Annual Litter Fall of Nitrogen-Fixing Tree Species in Rotational Woodlots at Tumbi (Tabora), Western Tanzania

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Introduction

A rotational woodlot is a method involving growing trees with crops up to 2-3 years until trees start competing with crops. Thereafter the woodlot is left as a source of fuelwood, building poles or fodder while restoring soil fertility until farmers start cutting down the trees and growing crops between the stumps 4 to 5 years later. The method was designed and developed by the South African Development Countries (SADC) and the World Agroforestry Centre (ICRAF) and their partners to alleviate rural farmers from the problems of fuelwood scarcity and poor soil fertility in the tobacco cereal land use system. The method is currently being practised at farmers' fields in Tabora rural district in western Tanzania involving a large number of farmers.

This study reports an assessment of litter production and seasonal pattern of *Acacia crassicarpa*, *A. julifera*, *A. leptocarpa*, *Leucaena pallida* and *Senna siamea* grown in rotational woodlots at five years of age.

Materials and Methods

The trial is located at the Agricultural Research Institute (ARI), at Tumbi (Tabora), western Tanzania (latitude 05°03′S, longitude 32°39′E, altitude 1160 m asl). The mean annual rainfall is 880 mm and is of monomodal type falling between November and April. The rest of the year is dry with a mean monthly rainfall of less than 50 mm. Soils in the study area are ferric acrisol (FAO) or Oxic Haplustalf (USDA) with a pH of about 5.

The trial was a randomised complete block design (RCB) with three replicates. Treatments were five different tree species: *A. crassicarpa*, *A. julifera*, *A. leptocarpa*, *L. pallida* and *S. siamea*. The plot size was 16 m x 20 m, with 20 trees at spacing of 4 m x 4 m. Distance between plots was 2 m.

Annual litter fall was measured using litter traps of 47 cm x 48 cm made of wooden frame with fibreglass screen bottoms (1 mm^2 mesh size), set at 50 cm above the ground. To avoid edge effect, 15 litter traps were located randomly at the centre of each plot and these per species. Observations were recorded for nine months (January to September). Collections were done during both dry and wet seasons. Litter fall was bulked by species for each plot and mean weight calculated on a unit area basis in tonnes per hectare (t ha^{-1}). Mean values for litter production were analysed by SAS statistical program and subjected to Duncan's Multiple Range Test (Zar 1984).

Results and Discussion

Litter production in rotational woodlots

Estimates of litter fall are shown in Table 1. *Acacia julifera* and *A. leptocarpa* produced higher litter fall than other species. *Acacia crassicarpa* and *S. siamea* had slightly lower litter production values, and *L. pallida* the lowest. Litter production for *A. julifera* and *A. leptocarpa* is comparable with the 10.2 t ha^{-1}yr^{-1} of *A. mangium* reported in Malaysia by Lim (1988).

Differences in litter production observed in this study could be attributed to differences in the species and canopy type of the trees. Australian acacias were characterised by a large stem, heavy branching and dense spreading crown while *L. pallida* were smaller trees with narrow and light spreading crown.

Table 1. Litter production for different tree components of five-year-old trees in rotational woodlots at Tumbi (Tabora), Tanzania.

Species	litter production (ha^{-1}yr^{-1})				
	leaves	woody	reproductive	other parts	overall total
A. crassicarpa	4.6b (95)	0.06b (1)	0.2b (3)	0.003c (1)	4.86b (100)
A. julifera	9.1a (87)	0.05b (0.4)	1.3a (12.5)	0.011bc (0.1)	10.46a (100)
A. leptocarpa	8.5a (83)	0.06b (0.6)	1.6a (15.7)	0.008ab (0.1)	10.17a (100)
S. siamea	4.3b (76)	0.80a (13.5)	0.6ab (9.9)	0.012bc (0.6)	5.60b (100)
L. pallida	0.2c (12)	0.93a (52.9)	0.6ab (33.9)	0.025a (1.6)	1.77c (100)

Mean values in the same column followed by the same letter do not differ significantly ($p > 0.001$). Values in brackets indicate percentage proportional contribution (100%).

The contribution of leaf litter varied between tree species. Leaf litter for *A. crassicarpa* accounted for over 95%, *A. julifera* (86%), *A. leptocarpa* (83%), *S. siamea* (76%) and *L. pallida* produced the least proportional leaf fall of only 12%. Lim (1988) also estimated the leaf litter of over 85% of the total fine litter production for *A. mangium* in a four-year old stand in Malaysia. The study indicates that the turnover of leaves in the canopy was higher than woody parts and other components, indicating that the stand was in a rapid growth phase.

Seasonal pattern of litter fall in a rotational woodlot

The total litter fall increased rapidly during the rainy season (May to August). *Acacia julifera* and *A. leptocarpa* shed substantial proportions of their annual litter between March and August with the peak in June – July (Fig. 1), while *L. pallida* showed the least fluctuations in litterfall throughout the year. Similar litter fall production observed for *A. crassicarpa* and *S. siamea* between May and June may be attributed to an increase in reproductive parts such as flowers and pods during the observed period. The study revealed *A. julifera* and *A. leptocarpa* shed their leaves during the dry period, an indication that these species are deciduous. *Senna siamea* had increased in litter fall prior to the rainy season because it is an evergreen species (Mbuya *et al.* 1994).

Litter production in rotational woodlots largely follows annual cycles of environmental factors (e.g. temperature variation, moisture availability and water stress) and the peak of litter fall occurs in the dry season for most species. Australian acacias are deciduous species whose litter fall follows a unimodal pattern. Further studies to quantify on litter fall production and seasonal pattern are recommended in

rotational woodlots for an understanding of their long-term litter fall behaviour.

Conclusions

Litter contributions were highest for Australian acacias indicating these species to have great potential of increasing soil productivity. Litter fall is important in soil fertility maintenance. Inclusion of Australian acacias in rotational woodlots is highly recommended for maintaining soil productivity as a supplement in the traditional shifting cultivation, which has been criticized over its sustainability as the practice tends to deplete soil nutrients in the long term.

Acknowledgements

The study was part of the SADC / ICRAF project at the Agricultural Research Institute (ARI) Tumbi (Tabora) western Tanzania. The trial was designed by G. Nyadzi, Soil Scientist at ARI in consultation with Dr R. Otsyina of ICRAF.

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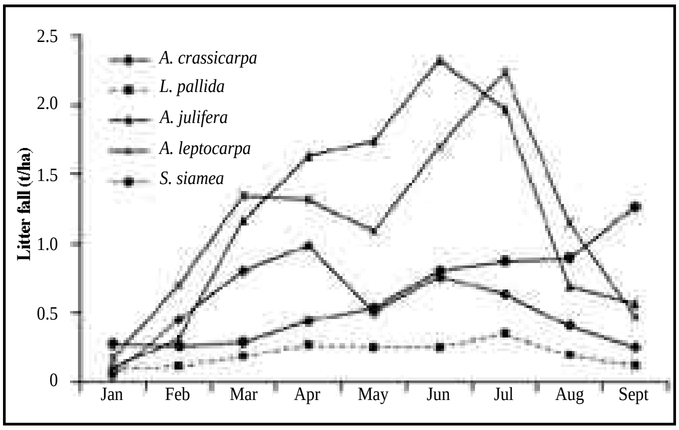

Figure 1. Seasonal pattern of litter fall in (t ha^{-1}) for trees grown in rotational woodlots at Tumbi (Tabora) western Tanzania

Performance of Australian Acacias in Chile

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Introduction

Various Australian acacias grown in Chile have shown adaptation and quick growth under the local conditions. *Acacia* species are becoming popular in the Chilean reforestation programs. However, these species are not widely used as their silvicultural treatments are not fully known.

Some of the *Acacia* species are adapted to sites where radiata pine and eucalypts have the least production. *Acacias* are also aiding in erosion control and soil improvement especially in degraded sites (Pinilla 2002). Thus small landholders may use *Acacia* species for reclaiming eroded lands. Farmers can also obtain additional income by selling acacia wood products.

In order to obtain relevant information for the forest industry, the Forestry Institute of Chile (INFOR) has been managing an Australian acacias project since 1987. Pilot plantations and small acacia plots have been established in various geographical locations. Silvicultural management, production of improved germplasm and their utilisation studies are undertaken by INFOR. The studies will help in a better use of *Acacia* species in the Chilean forest industry.

This paper reports on the main results of the studies carried out by INFOR from 1987 to 2001 on the selection and use of *Acacia* species in Chile.

Materials and Methods

Acacia dealbata, *A. melanoxylon* and *A. mearnsii* were the main species tested. The study covers areas and sites available for reafforestation programs in Chile (mainly between latitudes 35°30′S and 40°S and between longitudes 73°30′W and 72°30′W). Annual precipitation in the study area varied between 400 mm and 1500 mm with a monomodal distribution (falling from March to December in the south and April to October in the north). Mean annual temperature varies between 12°C and 14°C. Growth information was collected from 37 permanent plots established in plantations. Plots are 20 m x 25 m each. Height and diameter at breast height were recorded annually.

Results and Discussion

All species had high survival (85-90%) but *A. dealbata* had higher growth than *A. mearnsii* and *A. melanoxylon* (Table 1). The annual volume increment calculated from the plots is 20 m^3 ha^{-1} for *A. dealbata* and 10 m^3 ha^{-1} for *A. melanoxylon*, on sites of good quality. On some good sites, volume of 50 and 80 m^3 ha^{-1} were obtained for *A. melanoxylon* and *A. dealbata*, respectively.

Acacia dealbata is confirmed as the most promising species. The study obtained satisfactory growth for *A. melanoxylon* and *A. mearnsii*, however further research for a better understanding of these species is suggested.

Table 1. Growth results for the main Australian acacias nine years after planting in Chile

Species	DBH (cm)	Height(m)	Survival (%)
A. dealbata	16.5	18.4	90
A. mearnsii	12.5	16.1	87
A. melanoxylon	9.7	11.6	85

Following much interest in these species by the forest industry especially by private companies, a genetic improvement is being developed for these species. Open-pollinated families were obtained from CSIRO Australian Tree Seed Centre, and the Australian seed together with the local landraces are being tested for the production of improved germplasm (Gutierrez and Molina 2002). Both the growers and the Forestry Research Institute of Chile support the program aiming at the production of improved germplasm. Growth information