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COMPATIBILITY STUDIES IN SHOE FLOWER *(HIBISCUS ROSASINENSIS* L.)

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Ornamental *Hibiscus* is a highly polymorphic species (Gast, 1971). *H. rosa-sinensis* L. (shoe fower), *H. mutabilis* L. and *H. schizopetalus* Hook are the three important ornamental species of *Hibiscus* grown all over the tropics and subtropics. There exists tremendous possibilities of improving the different types/varieties of shoe flower through hybridization. In the present study, an attempt was made to find out different aspects of compatibility like self, intervarietal and interspecific so as to obtain information for future hybridization programme.

Materials and Methods

The investigations were carried out at the College of Horticulture, Vellanikkara, Trichur during the years 1981 to 1983. The experimental materials comprised of seven types/varieties of *H. rosasinensis* (Accession 2, 5, 11, 16, 18, 22 and 26) and two other species namely *H. mutabilis* and *H. schizopetalus*. (Table 1) There was distinct variation in the morphology of flowers in the nine types/varieties/species studied. Flower opening took place during the morning hours (4 to 8.30 am) and anther dehiscence commenced soon after flower opening. Selfing of all the nine types/varieties/species was done to find out self compatibility.

For finding out intraspecific cross compatibility, seven types/varieties of *H, rosa-sinensis* were used as female parents and the following crosses were effected. Acc. 5 and 16 produced only small quantity of pollen grains. Hence they were not used as male parent.

2x11	5x 2	11x 2	16x 2	18x 2	22x 2	26x 2
2x18	5x11	11x18	16x11	18x11	22x11	26x11
2x22	5x18	11x22	16x18	18x22	22x18	26x18
2x26	5x22	11x26	16x12	18x26	22x26	26x22
	5x26		16x26			

Three types/varieties of *H. rosa-sinensis* (Acc. 2, 18 and 26), *H. mutabilis* (HM) and *H. schizopetalus* (HS) were used to find out interspecific cross compatibility. The cross combinations were:

2xHM	18xHM	26xHM	HMx2	HSx2
2xHS	18xHS	26xHS	HMx18	HSx18
			HMx26	HSx26
			HMxHS	HSxHM

Mature buds of the female parent were emasculated on the evening prior to the expected date of flower opening and bagged with a butter paper cover.

Pollen from the bagged flower of the desired male parent, soon after anther dehiscence were brought along with the staminal column and slowly smeared on the stigmatic surface of the female parent. The pollinated flowers were bagged and properly labelled. The bags were removed after a week of pollination and young capsules were allowed to develop under natural conditions. For selfing, the same procedure was followed but pollen from the bagged flowers of the same plant was used.

Capsule development in each of the pollinated flowers was observed on the 5th day and 15th day after pollination. Wherever capsules were retained after 15 days, they were observed till maturity. For assessing the cross and self compatibility the capsules were harvested at full maturity and the hybrid seeds were freshly sown in pots containing the potting mixture (1:1:1 soil: sand: cowdung). A crossability index was calculated to measure the crossing affinity between each pair of parents as suggested by Rao (1979).

$$\text{Crossability index} = \frac{\text{Crossing efficiency of the cross}}{\text{Selfing efficiency of female parent}} \times 100$$

$$= \frac{A^c \times B^c * C^c \times D^c}{A^s \times B^s \times C^s \times DS} \times 100$$

Where, c = crossed s = selfed, A = percentage of fruit set, B = mean number of seeds per fruit, C = percentage germination of the seeds, and D = percentage survival of the germinated seedlings.

Results and Discussion

It was found that only Acc. 2 and *H. mutabilis* set fruits naturally. In Acc. 2, fruit set was occasional and occurred during the peak flowering season. The failure of natural fruit set in other types might be due to problems like lack of pollination, fertilization and self sterility.

Self compatibility

Results of the studies of self compatibility are presented in Table 2. Acc. 2, 5, 18, 22, 26 and *H. mutabilis* were found to be self compatible and more than 75 per cent fruit set was observed after five days from pollination. Only 36 to 82.6 per cent of capsules matured indicating that fruit shedding is a conspicuous problem in *Hibiscus.* At maturity *H. mutabilis* gave the maximum percentage of capsule set (82 6) followed by Acc. 2 (62). Acc. 11 and *H. schizopetalus* which had a high percentage of pollen germination and tube growth *in vitro* conditions (Markose, 1984), failed to set fruits on selfing. This might be due to inhibition of pollen germination on stigmatic surface, inhibition of pollen tube growth in style, early abscission, etc. It was observed that the success or failure to set fruit was also influenced by season. Compared to January-March, fruit setting was high in August-October. Number of days taken for maturity and germination of seeds varied for different types/varieties/species. The fruits matured in 28 days (Acc. 2)

Table 1
Morphology of nine types/varieties/species of *Hibiscus*

Col. No.	Acc. No./ Name of types/varieties/species	Leaves — shape, margin, apex	Flower — size and corolla colour	Stamens — length (cm), number of anthers and colour of filaments and stigma
1	Acc. 2	Ovate, serrate, acute	Single, erect, saffron yellow with ruby red base	8.1, 68–80 cedar bark, salvia
2	Acc. 5	Ovate, almost entire, white	Double, slightly erect, martius yellow with oyster white base	1.8, 14–17 yellow, mandarin orange
3	Acc. 11	Ovate, serrate, acute	Single, erect, rose with venetian rose base and yellow pink centre	5.5, 75–84 orange yellow, Chinese orange
4	Acc. 10 (Nazareth)	Cordate-ovate, serrate, acute	Single, erect, firefly with jasmine border. The base is ox heart with rose neyron border	5.0, 50–60, orange yellow, golden poppy
5	Acc. 18 (Hawaiian Yellow)	Ovate, serrate, acuminate	Single, erect single flower, dandelion with honey dew base	8.5, 70–81 golden glow orange peel
6	Acc. 22	Ovate, serrulate, acuminate	Single, pendulous, carnivel red with maroon base	8.0, 70–75 cedar bark, mescare
7	Acc.28	Ovate, serrate acuminate	Single, erect, valencia with ox heart base	5.8, 61–80 orange yellow red cross
8	*Hibiscus sinensis* (XM)	Broad-ovate to nearly round-ovate in outline, margin at base, 3 5 lobed, acute or acuminate, shallowly or deeply	Double, erect, white in the morning, pink colour at noon and spring beauty by evening	1.9, 160–185 pop corn pop corn
9	*Hibiscus schizopetalus* (HS)	Ovate, elliptic lanceate acute/ acuminate	Single pendulous, multipart fringed petals It is beautifully cut at various length (fringed corolla) Spring red with pollen base	7.5–8.0, 73–94 Cedar bark Maroon

Table 2

Self compatibility in different types/varieties/species of *Hibiscus*

Sl. No.	Genotype	No. of flowers pollinated	Capsule set at 5 days %	Capsule set at 15 days %	Capsule set at maturity (A^s) %	Days to maturity	Mean No. of seeds/ capsule (B^s)	Days to germination	Germination percentage (C^s)	Survival of germinated seedlings (D^s)
1	Acc. 2	50	80.00	64.00	62.00	30	12.20	17	45.90	100.00
2	Acc. 5	25	76.00	48.00	36.00	31	8.50	18	65.12	96.43
3	Acc. 11	50	—	—	—	—	—	—	—	—
4	Acc. 16	10	—	—	—	—	—	—	—	—
5	Acc. 18	13	76.92	61.54	46.15	38	8.50	14	69.77	96.67
6	Acc. 22	21	76.19	57.14	42.86	30	12.00	14	56.67	97.06
7	Acc. 26	23	82.61	60.87	60.87	28	10.67	12	67.92	100.00
8	HM	20	90.00	82.61	82.61	31	192.50	10	3.33	100.00
9	HS	25	—	—	—	—	—	—	—	—

Table 3

Intra-specific cross compatibility between different types/varieties of *Hibiscus rosa-sinensis*

Sl. No.	Genotype	No. of crosses made	Capsule set after 5 days %	Capsule set after 15 days %	Capsule set at maturity % (Ac)	Days to maturity	Mean No. of seeds/ fruit (Bo)	Days to germination	Germination percentage (O)	Survival of seedling percentage (Cc)	Crossability index %
1	2	3	4	5	6	7	8	9	10	11	12
1	Acc. 2 x Acc. 11	47	70 60	63.82	53.19	28	16.20	13	76.54	10000	189.96
2	Acc. 2 x Acc. 18	36	72.22	55.56	38.89	27	17.40	11	56.32	97.96	107.53
3	Acc. 2 x Acc. 22	30	80.00	63.33	40.00	28	12.20	12	73.77	95.56	99.09
4	Acc. 2 x Acc. 26	55	76.36	65.45	59.04	28	10.80	14	70.37	100.00	111.51
5	Acc. 5 x Acc. 2	49	75.51	31.78	20.49	27	13.80	16	62.32	100.00	91.71
6	Acc. 5 x Acc. 11	44	75.00	47.73	20.45	29	11.00	16	74.55	100.00	87.27
7	Acc. 5 x Acc. 18	33	69.70	51.52	36.36	30	8.00	15	55.00	95.45	79.47
8	Acc. 5 x Acc. 22	37	67.57	43.24	16.22	31	9.25	11	65.22	96.67	49.23
9	Acc. 5x Acc. 26	37	81.08	54.05	30.84	31	8.75	14	59.09	100.00	82.98
10	Acc. 11 x Acc. 2	50	—	—	—	—	—	—	—	—	—
11	Acc. 11 x Acc. 18	47	—	—	—	—	—	—	—	—	—
12	Acc. 11 x Acc. 22	49	—	—	—	—	—	—	—	—	—
13	Acc. 11 x Acc. 26	49	—	—	—	—	—	—	—	—	—
14	Acc. 16x Acc. 2	18	66.67	50.00	38.88	28	4.33	12	45.45	90.00	—
15	Acc. 16x Acc. 11	20	70.00	45.00	25.00	29	3.67	14	33.33	100.00	—

1	[illegible]	3	4	5	[illegible]	7	[illegible]	9	10	11	12
16	Acc. 16 × Acc. 18	14	71.43	42.00	21.43	30	7.00	13	45.71	93.75	—
17	Acc. 1[illegible] × Acc. [illegible]	1[illegible]	[illegible].15	47.[illegible]7	15.7[illegible]	[illegible]1	[illegible].[illegible]5	15	4[illegible].75	[illegible]5.71	—
1[illegible]	Acc. 1[illegible] × Acc. 26	15	7[illegible].83	[illegible]	[illegible]	[illegible]0	[illegible].[illegible]5	1[illegible]	[illegible]1.[illegible]5	100.00	—
1[illegible]	Acc. 1[illegible] × Acc. 2	[illegible]	7[illegible].78	[illegible]0.[illegible]1	48.49	[illegible]7	[illegible].87	12	55.81	100.00	[illegible]
[illegible]	Acc. 1[illegible] × Acc. 11	[illegible]	7[illegible]	58.[illegible]	50.00	[illegible]5	7.[illegible]	[illegible]	81.[illegible]	100.00	11[illegible].81
[illegible]1	Acc. 1[illegible] × Acc. [illegible]	[illegible]1	[illegible].67	47.[illegible]	[illegible].57	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]
[illegible]	Acc. 1[illegible] × Acc. [illegible]	20	75.[illegible]	4[illegible]	4[illegible]	3[illegible]	[illegible]	1[illegible]	57.14	100.00	[illegible]
[illegible]	Acc. [illegible] × Acc. [illegible]	[illegible]	7[illegible]	[illegible].4[illegible]	2[illegible]7	[illegible]	12.00	1[illegible]	57.89	[illegible].94	5[illegible]
[illegible]4	Acc. [illegible] × Acc. 11	[illegible]	[illegible].77	57.[illegible]	4[illegible].81	27	1[illegible].[illegible]	11	71.48	97.78	1[illegible]0.57
25	Acc. 22 × Acc. 1[illegible]	[illegible]4	7[illegible].17	[illegible]	[illegible]	[illegible]	10.7[illegible]	1[illegible]	[illegible]	[illegible].[illegible]7	4[illegible].51
[illegible]	Acc. [illegible] × Acc. [illegible]	[illegible]9	7[illegible].41	4[illegible]	[illegible]1.[illegible]	[illegible]	[illegible].[illegible]	[illegible]	[illegible].44	100.00	[illegible]
[illegible]7	Acc. [illegible] × Acc. [illegible]	50	[illegible]	[illegible]4.[illegible]	5[illegible].[illegible]0	[illegible]7	11.[illegible]0	14	71.48	100.00	1[illegible]
[illegible]8	Acc. [illegible] × Acc. 11	4[illegible]	77.55	[illegible]7.35	[illegible]7.14	[illegible]	1[illegible]	1[illegible]	77.[illegible]4	100.00	1[illegible]7.[illegible]
[illegible]	Acc. [illegible] × Acc. [illegible]	[illegible]4	7[illegible]	45.[illegible]	37.50	[illegible]	10.50	15	[illegible]	100.00	50.[illegible]
[illegible]0	Acc. [illegible] × Acc. [illegible]	[illegible]4	[illegible]7	[illegible]7.50	[illegible]	[illegible]7	[illegible].50	[illegible]	75.75	[illegible]	[illegible]5.71

Table 4

Inter-specific cross compatibility between three species of *Hibiscus*

Sl. No.	Genotype	No. of crosses made	Capsule set after 5 days %	Capsule set after 15 days %	Capsule set at maturity %	Days to maturity	Average No. of seeds/ fruit	Days to germination	Germination percentage
1	2xHM	49	16.33	—	—	—	—	—	—
2	2xHS	39	74.36	41.02	5.13	27	8.4	—	—
3	18 x HM	40	15.00	—	—	—	—	—	—
4	18xHS	22	54.35	31.82	0	0	7.0	—	—
5	26xHM	22	40 91	—	—	—	—	—	—
6	26xHM	31	70.96	35.48	6.45	26	10.0	—	—
7	HMx2	31	—	—	—	—	—	—	—
8	HM x 18	18	—	—	—	—	—	—	—
9	HMx26	22	—	—	—	—	—	—	—
10	HM x HS	24	—	—	—	—	—	—	—
11	HS x 2	20	—	—	—	—	—	—	—
12	HSx18	24	—	—	—	—	—	—	—
13	HS x 26	21	—	—	—	—	—	—	—
14	HS x HM	28	—	—					

to 38 days (Acc. 18) and seeds generated in 10 days (HM) to 18 days (Acc. 5). The number of seeds per capsule ranged from 8.5 (Acc. 5 and Acc. 18) to 192.5 (HM) and seed germination ranged from 3.33 per cent (HM) to 69.77 per cent (Acc. 18). In HM, low seed germination might be due to seed dormancy. All the types/varieties/species showed more than 95 per cent survival of germinated seedlings.

Intra-specific cross compatibility

Data relating to intraspecific cross compatibility among the seven types/varieties of *H. rosasinensis* are presented in Table 3. Out of the 30 intervarietal crosses made, only four with Acc. 11 as maternal parent were failures. This type was also self incompatible. This indicated that certain varieties are not suitable as female parent for hybridization programme. In the remaining 26 crosses, the percentage of capsule set was high after five days of pollination, but later the percentages reduced considerably. The capsule set in these crosses indicated the cross compatible nature of the types involved. The percentage of capsule set at maturity was maximum in crosses where Acc. 2 and 26 were used as the pistillate parent. With respect to seed set, in general, it was found that in crosses where Acc. 2, 5, 22 and 26 were the maternal parents, seed number per fruit was higher than that of the respective selfed maternal parent ranging from 10.8 to 17.4, 8 to 13.8, 8 to 12.5 and 6.5 to 13.6 seeds per capsule, respectively. This confirmed that intra-specific cross incompatibility is only very little in *H. rosa-sinensis* (Table 3). The possibility of evolving new varieties through intervarietal crosses is thus very high in shoe flower (Devaiah, 1968; Bhat and Verma, 1980). In the successful crosses, the number of seeds ranged from 3.25 to 17.6 per capsule which is comparable to the report of Bhat (1976). The germination percentage of the hybrid seeds was high (more than 60%) in crosses where Acc. 2, 22 and 26 were used as the female parent except in crosses with Acc. 18. The germination was well over 50 per cent in all the successful crosses, except where Acc. 16 was used as the pistillate parent. The percentage survival of the hybrid seedlings varied from 90 to 100. Germination of hybrid seeds was also earlier by 8 to 16 days than the seeds obtained from their selfed maternal parent (12-18 days). Bhat (1976) reported that the capsules took 41 to 70 days for seed maturity under Bangalore conditions. The influence of climate on seed maturity is thus clearly established. Crossability index was found to be highest for Acc. 2 x Acc. 11 (Table 3).

Inter-specific cross compatibility

The results of the inter-specific cross compatibility study indicated the existence of a cross incompatibility barrier among the three species of *Hibiscus* (Table 4). Crosses using *H. mutabilis* (HM) and *H. schizapetalus* (HS) as the maternal parent did not produce any ovary stimulation, while on selfing HM gave 82.6 per cent capsule set. Whenever *H. rosa-sinensis* (HR) was used as the

maternal parent, there was better fruit set. In the case of HRxHM, fruits that were initially set did not come to maturity while in HR x HS, in fruits which were carried to maturity, the seeds did not germinate.

Fruit and seed characters

Variation in fruit shape was noticed in different types/varieties/species. The shape of capsules in Fo was similar to that obtained by selfing the female parent. The capsules of different types/varieties of *H. rosa-sinensis* were beaked or without beak, with acute/flat or emarginate. The capsules of *H. mutabilis* were globose and hairy. The seeds of different types/varieties of HR were having more or less similar shape. They were globose and black The seeds of HM were reniform, brown and hairy.

Summary

Three ornamental species of *Hibiscus* viz. *H. rosa-sinensis* (HR), *H. schizopetalus* (HS), and *H. mutabilis* (HM) were utilised to study their self and cross compatibility. It was found that only Acc. 2 of HR and HM set fruits naturally. Out of the seven types/varieties of HR and two other species HM and HS selfed, only five types/varieties of HR and the species HM were found to be self compatible. The fruits matured in 28 to 38 days and seeds germinated in 10 to 18 days. The number of seeds per capsule ranged from 8.5 to 192.5 and seed germination ranged from 3.33 to 69.77 per cent. The survival percentage of germinated seedlings was more than 95 percent. Intra-specific cross compatibility was observed in all the crosses attempted in the species HR except in cases where Acc. 11 was used as the maternal parent. In all the cases the capsules took comparatively lesser time to attain maturity than their selfed maternal parent. In majority of crosses, the germination of hybrid seeds was earlier than the seeds obtained from the selfed maternal parent. The cross Acc. 2 x 11 had the highest crossability index followed by Acc. 2 x 18, 2 x 26, 18 x 11, 22 x 11, 26 x 2 and 26 x 11. Only in crosses between Acc. 2 x HS and Acc. 26 x HS fruit set was observed, but the seeds obtained from the fruits failed to germinate. Thus a strong barrier for crossability between the species was evident.

The capsules of different types or varieties of *H. rosa-sinensis* were of ovoid, oblong or sub globose and *H. mutabilis* were globose and hairy. The seeds of the former were globose and black and those of the latter were reniform, brown and hairy.

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