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Fruit/seed morphology and germination characteristics in ten species of *Calamus*

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Abstract: Seed biological aspects of 10 *Calamus* species were studied as a part of their *ex situ* conservation through seed-gene bank. Studies revealed that all the species possess relatively high moisture content, though their germination patterns like day of starting of germination and days taken to complete germination vary from species to species. Some seeds are found to be with a factor of dormancy, which has to be experimentally overcome. Studies on desiccation and storage have to be carried out for confirming the nature and storage physiology of seeds.

Keywords: Calamus, morphology, seed germination, moisture content, conservation.

INTRODUCTION

Calamus is the largest genus of the palm family belonging to the sub family *Calamoideae*. The genus is distributed in the tropics and subtropics comprising about 374 species throughout the world (Govaerts and Dransfield, 2005). Of these, 18 species are found throughout the Western Ghats and costal regions of Kerala (Anto *et al.*, 2001; Renuka 2000; Rangan *et al*., 2003; Joemon Jacob *et al.*, 2008). Ecologically, *Calamus* species are the indicators of the health of a very fragile and threatened ecosystem called tropical evergreen forest. Due to the large-scale clearing of forest, extensive extraction of cane as cottage industry resource and the poor regeneration percentage in natural conditions, their habitat is shrinking at an alarming pace. Hence, they are the least protected group of flowering plants; many of them are being severely threatened and become very rare. Moreover, some species are single-stemmed without any natural vegetative propagation. In this circumstances seed propagation is the alternative possible way to produce next generation which emphasises the significance of seed storage and related studies. Ten species of *Calamus viz*; *Calamus brandisii* Becc., *C. gamblei* Becc., *C. hookerianus* Becc., *C. karnatakensis* Renuka and Lakshmana, *C. pseudotenuis* Becc. ex Becc.& Hook. f., *C. metzianus* Schlecht, *C. shendurunii* Anto, Renuka & Sreekumar,*C. thwaitesii* Becc.& Hook.f., *C.*

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travancoricus Bedd.ex Becc. & Hook .f. and *C. vattayila* Renuka were taken up for detailed study of fruit/seed morphology to aid to their conservation and easy identification of species.

MATERIALS AND METHODS

Collection of fruits and seeds

Exploration trips were conducted to natural forests of the Western Ghats of Kerala during the seasons confined to fruiting in different species and located their population to document their habit, habitat, phenology and distribution. Specimens of all the species were collected and deposited in TBGRI herbarium. Fresh and ripened fruits were collected from the identified populations and brought to the laboratory for further studies. Morphological data of fruits *viz*; length, width, shape, colour and number of seeds per fruits were recorded. Seeds were extracted from fruits by de-pulping and washed thoroughly in running tap water. Seed characters were recorded and their shape as well as size indices were calculated using standard procedures. The seeds were accessioned and a few seeds deposited as reference collection in the seed bank.

The extracted and cleaned seeds were surface dried in laboratory conditions (28°C ±2°C /60% RH). The initial moisture content was determined on fresh weight basis (ISTA, 1985). Germination test was conducted in wet rolled paper towel placed in a seed germinator without light (30°C±2°C/80% RH). Day of starting germination and days taken to complete germination for each species were noted and germination value of each species was calculated. Germination value was calculated using the formula GV=PV x MDG, where PV=peak value of germination (maximum cumulative germination percentage divided by the number of days to attain that percentage) and mean daily germination MDG which is the mean number of seeds germinated per day (Czabator *et al.*, 1962).

RESULTS AND DISCUSSION

Calamus species are distributed in the Western Ghats at 50 -1000 m altitudinal ranges. The species like *C. thwaitesii, C. travancoricus, C. hookerianus* and *C. pseudotenuis* inhabit deciduous to evergreen forests at 50-1000 m altitudes, while *C. metzianus* grows well in coastal areas. *C. brandisii, C. gambleii, C. shendurunii, C. karnatakensis* and *C. vattayila* inhabit moderately higher altitude (400-1000 m). All the species except the *C. vattyila* are clustering. Phenological observations revealed that the flowering of 5 species (*C. brandisii C. metzianus, C. karnatakensis, C. travancoricus* and *C. vattayila*) spreads during October-December while that of the rest five species during July to August. Fruiting occurs during March-June in most of the species and bear single seeded berries. Fruit shape varies from ovate, globose to oblong. Number of fruit scales varies from 12 to 27 (Table 1). *C. gambleii* bears largest fruit as well as

seeds while *C. travancoricus* and *C. hookerianus* posses smallest fruit and seeds respectively (Table 2).

Fresh moisture content of the seeds varied from 19 to 34 per cent. Moisture content is highest in C. *gambleii* and C. *shendurunii* (34%), those produce largest seeds. Whereas, C. *hookerianus* producing smallest seeds also had lowest fresh seed moisture content (19.2%), (Fig.1). In general, majority of Palmae seeds are with recalcitrant character and hence *Calamus* seeds are probably of that type. Seeds with high fresh moisture content are usually character of recalcitrant seeds (Roberts, 1973). However, further studies on desiccation and storage are essential to confirm the storage physiology of *Calamus* seeds.

Species with high seed moisture content (above 30%) are mostly confined to higher

Table 1. Fruit characters of *Calamus* species

Species	Characters					
	Fruit type	Fruit colour	Fruit shape	Fruit size (Mean g±SD)	Fruit weight (mean cm± SD)	No. of scales
Calamus brandisii	Berry	Brown with dark brown margin	Ovoid	1.45±0.05× 1.79 ±0.81	0.77±0.04	17
C. gamblei	Berry	Pale yellow	Spherical	2.65±0.06× 2.19±0.09	6.72±0.38	23
C. hookerianus	Berry	Yellowish brown with a dark border	Sub globose	1.0± 0.02 ×0.63±0.01	0.24±0.005	18
C. karnatakensis	Berry	Yellow with brown margin	Globose	1.09±0.02 × 0.8± 0.02	0.38±0.025	19
C. pseudotennuis	Berry	Greenish yellow with a dark border	Sub ovoid	1.5 × 0.8	0.27±0.01	18
C. metzianus	Berry	Light brown with white border	Ovoid	1.39±0.01 × 0.89 ± 0.01	0.50±0.01	17
C. Shendurunii	Berry	Green	Globose or pyriform	2.51±0.05 × 2.01 ±0.04	5.67±0.12	25
C. thwaitesii	Berry	Yellow with dark brown margin	Ovoid	2.21±0.25 ×1.6±0.19	3.05±0.01	12
C. travancoricus	Berry	Yellow with dark brown border	Globose	0.8±0.09 (diameter)	0.36± 0.009	24
C. vattayila	Berry	Chest nut brown	Oblong	2.31±0. × 1.23±0.1	1.74±0.01	27

Table 2. Seed characters of *Calamus* species

Species	Seed colour	Seed shape	Seed size (cm)	Seed weight (gm)	Shape index (L/B)	Size index (LxB)	Germination speed	Emergence index
Calamus brandisii	Brownish black	Oblong	0.98±0.03 × 0.77±.01	0.35± 0.01	1.27± 0.01	0.755± 0.001	3.81± 0.1.4	12.86± 0.10
C. gamblei	Reddish brown	Sub spherical	1.75±0.0 3×1.61±0.03	3.052± 0.19	1.09± 0.02	2.82± 0.008	4.0± 0.35	20.2± 1.32
C. hookerianus	Brown	Sub spherical	0.393±0.01 ×0.55±0.12	0.09± 0.003	0.72± 0.01	0.216± 0.001	1.67± 0.8	1.72± 0.02
C. karnatakensis	Brown	Sub spherical	0.676±0.01 × 0.55±0.008	0.169± 0.05	1.23± 0.01	0.38± 0.009	1.67± 0.36	1.83± 0.02
C. pseudotennuis	Brown	Sub spherical	0.983±0.01 ×0.75±0.1	0.228± 0.01	1.31± 0.01	0.737± 0.05	0.85± 0.13	3.75± 0.08
C. metzianus	Brown	Sub spherical	0.80±0.11 ×0.52±0.07	0.20± 0.01	1.53± 0.02	0.42± 0.01	3.03± 1.0	4.37± 0.06
C. shendurunii	Light brown	Sub spherical	1.63±0.04 ×1.49±0.03	2.28± 0.13	1.09± 0.001	2.43± 0.21	1.54± 0.06	5.0± 0.64
C. thwaitesii	Brownish black	Sub spherical	1.38±0.17 ×1.13±0.15	0.72± 0.03	1.22± 0.07	1.56± 0.01	5.0± 0.16	12.5± 0.5
C. travancoricus	Brown	Sub spherical	0.93±0.07 ×0.77±0.13	0.2± 0.041	1.08± 0.21	0.64± 0.17	0.53± 0.02	0.28± 0.03
C. vattayila	Brown	Ovoid	1.39±0.3 ×0.89±0.17	0.29± 0.03	0.06± 0.001	1.24± 0.01	12.5± 1.43	33.3± 0.89

Values are mean ± SD,

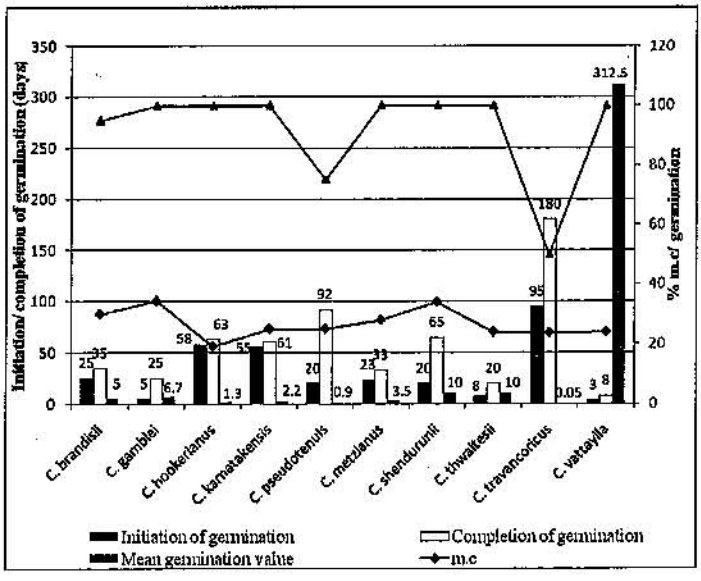

Figure 1. Seed germination behaviour of *Calmus* species

altitudes (above1000 m a.s.l.), while species with moisture content between 25-30 are seen in places having altitude between 500-1000 m a.s.l. But *C. metzianus* with moisture content 28 per cent is seen in all altitudes ranging from 50-250 m a.s.l.

Germination percentage of fresh seeds varied from 50 to 100 (Fig.1), except that of *C. travancoricus* and *C. pseudotenuis* with 50 and 70 per cent germination respectively. Most of the species exhibit 90 to 100 per cent seed germination (Fig.1). Seeds of *C. gambleii*, *C. vattayila* and *C. thwaitesii* started to germinate in 3-8 days. *C. travancoricus*, *C. hookerianus* and *C. karnatakanensis* posses a short dormancy period so that their seeds germinated after 95, 58 and 55 days respectively.

Based on the morphological characters of fruit/seed of the 10 *Calamus* species the systematic assortment of this highly sought for genus is strengthened. In addition to this an understanding of seed characters such as seed moisture, germination value and their correlation with viability retention helps to augment all conservation efforts of these endemics. Since rattan population in Kerala is diminishing due to over exploitation and insufficient regeneration, it is necessary to take immediate actions for conserving this valuable group of plants both by *ex situ* conservation in seed bank and seed germination in controlled condition followed by reintroduction in their natural habitats. The present study provides research leads to such future requirements.

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