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APOMIXIS IN *ARECA TRIANDRA* ROXB.

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ABSTRACT

Considerable morphological differences were observed in reciprocal hybrids involving *A. catechu* and *A. triandra*. While *A. catechu* × *A. triandra* hybrids were intermediate for some characters, showed heterosis and dominance for certain other characters, and were highly sterile, *A. triandra* × *A. catechu* plants were almost similar to *A. triandra* and did not indicate any evidence of hybridity. Based on these and the failure of *A. catechu* pollen to germinate on stigmatic surface of *A. triandra*, the latter species is inferred to be apomictic. This is further supported by the occurrence of limited extent of meiotic irregularities, reduced pollen fertility, low quantity of pollen and nut set obtained without pollination. It has been inferred that apomixis in *A. triandra* is autonomous.

INTRODUCTION

APOMICTIC development of fruit in palms was suspected by Sharma and Sarkar (1958) based on their observations that unpollinated flowers of the female palms in dioecious species develop into fruits. During an investigation involving two species of *Areca* L., *viz.*, *A. catechu* L. and *A. triandra* Roxb., analysis of their hybrids showed considerable reciprocal differences (Bavappa, 1974). Evidences are presented in this paper to show that the *A. triandra* × *A. catechu* plants may not be of sexual origin and that apomictic reproduction in *A. triandra* is possible.

MATERIALS AND METHODS

Crossing between *A. catechu* and *A. triandra* was done by the method described by Murthy and Bavappa (1960). In order to gather evidence in support of the occurrence of apomixis, the inflorescences of both *A. catechu* and *A. triandra* were emasculated and bagged prior to the opening of female flowers and the percentage of nuts set was recorded two months after pollination. Pollen germination was also studied *in vivo* on the stigmatic surface of *A. catechu* and *A. triandra* using aniline blue-lactophenol (Darlington and La Cour, 1960). Besides plants of the two *Areca* species, four plants each of *A. catechu* × *A. triandra* and *A. triandra* × *A. catechu* were also utilised in the study.

RESULTS

The morphological characteristics of *A. catechu*, *A. triandra*, and their hybrids are presented in Table I.

The important distinguishing characters of the two species are in number of stems and leaves/clump, arrangement of male flowers, number of stamens, size of female flowers, and maturity period of nuts.

The plants of *A. catechu* × *A. triandra* had only one stem as in *A. catechu*, while those of reciprocal cross had variable number of suckers as in *A. triandra* (Figs. 1–4). The hybrids resembled their respective female parents for the number of leaves/clump also. In *A. catechu* × *A. triandra*, there was considerable increase in the number of female and male flowers than the two parents; the arrangement of the male flowers on the rachis was in pairs, biseriate, and alternate (Fig. 6) and the fruit size was intermediate to that of the parents. The plants from the reciprocal crosses resembled the female parent *A. triandra* in the number of female and male flowers, arrangement of male flowers on the rachis (Figs. 7 and 8), and fruit size.

The hybrid nuts (F_0) obtained from *A. catechu* × *A. triandra* cross showed considerable differences in size and shape indicating the influence of *A. triandra* pollen. This was not apparent in the nuts obtained from the cross in which *A. triandra* was used as female

TABLE I

Morphological characteristics of A. catechu, A. triandra, *and their hybrids*

Sl. No.	Characters	*A. catechu*	*A. catechu* × *A. triandra*	*A. triandra* × *A. catechu*	*A. triandra*
1.	Number of stems	1	1	9·5±3·1	9·8±2·9
2.	Internodal distance at fixed mark (cm)	11·4±3·3	19·8±2·4	16·0±1·7	13·6±3·6
3.	Girth of stem at fixed mark (cm)	45·3±4·4	39·0±0·70	24·1±0·4	18·2±1·2
4.	Number of leaves/clump	9·5±0·3	9·5±0·3	35·0±3·4	51·4±14·4
5.	Mean length of spadix (cm)	56·3±2·9	87·8±2·6	50·3±1·2	43·0±2·3
6.	Number of female flowers/bunch	386·3±36·4	2856·8±340·3	409·8±64·6	588·2±133·4
7.	Mean length × breadth of female flowers (cm)	1·76×1·02	1·13×0·52	0·83×0·05	0·84×0·46
8.	Number of male flowers/bunch	33521±5080	48856±3868	29682±4027	27083±3191
9.	Mean length × breadth of male flowers (cm)	0·44×0·23	0·26×0·12	0·24×0·10	0·22×0·10
10.	Number of stamens	6, occasionally 5	3–5	3	3
11.	Arrangement of male flowers	Single. biseriate, alternate	Paired, biseriate, alternate	Paired, uniseriate	Paired uniseriate
12.	Mean length × breadth of fruit (cm)	5·3×4·2	4·2×2·1	2·9×1·44	2·7×1·5
13.	Maturity period of nuts (days)	287±16	298±19	162±1	163±8
14.	Pollen stainability	93·0±3·5	4·7±1·7	67·0 ±6·4	56·5±7·6

parent (Table II, Fig. 9). The maturity period of the F_0 nuts was the same as that of their respective female parents.

TABLE II

Mean size and weight of nuts of A. catechu, A. triandra, *and their hybrids* (F_0)

Sl. No.	Parents/hybrids	Length (cm)	Breadth (cm)	Weight (cm)
1.	*A. catechu*	5·3	4·2	43·6
2.	*A. catechu* × *A. triandra* (F_0)	5·5	3·3	34·2
3.	*A. triandra* × *A. catechu* (F_0)	2·7	1·5	3·9
4.	*A. triandra*	2·7	1·5	3·9

Under emasculated and bagged conditions, *A. triandra* set 9·2% nuts and *A. triandra* × *A. catechu* hybrids set 20·3% nuts, while *A. catechu* and *A. catechu* × *A. triandra* hybrids failed to set any nuts. Pollen germination *in vivo* showed that the pollen of *A. catechu* fails to germinate on the stigma of *A. triandra.*

DISCUSSION

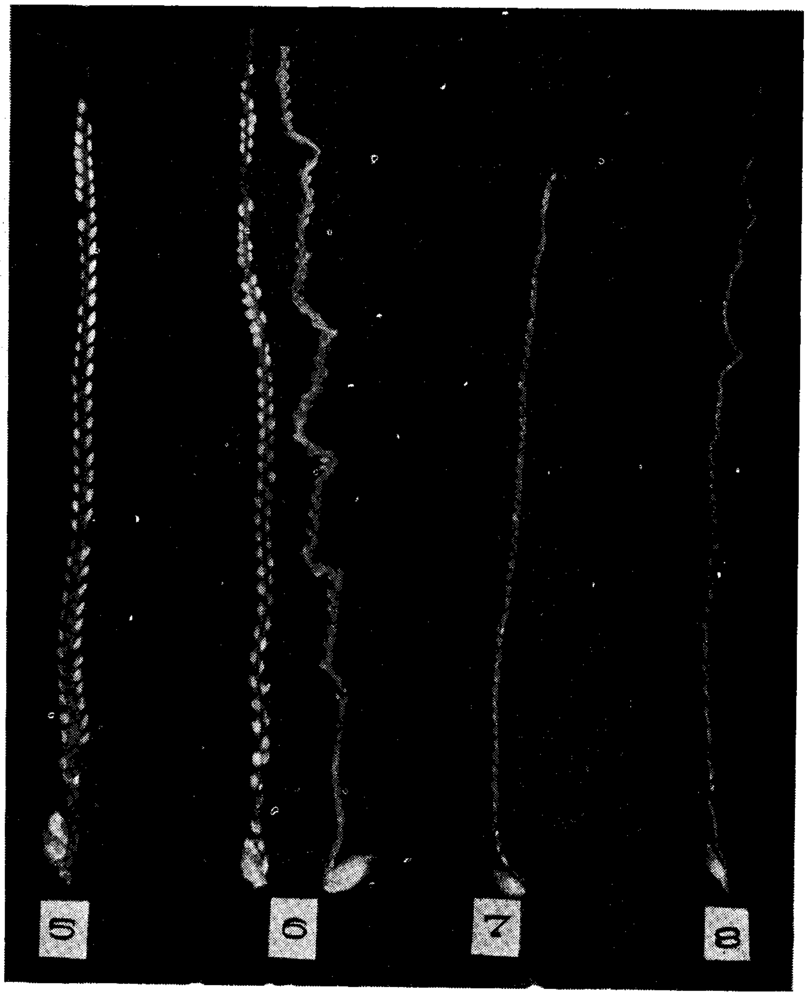
All the *A. triandra* × *A. catechu* plants showed considerable morphological similarities with the female parent for stem number, internode distance, stem girth at fixed mark, leaf number per clump, female flower size, number and size of male flowers, male flower arrangement, and size and maturity period of fruits. While F_1 of *A. catechu* × *A. triandra* showed clear evidences for heterosis and dominance for certain characters, the reciprocal hybrids did not show such genetic effects. The pollen stainability in *A. triandra* × *A. catechu* plants was also similar to that of the *A. triandra* parent. These, along with

FIGS. 1–4. Fig. 1. *A. catechu.* Fig. 2. *A. triandra.* Fig. 3. *A. catechu* × *A. triandra.* Fig. 4. *A. triandra* × *A. catechu.*

the differences in F_0 nuts observed in the reciprocal crosses, and failure of *A. catechu* pollen to germinate on the stigma of *A. triandra* show that the *A. triandra* × *A. catechu* 'hybrid' nuts (F_0) may not be of sexual origin.

Many of the apomictic species are characterised by abnormalities in meiotic divisions, such as univalent and multivalent formation, irregular distribution of chromosomes, laggards and micronuclei formation in tetrad stages in microsporogenesis, etc. (Gustafsson, 1947; Stebbins, 1950 ; Snyder, 1961). Desynapsis, multivalent formation, laggards and irregular distribution of chromosomes at anaphase-I and II, micronuclei, supernumerary spores at tetrad stage, and pollen sterility ranging from 24·5–66·9% have been observed in differrent ecotypes of *A. triandra* (Bavappa, 1974).

In addition to the low pollen fertility of *A. triandra*, the quantity of pollen/anther was also considerably reduced. Similar variation in pollen fertility as well as reduction in the quantity of pollen has been reported in the reversion types of the apomictic species *Potentilla collina* (Muntzing, 1958). Gerstel and Mishance (1950) also observed that in *Parthenium argentatum*, the apomictic type differed from the sexual type in having lower chiasma frequency/cell, scarce pollen, and reduced male and female fertility.



FIGS. 5–8. Arrangement of male flowers on the rachis. Fig. 5. *A. catechu*—single, biseriate, and alternate. Fig. 6. *A. catechu* × *A. triandra*—pairs, biseriate and alternate. Fig. 7. *A. triandra* × *A. catechu*—pairs, uniseriate. Fig. 8. *A. triandra*—pairs, uniseriate.

FIG. 9. The ripe nuts in *A. catechu*, *A. catechu* × *A. triandra* F_0, *A. triandra* × *A. catechu* F_0, and *A. triandra*.

While positive evidence for the presence of apomixis can be obtained only from studies of megaspore, embryosac, and embryo development, properly conducted breeding tests should provide reasonably decisive indirect evidence (Stebbins, 1950). The limited degree of meiotic irregularities, reduced pollen fertility, low quantity of pollen, and low chiasma frequency (Bavappa, 1974), together with the morphological and genetical evidences obtained from the reciprocal crosses, indicate apomictic reproduction in *A. triandra*. The observation that *A. catechu* pollen does not germinate on *A. triandra* stigma indicates that the apomixis in this species is autonomous. The fruit set obtained after emasculation and bagging in *A. triandra* and *A. triandra* × *A. catechu* lends further support to this view.

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