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Research Article

INTERMEDIATE STORAGE SEED PHYSIOLOGY IN *MIMUSOPS ELENGI* LINN

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ABSTRACT
The present paper deals with the storage of freshly collected seeds of *Mimusops elengi Linn.* Effect of two storage condition i.e. in open and closed containers under five temperature regimes 0°C, 7°C, 14°C, 21°C and ambient temperature were observed. The initial germination and moisture content of seeds were 81.50 % and 36.14% respectively. Seeds stored at room temperature showed rapid decline of moisture content. Maximum germination was found at 14°C in open and closed conditions are 68.25% and 69.75% respectively after 16 month of storage. Slow desiccation leads to good storage and longevity. The implementation of these result for the conservation management especially nursery development and suitable utilization of *M. elengi* have been suggested.

Keywords: *Mimosops elengi Linn, Intermediate Seeds, Storage Physiology, Moisture Content, Temperature, Germplasm Storage*

INTRODUCTION
Endangered species and declining biodiversity is the main concern among the scientists around the world these days. Continuous and indiscriminate use of forest produce has been alarming the ecological workers. Seed collection and storage is one of the most practical and effective ways for conservation of native plants. Seeds are categorized into three types according to their storage behaviour: Orthodox, Intermediate and Recalcitrant (Roberts, 1973; Ellis *et al.,* 1990). Depending upon the types of storage physiology, different storage facilities are required to store seeds to retain maximum seed viability. Ex-situ conservation of species by raising seedlings by seeds is a common strategy to support plant production and recovery programme. However, banking of seeds under conventional storage conditions is not straight forward for many species (Bewley and Black, 1994; Livington and Pritchard, 2001).
Mimusops elengi Linn. is an important multipurpose evergreen tropical tree, commonly known as Maulsari belongs to family Sapotaceae. It occurs in the Indian sub continent Srilanka, Andaman Islands, Myanmar and Indo-China but is commonly planted as ornamental tree throughout the tropics (Troup, 1921; Burkill, 2000). It is used in various ways to cure a variety of human diseases like toothache, leucorrhoea, fever, headache, palpitatious and possess antibacterial, anti hyperglycaemic anti urslithetic antioxidant and antistress properties (Narayanaswamy *et al*., 2011; Kar *et al*., 2012). In addition to its medicinal uses also provide timber, railways sleepers, musical instruments and walking sticks (Rajput *et al*., 1986; Hop and Ha, 1997; Roquiya *et al*., 2015). The seeds of *M.elengi* are generally referred to as short lived (Kaul, 1979; Bahar, 2016). Furthermore, its seeds are sensitive to storage at low temperature and posseses intermediate storage physiology category (Mai-Hong *et al.,* 2006; Luo *et al.,* 2012; Wen *et al*., 2013).
The present study investigated the longevity of *M.elengi* seeds under different storage conditions and temperature regime. The aim was to identify optimum storage conditions for retaining seed viability and longevity, which would be helpful for biodiversity conservation and management practices.

MATERIALS AND METHODS
Plant Material
Mature fruits of *M.elengi were* collected from tree with sound physiognomy in Orai of district Jalaun (UP), India located between 25°59′N latitude and79°28′ longitude during the month of june 2014.

Immediately after collection, fruits were transported in gunny bags within 24 hours to the laboratory. The fruit sample from all trees were pooled into a single lot and epicarps removed. Extracted seeds were then air dried on filter paper under fan at 25℃ for 24 hours.

Determination of Moisture Content

Seeds moisture content determined soon after extraction of seeds in laboratory. Determination was carried out using five replicates of five seed (Luo *et al.,* 2012). The fresh weight was taken by electronic balance. Seeds were grind later by grinding meal in a small fragment and dried in covered metal containers in an oven at constant temperature of 103°C for 17 hours, cooled in desiccators and reweighed (ISTA, 1985; 2005). The determination of moisture content was done until the death of seeds.

Determination of Viability and Germination

The viability of seeds was determined on the basis of the percentage of germinated seeds. After each treatment, two replicates of 50 seeds were taken for germination. Before the germination test, seeds were held for 20 hours at room temperature. The seeds were pre-soaked in distilled water for 12 hours and placed on moistened sterilized filter paper (Whatman No.1) in seed germination incubator at 27° C ±2° C temperature for 45 days. Seeds showing radical extension of 2 mm were considered to have germinated.

Storage Experiments

Fresh seeds were stored in open and closed glass bottle at room temperature (23 to 42°C), 21°C, 14°C, 7°C and 0°C up to 16 months. Observations were taken at an interval of two months.

Statistical Analysis

Factorial analysis for interaction of different storage condition, temperature of storage and storage period on seed germination was followed after (Mather, 1966).

RESULTS AND DISCUSSION

Result of the present study is based on the freshly collected *M.elengi* seeds with 36.14% moisture content having 81.5% germination. Seeds did not survive at 0^0C in open and closed conditions after two month of storage (Table 1). Seeds lost their viability at ambient temperature after 08 month irrespective of storage conditions. Whereas, seeds stored at 21°C show rapid decline in seed germination after 06 month of storage. Seeds showed 14.25% and 15.50% germination in open and closed conditions at 7°C temperature after 12 month of storage. Successful storage of seeds were found at 14°C under open and closed conditions where viability was 68.25% and 69.75% respectively after 16 months of storage.

Table 1: Variation in Seed Germination (%) of *M. elengi* Seeds at Different Temperatures and Storage Conditions

Temperature	Storage	Storage Periods (Months)								
(^{0}C)	Condition	0	2	4	6	8	10	12	14	16
RT	Open	81.50	37	16.25	6.50	00	00	00	00	00
RT	Closed	81.50	31	24.25	9.50	00	00	00	00	00
21^{0}C	Open	81.50	61.25	53.75	29.50	25.5	21.50	12.00	00	00
21^{0}C	Closed	81.50	64.25	56.50	31.0	29.50	25.25	14.75	00	00
14^{0}C	Open	81.50	81.0	80.5	78.75	77.0	76.00	76.0	70.0	68.25
14^{0}C	Closed	81.50	81.25	81.50	80.0	79.50	78.5	77.25	72.00	69.75
7^{0}C	Open	81.50	66.75	61.50	47.50	41.00	29.25	14.25	00	00
7^{0}C	Closed	81.50	68.0	66.25	49.0	42.25	32	15.5	00	00
0^{0}C	Open	81.50	00	00	00	00	00	15.5	00	00
0^{0}C	Closed	81.50	00	00	00	00	00	00	00	00

RT=Room Temperature

M. elengi seeds exhibited gradual loss of moisture content under all storage conditions with maximum 7.11% after 6 month at room temperature in open storage (Table 2). Similarly, at 21°C the moisture

content sharply declined as compared to other storage condition. However, the seed moisture content did not drop much at 0°C, 7°C and 14° C and remained above 18%.

Table 2: Variations in Seed Moisture Content (%) of *M. elengi* at Different Temperatures and Storage Conditions

Temperature (^{0}C)	Storage Condition	Storage Periods (Months)								
		0	2	4	6	8	10	12	14	16
RT	Open	36.14	14.83	11.53	7.11	5.71	-	-	-	-
RT	Closed	36.14	15.6	12.73	8.24	5.76	-	-	-	-
21^{0}C	Open	36.14	21.56	17.27	14.86	14.13	12.73	8.84 12.70	11.23	-
21^{0}C	Closed	36.14	21.87	18.41	16.38	16.09	12.93	12.79	11.45	-
14^{0}C	Open	36.14	31.28	29.16	27.86	25.86	22.66	21.34	20.68	18.09
14^{0}C	Closed	36.14	33.54	30.94	28.7	27.45	23.7	21.6	20.67	20.09
7^{0}C	Open	36.14	34.5	33.63	29.01	28.57	26.04	24.63	24.05	-
7^{0}C	Closed	36.14	35.29	34.37	34.02	29.19	28.78	28.16	24.29	-
0^{0}C	Open	36.14	24.23	-	-	-	-	-	-	-
0^{0}C	Closed	36.14	32.6	-	-	-	-	-	-	-

Table 3 Analysis Variance for Seed Germination in Intermediate *Mimusops elengi* Stored at Different Temperature Duration and Storage Condition
(Significance **- 0.01, *- 0.001, NS- Not Significant)**
(-Data not taken)

	Source	Sum of Squares	Degree of Freedom	Sum of Mean Square	Variance Ratio	Probability
Main effect	Storage Months (M)	709914.11	7	101416.30	36.69	***
	Temperature (T)	139923.28	4	34980.82	12.65	***
	Storage Condition (C)	42.78	1	42.78	0.01	NS
First order Interaction	MxT	77289.2	28	2760.35	0.99	NS
	MxC	11540.83	7	1635.83	0.59	NS
	TxC	57792.01	4	14448.0	5.22	**
Second order interaction	MxTxC	77393.71	28	2764.06	-	-
	Total	1073895.92	79			

Results of the analysis of variance for temperature, duration and storage conditions and their interaction reveal significant effects of temperature and storage duration (Table 3). The interaction of temperature and months was found significant ($p<0.001$). However, there was no significant effect of these parameters with storage conditions. For many years seeds would be classified into two groups of storage behaviour i.e. orthodox and recalcitrant (Roberts, 1973), but since then a number of species have shown not to confirm to either of the two pattern. These species tentatively termed intermediate species which include woody tropical species e.g. *Arucaria* species (Tompsett, 1984a, 1984b), Dipterocarpus (Tompsett, 1987), *Coffea arabica* (Ellis *et al*., 1990), papaya (Ellis *et al.*, 1991a).
Elaeis guineensis (Ellis *et al.*, 1991b) *Azadiricta indica* (Sacande *et al*., 1998), *Mimusops elengi* (Mai Hung *et al*., 2006), *Tremacannabina* (Chen *et al*., 2008). Intermediate seeds are able to tolerate

desiccation to moisture content in equilibrium with about 40-50% relative humidity, i.e. about 7-10% moisture content depending upon species, but further drying may result in more rapid loss in viability of stored seeds and sometimes immediate damage occurs on further desiccation (Ellis *et al.,* 1990; Hong and Ellis, 1996; Dussert *et al*., 2006).

In the present study results envisaged that *M. elengi* seeds were seriously deteriorated at room temperature due to loss of moisture content up to 7.11% after 6 month of storage. Various workers supported our result that the moisture content below 8% were deleterious of *M. elengi* seeds (Mai-Hong *et al*., 2006; Tang, 2012). Rapid loss of germination at 0ºC may be attributed that intermediate seeds are chilling sensitive particularly in tropical region (Ellis *et al.*, 1990, 1991a, 1991b; Pritchard, 2004; Sengar *et al.*, 2016).

These results suggested that seeds of *M .elengi* do not tolerate low temperature. Viability is rapidly lost at 0ºC and 7°C indicating that high temperature >7º C are better for storage of *M. elengi* seeds. Such conditions for intermediate seeds of various plant species also reported (Yang *et al.,* 2007; Chen *et al*., 2007; Luo *et al*., 2012; Sengar *et al.,* 2016). Seeds retained maximum germination at 14°C in closed condition after 16 month of storage in the present investigation. Luo *et al.,* (2012) reported that storage at 15°C was found to be optimal for *M. elengi* seeds and these seeds are better able to tolerate rapid drying than slow drying, but drying rate did not have an obvious effects on the storage behaviour.

Conclusion

The storage behaviour of seeds *M.elengi* is intermediate because seeds could not survive at freezing temperature i.e. 0°C and often have relatively high levels of desiccations tolerance compared to recalcitrant seeds, but do not have the very high desiccation tolerance of the orthodox seeds. It is evident from the results that seeds with unaltered moisture content and under slow desiccation can be stored for comparatively longer period of time than those stored by rapid desiccation.

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