Canopy height and its relationship with leaf area index and light interception in tropical grasses

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Introduction

Photosynthetically active tissues, mainly green leaves, are the major component of forage growth and development. The amount of these tissues in a forage plant is influenced directly by cutting management, i.e. cutting frequency and stubble height. The normal recommendation is to cut (or graze) forage whenever it reaches a given stubble height. Brougham (1956) stated that the critical leaf area index (LAI) is reached when the forage canopy is intercepting 95% of the photosynthetically active radiation, and the forage is near its maximum growth rate without shading itself. Alternatively, the optimum LAI occurs when the forage reaches the maximum point of mass accumulation, indicating the time to start grazing or cutting. Generally, the critical and optimum LAI values are quite similar, but not necessarily the same (Brown and Blaser 1968). This trial evaluated the relationships among canopy height, LAI and light interception in 10 tropical grasses.

Methods

The experiment was carried out at the Animal Science Department of the Universidade Federal Rural de Pernambuco. The evaluated species were: *Brachiaria decumbens*, *Brachiaria* hybrid cv. Mulato II, *Brachiaria brizantha* cv. Xaraés, *Brachiaria brizantha* cv. Marandu, *Panicum maximum* cv. Tanzânia, *Panicum* hybrid cv. Massai, *Sorghum vulgare*, *Sorghum bicolor*, *Pennisetum purpureum* "Common" and *P. purpureum* cv. Roxo. Light interception, LAI and mean leaf angle (MLA) were measured using a Plant Canopy Imager CI-120 from CID Bio-science®, simultaneously with canopy height, at 1-week intervals over 2 months, in experimental plots measuring 2.8 x 1.8 m. Measurements were replicated 4 times per plot in every weekly evaluation. Correlation analyses were performed using Sigmaplot 12.0, and the correlation magnitude was based on Franzblau (1958).

Results and Discussion

Correlation analyses between canopy height and light interception (Table 1) were non-significant (P>0.05) for the following species: *Brachiaria brizantha* cv. Xaraés, *Brachiaria brizantha* cv. Marandu, *Brachiaria* hybrid cv. Mulato II, *Panicum maximum* cv. Tanzânia, *Pennisetum purpureum* cv. Roxo and *Sorghum vulgare*. Positive linear correlations were shown for *Brachiaria decumbens* and *Panicum* hybrid cv. Massai (P<0.05; r = 0.44 and 0.47, respectively) and *Sorghum bicolor* and *Pennisetum purpureum* "Common" (P<0.01; r = 0.65). Correlation between canopy height and leaf area index showed that, only in the case of *Brachiaria decumbens*, there was a moderate correlation (r = 0.59), with the coefficient of determination (r^2) = 0.35. LAI and light interception were significantly correlated for all species except *Brachiaria brizantha* cv. Xaraés, *Brachiaria brizantha* cv. Marandu and *Brachiaria* hybrid cv. Mulato II.

In contrast with our findings, Galzerano et al. (2010) found, for *Panicum maximum* cv. Áries and *Cynodon nlemfuensis*, very strong correlation between canopy height and LAI, with coefficients of determination of 0.76 and 0.88, respectively. Engel et al. (1987), studying a cool season grass, *Bromus inermis*, found that LAI and light interception were strongly correlated with season of the year and fertilization level. They also found that forage mass per unit area correlated well with light interception of 95%. In the same study, the authors reported that, during the reproductive phase of *B. inermis*, tillers became elongated and the canopy became more erect and open, requiring higher values of LAI to intercept the same radiation as absorbed by a smaller and denser canopy.

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Table 1. Correlations between canopy height, light interception, leaf area index and mean leaf angle of 10 tropical forage grasses (T-test, with linear correlation).

Species	Canopy height x Light interception	Canopy height x Leaf area index	Light interception x Leaf area index	Light interception x Mean leaf angle	Leaf area index x Mean leaf angle
Brachiaria decumbens	0.4372 *	0.5883 **	0.6589 **	0.2579 ns	0.8452 **
Brachiaria brizantha cv. Xaraés	0.0332 ns	-0.1521 ns	0.2352 ns	-0.2236 ns	0.8598 **
Brachiaria brizantha cv. Marandu	-0.2947 ns	0.1203 ns	0.2795 ns	-0.6464 **	0.4364 ns
Brachiaria hybrid cv. Mulato II	-0.3287 ns	-0.2558 ns	0.2959 ns	-0.4922 *	0.5366 *
Panicum maximum cv. Tanzânia	0.0835 ns	0.0625 ns	0.6936 **	-0.1863 ns	0.5411 *
Panicum hybrid cv. Massai	0.4728 *	0.4157 ns	0.4631*	-0.1328 ns	0.5941**
Pennisetum purpureum "Common"	0.6478 **	0.2989 ns	0.8166 **	-0.6258 *	-0.3064 ns
Pennisetum purpureum cv. Roxo	0.4176 ns	0.3726 ns	0.8886 **	0.0774 ns	0.3358 ns
Sorghum vulgare	0.1099 ns	0.0866 ns	0.5244 *	0.1275 ns	0.2405 ns
Sorghum bicolor	0.6534 **	0.4639 ns	0.7207 **	-0.2698 ns	0.1608 ns

Falster and Westoby (2003) reported that small values for mean leaf angle are directly related to higher indices of light interception. In our study, LAI and mean leaf angle correlated positively (P<0.05) and affected *Brachiaria* hybrid cv. Mulato II, *Panicum maximum* cv. Tanzânia, *Panicum* hybrid cv. Massai, *Brachiaria decumbens* and *Brachiaria brizantha* cv. Xaraés. Mean leaf angle affected negatively (P<0.05) light interception for only 3 species: *Brachiaria brizantha* cv. Marandu, *Brachiaria* hybrid cv. Mulato II and *Pennisetum purpureum* "Common".

Conclusions

Canopy height seldom correlated well with light interception and leaf area index across a range of tropical grasses. Other measurements on the canopy, either directly as herbage mass or indirectly as disk settling height (Santillan et al. 1979), could be alternative measurements to correlate with light interception in tropical grasses.

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