Cytogenetic Studies on the F₁ Hybrid *Solanum incanum* × *S. melongena* var. American Wonder

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Solanum melongena L., the egg plant, is cultivated throughout the warmer regions of the world for its use as a vegetable (Chandra and Murty 1968) and medicine (Kirtikar and Basu 1975). Chromosome pairing in inter-specific hybrids has been of value in determining the relationship between any two plant species. This helps in observing the degree of chromosomal homology and finding numerical difference between pairing partners, if any. In the present work an attempt has been made to develop an inter-specific hybrid between a wild *Solanum incanum* and a cultivated species *S. melongena* var. American wonder (AW) with a view to combine the parents attributes in a new plant type and to see the genomic relationship between them.

Materials and methods

Seeds of *Solanum melongena* var. AW and *S. incanum* L. were sown in the botanical garden of the university in pots. Crosses were attempted in a reciprocal way using conventional methods and following usual precautions. Meiotic studies were made from young anthers fixed in 1:3 acetic-alcohol mixture supplemented with a few crystals of ferric chloride for 24 hr. Anthers were squashed in 2% acetocarmine. Pollen fertility was determined by staining fresh pollen in a drop of acetocarmine solution.

Results and discussion

A detailed comparative account of morphological features of hybrids and their parents is given in Table 1.

All crosses made between the two species succeeded but healthy seeds were obtained only in one direction when *S. incanum* was used as female parent. The reciprocal cross (*S. melongena* var. AW × *S. incanum*) yielded seedless fruits. The percent survival of the hybrid was better (91.5%) than either of *S. incanum* (78%) or *S. melongena* (56%). The F₁ plants bore morphological features indicative of their hybrid origin. They were spiny and distinct from either of the parents in showing vigorous growth since seedling stage. The hybrids surpassed their parents in various characters such as plant height, number of branches and fruits (Fig. 1A-C) per plant, days to flowering, days to maturity and ripening of fruits, and resistance to drought and to the shoot and fruit borer. The ovoid hybrid fruits (Fig. 1D), were green with discontinuous purplish streaks along the length when young and yellow to orang-red when ripe. Some hybrid flowers showed such interesting morphological anomalies as fusion of 2 or 3 flowers in one. The fused forms also were capable of fruit set.

Analysis of meiosis in pollen mother cells (PMCs) of *S. incanum* and *S. melongena* exhibited 12 bivalents both at diakinesis and metaphase I. The bivalents were both ring and rod

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Table 1. Comparison of morphological characters of *Solanum incanum*, *S. melongena* var. American Wonder (AW) and their F₁ hybrid. Range of values is given in parentheses

Character	<i>S. incanum</i>	<i>S. melongena</i>	F ₁ hybrid (<i>S. incanum</i> × <i>S. melongena</i>)
Plant habit	Erect and spiny	Semi-erect and spineless	Semi-erect and spiny
Average branches per plant	10 (2–13)	8 (3–10)	19 (17–21)
Plant height (cm)	67.00 (43.0–71.0)	40.0 (32.0–45.0)	79.55 (46.0–88.7)
Leaf surface	Dark green, spiny	Dark green spineless	Dark green, spiny
Petiole length (cm)	4.60 (3.8–4.7)	5.53 (5.0–5.9)	4.92 (4.1–5.3)
Lamina length (cm)	14.5 (12.0–14.9)	15.8 (14.6–16.2)	15.01 (12.7–15.6)
Lamina breadth (cm)	8.40 (8.2–9.8)	10.15 (9.2–13.5)	8.58 (8.0–10.0)
Inflorescence	Flowers in clusters of 2–9, arranged on a long axis in acropetal succession	Flowers solitary or in clusters of 3	Flowers solitary or in clusters of 2–8
Flower colour	Purple	Purple blue	Purple blue
Flower diameter (cm)	3.10 (2.9–4.7)	4.55 (2.9–4.7)	3.52 (3.2–4.3)
Days to flowering after transplantation	56	72	31
Days to fruit set after first flowering	25	20	59
Days to the initiation of fruit maturation	53	56	37
Days to the initiation of fruit ripening	73	88	69
Average fruit per plant	43 (18–57)	16 (14–19)	58 (42–66)
Fruit nature and shape	Solitary or in clusters of 2–9 each, globose	Solitary, cylindrical	Solitary or in clusters of 2–3 each, oval
Fruit colour	Green when young, orange when ripe	Purple when young, Yellow when ripe	Green with purple strips when young yellow-range when ripe
Fruit length (cm)	1.25 (1.1–1.5)	21.0 (18.0–22.5)	6.11 (4.3–6.5)
Fruit diameter	1.86 (1.4–2.0)	3.50 (3.0–4.2)	5.08 (4.0–5.2)
Fruit weight (g)	14.50 (8.5–15.0)	248.71 (217.5–293.1)	77.52 (69.3–80.0)
Pollen fertility (%)	79.00 (71.0–79.9)	94.83 (73.2–99.6)	47.50 (44.0–56.0)
Pollen size (μm)	24.80 (21.0–26.5)	25.59 (22.4–26.5)	24.02 (18.0–26.5)
Seeds per fruit	35 (00–73)	189 (172–215)	38 (20–46)
Weight of 100 seeds (gm)	4.22 (3.9–4.3)	4.59 (4.4–4.7)	4.16 (3.9–4.5)
Chromosome number (n)	12	12	12
Chiasma frequency per bivalent	1.37	1.44	1.37

type, the ring bivalents were more frequent. The mean number of chiasmata per bivalent at diakinesis and metaphase I was 1.98 and 1.37 in *S. incanum* while 1.97 and 1.44 in *S. melongena* var. AW respectively. The subsequent course of meiosis was normal in both species. Pollen fertility was 79% in *S. incanum* and 95% in *S. melongena* var. AW (Table 2).

The meiosis in PMCs of the F₁ interspecific hybrid was almost normal with 12 bivalents at both diakinesis and metaphase I (Fig. 2A, B) but resulted in as much as 53% sterile pollens with a good fruit and seed set. The mean number of chiasmata per bivalent at M-I was found to be 1.37 (Table 2). Chromosome distribution at anaphase I was perfectly normal (12:12). The easy crossability of *S. incanum* with *S. melongena* (AW) as evident from the successful crossing and from the study of pairing behaviour of chromosomes during meiosis in the F₁ hybrid is indicative of their close inter-relationship. The occurrence of regular meiosis with high chiasma frequency at diakinesis and M-I in the hybrid indicates a high degree of homology of the paired chromosomes (Stebbins 1950). Similar results have been reported by many workers on the genetic relationship of *Solanum* species (Krishnappa and Chennaveeraiah 1964, Rao 1969, Rajasekaran 1969a, b, 1970a, b).

Fig. 1. *Solanum incanum* (A), *S. melongena* variety American wonder (B), their F₁ hybrid showing heterosis in various morphological features (C) and comparative shape and size of fruits of the parent species and F₁ hybrid (D).

Table 2. Chromosome associations and Chiasma frequency in parents and F₁ hybrid at M-I

Chromosome association	<i>S. melongena</i> var. AW	<i>S. incanum</i>	F ₁ hybrid
No. of cells analysed	40	40	30
Average frequency/cell			
Ring bivalent	9.05 ± 0.60	8.15 ± 0.62	8.25 ± 0.63
Rod bivalent	2.95 ± 0.62	3.85 ± 0.60	3.75 ± 0.61
Chiasma frequency/nucleus	17.28 ± 0.58	16.44 ± 0.70	16.44 ± 0.70
Chiasma frequency/bivalent	1.44	1.37	1.37
Pollen fertility (%)	94.83	79.00	47.50

Mean ± S.E.

Pollen viability as measured by percentage staining in acetocarmine was appreciably low in the F₁ hybrid (47.5%) than in parental species where pollen fertility ranged between 82–95%. This could be explained on the basis of cryptic structural hybridity of the parental genomes which are cytologically undetectable (Magoon *et al.* 1964). The cryptic structural differences were, however unable to prevent the manifestation of 'heterosis' in the hybrid with as high as 47% pollen fertility and healthy seed setting.

The results of this investigation clearly indicate a high level of homology between the chromosomes of the two *Solanum* species which is further supported by their ready crossability

Fig. 2. Pollen mother cells of F_1 hybrid between *Solanum incanum* $\times$ *S. melongena* (AW). A—Diakinesis showing 12 bivalents, B—Prometaphase I showing perfect pairing in the form of 12 bivalents. $\times 1000$.

and the production of fertile hybrids. The development of new plant type characterized by increased plant height, average branches, flowers, earliness in flowering and in maturity combined with resistance to drought and brinjal fruit and shoot borer from the wild species *S. incanum* is a feasible venture. Through a series of back-crosses the undesirable features of the wild parent such as small size and bitter taste of fruit can be eliminated.

Summary

An interspecific cross was made between *S. melongena* var. American Wonder and *S. incanum*, a non-tuberosus wild species showing considerable resistance to various diseases and insect pests. Chromosome association and pollen sterility were analysed for the parent and hybrids. The hybrids ($n=12$) were obtained only when *S. incanum* was used as a female parent. The hybrids flowered, fruited and seeded normally. Meiosis was mostly normal. Cytomorphology of F_1 hybrids has been discussed.

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