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Cytomorphological studies of the hybrids between *Solanum pubescens*, *Solanum incanum* and *Solanum indicum*

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Abstract. Reciprocal hybrids were obtained between *Solanum pubescens* (non-spinous taxon) and *Solanum incanum* and *Solanum indicum* (spinous taxa) through modified hand pollination technique. The aspects studied relate to the cytomorphology of the F_1 and F_2 hybrids. On the basis of these studies it is concluded that *Solanum pubescens*, *Solanum incanum* and *Solanum indicum* are cross compatible and have considerable homologies among them. The F_1 hybrids were partially pollen sterile.

Keywords. *Solanum pubescens*; *Solanum incanum*; *Solanum indicum*; interspecific hybrids; cytomorphology.

1. Introduction

Among the non-tuberiferous Solanaceae, those armed with prickles, have been considered to be unrelated to those that are unarmed because of their non-cross-ability relationships (Magoon *et al* 1962; Rajasekharan 1969). In an earlier report, it has been shown that *Solanum pubescens* Willd which is placed under non-spinous group (Gamble 1957) has interspecific compatibilities when crossed with *S. melongena* L. and *S. melongena* var. *insanum* Prain; the later two are of the 'spinous' group (Rao and Rao 1986), thus, the recognition that the separation between the 'spinous' and 'non-spinous' taxa was more assumptive than real. As an extended study, *S. pubescens* was crossed with *S. incanum* L. and *S. indicum* L. (spinous) and the cytogenetic data on the F_1 hybrids and their derivatives (F_2s) are presented.

2. Material and methods

S. pubescens (non-spinous taxon), *S. incanum* and *S. indicum* (spinous taxa) are the species used in the present study. The genetic stocks of the species were obtained from Botanical Survey of India, Coimbatore. Interspecific crosses were made following the modified hand pollination technique of Rao and Rao (1977). Meiotic studies of pollen mother cells were done following the customary technique of fixation of young flower buds in 1:3 acetic acid and methyl alcohol and later transferred to 70% alcohol. Meiotic studies were carried out in PMCs stained with 2% acetocarmine.

3. Results

3.1 *Crossability*

S. pubescens was easily crossable with *S. incanum* and *S. indicum*. Data on crossability are presented in table 1.

Table 1. Results of the attempted interspecific cross pollinations of 3 *Solanum* species.

	S. pubescens × *S. incanum*	*S. incanum* × *S. pubescens*	*S. pubescens* × *S. indicum*	*S. indicum* × *S. pubescens*
No. of crosses made	42	80	30	40
No. of fruit set	4	8	1	3
Fruit set (%)	9·5	10	3·3	7·5
No. of healthy seeds/fruit	564	368	400	210
Germination (%)	29	50	53	20
Average number of seeds F_1	428	430	400	326
F_2	350	450	440	354
Germination (%)				
F_1	45	48	60	40
F_2	48	22	45	32

The number of seeds per fruit, in the F_1 hybrids was considerably less compared to the parents. The germination potential in the F_1s is higher than in the F_2s except in the F_1 hybrid *S. pubescens* × *S. incanum.*

3.2 *Morphology of parents and hybrids*

S. pubescens, *S. incanum* and *S. indicum* conform to the classical taxonomic description of Fyson (1932) and Gamble (1957). The F_1s and the reciprocal hybrids could be recognised right from the seedling stage and morphologically they were intermediate between the 2 parents involved in the cross. The 2 F_1 hybrids resemble *S. pubescens* in having pubescent nature on the stem, leaf and flower, and fewer spines on branches and other plant parts.

3.3 *Cytology of parents and hybrids*

Meiosis in all 3 species was characterized by the formation of 12 bivalents ($2n = 24$) at diakinesis and metaphase I, and regular chromosome segregation at anaphase I and II. Pollen fertility was as high as 98%.

Early stages of meiosis in F_1 hybrids were not amenable for detailed observations. The kinds of chromosome associations, their frequencies in the F_1 hybrids and their corresponding parents are given in table 2.

In F_1 and reciprocal hybrids of the cross *S. pubescens* × *S. incanum* 12 bivalents were observed. Further details of cytological observations are given in table 2. The mean chiasma frequencies in F_1 and reciprocal hybrids were less than those in the parents.

The meiotic behaviour of the F_2 progeny of both the F_1 and its reciprocals was almost similar to that of the F_1s (table 2, figures 1A, B).

In the F_1 and its reciprocal hybrids of the cross *S. pubescens* × *S. indicum*, chromosome associations higher than bivalents upto a maximum of 1 per cell was

Table 2. Chromosome associations, chiasma frequencies and pollen fertilities in *S. pubescens*, *S. incanum*, *S. indicum* and in the F_1 and reciprocal interspecific hybrids.

							S. pubescens × *S. incanum*				*S. incanum* × *S. pubescens*				*S. pubescens* × *S. indicum*				*S. indicum* × *S. pubescens*			
	S. pubescens		*S. incanum*		*S. indicum*		F_1		F_2		F_1		F_2		F_1		F_2		F_1		F_2	
	D	MI	D	MI	D	MI	D	MI	D	MI	D	MI	D	MI	D	MI	D	MI	D	MI	D	MI
No. of PMCs analysed	50	92	53	52	88	34	78	48	44	58	120	48	124	34	88	34	84	46	88	54	84	46
Mean occurrence of associations																						
Bivalents																						
Rings	10·90	10·66	10·79	10·50	9·44	9·06	9·79	8·98	9·39	9·26	9·43	9·12	9·63	9·73	9·46	9·21	9·38	9·08	8·99	8·68	8·76	8·75
Rods	1·10	1·34	1·21	1·50	2·56	2·94	2·21	3·02	2·61	2·74	2·57	2·88	2·37	2·27	2·25	2·55	2·45	2·74	1·99	2·36	2·72	2·75
Quadrivalents	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·13	0·12	0·08	0·09	0·51	0·48	0·26	0·25
Chiasma frequency																						
Mean	22·92	22·66	22·79	22·50	21·44	21·06	21·79	20·98	21·39	21·26	21·43	21·12	21·63	21·73	21·65	21·47	21·51	21·23	21·96	21·59	21·22	21·25
Range	21–24	21–24	22–24	21–24	19–23	19–22	20–24	19–24	19–23	19–24	19–24	19–24	19–24	20–23	20–24	20–24	17–24	20–23	20–24	19–24	18–24	18–24
Percentage of pollen fertility	88		90		86		33·5		52·5		22·5		35		27		30		47		55	

D, Diakinesis; MI, metaphase I.

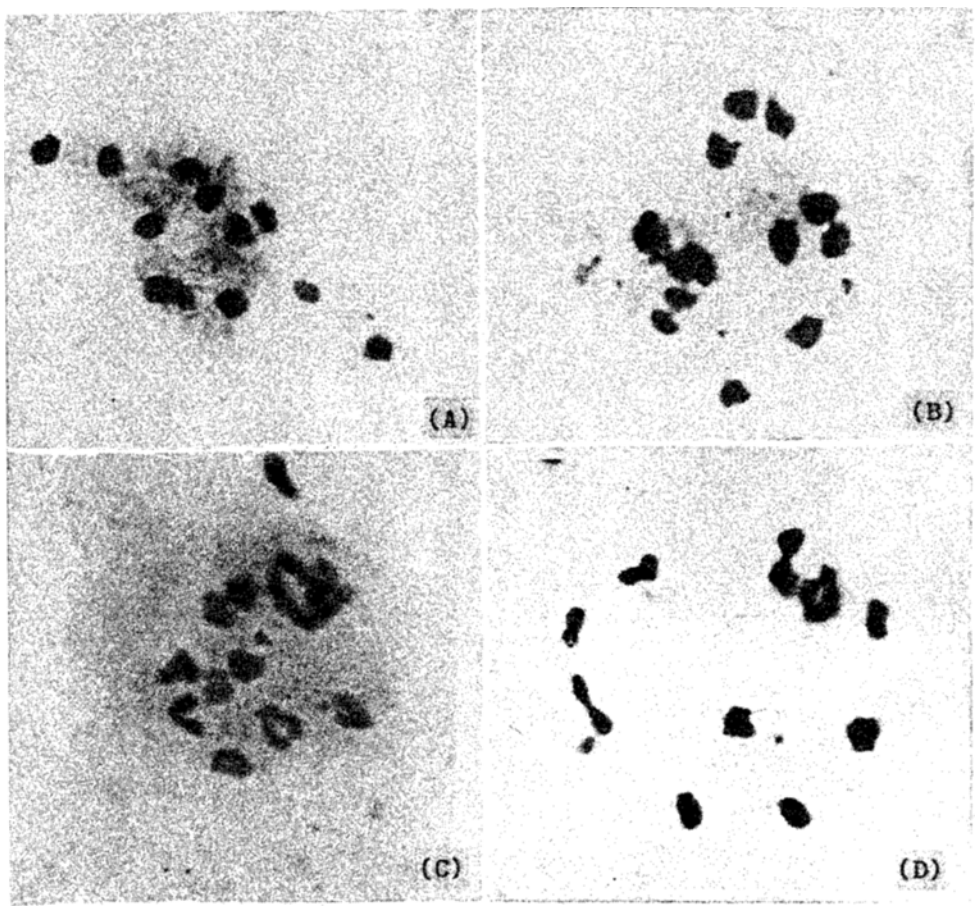

Figure 1. Diakinesis in F_1 hybrids. **A.** *S. pubescens* × *S. incanum* showing 12 II. **B.** *S. incanum* × *S. pubescens* showing 12 II. **C.** *S. pubescens* × *S. indicum* showing 1 IV + 10 II. **D.** *S. indicum* × *S. pubescens* showing 1 IV + 10 II.

observed at diakinesis and metaphase I. The mean chiasma frequencies in both the hybrids were less than that in the parents (table 2, figures 1C, D).

The meiotic behaviour of F_2 progeny of *S. pubescens* × *S. indicum* hybrid and its reciprocal was almost similar to that in the F_1s (table 2).

Post-metaphase I meiotic phenomena were regular and normal in all the 4 F_1 hybrids and their F_2 derivatives. As against the high pollen fertility in the parental genomes of *S. pubescens*, *S. incanum* and *S. indicum*, it was less in 2 F_1 hybrids (*S. pubescens* × *S. incanum*, *S. pubescens* × *S. indicum*) and their reciprocals and also the seed set was lower in the F_1 and reciprocal hybrids compared to the parental species (tables 1 and 2).

4. Discussion

The data on the interspecific cross compatability relationships involving *S. pubescens* (non-spinous taxon) and *S. incanum* and *S. indicum* (spinous taxa) reveal that the

successful crosses could be obtained, though the earlier workers (Magoon *et al* 1962; Rajasekharan 1969) opined that crosses between members belonging to the 2 groups (spinous and non-spinous) were not feasible. Apparently the compatibility vs incompatibility relationships between any 2 parental genomes involved in this study probably depend more on their interspecific genetic architecture rather than on their taxonomic identities as of one or the other taxon.

The chiasma frequencies that indicate recombination potentials are less in the 2 F_1 hybrids than in the corresponding parental genomes (table 2). However, the evidence that there exist homeologies between the chromosomes of the 2 parents involved in each of the crosses; obviously these are due to ancestral affinities which permit their pairing when 2 genomes come to be induced in a common nucleus through artificial hybridization. The occurrence of association of more than 2 chromosomes at meiosis I in each of the F_1 hybrids suggest that interchanges are involved in the divergence of the taxa from a common ancestral form. The specificity of the individual species concerned are obviously due to either post zygotic isolation mechanisms or possibly due to their allopatric distribution and occurrence.

The cytogenetic information provided earlier on the morphology, cytology, pollen fertility, and seed production and viability in the F_1s and F_2s involving the 3 different species have clearly shown that there are variations, though to different degrees on one or more of the above aspects. The different *Solanum* species both unarmed (*S. pubescens*) and armed (*S. incanum* and *S. indicum*) are cross compatible in the hybrid system. It is, therefore, logically concluded that their taxonomic distribution and separation as 'spinous' or 'non-spinous' is rather unnatural in terms of their evolution as unrelated taxonomic groups among the non-tuberiferous Solanaceae. Therefore the concept that the unarmed species and those armed with prickles are distinct groups as opined by Magoon *et al* (1962) is not supported.

It is to be emphasized that the presence or absence of arms or prickles is more dependent on the selection pressures exerted upon each of them during their individual evolutionary process of divergence; the classical example is that of cultivator *S. melongena* (egg plant) possessing different races or varieties, many of which exhibit both spinous and non-spinous conditions in their general morphological aspects.

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References

Fyson P F 1932 *The Flora of South India Hill Station* (Madras: Govt. Press)

Gamble G S 1957 *Solanaceae: Flora of the Presidency of Madras* (Calcutta: Botanical Survey of India) Vol. 2, pp 654–661

Magoon M L, Ramanujam S and Cooper D C 1962 Cytogenetical studies in relation to the origin and differentiation of species in the genus *Solanum* L; *Caryologia* **15** 151–252

Rajasekaran S 1969 Cytogenetic studies on the interspecific relationships of some common *Solanum* species occurring in south India; *Annamalai Univ. Agric. Res. Annu.* **1** 49–60

Rao Y V and Rao B G S 1986 Cytogenetic studies on the F_1 hybrids of *Solanum pubescens* with *S. melongena* and *S. melongena* var. *insanum*; *Indian J. Bot.* (in press)

Veerabhadra Rao and Rao B G S 1977 Screening of flowering in interspecific crosses of some spinous *Solanum* species; *Curr. Sci.* **46** 123-124