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## Effect of storage methods on seed germination of *Lophopetalum wightianum* Arn : An important tropical endangered tree of Western Ghats, India

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**ABSTRACT**

Storage of seeds is the most convenient methods of *ex-situ* conservation of plant germplasm which maintain viability. In case of orthodox seeds, viability achieved by storing in dry state under ambient temperature and low relative humidity but desiccation sensitive nature of recalcitrant species act as a hurdle for its storage. *Lophopetalum wightianum*is an important riparian tree with commercial prospects with recalcitrant nature of seeds. The seeds were stored in three different containers for four storage periods after imposing the seven different storage treatments. The study reveals that among the different storage containers, earthen pot was found to be the best storage container which maintains the viability up to two months with maximum germination of 38.23 per cent. Different chemical treatments applied to the seeds helped to maintain the seed viability for a longer period (90 Days), seeds treated with Chlorpyriphos (0.89 %) exhibited maximum (30.31 %) germination but there was a gradual decrease in germination with an increase in storage period. Among all the combination of treatments, seeds stored in an earthen pot treated with Carbendazim (0.25 %) + Chlorpyriphos (0.89 %) stored for 60 days exhibited maximum germination (64.61 %).

**Key Words:**

Germination, Storage chemicals, Storage containers, Storage period, and Viability

## INTRODUCTION

Tree seeds are the fundamental contributors determines the success of any tree planting activity and are regarded as an important genetic resource for species biodiversity, ecosystem restoration, conservation and domestication (Berjak and Pammenter 2004). Seed development and germination are two distinctive

physiological phases in life cycle of a tree during which metabolic actions related to the stored reserves differ markedly (Kumar 1998). Seed longevity is the germination ability of seeds after long-term storage or the period of survival of tree seeds and varies greatly among species as it is mainly influenced by differences in genotype and provenance in which it grows. The seed longevity also varies according to date of harvest of seeds (Shukla et al. 2007). The potential longevity of a tree seed results from the collective effect of the environment during seed maturation, harvesting, drying and the pre-storage environment and the time of seed harvest, duration of drying and the subsequent period before the seed is placed in storage. The longevity of the tree seeds and their storability can be expressed in terms of seed storage behaviour. Maintaining the viability of seeds of recalcitrant species is problematic mainly because of its desiccation nature. There is a wide range of morphological and structural variation among recalcitrant seeds. The seeds or nuts are often surrounded by thick endocarp while many tropical fruits are covered with a fleshy or juicy arilloid structure. Most of the recalcitrant seeds are spherical or oval in shape while some of them are flattened and of very light weight as in the case of *Lophopetalum wightianum* (Kumar 1998). The recalcitrant species are further classified into riparian and large size types. The easy availability of water for seed germination in riparian habitat benefits the species to establish well before being washed away. The recalcitrant species tend to originate from moist ecosystems in which seeds are subjected to high humidity during seed development, maturation and after shedding. Desiccation tolerance in recalcitrant seeds increases during seed development on the mother plant (Hong and Ellis 1996).

Seed storage studies on tropical forest fruit species mostly of with recalcitrant seeds is very meagre (Hanson 1984) and there are many storage problems yet to be solved in tropical trees. Recalcitrant seeds are maintained under storage condition that prevent water loss, they will ultimately lose viability and hydrated recalcitrant seeds are metabolically active and undergo germination associated changes in storage. Tree seed storage being one of the important aspects in afforestation programme, play a significant role in the supply of good seeds round the year. Even if fruiting is regular and seed production is abundant every year, it may be more cost-efficient to collect surplus seed to cover the needs of few consecutive years which are a prerequisite for the success of any massive afforestation programme (Umaraniet al.2015). Storage of recalcitrant seeds requires much attention than the orthodox seeds as it cannot tolerate desiccation and loose viability within a short time.

*Lophopetalum wightianum* is a recalcitrant seed bearing tree commonly called as Banate belonging to the family Celastraceae. It is an important riparian species in the evergreen forests of the Western Ghats of Karnataka, India, distributed from lower elevations up to 914.4 m above MSL from South Canara southwards, and in Central Sahyadris (Gamble 1935). It is an important element of the endangered Myristica swamps of Western Ghats (Chandra et al.2014) and the tree is identified by its straight bole and scaly greyish brown bark with coriaceous leaves. It is a fast-growing species of the evergreen forests and wood is in high demand for construction, plywood industry and match wood industry. It is light but strong timber with good working qualities and wood of the species is highly favored for photo frame (Rai 1999). Along with the timber values, the tree also provides some ecological services. It is one of the nesting trees of the near threatened Great Indian Hornbill (Bachanet al.2011) and succulent leaves and twigs of the species are used as fodder by Hanuman Langur and Bonnet Macaque (Kuladeepet al.2010). Seed viability of *L. wightianum* remains only for a short period and to overcome the seed storage problem, an experiment was conducted with objective to study the effect of different storage containers, storage

chemicals and storage period on seed viability.

## MATERIALS AND METHODS

### *Study site*

An experiment was carried out during 2015 to 2016 at College of Forestry, Ponnampet, located in the hilly zone (zone 9), Kodagu district of Karnataka state, India which is situated at 120 08.579' N latitude; 0750 56.317' E longitude and at an altitude of 856 m above Mean Sea Level (MSL). The study area is under tropical humid climate with monthly mean maximum temperature which varied from 31° C to 37° C and mean monthly minimum temperature varying from 24° C to 27° C.

### *Seed collection*

The seeds were collected from natural population of *L. wightianum* found in Western Ghats of Karnataka. Phenotypically superior trees were identified and matured pods were collected from the standing trees by shaking the branches vigorously, making the pods to fall on the ground. Then the seeds were extracted from the pods, each of which contained 15-20 seeds (Photo 1).

### *Seed treatments*

To study the effect of different aspects of storage on seed viability, seeds were subjected to different conditions *viz.*, storage containers as M1: Earthen pots (6"×3"×6"), M2: Poly pots (6"×3"×6") and M3: Polythene bags (200 gauge), Storage treatments as T1: Control, T2: Carbendazim (0.25 %) , T3: Chlorpyriphos (0.89 %), T4: Abscisic acid (0.005%), T5: Carbendazim (0.25 %) + Chlorpyriphos (0.89 %), T6: Carbendazim (0.25 %) + Chlorpyriphos (0.89 %) + Abscisic acid (0.005%) , T7: Cow dung + Ash and storage period as S1: Freshly collected seeds, S2: 30 Days after collection, S3: 60 Days after collection, S4: 90 Days after collection

### *Design and layout*

The experiment was laid out in Split-Split plot design. Storage container was considered as main plot, storage treatment as sub plot and storage period as sub-sub plot. There were three main plots, seven sub plots and four sub-sub plots. All the treatments were replicated thrice with 30 seeds per replication. Plastic sheets were used to cover the mouth of the containers, to avoid further moisture loss. During sowing period, required number of seeds were taken out from the container carefully without damaging the other seeds present in the container and were sown in the sand bed (Photo 2). The number of seed used for each storing period was 1,890, which altogether accounts for a total of 7,560 (1,890 × 4 storage periods) numbers of seeds till the completion of the study up to 90 days.

The following observations on germination were noted for further calculations:

- **Germination initiation period (GIP)**: Number of days taken to initiate germination in each treatment was recorded.
- **Germination Energy (G.E)**: The per cent of seeds in a given sample that have germinated up to the time of peak germination.
- **Germination Percentage (G.P)**: The germination was recorded when cotyledons emerged out from sand bed and is expressed in percentage.

  Germination % =Number of seeds germinated Number of seeds sown× 100
- **Mean daily germination (MDG)**: Mean daily germination=Cumulative per cent germination * Total number of days
- **Peak value (PV)**: Maximum mean daily germination reached at any stage of germination period.
- **Germination value (G.V):** It is the index of combining seed and completeness of seed germination.

Germination value = Final daily speed of germination × Peak Value

## RESULTS AND DISCUSSIONS

The collected seeds were measured and seed length of *L. wightianum* varied from 5.3 cm to 8.9 cm and the average

length of the seed was 6.88 cm with seed width varied from 1.5 cm to 2.4 cm with an average value of 1.82 cm. Fresh weight of


**Photo 1.** A) *Lophopetalum wightianum*tree; B) opened pod of *L. wightianum* showing seeds; C) *L. wightianum* seeds after extraction

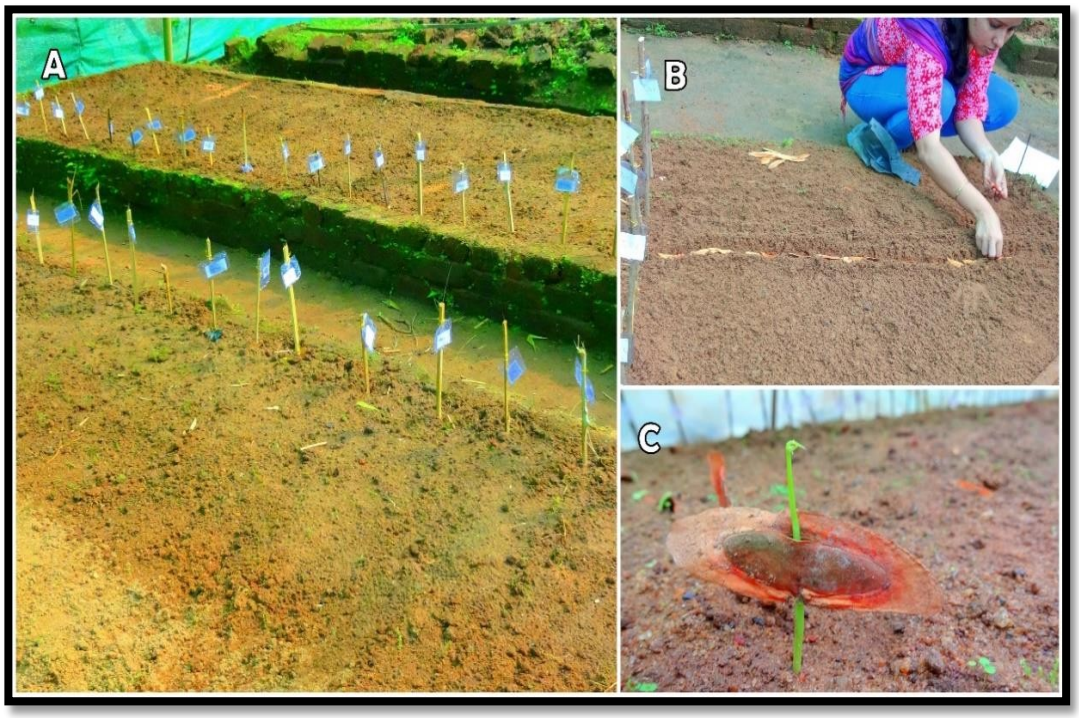


**Photo 2.** A) Sand beds; B) Seeds are sowing in sand bed; C) Emergence of *Lophopetalum wightianum* seed

100 seeds of *L. wightianum* varied from 26 g to 29 g with an average weight of 27.80 g. The number of seeds present in a one kilo gram of *L. wightianum* on an average was 3597. The moisture content of the seed varied from 54.76 to 71.59 per cent. Average moisture content was estimated to be 61.88 per cent.

Moisture content is a decisive factor in maintenance of recalcitrant seed quality (Patil and Krishna 2016) and it also plays a very significant role in maintaining the seed viability and germination. Preservation of moisture content above the critical level is one of the key factors to be considered during storage. The average moisture content of *L. wightianum* seed was found to be 61.88 per cent. The moisture content of fresh seed varied from 54.76 per cent to 71.59 per cent. Generally, the moisture content of the recalcitrant seeds were reported to be around 30 to 70 per cent (Chin et al.1984). High moisture content of recalcitrant seeds during shedding was due to lack of maturation drying or desiccation on the mother plant (Sheela and Salim 2013 ).

The weight of the seeds per Kilogram helps to know the seed requirement in planting activities and assessment of seed demand in future. According to the present study, one Kilogram of *L. wightianum* contained 3,597 seeds. The results are in line with Rai (1999), who reported about 4000 to 5000 seeds of *L. wightianum* weighing one kilogram. Seed germination is controlled by many internal and external factors, one among them is the seed size (seed length and seed width). This is an important parameter which influences the germination, growth and biomass of the nursery seedlings and that trend lead to the future crop (Gunaga et al. 2011). In the present study, thickness of the seeds range from 0.39 mm to 1.33 mm with the mean of 0.68 mm.

***Effect of storage containers on germination parameters***

Storage containers were found to have a significant effect on seed germination. The maximum germination per cent was achieved for the seeds stored in an earthen pot (34.32 %), followed by poly pot (7.03 %) and polythene bag (1.40 %) (Table 1). The findings of the study are in accordance with in germination per cent of *Azadirachta indica*, where the seeds were kept in an earthen pots, buried up to neck level in 20-25 per cent moist sand bed for three months. Generally, earthen pot allow the exchange of gasses between container and atmosphere, hence resulting in gradual loss of moisture content in seeds stored in the container and retains the viability. Reduction in moisture content avoids the fungal growth and allows the seeds to be stored in a clean condition. These reasons could be ascribed to the maximum germination obtained from the seeds stored in the earthen pots. Whereas polythene bag allows the slight exchange of gasses with a long period of storage and in the case of poly pot, gas exchange is almost nil.Rotting and fungal growth were also observed on seeds stored in a polythene bag and poly pot which could be correlated to the increased moisture content in seeds and as relative humidity increases there will be disconnection of moisture between the container and surrounding atmosphere. According to Anandalaxshmi et al. (2005) seeds stored in airtight containers will be unable to replenish oxygen. Therefore accumulation of toxic gases which are produced as a result of metabolism affects the germination. Most of the seeds create heat and consume oxygen during storage. If the oxygen is depleted because of inadequate aeration, fermentation replaces the respiration could be the reason for the lower germination in poly pot and polythene bag.

Germination initiation period is an important factor to be considered while propagating a species because some species may germinate immediately whereas others may take up to a month to germinate after sowing. Hence, the storage container which initiates the early germination proves to be advantageous. Germination initiation

period was minimum (8.79 days) in seeds stored in the poly pot (M2) and maximum (11.25 days) in seeds stored under polythene bag (M3). No desiccation or little desiccation of seeds stored in a poly pot might be the reason for early germination compared to other containers.

The peak value of the species achieved the maximum in the poly pot (3.15) and polythene bag (3.15) may be due to the accumulation of more nutrients in the embryo of the seed during storage. Germination energy is a measure of the speed of germination and was assumed as a measure of the vigour of seedling which it produces (Hossain et al.2005). In the present study, it was found that seeds stored in the earthen pots had a minimum germination energy of 18.11 days, which implies that the seeds stored in the earthen pot germinated rapidly and vigorously under favorable conditions compared to poly pot (19.93 days) and polythene bag (23.50 days). Such seeds which germinate rapidly (less germination energy) are capable of producing vigorous seedling in field condition, where as weak or delayed germination is often fatal (Masoodi et al.2014; Thakur et al. 2019).

**Table 1.** Effect of seed storage containers on germination parameters of *Lophopetalum wightianum*

| Storage containers | Germination Per cent | Germination Initiation Period (Days) | Mean Daily Germination | Peak Value | Germination Energy (Days) | Germination Value |
|---|---|---|---|---|---|---|
| M1 | 34.32(35.86)[c] | 10.25 | 0.94 | 2.46 | 18.11 | 8.99 |
| M2 | 7.03(15.38)[b] | 8.79 | 1.57 | 3.15 | 19.93 | 8.53 |
| M3 | 1.40(6.80)[a] | 11.25 | 1.61 | 3.15 | 23.50 | 7.49 |
| S.Em (±) | 1.17 | | | | | |
| LSD (0.05) | 4.58 | | | | | |

**a, b, c have statistical significant difference among them*

***Effect of Seed storage chemicals and material on germination parameters***

The existence of considerable effect of storage chemicals and material on germination parameters were observed during the study. Among all the storage chemical treatments, maximum germination per cent was found in control (18.16 %) which was on par with T2 [Carbendazim (0.25%)] (16.76 %), T3 [Chlorpyriphos (0.89 %)] (15.50 %) and T4 [Abscisic acid (0.005 %)] (14.34 %) (Table 2). Effect of these treatments significantly differed with the remaining treatments and least (3.89) was observed in T7 (cow dung and ash). Compared to the other treatments, seeds treated with T2 [Carbendazim (0.25%)] chemical gave better germination. Use of Carbendazim is believed to have a positive effect in maintaining clean and hygienic condition, by avoiding the growth of fungus on the seeds, while in stored condition, which helps in increased germination. Contrary to the present results, Mittal (1986) reported that the seeds treated with Carbendazim reduced the germination (30 %) in *Eucalyptus hybrid* species compared to the control (70 %).

Seeds stored with ash and cow dung (T7) showed least germination (3.89 %) in the current study which may be due to the use of unsterilized cow dung in slurry form and subsequent rotting of the seeds. Whereas, the seeds of *Elaeocarpus munronii* (Basavarajet al.2002), *Terminalia chebula* (Lokesh 2007) and *Melia azedarach* (Sujatha and Manjappa 2015) reported maximum germination when treated with cow dung slurry. This could be clearly attributed to the fact that the microbial activities taking place in the cow dung

slurry feeds on the hard seed coats of these species which might help in the increased germination, which on contrary to the present study showed a negative effect which damages the light embryo of the *L. wightianum* leading to the least germination.

Seeds treated with cow dung and ash (T7) took least number of days (4.83 days) to germinate. The presence of moisture content in cow dung enhances the initiation of germination, which might be the reason for early germination. The seeds treated with T6 [Carbendazim (0.25 %) + Chlorpyriphos (0.89 %) + Abscisic acid (0.005 %)] have taken maximum days for initiation of germination (13 days), followed by T4 [Abscisic acid (0.005 %)]. The seeds treated with a combination of three different chemicals (T6) might have had a deleterious effect due to a high concentration, which in turn increased the days for germination initiation. Usage of Abscisic acid in T6 treatment will inhibit the germination by keeping the seeds dormant for several days. Though the abscisic acid will reduce the germination percentage, it will help in storing the seeds for a longer duration as the seeds will be under dormant condition.

The maximum (2.01) mean daily germination was observed in seeds stored with Carbendazim (0.25 %) whereas peak value of germination was found maximum in T3 [Chlorpyriphos (0.89 %)]. Findings of the study were in line with that of Koppad and Umarbhadsha (2006), who reported that use of Carbendazim helped in the proper emergence of seeds by controlling the pathogen. Seed treated with Chlorpyriphos (0.89 %) (T3) treatment avoids pest occurrence during storage, which helps to reach a maximum peak value of germination in seedlings. In both the above parameters, the least values (0.65, 0.95 respectively) were observed in T7 (cow dung and ash) treatment and this was mainly because of excess moisture content which damage the seeds by rotting during the storage.

The study reveals that the maximum germination energy (26.75) was observed in T4 [Abscisic acid (0.005 %)] treatment and the least was observed in T7 (cow dung + ash) treatment. As previously mentioned, the use of Abscisic acid inhibits the germination, which takes more time to reach the peak germination. The germination value (19.69) in the present study was found to be maximum in T3 [Chlorpyriphos (0.89 %)] treatment and the least in T7 (2.03). Germination value is a composite value that combines both germination speed and total germination which helps in evaluating the germination test (Hossain et al. 2005). Hence the seeds treated with T3 was effective in terms of germination value.

**Table 2.**Effect of seed storage treatments on germination of *Lophopetalum wightianum*

| Seed storage treatments | Germination Per cent | Germination Initiation Period (Days) | Mean Daily Germination | Peak Value | Germination Energy (Days) | Germination Value |
|---|---|---|---|---|---|---|
| T1 | 18.16 (25.22)$^{b*}$ | 9.67 | 0.87 | 1.86 | 16.17 | 4.36 |
| T2 | 16.76 (24.17)$^{b}$ | 9.42 | 2.01 | 3.91 | 21.08 | 11.32 |
| T3 | 15.50 (23.19)$^{b}$ | 11.08 | 1.52 | 4.59 | 22.92 | 19.69 |
| T4 | 14.34 (22.25)$^{b}$ | 12.75 | 1.23 | 2.81 | 26.75 | 6.59 |
| T5 | 8.28 (16.73)$^{a}$ | 9.92 | 1.54 | 2.60 | 21.83 | 5.18 |
| T6 | 4.70 (12.52)$^{a}$ | 13.00 | 1.80 | 3.71 | 25.75 | 9.19 |
| T7 | 3.89 (11.38)$^{a}$ | 4.83 | 0.65 | 0.95 | 9.08 | 2.05 |
| S.Em (±) | 1.83 | | | | | |
| CD (0.05) | 5.28 | | | | | |

**Parenthetical values are arc sine transformed; CD- Critical Difference; Figures with similar letters as superscript do not differ significantly*

***Effect of seed storage periods on Germination parameters***

Seed germination under different storage periods did not show any significant difference. However, comparatively higher germination was observed when the freshly collected seeds were sown. It is prudent to mention that, the least (8.77 %) germination per cent was recorded for the seeds that were sown after storing them for 90 days (Table 3).

Seeds stored for 90 days took minimum (3.29 days) number of days for initiation of germination and maximum (19.71) was observed in seeds sown afresh. This implies that the seeds when sown afresh, consumed more time for the emergence of plumule and radicle which increased the days of germination initiation. Whereas, the seeds stored for 90 days germinated early, this could be attributed to the fact that the recalcitrant seeds germinate before sowing, while still in the stored condition (Berjak et al.1993), which was also evident in the present study. These reasons could also be ascribed to the germination energy which was minimum (4.05 days) in seeds sown after 90 days of storage and maximum (40.38 days) for seeds sown afresh.

Effect of storage period did not have much influence on mean daily germination and was maximum (1.77) in seeds stored up to 30 days (S2) and minimum (1.07) in seeds stored for 60 days (S3) storage period. The peak value of germination was maximum after 90 days of storage (S4) and minimum in seeds stored for 60 days (S3). Seeds attained peak germination after a longer period implies that reduction in moisture content facilitates longer storability and better germination and the result is in agreement with Anandalashmi et al. (2005), who investigated on seed storage studies in *Syzigium cuminii*, a recalcitrant species where seed attained peak germination after longer period due to desiccation of seeds.

***Interaction effect of storage containers and treatments on germination***

Seed germination due to interaction effect of different storage containers and storage chemicals and material differed significantly. Germination per cent was highest in seeds stored in earthen pot treated with Abscisic acid (0.005 %). The minimum germination (0.88 %) was observed in seeds treated with Chlorpyriphos (0.89 %) and stored in polythene bag (Table 4). Accumulation of high moisture content without any gas exchange in polythene bag led to the fungal activity and use of insecticide as a storage chemical might be the cause for less germination. If the moisture content of the recalcitrant seeds is not reduced then the germination occurs during the storage period itself and there may be a chance of occurrence of fungus (Adelina et al. 2014).

***Interaction effect of seed storage containers and storage periods on germination***

Interaction effect of storage containers and storage periods on the seeds of *L. wightianum* was not evident in the present study. However, comparatively seeds stored for 60 days in earthen pot showed maximum germination (38.23 %) and it was minimum in seeds stored under polythene bag at all the storage periods (Table 5).

***Interaction effect of seed storage treatments and storage periods on germination***

The study revealed significant difference in interaction effect of storage treatment and storage periods on germination. The maximum germination (38.25 %) was found in seeds sown afresh after treating with Carbendazim (0.25 %) and lowest in T7 (cow dung + ash) treatment after 90 days of storage (Table 6). According to Sharma et al. (2004), Carbendazim provided 90 per cent disease control in pre-emergence mortality and 78 per cent in post emergence mortality and it could be the key factor for better germination (38.25 %). As previously mentioned seeds treated with cow dung and ash were affected by fungal growth due to high moisture content and storing the recalcitrant seeds for longer duration

results in lower germination. However, seed treated with cow dung and ash remained inferior throughout the study. It is possible that the retention of moisture by cow dung ash as a seed, equilibrate with the atmospheric moisture content when the ambient temperature is low and relative humidity is high and thereby causing faster deterioration (Khan 2013).

**Table 3.**Effect of seed storage periods on germination parameters of *L. wightianum*

| Storage periods (Days) | Germination Per cent | Germination Initiation Period (Days) | Mean Daily Germination | Peak Value | Germination Energy (Days) | Germination Value |
|---|---|---|---|---|---|---|
| S1 | 12.42 (20.63)* | 19.71 | 1.36 | 2.20 | 40.38 | 3.09 |
| S2 | 12.76 (20.92) | 12.48 | 1.77 | 3.57 | 22.90 | 9.02 |
| S3 | 10.18 (18.61) | 4.90 | 1.07 | 1.81 | 14.71 | 3.68 |
| S4 | 8.77 (17.23) | 3.29 | 1.30 | 4.11 | 4.05 | 17.56 |
| S.Em(±) | 1.39 | | | | | |
| LSD (0.05) | NS | | | | | |

**Parenthetical values are arc sine transformed; LSD- Least Significant Difference; NS- Non Significant*

**Table 4.**Effect of seed storage containers and storage treatments on germination of *L. wightianum*

| Storage containers / storage treatments | T1 | T2 | T3 | T4 | T5 | T6 | T7 |
|---|---|---|---|---|---|---|---|
| M1 | 33.52bc (30.50)* | 36.42c (35.25) | 46.88d (53.28) | 47.53 d (54.41) | 45.35 cd (50.61) | 26.53b (19.95) | 14.80a (6.53) |
| M2 | 23.18c (15.49) | 22.89c (15.13) | 21.79c (13.78) | 15.89bc (7.50) | 1.75a (0.09) | 7.94ab (1.91) | 14.20bc (6.02) |
| M3 | 18.97b (10.57) | 13.20b (5.21) | 0.88a (0.02) | 3.32a (0.34) | 3.07a (0.29) | 3.07a (0.29) | 5.12ab (0.80) |
| S.Em (±) | | | | 3.18 | | | |
| CD (0.05) | | | | 9.14 | | | |

**Parenthetical values are arc sine transformed; CD- Critical Difference; Figures with similar letters as superscript do not differ significantly.*

**Table 5.**Effect of seed storage containers and storage periods on germination of *L. wightianum*

| Storage containers / Storage periods | S1 | S2 | S3 | S4 |
|---|---|---|---|---|
| M1 | 37.10 (36.39)* | 33.22 (30.01) | 38.23 (38.29) | 34.90 (32.74) |
| M2 | 19.60 (11.25) | 19.79 (11.46) | 11.55 (4.01) | 10.58 (3.37) |
| M3 | 5.20 (0.82) | 9.77 (2.88) | 6.04 (1.11) | 6.21 (1.17) |
| S.Em (±) | 2.40 | | | |
| CD (0.05) | NS | | | |

**Parenthetical values are arc sine transformed; CD- Critical Difference;NS- Non Significant*

***Interaction effect of storage containers, storage chemicals and storage periods on germination***

The interaction effect of storage containers, storage chemicals and material and storage periods had a significant effect on germination of *L. wightianum*. In the present study, seeds treated with Carbendazim (0.25 %) + Chlorpyriphos (0.89 %) (T5) and stored up to 60 days (S3) in an earthen pot attained maximum germination of 64.61 per cent, followed by seeds treated with Abscisic acid (0.005 %) (T4) and stored for 60 days in earthen pot container (Table 7). In addition to the effect of the combination of fungicide (Carbendazim) and insecticide (Chlorpyriphos), the earthen pot also contributed towards the better germination.

**Table 6.** Effect of seed storage treatments and storage periods on germination of *L. wightianum*

| Storage treatments/ storage periods | S1 | S2 | S3 | S4 |
|---|---|---|---|---|
| T1 | 15.76a (7.38)* | 37.32c (36.76) | 26.15b (19.42) | 21.65ab (13.61) |
| T2 | 38.25b (38.33) | 30.12b (25.18) | 12.99a (5.05) | 15.31a (6.97) |
| T3 | 22.84ab (15.07) | 23.63ab (16.07) | 15.96a (7.56) | 30.31b (25.47) |
| T4 | 27.43a (21.22) | 22.26a (14.35) | 17.48a (9.02) | 21.83a (13.83) |
| T5 | 14.59a (6.35) | 12.62a (4.77) | 19.88a (11.56) | 19.81a (11.49) |
| T6 | 15.86b (7.47) | 4.04a (0.50) | 18.46b (10.03) | 11.70ab (4.11) |
| T7 | 9.69ab (2.83) | 16.50b (8.07) | 19.32b (10.95) | 0.00a (0.00) |
| S.Em (±) | 3.67 | | | |
| CD (0.05) | 10.27 | | | |

**Parenthetical values are arc sine transformed; CD- Critical Difference;*
*Figures with similar letters as superscript do not differ significant*

## CONCLUSION

The study reveals that the viability and longevity of seeds of *L. wightianum* can be maintained by storing the seeds in an earthen pot given a combined treatment of Carbendazim (0.25 %) and Chlorpyriphos (0.89 %). It is pragmatic to mention that, though the species being recalcitrant can be stored up to 60 days after collection (with viability) when treated with above-mentioned storage treatment.

## ACKNOWLEDGEMENT

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**Table 7.** Effect of Storage containers, storage treatments and storage periods on germination of *L.wightianum*

| | Earthen pot (M1) | | | | | | | Poly pot (M2) | | | | | | | Polythene pot (M3) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T1 | T2 | T3 | T4 | T5 | T6 | T7 |
| S1 | 27.52 (31.64)* | 31.74 (34.29) | 61.50 (51.65) | 43.29 (41.15) | 47.86 (43.77) | 54.49 (47.58) | 2.80 (9.63) | 7.27 (15.64) | 54.54 (47.61 | 8.44 (16.89) | 43.28 (41.14) | 0.00 (0.00) | 0.00 (0.00) | 7.53 (15.93 | 0.00 (0.00) | 29.45 (32.86) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.37 (3.51) |
| S2 | 42.88 (40.91) | 25.00 (30.00) | 57.85 (49.52) | 48.86 (44.35) | 37.66 (37.86) | 4.41 (12.13) | 9.33 (17.78) | 32.19 (34.57) | 42.06 (40.43 | 9.42 (17.87) | 14.57 (22.44) | 0.00 (0.00) | 0.00 (0.00) | 15.54 (23.22 | 35.37 (36.49) | 11.61 (19.93) | 0.37 (3.51) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 2.18 (8.49) |
| S3 | 32.00 (34.45) | 39.56 (38.97) | 31.32 (34.03) | 62.82 (52.43) | 64.61 (53.50) | 14.52 (22.40) | 27.77 (31.80) | 22.97 (28.64) | 0.00 (0.00) | 5.72 (13.84) | 0.00 (0.00) | 0.00 (0.00) | 12.49 (20.70 | 9.20 (17.66 | 7.01 (15.35) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 1.15 (6.15) | 4.53 (12.29) | 2.18 (8.49) |
| S4 | 20.70 (27.06) | 45.51 (42.42) | 62.67 (52.34) | 62.43 (52.20) | 52.21 (46.27) | 16.58 (24.03) | 0.00 (0.00) | 5.75 (13.87) | 0.37 (3.51) | 38.88 (38.58) | 0.00 (0.00) | 1.49 (7.01) | 3.69 (11.07 | 0.00 (0.00) | 16.56 (24.01) | 0.00 (0.00) | 0.00 (0.00) | 5.28 (13.28) | 1.15 (6.15) | 0.00 (0.00) | 0.00 (0.00) |
| S.Em(±) | 6.36 | | | | | | | | | | | | | | | | | | | | |
| CD (0.05) | 17.79 | | | | | | | | | | | | | | | | | | | | |

*Parenthetical values are arc sine transformed; CD- Critical Difference

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