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SEED SET AND POLYEMBRYONY IN AMORPHOPHALLUS CAMPANULATUS BLUME¹

J. S. JOS AND K. VIJAYA BAI

Central Tuber Crops Research Institute, Trivandrum

ABSTRACT

In Amorphophallus campanulatus there is a complete absence of seed set under natural conditions. Six cultivars were studied for stigma receptivity in relation to seed set of which 5 cultivars were identical regarding morphological and other characteristics while one cultivar differed regarding the time of anthesis, shedding o' pollen and fruit maturity. The pollination was 100% successful in the period between 24 hrs to 78 hrs before anthesis. A mean seed set of 226 per fruit bunch could be obtained between 30 hrs and 78 hrs before anthesis and it is concluded that the presence of extreme protogyny coupled with the delay in the opening of the spathe is responsible for the lack of seed set under natural conditions. Seeds did not show any dormancy and a mean of 2.8 sprouts per seed was noticed. Two seedlings having independent root system were noticed in the same seed and up to 3 seedlings could be raised from a seed through seed pieces suggesting the presence of polyembryony.

INTRODUCTION

In Amorphophallus campanulatus Blume, popularly known as Elephant foot yam, is widely cultivated in India and many tropical countries and is consumed as a vegetable or as a subsidiary food. The lack of seed set under natural conditions is an important constraint in the genetic improvement of the crop. Successful seed production has been reported in Amorphophallus (Arakeri, 1950) and the seeds are reported to be dormant for 5-6 months (Arakeri, 1956) and Rajendran and Hrishi (1976) could overcome the dormancy through running water treatment. However, the causes restricting the seed set under natural conditions have not been determined hitherto and generally presumed to be due to high female

tics, mutation and continuous vegetative multiplication (Arakeri, 1950; Krishnan et al., 1970). The present investigation was undertaken to determine the causes for the lack of seed set under natural conditions and to devise means to achieve seed set so that intragenomic improvement through intervarietal hybridization can be attempted.

MATERIALS AND METHODS

The well developed, one year old tubers belonging to six cultivars were used in the study. The vegetative, tuber and other floral characters were found to be identical in five accessions and hence considered to be a single variety. However, in one cultivar, though it did not differ significantly on morphological characteristics, the time of anthesis and dura-

tion of fruit maturity were found to be

sterility result from cytological abnormali-

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 Accepted for publication on March 31, 1985 The authors are grateful to Sri. P. K. Thomas, Director of the Institute for the encouragement. Thanks are due to Sri. C. S. Antonisamy, Artist-cum-Photographer for help rendered in photography. characteristically different and considered to be a separate variety. Because of the paucity in getting flowers and flowering confined only to a few days prior to sprouting the studies were continued for 3 years to achieve sufficient number of pollinations. A total of 850 tubers were observed from which only 34 inflorescences could be obtained. The tubers were planted only after the formation of inflorescences.

The stigma receptivity was determined in relation to anthesis. In pollinations only fresh pollen was utilized. In order to eliminate the possibility of failure in pollinations due to lack of pollen viability at later periods, longevity of pollen up to 24 hrs was determined by growing the pollen in culture medium as described by Jos et al. (1967). Altogether 30 pollinations in Var 1 and 4 pollinations in Var. 2 were made. The presence of more than one active sprout in a number of seeds indicated the possible occurrence of polyembryony. Hence germination studies were conducted on full seeds and seed pieces to determine the possibility of obtaining more than one plant from a seed.

opening of the spathe may be considered as anthesis. Anthesis takes place about 24 hrs before the liberation of pollen.

The two varieties were found to be characteristically different from each other (Table I) and the duration and peak stigma receptivity were also computed differently in the two according to the time of anthesis.

Pollination studies in Var. 1 : The anthesis took place at about 6.30 p.m. and the inflorescence emitted a nauseating smell. The pollen were liberated on the next day and were collected and kept at room temperature. The pollen were slightly sticky and found suitable for insect pollination and a large number of bees were found attracted by the odour emitting from the inflorescence. Since the same pollen had to be used till next day to determine the stigma recedtivity the longevity up to 24 hours was critical. When one day old pollen was grown in a medium containing 1% sucrose+25 ppm boric acid, the pollen germination was high and very long pollen tubes were noticed suggesting that the pollen were viable up to 24 hours and there by ruling out the ambiguous factor of longevity from the stigma receptivity studies.

OBSERVATIONS

In Amorphophallus campanulatus the inflorescence is a spadix where the spathe encloses the male and female flowers (Fig. 1). The flowers are naked and hence the

Pollinations were effected about 126 hours earlier to anthesis to 24 hours after anthesis. There was a complete absence

TABLE I

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Characters .	Var. 1	Var. 2			
Time of anthesis	Evening	Noon			
Time of shedding of pollen	Next day evening	Next day noon			

VARIATION BETWEEN THE TWO CULTIVARS







81 months



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TABLE III

No. of sprouts	₿ 	2	3	4	5	6	Mean No. of sprouts per seed
No. of seeds	12	27	40	25	1	1	2.8

THE FREQUENCY OF SPROUTS ON THE SEEDS

number of sprouts varied from 1 to 6 (Figs. 4-6) and about 38% seeds showed 3 sprouts and the mean number of shoots was 2.8 per seed (Table III).

The sprouts were found up to the middle of the seed and most of the sprouts were confined to the micropylar region. Among the 158 seeds germinated, 11 were found to be albinos (Figs. 14). When more than one seedling was established from a single seed, all the seedlings were of the same type either normal or albinos and never occurred together. The albino seedlings failed to establish and later they dried.

When the seeds were cut transversely into 2 pieces and sown separately, the basal portion of the seed did not germinate at all and the shoots developed only from the top portion (Figs. 7, 8). In a number of seeds there was a central well developed sprout flanked by smaller lateral sprouts (Fig. 4). When the main sprout was removed, one or more lateral sprouts could develop vigorously (Fig. 9). The seeds were made into pieces having one sprout each and a minimum of 1/6 seed was also sown. Interestingly, independent seedlings could be established from seed pieces (Figs. 10, 11) and significantly a seedling could be obtained even from a 1/6 seed piece. By establishing seedling from seed pieces up to 3 independent seedlings could be developed from a single seed. Even without resorting to raise more than one seedling from a seed through seed pieces, up to two separate seedlings with independent root system could be observed in situ on the seeds (Fig. 12).

DISCUSSION

Araceae is a family where sterility is widely prevalent which is attributed to various cytogenetical factors (Jos and Magoon, 1971; Jos and Nair, 1976; Jos et al., 1977a; Rajendran et al., 1972). Seed set is absent in almost all the edible and a number of wild species of aroids under natural conditions. Though seed set had been achieved in a few plants adopting extensive hybridization (Arakeri, 1950; McColley and Miller, 1965; Hartman and Zettler, 1972; Volin and Zettler, 1976), the causes of lack of seed set under natural conditions was not critically analysed. The present study on Amorphophallus campanulatus has clearly shown that the lack of seed set is not due to any sterility barrier but due to the time of anthesis in relation to stigma receptivity. The maximum fruit set and seed set have been achieved between 30

The resulting seedlings raised from hrs and 78 hrs before anthesis where a seeds and seed pieces were vigorous and established normally and the leaves were 1 and 886 seeds in a bunch in Var. 2 could dark green and leathery (Fig. 13). be realised showing when the stigma is

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receptive the inflorescence is in a closed condition and the stigma receptivity is altogether lost about 24 hrs before anthesis. Thus it is quite apparent, cross pollination is prevented by the closed nature of the spathe while the anthers do not dehisce until 24 hrs later to anthesis eliminating self pollination also. Hence it is concluded that the lack of seed set in elephant foot yam is due to extreme protogyny coupled with the delay in the opening of the spathe.

Recent studies have established the occurrence of protogyny in varying degrees among the different species of aroids. Though Colocasia esculenta is also protogynous, because of the fact that the anthesis coincides with peak stigma receptivity, seed set occurs readily under field conditions (Jos et al., 1977 b). In Caladium bisolor even though reduced receptivity is discernible just at the time of anthesis, the failure of spathe to separate at the neck region obstructs the entry of nocturnal insects to the female region thereby eliminating seed set under natural conditions (Jos et al., 1980 b). However, in Xanthosoma sagittifolium popularly known as tannia, even the trace stigma receptivity is lost about 13 hrs earlier to anthesis and maximum seed set is realised 24 hrs and 40 hrs before anthesis (Jos et al., 1980 a). Hence, it may be concluded that the presence of extreme protogyny coupled with the delay in the opening of the spathe is responsible for the lack of seed set in Amorphophallus campanulatus under natural conditions. The seed dormancy has been reported to be responsible for reducing seed germination in elephant foot yam (Arakeri, 1956) and running water treatment for about 6 days is reported to be advantageous in overcoming seed dormancy (Rajendran and Hrishi, 1976). However, in the present study the seeds have shown

a tendency to develop sprouts in situ and direct planting also resulted in successful germination to the extent of 75.3% ruling out the presence of any seed dormancy in the present material under study and it may be a varietal character.

The presence of more than one sprout in the seeds makes one to doubt whether the seed has developed after true fertilization or apomictic in nature. But the occurrence of albinos in the seedling population clearly establishes the fact that it is possible only through segregation and apparently through sexual reproduction and not somatic apospory. Interestingly, the sprouts are confined only to the micropylar half of the seed. The seeds showing up to 6 sprouts and a mean of 2.8 sprouts per seed were noticed. The production of 3 independent seedlings from a single seed through growing the seed pieces and the presence of two well developed seedlings with independent root system on the same seed indicate the probable occurrence of polyembryony. Besides when more than one seedling was established they were found to be of same genetic make up showing either normal or albinos and never together suggesting that all the seedlings arising from a single seed have a common origin. When the occurrence of sexual reproduction and the common origin of the seedlings developing from the seed are considered together, the phenomenon may be attributed to cleavage polyembryony. Moreover, the distribution of sprouts up to the middle of the seed and most of the sprouts in the region where the true embryo is located further augments the probable development through cleavage polyembryony as

reported in a number of plant species (Maheshwari, 1950). However, the mode of development of multiple sprouts in the seeds has to be studied in detail to determine the origin of multiple seedlings and the work is in progress.

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