# COLLECTION AND HANDLING OF MAHOGANY (*SWIETENIA MACROPHYLLA*) SEEDS FOR OPTIMUM VIABILITY

**Marzalina Mansor,**

*Forest Research Institute Malaysia, Kepong, 52109 Kuala Lumpur, Malaysia*

**Normah Mohd. Noor**

*Department of Botany, University Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia*

**&**

**B. Krishnapillay**

*Forest Research Institute Malaysia, Kepong, 52109 Kuala Lumpur, Malaysia*

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**MARZALINA, M., NORMAH, M.N. & KRISHNAPILLAY, B. 1997. Collection and handling of mahogany (*Swietenia macrophylla*) seeds for optimum viability.** In order to ensure high viability of mahogany seeds, studies on size and maturity of fruits were carried out. It was found that big-sized fruits (length ranging from 101.3 to 174.0 mm and weighing 222 - 482 g) produced seeds with higher speed of germination compared to seeds from medium- and small-sized fruits. However, small-sized fruits were found to produce more filled seeds compared to medium- and big-sized fruits. The moisture content of the seeds decreased as fruits became mature. The seeds were found to be hygroscopic in nature. Cracks on the pericarp indicated that the fruits were fully mature. Seeds from fruits that were forced open were able to retain 35% moisture content after 24 h ambient drying and maintained higher seed viability when compared to seeds gathered from fruits that cracked naturally.

Key words: Mahogany - fruit - seeds - collection - handling - size - maturity - moisture content - germination - optimum viability

**MARZALINA, M., NORMAH, M.N. & KRISHNAPILLAY, K. 1997. Kutipan dan pengurusan biji benih mahogani (*Swietenia macrophylla*) bagi mengekalkan kemandirian yang optimum.** Bagi memastikan kemandirian biji benih mahogani yang tinggi, kajian saiz dan kematangan buah mahogani telah dijalankan. Kajian menunjukkan bahawa buah bersaiz besar (panjang di antara 101.3 hingga 174.0 mm dan berat 222 - 482 g) mampu mengeluarkan biji benih yang mempunyai kadar percambahan yang lebih tinggi berbanding dengan biji benih daripada buah bersaiz sederhana dan kecil. Walau bagaimanapun buah bersaiz kecil menghasilkan lebih biji benih berisi berbanding dengan buah bersaiz besar dan sederhana. Kandungan lembapan biji benih berkurangan apabila buah semakin matang. Biji benih didapati bersifat higroskopik secara semula jadi. Rekahan pada perikap menunjukkan bahawa buahnya cukup matang. Biji benih daripada buah matang yang dipecahkan mampu menyimpan 35% kandungan lembapan selepas mengalami 24jam pengeringan ambien serta dapat mengekalkan kemandirian yang tinggi berbanding dengan buah yang merekah secara semula jadi.

## Introduction

Various reforestation and forest plantation programmes have been formulated due to the present awareness of forest and biodiversity conservation. Procurement of adequate planting material is always an issue. In addition, tropical seeds have generally a low viability if they are not collected at the right stage. Wildings are being sought after but the number is never enough to meet the demand, particularly when it comes to gathering them from the limited number of local plantations.

Mahogany (*Swietenia macrophylla*) is one of the best quality timbers in the world. In Malaysia, this species is regarded as an exotic species, planted in some small plantations in the Forest Research Institute Malaysia (Kepong), Sg. Buluh, Rawang, Raub and Lentang and is also used in enrichment planting in several forest reserves, as a roadside tree and in parks. According to Appanah and Weinland (1993), under favourable conditions, this species grows rapidly, reaching 20 m height with 60 cm diameter in 25 years. Annual volume increment is between 15 and 20 $m^3$ $ha^{-1}$ which is achieved within 40 to 50 years. Very limited number of studies on mahogany seeds have been carried out previously by Vivekanandan (1978), Martini (1985), Pena and Montalvo (1986), Uetsuki (1988), Pukittayacamee (1991) and Pukittayacamee *et al.* (1995). Martini (1985) found that seeds extracted from fruits freshly forced open failed to germinate. But if the fruits were to be dried for three days, the viability was recorded at 85% (moisture content of 9%), subsequently dropping to 54% germination after the fourth day of drying. Uetsuki (1988) found that mature mahogany seeds could give about 80 - 95% germination. Pukittayacamee (1991) proposed that the drying period is only important if the seeds are unripe and have a moisture content of 45 - 52%. However, maturity and size of fruits are hardly defined. The objective of this study was to determine the effect of fruit size and the techniques of handling the mature fruits after collection on seed viability.

## Materials and methods

For experiment 1, matured fruits were collected between December 1991 and January 1992 from the mahogany plantations in Sg. Buluh and Lentang and from some roadside trees in the campus of the Universiti Kebangsaan Malaysia at Bangi. These were placed in open card boxes and transported within the same day (longest journey took 1.5 h) to the laboratory. For experiment 2, materials were observed weekly and collected from research plots in the Forest Research Institute Malaysia (FRIM), Kepong.

*Experiment 1. Determination of fruit size to provide a source of seed with high viability*

The collected mahogany fruits were graded in three different sizes, i.e. large, medium and small. For each category, 20 fruit were used The length, both upper and lower circumference and weight of each fruit were measured. Seeds for each fruit were counted and in addition the number of filled and empty seeds were also determined. The weights of seeds with testa and without testa were also recorded. Then each different group of seeds were germinated to test their viability. Three replicates of 50 seeds per replicate were sown in sand and germination number was scored every other day. The time to reach 50% germination (R50) was determined from the following formula:

$$R50 = D_1 + [\ 2\ (G_{50} - G_{D1}) \div (G_{D1} - G_{D2})]$$

where

$D_1$ = day before 50% of germination
$D_2$ = day after 50% of germination
$G_{50}$ = actual value of 50% germination
$G_{D1}$ = germination value on day $D_1$
$G_{D2}$ = germination value on day $D_2$

Germination energy (GE) of seeds which germinated up to the time of peak germination was expressed as percentage,

$$GE = (G_{Dmax} \div G_{final}) \times 100$$

where

$G_{Dmax}$ = maximum mean daily germination value
$G_{final}$ = final germination value

Germination value (GV) was calculated from the formula:

$$GV = MDG \times PV$$

where

MDG = mean daily germination
PV = peak value

According to Czabator (1962), GV is a single figure that expresses the total germination at the end of the test period with an expression of germination energy or speed of germination. Total germination is expressed as MDG, calculated as the cumulative percentage of full seed germination at the end of the test, divided by the number of days from sowing to the end of the test. The speed of germination, which is expressed as PV, is the maximum mean daily germination reached anytime during the period of the test. All these values calculated will help identify the fruit size that would give seeds of quality and high viability.

### *Experiment 2. Determination of the appropriate handling technique for maximum survival of seed*

All the fruits tested came from the same batch of fruits collected. Different techniques of fruit handling were tested:

a) mature fruits that cracked naturally - fruits that appeared cracked were allowed to remain for a futher three days before collection. The collected fruits were then brought to the laboratory and left in trays for two days until all the seeds become detached from the placenta of the fruit by themselves.

b) mature fruits that were cracked open manually - when cracks were seen on the pericarp, the fruits were forced open manually and the seeds were taken out from the fruits.

In this experiment, germination percentage and moisture content tests were carried out every 2 h within 24 h at room temperature (25 °C). Three sets of seeds in each group were tested. Each set contained 3 replicates of 10 seeds per replicate. The large number of seeds used in this experiment was to ensure an acceptable average value. The relative humidity of the environment and the temperature were determined using an electronic thermohygrograph (model R-704, Sato Co. Ltd., Japan).

## Results

### *Experiment 1*

Line drawings of parts of the mahogany fruit and arrangement of seeds are given in Figures 1a and 1b. Figure 2 shows examples of fruits that were graded into three different sizes. Table 1 gives the average sizes of fruit and seeds of mahogany. The large fruits had 64% filled seeds and small-sized fruits 88% filled seeds. More than half of the medium-sized fruits were empty. From overall counts, there were 48-65 seeds per fruit. There were no differences in measurement between seeds with and without testa from fruits of different sizes.

Figure 3 indicates that the germination percentage from each seed source was 100%. However, this was attained by large-sized and medium-sized fruits at day 20 while seeds from small-sized fruits attained it at day 22. Overall, the figure clearly shows that the seeds derived from large-sized fruits had the most energy, followed by medium-sized and small-sized fruits. Figure 4 shows that the average rate of germination, in which seeds from large-sized fruits were more vigorous then from the other sources. Table 2 indicates that seeds from large-, medium- and small-sized fruit reached 50% germination (R50) at 13 days, 14 days and 16 days respectively. The germination energy (GE) was highest on the 18th day for seeds from large- and medium-sized fruits and 20th day for those from small-sized fruits. However, the germination percentage of seeds sourced from large-sized fruits was 96.7% as compared to 90% for seeds from medium-sized fruits. The overall germination index (GV) indicated that the speed of germination was highest for seeds from large-sized fruits (22.39) followed by the medium- (20.85) and small-sized fruits (18.77). The ANOVA tests indicated a significant difference at $p \leq 0.05$ for each value of R50, GE and GV.

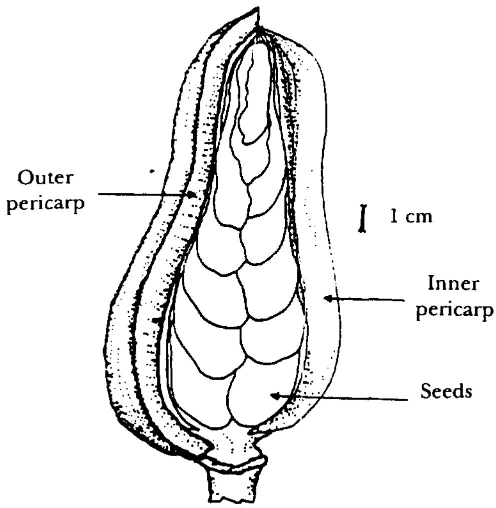



**Figure 1a.** Sketch of mahogany fruit showing the outer and inner pericarps and rays of seeds

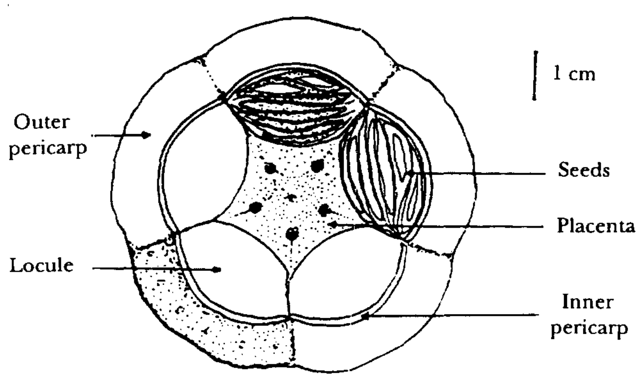



**Figure 1b.** Cross section of mahogany fruit

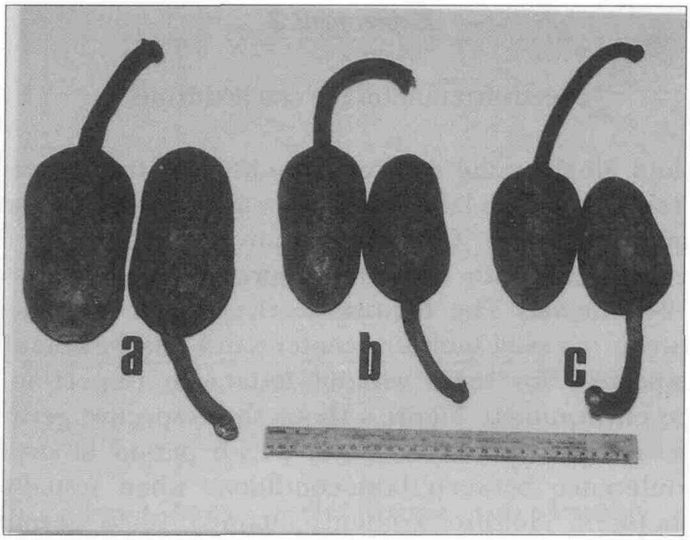



**Figure 2.** Fruits graded into three sizes: (a) large, (b) medium, and (c) small

**Table 1.** Average measurements of mahogany fruit and seeds

| Grade | Measurement of fruit | | | |
|---|---|---|---|---|
| | Length (mm) | Circumference (mm) | | Weight (g) |
| | | Bottom | Top | |
| Large | 174.0 ± 8.8a | 174.0 ± 14.9b | 269.3 ± 15.1a | 482.2 ± 32.7a |
| Medium | 124.0 ± 9.0b | 196.0 ± 3.5a | 233.7 ± 37.2b | 234.8 ± 43.5b |
| Small | 101.3 ± 12.7c | 131.7 ± 8.8c | 157.0 ± 35.9c | 222.3 ± 55.3b |

| | Seeds | | | | |
|---|---|---|---|---|---|
| | Counting | | Average weight of each seed (g) | | |
| | Filled | Empty | With testa | Without testa | Empty |
| Large | 63.49%b | 36.51%b | 0.79a | 0.55a | 0.13a |
| Medium | 46.03%c | 53.97%a | 0.77a | 0.53a | 0.10b |
| Small | 87.50%a | 12.50%c | 0.76a | 0.56a | 0.10b |

Note: Within each column, mean values sharing the same letter are not significantly different, according to Duncan's multiple range test at 5% level.

**Table 2.** Average germination percentage and germination value of seeds from diferent sources

| Grade | Germination | R50 | GE | | GV |
|---|---|---|---|---|---|
| | | | Days | Germination | |
| Large | 100%a | 13.42c | 18b | 96.7%a | 22.39a |
| Medium | 100%a | 14.14b | 18b | 90.0%b | 20.85b |
| Small | 100%a | 16.00a | 20a | 90.0%b | 18.77c |

Note: Within each column, mean values sharing the same letter are not significanttly different, according to Duncan's multiple range test at 5% level.

## *Experiment 2*

### Seeds from naturally cracked fruits

Figures 5a and 5b show the relative humidity and the temperature of the environment respectively. Relative humidity was within 61-68% while the temperature was minimum at 18 °C and maximum at 24 °C. Figure 5c shows the moisture content of seeds with testa and Figure 5d shows those without testa tested at every 2-h intervals. The figures clearly indicate that there is a direct correlation between the seed moisture content and relative humidity and room temperature, especially for seeds without testa with respect to the relative humidity of the environment. Figure 6 shows the respective germination rates for both seeds with and without testa over a 24-h period of drying. There is a significant difference between both conditions when tested with ANOVA. Seeds with testa (6.2% moisture content) attained 100% germination while seeds without testa (5.0% moisture content) only attained 93% germination. The difference could be due to the different moisture content levels. However, the germination rate of both seeds decreased constantly at 1.5% per hour. At the end of the experiment, seeds with testa attained 73% germination while seeds without testa only 60%.

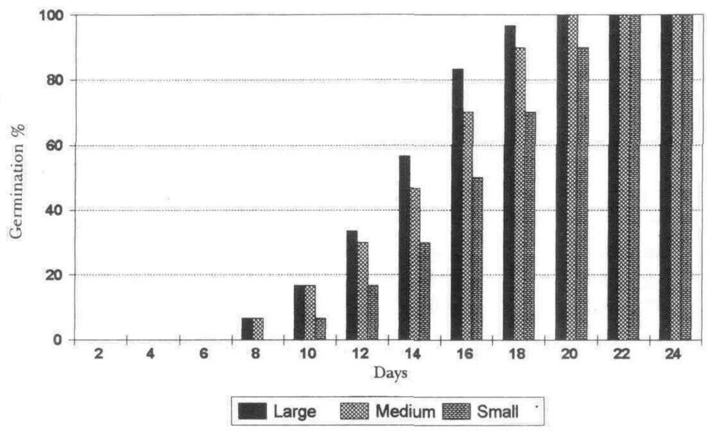



**Figure 3.** Average germination of mahogany seeds from different sources

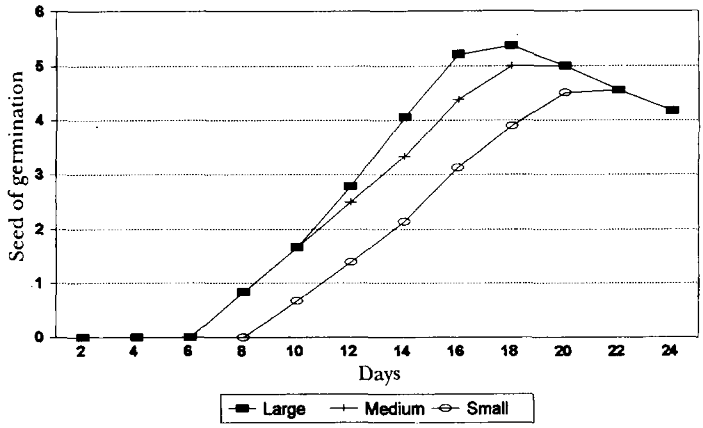



**Figure 4.** Average speed of germination of mahogany seeds from diffferent sources

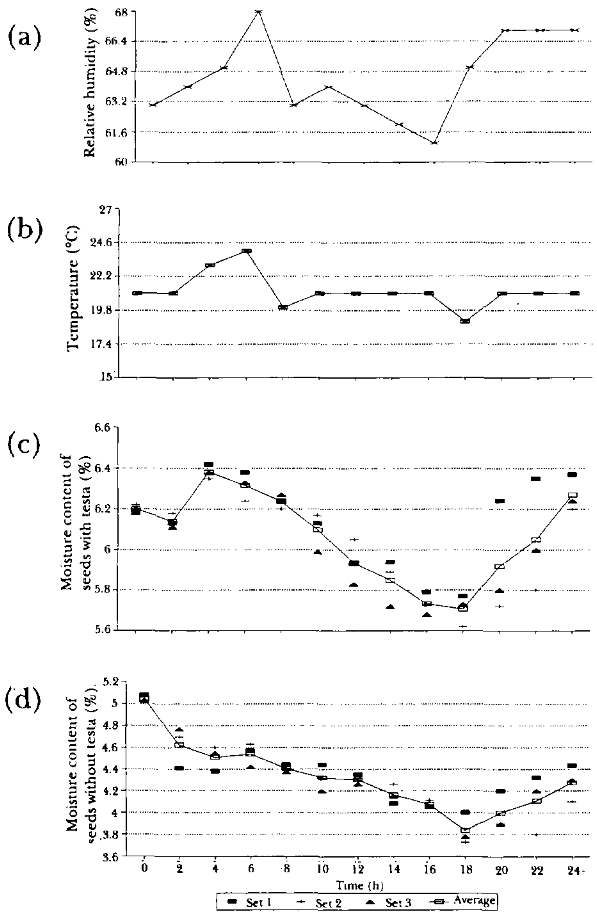



**Figure 5.** (a) Relative humidity, and (b) ambient temperature of the environment while drying; moisture content of seeds (c) with testa, and (d) without testa from naturally cracked fruits

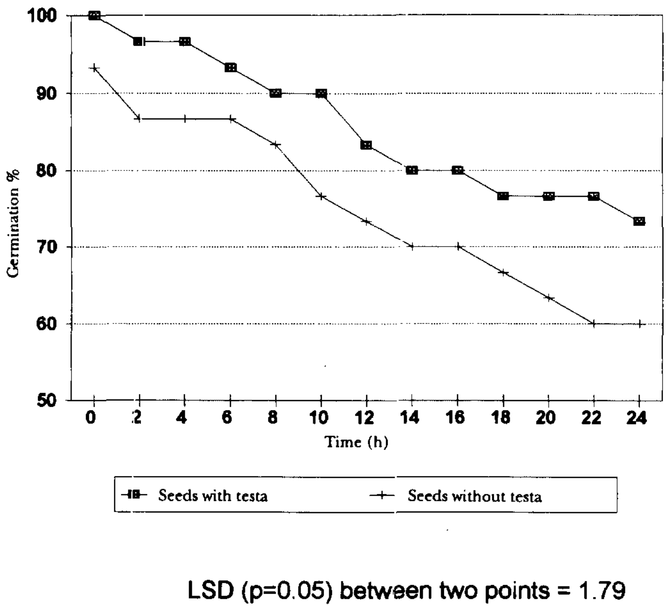



**Figure 6.** Average germination percentage of seeds from naturally cracked fruits

## Seeds from forced open fruits

Figures 7a and 7b show the relative humidity and room temperature during the experiment respectively. Figure 7c shows the moisture content of seeds with testa that started with 44% and decreased at the rate of 1.25% per hour until the seeds reached 14% at the end of 24 h of drying. Although there was an increment of 2% moisture content over that attained by seeds without testa at the end of the period, this was not due to the environment effects as Figures 7a and 7b show stability of relative humidity and temperature respectively. Seeds without testa tend to lose moisture content at a higher rate of 1.4% per hour, and this was due to no physical barrier blocking the moisture loss. Such seeds indicate a more direct correlation with the environment as compared to seeds with testa. Figure 8 shows the germination rate of both seeds with and without testa. Both started at 100% germination until 14 hours of tests for seeds with testa and 12 hours for seeds without testa. Despite the differences in moisture content between both seeds, these do not affect the germination percentage. But when the moisture content was reduced to 15% at the end of the period, there was a significant difference for seeds with testa (87% germination) and seeds without testa (83% germination).

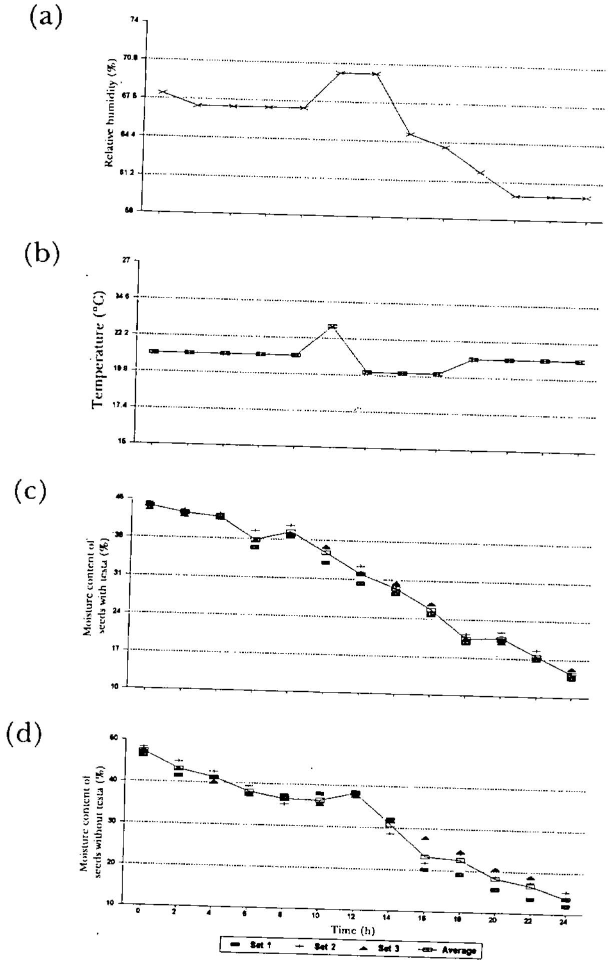
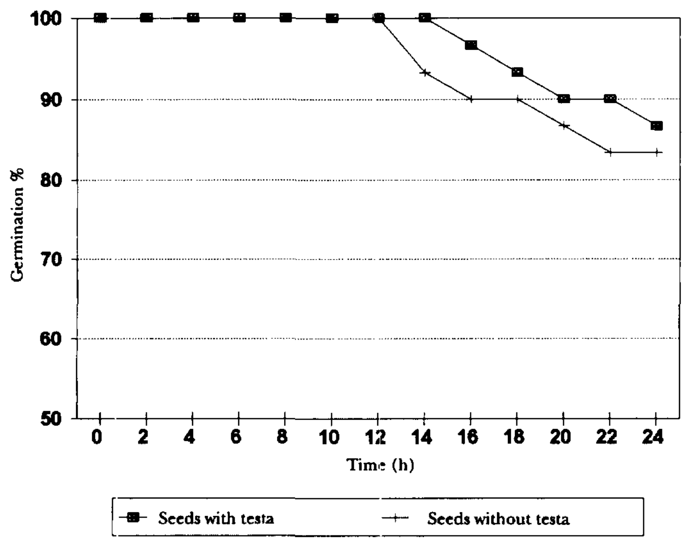



**Figure 7.** (a) Relative humidity percentage, and (b) ambient temperature of the environment while drying; percentage of moisture content of seeds (c) with testa, and (d) without testa from forced open fruits

## Discussion

There were large differences between the fruit sizes with fruit length ranging from 101.3 to 174.0 mm and weights ranging from 222 to 482 g as these matured fruits were collected from different localities. The number of seeds in each fruit ranged between 48 and 65. However , the sizes of seeds from different sources showed no significance difference. The main factor here is the seed viability and performance. The mahogany seeds from this experiment could attain 100% germination when compared to tests done by Uetsuki (1988) where he obtained only 80-95% germination. Seeds from large-sized fruit gave better speed of germination than those from medium- and small-sized fruits. According to Aldhous (1972), germination capacity is normally used to compare the energy for germination between different batches of seeds. The source that gives a higher amount of energy to germinate will ensure the viability of seedlings when planted out (Thomson & Doyle 1955). Usually seeds from large-sized fruit can produce a better survival of seeds and plants (Thomson & Doyle 1955, Yap 1976, Willan 1984). Willan (1984) stated that germination index should be used to certify seed lots before the seeds are sold. However, seeds from the tropics are hardly certified due to the small number of seeds available (Perera 1973, Chin & Roberts 1980). Therefore, if one has to buy seeds, the recommended preference is to choose from a good source of large-sized fruits having all other information of the mother tree if possible. But if one were to be interested in having a larger quantity of seeds then one can collect small-sized fruits as these tend to produce more filled seeds when compared to the large-sized fruits.




LSD (p=0.05) between two points = 3.50

**Figure 8.** Average germination percentage of seeds from forced open fruits

In the experiment on seed handling in mature fruits, the moisture content of the seeds was reduced as the fruits matured. Seeds without testa from the naturally cracked fruits reached the minimum moisture content (5%) much earlier than seeds with testa. This indicates that the testa plays a big role in maintaining the moisture content and acts as a physical barrier against moisture loss. The seeds also absorbed moisture from the environment to stabilise their own moisture content but this did not increase the seed viability. This absorption capacity within the seed is due to the hygroscopic behaviour of the testa that responded to changes in temperature and relative humidity of the room as suggested by Roos (1989). Purohit *et al.* (1982) reported that increment of temperature causes the moisture content to decline while Martini (1985) found that increase in temperature and reduction of relative humidity reduce the viability of mahogany seeds tested. Therefore, in order to maintain high germination capacity, it is best to maintain a stable environmental temperature and relative humidity. Compared to the study by Martini (1985), the seeds derived from the forced open fruits were also able to produce 100% germination. The main idea is to make sure that the fruits are fully mature before collecting. According to Bass (1980) it is difficult to gather all the mature fruits/seeds at once. Thus, from this experiment, mahogany fruits that show cracks could be collected and opened to gather the seeds. At this point, the moisture content of the seeds is at a maximum of 44 - 47%. The seeds should then be left in a tray at 24 °C for 12 h to attain 35% moisture content at which they have a better chance of survival.

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