDEF	12.8B
"S. melongena var. *potangi"*	185.8BCD	108.4DEF	7.4E	30.2G	5.0F

In each column, figures followed by the same letter are not significantly different.

The above detailed close similarly in the seed characters of *S. melongena*, *S. incanum*, and *S. insanum* points to the close phylogenetic relationship existing among them. Previous crossability studies have led to similar conclusions (Narsimha Rao, 1979); consequently these species have been treated as closely interrelated forms of a larger group, *S. melongena* complex (Lester and Hasan, 1991). Several taxonomists have treated *S. insanum* as a variety of *S. melongena* while Deb (1989) merged both the taxa under *S. incanum*.

The shape and size of seed epidermal cells of "*S. melongena* var. *potangi*", on the other hand, establish this taxon as a form quite distinct from the *S. melongena* complex. Thus the present studies do not support the contention of Bhaduri (1951) that "*S. melongena* var. *potangi*" is a progenitor of *S. melongena*. As mentioned in the introduction, the validity of the nomenclature "*S. melongena* var. *potangi*" is disputed (Khan, 1979; Karihaloo and Malik, 1992). Further, there seems to be no reference material, except nongerminable seeds, available for the verification of its identity and relationships. In view of these facts, it seems doubtful whether as one of "*S. melongena* var. *potangi*" should be given any serious consideration.

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