A TETRAPLOID JUTE HYBRID

C-4X JUTE, C. OLITORIUS X NEW WORLD WILD JUTE SPECIES, C. SILIQUOSUS

A. S. Islam and Zeeshan Abbasi

Department of Botany, University of Sind.

Introduction

Since 1956 a series of crosses are being made in this department with a view to determining first the extent of crossability between wild and cultivated species of *Corchorus* and then utilizing the combinations showing good flow of genes for breeding disease and drought resistant varieties. One of such crosses was between a tetraploid species, *C. siliquosus* (2n=28) from Jamaica and the cultivated species of *C. olitorius* var. C.G. To facilitate crossing the colchicine induced tetraploid *C. olitorius* var. C.G. was used. The results of this investigation are presented in this paper.

Review of literature

Rao and Datta (1953) reported for the first time the haploid chromosome number of *C. siliquosus* to be 14, indicating that it is a natural tetraploid. Sharma and Roy (1958), Islam and Qaiyum (1961) determined the somatic chromosome number to be 28 from the root-tip cells of this species and thus confirmed the report of Rao and Datta (1953).

Interspecific hybridization was attempted by Datta and Sen (1961) between *C. siliquosus* and *C. sidoides*—an Australian species but they failed to obtain any hybrid although the crossing yielded fruits with shrivelled seeds. The seeds labelled as *C. sidoides* received in this laboratory from Australia was from the same source, namely, C.S.I.R.O., Australia as those obtained by Datta and Sen (*l.c.*). Since we found these to be the seeds of *C. aestuans* L., it is quite likely that the crosses made by them were between *C. siliquosus* and *C. aestuans* and not between the species of *C. siliquosus* and *C. sidoides* as claimed by them. Mughal and Islam (1966) in an attempt to cross, c-4x *C. olitorius* X *C. pascuorum* —a natural tetraploid from Australia, obtained two parthenogenetic polyhaploids of maternal origin.

Material and Method

Material used

(*a*) *Cultigen*

c-tetraploid *C. olitorius* L. var. C.G. ex-Dacca (Fig. 1 *a*)

(*b*) *Wild*

Natural tetraploid *C. siliquosus* L. ex-Jamaica (Fig. 1 *c*)

Method

When no fruit set was obtained in the cross, c-4x *C. olitorius* X *C. siliquosus*, the stalks of the pollinated flowers were smeared with 300 p.p.m. IAA in lanolin paste. Since the flowering time in the two species was different (the flowers of *C. olitorius* open at 9-00 a.m. and those of *C. siliquosus* between 12-0 noon to 1-0 p.m.), the flowers used were first placed in a desiccator and then kept inside a refrigerator until used. The hybrid seeds were grown in sterilized soil and from some, embryos were dissected and implanted in embryo culture medium (Qureshi, 1964).

Experimental Results

672 reciprocal crosses were made between c-4x *C. olitorius* and *C. siliquosus* during September to October, 1964. Crosses were first attempted without the use of hormone. None of the 125 crosses with c-4x *C. olitorius* as pollen parent yielded any fruit nor there was any fruit set in the 65 reciprocal crosses. When the hormone was used in 206 crosses of the latter combination, 25 fruits were obtained.

Of the 25 fruits 4 were parthenocarpic and the remaining 21 had a total number of 100 seeds, their number varying from 1-16 per fruit. There was no fruit set in any of the 276 hormone applied reciprocal cross. The results of the crosses are summarised in table I.

TABLE 1

Results of crosses, c-tetraploid *C. olitorius* X *C. siliquosus* with and without the use of IAA

Parents		Hormone	No. of crosses	No. of fruit set	No. of fruits harvested	Percentage of fruit set	No. of seeds per fruit	No. of adult plants
Female	Male							
c-4x *C. olitorius*	*C. siliquosus*	(+)	206	25	25	8.3	0.16	2
Reciprocal		(+)	276	..	..	..	..	..
c-4x *C. olitorius*	*C. siliquosus*	(—)	65	..	..	..	..	..
Reciprocal		(—)	125	..	..	..	..	..

(+) With hormone

(—) Without hormone

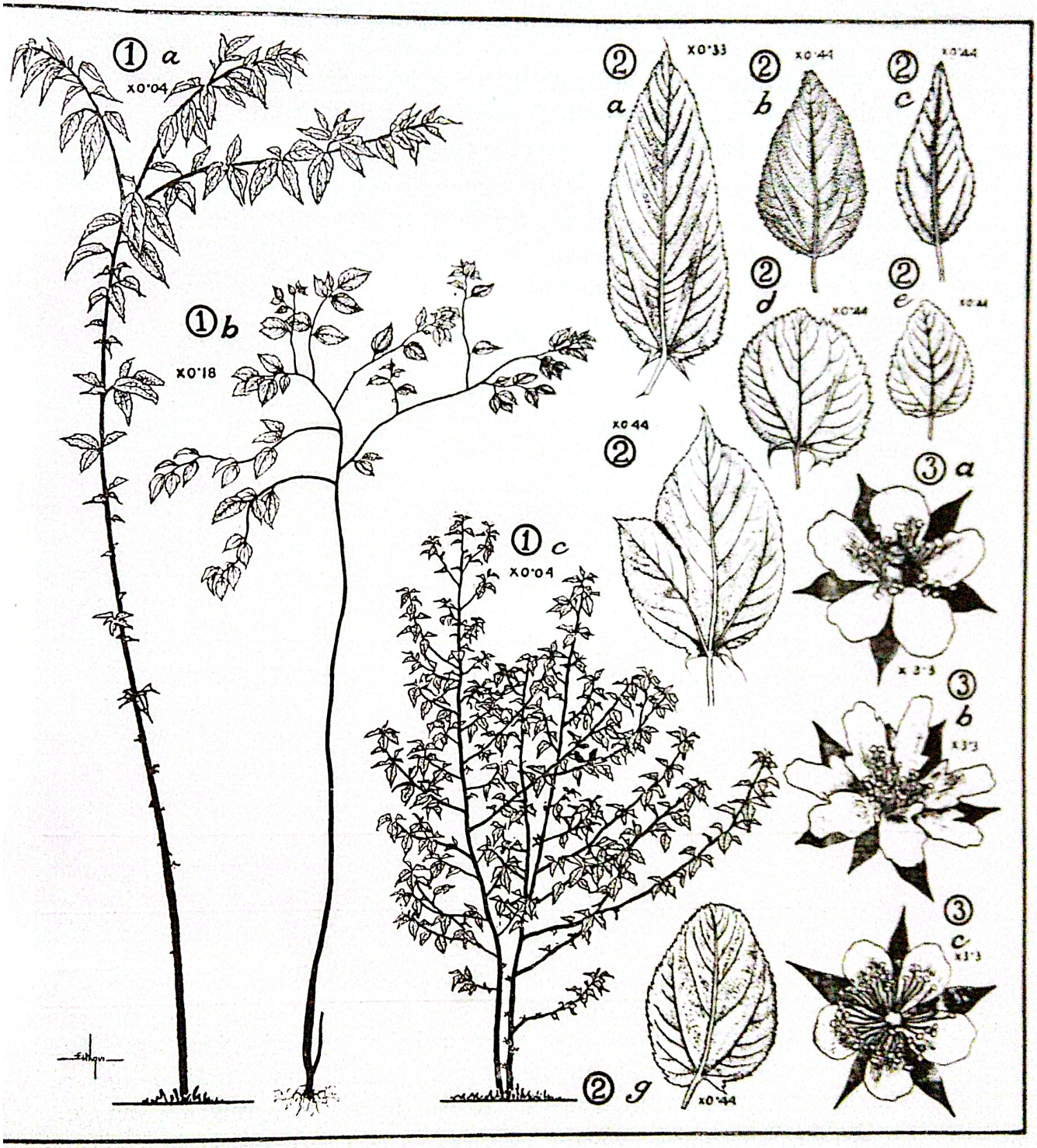

Fig. 1. Comparative height and habit of (*a*) c-4x *C. olitorius* var. C. G. (*b*) F_1 hybrid (*c*) *C. siliquosus*. Fig 2. comparative size and shape of the leaf of 2a, c-4x *olit*; 2b, F_1 hybrid; 2c, *siliquosus*; 2, bifid leaf; 2d, 2e, 2g, abnormal leaves of the hybrid. Fig 3. Comparative size and shape of the flower of 3a, c-4x *olit*; 3b, F_1 hybrid showing irregularly outlined petals; 3c, *siliquosus*.

Table I shows clearly that with the use of hormone only, it was possible to obtain 8.3 per cent fruit set with *C. olitorius* as seed parent, while in reciprocal crosses there was no fruit set in spite of the use of hormone.

Thirty embryos were dissected out from the hybrid seeds and implanted in the culture medium. For comparison a few embryos from the c-4x *C. olitorius* were also grown in the culture medium side by side with hybrid embryos. The dissected embryos were kept in the dark at 25°C ± 2 for 48 hours, after which they were transferred to constant light at room temperature.

Only 12 hybrid embryos showed signs of growth after implantation. Of these, six were albino, 5 completely so and the sixth one had one green normal sized and one small albino cotyledon. The latter grew for six weeks in the culture tube (Fig. 4) while the remaining 5 albino died within a period of one week. The growth of the control as well as that of six other green hybrid seedlings was normal in the culture tube but none of these as well as the six weeks old semi-albino seedling survived on transfer to the soil. Since all the control also died in the culture tube, the reason of the death of the hybrid seedlings may be on account of the drastic change of mode of nutrition which the seedlings had to face on transfer from cultural medium to the soil. Thirty hybrid seeds were also sown in sterilized soil. Eighteen of them germinated of which 2 grew to adult stage. The results are shown in table 2.

TABLE 2

Percentage of germination of hybrid seeds of the cross, c-tetraploid *C. olitorius* X *C. siliquosus*

	No. of seeds used	No. of seedlings obtained	Percentage of germination	No. of adult plants
Embryo culture	30	12	40	Nil
Soil	30	18	60	2

All the two hybrid plants were weak and slow growing—characters which are often exhibited by interspecific hybrids of distantly related species. They flowered later than their parents. Similar delayed flowering was reported in the F_1 hybrids, *C. olitorius* var. C.G. X *C. capsularis* var. D. 154 (Islam and Rashid, 1960). In the length of the stem, base (Fig. 1b) and pollen diameter, both the hybrids showed the dominance of the male parent while in the other characters *e.g.*, B/L ratio of leaf, shape and size of flower, the hybrids were intermediate. The hybrids showed the dominance of the female parent in the type of serration (Fig. 2 *a, b, c*) and shape of flower (Fig. 3 *a, b, c*) and in being annual. In addition, the hybrids showed abnormal characters, such as, a few of

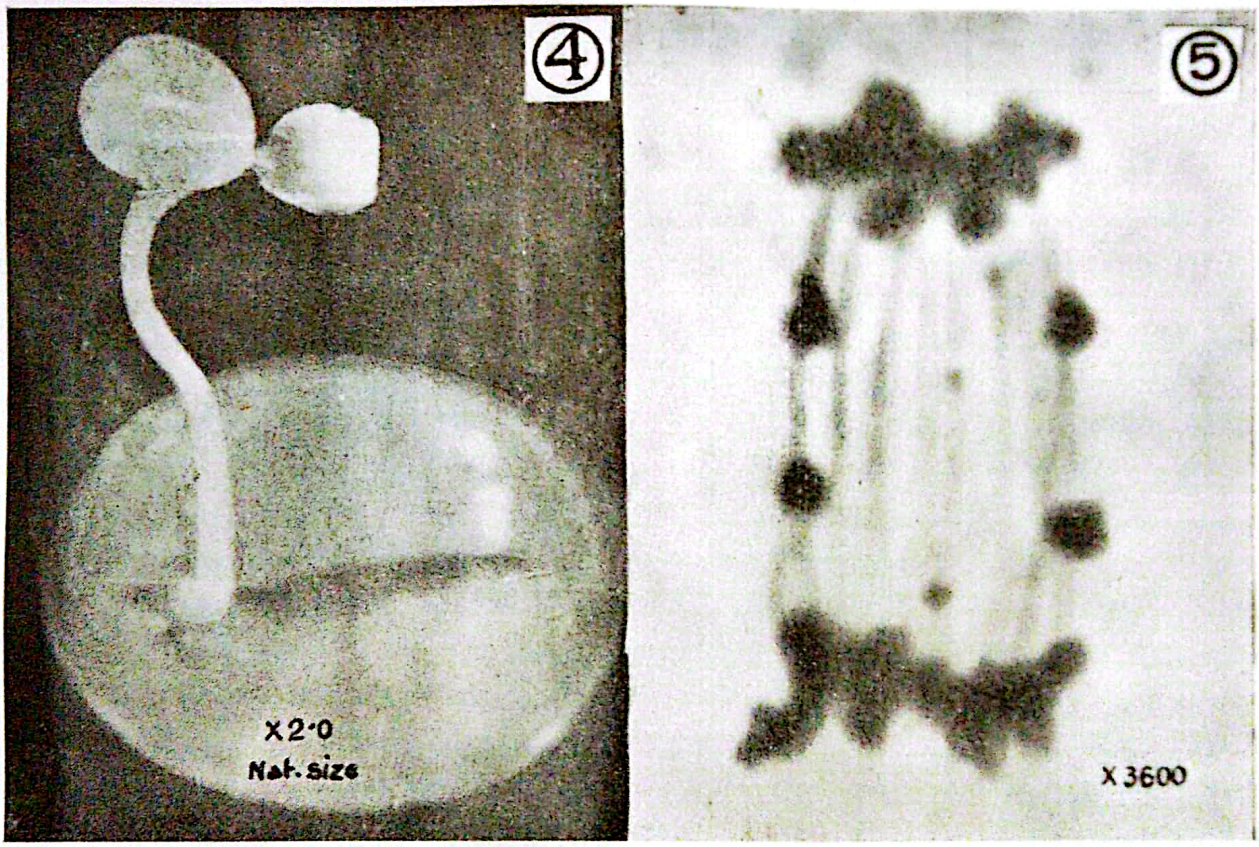

Fig 4. A semi-albino F_1 hybrid seedling with one normal-sized green and one small albino cotyledon. Fig 5. Anaphase I of the hybrid showing 4 lagging chromosomes.

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the leaves had broader base, obtuse apex (Fig. 2 *d*, *g*), irregular serration and a few were bifid (Fig. 2). In some flowers, the number of petals was 4, in some six and in a few others the number increased to 7 (Fig. 3b). In the latter, the petals were not well developed showing irregular outlines (Fig. 3b). In table 3, a comparison between the parents and the hybrids has been made.

TABLE 3

Comparative study of morphological characters of the hybrids and parents

Character	c-tetraploid *C. olitorius*	Hybrid	*C. sil'quosus* (tetraploid)
1. *General*			
(*a*) Habit	Herb	Herb	Perennial
(*b*) Height	101-305 cm	61, 91.5 cm	60-92 cm
(*c*) Base diameter	1.65 cm	0.6 cm	0.5 cm
2. *Leaf*			
(*a*) B/L ratio	0.526 ±.02	0.397 ± 0.21	0.306 ± 0.03
(*b*) Shape	Simple	Simple, rarely bifid	Simple
(*c*) Serration	Serrated	Greater portion of the margin serrated, very little dentate, *olitorius* dominant	Dentate
3. *Flower*			
(*a*) Colour	Yellow	Yellow	Yellow
(*b*) Size	Large	Intermediate	Small
(*c*) Sepals	5	4-7	5
(*d*) Petals	5	4-7, some irregularly outlined	5
(*e*) Percentage of stainable pollen	92	59	90
(*f*) Pollen diameter	52±2.4μ	37±3.2μ	39±2.4μ
4. Fruit	Normal	Flower dropped after anthesis	Normal

The stainability of pollen grains in the hybrids was 59 per cent. No fruit developed on either of the hybrids since the flowers were shed one day following anthesis. Hormone was applied on the pedicel to prevent the flower drop but without any effect.

Cytology

Meiosis was studied in order to learn the extent of homology between the chromosomes of the two species and to form an idea of the contributory factors affecting the fertility of the hybrid. Detailed meiotic study was not possible due to the small number of buds. Seven p.m.cs. were studied at side view of metaphase and anaphase I. In three of them two to four lagging chromosomes were observed in late anaphase I (Fig. 5). These may have resulted in the formation of pollen grains with unequal chromosome numbers. The meiotic irregularities may be one of the major factors in causing as much as 41 per cent pollen unstainability but this cannot account for the shedding of flowers. Dropping of flowers may be due to physiological reasons.

Discussion

Two F_1 hybrids were obtained in the hormone applied cross, c-4x *C. olitorius* X *C. siliquosus*; both the hybrids were derived in one direction, namely, when *C. olitorius* was the seed parent. Without the application of IAA, there was no fruit set even in the direction in which hybrids were obtained. The use of hormone thus makes it possible to determine the interspecific relationships between species in which hybrids are not possible to raise in the usual way. It is interesting to note here that excepting a few instances, the majority of the *Corchorus* species crosses, yield hybrids in one direction only (Islam, 1965). Both the hybrids were slow growing and when they attained their full growth they were still weak. They also showed delayed flowering which may be due to slow growth of the hybrid. Such slow growth is the characteristic of the hybrids between the distantly related species as exemplified by *C. olitorius* X *C. capsularis* (Islam and Rashid, 1960), *Layia* hybrids (Clausen, 1951) etc. In the hybrids, *C. olitorius* X *C. siliquosus*, the flowers dropped one day following anthesis. Such flower drop was also observed in the hybrid between *C. olitorius* and *C. pseudo-olitorius* (Islam & Kadir, 1960). But in this combination, unlike others, hybrids were obtained reciprocally and only in the direction in which *C. olitorius* was female, flower drop was noticed while the reciprocal hybrids fruited. Meiotic studies of the hybrid, *C. olitorius* X *C. siliquosus* showed more or less the same irregularities as were observed in *C. olitorius* (female) X *C. pseudo-olitorius* hybrids.

The present studies suggest that the genomes of *C. olitorius* and *C. siliquosus* species of the old and new world respectively, have differentiated so much that the hybrid formation between them is barely possible and that also in one direction and only through the use of hormone.

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On account of such genomic differentiation the genetic physiologic system in the F_1 hybrids was upset resulting in the flower drop, irregular development of petals, and irregular meiosis.

Summary

Two hundred six hormone applied crosses, c-tetraploid *C. olitorius* X *C. siliquosus* yielded two hybrids unidirectionally with the latter species as the pollen parent. Both the hybrids were slow growing and showed delayed flowering. Flowers in both the hybrids were shed one day following their opening. Both the plants showed appox. 59 per cent pollen sterility. From the results it is concluded that the genomes of *C. olitorius* and *C. siliquosus* are well differentiated from each other with the result that only weak hybrids may be formed between them and that also when hormone is applied in the pedicels of pollinated flowers.

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