# EFFECT OF NUTRIENT CONDITIONS ON THE GROWTH OF *CALAMUS MANAN* FROM FIVE PROVENANCES IN PENINSULAR MALAYSIA

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**AMINUDDIN MOHAMAD. 1990. Effect of nutrient conditions on the growth of *Calamus manan* from five provenances in Peninsular Malaysia.** *Calamus manan* seedlings from five provenances (Bukit Lanjan, Gombak I and II, Kuala Lipis and Tapah) in Peninsular Malaysia were fertilised using seven different strengths of Hoagland solution (0/4H, 1/4H, 2/4H, 3/4H, 4/4H, 5/4H and 6/4H). Twenty seedlings from each provenance were treated using the respective Hoagland strength replicated two times. Extension growth and leaf increment were observed over a three month period. Extension growth responses to Hoagland solution application varied with provenances and were more pronounced in the second and third month. Leaf increment was pronounced with higher Hoagland strength (5/4H and 6/4H).

Key words: *Calamus manan* - nutrient conditons - growth performances - provenances - Peninsular Malaysia

## Introduction

Rattan is the most important forest product after timber in Peninsular Malaysia. Of the 105 rattan species found in Peninsular Malaysia, *Calamus manan* is the most important commercially. This species is now rapidly depleting due to over exploitation (Menon 1980, Caldecott 1988, Aminuddin 1990). Therefore, steps have been taken by government and non-government agencies in Peninsular Malaysia to plant *C. manan* on a large scale.

Currently, knowledge on the fertiliser requirements of *Calamus* species is still lacking. In Bangladesh, Gulati and Sharma (1983) reported that application of N and P fertiliser to *Calamus tenuis* after transplanting from the nursery to the field had no significant effect. In Indonesia, th se of P a' ne did not significantly affect the height growth of *C. manan* grown under gi een house conditions for two months (Sutiyono & Sukardi 1986). The growth of *Calamus trachycoleus* seedlings was not affected by NPK compound fertiliser treatments (Mindawati & Suriamiharja 1986). On the contrary, in Malaysia, a response was observed for N-fertiliser application to field grown *Calamus tumidus* at the Pasoh Forest Reserve (Aminuddin 1987) and to field grown *C. manan* planted under a stand of rubber trees at Taiping (Aminuddin & Hall 1990).

This study investigates the response of *C. manan* seedlings from five provenances to Hoagland solution of different strengths in an attempt to clarify the importance of nutrient application at the nursery stage and the possibility of variable response with provenances.

## Materials and methods

### *Identification of provenances*

Seed provenances were determined after analysing the situation of possible seed supply and identifying promising areas within different ecozones. The areas selected were:

- Kuala Lipis, Pahang (240 *km* northeast of Kuala Lumpur). Seeds were from the Sungei Yu Forest Reserve (150 - 200 *m*); virgin forest. The mean annual rainfall is 2800 to 3050 *mm*.
- Bukit Tapah, Perak (190 *km* northwest of Kuala Lumpur). Seeds were from the Bukit Tapah Forest Reserve (500 to 550 *m*); virgin forest. Mean annual rainfall exceeds 3550 *mm*.
- Bukit Lanjan, Selangor (30 *km* west of Kuala Lumpur), in Sungei Buloh Forest Reserve, (100 *m*); previously logged. Mean annual rain- fall is 2280 to 2800 *mm*.
- The Gombak Forest Reserve, Selangor (50 *km* east of Kuala Lumpur); previously logged. Mean annual rainfall is 2280 to 2540 *mm*. Two sites were chosen: Gombak I (altitude 80 *m*) and Gombak II (altitude 150 *m*).

Rainfall and temperature data representing provenance localities were obtained from meteorological stations at Raub (for Kuala Lipis), Tapah (for Bukit Tapah), Kuala Lumpur (for Gombak) and Forest Research Institute Malaysia (FRIM), Kepong (for Bukit Lanjan).

### *Seed procurement*

Newly collected fruits were brought back to FRIM nursery for cleaning and seeds were sown as per standard nursery practice. The seedlings were subsequently used for the experiments described below.

### *Fertilisers/nutrients*

A decision was made to conduct a fertiliser experiment using modified Hoagland (No. 2) solution (Went 1957) at different strengths (1/4H, 2/4H, 3/4H, 4/4H, 5/4H, 6/4H) after analysing an existing fertiliser field trial which gave growth responses to different NPK combinations (Aminuddin & Hall 1990). The reaction of the solution was in the range of pH 6 to 7. llustrative mineral compositions of different solutions (1/4H, 3/4H, 4/4H and 5/4 H) are given in Table 1.

### *Experimental plants and arrangements*

The experiment consisted of two replicates. To minimise the errors of Hoagland application in routine tending, the arrangement was systematic.

Uniformity of medium and light intensity were assumed. Twenty seedlings of each provenance were used in each of two blocks; that is in each of the seven treatments which were represented. Each block consisted of a seedling bed under 50% shade.

**Table 1.** Composition of Hoagland solution for nutrient studies

| Full strength (4/4H) | | | | Strength of treatment solutions | | | |
|---|---|---|---|---|---|---|---|
| Composition | $mg\ l^{-1}$ | Elements | $mg\ l^{-1}$ | Elements | 1/4H | 3/4H | 5/4H ($mg\ l^{-1}$) |
| $Ca(NO_3)2.4H_2O$ | 950 | N | 211.7 | N | 52.9 | 158.7 | 264.5 |
| $(NH_4)H_2PO_4$ | 120 | P | 32.2 | P | 8.1 | 24.3 | 40.5 |
| $KNO_3$ | 610 | K | 235.9 | K | 58.9 | 176.7 | 294.5 |
| $MgSO_4.7H_2O$ | 490 | Ca | 160.9 | Ca | 40.2 | 120.6 | 201.0 |
| $H_3BO_3$ | 0.6 | Mg | 48.3 | Mg | 12.1 | 36.3 | 60.5 |
| $MnCl_2.4H_2O$ | 0.4 | Na | 3.6 | Na | 0.9 | 2.7 | 4.5 |
| $ZnSO_4.7H_2O$ | 0.09 | S | 66.7 | S | 16.7 | 50.1 | 83.5 |
| $CuSO_4.5H_2O$ | 0.05 | Cl | 0.143 | Cl | 0.036 | 0.108 | 0.18 |
| $H_2MoO_4$ | 0.02 | Fe | 5.007 | Fe | 1.252 | 3.756 | 6.26 |
| $Co(NO_3)_2H_2O$ | 0.025 | B | 0.105 | B | 0.026 | 0.078 | 0.13 |
| $FeSO_4.7H_2O$ | 24.9 | Co | 0.005 | Co | 0.001 | 0.003 | 0.005 |
| (Chelated | | Mn | 0.111 | Mn | 0.028 | 0.084 | 0.14 |
| with EDTA) | | Cu | 0.013 | Cu | 0.003 | 0.009 | 0.015 |
| NaOH | 6.3 | Zn | 0.02 | Zn | 0.005 | 0.015 | 0.025 |
| | | Mo | 0.012 | Mo | 0.003 | 0.009 | 0.015 |

The twenty plants representing each replicate of each treatment for each provenance were arranged in two lines of ten plants at 6 *cm* intervals; there was an interval of 6 *cm* between plants from the edge of bed and an interval of 20 *cm* separated lines of plants subject to different treatments.

The experiment occupied two beds in parallel, separated by an access line 50 *cm* wide. In the experiment, a total of 1400 plants were used.

Treatments:

- 0/4 H strength (control)
- 1/4 H strength
- 2/4 H strength
- 3/4 H strength
- 4/4 H strength
- 5/4 H strength
- 6/4 H strength.

Seedlings were given Hoagland solution weekly (each plant about 15 *ml*) for a period of three months. Portable partitions were used during application operations to isolate the seedlings being treated from adjacent seedlings allocated to different strength of Hoagland solution.

Assessment

| Parameters | Days 0 | 34 | 69 | 97 | 128 |
|---|---|---|---|---|---|
| Stem length | + | + | + | + | |
| Number of leaves | + | + | + | + | |
| Shoot weight | | | | | + |
| Root weight | | | | | + |
| Foliar nitrogen concentration | | | | | + |
| Foliar phosphorus concentration | | | | | + |
| Foliar potassium concentration | | | | | + |

Ten seedlings from each treatment were subjected to destructive sampling for dry weight assessment and foliar analysis after four and a half months.

### *Data summarization and analysis*

Measurements were made during the onset of the experiment and monthly thereafter. Parameters counted/measured were:

Height (stem length):

Height or length from a marked point at the base of the plant to the base of the petiole of the youngest leaf shoot was measured to 0.5 *cm.*

Number of leaves produced:

The number of leaves (additional to those at outplanting) expanding over the period of study was counted.

Dry-matter production:

At the end of the experiment, dry matter assessment of seedlings (sampled at random within treatment, within replicate) were made, after partitioning into shoot and root portions.

### *Leaf production/analysis*

The total number of leaves produced and the leaf increment (number of leaves $month^{-1}$) over the period were calculated.

On destructive sampling, leaves from fertiliser experiments were analysed for nitrogen, phosphorus and potassium content using the standard techniques employed by the soils section at FRIM.

### *Height increment*

Height increments relating to periods of three months duration were calculated.

### *Statistical analysis*

All data were subjected to appropriate analyses of variance (ANOVA). Significant differences were sought through calculation of the least significant difference. Diagrammatic approaches have been used to display interaction situations where these proved significant.

Data for the various variables measured and analysed were expressed as follows:

- mean height and height increment in *cm* and *cm* $mth^{-1}$ respectively
- total dry matter production (*g*)
- shoot:root ratios were calculated from oven dry weight figures.

## Results

Responses to Hoagland's solution application varied with provenance but became generally more pronounced in the second and third months of the experiment. During the first month (Table 2), there was minimal reaction from plants of the Bukit Lanjan provenance to any solution applied: extension increment did not exceed 1 *cm.* Increments in the other provenances during the initial month were greater, in excess of 4.5 *cm* in Gombak I plants and rising from about 4.5 to 5.0 *cm* in Gombak II plants as solution strength increased from 2/4H to 6/4H. More consistent trends among provenances emerged in the second month with a clearly positive general relationship between increment (from 0-2 *cm* depending on provenance, with the control solution to 2 - 4 *cm* with the 6/4H strength) and solution strength. Although the trend was general, the Gombak provenance was no longer the one displaying the highest increment, the best growth generally being in Tapah plants at this stage (Figure 1).

**Table 2**. ANOVA for height increment (*cm* $mth^{-1}$) for *Calamus manan* provenances subjected to application of Hoagland solution conducted at FRIM, Kepong, Malaysia

| | | Height increment (*cm* $mth^{-1}$) | | |
|---|---|---|---|---|
| Observation period (*mth*) | | 0-1 | 1-2 | 2-3 |
| Analysis of variance: | | | | |
| Main factor | d.f. | | | |
| Provenance (P) | 4 | *** | *** | *** |
| Hoagland level (H) | | ** | *** | *** |
| | 6 | | | |
| First-order interaction: | | | | |
| P × H | 24 | * | ** | * |
| Residual | 35 | | | |
| Total | 69 | | | |

Note: * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

In the third month, the trend remained positive but weaker, with increment levels stabilising at 2 to 4.5 *cm* $mth^{-1}$ depending on provenance, at above 3/4H strength. Control treatments were associated with increments from 0.4 to 3.0 *cm* $mth^{-1}$. The relative performance of different provenances was approximately the same as in the previous month.

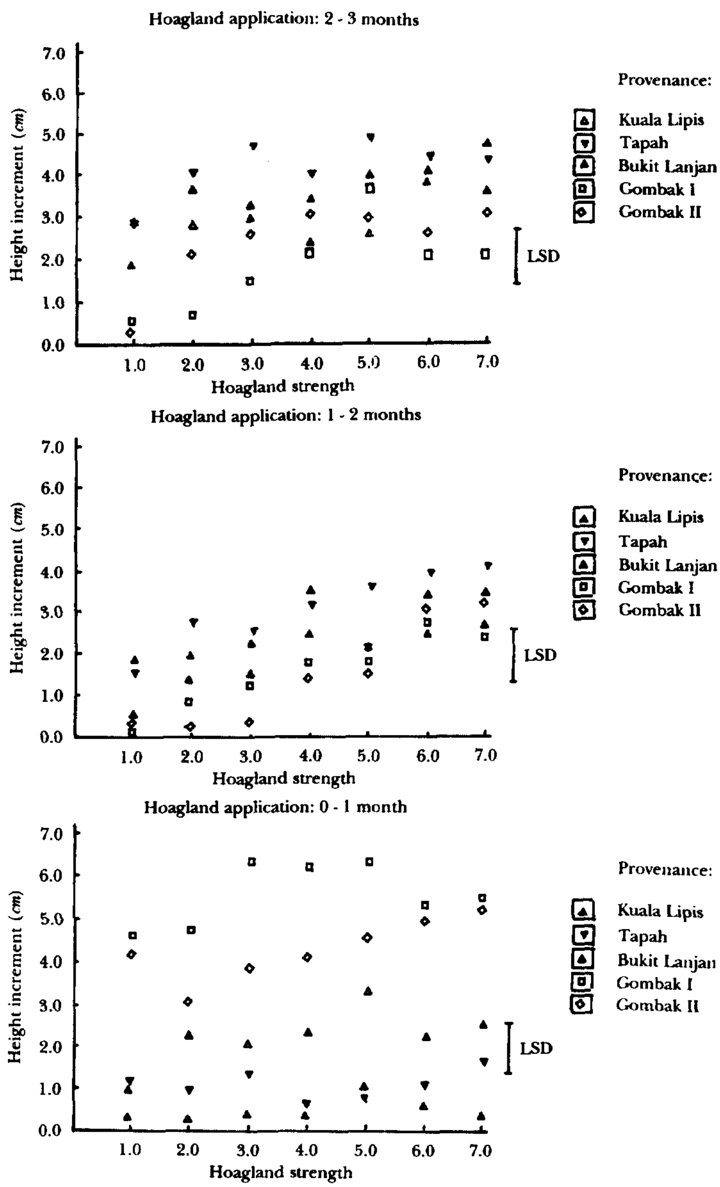


**Figure 1**. Relationship of height increment (*cm mth*$^{-1}$) of *Calamus manan* of five provenance with Hoagland application of different strength at FRIM [Hoagland strength: 1. control (0/4H), 2. 1/4H, 3. 2/4H, 4. 3/4H, 5. 4/4H, 6. 5/4H, 7. 6/4H; follows for all figures]

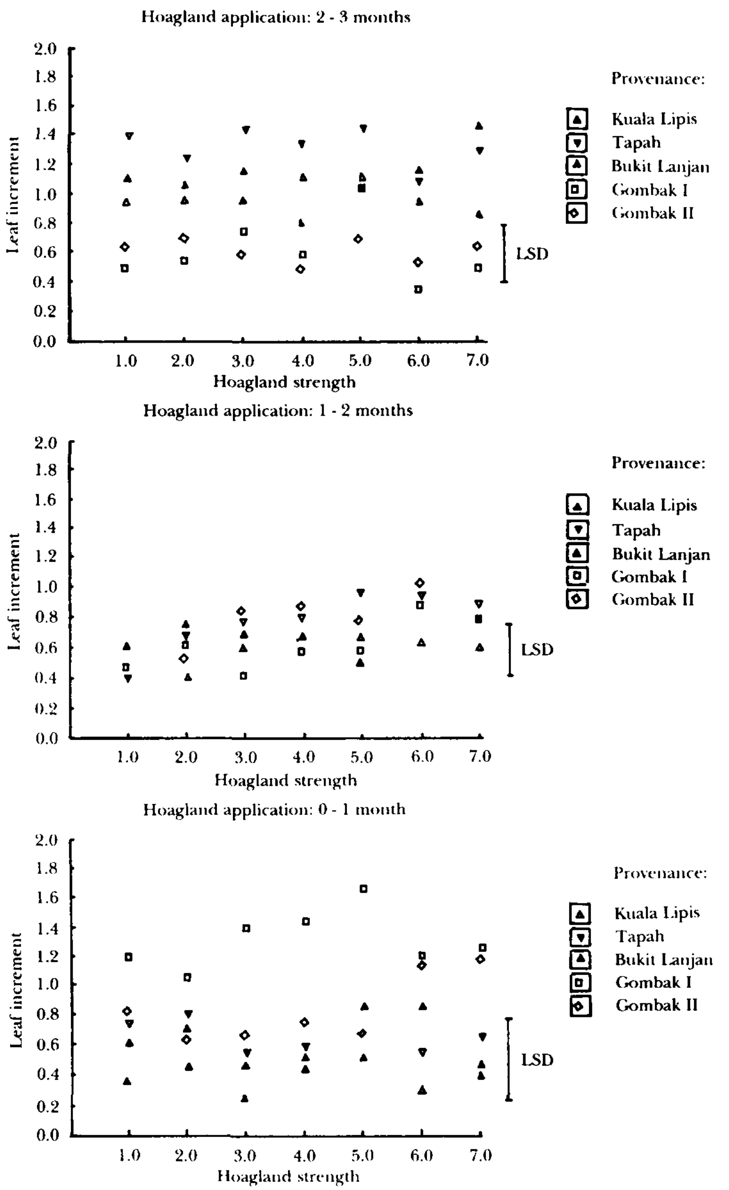


**Figure 2.** Relationship of leaf increment (leaves $mth^{-1}$) of *Calamus manan* of five provenance with Hoagland application of different strength at FRIM

In terms of leaf increment to Hoagland's solution strength during the first month, the response was greatest from the Gombak I provenance (1.0 - 1.6 leaves *mth*$^{-1}$) with the highest increment at 5/4H strength. Other provenances showed poor increment (0.2 - 0.8 leaves *mth*$^{-1}$) (Table 3 & Figure 2).

**Table 3.** Leaf increment (leaves *mth*$^{-1}$) for *Calamus manan* subjected to application of Hoagland solution conducted at FRIM, Kepong, Malaysia

| | | Leaf increment rate | | |
|---|---|---|---|---|
| Observation period (*mth*) | | 0-1 | 1-2 | 2-3 |
| Provenances (P): | | | | |
| Kuala Lipis | | na | 0.56 | 1.12 |
| Bukit Lanjan | | na | 0.76 | 1.33 |
| Tapah | | na | 0.67 | 0.96 |
| Gombak I | | na | 0.59 | 0.61 |
| Gombak II | | na | 0.75 | 0.62 |
| LSD | | | 0.15 | 0.26 |
| Hoagland level (H): | | | | |
| Control (H1) | | na | 0.50 | 0.92 |
| 1.00 H (H2) | | na | 0.68 | 1.07 |
| 0.25 H (H3) | | na | 0.59 | 0.90 |
| 0.50 H (H4) | | na | 0.65 | 0.98 |
| 0.75 H (H5) | | na | 0.70 | 0.87 |
| 1.25 H (H6) | | na | 0.79 | 0.82 |
| 1.50 H (H7) | | na | 0.75 | 0.95 |
| LSD | | | 0.18 | |
| Corresponding analysis of variance: | | | | |
| Main factor | d.f. | | | |
| Provenances (P) | 4 | *** | ** | *** |
| Hoagland level (H) | 6 | * | ** | ns |
| First-order interaction: | | | | |
| S × H | 24 | *** | ns | ns |
| Residual | 35 | | | |
| Total | 69 | | | |

Note: * p≤0.05, ** p≤0.01, *** p≤0.001, ns - not significant, na - not applicable, LSD - least significant differences

In the second month, a positive trend emerged for three provenances (Gombak I, Gombak II, Kuala Lipis) with leaf increment increasing from 0.4 leaves *mth*$^{-1}$ (control) to 0.6 to 0.9 treatment (5/4H & 6/4H). This trend dis-appeared in the third month but at this stage consistent rankings for different provenances were evident with high leaf increments (1.1 - 1.5 *mth*$^{-1}$) for the Tapah provenance and increments generally <0.8 *mth*$^{-1}$ for both Gombak provenances.

Most provenances responded positively in terms of shoot dry weight at three months (Table 4 & Figure 3) to increasing Hoagland solution strength: at higher strength, for all provenances except Kuala Lipis, values in excess of 3 *g* seedling$^{-1}$ were obtained. Root weights followed a similar pattern but with a weaker trend and were only about half the value of shoot weights.

Shoot:root ratios were generally close to 2 except for an anomalous value of 6 for the Gombak I provenance at 6/4H strength Hoagland solution which was due to an anomalously low shoot weight.

**Table 4.** Shoot weight (*g*) and root weight (*g*) for *Calamu manan* subjected to application of hoagland solution conducted at FRIM, Kepong, Malaysia

| | | Harvest at 3 *mth* | |
|---|---|---|---|
| | | Shoot (*g*) | Root (*g*) |
| Sources: | | | |
| Tapah | | na | 1.89 |
| Kuala Lipis | | na | 0.96 |
| Bukit Lanjan | | na | 1.69 |
| Gombak I | | na | 1.61 |
| Gombak II | | na | 1.46 |
| LSD | | | 0.68 |
| Hoagland level (H): | | | |
| Control (H1) | | na | 1.26 |
| 1.00 H (H2) | | na | 2.01 |
| 0.25 H (H3) | | na | 1.22 |
| 0.50 H (H4) | | na | 1.48 |
| 0.75 H (H5) | | na | 1.59 |
| 1.25 H (H6) | | na | 1.82 |
| 1.50 H (H7) | | na | 1.24 |
| LSD | | | 0.46 |
| Corresponding analysis of variance: | | | |
| Main factor | d.f. | | |
| Sources (S) | 4 | *** | *** |
| Hoagland level (H) | 6 | *** | ** |
| First-order interaction: | | | |
| S × H | 24 | ** | ns |
| Residual | 35 | | |
| Total | 69 | | |

Note: *** p≤0.001, ** p≤0.05, ns - not significant, na - not applicable, LSD - least significant difference

Foliar analysis revealed levels of nitrogen which were generally in the range of 1.0 to 1.5% regardless of solution strength but showed no consistency in provenance rankings of trends with increasing solution strength (Table 5 & Figure 4).

Foliar phosphorus levels did not exceed 0.5% except for the Tapah provenance at low solution strength, and were consistently <0.1% for the Kuala Lipis plants. There was a detectable fall in foliar phosphorus levels as strength rose from 2/4H to 6/4H with the exception of the Kuala Lipis provenance. In terms of foliar phosphorus concentration, provenance rankings were sustained with change in solution strength.

Foliar potassium concentrations were very variable and mostly from 0.7 to 1.4%. Concentration in the Tapah, Gombak I and Kuala Lipis provenances were higher at the lower solution strengths but rankings were otherwise inconsistent.

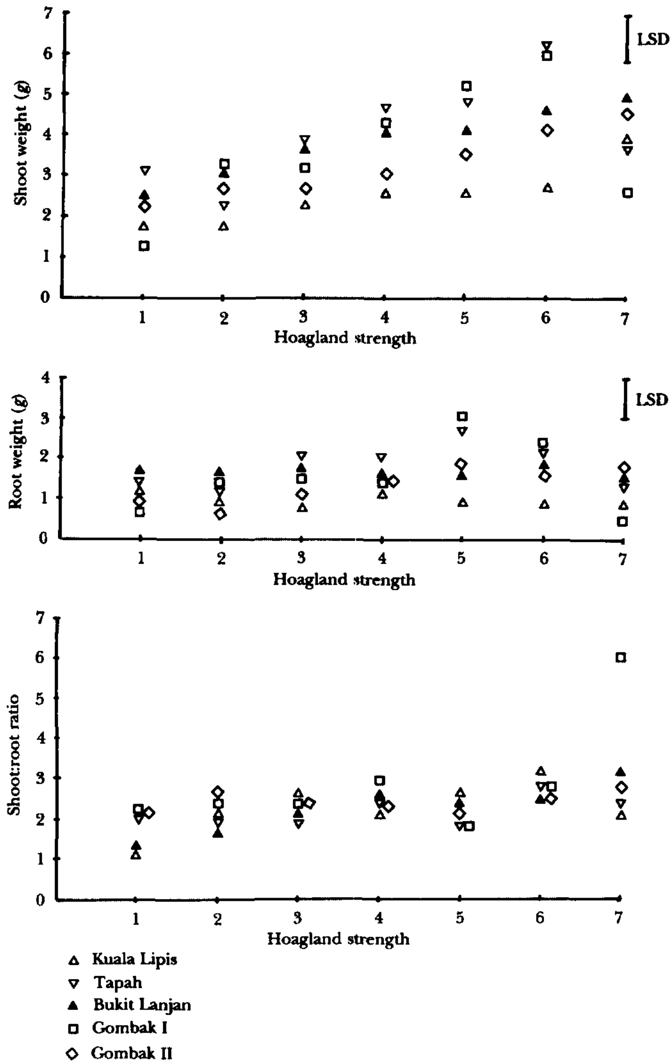


**Figure 3.** Relationship of shoot weight (g), root weight (g) and shoot:root ratio of *Calamus manan* of five provenance with Hoagland application of different strength at FRIM

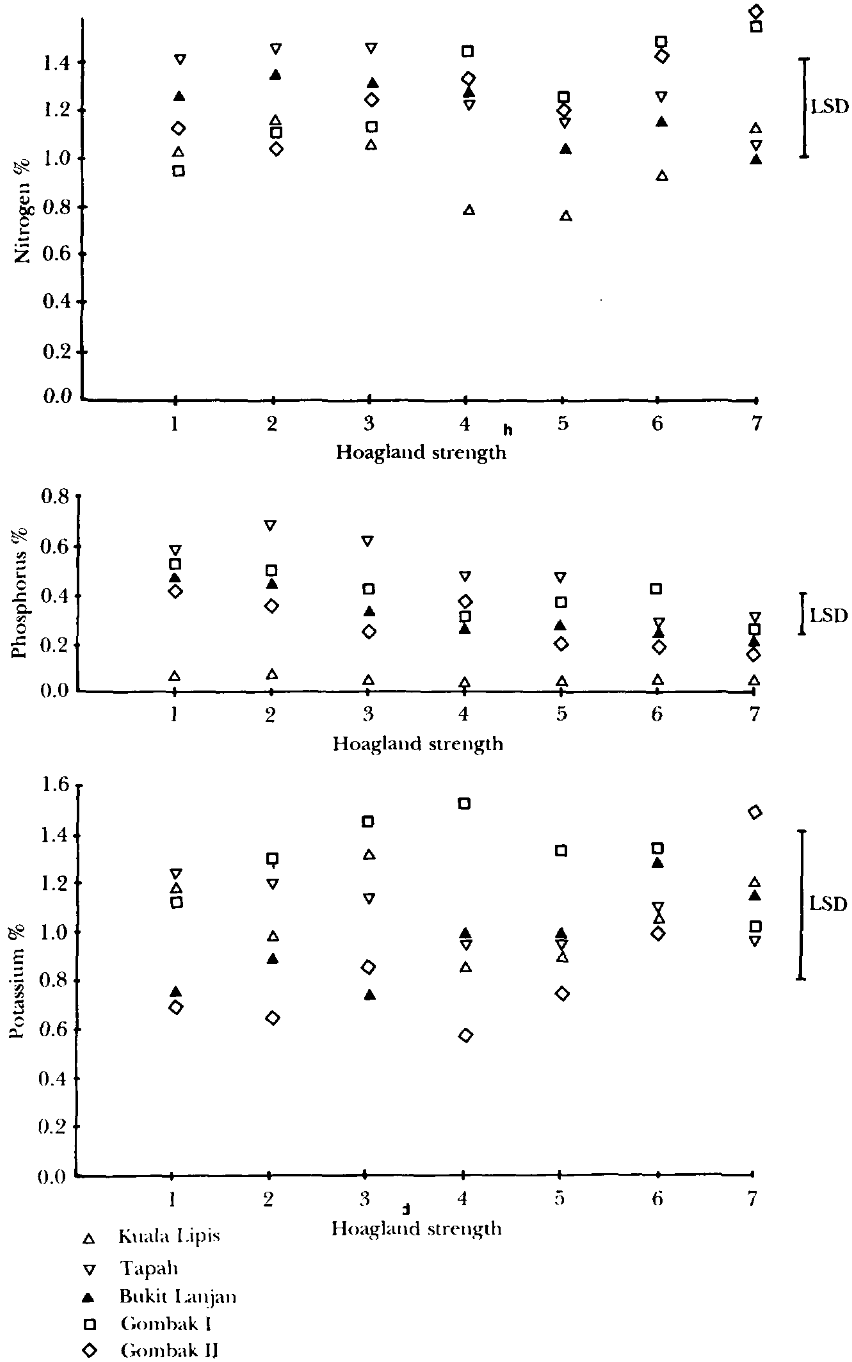


**Figure 4.** Relationship of leaf analysis of *Calamus manan* of five provenance with Hoagland application of different strength at FRIM

**Table 5.** ANOVA for leaf analysis data for *Calamus manan* from different seed provenances subjected to different Hoagland solution levels

| | | Nitrogen | Phosphorus | Potassium |
|---|---|---|---|---|
| Analysis of variance: | | | | |
| Main Factors | d.f. | | | |
| Provenance (P) | 4 | *** | *** | *** |
| Hoagland strength (H) | 6 | *** | *** | ns |
| First-order interactions: | | | | |
| P × H | 24 | *** | *** | *** |
| Residual | 35 | | | |
| Total | 69 | | | |

Note: *** $p \leq 0.001$, ns - not significant

## Discussion

Previous studies have shown that *C. manan* and *C. caesius* vary in growth when planted (Aminuddin 1985, Nainggolan 1985, Nur Supardi & Wan Razali 1989, Manokaran 1981, 1982). This could be due to genetic differences in seedlings from different sources. This study has demonstrated that under FRIM conditions, the seedlings from different provenances responded differently when treated with Hoagland solutions. Positive effects of fertiliser application do arise in the early stages of application. Seedlings from higher ecozones perform better under the conditions applied. Growth trends however suggested that seedlings from all the provenances benefitted from the fertiliser application.

Within the period of study, a positive effect of fertiliser application is indicated in terms of leaf increment. Seedlings from higher ecozones (Tapah) showed better growth response than other provenances. Similar trend is observed in shoot dry weight. This showed that there could be genetic differences between seedlings from different provenances.

Nursery managers have in the past been using fertiliser for seedlings, including that of rattan seedlings in the nursery. However, the amount applied is not quantified. As plans for large scale rattan planting are being made, it will be desirable to know the optimal timing and frequency of fertiliser needed for each plant in the nursery.

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