EFFECTS OF INDOLE BUTYRIC ACID CONCENTRATIONS AND MEDIA ON ROOTING OF LEAFY STEM CUTTINGS OF *SHOREA PARVIFOLIA* AND *SHOREA MACROPTERA*

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Received March 2004

AMINAH, H., NOR HASNITA, R. M. N. & HAMZAH, M. 2006. Effects of indole butyric acid concentrations and media on rooting of leafy stem cuttings of *Shorea parvifolia* and *Shorea macroptera*. An experiment was set up using stem cuttings of *Shorea parvifolia* taken from coppices of four-year-old stock plants. The bases of these cuttings were treated with indole butyric acid (IBA) of varying concentrations between 2000 and 10 000 ppm. The control was without IBA. The cuttings were planted separately in an enclosed mist propagation system using three types of media, namely, sand, coconut husk and a combination of sand:coconut husk (1:1). Similar experiment was carried out with stem cuttings of *S. macroptera* taken from one-year-old potted seedlings. Results showed that 16 weeks after planting, there were significant differences between rooting percentages of *S. parvifolia* cuttings treated with various IBA concentrations. The highest rooting of 63% was obtained with 8000 ppm IBA compared with only 32% with control treatment. However, no significant difference was obtained in the mean number of roots between 8000 ppm IBA and the control. Similar results were obtained with *S. macroptera*. However, lower rooting percentage was obtained. The highest rooting of 46% was obtained with 10 000 ppm IBA compared with the 17% with control treatment. Unlike *S. parvifolia*, means number of roots in *S. macroptera* was significantly higher when cuttings were treated with 6000, 8000 and 10 000 ppm IBA compared with control. Cuttings treated with 10 000 ppm IBA had 3.1 roots compared with the control (1.7). However, when different types of media was used no significant effect was observed on rooting and number of roots in the two species studied. In both species, cuttings with diameters < 4.5 mm gave better rooting percentages than those with thicker diameters.

Keywords: Dipterocarp species, vegetative propagation, number of roots, hormone, coppices, juvenile cutting materials

AMINAH, H., NOR HASNITA, R. M. N. & HAMZAH, M. 2006. Kesan kepekatan asid indol butirik dan media ke atas pengakaran keratan batang berdaun *Shorea parvifolia* and *Shorea macroptera*. Satu uji kaji telah dibuat menggunakan keratan batang *Shorea parvifolia* yang diambil daripada pucuk pokok stok yang berumur empat tahun. Bahagian bawah keratan dirawat dengan kepekatan asid indol butirik (IBA) antara 2000 ppm ke 10 000 ppm berserta kawalan (tanpa IBA). Keratan-keratan ini kemudiannya ditanam dalam media (1) pasir, (2) sabut kelapa dan (3) pasir:sabut kelapa (1:1) dalam sistem pembiakan berenjis yang bertutup. Uji kaji yang sama telah dijalankan ke atas keratan batang *S. macroptera* yang diambil daripada anak benih tabung berumur satu tahun. Keputusan 10 minggu selepas ditanam menunjukkan terdapat perbezaan signifikan pada peratusan keratan *S. parvifolia* yang dirawat dengan beberapa kepekatan IBA. Kesemua kepekatan IBA kecuali 2000 ppm didapati menunjukkan kesan yang signifikan berbanding dengan kawalan. Pengakaran yang paling tinggi iaitu 63% diperoleh dengan 8000 ppm IBA berbanding dengan 32% daripada kawalan. Walau bagaimanapun, tidak terdapat perbezaan yang bererti pada purata bilangan akar antara 8000 ppm IBA dan kawalan. Keputusan yang sama didapati dengan *S. macroptera*, tetapi peratus pengakaran spesies ini adalah lebih rendah berbanding *S. parvifolia*. Peratus paling tinggi adalah 46%yang didapati dengan 10 000 ppm IBA berbanding 17% daripada kawalan. Berbeza dengan *S. parvifolia*, purata jumlah akar *S. macroptera* menunjukkan perbezaan yang bererti bagi keratan yang dirawat dengan 6000 ppm, 8000 ppm dan 10 000 ppm IBA berbanding kawalan. Keratan yang dirawat dengan 10 000 ppm IBA mempunyai 3.1 akar berbanding 1.7 daripada kawalan. Tidak terdapat perbezaan signifikan dalam pengaruh media pada pengakaran dan jumlah akar keratan untuk kedua-dua spesies walaupun terdapat perbezaan dalam komponen media yang digunakan. Pada kedua-dua spesies, keratan berdiameter < 4.5 mm memberi pengakaran yang lebih baik berbanding dengan keratan yang lebih besar diameternya.

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Introduction

Shorea parvifolia and *S. macroptera* belong to the family Dipterocarpaceae and their preferred vernacular names are meranti kepong and meranti melantai respectively. They are valuable commercial timber species in the local and international markets. A major problem among dipterocarp species is their recalcitrant seeds which have low viability period and cannot be stored by conventional methods. Therefore, improved propagation techniques will help to secure continuous supply of their planting stocks for reforestation purposes. Earlier research showed that these species can be propagated using juvenile cuttings (Aminah 1991). To consistently get high rooting percentages, factors that affect the rooting process for each species have to be studied.

Several studies have reported the benefit of hormone application in promoting adventitious root development of cuttings. Indole butyric acid (IBA) has been successfully used to root *S. leprosula* (Aminah *et al.* 1995), *S. macrophylla* (Lo 1985), *Milicia excelsa* (Ofori *et al.* 1996), *Ricinodendron heudelotii* (Shiembo *et al.* 1997), *Khaya ivorensis* (Tchoundjeu & Leakey 1996), and *Calliandra calothyrsus* (Wolf & Jaenicke 2000). Cuttings of many dipterocarp species have been reported to root in various types of media. However, experimental evidence indicated that the rooting percentages and number of roots of each species may differ in different kinds of media (Loach 1985, Hartmann *et al.* 1990, Leakey *et al.* 1990). This experiment was carried out to assess the effects of IBA concentrations and rooting media on leafy stem cuttings of *S. parvifolia* and *S. macroptera*.

Materials and methods

Two different experiments to study the effects of different IBA concentrations and rooting media using *S. parvifolia* and *S. macroptera* were carried out in the nursery at the Forest Research Institute Malaysia (FRIM).

Stock plants

Stock plants of both species used were raised from open pollinated seeds. Stock plants of *S. parvifolia* were four years old when the experiments were carried out. They were potted in polythene bags (15 cm diameter × 45 cm height) filled with decomposed oil palm mesocarp fibre and forest soil (1:2). These plants were regularly pruned to produce coppice shoots for cutting materials. Granular compound commercial fertilizer, NPK Blue (12N:12P_2O_5:17K_2O: 2MgO + trace elements), was applied at 3 g plant^{-1} month^{-1}.

Chemical properties of the potting media are shown in Table 1. Nitrogen was extracted using Kjedahl method, phosphorus by Bray and Kurtz No. 2 and potassium by nitric acid digestion. These elements were then determined colorimetrically using Technicon autoanalyser. Details of these methods are described in Wan Rashidah *et al.* (1990). Carbon was analysed using the Walkley and Black method (Nelson & Sommers 1982). For pH measurement, 10 g of each sample was taken and mixed with 20 ml distilled water.

Stock plants of *S. macroptera* were one-year-old at the time of experiment. They were potted in polythene bag (9 cm diameter × 17 cm height) using similar media as *S. parvifolia*. The NPK Blue fertilizer was at applied 1 g plant^{-1} month$^{-1.}$

Stock plants of both species were kept on transplanting beds shaded with plastic netting (50% light intensity). The plants were watered twice daily, in the morning and late afternoon. Weeding, insecticide and fungicide applications were carried out as needed.

Rooting experiments

Single node stem cuttings were taken from these stock plants from the second top most node to the bottom. The apical undeveloped shoots were discarded as they were not suitable for cuttings. The length of the cuttings was 5 cm and the leaf area retained on each cutting was 30 cm^2. The leaf area was cut using a 30 cm^2 paper template measured with a leaf area meter (Delta-T series, Taiwan). The initial diameter of each cutting was recorded and grouped for rooting analysis. The base of the

cutting was cut at a right angle and treated with the following IBA concentrations: 0, 2000, 4000, 6000, 8000 and 10 000 ppm. IBA formulation was prepared in liquid form using absolute ethyl alcohol. 10 µl IBA was applied to each cutting base using a micropipette (Model F10, Gilson Medical Electronic France). The alcohol was dried in a stream of air (following Leakey *et al.* 1982) before cuttings were inserted separately into media comprising (1) river sand, (2) coconut husk and 3) river sand:coconut husk (1:1). For *S. parvifolia*, nine cuttings were used per treatment combination giving a total of 486. Ten cuttings of *S. macroptera* were used for each treatment combination, thus a total of 540. The cuttings of each species were planted separately on rooting beds in a cutting shed. They were arranged in three blocks using a split plot design with the media and IBA as main plot and subplot respectively. The rooting beds were covered with transparent plastic enclosures supported by steel frames to maintain high humidity of more than 80%. The plastic enclosures were then shaded with black plastic netting (20% light intensity). Temperature around the cuttings ranged from 22 °C during night time to 35 °C at midday. Cuttings were kept moist by an automatic mist system set for one minute of misting for every hour.

The river sand used for the experiment was sieved to remove stones and other debris and washed clean with water before use. The size of sand particles used consisted of 24% 0.5 mm, 54% 2 mm and 22% ≥ 2 mm. Coconut husk (uncomposted) was purchased from a commercial plant nursery. The chemical properties of the media used are as shown in Table 2. The components of solid matter, water and air of rooting media and their pH were determined as described in Aminah (1995a) and the results and shown in Table 3. Samples were taken from each treatment and block. The data was then subjected to analysis of variance (ANOVA).

A biweekly assessment was carried out on cuttings starting from the second to the 16th week after planting. The number of rooted, unrooted, and dead cuttings and the number of roots produced were recorded. Unrooted cuttings were replanted into the rooting bed and reassessed biweekly until the end of the experiment. In this assessment, a cutting was scored as rooted when it produced at least one root of about 1 cm long. The cuttings were considered dead when the whole stem turned brown. The mean accumulated number of roots was calculated by dividing the total number of roots produced by the total number of rooted cuttings at each assessment week.

To test for significant differences, percentages of rooted, unrooted, and dead cuttings were log transformed and subjected to ANOVA. Duncan's multiple range test (DMRT) was used to test the significant difference between treatments. The results were considered significant when $p \leq 0.05$.

Table 1 Chemical properties of the potting media used for stock plants

Media	Nitrogen (%)	Carbon (%)	Exchangeable potassium (cmol/kg)	Available phosphorus (ppm)	pH
Forest soil (S)	0.03	0.73	0.03	4.24	5.15
Mesocarp fibre (MF)	0.57	11.21	1.12	68.92	6.71
S:MF (1:2)	0.16	2.07	0.19	8.86	5.59

Table 2 Chemical properties of rooting media

Media	Nitrogen (%)	Carbon (%)	Exchangeable potassium (cmol/kg)	Available phosphorus (ppm)	pH
River sand (R)	0.04	0.44	0.01	8.40	6.17
Coconut husk (C)	0.67	36.06	11.51	56.86	5.86
R:C (1:1)	0.03	1.26	0.61	17.91	6.33

Table 3 Components of rooting media and their pH values

Media	Solid (%)	Water (%)	Air (%)	pH
River sand (R)	76.28 a	10.26 c	13.46 b	7.69 a
Coconut husk (C)	8.04 c	60.56 a	31.4 a	6.21 c
R:C (1:1)	61.64 b	25.78 b	12.58 b	6.87 b

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

Results and discussion

Analyses on rooting data taken for 16 weeks after planting showed that there was no significant interaction between IBA and types of media on rooting of both species. The rooting of these species also did not show any significant preference to the various media tested.

There was a significant difference between the rooting percentage of *S. parvifolia* cuttings treated with various IBA concentrations (Table 4). All IBA concentrations except 2000 ppm differed significantly from control. Highest rooting (63%) was obtained with 8000 ppm IBA. Control treatment had 32% rooting. However, no significant difference was obtained in the mean number of roots between 8000 ppm IBA and control. No significant difference was obtained in rooting percentages of cuttings among the IBA concentrations used (Table 4).

Similar results were obtained with *S. macroptera*. However, rooting of *S. macroptera* was lower compared with *S. parvifolia*. The highest rooting was obtained with 10 000 ppm IBA (46%). Earlier experiment have shown a similar trend, indicating that *S. parvifolia* is easier to root than *S. macroptera* (Aminah 1991).

In the present study, cuttings of both species that were without hormone or with 2000 ppm IBA had higher unrooted cuttings compared with those treated with other IBA concentrations (Table 4). The rates of rooting for cuttings without hormone, especially for *S. macroptera* which produced roots at the 12th week, were slower compared with those treated with hormones (Figures 1a and b). The beneficial effects of hormone in accelerating the rate of rooting have been observed with cuttings of *S. leprosula* (Aminah *et al.* 1995) and *S. macrophylla* (Lo 1985).

In terms of number of roots, unlike *S. parvifolia,* cuttings of *S. macroptera* had significantly more roots when treated with 6000, 8000 and 10 000 ppm IBA compared with control. The effects of hormone in increasing the number of roots also differed between species. When applied to the base of cuttings, exogenous hormone increases the supply of carbohydrate for the formation and development of roots (Haissig 1982, Dick & Dewar 1992).

In terms of media, no significant effects were observed in rooting percentage and number of roots despite differences in the components of the media (Table 3). Earlier experiments with *S. parvifolia* (Noraini & Ling 1993), *S. leprosula* (Aminah 1995a), *S. splendida* (Brodie 2003) also did not show any preference for rooting medium. It has been found that rooting of *S. ovalis* cuttings was significantly higher in coconut husk compared with sand and their mixtures (Aminah *et al.* 2004). This indicated that the influence of medium on rooting differed among species. Water uptake by cuttings is positively related to volumetric water content of the medium and this may enhance rooting by reducing water deficits (Loach 1985). Water uptake is particularly important for overcoming the initial physiological shock when cuttings are taken from stock plants, which can lead to high moisture deficit, leaf abscission and death of cuttings (Newton & Jones 1993).

In both species, cuttings with diameters < 4.5 mm gave better rooting percentages than cuttings with bigger diameters. The latter resulted in higher mortality rates compared with cuttings from other diameter groups for both species (Table 5). Poor rooting of cuttings from the bigger diameter groups in this experiment may be due to secondary growth and thickening of lignin layer which may create physical barrier to root initiation (Hartmann *et al.* 1990). These lignified cuttings were

Table 4 Effects of IBA concentrations the percentage of rooted cuttings and mean number of roots of *Shorea parvifolia* and *S. macroptera* stem cuttings sixteen weeks after planting (pooled data from all media tested)

Shorea parvifolia				
IBA concentration (ppm)	Rooting (%)	Dead (%)	Unrooted (%)	Mean number of roots
2000	42.0 ab	14.8 a	43.2 bc	1.9 a
4000	54.3 a	12.4 a	33.3 abc	1.9 a
6000	58.0 a	16.1 a	25.9 ab	1.8 a
8000	63.0 a	14.8 a	22.2 a	2.2 ab
10 000	56.8 a	16.0 a	27.2 bc	2.6 b
Control	32.1 b	21.0 a	46.9 c	2.3 ab
S. macroptera				
IBA concentration (ppm)	Rooting (%)	Dead (%)	Unrooted (%)	Mean number of roots
2000	31.1 ab	17.8 a	51.1 a	1.5 a
4000	37.8 a	22.2 a	40.0 ab	2.3 ab
6000	38.9 a	25.5 a	35.6 b	3.0 b
8000	38.9 a	20.0 a	41.1 ab	3.2 b
10 000	45.6 a	22.2 a	32.2 b	3.1 b
Control	16.6 b	17.8 a	65.6 c	1.7 a

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

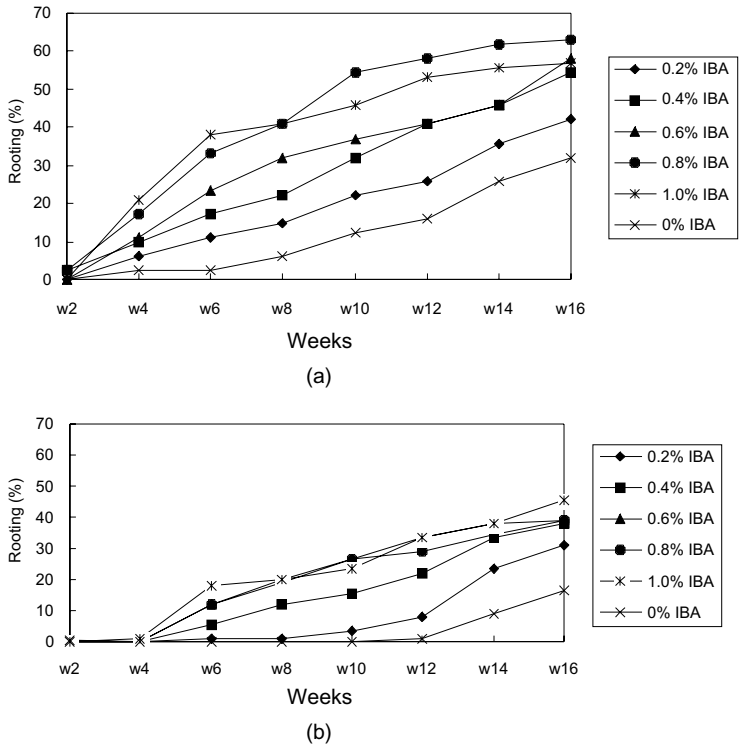

Figure 1 Rooting rates of (a) *Shorea parvifolia* and (b) *S. macroptera* as affected by indole butyric acid (IBA) treatments

Table 5 Effect of node positions and diameter on the rooting of *Shorea parvifolia* and *S. macroptera* stem cuttings sixteen weeks after planting (pooled data of all treatments)

Shorea parvifolia			
Diameter (mm)	Rooting ± SE (%)	Dead ± SE (%)	Unrooted ± SE (%)
1.65–2.99	53.4 ± 5.3	12.5 ± 3.6	34.1 ± 5.0
3.00–3.49	58.0 ± 5.5	16.1 ± 4.1	25.9 ± 4.9
3.50–3.99	54.7 ± 5.1	15.8 ± 3.8	29.5 ± 4.7
4.00–4.47	56.4 ± 4.9	12.9 ± 3.3	30.7 ± 4.6
4.50–6.90	37.2 ± 4.4	20.7 ± 3.7	42.1 ± 4.5
Shorea macroptera			
Diameter (mm)	Rooting ± SE (%)	Dead ± SE (%)	Unrooted ± SE (%)
1.88–2.99	37.5 ± 4.3	10.2 ± 2.7	52.3 ± 4.4
3.00–3.49	44.3 ± 4.7	15.0 ± 3.4	40.7 ± 4.6
3.50–3.99	34.5 ± 4.4	25.9 ± 4.1	39.6 ± 4.5
4.00–4.49	34.3 ± 4.7	22.6 ± 4.6	43.1 ± 4.9
4.51–6.44	18.5 ± 4.4	37.0 ± 5.4	44.5 ± 5.5

SE = Standard error of means

generally poor rooters and they either did not root or died when their carbohydrate reserves were depleted. Relationship between rooting and diameter of cuttings is inconsistent and depends on species, age and condition of the stock plants (Aminah 1995b, Aminah *et al.* 1995).

From the results 8000 and 10 000 ppm IBA are recommended to be used for rooting *Shorea parvifolia* and *S. macroptera* stem cuttings respectively. Any of the media tested can be used for rooting these species. Cuttings with diameters < 4.5 mm gave better rooting percentages than thicker cuttings in both species.

Acknowledgement

A. K. Annuar from Agricultural Faculty, Universiti Putra Malaysia is acknowledged for his help in statistical analysis.

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