**Growth Performances of Six Dipterocarp Species Planted on Abandoned Mining Area in Phangnga Forestry Research Station**

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# INTRODUCTION

Plantations are commonly established in many mining areas for improving soil, forest structure and ecological restorations (Singh *et al.* 2004; Bohre & Chaubey 2014). However, tree composition and diversity were low and using a long time. Mixed plantation between nurse and native trees can increase tree diversity and improve forest structure. Tree selection and silvicultural practices were important process in forest restoration. Thus, the objectives of this study were to investigate survival and growths of dipterocarp trees planted on abandoned mining area. These results were benefit for mining restoration and other degraded lands.

# Materials and methods

**Study site and experimental plots** The experimental plots of 15x15 m were established on abandoned mining area in Phangnga Forestry Research Station, Thakuapa district, Phangnga province. Completely randomized design with three replications was used. Six dipterocarp seedlings namely *Dipterocarpus alatus* Roxb. (DA), *Dipterocarpus gracilis* Bl. (DG), *Hopea odorata* Roxb. (HO), *Shorea gratissima* Dyer (SG), *Shorea roxburghii* G. Don (SR) and *Parashorea stellata* Kurz (PS) were planted with spacing of 3x3 m in open plot and in 6-year-old *A. mangium* plots. For *A. mangium* plot, dipterocarp seedlings were planted between row of *A. mangium*. Survival rate, diameter at root collar (D0) and height (H) of dipterocarp seedlings were measured. Moreover, soil samples in open and *A. mangium* plots were corrected for analyzing physical and chemical properties and 7-year-old *A. mangium* was cut by row thinning method.

**Data analysis** Survival rate, D0, H and relative growth rate (RGR) of dipterocarp seedlings were analyzed by analysis of variance (ANOVA) and means were tested using Duncan, s New Multiple Range Test.

**RESULTS AND DISCUSSION**

**1. Soil properties**

Soil texture of topsoil both open and *A. mangium* plots was loamy sand, while subsoil was sandy. Soil nutrients and OM both open and *A. mangium* plots had relatively low.

1. **Survival rate**

Survival rate of 3-year-old DA, HO, SG and SR in *A. mangium* plot was exceed 90%, except DG (Table 1). For open plot, SR was the highest survival. Survival of all dipterocarp seedlings under shade of *A. mangium* were higher than open plots. Nurse tree was an important role on high survival of dipterocarp trees (Yang *et al.* 2009).

Table 1 Survival, diameter at root collar (D0) and height (H) of 1 to 3-year-old dipterocarp species planted on open and *A. mangium* plots

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Age | Species |  | Open plot | | 1. *mangium* plot | | |
| Survival  (%) | D0 (cm) | H  (cm) | Survival  (%) | D0 (cm) | H (cm) |
| 1 | *Dipterocarpus gracilis* | 97.78ab | 0.48a | 28.43a | 75.00a | 0.85a | 64.26a |
|  | *Dipterocarpus alatus* | 87.50a | 1.82c | 93.31c | 98.33b | 1.27b | 88.21b |
|  | *Hopea odorata* | 100.00b | 1.07b | 69.87bc | 100.00b | 0.89a | 71.68a |
|  | *Shorea gratissima* | 100.00b | 0.94b | 68.91b | 100.00b | 1.05a | 88.66b |
|  | *Shorea roxburghii* | 95.56ab | 1.15b | 64.33bc | 98.33b | 0.88a | 67.53a |
|  | *Parashorea stellata* | 97.78ab | 1.18b | 76.64bc | 98.33b | 1.31b | 124.07c |
|  | F- value | 3.47\* | 15.81\*\* | 8.43\*\* | 18.55\* | 11.77\*\* | 28.04\*\* |
| 2 | *Dipterocarpus gracilis* | - | - | - | 45.00a | 1.21a | 85.75a |
|  | *Dipterocarpus alatus* | 33.33a | 3.44b | 119.40 | 96.66b | 2.38d | 123.38ab |
|  | *Hopea odorata* | 44.44ab | 1.90a | 98.53 | 100.00b | 1.83bc | 114.08ab |
|  | *Shorea gratissima* | - | - | - | 100.00b | 1.57ab | 126.69b |
|  | *Shorea roxburghii* | 62.23b | 2.58a | 143.53 | 98.33b | 2.15cd | 142.34b |
|  | *Parashorea stellata* | - | - | - | 85.00b | 2.13cd | 185.17c |
|  | F- value | 5.61\* | 9.98\* | 1.88ns | 12.74\*\* | 9.23\*\* | 7.37\*\* |
| 3 | *Dipterocarpus gracilis* | - | - | - | 36.67a | 1.62a | 138.87a |
|  | *Dipterocarpus alatus* | 33.33a | 6.04b | 280.08 | 96.66c | 3.25b | 189.97ab |
|  | *Hopea odorata* | 44.44ab | 2.95a | 148.13 | 100.00c | 2.93b | 188.87ab |
|  | *Shorea gratissima* | - | - | - | 100.00c | 1.95a | 181.55ab |
|  | *Shorea roxburghii* | 62.23b | 4.07ab | 236.40 | 98.33c | 3.23b | 255.01c |
|  | *Parashorea stellata* | - | - | - | 75.00b | 2.95b | 215.78bc |
|  | F- value | 5.61\* | 7.28\* | 2.12ns | 17.21\*\* | 5.76\*\* | 5.95\*\* |

Remark: \*, \*\* = significantly different at p< 0.05 and 0.01, respectively, and ns = non-significantly different at p>0.05.

**3. Growth performances** D0 of 3-year-old DA, HA, SR and PS was relatively high in *A. mangium* plot, while D0 ofDA and SR was the high in open plot.   
 H of 3-year-old SR and PS was prominent in *A. mangium* plot and H of SR in open plot was the highest. 50% of thinned *A.mangium* had positively influent on H of SR, DA, PS and OH. Decreasing of crown cover of *A. mangium* with increasing light intensity had significantly influent on growth of dipterocarp trees.   
 RGRD0 and RGRH of 3-year-old SR were relatively high in open and *A. mangium* plots. These results indicated SR was well growths and it should be selected in mining and other degraded areas.

**CONCLUSIONS**

1. Soil texture of topsoil both open and *A. mangium* plots was loamy sand while subsoil was sandy. Soil nutrients both sites were low level.
2. Survival, D0 and H of DA, SR, PS and HO in *A. mangium* plot were relatively high, therefore they should be planted under *A. mangium* plantation for mining restoration. In addition, SR was outstanding survival and growths in open area. Thus, it should be considered in other degraded land restorations because good adaptation with poor soil condition.

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