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Influence of storage conditions on shelf-life of *Dendrocalamus sikkimensis* seeds

P. K. Chandrasekhara Pillai*, C. J. Lakshmi, K. K. Seethalakshmi, V. P. Raveendran and **G. E. Mallikarjunaswamy**
Kerala Forest Research Institute, Peechi-680 653, Thrissur, Kerala, India

Abstract: Bamboo is one of the renewable natural resources and plays significant role in livelihood of rural people. Its propagation through seeds is efficient and cost effective but development of appropriate storage technique is extremely useful for prolonging seed viability. Seeds were processed, sealed in polythene bags and stored in air tight containers under 4° C, 16° C and ambient temperature. Effect of leaf extract/fungicides on seed-borne mycoflora was evaluated. Periodical viability tests were conducted to evaluate shelf-life of seeds. Seeds stored at 4° C and 45±5 % relative humidity had maintained viability for 36 months with 52 % germination. Occurrence of mycoflora was minimal on seeds treated with Neem leaves/Mancozeb 75% WP and stored at 4°C. It could be inferred from the study that the best conditions for storage of bamboo seeds to extend shelf-life is air tight container under 4° C with 45±5 % relative humidity.

Key words: Germination, longevity, seed, viability, *Dendrocalamus sikkimensis*

INTRODUCTION

Bamboo is one of the most useful of renewable natural resources which plays a significant role in the livelihood of rural people and supports rural industry. It has multiple end-uses like food, bamboo handicrafts, household articles, etc. (Seethalakshmi and Kumar, 1998). Propagation through seeds is efficient and cost effective. Though, abundant seed production was observed in gregarious flowering species, viability of seeds under natural condition is reported to be very poor. Seed-borne diseases also lead to reduced seed viability. Improper storage is responsible for infestation by microorganisms and resulted in low seed viability. Since the flowering cycle of bamboo is long, it will be extremely useful to develop appropriate storage method that would prolong seed viability. In this context, the present study was undertaken to develop an appropriate seed storage technique for the commercially important bamboo species viz., *Dendrocalamus sikkimensis* Gamble *ex* Oliv.

Dendrocalamus sikkimensis is one of the large sized bamboo (17-20 m height, 12-20 cm culm diameter) having caespitose stems with few culms. It is distributed in North-Eastern India, West Bengal, Sikkim, Arunachal Pradesh, Nagaland and Meghalaya

* To whom correspondence should be addressed: pkcpillai@gmail.com

(Garo Hills) and distributed up to the elevation of 2100 m (Seethalakshmi and Kumar, 1998; Somen *et al*., 2011). It is being used for pulp and paper, posts, ropes, boxes, water pipes, etc. (Holstrom, 1993). Flowering cycle of this species is 45-60 years and flowering was reported during 1916, 1932, 1982, 1992, 2004 and 2009, respectively (Seethalakshmi and Kumar, 1998; Jijeesh *et al*., 2012).

Information on seed storage of *D. sikkimensis* is scarce in literature. Considering the increasing demand of this commercially important bamboo species, investigation was conducted to develop an appropriate storage technique for prolonging the seed viability. It will also help to provide high quality seeds for bamboo planting programmes in future.

MATERIALS AND METHODS

Naturally fallen mature seeds of *D. sikkimensis* were collected from Velupadam in Thrissur District, Kerala (10° 26' 07.95" N; 76° 21' 32.92" E) during May 2011. The cleaned seeds were measured for moisture content by oven-dry method (103±2° C for 17 ± 1 hr). Moisture content was calculated as follows (Anon., 2005):

$$\text{Moisture content (\%)} = \frac{\text{(Fresh weight – Dry weight)}}{\text{Fresh weight}} \text{ X } 100$$

The cleaned seeds were air-dried to a critical moisture level for successful storage. Effect of leaf extract/fungicides on seed-borne mycoflora was evaluated to develop appropriate storage method. Fresh leaves of *Azadirachta indica*, *Aegle marmelos* and *Lawsonia inermis* were used for the study. Leaves were air dried at room temperature. Leaf extracts were prepared by crushing the leaves in a mortar and pestle using distilled water in the ratio 1:1 (50 g leaves crushed in 50 ml water). Seed samples were dipped in the leaf extract for 1 hour. The treated seeds were air-dried on filter paper. Seed samples dipped in distilled water served as control. Fungicides such as Bavistin, Thiram and Mancozeb 75% WP (Indofil) were used to evaluate their effect on seed-borne mycoflora. Seeds were mixed with requisite amount of each fungicide and shaken mechanically for 20 min for proper coating. Untreated sample served as control. The effects of leaf extracts/fungicides were determined on seed-borne mycoflora by standard blotter method as per ISTA rules (ISTA, 2005).

Seed storage

Seed longevity was evaluated under different storage conditions at one month interval. Seeds in sealed polythene bags (0.05 mm thick) were kept in air tight plastic containers and stored at three conditions viz., ambient temperature ranging from 16° C to 4° C, respectively. Relative humidity (RH) was maintained at 45±5 % in 16° C and 4° C in storage rooms throughout the period of study

Viability tests

Periodical viability test in terms of germination under laboratory conditions (about 32° C

& 90 % RH) was carried out to determine the potential germinability of stored seeds. Hundred seeds in four replications were used for the study. Germination tests were carried out in vermiculite medium. Daily observations were recorded till culmination of seed germination.

Statistical analysis

Experimental design used for the study was Completely Randomized Design (CRD). Data were statistically analyzed using Analysis of variance (One-way ANOVA) test.

RESULTS AND DISCUSSION

Seed germination commenced on the 3rd day after sowing (DAS) and completed in 20 days with 52 ± 0.53 per cent germination.

Seed storage

Figure 1 depicts germination pattern of the seeds stored under different conditions. The result showed that the best storage condition for *D. sikkimensis* was 4° C and 45±5 % RH. It indicated that bamboo seeds shall be stored at 4° C with 45±5 % RH for long duration without much reduction of viability. The average seed germination at 36 month storage was about 52 %. Seeds stored at 16° C were able to retain viability only up to 10 months (47 %). Gradually, viability decreases from 11th month onwards and total loss of viability was observed at 24th month. However, viability of seeds stored at ambient temperature was stable only for 4 months (52 %), which thereafter decreased and lost its viability after 11 months of storage. Statistical analysis (ANOVA) revealed that storage temperature had significant influence on shelf-life of the bamboo seeds (Table 1). As the bamboo seeds exhibit orthodox seed physiology, they could be stored at RH less than 45 %; but it will be expensive to maintain at lower RH.

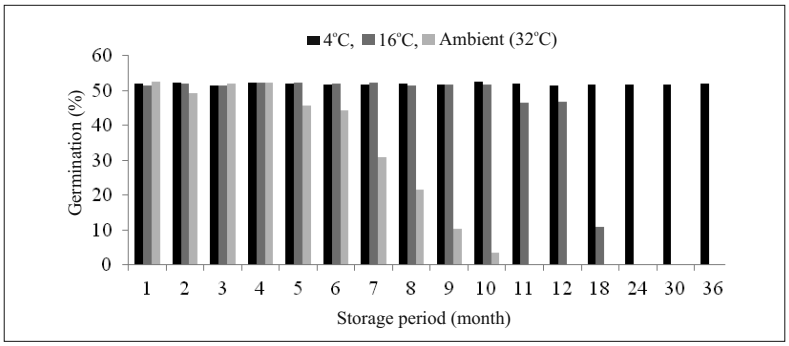

Figure 1: Germination pattern of *D. sikkimensis* seeds under storage

Seeds of *D. sikkimensis* were able to maintain viability up to 36 months in cold condition (4° C & 45±5 % RH). The result obtained in this study substantiated the finding of Boonarutee and Somboon (1990) that viability can be extended for 18

months by storing under cold condition (2-4° C). Earlier studies on *Bambusa arundinacea*, *B. nutans*, *D. strictus*, *D. membranaceus* and *Thyrsostachys siamensis* showed more or less similar results (Gupta and Sood, 1978; Somen and Seethalakshmi, 1989; Thapliyal *et al*., 1991; Rawat and Thapliyal, 2003; Warrier *et al*., 2004).

Table 1: ANOVA Table: Significant levels of seed viability under different storage temperature

Source	d.f	SS	MSS	F - ratio	F – value
Storage temperatures (4°C, 16°C & ambient)	2	23221.07	11610.54	24.45174*	3
Interactions	4	1.87	0.4687	0.00098 ns	2.57
Residual	135	64102.67	474.834		
Total	143	87326.81			

*ns = non-significant; * = significant at P ⩽ 0.05*

Effect of storage temperature on seed moisture content

Seed viability of *D. sikkimensis* could be extended by reducing moisture content up to a critical level (8 %) prior to storage. Maintaining such critical level was influenced by storage temperature. Seeds were able to maintain their lowest safe moisture level up to 36 months in cold storage condition having 4°C and 45±5 % RH (Fig. 2).

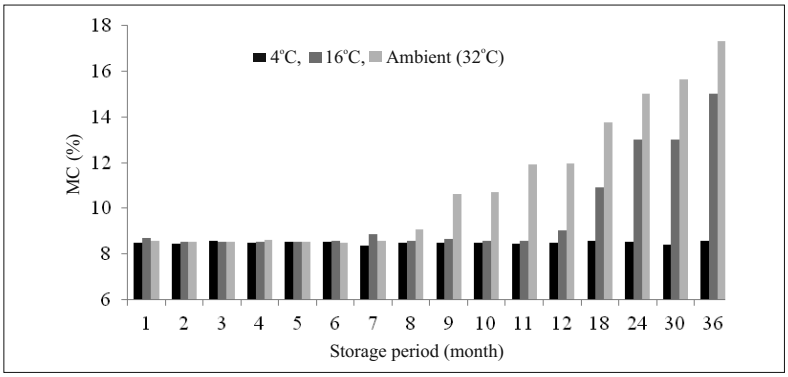

Figure 2: Moisture content of seeds under storage

Effect of biologicals and fungicides on seed-borne mycoflora

Effect of leaf extract of *A. indica*, *A. marmelos* and *L. inermis* and chemical fungicides such as Bavistin, Thiram and Mancozeb 75% WP on seed mycoflora was evaluated. The treatments reduced seed-borne mycoflora and seed deterioration. Among the biologicals, leaf extract of *A. indica* exhibited significant protective effect. With respect to fungicides, Mancozeb 75% WP followed by Thiram significantly reduced

mycoflora and seed deterioration. The result indicated that reduction of seed germination during storage might also be due to fungal infection resulting in seed deterioration and viability loss and it supports the earlier report by Ora *et al*. (2011). Another study on cultivated hybrid rice varieties revealed that infection of seed-borne pathogen is more in seeds having poor germination (Bakan *et al*., 2002; Toth and Teren, 2005). Use of biologicals such as leaf extract of *A. indica*, and fungicides like Mancozeb 75% WP and Thiram for treating seeds can effectively reduce seed-borne mycoflora and help to reduce seed deterioration. Occurrence of mycoflora was minimal on seeds stored at 4°C. Proper storage of bamboo seeds under low temperature and optimum moisture content is necessary to prevent fungal incidence, mycotoxin production and seed deterioration.

CONCLUSION

The study concluded that moisture content (MC %) of the fresh seeds of *D. sikkimensis* is 8.33 % and the lowest safe moisture level (critical MC%) for successful seed storage is 8%. Seed germination commenced on 3rd day after sowing and completed on 20th day with 52 % cumulative germination. Seeds with the lowest safe moisture level (8 %) retained their viability for longer duration. Storage temperature and relative humidity (RH) had significant influence on seed longevity of the species. The best storage condition was found to be 4° C with 45±5 % RH, where seeds of the species were able to maintain viability and lowest safe moisture level for 36 months. Occurrence of seed mycoflora was minimal on seeds stored at 4° C. Treatment with biologicals like leaf extract of Neem and fungicides like Indofil and Thiram effectively reduced incidence of mycoflora and seed deterioration. The present study suggests that storage of bamboo seeds under low temperature helps reduction in seed deterioration and prolongs the seed longevity.

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