Legumes for Agroforestry Systems

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ABSTRACT

Six species of tropical legume (*Desmodium intortum* cv. Greenleaf, *D. canum* CQ1781, *Arachis pintoi* cv. Amarillo, *Macrotyloma axillare* cv. Archer, *Vigna luteola* cv. Dalrymple and *Calopogonium mucunoides* 43428) were grown under 37%, 24% and 16% light compared to an unshaded control. Dry matter production and nodulation level were measured. *Calopogonium mucunoides*, *Desmodium intortum* and *Arachis pintoi* displayed adaptation to low light levels and have potential for use beneath tree canopies.

KEY WORDS

Agroforestry, legumes, shade, tropics, shade adaptation.

INTRODUCTION

Following the cessation of logging in Queensland rainforests in 1988, there has been increased interest in establishing tree plantations on private land. One problem associated with timber plantations is that they are a long-term investment, with several decades required before landowners can obtain a return. Incorporating animals into timber plantations in an agroforestry system can allow earlier cash income to be made from the land. Other potential benefits of establishing pasture in young plantations include maintaining soil organic matter levels, increasing nutrient levels (1), addition of nitrogen through N fixation by pasture legumes, diversification of income and increased sustainability through reduced erosion and nutrient leaching (3). The selection of legumes adapted to the conditions encountered beneath tree canopies is of major importance if a productive pasture is to be maintained. More specifically, at different stages of plantation growth, legumes are required which are palatable, nutritious, productive, persistent, resistant to grazing and competitive enough to control weed levels and yet not cause a reduction in tree growth. In order to determine legume suitability for use in agroforestry systems a glasshouse pot trial was conducted at James Cook University (Townsville) examining six species of legume beneath four light levels in which dry matter production (yield) and nodulation level were examined.

RESULTS AND DISCUSSION

Above-ground dry matter production

Highly significant differences ($P<0.01$) in yield were detected between species and light levels. Upon comparison of species within one light level by the LSD method, groups of significantly different species were identified (Table 1).

Table 1. L.S.D. groupings of mean above ground dry matter production (g) of six species of legume beneath 4 light levels. Species in a column followed by the same letter were not significantly different. Number in parentheses is percentage of yield at 100% light.

Light	100%	37%	24%	16%
Species				
D. intortum	52.52 a b	24.6 (46) a	9.86 (18) a b	7.45 (14) b

D. canum	24.2 c d	5.63 (23) b	5.00 (20) b c	4.07 (16) b c
A. pintoi	20.66 d	6.73 (32) b	4.34 (21) b c	4.8 (23) b c
V. luteola	61.18 a	32.7 (53) a	7.95 (13) b	7.76 (12) b
M. axillare	46.81 a b	24.8 (53) a	1.08 (2) c	0.76 (1.6) c
C. mucunoides	38.23 b c	30.0 (78) a	13.4 (35) a	12.62 (33) a

Under full sunlight (100%) *V. luteola, D. intortum* and *M. axillare* comprised the group producing the most dry matter. Beneath 37% light *V. luteola, D. intortum, M. axillare* and *C. mucunoides* formed the most productive group. Under 24% light the greatest yields were produced by *C. mucunoides* and *D. intortum.* The large decrease in yield by *Macrotyloma axillare* at 24% light suggests that a critical light level is located between 37% and 24% of full sunlight for this species. Beneath 16% light *C. mucunoides* was the only species in the most productive LSD group, with 62% higher yield than the next highest producer, *V. luteola*.

The comparatively smaller reduction in yield at lower light levels by *C. mucunoides* is consistent with its light response curve (not shown), indicating *C. mucunoides* is shade-tolerant. *Desmodium intortum* and *A. pintoi*, also yielded sufficient dry matter under low light levels to suggest they have promise as shade-tolerant species for use beneath plantations.

Nodulation

Nodulation was scored according to Sykes *et al*. (4) and an overall decrease was found with decreasing light level (Table 2). Two possible reasons for this include the supply of nitrogen from the soil and applied fertiliser being adequate at lower light levels for the reduced growth of plants while at higher light levels plants were required to fix nitrogen in order to meet demand resulting from greater levels of growth, as higher levels of nodulation correspond to plants producing greater amounts of above-ground biomass. A second reason may be the possibility that under lower light levels nodulation was reduced due to lower levels of photosynthate being available for nitrogen fixation.

Table 2. Nodulation score of six species of legume beneath 4 light levels. Light levels in a column followed by the same letter were not significantly different (0 = no nodules, 5 = most).

	Nodulation Score					
Species	*D. intortum*	*D. canum*	*A. pintoi*	*V. luteola*	*M. axillare*	*C. mucunoides*
Light						
100%	3.6 a	0 a	0 a	5 a	5 a	5 a
37%	0 b	0 a	0 a	4.8 a	1.2 b	1 b

24%	0 b	0 a	0 a	0.2 b	0 c	0 c
16%	0 b	0 a	0 a	0 b	0 c	0 c

CONCLUSIONS

Of the six species tested *C. mucunoides* consistently produced high quantities of dry matter under the 37%, 24% and 16% light treatments. Certain characteristics of *C. mucunoides,* however, may reduce its potential as a fodder beneath tree plantations. A vigorous climbing/scrambling habit could smother young trees while palatability of *C. mucunoides* to livestock is reported to be poor due to hairiness, and it is often refused by cattle until well into the dry season (2). Despite *V*. *luteola* producing good amounts of biomass under all light levels, the poor condition of plants (small, deformed leaves with varying amounts of necrosis) under the lower light levels (24% and 16%) would suggest that this species may not be a suitable choice for deeply shaded situations. *Desmodium intortum* also shows potential for use beneath tree canopies, maintaining a relatively good yield under all shade levels with the additional benefit of good production under full sunlight. This provides the potential for forage production during the early, relatively unshaded conditions of plantation establishment while still maintaining a comparatively good level of growth as the plantation ages and light levels fall.

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