DEWINGING DIPTEROCARP SEEDS

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MARZALINA, M., WAN TARMEZE, W. A. & STAINES, H. 2004. Dewinging dipterocarp seeds. When mass flowering season occurs every three to eight years in the tropics, seeds of many forest species tend to mature at about the same time. They include the majority of dipterocarp seeds that are 'winged' and classified as recalcitrant. In order to secure as many planting materials as possible, harvested seeds must be planted immediately. Previous studies indicated that dewinging facilitates seed germination and is advantageous when sowing space is limited. Usually seed dewinging is processed manually, which is labour intensive, time consuming but critical in retaining the quality of recalcitrant seeds. An experiment was carried out to reduce processing time using a prototype machine, namely seed dewinger machine, produced by the Forest Research Institute Malaysia. Mechanical dewinging of four dipterocarp species significantly reduced the processing time without affecting seed viability. The process of dewinging was longer for seeds with greater wing length, smaller wing waist and which were heavier. The best-fit model for the duration of processing was determined as time = 0.65548 + 0.0297 (length) – 0.379 (waist) + 0.134 (weight).

Key words: Seed dewinger machine – seed moisture content – germination – speed

MARZALINA, M., WAN TARMEZE, W. A. & STAINES, H. 2004. Pembuangan sayap biji benih dipterokarpa. Ketika musim pembungaan pokok hutan yang berlaku antara 3 tahun hingga 8 tahun, ratusan biji benih dihasilkan secara serentak. Kebanyakan biji benih ini terdiri daripada spesies dipterokarpa yang bersayap dan dikelaskan sebagai rekalsitran. Biji benih ini perlu dicambah dengan serta-merta untuk memperoleh sebanyak anak benih yang boleh. Kajian menunjukkan yang pembuangan sayap biji benih memudahkan percambahan dan berfaedah sekiranya ruang semaian terhad. Biasanya proses membuang sayap dilakukan dengan tangan. Ini memerlukan pekerja yang ramai serta mengambil masa yang panjang. Namun proses ini adalah kritikal bagi mengekalkan kualiti biji benih rekalsitran. Satu kajian dijalankan untuk mengurangkan masa memproses menggunakan mesin prototaip bergelar mesin pembuangan sayap yang dihasilkan oleh Institut Penyelidikan Perhutanan Malaysia. Membuang sayap biji benih empat spesies dipterokarpa secara mekanikal mengurangkan masa memproses tanpa menjejaskan keupayaan hidup biji benih. Masa memproses lebih lama apabila sayap biji benih lebih panjang, lebar pinggang sayap lebih kecil dan biji benih lebih berat. Model terbaik untuk menganggar masa memproses ialah Masa = 0. 65548 + 0.0297 (panjang sayap) – 0.379 (lebar pinggang sayap) + 0.134 (berat biji benih).

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Introduction

Dipterocarp species flower and fruit irregularly, often producing the famous phenomenon of mass flowering-cum-fruiting season, which occurs every three to eight years (Krishnapillay *et al.* 1999). During this period, dipterocarps produce abundance of seeds. Unfortunately, about 94% of the species in this family so far investigated produce short-lived 'recalcitrant' seeds that are difficult to handle (Tompsett 1994). This is because the seeds germinate readily, have high moisture content (40–60%) at shedding, are low-temperature sensitive and cannot be kept in the fridge for a long time. In addition, seed handling immediately after collection and transit, processing, storing and sowing affect viability (Krishnapillay & Tompsett 1998, Marzalina & Krishnapillay 2002). Any delay in the handling process can result in further loss of viability and reduce the amount of planting material available. These factors have a major impact on planting of dipterocarp seeds (Marzalina *et al.* 1999).

Dewinging dipterocarp seeds facilitates germination (Aminah *et al.* 1995) and helps when the space for seed germination is limited. Usually these seeds are dewinged manually, which is labour intensive, time consuming and yet critical in retaining the quality of seeds. Hence, a prototype machine (Figure 1), named the seed dewinger machine (SDM), was developed to facilitate the mechanical processing of dipterocarp seeds. The aim of this study was to investigate the effects of manual and mechanical dewinging on seed viability. The optimum mechanical processing time and processing speed were also investigated.

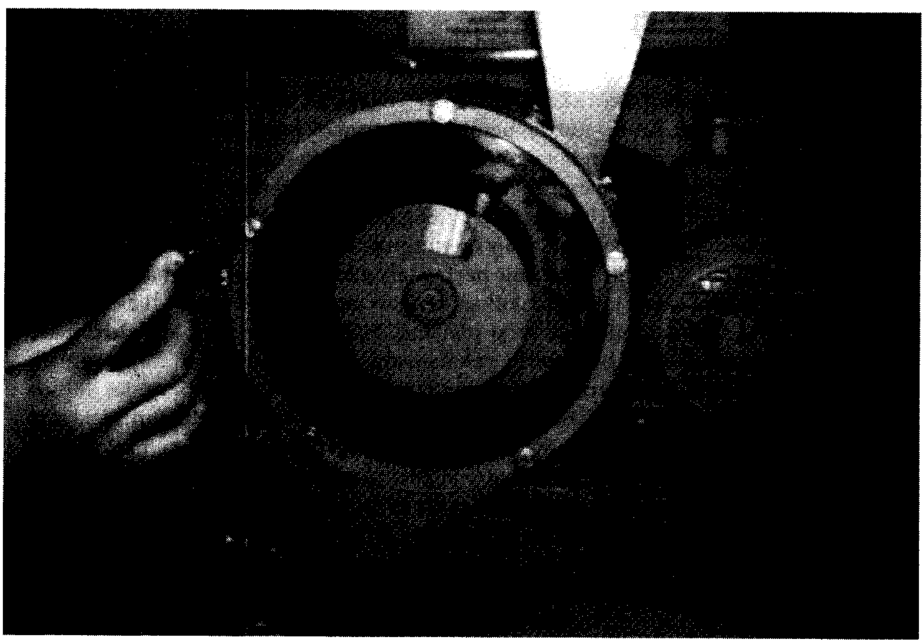

Figure 1 Seed dewinger machine

Materials and methods

Species

Four species of dipterocarps were used in this study, namely *Hopea odorata, Dryobalanops aromatica, Shorea leprosula* and *S. assamica.*

Effects of time and processing method on seed germination

Seeds were chosen randomly and dewinged mechanically using the prototype SDM machine (speed 55 Hz; duration 60 s) and manually by one staff. Five replicates of 100 seeds were used for each method. The time taken to complete 100 seeds per dewinging method and the percentage of refined/cleaned seeds were recorded. Fifty seeds each were randomly selected from the 500 seeds twhich had been processed by each method (five replicates of ten seeds each) and germinated using tissue paper in glass Petri dishes. The dishes were placed in a germination room of 8 hours dark : 8 hours light photoperiod. Seeds were checked every other day.

Effect of attributes on dewinging

Twenty-five seeds of each species were randomly taken for measurement of physical attributes (Figure 2). Seed weight (with wings) and fresh seed moisture content were recorded at the time of the experiment. Seed moisture content (5 replicates of 5 seeds each) was determined using the oven-dry method (103 ± 3 °C for 17 hours) (ISTA 1996) and calculated on a wet weight basis. Five replicates of 100 seeds were dewinged mechanically. The time taken to dewing all seeds was recorded.

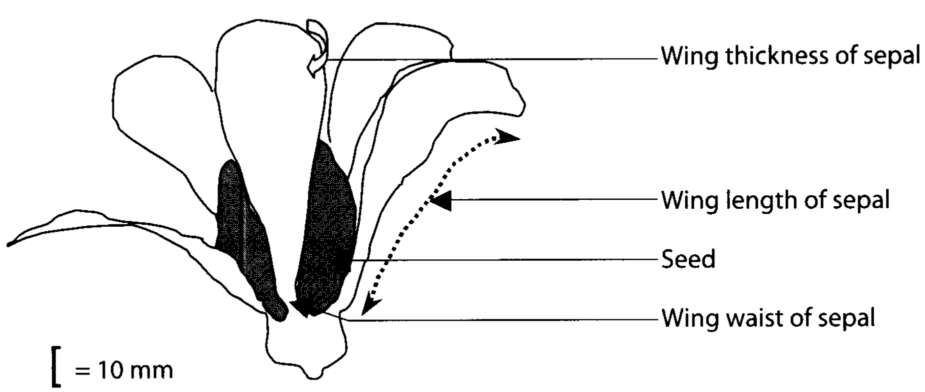

Figure 2 Illustration of measurements taken from dipterocarp seed (e.g. *Dryobalanops aromatica*)

Effect of SDM speed and processing time on seed refinement (cleaned) and its viability

Using a random complete block design, five replicates of 100 seeds were processed at two speeds (55 and 60 Hz) and two durations (30 and 60 s). The percentage of refined seeds was recorded. Five replicates of ten seeds each were subjected to germination.

The results were subjected to analysis of variance (ANOVA) using SAS program. The time taken to process all seeds was determined for significant differences ($p = 0.05$) using General Linear Models (GLM) and Duncan's multiple range test (DMRT). Stepwise regression analysis was used to determine the variables (length, waist and weight) which affect processing time.

Results and discussion

Effects of time and processing method on seed viability

The time taken to dewing the four dipterocarp seed lots manually varied from 10 to 18 min (Table 1). Germination of seeds remained high (94–99%). Germination of SDM-processed seeds were slightly better (96–100%) but the percentage of completely cleaned seeds was as low as 48%. ANOVA showed that there was significant difference between the two techniques with respect to processing time and percentage of refined seeds (Table 2). No significant difference was observed in seed viability. Although manual dewinging gave 100% refined seeds the processing time ranged from 10 to 18 min as compared with 1-min mechanical dewinging. Thus, the SDM was effective in processing seeds.

Table 1 Effects of dewinging techniques on mean of processing time, % refined seeds and % seed germination

Species	Manual			Dewinging machine		
	Time (min)	% Refined seeds	% Germination	Time (min)	% Refined seeds	% Germination
H. odorata	15.6	100.0	95.2 ± 1.8	1.0	97	100.0 ± 0.0
D. aromatica	18.4	100.0	99.2 ± 5.4	1.0	96	100.0 ± 0.0
S. leprosula	10.2	100.0	94.6 ± 5.5	1.0	89	100.0 ± 0.0
S. assamica	12.4	100.0	93.8 ± 7.3	1.0	48	96.0 ± 8.9

Table 2 Statistical analyses on the effects of dewinging techniques on processing time, % refined seeds and % seed germination

Source	DF	Mean sum of squares		
		Time (min)	% Refined seeds	% Germination
Replicates	4	0.78	24.25	13.53
Species	3	32.35	1356.37	37.10
Techniques	1	1729.23**	3062.50**	108.90
Error	31	4.20	148.16	24.67

Effect of physical attributes on dewinging

All four seed lots (Table 3) had variable moisture content (31–52%), seed weight (0.2–6.3 g) and wing length (39 to 89 mm). However, the wing thickness and wing waist for all species except *D. aromatica* varied very little, 0.22–0.28 and 2.13–3.99 mm respectively. Such differences in physical attributes had little effect on the time taken to mechanically process the seeds (Table 3) as the Duncan's grouping for *S. leprosula*, *D. aromatica* and *H. odorata* was not significantly different. Stepwise linear regression showed that the most important factor affecting the time taken to clean seeds (Table 4) was wing length of seeds, followed by waist and then weight if species is not considered. Once these variables are in the model, the other three possible explanatory variables in Table 3 do not provide a significantly better model. The model is

$$\text{Time} = 0.65548 + 0.0297\ (\text{length}) - 0.379\ (\text{waist}) + 0.134\ (\text{weight})$$

This means that the time to dewing is longer for seeds with greater wing length and smaller waist as well as for heavier seeds. Further studies should be carried out on other dipterocarp species when seeds are available to confirm the validity of this model.

This is consistent with the results in Tables 3 and 4. *Shorea assamica* which is a much longer seed, took significantly longer to process than the other species. The

Table 3 Measurement of wing size, seed weight and moisture content and DMRT grouping for time taken by seed dewinging machine to process 100 seeds

Species	Mean time (min)	Wing thickness (mm)	Wing length (mm)	Wing waist (mm)	Seed weight (g)	No. of long wings	Seed moisture content (%)
H. odorata	1.034 b	0.22 ± 0.08	39.4 ± 3.40	2.13 ± 0.17	0.19 ± 0.01	2	48.0 ± 1.15
D. aromatica	1.038 b	0.54 ± 0.10	54.0 ± 6.16	5.43 ± 0.68	6.25 ± 0.10	5	51.7 ± 0.91
S. leprosula	1.130 b	0.28 ± 0.04	64.7 ± 6.93	3.99 ± 0.31	0.98 ± 0.07	3	30.9 ± 1.09
S. assamica	2.162 a	0.24 ± 0.02	88.7 ± 5.77	3.75 ± 0.37	1.56 ± 0.09	3	37.4 ± 0.99

Values followed by the same letter in the same column are not significantly different.

Table 4 Stepwise regression analysis to determine the most important variables that affect processing time regardless of species

Step	1	2	3
Constant	-0.03643	0.30514	0.65548
Length	0.0223	0.0245	0.0297
T-Value	4.99	5.62	5.86
P-Value	0.000	0.000	0.000
Waist		-0.125	-0.379
T-Value		-1.85	-2.40
P-Value		0.082	0.029
Weight			0.134
T-Value			1.76
P-Value			0.098
S	0.367	0.345	0.325
R-Sq	58.06	65.09	70.73
R-Sq (adj)	55.73	60.98	65.24

Final model: Time = 0.65548 + 0.0297 (length) – 0.379 (waist) + 0.134 (weight) four species could be grouped into two proceeding times, i.e. more than 2 min for seeds with wing lengths longer than 65 mm (*S. assamica*) and about 1 min for seeds between 40 and 65 mm long (*S. leprosula, D. aromatica* and *H. odorata*).

It is surprising that wing length, rather than moisture content, is the main factor in determining the processing time. No prior study was performed before this to determine such situation since it had been assumed that the drier the seeds, the easier the processing operation. Moisture content plays an important factor in determining viability of recalcitrant seeds, which remains high for mechanically dewinged seeds.

The effects of speed and time of the SDM on percentage of refined seeds and percentage of seed germination of four dipterocarp species are shown in Table 5. ANOVA showed that there was significant difference between the species being processed with respect to percentage of refined seeds (Table 6). Speed and time of mechanical processing did not affect percentage of refined seeds or seed germination.

Table 5 Effect of SDM processing speed and time on % refined seeds and % seed germination

Species	Speed (Hz)	Time (s)	% Refined seeds	% Germination
Shorea assamica	55	30	84 a	98.4 ± 2.19 ab
	55	60	96	95.2 ± 3.35
	60	30	91	96.0 ± 2.83
	60	60	97	100.0 ± 0.00
Shorea leprosula	55	30	76 a	98.0 ± 2.83 ab
	55	60	100	98.4 ± 3.58
	60	30	93	98.0 ± 1.41
	60	60	96	100.0 ± 0.00
Dryobalanops aromatica	55	30	86 a	97.6 ± 2.61 a
	55	60	96	99.6 ± 0.89
	60	30	91	99.2 ± 1.79
	60	60	89	100.0 ± 0.00
Hopea odorata	55	30	46 b	88.0 ± 17.89 b
	55	60	80	96.0 ± 8.94
	60	30	75	100.0 ± 0.00
	60	60	48	96.0 ± 8.94

Means with the same letter in the same column are not significantly different across species.

Table 6 Statistical analysis on the effect of SDM processing speed and time on % refined seeds and % seed germination of four dipterocarp species

Source	DF	Mean sum of squares	
		% Refined seeds	% Germination
Replicates	4	41.70	64.80
Species	3	4173.93**	66.85
Speed	1	63.45	101.25
Time	1	1155.20	31.25
Error	70	120.82	32.02

** significantly different ($p < 0.01$)

Conclusions

Dewinging seeds mechanically prior to sowing reduces the time taken in handling sensitive recalcitrant seeds. The seed dewinger machine performs this task better than manual dewinging, without significantly affecting the viability of seeds. The best-fit model for processing is time = 0.65548 + 0.0297 (length) – 0.379 (waist) + 0.134 (weight).

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