ATTEMPTS TO OVERCOME THE CROSSABILITY BARRIER BETWEEN GOSSYPIUM SPECIES. I. G. ARBOREUM X G. HIRSUTUM

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Introduction

In interspecific hybridisation involving two species differing in ploidy level, chances of success are almost always enhanced if level of ploidy in the two is brought to even. Thus Stephens (1942) reported greater percentage of boll set in *Gossypium arboreum-G. hirsutum* crosses by using colchicine-induced tetraploids of *G. arboreum* in place of natural diploid. The use of hormones *e.g.*, indole acetic acid, indole butyric acid etc. on the pedicels of pollinated flowers has also been found to increase the chances of success such as in *Corchorus* species crosses (Islam, 1965). It was therefore thought that chances of success to cross *G. arboreum* with *G. hirsutum* would increase if both the above mentioned techniques are employed together.

Material and Methods

(*a*) Species used:

(*i*) Colchicine-induced tetraploids of *G. arboreum* var. T.D.I. (2n=52).

(*ii*) *G. hirsutum* var. M. 4 (2n=52).

(*b*) Hormone used:

Thirty mgs. of indole-3-acetic acid was first dissolved in a small quantity of alcohol and then made into a paste in 10 gms. of lanolin. 300 ppm strong IAA was prepared from this stock.

Experimental results

Reciprocal crosses were made between c-4x *G. arboreum* and *G. hirsutum* applying IAA in the pedicels of some pollinated flowers and in the rest, no hormone was used. The results of these crosses are summarised in table 1.

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TABLE I

Results of crosses, c-4x *G. arboreum* (GA) x *G. hirsutum* (GH); (—) without IAA, (+) with IAA

Parents		No. of crosses	No. of fruit set	Percentage of harvest	Total No. of seeds obtained & sown	No. of seeds germinated	Percentage of germination	No. of adult plants
Female	Male							
c-4x GA	GH	42 (—)	5	11.9	24	3	12.5	2*
do.		175 (+)	6	3.4	9	1	11.1	1*
GH	c-4x GA	112(—)	5	4.4	1	..	..	..
do.		165(+)	9	5.5	7	2	28.5	1*

*All the plants died at the initiation of flowering.

The results presented in table I show that the use of hormone brought down the percentage of fruit set from 11.9 to 3.4 in c-4x *arboreum-hirsutum* crosses with the latter as the pollen parent. In the reciprocal direction, on the other hand, hormonal application increased the percentage of fruit set from 4.4 to 5.5. IAA produced the same effect in the development of hybrid seeds. With *arboreum* as the mother, the number of seeds in 5 fruits was 24 in the control as against 9 in 6 fruits in hormone applied crosses. In the reciprocal direction, IAA definitely stimulated the development of seeds since as against 1 seed in 5 fruits in the control, hormonal application in the crosses gave 7 seeds in 9 fruits, almost one seed per fruit.

There was not much of difference in the percentage of germination of hybrid seeds in the cross, c-4x *arboreum* (female) x *G. hirsutum* whether or not hormone was applied; in both the cases adult plants were obtained. In reciprocal direction however hybrid seeds of only hormone applied crosses germinated and the only one seed obtained in the cross without the use of hormone did not germinate; obviously then in this direction adult plants were obtained in hormone applied crosses only. All the 4 adult hybrids irrespective of the way the cross was made showed yellowing of leaves just at the initiation of flowering and eventually they all died without any exception for apparently no cause. There was not much of difference in the character of leaves in the reciprocal hybrids with their shape and lobing more towards the *G. arboreum* parent.

Discussion

The purpose of applying the hormone on the pedicel of pollinated flowers in the cross, *G. hirsutum* x c-4x *G. arboreum* was to increase the fruit set. The

results obtained however showed that it is only true when *G. hirsutum*, the natural allotetraploid, was used as mother. In the reciprocal direction in which the colchicine induced tetraploid *G. arboreum* was the female parent, the use of hormone decreased the fruit set sharply (cf. table 1). In other words, in this direction the hormone instead of preventing, enhanced the formation of abscission layer causing the flower drop following pollination. It is quite likely that the chromosome doubling brought in a maximum increase in the level of internal IAA that could be tolerated by *G. arboreum* plants; any further supply of IAA from outside in the pedicel of c-4x *G. arboreum* caused an excess of this hormone in the tetraploid plant and thus produced a harmful effect. That chromosome doubling increases vitamin content in certain plants such as vitamin C in tomato, vitamin A in corn is well known (Sharp, 1943); so possible increase of IAA in synthetic tetraploid is quite likely although it needs experimental verification.

The cross with *G. arboreum* as female succeeded more easily when the tetraploid instead of diploid was used. Two hybrids were obtained in 42 crosses in the present study while previous workers reported having obtained a maximum of 0.4 per cent hybrids. From a comparison of the results reported here and those obtained by others, namely, Beasley (1940), Nakatomi (1931), & Zaitzev (1927), it is evident that the use of c-4x *G. arboreum* increased the crossability between it and *G. hirsutum*. Weaver (1957, 1958) ascribes the failure of hybrid formation between diploid *G. arboreum* as mother and *G. hirsutum* to lack of differentiation of embryo. The success of getting hybrids with the synthetic tetraploid may be due to better differentiation of hybrid embryos resulting from an equal contribution of chromosomes by both the species involved in the cross.

In the reciprocal crosses also, the use of tetraploid *G. arboreum* as pollen parent gave better percentage of success in hormone applied crosses. According to Weaver (1957, 1958), the failure in this cross with diploid *G. arboreum* as male is due to antagonism between the hybrid embryo and endosperm but the antagonism seems to be removed when the synthetic tetraploid instead of diploid strain was used together with the hormone applied on the pedicel of pollinated flowers of *G. hirsutum*. Hybrid seeds between c-4x *arboreum* and *G. hirsutum* were previously obtained by Hutukaiti (1940), Stephens (1942) and Kasparyan (1945). Stephens as well as others did not report the breakdown of the hybrids. The only report known to the authors of the breakdown of the hybrid, c-4x *G. arboreum* x *G. hirsutum* is by Gerstel (1953). The trispecies hybrid, (c-4x *G. arboreum* x c-4x *G. herbaceum*) x *G. hirsutum* segregated into a tetrasomic ratio for the lethal factor.

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It is difficult to explain the sudden breakdown of all the four hybrids at the initiation of their flowering in the light of the results obtained by Skovsted (1934) and Iyengar (1944). These authors reported that the hybrids between c-4x *G. herbaceum* and the American cultivated cotton involving similar gross genomic combination, namely, 3A and 1D survived and flowered normally. The differential behaviour between *G. arboreum*-*G. hirsutum* and *G. herbaceum*-*G. hirsutum* hybrids may possibly be ascribed to the difference in the number and arrangement of translocated segments which *G. hirsutum* shares with *G. arboreum* and *G. herbaceum* respectively.

Summary

In an attempt to bring about more success in the cross of *G. arboreum* by *G. hirsutum*, the colchicine induced tetraploid strains of *G. arboreum* were used together with IAA applied on the pedicels of pollinated flowers. Whereas the use of hormone increased the fruit set in the direction in which natural allotetraploid, namely, *G. hirsutum* was used as mother (a), its application in the reciprocal direction brought a decrease in the percentage of fruit set. Four hybrids were obtained, 1 in combination (*a*) and 3 in reciprocal. All hybrids died at the onset of flowering.

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