EFFECTS OF FERTILISER TREATMENTS ON GROWTH OF *DYERA COSTULATA* STOCK PLANTS AND ROOTING ABILITY OF THEIR STEM CUTTINGS

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AMINAH, H. & LOKMAL, N. 2002. **Effects of fertiliser treatments on growth of *Dyera costulata* stock plants and rooting ability of their stem cuttings.** Application of NPK (12N:12P_2O_5:17K_2O:2MgO + trace elements) significantly improved the height and diameter growth of potted *Dyera costulata* stock plants compared with those without fertiliser. Cuttings taken from non-fertilised stock plants and plants treated with 1 g fertiliser did not differ significantly in rooting but their rooting percentages were significantly higher than those from stock plants receiving 5 g fertiliser. The highest rooting percentage was obtained with cuttings from non-fertilised stock plants (66.7%) followed by those receiving 1 g (56.7%) and 5 g (46.7%) fertiliser. However, without fertiliser, frequent harvest of cuttings will eventually exhaust the nutrients from the potted stock plants. In view of this, application of 1 g fertiliser plant^{-1} monthly may help maintain healthy stock plant growth for continuous production of cutting materials. High doses of fertiliser (5 and 10 g plant^{-1} month^{-1}) are not recommended, being detrimental to both survival of stock plants and rooting of cuttings. It was also observed that high rooting percentages (82%) could be obtained from cuttings taken from node position two.

Key words: Fertiliser - *Dyera costulata* - stock plant - growth - survival - rooting

AMINAH, H. & LOKMAL, N. 2002. **Kesan rawatan pembajaan terhadap pertumbuhan pokok stok *Dyera costulata* dan keupayaan pengakaran keratan batang.** Pokok stok *Dyera costulata* yang dirawat dengan baja NPK (12N:12P_2O_5:17K_2O:2MgO + unsur surih) menunjukkan peningkatan yang bererti dalam ketinggian dan diameter berbanding dengan pokok yang tidak dibaja. Pengakaran keratan yang diambil daripada pokok stok yang tidak dibaja dan yang dibaja dengan 1 g menunjukkan perbezaan yang tidak bererti tetapi adalah bererti berbanding kadar pembajaan 5 g. Peratus pengakaran yang paling tinggi didapati daripada keratan yang tidak dibaja (66.7%) diikuti oleh pembajaan 1 g (56.7%) dan 5 g (46.7%). Sungguhpun begitu, tanpa pembajaan, pokok stok akan kekurangan nutrien apabila keratan diambil berulang-ulang. Dalam keadaan ini, pembajaan pokok stok sebanyak 1 g pokok^{-1} bulan^{-1} akan membantu pertumbuhan dan kesuburan pokok serta penghasilan bahan keratan yang berterusan. Kadar pembajaan yang tinggi (5 dan 10 g pokok^{-1} bulan^{-1}) tidak digalakkan kerana ia akan mengurangkan kemandirian pokok stok dan pengakaran keratan. Selain itu, pengakaran yang tinggi (82%) boleh didapati menggunakan keratan daripada ruas yang kedua.

Introduction

Dyera costulata belongs to the family Apocynaceae and it is locally known as jelutong in Peninsular Malaysia. It is amongst the biggest trees in Southeast Asia. In

Peninsular Malaysia, it has been recorded to reach 60.6 m in height and 7.9 m in girth (Anonymous 1979), with straight and cylindrical bole without buttress. Its distribution covers south Thailand through the Malay peninsula, Sumatra and Borneo and the trees are mostly scattered in dry land below 303 m (Anonymous 1979). Jelutong is a light hardwood timber that can be used in the manufacture of a very wide range of consumer products for use in situations where strength and natural durability are not needed, for example, pencils, picture frames, match sticks, packing cases, clogs, drawing boards and ceiling materials. Besides timber, latex produced from jelutong trees can be used for manufacturing chewing gum (Thomas 1950, Burkill 1966). The trees are also popular among landscapers because of their beautiful bole shapes and crowns.

Most jelutong timber is extracted from natural forests and the continued exploitation of trees without compensatory planting programmes will lead to diminishing production of jelutong timber within the next few years. Therefore, future production of this timber may depend upon plantations. Growth rates of jelutong trees are relatively fast. Under proper management, diameter at breast height (dbh) of trees could reach 60 cm in 40 years (1.5 cm $year^{-1}$) (Wan Razali 1988). In terms of height, measurements made on trees line-planted in an experimental plot in Tapah Hills indicated that an average height of 4.5 m was obtained in five years (Anonymous 1979).

The problem of obtaining sufficient planting materials has hindered the setting up of jelutong plantations. Although seeds are produced every year and can be stored up to one year in cold rooms, it is now difficult to get seeds in abundance due to scarcity of mother trees. Collection of seeds should be made directly from trees because if pods are opened, seeds can be scattered far and wide by wind, making collection on the ground unrewarding. The problem is worsened with ants attacking and eating the seeds on the ground (Duncan 1977). To increase the supply of planting materials, propagation by stem cuttings (Aminah 1996) and tissue culture (Aziah & Darus 1995) had been carried out and appeared to be successful. To ensure continuous supply of cutting materials for rooting, proper management of stock plants is required. The importance of nutrient applications to stock plants is widely recognised, but their reported effects on subsequent rooting of cuttings have been inconsistent and dependent on plant species (Moe & Andersen 1988). Leakey (1983) reported that application of fertiliser to stock plants of *Triplochiton scleroxylon* enhanced their growth and improved rooting of cuttings from lower lateral shoots, but had no effect on cuttings from apical shoots. On the other hand, Aminah *et al.* (1999) found that application of fertiliser to stock plant of *Shorea leprosula* significantly increased height and diameter growth but had no effect on rooting when compared with non-fertilised plants. Work on stock plant fertilisation of *D. costulata* and its effect on the rooting of subsequent cuttings have not been reported. This paper reports the effect of different fertiliser applications on the growth of *D. costulata* potted stock plants raised from rooted cuttings and the rooting ability of cuttings harvested from these plants.

Materials and methods

This experiment was carried out at the nursery of Forest Research Institute Malaysia (FRIM). Rooted cuttings from mixed *D. costulata* clones were potted into polythene bags (9 cm diameter × 17 cm height) filled with forest soil and sand in the ratio of 3:1 by volume. These potted cuttings were kept at the transplanting beds with 33% shade as recommended by Aminuddin (1982). Granular compound fertiliser ($12N{:}12P_2O_5{:}17K_2O{:}2MgO$ + trace elements) was applied monthly to the plants. The four concentrations used were 0, 1, 5 and 10 g plant^{-1}. These plants were randomly arranged in four blocks with 12 plants per fertiliser treatment per block. These plants were watered to field capacity twice a day in the morning and late afternoon except on rainy days. Weeding, insecticide and fungicide applications were carried out whenever necessary. The insecticide used was Tamaron special (50% Methamidopos active ingredient, Bayer Company, Leverkusen, Germany) and the fungicide applied was Benlate (50% Benomyl active ingredient, E. I. Dupont, Denemours and Co. Inc., USA).

Initial height of the cuttings (from ground level to the shoot apex) was measured one week after the rooted cuttings were potted but their initial diameter was not measured because the stems were too small and fragile. Subsequent height growth was measured monthly until the experiment was terminated after the plants were four months old. At this time the root collar diameter was also measured.

Before the cuttings were harvested for rooting, one plant per block from each treatment was randomly selected for measurement of nitrogen content. A total of eight single node stem sections per treatment were obtained from these plants. These cuttings were dried in an oven at 50 °C for 48 hours, before being finely ground into powder form. A total of 50 mg of the sample was used for the analysis. The nitrogen was extracted using Kjedahl method and total nitrogen was determined colorimetrically using Technicon auto analyser. Details of the method are provided in Wan Rashidah *et al.* (1990).

To test the rooting performance, single node stem cuttings were taken from the above stock plants. Only cuttings from stock plants treated with 0, 1 and 5 g fertiliser were available for this experiment. Plants treated with 10 g fertiliser suffered high mortality and sufficient cutting materials could not be obtained for experiment. Sixty cuttings were used for each treatment, which was laid out in four blocks. Cuttings were taken from the second node basipetally. Stems from the first node (shoot apex) which were not fully developed were discarded. A 30-cm^2 leaf area was retained on each cutting. The leaf area was cut using a 30-cm^2 paper template, which was measured with a leaf area meter. The bases of cuttings were cut at right angles to the stem and each cutting was treated with 20 μg indole butyric acid (IBA) using a micropipette (Model F10, Gilson Medical Electronic, France). The IBA formulation was prepared using absolute ethyl alcohol. The alcohol was immediately evaporated in a stream of air from a fan. These cuttings were then planted into rooting medium comprising river sand. The sand was cleaned with water to remove plant debris, mud and stones before being placed into the rooting beds. Node positions in the rooting beds were held in sequential order as they occurred on the stock plants. These cuttings were set in an enclosed mist propagation system with a misting frequency of every hour. The duration of each spray was one minute. The propagation systems were shaded with black plastic netting (about 86% shade). The environmental data for the propagation system were similar to that described in Aminah *et al.* (1995).

An assessment was made on cuttings every fortnight starting two weeks after planting. At each assessment, variables measured were number of rooted, non-rooted or dead cuttings and number of roots on each cutting. A cutting was scored as rooted when it produced a root of at least 1-cm length and a cutting was scored dead when the whole stem turned brown. After each observation, the cuttings were replanted into the rooting bed for reassessment. This experiment was terminated 16 weeks after planting when no more new rooting had occurred. The mean accumulated root number was calculated by dividing the total number of roots produced by the total number of rooted cuttings at each assessment.

Analyses of variance followed by least significant difference (LSD) tests were carried out on height, diameter, nitrogen content and mean accumulated number of roots per rooted cutting. Chi-square analyses were used to analyse all binomial data.

Results

Stock plants

Analysis of variance showed that initial height of stock plants did not differ significantly between treatments. Mean heights were 9.9, 10.5, 10.4 and 10.2 cm for the 0, 1, 5 and 10 g fertiliser levels respectively. At four months, there were significant differences in both height and diameter between fertiliser treatments (Table 1). However, individual comparison between the 1, 5 and 10 g fertiliser treatments was not significant (Table 2). Plants receiving fertilisers were about 72% taller than the non-fertilised controls (Table 2). Plants treated with 1 g fertiliser had the highest height followed by 10, 5 and 0 g (Table 2). On the other hand, diameter of plants treated with 10 g fertiliser was significantly greater than the other fertiliser treatments (Table 2). Differences in mortality of plants were found to be significant among treatments. Highest mortality (79%) was obtained with the 10 g fertiliser treatment followed by 5, 1 and 0 g (Table 2). Nitrogen content of leaf and stem of cuttings was significantly different between treatments (Table 3). The percentages of nitrogen in plants treated with 5 and 10 g fertiliser were significantly higher compared with those with 0 and 1 g fertiliser (Table 2).

Table 1 Analysis of variance on height and diameter of *Dyera costulata* potted stock plants at four months after transplanting (n = 48 per treatment)

Source of variation	Degrees of freedom	Height mean square	Diameter mean square
Blocks (Bl)	3	335.09ns	15.56ns
Treatments (Tr)	3	1695.01**	25.09**
Bl × Tr	9	222.11ns	6.40ns
Error	110	248.50	6.87
Total	125		

** : Significant at $p \leq 0.01$
ns : Not significant at $p \leq 0.05$

Table 2 Mean height, diameter, mortality and nitrogen content of leaf and stem of *Dyera costulata* stock plants measured at four months after transplanting

Fertiliser treatment (g)	Height (cm)	Diameter (mm)	Mortality (%)	Nitrogen content (%)
1.0	31.6 a	6.5 ab	12.5 a	2.7 a
5.0	29.9 a	6.8 ab	43.8 b	4.2 b
10.0	31.1 a	7.4 a	79.2 c	5.5 b
0 (control)	17.9 b	5.2 b	2.1 d	2.5 a

Means followed by the same letter are not significantly different at $p \leq 0.05$

Table 3 Analysis of variance on nitrogen (of leaf and stem) of *Dyera costulata* potted stock plants at four months after transplanting (n = 8 per treatment)

Source of variation	Degrees of freedom	Mean square
Blocks (Bl)	3	2.22ns
Treatments (Tr)	3	15.16**
Bl × Tr	9	0.96ns
Error	16	1.64
Total	31	

** : Significant at $p \leq 0.01$
ns: Not significant at $p \leq 0.05$

Stem cuttings

Fertiliser treatments applied to stock plants significantly affected the final rooting percentage and mortality of cuttings (Figure 1). Although cuttings taken from stock plants with 0 g and 1 g fertiliser did not differ significantly in these values, they were significantly higher than those taken from stock plants treated with 5 g fertiliser. Figure 2 shows rooting decreased with increasing fertiliser levels. Highest rooting was obtained with cuttings taken from stock plants without applied fertiliser (66.7%), followed by 1 g (56.7%) and 5 g fertiliser treatments (41.7%).

Percentage mortality was significantly greater (41.7%) in cuttings from plants treated with 5 g compared with those that received 0 and 1 g fertiliser treatments (Figure 1). Cuttings, which did not root, were not significantly affected by the treatments applied (Figure 1). Rooting was influenced by the node position where cuttings from node 2 produced a high rooting rate of 82% (Table 4). Number of roots per rooted cutting was not significantly affected by treatments.

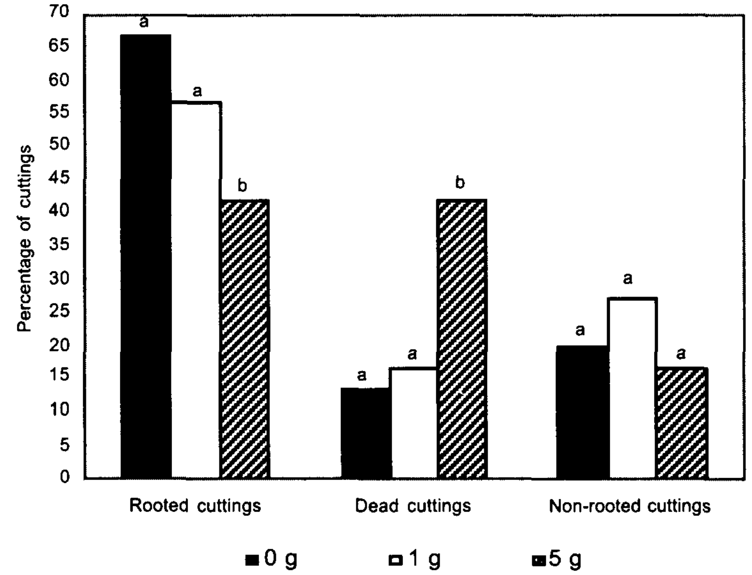

Figure 1 Influence of fertiliser applications to *Dyera costulata* stock plants on subsequent rooted, dead and non-rooted stem cuttings (n = 60 per treatment). Means followed by the same letter are not significantly different at $p \leq 0.05$

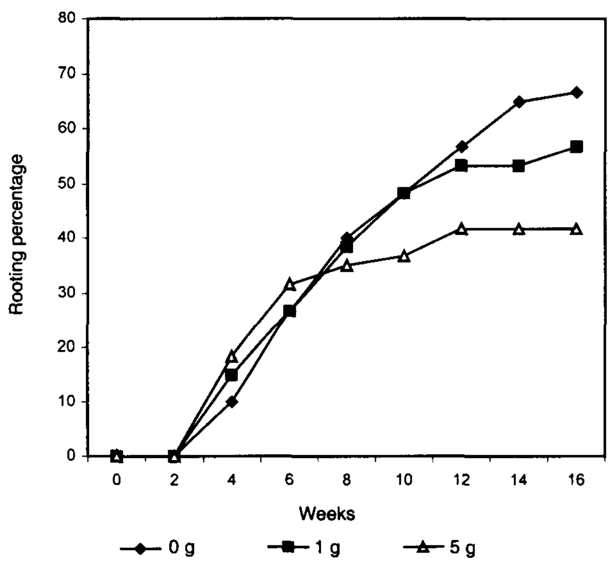

Figure 2 Influence of fertiliser applications to *Dyera costulata* stock plants on subsequent rooting rate of stem cuttings (n = 60 per treatment)

Table 4 Effect of node positions on rooting of *Dyera costulata* stem cuttings

Node positions	Total number of cuttings	Rooted cuttings	Non-rooted cuttings	Rooting (%) ± SE
2	45	37	8	82.2 ± 5.7
3	47	22	25	46.8 ± 7.3
4	39	20	19	52.3 ± 8.0
> 5	49	20	29	40.8 ± 7.0

SE: Standard error of means

Discussion and conclusions

Both height and diameter growth of *D. costulata* stock plants were enhanced by application of fertiliser. The results confirmed previous studies by Leakey (1983), Moe and Andersen (1988) and Aminah *et al.* (1999) who demonstrated that application of nutrients is important for healthy growth of stock plants. However, this study showed that high rates of application (5 and 10 g plant^{-1} month^{-1}) significantly reduced survival. This could be because the treatment was toxic to the plants in this experiment.

The effect of fertiliser on subsequent rooting of cuttings was reported to be inconsistent and dependent on the species (Leakey 1983, Moe & Andersen 1988, Aminah *et al.* 1999). In this experiment, application of fertiliser affected rooting percentages of cuttings and they were significantly reduced when high fertiliser treatment (5 g plant^{-1} month^{-1}) was applied to the stock plants. The lower fertiliser treatments of 0 and 1 g did not significantly affect the rooting percentages of cuttings. Several other authors, in their experiments with fertiliser and light regimes, have reported similar trends in rooting results. For example, Mesen (1993) found that application of 7.5 g per plant per two weeks of NPK fertiliser (10:30:10) to stock plants grown under shade or full sunlight was detrimental to rooting of subsequent cuttings compared with those from non-fertilised plants. In another experiment, the author observed that cuttings of *Albizia guachepele* rooted better when stock plants were grown under low irradiance (200 µmol photons m^{-2} s^{-1}) and low dose (0.25% plant^{-1}) of fertiliser (20:20:20 N:P:K). On the other hand, rooting was reduced when stock plants were treated with high irradiance (500 µmol photons m^{-2} s^{-1}) and high dose (1.25% plant^{-1}) of 1:1:1 NPK.

Rooting has previously been negatively correlated with high nitrogen content in cuttings (Hartmann *et al.* 1990). This experiment also indicated such a trend. Stock plants treated with high levels of fertiliser had high leaf and stem nitrogen contents and produced poor rooting of cuttings. Similar results were obtained by Tchoundjeu (1989) where high rates of nitrogen fertiliser application to *Khaya ivorensis* yielded cuttings which suffered high mortality.

An influence of nodal positions of cuttings on rooting was also observed in this experiment. Cuttings taken from node position 2 produced high rooting percentages. Poor rooting of cuttings from the lower node positions may be due to secondary growth and thickening of lignin layer which may create physical barrier to root initiation (Hartmann *et al.* 1990, Liew 1992). These lignified cuttings were generally poor rooters and either did not root or died when the carbohydrate they reserve were depleted. Another possibility is that cuttings from lower nodes on the stem have lower photosynthetic capacity compared with the upper nodes (Leakey 1983).

The results of the present experiment indicated that rooting juvenile stem cuttings could serve as an alternative means of propagating planting stock of *D. costulata.* The highest rooting percentage was obtained with cuttings from non-fertilised stock plants (Figure 2). However, frequent harvest of cuttings will eventually exhaust the nutrients from the potted stock plants. In view of this, application of 1.0 g fertiliser plant^{-1} monthly may help to maintain healthy stock plant growth for continuous production of cutting materials. High doses of fertiliser (5 and 10 g^{-1} plant^{-1} month^{-1}) are not recommended, being detrimental to both survival of stock plants and rooting of cuttings.

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