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Potential of Paclobutrazol for Controlling Excessive Growth of *Acacia mangium* and Storing Recalcitrant Dipterocarp Seedlings for Forest Rehabilitation

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ABSTRAK

Anak benih Acacia mangium *akan membesar berlebihan apabila jadual penanaman di ladang tidak dapat diselaraskan dengan jadual pengeluaran anak benih. Biji benih dipterokarp sebaliknya tidak dapat hidup lama dan perlu disemai segera untuk menghasilkan anak benih. Oleh kerana kaedah biasa untuk menyimpan biji benih didapati belum lagi berkesan untuk mengekalkan kebolehidupannya, kaedah menyimpan anak benih dalam keadaan terbantut dengan menggunakan paklobutrazol dan kemudiannya disembur dengan asid gibberellik untuk menggalakkan semula tumbesaran apabila perlu bagi penanaman di ladang adalah satu pilihan yang menarik. Kertas kerja ini melaporkan keputusan beberapa kajian berkenaan penggunaan paklobutrazol dan asid gibberellik kepada anak benih* A. mangium, Shorea leprosula *dan* S. parvifolia. *Keputusan-keputusan dibincangkan dengan mengambil kira implikasi-implikasi untuk kegunaan praktikal.*

ABSTRACT

Acacia mangium *seedlings often overgrow in size when the timing between plant production and field planting cannot be synchronized. Dipterocarp seeds, on the other hand, are short-lived and when available need to be sown immediately for the production of planting stocks. Since conventional storage methods have not been proven to be successful in maintaining the viability of these seeds, storing their seedlings at a slow growth phase with paclobutrazol and applying gibberellic acid to induce growth recovery when needed for field planting is an attractive option. This paper reports the results of various experiments on the use of paclobutrazol and gibberellic acid for* A. mangium, Shorea leprosula *and* S. parvifolia *seedlings. The results are discussed with implications for practical application.*

INTRODUCTION

Forest rehabilitation can take the form of the restoration of vegetative cover which may be purely an ecological exercise or reforesting an area with timber trees of commercial value. In the former, the sites are often very denuded and *Acacia mangium* is the principal species used in Malaysia. On the other hand, the better sites as in logged over forests are often rehabilitated by enrichment planting with commercial dipterocarp species.

Acacia mangium is selected to rehabilitate tailing sites, ex-shifting cultivated areas and other denuded sites because of the species' ability to survive and grow remarkably fast even in very poor soils. In the nursery, however, excessive growth of *A. mangium* is a liability if transplanting in the field is delayed. Overgrown seedlings are difficult to transport and plant and have poor survival rates because of root coiling and unfavourable root to shoot ratio resulting in desiccation post-transplanting (Abod and Abun 1989).

Adequate and continuous supply of dipterocarp seedlings are unpredictable because of the gregarious flowering pattern of the mother trees and the recalcitrant nature of the seeds. Dipterocarp seeds are short-lived and when available need to be sown immediately for the production of planting stocks. Storage of these

seedlings at a slow growth phase is one option to provide planting material on a continuous basis for various planting programmes. Factors that are of main concern for storage of seedlings are the quality of such seedlings during storage and the potential of the stored seedlings to resume rapid growth on return to normal growth condition (Tsan *et al.* 1997).

Paclobutrazol, a gibberellin biosynthesis inhibitor, has been reported to be effective in controlling the growth of a wide range of angiosperms (Williams 1982; Quinlan and Richardson 1984; Abod and Webster 1991). This paper reports the results of some preliminary studies on the potential of paclobutrazol for controlling excessive growth of *A. mangium* and for storing recalcitrant dipterocarp seedlings for forest rehabilitation.

MATERIALS AND METHODS

This paper reviews materials and methods from a number of experiments. In all cases potted, uniform size seedlings, well supplied with water and nutrients were used in experiments in a green house at Universiti Putra Malaysia, Serdang, Selangor. The air temperature ranged from 22°C at night to 38°C in the day and the relative humidity from 60 to 90 % while light intensity was above 50% of full sun.

Paclobutrazol (PP333) was supplied by Imperial Chemical Industries (ICI) in aqueous suspension at a concentration of 250 g/l with an active ingredient content of 22.0% w/w. Its trade name is Cultar and chemical formula (2RS, 3RS) – 1-(4 chlorohenyl) –4, 4 dimethyl 1-2 (1H-1, 2, 4, triazol-1-yl) pentan –3-ol). The chemical was diluted in distilled water to give a range of concentrations. A surfactant (Du Pont Agricultural surfactant) also supplied by ICI was added at a concentration of 2.0 mL/l. The aerial parts of plants were sprayed to runoff using a hand-held pressure sprayer.

Effects of Methods of Application

Experiment 1 tested the effects of five concentrations from 0 (control) to 12 g/l paclobutrazol and four methods of application on 10 week-old *A.mangium* seedlings as follows:

S : Soil drenching at week 0 (i.e. at the start of the treatment)

F1 : Foliar spray at week 0 (potting soil protected from chemical)

F2 : Foliar spray at weeks 0 and 6 (potting soil protected from chemical)

S+F : Foliar spray at week 0 (potting soil exposed to chemical)

The surfaces of the pots in the F1 and F2 treatments were covered with plastic sheets to shield the soil from the foliar sprays.

Effects of Concentration and Frequency of Application

Experiment 2 tested the effects of foliar spraying (i.e. potting soil exposed to chemical deposits) paclobutrazol at 8 concentrations and 2 frequencies of spray on 10 week-old *A. mangium* seedlings.

Effects of Paclobutrazol and Gibberellic Acid on Shorea leprosula *and* S.parvifolia *Seedlings*

Two experiments labelled as experiments 3 and 4 were conducted on the dipterocarp species. Experiment 3 tested the effects of foliar spraying 2 sizes i.e. 20 and 45 cm tall *S.leprosula* and *S.parvifolia* seedlings to a wide range of paclobutrazol concentrations from 0 to 12.0 g/l. When the results (Table 2) showed that growth control was more effective on smaller seedlings and that low concentrations were adequate, Experiment 4 was set up.

Experiment 4 tested the effects of spraying 10 cm tall *S.leprosula* and *S.parvifolia* seedlings to a range of low concentrations from 0 to 1000 mg/l paclobutrazol. The effects of foliar spray with different concentrations of gibberellic acid (GA3) were also tested to determine the effects on the recovery in height growth of paclobutrazol-treated plants.

RESULTS AND DISCUSSION

Effects of Methods Application

Soil drenching (S) or soil and foliar spray (S+F) gave similar and statistically significant reductions ($P<0.05$) in height increment compared to the foliar spray alone at either one (F1) or two (2) frequencies (Table 1, *Fig. 1a*). It appeared that the chemical can be absorbed by both the shoots and roots. Richardson and Quinlan (1986) reported paclobutrazol to be translocated almost exclusively in the xylem acropetally to the metistematic regions. The binding nature of the chemical with the soil colloidal particles might

account for the greater persistence of its effects observed in this study. Conversely, paclobutrazol when sprayed onto the foliage alone (F1 and F2), merely accumulated in leaves and was not translocated into other shoot tissues; the quantity of chemical reaching the sites of action was often reduced. Foliar spraying of the shoot which inevitably would also result in deposition of the chemical to the soil (if unprotected) appeared to be the most effective and pragmatic method of application.

Effects of Concentration and Frequency of Application

The results revealed the main effects of concentration (Table 1, *Fig. 2*) and frequency of application (Table1, *Fig.1a*) to be significant in reducing height increment. This concurs with the works of Tsan (2000) on recalcitrant dipterocarp seedlings at the Forest Research Institute of Malaysia.

The results in both experiments 1 and 2 revealed that paclobutrazol-treated plants had significantly lower height increments than the control. The growth reduction increased with increasing chemical concentration and time after application (Table 1, *Figs. 1b* and *2*)

Two frequencies of spray in both experiments 1 (*Fig. 1a*) and 2 (Table 1) gave statistically greater reduction in height growth. Abod and Leong (1993) suggested that the uptake and translocation of the chemical at the second spray additively act together with the remaining triazole compounds from the previous application.

Minimal height increments were recorded for treated plants from the onset of spray to 8 weeks for both species (*Figs. 3a, 3b*). On the other hand, control plants grew markedly in height recording up to 400 percent more increment at week 8.

At week 8, all paclobutrazol-treated plants were sprayed with gibberellic acid (GA3) at 100, 300 and 500 mg/l to induce a recovery in height growth. The results in *Fig. 3a* and *3b* revealed that the recovery in height growth was instant in all treatments. Generally, the recovery was more pronounced in plants initially treated with a low concentration of paclobutrazol and subsequently given a higher dosage of gibberellic acid. At week 16, eight weeks after the GA3 treatment, most of the paclobutrazol-treated plants recorded significantly greater increment than the control for both species.

TABLE 1
Main effects of paclobutrazol on the growth of *A. mangium* seedlings 12 weeks after treatment

Experiment 1			Experiment 2		
Factor		Height increment (cm)	Factor		Height increment (cm)
Method of application	Soil	4.5	Concentration	0_	10.7
	Foliar F1	7.2		0.25	7.4
	Foliar F2	6.1		0.5	5.1
	Soil & Foliar	4.4		1.0	2.5
				2.0	2.5
				8.0	2.3
				12.0	1.2
F-test		**	F-test		**
Sed		0.11	Sed		0.50
Concentration (g/l)	0	13.3	Frequency of spray	1	5.1
	0.5	5.0		2	3.3
	1.0	4.3			
	4.0	2.7			
	12.0	2.5			
F-test		**	F-test		**
Sed		0.12	Sed		0.25

**, $p<0.01$; Sed in standard error difference

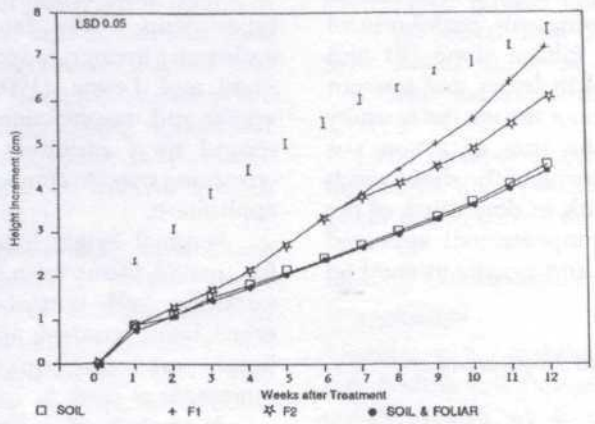

Fig. 1a: Effect of method of applying paclobutrazol on the height increment of Acacia mangium seedlings

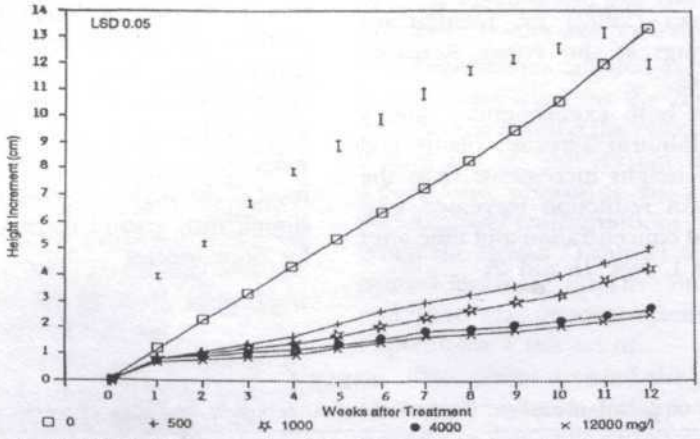

Fig. 1b: Effect of concentration of paclobutrazol on the height increment of Acacia mangium seedlings

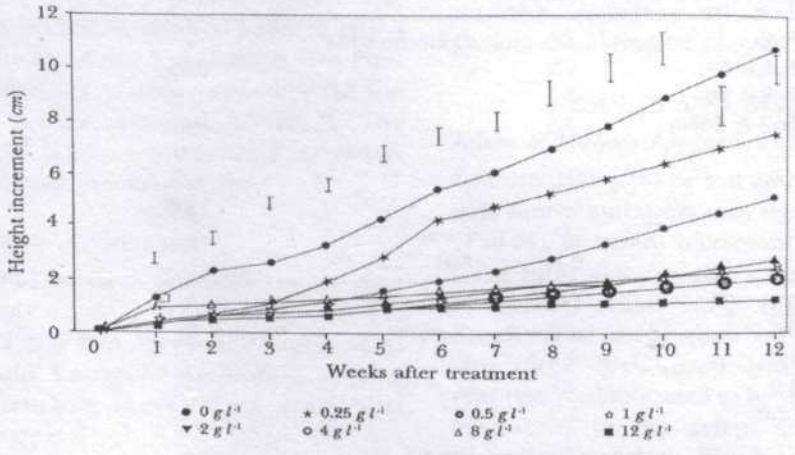

Fig. 2: Main effect of concentration of paclobutrazol on the weekly height increment of Acacia mangium seedlings

TABLE 2
Main effect 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)
Species	
S. leprosula	4.9
S. parvifolia	4.3
Df=1 Sed	0.02
F-test	**
Size	
Big (45 cm)	6.5
Small (20 cm)	2.8
Df=1 Sed	0.02
F-test	**
Concentration (g/l)	
0	11.6
0.1	8.2
0.25	7.5
0.5	5.8
1.0	4.0
2.0	2.7
4.0	1.2
8.0	0.7
12.0	0.7
Df=8 Sed	0.58
F-test	**

** p<0.01; Sed is standard error difference

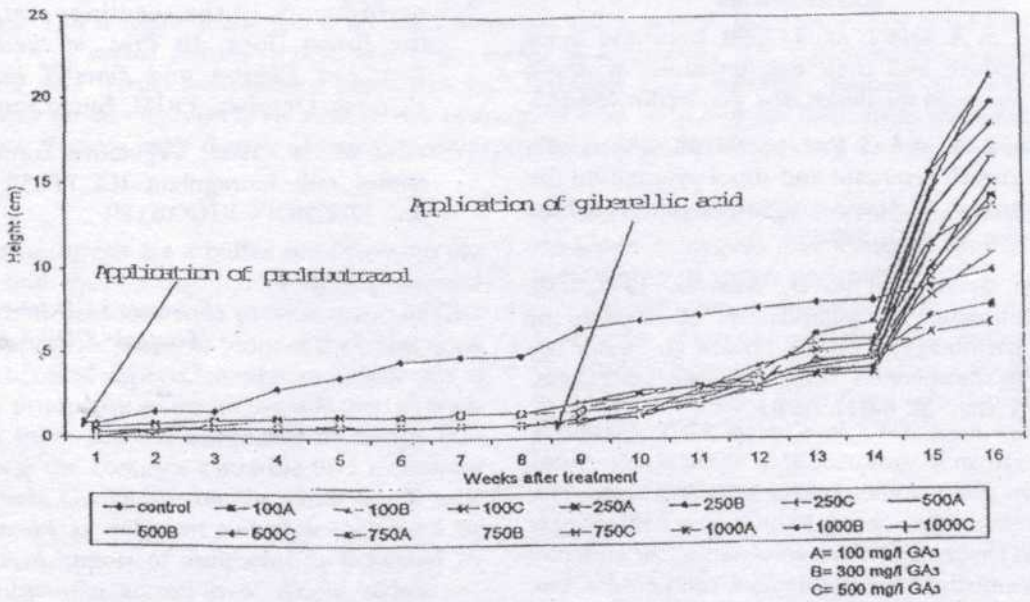

Fig. 3a: Effect of paclobutrazol and gibberellic acid on the height increment of Shorea pavifolia

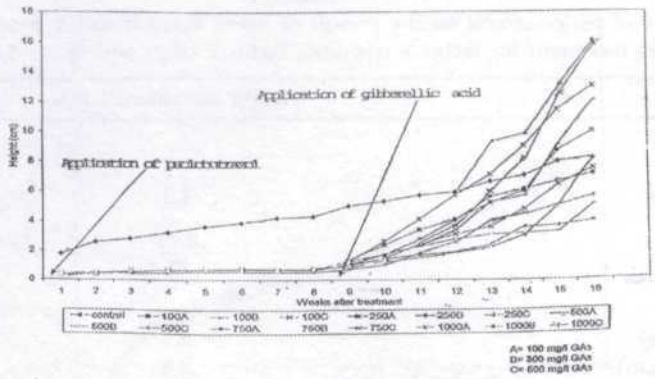

Fig. 3b: Effect of paclobutrazol and gibberellic acid on the height increment of Shorea laprosula

CONCLUSION

Paclobutrazol is a cheap, effective and practical method for controlling the growth of *A. mangium*, *S.leprosula* and *S. parvifolia* seedlings.

Storage of the dipterocarp seedlings at a slow growth phase inhibited by paclobutrazol may be the solution to a regular supply of planting stocks. The ability of such seedlings to recover and gain rapid growth when treated with gibberellic acid gives further credence to this method of storage.

Further research is necessary to develop blueprints for practical application.

REFERENCES

ABOD, S. A. and J. ABUN. 1989. Root and shoot growth and their manipulations of *Acacia mangium* seedlings. *Mal. For.* **52(3)**: 136-145.

ABOD, S. A. and C. K. LEONG. 1993. Effects of a growth retardant and shoot pruning on the growth of *Acacia mangium* seedlings. *J. Trop. For. Sc.* **6(3)**: 239-48.

ABOD, S. A. and A. D. WEBSTER. 1991. The influence of foliar sprays of *tetcyclasis* or paclobutrazol on the growth and water use by transplanted *Malus, Tilia* and *Betula* stocks. *J. Hort. Sc.* **66(1)**: 85-94.

QUINLAN, J. D. and P. J. RICHARDSON. 1984. Effects of paclobutrazol on apple shoot growth. *Acta Horticulturae* **146**: 105-111.

RICHARDSON, P. J. and J. D. QUINLAN. 1986. Uptake and translocation of paclobutrazol by shoots of M.26 apple rootstocks. *Plant Growth Regulator* **4**: 347-56.

TSAN, F. Y. 2000. Storage of seedlings of three recalcitrant dipterocarp species by slow growth techniques. Ph.D. dissertation. Universiti Putra Malaysia. 358p.

TSAN, F. Y., J. BASHARUDDIN, K. AWANG and B. KRISHNAPILLAY. 1997. The growth performance of the seedlings stored on the forest floor. In *Proc. of the Fourth Conf. on Forestry and Forestry Products Research*, October, FRIM, Kuala Lumpur.

WILLIAMS, M. W. 1982. Vegetative control of apples with bioregulant ICI PP333. *Hort. Sci.:* 17-577.

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