Abstract

Pakkad, G. (2002)

Selecting Superior Parent Trees for Forest Restoration Programs, Maximising Performance whilst Maintaining Genetic Diversity.

The framework species method of forest restoration addressed the serious problem of tropical deforestation by planting selected tree species that accelerate the natural processes of forest regeneration and biodiversity recovery. Recent field trials have shown that the performance of framework tree species planted in deforested sites in northern Thailand is highly variable, due to variations among different seed batches originating from different parent trees. The objective of this study was to develop criteria, based on nursery and field performance of planted saplings and genetic variability, to select superior parent seed trees, to optimise production methods and performance of the 5 species studied for forest restoration projects.

The five framework tree species were Spondias axillaris Roxb. (Anarcardiaceae), Melia toosendan Sieb. & Zucc. (Meliaceae), Gmelina arborea Roxb. (Verbenaceae), Prunus cerasoides D. Don (Rosaceae) and Castanopsis acuminatissima (Bl.) A. DC. (Fagaceae). They have all been identified as a 'framework species' for restoring evergreen forest in seasonally dry climates.

Variability in both nursery and field performance of seedlings germinated from a maximum 50 individual parent trees per species studied is reported. Relationships between seed size, germination characteristics, seedling performance in the nursery and in the field were found, but the relationships were mixed.

Seed and pyrene size of S. axillaris, M. toosendan and C. acuminatissima increased with increasing elevation of the parent trees, but there was no such relationship for G. arborea and P. cerasoides.

Percent seed germination of M. toosendan and C. acuminatissima increased with increasing seed size. In contrast, the percent germination of G. arborea increased with decreasing pyrene size and there was no relationship for S. axillaris and P. cerasoides. Mean seed size of germinating seeds of M. toosendan and C. acuminatissima was larger than those of non-germinating seeds. On the other hand mean pyrene size of germinating seeds of G. arborea and P. cerasoides was smaller than those of non-germinating seeds.

Percent germination was negatively correlated with time to germination and median length of dormancy for all species studied.

Seed and pyrene sizes were correlated with seedling size in the nursery, but only weakly correlated with relative growth rate (RGR). Seedling size (height and root collar diameter) of M. toosendan, P. cerasoides and C. acuminatissima increased with increasing seed sizes, but there was no relationship for G. arborea and S. axillaris. Seedling survival in the nursery was not correlated with seed size.

There were some correlations between seedling performance in the field and seed (pyrene) size, germination characteristics and seedling performance in the nursery. However, the correlations were equivocal and weak.

Four standards for selection of superior seed trees were recognised: (i) 70% or greater sapling survival in the field, (ii) a sapling height of 100 cm or taller after the first growing season in the field, (iii) 40% or greater germination in the nursery and (iv) 70% or higher seedling survival in the nursery. Twelve seed trees of S. axillaris, twenty-one for P. cerasoides and seventeen for C. acuminatissima met these standards and were therefore selected as the superior seed trees. M. toosendan and G. arborea had no seed trees that qualified in all 4 standards. Seeds for seedling production in reforestation programmes should be collected from those seed trees.

The genetic diversity of P. cerasoides and C. acuminatissima was examined using microsatellite markers. This study enables a more informed selection of seed trees in our forest restoration prgrammes. Firstly, the FST values indicate that there is no differentiation between the three C. acuminatissima populations, hence seed may be collected and moved between the three Nastional parks. In contrast, there is significant differentiation amongst the three populations of P. cerasoides, indicating that for this species, seed should be collected locally, and not transferred between the National parks. Secondly, the data for both species suggests a large amount of genetic diversity, because of the high number of rare and low-frequency microsatellite alleles. Seed should therefore be collected from as many trees as possible, certainly within, or close to the FAO recommendation of 25-50 individuals per population (FAO Forest Resources Division, 1995).

Furthermore, I believe that microsatellite data can 'inform' a genetic conservation programme at this time, in the absence of more sophisticated genetic data, through the selection of individuals to capture microsatellite allelic diversity. To capture genetic diversity, two alternative algorithms were designed to: select individual seed trees based on their individual genotype (model I) and randomly select seed trees from a population of unknown genetic makeup (model II). This approach is presented and discussed fully in Chapters 6 and 7.

By combining the additional field data relating to establishment and growth rates, with the nursery performance and genetic information, I expect to have a more robust, practical procedure for identifying parent seed trees.