Genetic Improvement and Propagation of Multipurpose Tree Species*

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Introduction

Plantation forestry is adopted as an effective strategy to overcome the anticipated timber shortage in Malaysia. Comprehensive and critical reviews of all aspects of plantation forestry trials in Malaysia have been reported by Ng (1996). The fact is that it is based on limited number of species including *Acacia mangium, A. auriculiformis*, and their hybrid, *Azadirachta excelsa*, some exotic pines, *Eucalyptus*, *Paraserianthes falcataria* and *Gmelina arborea*. In addition to fast growth, these species offer a wide range of potential uses as well. But plantings have not so far relied on improved genetic materials and in addition some of the species tried were from a narrow genetic base that limited their success i.e. *A. mangium* (Sim et al. 1984). A high productivity and better quality of the future plantations of these species can be assured only if improved seeds and superior planting materials are used for their establishment. Hitherto, there has been a limited amount of research conducted on the genetic improvement and propagation of *A. mangium, A. auriculiformis, A. crasssicarpa* and *A. aulacocarpa* (Kamis *et al.*, 1994, Nor Aini *et al.*, 1994, Kamis *et al.*, 1995) and almost nonexistence on *A. excelsa*. This research was undertaken with two objectives: (1) to select and improve several provenances of the chosen species and (2) to develop appropriate technologies of mass propagation of the improved materials.

Materials and Methods

The research comprised three components: an acacia progeny and provenance trials, multilocational trials of *A. excelsa* and development of cloning techniques for mass propagation of improved materials. A trial of 80 progenies of *A. mangium, A. auriculiformis, A. crasssicarpa* and *A. aulacocarpa* using seeds from Papua New Guinea (PNG), Queensland and Northern Territory Australia were established at How Swee Estate, Aur Gading, Kuala Lipis, Pahang to evaluate their growth performance. In addition a preliminary provenance trial of 8 *A. mangium* and *A. auriculiformis* provenances 4 each, to relate the effect of land preparation method by burning to the formation of the multiple leaders (ML) was also conducted.

Provenance trials of *A. excelsa* were established at three locations viz., Rantau Panjang (Selangor), Merchang (Terengganu) and Balai Ringin (Sarawak). Six provenances of *A. excelsa* from Bukit Lagong (Selangor), Manong (Perak), Pasir Mas (Kelantan), Pengkalan Arang (Terengganu), Semengoh (Sarawak) and Narathiwat (Thailand) were used. Concurrently, an isozyme study was conducted on these provenances to determine their actual genetic variation. The trials were monitored for survival and growth in terms of height, diameter and form.

Two approaches were used for the cloning of the species, micro propagation through tissue culture and macro propagation through rooting of cuttings. The former involved development of micropropagation protocols for three species, *A. auriculiformis, A. crassicarpa* and *A. excelsa* while the latter examined the various factors controlling rooting of cuttings of *A. excelsa* seedlings.

Results and Discussion

The performance and assessment of the ML formation of the acacia provenance trial at the age of two years indicated and confirmed that the use of fire to clear land caused this growth habit. It also revealed significant variation in growth performance between the burnt and unburned sites, between the species and among provenances of the same species for height, basal diameter and ML formation.

The two-year assessment of the *A. excelsa* trials indicated that survival and growth were significantly different among the respective sites and provenances. For all the provenances, the best performance was generally obtained at Balai Ringin (Sarawak). The provenances from Bukit Lagong, Manong and Semengoh consistently performed better than the other sources at all the three locations. Analysis of morphological and genetic variation showed that these provenances were closely related.

Results of micro propagation studies indicated that rinsing with commercial clorox (15%) for at least 15 minutes was effective in producing aseptic *A. crassicarpa* seeds, and that nodal stem segments obtained from aseptically germinated *A. crassicarpa* seedlings was the most appropriate explant for shoot formation when cultured in a MS medium supplemented with BAP. Shoot proliferation was also observed in the same medium with the highest multiplication rate obtained from the second subculture on the medium supplemented with 2.0 mg/L BAP. Rooting and development of callus were best achieved on a medium supplemented with 2,4-D after 14 days in culture incubation. Development of micro propagation technique from marcots and axillary buds of *A. auriculiformis* trees of different ages also yielded some promising results although more successful when the explants were taken from younger trees. Survival of plantlets were high when transplanted into autoclaved mixture of soil, sand and peat (3:3:1) for *A. crassicarpa* and into shredded coconut husk for *A. auriculiformis* during acclimatisation.

A micro propagation protocol of *A. excelsa* has also been developed using

nodal stem segments. Petiole nodal segments, shoot tip and young leaves produced the highest percentage of shoot formation (93%). The combination of 2 mg/L BAP +2 mg/L NAA was found to be optimum for rooting of *in vitro* plantlets with shoot proliferation rate of 2 within 53 days. In addition, a concentration of 20 to 25% commercial clorox was found to be the best sterilisation method for shoot tip explants that yielded 100% aseptic cultures. The study on coppice-abality of stumped seedlings of *A. excelsa* examined the effect of stump heights, while in the rooting of cuttings examined the effect of different materials, positions and hormones. Coppiceability was found to vary with stump heights i.e. 60cm > 100cm > 30cm. However, 100cm stumps produced more vigorous coppices in terms of length (mean = 37.29 cm). Generally, survival and rooting percentages of cuttings were low. Cuttings from coppice shoots survived and rooted better than those of seedlings. Both positions and hormonal treatments significantly affected the survival and rooting percentages. Terminal cutting position and hormo- nal treatments of Seradix 2 (0.3% IBA) recorded the highest rooting ability.

Conclusions

Initial selection of promising provenances of *A. excelsa, A. mangium* and *A. auriculiformis* provenances can be made from the results obtained so far but further testing of the selected plus trees from the trials should be undertaken. Similarly, acacia progenies can be selected once the full results are obtained. The use of fire as a means of land preparation causes the multiple leader-formation in the acacia provenances tested at Aur Gading, Pahang. However, these findings may support and provide some guideline for an appropriate decision-making process concerning the banning of the use of fire as a tool to clear large tracks of lands for plantation establishment especially when acacias are to be planted. Cloning of acacia species and *A. excelsa* is technically feasible either through micro or macropropagation techniques. However, a scaling up process is still required to determine its economic feasibility. Because of the limited timeframe, clones produced through these means have not been tested out in the field and this needs to be further accomplished.

Benefits from the study

The study reveals that availability of selected set of provenances of *A. excelsa* can be recommended for planting. A screened list of selected progenies and provenances of *A. mangium, A. auriculiformis, A. crassicarpa* and *A. aulacocarpa* could provide a wider choice of improved materials for the industry. The study also provides guidelines for the selection of appropriate land preparation method for plantation establishment especially when acacias are to be used. Protocols for the micropropagation of *A. crassicarpa, A. auriculiformis* and *A. excelsa* have been developed. These can be used as the starting point for the upscaling and optimisation process. It is possible to develop a mass propagation technique for *A. excelsa* seedlings through the rooting of cutting.

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