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ESTABLISHMENT AND GROWTH OF SOME MEDICINAL TREE SPECIES ON TWO DEGRADED LANDS AND IN AN AGROFORESTRY SYSTEM IN KERALA, INDIA

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CHANDRASHEKARA, U. M., SIVAPRASAD, A., NAIR, K. K. N. & PANDALAI, R. C. 2001. Establishment and growth of some medicinal tree species on two degraded lands and in an agroforestry system in Kerala, India. Survival and growth of seedlings of three medicinal trees species, viz. *Aegle marmelos* (Rutaceae), *Caesalpinia sappan* (Ceasalpiniaceae) and *Pterocarpus santalinus* (Papilionaceae), were studied on two degraded lands and in a coconut-based agroforestry system in Thrissur and Palakkad districts of Kerala, India. Seedling survival was in general high for all the three species (63–94%). The best growth was recorded in *C. sappan* followed by *A. marmelos* and *P. santalinus*. Seedlings of *C. sappan* and *A. marmelos* showed better growth in the coconut garden than in the degraded sites, whereas *P. santalinus* did not show any significant difference in growth in the three sites. Among the three species, highest shoot: root ratio was recorded for *C. sappan*. Shoot: root ratio of seedlings of all the species was consistently lower on the degraded sites than in the coconut garden.

Key words: Medicinal trees - growth - degraded lands - agroforestry systems

CHANDRASHEKARA, U. M., SIVAPRASAD, A., NAIR, K. K. N. & PANDALAI, R. C. 2001. Penubuhan dan pertumbuhan beberapa spesies pokok ubatan di dua tanah usang dan sistem perhutanan tani di Kerala, India. Kemandirian dan pertumbuhan anak benih tiga spesies pokok ubatan iaitu *Aegle marmelos* (Rutaceae), *Caesalpinia sappan* (Caesalpiniaceae) dan *Pterocarpus santalinus* (Papilionaceae) di dua tanah usang dan sistem perhutanan tani yang berasaskan kelapa dikaji di daerah Thrissur dan daerah Palakkad di Kerala, India. Kemandirian anak benih pada umumnya adalah tinggi bagi ketiga-tiga spesies (63–94%). Pertumbuhan terbaik dicatatkan di dalam *C. sappan* diikuti oleh *A. marmelos* dan *P. santalinus*. Anak benih *C. sappan* dan *A. marmelos* menunjukkan pertumbuhan yang lebih baik di dalam tapak kebun kelapa berbanding dengan tapak tanah usang, manakala *P. santalinus* tidak menunjukkan perbezaan yang bererti dalam pertumbuhan di ketiga-tiga tapak. Antara ketiga-tiga spesies, nisbah pucuk:akar anak benih di dalam kesemua spesies tersebut adalah lebih rendah secara konsisten di tapak tanah usang berbanding dengan kebun kelapa.

Introduction

India exports about 71 485 tonnes of medicinal plant products worth Rs. 18 800 million (approximately US$470 million) (Shiva *et al.* 1996). About 4% increase in the export of the medicinal plants over a 10-y period is also recorded. Despite these facts, cultivation of medicinal plants is a rare practice in the country. With some exceptions, most of the demand for medicinal plants is met from wild sources. However, the increasing demand for medicinal plants and depletion of the forest resources often lead to a high cost of collection. Thus, in order to provide a regular and sustainable supply of drug raw materials, domestication of medicinal plants is essential. Furthermore, while some of the medicinal plants are known as potential plants for the reclamation of waste and degraded lands (CSIR 1990), many are regarded as suitable for introduction in agroforestry systems (Nair & Sreedharan 1993). However, detailed studies on the growth and establishment pattern of medicinal plants in degraded sites and in agroforestry systems are scanty. The present paper discusses the results of a study on the early establishment and growth patterns of a few medicinal tree species on degraded lands in low rainfall dry and humid areas and in a coconut-based agroforestry system in Kerala. The species examined were *Caesalpinia sappan*, *Aegle marmelos* and *Pterocarpus santalinus*.

Aegle marmelos is a spiny tree distributed in the Indo-Malaysian region. Its fruit is regarded as an astringent, digestive and stomachic and used in chronic diarrhoea and also as tonic for the heart and brain. The root of *A. marmelos* is an ingredient of many Ayurvedic medicines. Fresh leaves are used as a remedy for dropsy, beriberi, fever, etc. The bark is used as remedy for melancholia, fever and palpitation of the heart (Kirthikar & Basu 1935). *Caesalpinia sappan* grows as a small tree. It is often cultivated as a hedge plant in South India, Bengal, Sri Lanka and Burma. The wood is bitter and is used for fever, bilousness, ulcers, urinary concretions, blood complaints, haemorrhages and wounds. Decoction of the wood is used as an astringent and in the treatment of dysentery and diarrhoea. It is consumed internally for certain skin diseases. It is also used to improve complexion. Because of its cooling effect, the powdered wood is used as an ingredient in boiled drinking water (Sivarajan & Balachandran 1994). *Pterocarpus santalinus* (commonly known as red sandal) is found in the southwestern and Deccan plateau of India. Its wood is considered as an astringent, tonic and diaphoretic. It is also used for bilious affection, skin diseases, mental disorders, fever, toothache and eye diseases. A decoction of the fruit is used as an astringent, tonic and against chronic dysentery. The wood is also used for colouring pharmaceutical products (Kirthikar & Basu 1935, Sivarajan & Balachandran 1994).

Materials and methods

The study was conducted in a coconut-based agroforestry system and on a degraded land, both belonging to farmers in Muthalmada Panchayat in Palakkad district, and also on a degraded farmland of the Pharmaceutical Corporation of

Kerala (Indian Medicine) Limited, situated in Kuttanelloor Panchayat in Thrissur District, Kerala. Muthalmada Panchayat is located in the low rainfall dry agroclimatic zone of the State. It receives about 960 mm annual rainfall and remains dry for most of the months. The mean maximum temperature is 44 °C and mean minimum temperature 21.1 °C. The soil is Inceptisol. Kuttanelloor Panchayat is situated in the humid zone in the central part of the State. The annual rainfall varies from 2400 to 2700 mm. The mean maximum temperature is 32 °C and mean minimum 21 °C. The soil is laterite alluvium and acidic.

Seedlings of all three species were raised in polypots in a centralised nursery at the Field Research Station of the Institute at Palappilly, Trichur district, Kerala State. However, seeds were collected from both the low rainfall dry agroclimatic zone and the humid agroclimatic zone. In each of the three sites, one-year-old seedlings raised in the centralised nursery were transplanted during May–June 1996 in 30 × 30 × 30 cm pits and with a minimum space of 2 × 2 m between plants. The heights of the seedlings of *A. marmelos, C. sappan* and *P. santalinus* at the time of transplantation were 30 ± 9 cm, 75 ± 26 cm and 32 ±16 cm respectively (n=50 seedlings for each species). The seedlings were also branchless. Post-planting management such as irrigation, weeding and shading was not carried out at any site. However, in the case of the coconut garden, the soil remained moist due to irrigation provided to the coconut trees.

The seedlings were monitored at 3-month intervals for survival and growth. One hundred seedlings of each species were randomly selected at each site and labelled. Above-ground plant height, stem girth at 10 cm above ground level and number of leaves of each labelled plant were recorded.

Since it was decided not to harvest seedlings planted in the farmers' fields, 50 seedlings (one year old) of each species were randomly harvested from the nursery beds for biomass measurements. After measuring the seedling height and girth at 10 cm from ground level and counting the number of leaves present, the root, stem and leaf components were separated and dried at 80 °C for 24 h and weighed. Leaf area was measured using leaf area meter. Simple regression equations were developed between the weight of foliage, stem, root and above-ground parts and d^2h (d, diameter; h, height) for each species. These regression equations were used to estimate the biomass of different plant components of labelled plants. Biomass change in one-year period after planting was also estimated. Growth parameters such as relative growth rate (RGR), net assimilation rate (NAR) and leaf area ratio (LAR) of the labelled plants were measured based on the methods of Hughes and Freeman (1967), and Radford (1967).

Results and discussion

The seedling survival at one year after planting ranged 82–90% in the case of *A. marmelos* (90% on the degraded land at the humid central zone, 82% on the degraded land at the low rainfall dry zone and 85% in the coconut garden on the low rainfall zone), 63–80% in the case of *C. sappan* (63, 65 and 80% on the degraded

land at the humid zone, and on the degraded land and in the coconut garden both at the low rainfall dry zone respectively), and in the case of *P. santalinus* (94, 92 and 90% on the degraded land at the humid zone, and on the degraded land and in the coconut garden both at the low rainfall dry zone respectively). The survival rate of these species is comparable to that of other fast-growing tree species like *Acacia auriculiformis, A. mangium, Pinus caribaea, Casuarina equisetifolia, Eucalyptus grandis, Calliandra calothyrsus, Melia azadirach* and *Gmelina arborea* planted on a degraded forest site at Malalimath (13°14' N latitude and 75° 12' E; mean annual rainfall 2600 mm, mean annual temperature 25.5 °C) in Shimonga district, Karnataka (Manaturagimath 1994).

Even though the three species showed high rates of survival at all three sites, in general, the height attained by the seedlings at one year after planting (Table 1) was much less than that recorded by Manaturagimath (1994) for other tree species. No significant difference between species was recorded for the number of branches produced in the 1-year period. However, a wide variation among species in their growth and biomass accumulation pattern was recorded (Table 1). The best growth, as indicated by the highest values for relative growth rate (RGR) in all three sites, was recorded in *C. sappan* followed by *A. marmelos* and *P. santalinus*. A higher shoot:root ratio for *C. sappan* also suggests that the greater allocation of biomass to shoot would facilitate faster above-ground growth of seedlings. Although the leaf area ratio (LAR) was also more in *C. sappan*, net assimilation rate (NAR) was lowest. This may indicate the lowest dry weight production per unit leaf area in *C. sappan*, when compared to the other two species. However, biomass accumulation per plant was comparatively more in this species. This could be attributed to the presence of a greater number of leaves and in turn a greater leaf area per plant.

Comparison of growth of the species at different sites showed that *C. sappan* and *A. maremelos* grew well in the coconut garden and in the degraded sites, indicated by their RGR and LAR. *Aegle marmelos* also showed better growth in the coconut garden. *Pterocarpus santalinus* did not show any significant difference in its growth at different sites.

The shoot:root ratio indicated that all the three species contributed more biomass to the root portion when their seedlings were grown on degraded sites. This helps them to withstand drought conditions during the dry season (Kushalappa 1991). *Caesalpinia sappan* and *A. marmelos* seedlings growing in the coconut garden showed better growth and more allocation of biomass to the above-ground parts. This observation may be an indication that more emphasis needs to be given for water and shade management on degraded lands. Once the amount and time of water availability are increased and proper shade conditions are provided, the allocation of biomass to above-ground parts in these species would increase. As already mentioned, *P. santalinus* did not show any significant difference in its growth at the different sites. Thus it is also concluded that the growth pattern of *P. santalinus* may not alter even with better shade and water management.

Table 1. Growth parameters of seedlings of *Aegle marmelos, Caesalpinia sappan* and *Pterocarpus santalinus* growing on degraded lands in a low low rainfall dry agroclimatic zone and a humid agroclimatic zone, and in a coconut garden in Kerala. Values recorded during the first 1-year after planting are means ± SE. n= 50 seedlings.

Parameter	Degraded land in humid zone	Degraded land in dry zone	Coconut garden in dry zone
Height growth (cm y^{-1})			
A. marmelos	$11.8 \pm 4.6^{a,1}$	$14.5 \pm 5.6^{a,b,1}$	$69.3 \pm 10.7^{a,2}$
C. sappan	$10.6 \pm 3.9^{a,1}$	$11.3 \pm 3.8^{a,1}$	$238.7 \pm 26.9^{b,2}$
P. santalinus	$28.7 \pm 6.3^{b,1}$	$27.4 \pm 7.0^{b,1}$	$32.9 \pm 5.8^{c,1}$
Number of branches			
A. marmelos	$2 \pm 1^{a,1}$	$2 \pm 1^{a,1}$	$4 \pm 1^{a,1}$
C. sappan	$3 \pm 1^{a,1}$	$3 \pm 1^{a,1}$	$5 \pm 1^{a,1}$
P. santalinus	$2 \pm 1^{a,1}$	$2 \pm 1^{a,1}$	$3 \pm 1^{a,1}$
Relative growth rate (mg g^{-1} day^{-1})			
A. marmelos	$1.5 \pm 0.2^{a,1}$	$2.4 \pm 0.47^{a,2}$	$0.84 \pm 0.33^{a,3}$
C. sappan	$2.5 \pm 0.33^{b,1}$	$3.1 \pm 0.29^{b,2}$	$16.0 \pm 2.4^{b,1}$
P. santalinus	$0.92 \pm 0.46^{a,1}$	$1.1 \pm 0.38^{c,1}$	$1.5 \pm 3.1^{a,1}$
Net assimilation rate (mg^{-1} cm^{-1} day^{-1})			
A. marmelos	$1.6 \pm 0.23^{a,1}$	$0.73 \pm 0.10^{a,2}$	$0.023 \pm 0.01^{a,3}$
C. sappan	$3.7 \pm 0.04^{b,1}$	$0.24 \pm 0.15^{b,1}$	$0.00014 \pm 0.00003^{b,2}$
P. santalinus	$1.2 \pm 0.34^{a,1}$	$0.91 \pm 0.14^{a,1}$	$0.57 \pm 0.26^{c,2}$
Leaf area ratio (cm^2 day^{-1})			
A. marmelos	$298.87 \pm 9.7^{a,1}$	$291.67 \pm 36.3^{a,1}$	$330.50 \pm 42.8^{a,1}$
C. sappan	$375.21 \pm 18.9^{b,1}$	$361.23 \pm 21.6^{b,1}$	$767.76 \pm 56.9^{b,2}$
P. santalinus	$230.59 \pm 31.7^{a,1}$	$233.29 \pm 34.9^{a,1}$	$238.28 \pm 26.9^{c,1}$
Shoot:root ratio			
A. marmelos	$0.43 \pm 0.11^{a,1}$	$0.56 \pm 0.08^{a,1}$	$1.61 \pm 0.34^{a,2}$
C. sappan	$1.97 \pm 0.46^{b,1}$	$2.35 \pm 0.34^{b,1}$	$12.13 \pm 3.60^{b,2}$
P. santalinus	$0.90 \pm 0.28^{c,1}$	$0.96 \pm 0.20^{c,1}$	$1.07 \pm 0.32^{a,1}$

In a given site type, values obtained for a parameter for different species are not significantly different ($p > 0.05$) when repesented by a similar letter in the superscript.
For a given species, values obtained for a parameter in different sites are not significantly different ($p > 0.05$) when represented by a similar number in the superscript.

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