from 0.5 and 1.0 *g* (Table 5). Mean shoot-root ratio decreased as the level of fertiliser decreased.

Table 4. Student Newman-Keuls test for mean shoot-root ratio by fertiliser type

Fertiliser type	Mean shoot-root ratio
1 (Self prepared)	1.9758 a
2 (NPK yellow)	1.8533 ab
3 (NPK blue)	1.7083 b

Table 5. Student Newman-Keuls test for mean shoot-root ratio by fertiliser level

Fertiliser level (*g*)	Mean shoot-root ratio
2.0	2.0078 a
1.5	1.8956 ab
1.0	1.7478 b
0.5	1.7322 b

Means with same letter are not significantly different at the 1% level of significance

The mean shoot-root ratio obtained in this experiment was still in the acceptable range. Liegel and Vernator (1987) stated that shoot-root ratio of 2 was acceptable for most seedlings. Higher ratios usually indicated excessive shoot growth which would lead to less sturdy seedlings produced.

Based on the results of this experiment, potted seedlings of *C. manan* raised in the nursery could be fertilised with any three different types of these fertilisers namely self prepared NPK mixture or NPK yellow or NPK blue obtained commercially to improve their survival and quality.

The recommended levels are between 0.5 to 2.0 *g* per seedling applied every two months. Mean shoot-ratio between these levels ranged from 1.7 to 2.0. NPK blue and lower levels of 0.5 to 1.0 *g* would give smaller ratio than other fertiliser types and levels respectively.

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A NOTE ON A LABORATORY METHOD FOR ESTIMATING DURABILITY OF SOME TROPICAL HARDWOODS

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The natural durability of timbers is determined from data obtained through field trials by long term exposure of the timbers to biodegrading organisms in the field (Jackson 1957). The Forest Research Institute Malaysia has used this procedure for classifying natural durability of timbers and a revision of the durability classification of some Malaysian timbers has been published (Mohd. Dahlan & Tam 1985). Such tests give good estimates of the natural durability because the timbers are exposed to both types of biodeteriorating agents, but a long time is needed to obtain meaningful data.

Standard laboratory testing procedures for estimating fungal decay and insect resistance have been established (Anonymous 1980, Anonymous 1985). In a tropical environment the natural durability obtained by field trials is further complicated by the presence of termites. Very often susceptible timbers are completely destroyed by termites between three to six months of exposure. Therefore it becomes more difficult to relate laboratory data to field data for durability assessment. It is with this consideration in mind that a laboratory decay assessment was carried out on 17 timbers and the data obtained were compared with field data for evaluation. A summary of the study is presented here.

Laboratory data

A modified version of the ASTM D 2017 American Standard Testing procedure for decay was used to assess 17 Malaysian timbers for their resistance to decay by the fungus, *Coriolus versicolor.* In addition various parameters of the timbers namely density, water absorption, extractives, pH, lignin content, proportion of vessel elements and ratio of fibre elements were determined for each of the timbers. The weight loss of each timber obtained from the standard test procedure was compared to these parameters to establish a regression equation for durability estimation. Factors that have low correlation between each other but which have high correlation to weight loss were chosen to derive a regression equation for estimating durability (Table 1).

The factors chosen were density (X_1), water absorption capacity (X_2), hot water extractives (X_3), pH (X_4) and lignin content (X_5). The remaining factors were not used because they have high coefficients of correlation with one of the five selected factors. However, the coefficient of multiple correlation was 0.926

Table 1. Correlation matrix of weight loss and the factors studied

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	Y
X_1	1.00000	-0.36207	0.26251	0.01729	0.33778	0.09542	0.73016	-0.62872
X_2	-0.36207	1.00000	-0.18629	0.35586	-0.40874	-0.13920	-0.24278	0.59221
X_3	0.26251	-0.18629	1.00000	-0.41663	0.39273	0.46456	0.11545	-0.57464
X_4	0.01729	0.35586	-0.41663	1.00000	-0.60583	-0.24009	-0.10949	0.62305
X_5	0.33778	-0.40874	0.39273	-0.60583	1.00000	-0.11660	0.21010	-0.66744
X_6	0.09542	-0.13920	0.46456	-0.24009	-0.11660	1.00000	0.48506	-0.40605
X_7	0.73016	-0.24278	0.11545	-0.10949	0.21010	0.48506	1.00000	-0.61429
Y	-0.62872	0.59221	-0.57464	0.62305	-0.66744	-0.40605	-0.61429	1.00000

(X_1 - Density; X_2 - Water absorption; X_3 - Hot water extractive; X_4 - pH; X_5 - Lignin content; X_6 - Vessel proportion; X_7 - Ratio of fibre wall; Y - Weight loss)

Table 2. Partial and multiple correlation analyses of the five selected factors

Number of regressors	Partial correlation					Multiple correlation	Coefficient of determination
	Density	Water absorption	Hot water extractive	pH	Lignin content		
5	-0.726	0.396	-0.414	0.619	-0.165	0.926	0.856
4	-0.760	0.408	-0.421	0.718	-	0.924	0.854
4	-0.760	-	-3.58	0.651	-0.195	0.912	0.831
3	-0.802	-	-0.365	0.765	-	0.908	0.824
2	-0.818	-	-	0.815	-	0.893	0.797
2	-0.605	-	-0.546	-	-	0.759	0.575
2	-	-	-0.443	0.516	-	0.713	0.508

and 0.924 when lignin (X_5) was included and omitted, respectively (Table 2), indicating that lignin could be omitted. That apart, the multiple correlation coefficient of 0.924 and coefficient of determination of 0.854 indicated that 85.4% of variation (for weight loss) could be accounted for by the four factors X_1, X_2, X_3 and X_4.

A regression equation was then obtained using these four factors to predict durability (as measured by weight loss values). The regression is:

$$y = -11.028 - 31.659(X_1) + 0.007(X_2) - 0.447(X_3) + 9.852(X_4).$$

The estimated (or calculated) weight loss of the 17 timbers obtained by applying the regression equation approached that of the measured values obtained in this study (Table 3).

Table 3. Calculated and measured weight loss values of 17 timbers used

	Weight loss (%)		
	Measured value	Calculated value	Error
Chengal	0.400	-2.349	2.749
Keranji	2.400	3.218	-0.818
Merbau	3.400	9.126	-5.726
Kapur	5.900	9.887	-3.987
Kempas	11.900	10.595	1.305
Keruing	10.500	13.409	-2.909
Mata ulat	25.500	20.606	4.894
Punah	26.100	29.254	-3.154
Rengas	3.400	0.411	2.989
Bintangor	31.000	24.364	6.636
Jelutong	30.500	30.033	0.467
Meranti bakau	16.700	18.571	-1.871
Meranti, dark red	19.500	17.617	1.883
Meranti, yellow	27.500	23.698	3.802
Mersawa	16.800	30.264	-13.464
Ramin	37.300	36.655	0.645
Rubberwood	42.500	35.942	6.558
Mean	18.312	18.312	0.000
S.D.	12.680	11.714	4.853

Field data

The natural durability of Malaysian timbers obtained by field trials located in different parts of the world has been shown to be quite similar (Table 4). In order to compare the laboratory data to the natural durability classification the following criteria were followed. A timber with less than 3% weight loss (calculated by using regression equation) is classified as very durable; 3 - 10% weight loss is durable, 10 - 30% weight loss is moderately durable; and greater than 30% weight loss is non-durable (Table 3). The classification thus obtained matched that obtained from field durability trials with minor differences only (Table 4). Therefore the regression equation could be used to estimate the durability of a timber whose resistance to decay is yet unknown and where such data is needed before field exposure trials are completed.

Table 4. Comparison of natural durability classification of some Malaysian timbers

	Durability classification** obtained in				
	Malaysia*	England*	U.S.A.*	Japan*	This report
Chengal	1	1	1	-	1
Keranji	3	3	3	-	2
Merbau	2	2	3	1	2
Kapur	3	1	3	3	2
Kempas	3	2	3	3	3
Keruing	3	3	3	3	3
Mata ulat	3	-	-	-	3
Punah	3	3	3/4	-	3
Rengas	3	2/3	3	2	1
Bintangor	3/4	3	4	4	3
Jelutong	4	4	5	5	4
Meranti bakau	-	-	-	-	3
Meranti, dark red	3	2	3	3	3
Meranti, yellow	4	3	4	4	3
Mersawa	3	3	3	4	4
Ramin	4	4	5	5	4
Rubberwood	4	5	5	5	4

* Source: Anonymous 1975, Anonymous 1979, Chudnoff 1984, Matsuoka *et al.* 1984 and Mohd. Dahlan & Tam 1985.

** Classification 1-4: 1 = very durable; 2 = durable; 3 = moderately durable; 4 = non durable

Classification 1-5: 1 = very durable; 2 = durable; 3 = moderately durable; 4 = non durable; 5 = perishable

The regression equation might be further improved by using additional data from more timber species to try to increase the coefficient of determinations.

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A NOTE ON *ACACIA* HYBRIDS IN A FOREST PLANTATION IN PENINSULAR MALAYSIA

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Acacia mangium Willd × *A. auriculiformis* A. Cunn. ex Benth hybrids were first spotted at Ulu Kukut, Sabah, East Malaysia, in 1971 (Rufelds 1987). The hybrid possesses some of the outstanding intermediate characteristics of its parents such as better stem form and longer clear bole height than *A. auriculiformis* and lighter branching, circular trunks, smoother bark with whiter colour and smaller phyllodes compared to *A. mangium.*

We observed *Acacia* hybrids at the Compartment 2.4 B, Ulu Sedili Forest Plantation, Peninsular Malaysia, in August 1989. We investigated on its occurrence as well as its form and growth. A 100% survey of the hybrid in the compartment was made. Total height, diameter at breast height (DBH) and clear bole length of ten randomly selected hybrids were recorded. Observations were also carried out on stem straightness, forking, crown and branching characteristics. For comparison, for every hybrid tree assessed and measured, four neighbouring *A. mangium* trees were also assessed and measured.

There are 34 (7.6%) hybrids out of 448 *Acacia* trees planted in that compartment. In general, *Acacia* hybrids have predominant and dominant crowns and smaller branches with a wider angle compared to their neighbouring *A. mangium* trees. They also have rounded trunks and smoother bark. In terms of total height and DBH, the hybrids did better than *A. mangium* (Table 1). Analyses of variance on total height and DBH of the hybrids and *A. mangium* trees revealed a highly significant difference (t-Test; $p=0.01$). For clear bole height, there was no significant difference between the hybrids and *A. mangium* trees.

Due to the superiority and excellent vigor of the hybrid trees compared to their parents, the hybrids definitely have greater potential to be used in future large scale reforestation programmes.