# Major Factors Limiting Seed Set in Aroids

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## Abstract

The causes limiting seed set in aroids were studied through pollinations effected a few days prior to the opening of the inflorescence to a few hours after the shedding of pollen. A highly fertile female clone of *Colocasia esculenta* was also included to compare the factors which promote high seed set and the factors that prevent seed set in *Xanthosoma sagittifolium* and *Caladium bicolor.* In all the three species, the dehiscence of anthers took place 24 hours after anthesis. In *Colocasia esculenta,* the stigma receptivity lasted for about 4 days and was highly receptive at the time of anthesis up to 36 hours after anthesis resulting in high seed set. In *X. sagittifolium,* the receptivity completely disappeared about 20 hours before anthesis.

Complete elimination of seed set was due to enclosed nature of the spathe and non-availability of pollen when the stigma was receptive. However, in the clone of *Caladium, bicolor,* the entry of pollinating insects to the female region was obstructed by the failure of the spathe to separate below and at the neck region. By overcoming these apparent sterility barriers, high seed set to the extent of 4241 per fruit bunch in *X. sagittifolium* and 385 seeds per fruit bunch in *Caladium bicolor* could be achieved.

## Introduction

Seed set is an important parameter in the effective utilization of germplasm in crop plants. Seed set in aroids, being a highly sterile group, is unknown in a large number of genera and species. They are primarily propagated through tuber and rhizomes which apparently restrict genetic variability. Araceae is comprised of about 100 genera and 1000 species distributed throughout tropical and sub-tropical regions (Hooker, 1894). It includes important edible tuber-bearing species like *Colocasia esculenta, Alocasia* sps., *Xanthosoma sagittifolium, Amorphophallus campanulatus* and *Cyrtosperma* sps.

The extensive pollen sterility noticed in Araceae is attributed to different cyto-genital causes like polyploidy (Jos *et al,* 1977; Rajendran and Jos, 1972), structural hybridity (Jos *et al,* 1968, 1971), multiple sporocytes (Jos and Nair, 1976), desynapsis (Rajendran *et al,* 1972), B-chromosomes (Jos and Rajendran, 1976), polymitosis (Jos *et al,* 1977) and abnormal tapetal development (Jos and Magoon, 1971). Though non-flowering and shy-flowering are also hindrances to the occurrence of recombinants, other factors which have been identified recently restrict seed set in the clones. The present communication describes two other major factors limiting seed set and the possibility of circumventing the barriers.

## Materials and Methods

Two edible and one ornamental genera have been included in the present investigation.

*Colocasia esculenta* – commonly known as Taro, Dasheen – "female fertile"

*Xanthosoma sagittifolium* – commonly known as Tannia – "female sterile"

*Caladium bicolor* – Ornamental plant – "female sterile"

A highly fertile female clone of *Colocasia esculenta* was also included in the present study to compare the factors which promote high seed set and determine the causes which prevent seed set in the latter two species.

Pollinations were effected a few days prior to the opening of the inflorescence to a few hours after the shedding of pollen. The duration of stigma receptivity in relation to the anthesis was determined through seed set. The pollen fertility was determined through the culturing of pollen as described by Jos *et al* (1967) and through tests.

To eliminate the overlapping discrepancy of pollen longevity on stigma receptivity studies, pollen longevity of *C. esculenta* was established up to 24 hours in sucrose medium with boric acid.

## Results

*C. esculenta.* The shedding of pollen takes place about 24 hours after the opening of the inflorescence. Because the flowers are naked, the opening of inflorescence may be considered as anthesis itself. The stigma receptivity is found to last for a considerable length of time (Table 1). On the day of opening of the inflorescence, the percentage of successful pollination is 85.7 and the mean seed set is 5960 per fruit bunch. This is the ideal time for pollination. The stigma receptivity is at a peak for some hours after the liberation of pollen. The range of seed set is 4603 ot 7468 and the mean is 5712. The receptivity is noticed about 44 hours before anthesis and up to 60 hours later.

*X. sagittifolium.* Seed set is unknown in *X. sagittifolium.* Liberation of pollen takes place a day after anthesis. Pollinations have been effected 2 days prior to anthesis to a few hours after the liberation of pollen. There is no seed set on or after the day of anthesis (Table 2). Trace stigma receptivity is noticed about 13½ hours prior to anthesis. At 24 hours to 45½ hours prior to anthesis, the pollination is 100% successful. The range of seed set is 2927-4241 with a mean of 3831 seeds per fruit bunch.

*Caladium bicolor.* In the clone adopted in the present study, there was no seed set under natural conditions. The dehiscence of anthers takes place about a day after anthesis. The peak stigma receptivity is found to last 24 hours prior to anthesis. As many as 385 seeds have been obtained form a fruit bunch when pollination had been effected 23½ hours prior to the female region does not open and is found tightly adhered to the spadix at the neck region, thereby obstructing the entry of insects as well as pollen into the stigmatic region. There is a complete absence of seed set after anthesis.

## Discussion

The inflorescence of Araceae is a spadix where the male and female regions are separated and enclosed by an elaborately developed spathe. Since the flowers are naked, the opening of the tightly encircled spathe is considered as anthesis because the liberation of pollen as well as pollination at the female region are possible only after the opening of spathe under natural conditions. This underlines the importance of anthesis in relation to the prevailing stigma receptivity in aroids.

In *Colocasia esculenta,* the stigma receptivity which lasts for more than 4 days is of significance. The stigma is found at the peak of receptivity from the time of anthesis to about 24 hours later. However, high seed set is achieved up to 36 hours after anthesis. Since peak receptivity is noticed after anthesis, high seed set prevalent in a number of clones under natural conditions is only a logical consequence. Jos and Vijaya Bai (1977) have identified a wild variety of *C. esculenta* having a seed set above 7000 per fruit bunch under natural conditions. The limited seed set recorded in *Colocasia* (Purseglove, 1972) may be due to other cytogenitical causes (Jos and Nair, 1976; Krishnan *et al* (1970).

On the other hand in *X. sagittifolium,* there is no seed set on the day of anthesis or later while intense stigma receptivity is noticed between 20 hours to 45½ hours anthesis. These observation show that when the stigma receptivity is at peak, the inflorescence is in a closed condition and the receptivity has completely disappeared about 20 hours before anthesis. Besides, the shedding of pollen occurs 24 hours after anthesis and prevents self pollination. Hence, it may be concluded that the female sterility prevalent in *Xanthosoma* is due to extreme protogyny coupled with the delayed opening of the spathe.

However, in a clone of *Caladium bicolor,* the unique behavior of spathe itself eliminates seed set. Under natural conditions, even though receptivity is discernible at the time of anthesis, the failure of spathe to separate at the neck region obstructs the entry of insects to the female region thereby preventing pollination. Jos *et al* (1978) have reported the production of intervarietal hybrids in *Caladium* by overcoming this barrier to seed set.

Hence, it may be concluded that in aroids, extreme protogyny in relation to the opening of spathe as in *Xanthosoma* and the failure of spathe to separate at the neck region and below as in *Caladium* may be two important factors limiting seed set. Further studies in other genera and species will determine the extent to which these unique factors are responsible in reducing or rather eliminating seed set in the family Araceae.

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**Table 1. Duration of stigma receptivity in *Calocasia***

| Age of stigma | No. of pollination Success | Failure | Percentage of successful pollination | Seed set in successful pollination Range | Mean |
|---|---|---|---|---|---|
| Above 60 hrs after anthesis | – | 4 | 0 | – | – |
| Above 52 hrs to 60 hrs after anthesis | 2 | 2 | 50.0 | 17-25 | 21 |
| Between 48 hrs and 52 hrs after anthesis | 2 | 1 | 66.6 | 153-288 | 220 |
| Above 30 hrs and 36 hrs after anthesis | 1 | – | 100.0 | – | 3406 |
| Between 24 hrs and 30 hrs after anthesis (at the time of shedding of pollen and later) | 7 | 9* | 43.8 | 4603-7468 | 5712 |
| Between anthesis and shedding of pollen | 24 | 4 | 85.7 | 4370-6790 | 5960 |
| 24 hrs before anthesis | 9 | 6 | 60.0 | 6-79 | 29 |
| Between 24 hrs to 44 hrs before anthesis | 3 | 2 | 60.0 | 1928 | 24 |
| Before 44 hrs to 44 hrs 20 min before anthesis | 2 | 2 | 50.0 | 16-10 | 8 |
| Below 44 hrs 20 min. before anthesis | – | 6 | .0 | – | – |

*Most failures occurred in December

**Table 2. Duration of stigma receptivity in *Xanthosoma***

| Age of stigma | No. of pollinations Success | Failure | Percentage of successful pollination | Seed set in successful pollination Range | Mean |
|---|---|---|---|---|---|
| Up to 3 1/2 hrs after dehiscence of anthers | | 3 | 0 | – | |
| Between anthesis and dehiscence of anthers | - | 8 | 0 | | |
| Up to 20 hrs before anthesis | 2* | 6 | 25.0 | 21-27 | 24 |
| Between 20 hrs and 24 hrs before anthesis | 7 | 5 | 58.3 | 491-2520 | 1067 |
| Between 24 hrs and 45 1/4 hrs before anthesis | 11 | – | 100.0 | 2927-4241 | 3831 |
| Still earlier to 45 1/4 hrs prior to anthesis | – | 13 | – | – | |

*Trace receptivity noticed in two pollinations