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# IV. STORAGE AND GERMINATION TESTS ON *SHOREA JAVANICA* SEEDS

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**ABSTRACT**

Seeds *of Shorea javanica* K & V (Dipterocarpaceae), were subjected to different treatments of temperature (27 ± 2°C, 20 ± 2°C and < 10°C), coating (ash and paraffin) and relative humidity (20, 66 and 86%) and their germination capability as well as moisture content assessed after 3, 7, 14 and 30 days of storage.

The germination percentage of the seeds stored 30 days in a cloth bag under different conditions of temperature showed highly significant differences (a = 0.01). No significant differences were found on the effect of coating, duration of storage as well as on the interaction between these two factors. The moisture content of the seeds between 13 and 14% gave a germination percentage above 50% after 30 days.

## INTRODUCTION

Like in other Dipterocarpaceae, the production of seeds in *Shorea javanica* is irregular (Ashton 1960, Torquebiau 1984). Knowledge of seed storage technology for preserving planting stocks from one fruiting season until the next is therefore a very important prerequisite for making genetic and breeding studies of this timber species. This work is a preliminary study on the effect of storage temperature, coating, relative humidity and moisture content on the germination capacity of *Shorea javanica.*

## MATERIALS AND METHODS

Seeds were collected in August and September 1985 from the forest plantations near Krui, Lampung (Sumatra). Immediately after collection from the trees, seeds with complete structure (i.e. with wings) were put in a cloth bag for transport to Bogor.

Two experiments were conducted :

**Experiment 1 :**

Three days after harvest, 3600 seeds were divided into 3 groups: 2 groups coated with ash or paraffin wax and uncoated control. The seeds were then stored under three different temperature conditions: room temperature (27 ± 2°C), air conditioned room (20 ± 2°C) and inside refrigerator ( < 10°C) for 3, 7, 14 and 30 days. There were 50 seeds per treatment and each treatment was in replicate.

**Experiment 2 :**

1800 seeds were stored in eight dessicators (200 seeds per dessicator) four of which were kept at room temperature (27 ± 2°C) and the others at air conditioned room temperature (20 ± 2°C). Three of the four dessicators of each series were filled with saturated solutions of potassium acetate ($KC_2H_3O_2$), sodium nitrate ($NaNCO_2$) and potassium chlorite (KCl) to keep relative humidities (RH) at around 20%, 66%, and 86%, respectively (Suchslands 1980). One dessicator of each series was without chemical and had approximately 67% RH at room temperature or less than 60% RH in air conditioned room. In each dessicator, the seeds were stored for 3, 7, 14 and 30 days and fifty seeds were taken at the end of each period.

The germination tests were done in two sand-filled seed beds which measured 5 x 1.2 m. These seed beds were covered with plastic sheets to keep moisture at ca. 90% RH. The emergence of the shoot on the surface of sand was indicated by a small stick. The data on germination percentage of the first experiment were subjected to analysis of variance for the three factors (i.e. temperature, coating and duration of storage) with completely randomized block, whereas the data on the second experiment were presented as germination percentage for each experiment.

Determination of seed moisture content in relation with the germination capacity was also made. For this purpose, five seeds were added for each treatment and they were dissected and weighed before and after they were placed in an oven at 110°C for 20 hours. The formula of moisture content was on a wet weight basis :

$$\% \text{ moisture content} = \frac{\text{Fresh weight of seed} - \text{Dry weight of seed}}{\text{Fresh weight of seed}} \times 100$$

## RESULTS

**Experiment 1.**

The development of the seedling until the appearance of cotyledons and a small part of the apex needed one to two weeks after sowing. Results are shown in Table 1.

Table 1. Percent germination of *S. javanica* seeds at different temperatures and with different duration of storage and coating (means of two replications).

| Storage (days) | Temperatures: | 27 ± 2°C | | | 20 ± 2°C | | | <10°C | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Coating: | C | A | P | C | A | P | C | A | P |
| 3 | | 60 | 49 | 58 | 58 | 63 | 61 | 9 | 20 | 7 |
| 7 | | 59 | 59 | 55 | 54 | 62 | 50 | 6 | 6 | 3 |
| 14 | | 52 | 52 | 48 | 50 | 53 | 49 | 2 | 5 | 5 |
| 30 | | 46 | 50 | 41 | 45 | 48 | 50 | 8 | 4 | 3 |

Notes: C : Without coating; A : Coated with ash; P : Coated with paraffin.

*Effect of temperature*

The analysis of variance of the data showed that there were highly significant differences in the germination percentage of seeds according to the different temperature conditions (Table 2).

The comparison of the germination percentages of seeds stored at different temperatures was performed by Tukey's identification and is shown in Table 2a. There was no significant difference of germination percentage between seeds placed at 27 _+ 2°C (52.42%) and 20 ± 2°C (54.42%) but percent germination of

Table 2. Analysis of variance on the effect of temperature, coating and duration of storage and the interaction of these factors on the percent germination of S. *javanica* seeds.

| Source of variation | Degree of freedom | Sum square | Mean square | F value |
|---|---|---|---|---|
| Blocks | 1 | 41953.3872 | 41953.3872 | |
| Temperature | 2 | 35643.1078 | 17821.5341 | 39.2678 ** |
| Coating | 2 | 172.4444 | 86.2222 | 0.1900 NS |
| TC | 4 | 48.2222 | 12.2556 | 0.0266 NS |
| Duration | 3 | 876.6111 | 292.2037 | 0.6438 NS |
| TD | 6 | 306.2222 | 51.0370 | 0.1125 NS |
| CD | 6 | 104.8889 | 17.4815 | 0.0385 NS |
| TCD | 12 | 463.7778 | 38.6481 | 0.0385 NS |
| Residual | 35 | 15884.6178 | 453.8462 | |

Notes: ** = highly significant at level α = 0.01
NS = not significant at level α = 0.05
TC : interaction between temperature coating
TD : interaction between temperature duration
CD : interaction between coating and duration
TCD : interaction among temperature, coating and duration

Table 2a. Tukey's identification of means of germination percentage (mean of all data of Table 1 for each temperature).

| Temperature | 27±2°C | 20±2°C | 10°C |
|---|---|---|---|
| Mean of germination (%) | 52.42 | 54.42 | 6.25 |
| | NS | | |

NS: non-significant at level a = 0.05
* significant difference at level a = 0.05

seeds placed at both temperatures compared with those at < 10°C (6.25%) was significantly different.

*Effect of presence and absence of coating*

As shown in Table 2, the effect of coating the seeds, and of the duration of storage as well as the interaction among factors of temperature, coating and duration of storage gave germination percentages which were not significantly different. The seeds coated with ash germinated better than those coated with paraffin which had a lower germination percentage than untreated seeds (Table 2b). However, statistical test showed that the differences were not significant.

Table 2b. Percent germination according to different coatings (means of all data of Table 1, for each coating).

| | Control | Ash | Paraffin |
|---|---|---|---|
| Germination % means | 38.25 | 39.25 | 35.58 |

*Effect of the duration of storage*

The means of germination percentages decreased for all storage duration of treatments 3 to 30 days (Table 2c) but the differences were not statistically significant.

Table 2c. Percent germination according to the duration of storage (means of all data of Table 1, for each duration of storage).

| Duration (days) | 3 | 7 | 14 | 30 |
|---|---|---|---|---|
| Germination % means | 42.78 | 38.00 | 35.11 | 33.89 |

**Experiment 2:**

*Effect of relative humidity*

The germination percentage of seeds stored at 27 ± 2°C with 20% RH (R20) and 66% RH (R66) went down to almost zero after 14 and 30 days of storage respectively (Fig. 1). However, the seeds stored without chemicals i.e. RH aproximately 67% (RC) had a germination capacity slightly above 50% after 30 days of storage.

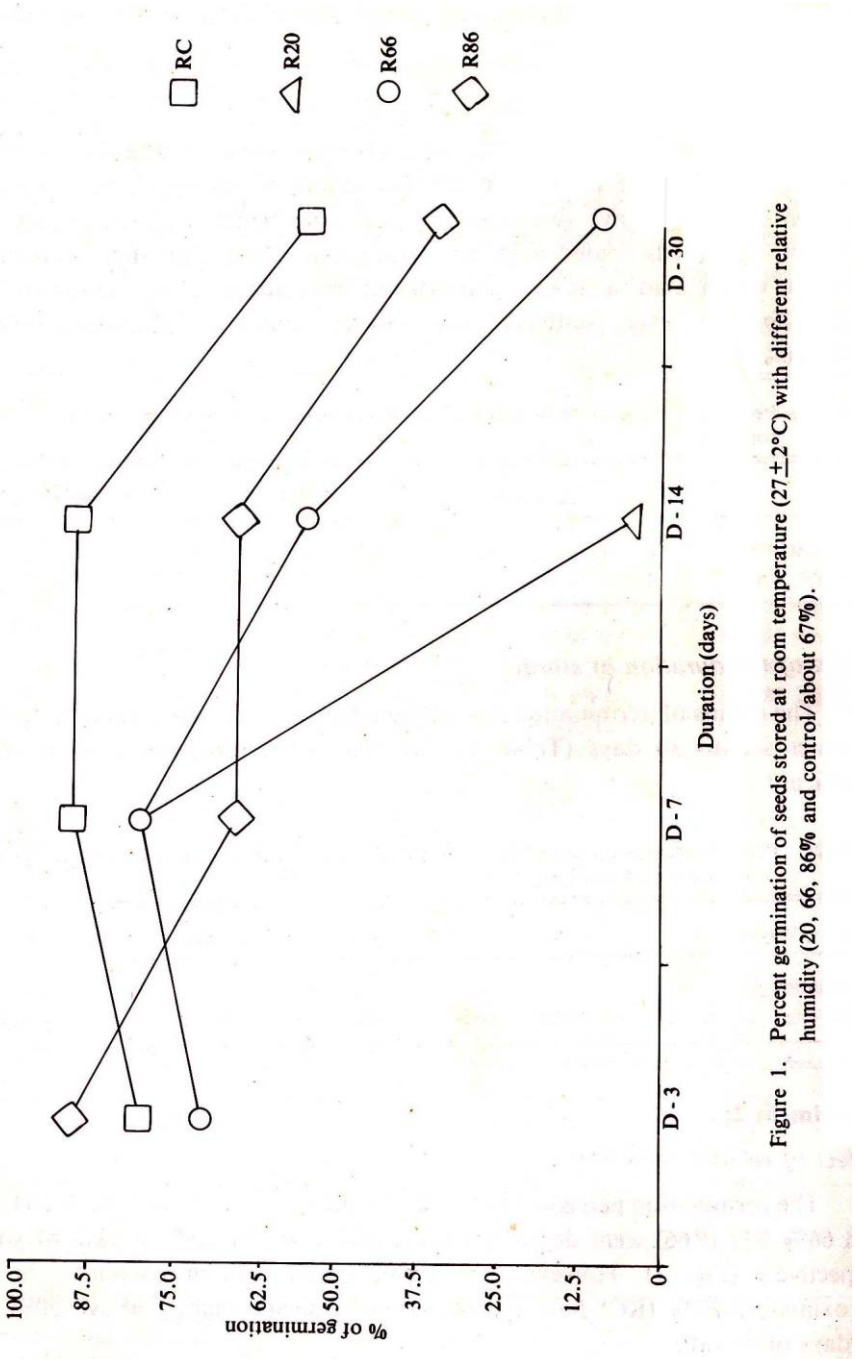


Figure 1. Percent germination of seeds stored at room temperature (27±2°C) with different relative humidity (20, 66, 86% and control/about 67%).

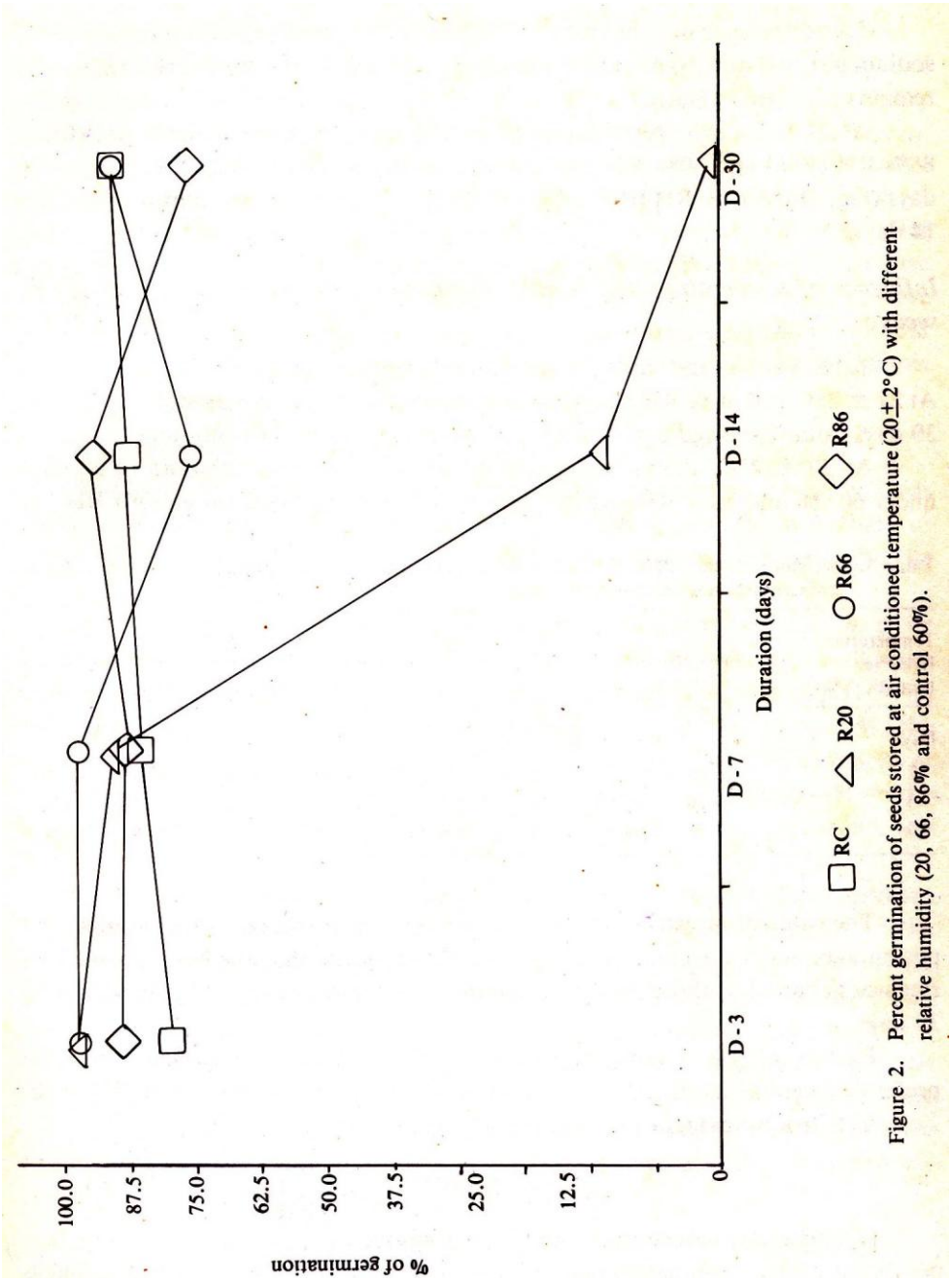


Figure 2. Percent germination of seeds stored at air conditioned temperature (20±2°C) with different relative humidity (20, 66, 86% and control 60%).

This difference may be due to a negative effect on germination capability of sodium nitrite ($NaNO_2$) used to maintain the RH at 66%. However, this effect still remains to be investigated.

At 20 +. *2°C,* the germination percentage of seeds stored at 66% RH (R66), 86% RH (R86) and 60% RH (without chemicals), were still above 80% after 30 days (Fig. 2). At 20% RH (R20), the germination percentage was almost zero after 14 days.

*Influence of temperature and relative humidity on the moisture content of the seeds :*

Table 3 shows the values of moisture content of seeds during experiment 2. At 27 ± 2°C and 86% RH, the moisture content of the seeds was stable from 7 to 30 days, and it showed a slow decrease under the other RH conditions.

At 20 ± 2°C, the moisture content of the seeds was stable up to 30 days under 60, 66 and 86% RH, while it was very low from day 7 on at 20% RH.

Table 3. Moisture content (%) of seeds, after various durations of storage and under different temperatures and relative humidities.

| Temperature / Relative humidity *(%)* | 27 ±2°C | | | | 20 ±2°C | | | |
|---|---|---|---|---|---|---|---|---|
| | 67 | 20 | 66 | 86 | 60 | 20 | 66 | 86 |
| Days | | | | | | | | |
| 7 | 14.83 | 12.71 | 15.24 | 15.50 | 14.40 | 11.36 | 15.14 | 15.31 |
| 14 | 14.48 | 10.58 | 14.34 | 15.06 | 14.51 | 10.27 | 14.87 | 14.96 |
| 30 | 13.21 | 10.58 | 12.21 | 14.86 | 13.04 | 7.88 | 13.17 | 14.44 |

The value of moisture content of the seeds, when related to the germination percentages under different relative humidities, indicate that the best germination rate was achieved by those seeds with a moisture content between 13 and 14% after 30 days.

Results of the second experiment indicate that *S. javanica* seeds are preferably kept at 20 ±. *2°C* (air conditioned room) under 60 to 66% RH or at 27 ± 2°C (room temperature) under 67% RH.

## DISCUSSION

It is generally agreed that viability of seeds may be defined as the capability of the seeds to germinate under favorable conditions. The conditions which influence the germinating capacity of seeds are: temperature, moisture content, relative humidity, physiology of seed and some genetic factors.

*Effect of temperature, coating and duration of storage*

There are interrelationships among temperature, moisture content and storage time on the life of seeds (Justice & Bass 1979). The germination capability of *S. javanica* seeds was influenced by temperature. For example, the percent germination of seeds stored at 27 ± 2°C or at 20 ± 2°C and those stored at < 10°C varied significantly (at level a = 0.01). The germination percentage of seeds at < 10°C was almost zero after 30 days of storage, or 33 days after collection from the trees. However, different coatings and storage up to 30 days had no effect on the percent germination. It is therefore considered better to store *S. javanica* seeds in a cloth bag at air conditioned room temperature without coating (Table 1). Such physiological characteristics allow one to consider *Shorea javanica* seeds as recalcitrant seeds (Chin & Robert 1980).

*Effect of temperature, relative humidity and moisture content*

The higher the relative humidity, the higher the moisture content of the seeds (Nuhamura 1958 cited by Justice & Bass 1979). It is also known that, as temperature is increased when seeds are held at a constant relative humidity, the seed moisture content decreases.

In the present experiment with *S. javanica,* temperature had a more important effect on seed germination than relative humidity. At 20°C, all seeds under 60, 66 and 86% RH still had very good germination capability (above 80%) after 30 days of storage. When the relative humidity was decreased to 20%, the moisture content decreased and it influenced negatively the germination capacity at both 27 or 20°C. This is similar with the observations of Tompsett (1985) on the decrease of germinability of *S. robusta* seeds when their moisture content was decreased.

Due to the limitation of seed production at the beginning of the experiment in August and September 1985, it is recommended that further research on the effect of moisture content of the seeds on germination should be conducted. Also, it is important to determine the composition of S. *javanica* seeds because there may be a relation between the lipid contents of a seed and its moisture content. This is based on the observation of Barton (1941, cited by Justice & Bass 1979) i.e. seeds containing high percentage of carbohydrates, proteins, or both like rice, other grains and soybean, can have moisture contents of about 13-15% at 25°C and 75% RH whereas peanuts, which are rich in oil, would have a moisture content of approximately 9-11% under the same conditions.

## CONCLUSION

There were up to 30 days no significant differences in the percent germination of seeds stored at 27 ±. 2°C (52.42%) and at 20 ± 2°C (54.42%) but

the germination of seeds stored at both temperatures compared with those at 10°C (6.25%) was significantly lower. Presence or absence of paraffin or ash seed coating had no effect on the percent germination of seeds.

The percent germination of seeds decreased for all treatments with an increase of the duration of storage from 3 to 30 days.

The seeds stored without chemicals at a relative humidity (RH) of about 67% (RC) still had a germination capacity above 50% after 30 days of storage. At 20 ±_ 2°C (room air-conditioned), the percent germination of seeds stored at 66% RH (R66), 86% RH (R86) and 60% RH (without chemicals), were still above 80% after 30 days. In all experiments, at 20% RH, the percent germination was reduced to zero after 30 days.

At room temperature (27 ±. 2°Q with 86% RH, the moisture content of seeds was stable from 7 to 30 days (±_ 15%), but it showed a slow decrease under other RH conditions. At room air-conditioned (20 +. 2°C), the moisture content of seeds under 60, 66 and 86% RH were about 14% up to 30 days but it was very low at 20% RH.

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