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EFFECTS OF PACLOBUTRAZOL ON THE GROWTH OF SEEDLINGS OF TWO DIPTEROCARP SPECIES

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ABOD, S. A. & AZNINA, A. 2000. Effects of paclobutrazol on the growth of seedlings of two dipterocarp species. *Shorea leprosula* and *S. parvifolia* seedlings of two different heights, 20 cm (small) and 45 cm (big), were foliar sprayed to runoff with a growth retardant, paclobutrazol (PP_{333}), at concentrations of 0, 0.1, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0 and 12.0 g l^{-1}. Plants were harvested after 12 weeks for measurements of height, diameter, leaf area, number of branches, root and shoot dry weights and their ratio. Height increment was monitored at weekly intervals. Paclobutrazol was found to be effective in controlling the growth of the two species at both sizes tested. The effects of the chemical increased with increasing concentration. Weekly measurements of height increment revealed the onset of growth retardation to occur about 2 weeks after treatment. There was no complete recovery for any of the growth parameters even at the lowest concentration tested 12 weeks after treatment. The results are discussed with implications for practical application.

Key words : Paclobutrazol - dipterocarp seedlings - growth control - recovery

ABOD, S. A. & AZNINA, A. 2000. Kesan paklobutrazol terhadap pertumbuhan anak benih dua species dipterokarpa. Dua saiz anak benih *Shorea leprosula* dan *S. parvifolia* berukuran ketinggian 20 cm (kecil) dan 45 cm (besar) telah disembur kepada daun hingga menitis dengan pembantut tumbesaran paklobutrazol (PP_{333}) dengan kepekatan 0, 0.1, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0 dan 12.0 g l^{-1}. Pokok-pokok dituai selepas 12 minggu untuk pengukuran ketinggian, garis pusat, keluasan daun, bilangan cabang, berat kering akar dan pucuk dan nisbahnya. Pertambahan ketinggian diukur setiap minggu. Paklobutrazol didapati berkesan untuk mengawal tumbesaran kedua-dua saiz bagi dua spesies yang diuji itu. Kesan kimia bertambah dengan bertambahnya kepekatan kimia daripada 0.1 hingga 12.0 g l^{-1}. Pengukuran pertambahan ketinggian yang dibuat setiap minggu menunjukkan bahawa permulaan kerencatan tumbesaran berlaku lebih kurang 2 minggu selepas semburan. Semua parameter yang diukur tidak menunjukkan pemulihan yang lengkap walaupun dengan kepekatan yang terendah 12 minggu selepas semburan. Keputusan-keputusan dibincangkan dengan mengambil kira implikasi-implikasi untuk kegunaan praktikal.

Introduction

Most of the commercially valuable timbers in Malaysia belong to the family Dipterocarpaceae. Logged-over forests, known to be poor in natural regeneration, are rehabilitated by enrichment planting with dipterocarp seedlings. Adequate supply of these seedlings is, however, unpredictable because of the gregarious flowering pattern of the mother trees and the recalcitrant properties of the seeds. Dipterocarp seeds are short lived and when available need to be sown immediately for the production of planting stocks. Seedlings will, however, be overgrown in size if not outplanted within a year or two. Overgrown seedlings have poor survival because of unfavourable root to shoot ratio resulting in post-transplanting desiccation (Abod & Abun 1989). The cost of maintaining large seedlings in nurseries is also more

expensive than for smaller ones. In view of this, it is envisaged that the development of some manipulative techniques for controlling the size of these seedlings pending outplanting would be useful.

Abod and co-workers (Abod & Jeng 1993, Abod & Leong 1993, Abod & Yap 1993) have demonstrated the effectiveness of a growth retardant, paclobutrazol (PP_{333} or Cultar), to control excessive growth of *Acacia mangium* seedlings. The present study evaluates the effects of the chemical on the growth of two species of Dipterocarpaceae seedlings.

Materials and methods

Two species of Dipterocarpaceae seedlings, namely *Shorea leprosula* and *S. parvifolia*, were studied in a 2 (species) × 2 (sizes) × 9 (paclobutrazol concentrations) factorial design using 5 replications which were completely randomised. The experiment was conducted at the Universiti Pertanian Malaysia in a greenhouse which provides good ventilation and adequate light intensity of about 50% of full sun. The air temperature ranged from 22 °C at night to 38 °C in the day with a minimum relative humidity of 60% throughout the duration of the experiment. All plants received adequate watering. A total of 180 seedlings were used half of which were 2-y-old uniform-sized big plants measuring 45 cm tall and the other half 8-month-old smaller plants of 20 cm tall. The seedlings were supplied by the Negeri Sembilan Department of Forestry nursery at Mantin in polythene bags measuring 6.0 cm diameter × 18.0 cm length with a potting medium of 3 parts top soil × 2 parts organic matter.

Paclobutrazol (PP_{333}) was supplied by Imperial Chemical Industries (ICI) in a aqueous suspension at a concentration of 250 g l^{-1} with an active ingredient of 22% w/w. Its trade name is Cultar and chemical formula [2 (RS, 3RS) -1-(4-chlorophenyl)] - 4, 4-dimethyl-2- (1H-1, 2, 4 triazol-1-yl) pentan -3-ol). The chemical was diluted in distilled water to give a wide range of concentrations, i.e. 0 (control), 0.1, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0 and 12.0 g l^{-1}. A surfactant (Du Pont Agricultural surfactant) also supplied by ICI was added at a concentration of 2.0 ml l^{-1}. The aerial parts of plants were sprayed to runoff using hand-held pressure sprayer. Some of the chemicals were inevitably also deposited in the potting medium. Plants were harvested 12 weeks after treatment and measurements taken of height (length of main stem from the pot soil to the shoot apex), main stem diameter, total leaf area, total number of branches, root and shoot oven dry weights. Roots were washed over a sieve of mesh pore size less than 1.0 mm square using pressurized tap water. Leaf area was measured by a Li-Cor 3100 portable leaf area meter. Increments in height were monitored at weekly intervals.

Results and discussion

Except for the ratio of root to shoot dry weights, the main effects of paclobutrazol were statistically significant on increments in height, diameter and leaf area and the number of branches, root and shoot dry weights for species, plant sizes and chemical concentrations 12 weeks after treatment (Table 1). There were, however, significant interactions between species × size, species × concentration, size × concentration and species × size × concentration for these parameters.

Table 1. Main effects of paclobutrazol on the growth of *Shorea leprosula* and *S. pavifolia* seedlings 12 weeks after treatment for factor 1 (species), factor 2 (size) and factor 3 (concentration)

Factor	Height increment (cm)	Diameter increment (cm)	Leaf area increment (cm^2)	Number of branches	Total root dry weight (g)	Total shoot dry weight (g)	In ratio Total root dry weight (g) / Total shoot dry weight (g)
Species							
S. leprosula	4.9	0.45	134.8	3.0	5.25	11.64	- 0.80 (0.45)
S. parvifolia	4.3	0.39	85.1	2.6	4.72	9.71	- 0.73 (0.48)
Df=1 Sed	0.02	0.004	5.03	0.04	0.038	0.059	0.618
F-test	**	**	**	**	*	**	ns
Size							
Big	6.5	0.58	169.1	4.3	7.19	16.52	- 0.84 (0.43)
Small	2.8	0.27	88.9	1.4	2.78	4.82	- 0.56 (0.57)
Df=1 Sed	0.02	0.004	5.03	0.04	0.038	0.059	0.618
F-test	**	**	**	**	**	***	ns
Concentration (g l^{-1})							
0	11.6	0.45	206.4	3.2	7.06	13.53	- 0.78 (0.46)
0.1	8.2	0.45	166.2	3.2	5.30	11.38	- 0.78 (0.46)
0.25	7.5	0.43	143.5	3.2	4.89	11.55	0.87 (0.42)
0.5	5.8	0.43	94.8	3.0	4.86	10.20	- 0.87 (0.42)
1.0	4.0	0.43	81.9	2.9	4.71	9.77	- 0.78 (0.46)
2.0	4.2	0.42	72.3	2.9	4.61	9.69	- 0.76 (0.47)
4.0	2.7	0.40	88.9	2.6	4.55	9.38	- 0.76 (0.47)
8.0	1.2	0.39	61.3	2.4	4.54	9.37	- 0.73 (0.48)
12.0	0.7	0.38	56.8	2.0	4.31	8.15	- 0.78 (0.46)
DF=8 Sed	0.58	0.006	13.80	0.62	0.728	1.236	0.115
F-test	**	*	**	*	*	*	ns

Error df : 1724; *p < 0.05, **p < 0.01, ***p < 0.001; ns is not significant. Bracketed means are retransformed values. Sed is standard error difference.

Shorea parvifolia recorded less height, stem diameter, leaf, branch, root and shoot growth compared to *S. leprosula*. Similarly, smaller plants showed less growth increments than the bigger plants (Table 1).

Increments in height, diameter, leaf area and number of branches, root and shoot dry weights of the treated plants were statistically lower ($p < 0.05$) than in the unsprayed control 12 weeks after treatment. The effects of the chemical increased from 0.1 to 12.0 g l^{-1}. For example, there was minimal height increment (0.7 cm) at the highest concentration of 12 g l^{-1} compared to 11.6 cm growth for the untreated plants at harvest. The number of branches of these plants was also about 40% lower than that of the control (Table 1).

Differences in height increment between treated and control plants for both species and sizes became apparent about 2 weeks after treatment (Figures 1a, b, c, d). Subsequently, plants treated with paclobutrazol concentration of 0.25 g l^{-1} or greater

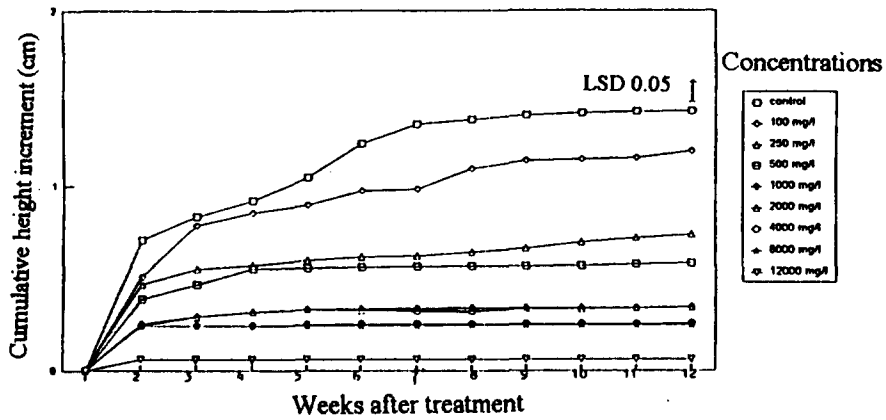

Figure 1a. Effect of paclobutrazol on height increment of *Shorea leprosula* (big) seedlings

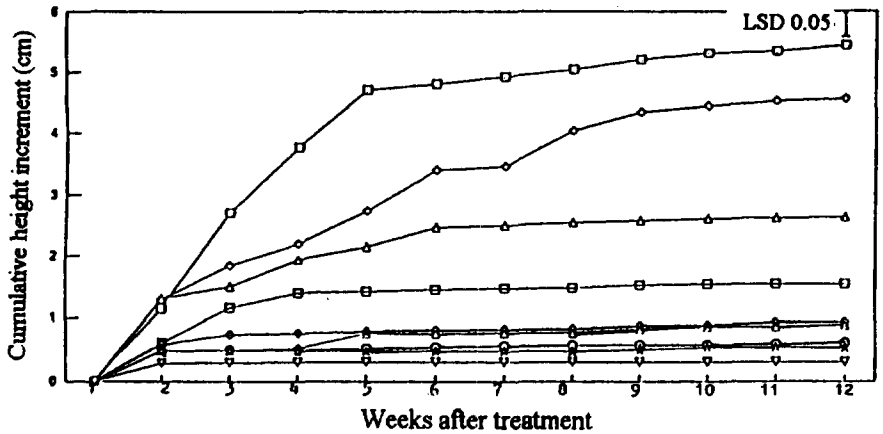

Figure 1b. Effect of paclobutrazol on height increment of *S. leprosula* (small) seedlings

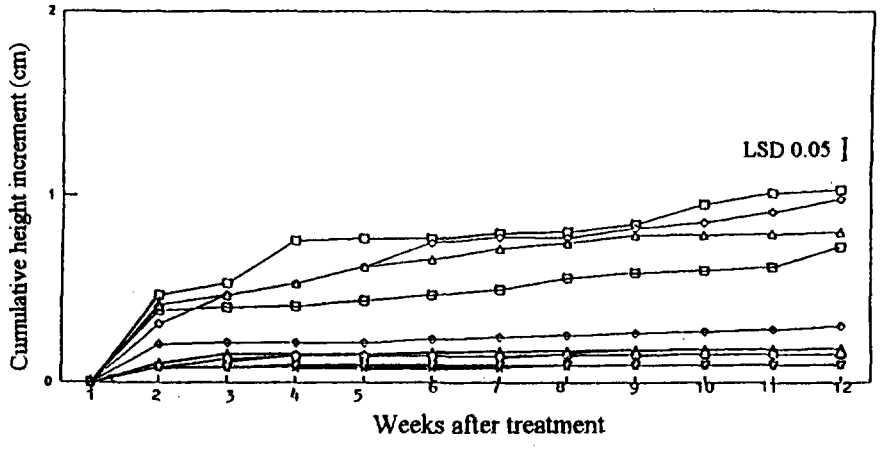

Figure 1c. Effect of paclobutrazol on height increment of *S. parvifolia* (big) seedlings

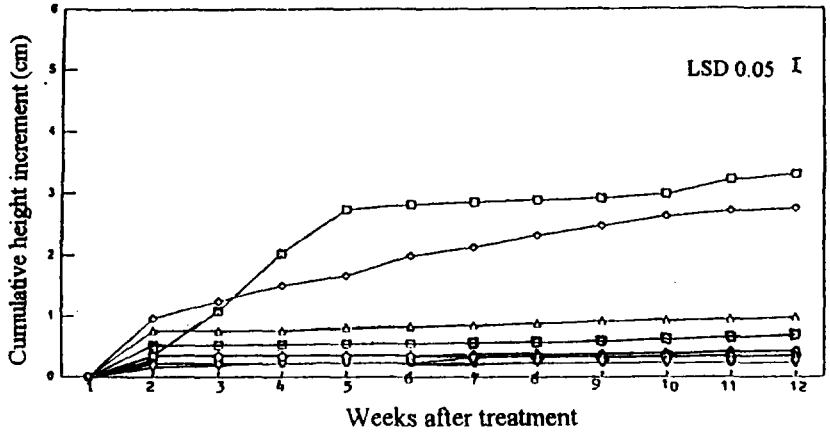

Figure 1d. Effect of paclobutrazol on height increment of *S. parvifolia* (small) seedlings

showed minimal growth for both sizes of *S. leprosula* (Figures 1 a & b) and the small size of *S. parvifolia* (Figure 1d). However, a concentration of 1.0 g l^{-1} or greater was needed to effectively arrest the height increment of the bigger-sized *S. parvifolia* seedlings (Figure 1c).

Paclobutrazol appeared to be very effective in controlling the growth of both the small (20 cm tall) and big (45 cm tall) seedlings of *S. leprosula* and *S. parvifolia*. The concentration of the chemical greatly influenced the magnitude of the growth responses. No treatment damaged or deformed any seedling. Abod (1988) has cautioned that a high concentration of paclobutrazol can damage and deform plants. The chemical has also been reported to induce early flowering in a wide range of flowering plants. There was no complete recovery for any of the growth parameters even at the lowest concentration tested 12 weeks after treatment. Low concentrations of 0.5 g l^{-1} or less were also found to be adequate in controlling

excessive growth of *A. mangium* seedlings (Abod & Jeng 1993, Abod & Leong 1993, Abod & Yap 1993).

Quinlan and Richardson (1984) showed that foliar sprays of paclobutrazol reduced shoot growth of apple trees as a result of the chemical being taken up by the shoot tip and young unlignified shoot stem. These workers in 1986 reported, in studies on the uptake and translocation of paclobutrazol in apple trees, that the chemical is taken up through the xylem and translocated acropetally to the meristematic regions. Growth inhibition from foliar application of paclobutrazol in the present study may have resulted from the absorption by the young stems and leaves as well as by the roots (since the pot soil was not covered during application) with subsequent acropetal translocation of PP_{333} to the meristematic areas of plant organs. Paclobutrazol retards growth by inhibiting the biosynthesis of endogenous gibberellin of plants (Dalziel & Lawrence 1984).

Storage of dipterocarp seedlings inhibited with paclobutrazol may be the solution to a regular supply of planting stocks for plantation programmes. Further research is, however, necessary to develop guidelines on chemical concentration, frequency of application and implication to the production and establishment of the seedlings.

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