From Forest Nursery Notes, Winter 2012

268. © Early growth and survival of 49 tropical tree species across sites differing in soil fertility and rainfall in Panama. van Breugel, M., Hall, J. S., Craven, D. J., and Gregoire, T. G. Forest Ecology and Management 261:1580-1589. 2011.

Forest Ecology and Management 261 (2011) 1580–1589

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Early growth and survival of 49 tropical tree species across sites differing in soil fertility and rainfall in Panama

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ARTICLE INFO

Article history:
Received 25 April 2010
Received in revised form 10 August 2010
Accepted 15 August 2010
Available online 20 September 2010

Keywords:
Reforestation
Soil fertility
Rainfall
Growth
Survival
Species screening trial

ABSTRACT

Reforestation in the tropics takes place across a wide variety of edaphic and climatic conditions. Reforestation trials have demonstrated that edaphic conditions may have a strong effect on species growth and survival. However it is unclear how the relative importance of soil conditions influences species survival and growth under varying amounts of rainfall and lengths of dry season.

Two-year growth and mortality of 49 tree species were evaluated in four sites across Panama, representing a soil fertility–rainfall matrix. Despite strong contrasts in environmental conditions, 65% of individual species did not show consistent differences in growth between high- and low-fertility sites or between wet and dry sites. However, early growth and survival were more strongly affected by soil fertility than by rainfall patterns for the second-largest group; 30% of the species grew significantly better in both high-fertility sites than in both low-fertility sites, compared to 6% in both wet sites vs. both dry sites. In the two high-fertility sites, growth of 47% and 69% of the species was better than their across-site means. On the other hand, 55% and 73% of the species grew significantly slower than their across-site averages in the two low-fertility sites.

Survival did not appear to be associated to either soil fertility or rainfall. In each site, only a few species had a significantly higher or lower within-site survival than across-site survival.

Diversifying the choice of tree species increases the options for reforestation strategies that match species characteristics to local site conditions and to the objectives and management possibilities of landholders. Testing the performance of potential species under different site conditions in screening trials is paramount, both to inform selection from among the vast diversity of tree species in the tropics that show good growth and survival under different local site conditions and to filter out unsuitable species and avoid early failure of the reforestation effort.

1. Introduction

Reforestation objectives differ widely and include production of timber and other goods and services. Objectives include aiding the recovery of biodiversity by re-establishing forest cover (Parrotta et al., 1997; Lamb et al., 2005; Benayas et al., 2009), ecological rehabilitation with the goal of restoring high-diversity native tropical forest (Ashton et al., 2001; Rodrigues et al., 2009), improving connectivity in rural landscapes (Tucker and Murphy, 1997; Bennett, 2003; Harvey et al., 2008), enhancing carbon sequestration for climate change mitigation (Silver et al., 2000; Lal, 2008), and regulation of water cycles (Bruijnzeel, 2004; van Dijk and Keenan, 2007). In agroforestry and silvopastoral projects, trees are generally planted to improve the livelihood of local farmers by diversifying their agricultural production and improving overall productivity and/or sustainability (Nair, 1993; Garen et al., in review, this volume).

Despite a wide and divergent range of management objectives and environmental conditions across the tropics, a remarkably small number of genera dominate tropical plantations. Four genera alone – *Tectona*, *Eucalyptus*, *Pinus* and *Acacia* – comprise approximately 50% of all forest plantations in Africa, 34% in Asia, 91% in South America and 53% in Central America (FAO, 2000). Similarly, agroforestry projects and trials tend to be dominated by very few genera (Young, 1997). Given the vast diversity of tree species in the tropics, there could be many more species suitable for reforestation than currently used (Condit et al., 1993, 1995). However, in con-

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doi:10.1016/j.foreco.2010.08.019