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Short communication

Influence of inanimate shade on growth of rooted *adalodakam* (*Adhatoda beddomei* C.B. Clarke) cuttings

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Abstract

A pot culture experiment to optimize the shade requirements of *Adhatoda beddomei* C.B. Clarke was conducted during 1991-92. Three month-old rooted stem cuttings were grown under six inanimate shade levels (0, 30, 40, 50, 60 and 70%). Total dry matter yield, leaf area per plant, specific leaf area, leaf weight ratio and leaf area ratio increased with increasing shade intensities and 60% shade was found to be optimum. Specific leaf weight, however, declined with shade and crop growth rate and relative growth rate increased with shade intensity only during the initial sampling periods.

Keywords: Growth analysis, intercrop, medicinal herb, rubber plantations, shade adaptation, stem cuttings

Cultivation of shade-loving medicinal plants in the subcanopy of rubber (*Hevea brasiliensis* Muell. Arg), the second most widely grown plantation crop in the west coast of peninsular India (> 5 lakh ha in extent), holds promise as a source of subsidiary income. The rubber canopy, however, closes by the fourth year and the sub-canopy light levels often fall below the optimal range of many medicinal and aromatic plants. This in turn, necessitates the identification of appropriate species for cultivation under differing light regimes. Preliminary studies at the Rubber Research Institute of India (RRII) revealed that *Adhatoda beddomei* C.B. Clarke (*cheriya adalodakam*—known for its broncho-dilatory and antispasmodic properties; Sivarajan and Indira, 1995)—holds promise for cultivation under the rubber canopy (RRII, 1992). Yet, specific information on the growth performance of this species under varying light regimes is not available. Hence, the present study was undertaken to evaluate the growth of *A. beddomei* under differing shade levels.

The experiment was carried out at the Rubber Research Institute, Kottayam, India (9°32′ N; 76°6 ′ E and 73 m above mean sea level) during 1991. Tender vegetative cuttings (~30 cm long) of *A. beddomei* were grown in pots (uniform earthenware; 30 x 30 cm) containing six kg soil (clay loam texture, 2.1% organic C, 0.21% N, 0.25 mg available P 100 g^{-1} soil, 0.75 mg available K 100 g^{-1} soil and 1.15 mg available Mg 100 g^{-1} soil; pH 4.9) and half kg of composted cow dung. The pots were initially kept under 70% shade to ensure optimum establishment. After 90 days, however, six levels of inanimate shade [0 (open), 30, 40, 50, 60 and 70%] were super-imposed on these sprouted cuttings, using Tildenets (M/s Kerrypak Limited, U.K.) supported on bamboo poles. The experimental setup was a completely randomized design with four replications. Random samples were collected at the start of the shade experiment (28-2-1991) and at 92, 148, 211 and 274 days after treatment (corresponding to 90, 182, 238, 301 and 364 days of growth of the rooted cuttings). The plants were harvested in four replicates for estimating leaf area and dry weight. Dry weights of the components (leaf, stem, root and rhizome) were estimated gravimetrically after

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oven-drying at 80°C. Leaf area was measured using a leaf area meter (LI-3000, LI-Cor, USA) and total leaf area was computed from the leaf number and the mean area of individual leaves. The ratios of shoot-to-root, root-to-shoot and photosynthetic tissue- to-support tissue were computed. In addition, relative growth rate (RGR), crop growth rates (CGR), net assimilation rate (NAR), leaf area ratio (LAR), leaf weight ratio (LWR), specific leaf area (SLA), specific leaf weight (SLW), leaf area growth ratio (LAGR) and leaf area duration (LAD) were calculated using standard formulae (Watson, 1952; Friend et al., 1962; Radford, 1967; Hunt, 1982). The data were statistically analysed following the ANOVA technique and means compared using Duncan's Multiple Range Test.

Results show that total dry matter (TDM), leaf dry weight and leaf area per plant increased with increasing shade levels (Table 1; Fig. 1). Plants grown under 60% shade consistently showed the highest TDM, leaf dry weight and leaf area. Shoot dry weight also followed a similar trend, but root dry weight was unaffected by shade levels (range: 19.5 to 31.3 g and 8.5 to 11.2 g per plant for shoot and root biomass respectively at 364 days of growth). Consequently, shoot: root ratio and the ratio of photosynthetic tissue-to-support tissue increased with increasing shading intensity (data not presented). Concomitant increases in CGR, RGR and LAD were also noted, especially during the initial stages of sampling (Table 2). CGR and RGR, however, remained the same or declined in comparison with open-grown plants during the final phases of growth. As regards to LAR, it generally increased with shade levels and the maximum was at 60%. Unshaded plants had the lowest LAR and as expected, the LAR decreased with seedling age.

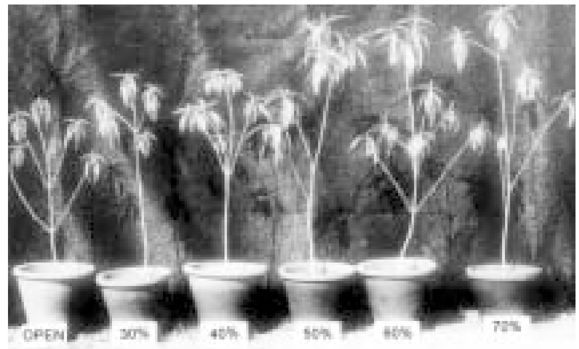

Fig. 1. Growth of *Adhatoda beddomei* at different levels of shade.

Among the shade treatments, 60% presumably represents the optimum for *A. beddomei*, as it consistently out-performed other treatments. Higher shoot: root ratio with increasing shade intensities probably signifies that proportionally less photosynthates are allocated to the root tissue (2.87 for 60% shade compared to 1.84 for open-grown plants at 274 d after treatments were administered). This is further exemplified by the increased photosynthetic tissue: support tissue ratio (0.17 for the 60% shade as against 0.10 in the open). Several previous authors (Boardman, 1977; Regnier et al., 1988) also reported that to utilise available photosynthetic photon flux density (PPFD) efficiently, shade adapted plants maximise production of photosynthetic tissues by redistributing dry matter.

Table 1: Effect of different shade levels on total dry matter, leaf area and dry weight of *Adhatoda beddomei*

Shade level (%)	Total dry matter per plant (g)				Leaf dry weight per plant (g)				Total leaf area per plant (cm^2)				Specific leaf area (cm^2 g^{-1})	
	Sampling periods													
	1	2	3	4	1	2	3	4	1	2	3	4	1	2
0	24.7^{c}	25.3^{d}	25.8^{c}	30.1^{c}	7.93^{b}	4.93^{c}	2.28^{c}	3.60^{b}	763^{c}	542^{d}	273^{d}	376^{c}	96.9^{c}	111^{c}
30	28.8^{bc}	29.5^{cd}	29.9^{bc}	33.5^{bc}	9.18^{ab}	7.63^{ab}	3.65^{b}	4.03^{b}	1189^{c}	800^{c}	426^{cd}	533^{bc}	130.0^{ab}	105^{c}
40	30.8^{b}	31.3b^{cd}	31.7^{b}	36.9^{ab}	9.45^{ab}	7.80^{ab}	4.03^{b}	4.23^{b}	1366^{ab}	980^{bc}	499^{c}	587^{b}	148.0^{a}	126^{bc}
50	35.7^{a}	36.5^{ab}	39.3^{a}	38.5^{ab}	11.80^{a}	8.48^{ab}	5.45^{a}	4.38^{b}	1435^{ab}	1218^{b}	718^{ab}	600^{b}	121.0^{b}	147^{ab}
60	36.8^{a}	38.1^{a}	40.7^{a}	42.5^{a}	11.70^{a}	9.08^{a}	6.13^{a}	6.05^{a}	1619^{a}	1473^{a}	824^{a}	880^{a}	140.0^{ab}	163^{a}
70	37.1	32.5^{abc}	38.4a	29.0c	11.40^{a}	6.20^{bc}	4.35^{b}	3.08^{b}	1515^{a}	1023^{bc}	610^{bc}	396^{a}	133.0^{ab}	169^{a}
CD (5%)	4.58	5.77	4.35	5.6	2.43	2.17	1.05	1.27	308	261	199	161	22.3	26.5

Sampling periods 1,2,3 and 4 corresponds to 92,148, 211 and 274 day after treatment, i.e. 182, 238, 301 and 364 days of growth respectively; NS- not significant

Table 2: Effect of different shade levels on growth attributes of *Adhatoda beddomei*

Shade level (%)	Relative growth rate (g g^{-1} day $^{-1}$)				Crop growth rate (g $plant^{-1}$ day^{-1})				Leaf area duration	Leaf area ratio		Specific leaf weight (g cm^{-2})	
	Sampling periods												
	1	2	3	4	1	2	3	4		2	4	1	2
0	0.0149	0.0004	0.0003	0.00258^{a}	0.1920^{c}	0.0107	0.0067	0.0694^{a}	146036^{e}	25.754^{c}	11.376^{c}	0.0104^{a}	0.009^{ab}
30	0.180	0.0005	0.0002	0.00176^{a}	0.2530^{b}	0.0129	0.0067	0.0575^{a}	200462^{d}	33.513^{b}	14.877^{bc}	0.0078^{bc}	0.0097^{a}
40	0.0188	0.0003	0.0002	0.00232^{a}	0.2753^{b}	0.0098	0.0056	0.0821^{a}	230495^{c}	37.531^{ab}	15.959^{b}	0.0069^{c}	0.0079^{bc}
50	0.0204	0.0003	0.0013	-0.0004^{a}	0.3291^{a}	0.0147	0.0437	-0.012^{b}	263932^{b}	36.565^{ab}	16.961^{b}	0.0083^{b}	0.0070^{cd}
60	0.0208	0.0006	0.0011	0.00062^{a}	0.3415^{a}	0.0228	0.0425	0.0274^{a}	308074^{a}	41.226^{a}	20.409^{a}	0.0072^{bc}	0.0062^{d}
70	0.0208	-0.002	0.0028	-0.0044^{b}	0.3451^{a}	-0.083	0.0948	-0.15^{b}	244922^{bc}	36.006^{b}	14.536^{bc}	0.0076^{bc}	0.0060^{d}
$CD_{(5\%)}$	NS	NS	NS	0.0027	0.053	NS	NS	0.092	20203	4.58	3.41	0.0012	0.0014

Sampling periods 1,2,3 and 4 corresponds to 92,148 211 and 274 day after treatment, i.e. 182, 238, 301 and 364 days of growth respectively; NS- not significant

Moreover, leaves under a shaded environment typically had lower SLW than leaves under sunny conditions (Table 2). Lower SLW reflects a complement of leaf characteristics such as decreased leaf thickness, decreased palisade cell development, lower number of photosynthesising cells per unit leaf area, lower light saturation point and/or decreased respiration rate (Boardman, 1977). Differences in SLA further illustrate changes in structure and thickness of leaves. Thus, *A. beddomei* compensates for the low irradiance by increasing the amount of photosynthetically active area in proportion to aboveground plant mass by decreasing leaf thickness.

Indeed, several shade-adapted species exhibit such an increase in leaf area ratio when grown at low irradiance (Begonia et al., 1988). The increase in LAR with shading is an important adaptation to low PAR because a greater LAR results from a greater allocation of plant materials into photosynthetic, light harvesting structures. The effect of shade on RGR can be attributed to reduced maintenance respiration and increased leaf growth. In the initial samplings, increased LAR fully compensated for decreased NAR but also resulted in an increased RGR over shade levels. Venkataramanan and Govindappa (1987) observed a similar pattern for coffee plants.

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