NOTES

EFFECT OF SHADE ON THE GROWTH OF SELECTED TROPICAL FOREST TREE SPECIES UNDER NURSERY CONDITION

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Light requirements vary with species and their growing habits. The present investigation was conducted at the College of Forestry, Kerala Agricultural University, Vellanikkara, India (10° 22'N, 76° 26'E; 40 m above sea-level). The climate is warm humid with mean annual rainfall of 2756 mm, mean maximum temperature of 29–36 °C and mean minimum temperature of 22–24 °C. The objective of the study was to investigate the effect of shade on growth and vigour of ten most important tropical commercial tree species, *Artocarpus hirsuta* (anjili), *Cedrela toona* (toona), *Diospyros ebenum* (ebony), *Gluta travancorica* (chenkuringi), *Gmelina arborea* (kumbil), *Pterocarpus marsupium* (venga), *Terminalia paniculata* (thanni), *Terminalia tomentosa* (karimaruthu), *Vateria indica* (Vellapayin) and *Xylia xylocarpa* (irul).

Uniformly growing 3-month-old seedlings were planted in polybags (30×15 cm). The height (cm) and girth (cm) were recorded at fortnightly intervals for a period of about one year. The girth of seedlings was recorded at 2.54 cm (1 in) above the ground level. The experiment was laid out in a randomised block design with three replications. Three hundred seedlings of each species were used for observations. The bags were arranged under full sunlight and 50% shade in a thatched shed. Light intensity was measured periodically using a quantum sensor and was controlled by adjusting the gap between the roofing materials.

The seedlings were uprooted at periodical intervals and the tap root length and the number of laterals were recorded. The shoot and root portions were separated and their fresh and dry weights were estimated separately using a precision balance.

Leaf area was measured using the Licor leaf area meter and was expressed as cm^2 . The number of stomata per sq.cm was counted taking fresh leaf samples from the open and shade condition. Stomata were counted at the base, middle and top portions of the leaves using a compound microscope. Fresh samples were taken at periodic intervals and chlorophyll content in acetone extract was estimated calorimetrically

Table 1 shows that A. hirsuta, C. toona, G. travancorica, T. paniculata and V. indica recorded more height and vigorously growth under shade; G. arborea, P. marsupium and T. tomentosa gave better height in the open. In the case of girth, most of the species were found to record more increment under shade except C. toona and T. tomentosa. Shade had no significant effect on the girth increment of V. indica.

An increase in height due to the effect of shade was recorded in species like Ailanthus triphysa (Saju 1992). Sazuki and Jacaline (1986) observed that species like Hopea and Vateria mangachopi grow vigorous in the open. Bush and Auken (1987) showed that as light intensity increased, stem length, stem dry weight and basal diameter of seedlings of Prosopis glandulosa increased.

Tree species	Height (cm)		Girth (cm)		Leaf area (cm²)		Stomata (cm²)		Chlorophyll (mg g ¹)	
	Open	Shade	Open	Shade	Open	Shade	Open	Shade	Open	Shade
Artocarpus hirsuta	3.87	6.66	0.12	0.20	493.4	1069.5	39.60	26.96	1.188	1.714
Cedrela toona	9.84	11.53	0.62	0.53	396.3	411.3	12.55	14.97	0.723	0.440
Diosyros ebenum	7.37	2.48	0.04	0.24	99.8	158.6	21.02	15.95	0.592	1.430
Gluta travancorica	12.52	23.42	0.58	0.91	391.6	518.3	11.64	13.38	0.811	1.115
Gmelina arborea	26.95	22.64	0.48	0.99	564.1	889.3	26.89	19.60	1.021	1.605
Pterocarpus marsupium	11.92	2.49	0.11	0.17	207.6	280.3	17.36	10.35	1.271	1.706
Terminalia paniculata	20.76	22.31	0.41	0.68	518.3	603.4	21.24	21.46	0.691	1.014
Terminalia tomentosa	14.84	5.44	0.41	0.18	229.4	119.3	22.38	22.53	1.155	1.485
Vateria indica	23.67	33.25	0.32	0.32	683.1	952.3	22.56	21.05	0.549	1.148
Xylia xylocarpa	3.21	3.07	0.12	0.19	281.8	186.6	17.71	15.53	0.805	1.598
F-test	*	*	*	*	*	*	*	*	*	*
CD (5%)	3.81	6.21	0.20	0.10	91.6	168.3	20.3	10.3	0.161	0.421

 Table 1. Growth behaviour of ten tropical tree species in the open and under shade in the nursery

* Significant at 5% probability level.

The highest leaf area of 1069.5 cm² was recorded by A. hirsuta under shade. This was followed by V. indica (952.3 cm²) while Terminalia tomentosa recorded the least area (119.3 cm²). In terms of leaf area, T. tomentosa and X. xylocarpa showed preference for the open while the remaining species gave greater leaf area under shade. Wadsworth and Lawton (1968) demonstrated the positive effect of shade on leaf area expansion of Eucalyptus deglupta, Khaya grandifoliola and Aucoumea kalaimeana. In Acacia tortilis, leaf area ratio was found to increase with decreasing light intensity (Smith & Shackleton 1988). However, Fagus silvatica grown under different shade levels showed an increase in average leaf area, specific leaf area, and leaf mass with increased light intensity (Masarovicova 1985).

In the open, stomatal number ranged from 11.64 cm^2 in *G. travancorica* to 39.60 cm^2 in *A. hirsuta*. The variation was from 10.35 cm^2 in *P. marsupium* to 26.96 cm^2 in *A. hirsuta* under shade. No systematic pattern was observed in the distribution of stomata between base, middle and top portions of the leaves. Even though the leaf areas were generally higher under shade, all the species except *C. toona, G. travancorica, T. paniculata* and *T. tomentosa* possessed more stomata when grown in the open.

Shade-loving species like *G. travancorica* and *T. paniculata* recorded more chlorophyll content when grown under shade while no pattern was observed in chlorophyll content in other species. These two species also gave the highest root and shoot fresh weights, root number and tap root length when grown under shade; the other species showed preference for the open in terms of these parameters. Shafiq *et al.* (1974) observed maximum biomass production in *Casuarina equisetifolia* when seedlings were grown in full sunlight.

Of the ten species studied, *P. marsupium* and *T. tomentosa* grew well in the open while *G. travancorica* and *T. paniculata* grew well under shade. The shoot and root biomass, chlorophyll production and leaf area of these species grown under their preferred conditions were found to be high. Shade did not have any marked effect on the other species. As this study was conducted only in the nursery, the results would be useful for commercial nursery establishment of these species, but their performance in the field under various shade conditions needs further investigation.

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