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

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Introduction

Photosynthetic 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 the cutting management, which is based on cutting frequency and stubble height. It is usual to recommend as a management practice to cut (or graze) the forage whenever it reaches a given stubble height. Brougham (1956) stated that, when the forage canopy is intercepting 95% of the photosynthetic active radiation, this is the critical leaf area index (LAI), which means the forage is near its maximum growth rate without shading itself. There is also the optimum LAI, where the forage reaches the maximum point of mass accumulation, indicating time to start grazing or cut. Generally the critical and optimum LAI have close values, but they are not necessarily the same (Brown and Blaser, 1968). This trial evaluated the relationship among canopy height, leaf area index, and light interception in ten different tropical grasses.

Methods

The experiment was carried out at the Animal Science Department from the Universidade Federal Rural de Pernambuco. The evaluated species were *Brachiaria decumbens* Stapf, *Brachiaria* cv. Mulato II, *Brachiaria brizantha* cv. Xaraés, *Brachiaria brizantha* cv. Marandú, *Panicum maximum* cv. Tanzânia, hybrid *Panicum* cv. Massai, *Sorghum vulgare* Pers, *Sorghum bicolor* (L.) Moench, *Pennisetum purpureum* Schum. and *Pennisetum purpureum* cv. Roxo. Light interception, leaf area index, and mean leaf angle (MLA) were taken using a Plant Canopy Imager CI-120 from CID Bio-science®; these variables were measured simultaneously with canopy height. Measurements were taken at 1-week intervals over two months, using as experimental units forage plots measuring 2.80 x 1.80 m; measurements were replicated four 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) showed non-significant correlation (P>0.05) for the following species: *Brachiaria brizantha* cv. Xaraés, *Brachiaria brizantha* cv. Marandú, hybrid *Brachiaria* cv. Mulato II, *Panicum maximum* cv. Tanzânia, *Pennisetum purpureum* cv. Roxo and *Sorghum vulgare* Pers. *Brachiaria decumbens* and hybrid *Panicum* cv. Massai showed positive (P<0.05) correlation (r= 0.44 and 0.47, respectively). *Sorghum bicolor* (L.) Moench and *Pennisetum purpureum* Schum showed linear correlation (P<0.01) both with r=0.65. Correlation between canopy height and leaf area index showed that only in the case of *Brachiaria decumbens* Stapf was there a moderate correlation (r= 0.59), with the coefficient of determination (r^2) =0.35. Correlation between LAI and light interception was significant for most species, except for three species that showed non-significant results: *Brachiaria brizantha* cv. Xaraés, *Brachiaria brizantha* cv. Marandú and *Brachiaria* cv. Mulato.

Galzerano *et al*. (2010) found, for *Panicum maximum* cv. Áries and *Cynodon nlemfuensis*, very strong correlation between canopy height and leaf area index. They observed coefficient of determination =0.76 and r^2=0.88, respectively. Engel *et al.* (1987) studying a cool season grass, *Bromus inermis Leyss*, found that leaf area index and light interception had a strong correlation with season of the year and fertilization level. They also found that forage mass per area correlates well with light interception of 95%. In the same study, the authors observed that during the reproductive phase of the *Bromus inermis* Leyss, this forage elongated its tillers and the canopy became more erect and opened, requiring higher values of LAI to intercept the same radiation than in a smaller and denser canopy.

Falster and Westoby (2003) reported that small values for mean leaf angle are directly related with higher indices of light interception. In our study, leaf area index and mean leaf angle correlated positively (P<0.05) and affected *Brachiaria* cv. Mulato II, *Panicum maximum* cv. Tanzânia, *Panicum maximum* cv. Massai, *Brachiaria decumbens* Stapf, and *Brachiaria brizantha* cv. Xaraés. Mean leaf angle affected negatively (P<0.05) light interception only for three species: *Brachiaria brizantha* cv. Marandú , *Brachiaria* cv. Mulato II, and *Pennisetum purpureum* Schum.

Table 1. Correlation between canopy height, light interception, leaf area index and mean leaf angle on ten tropical forages

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 Stapf	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. Marandú	-0.2947 ns	0.1203 ns	0.2795 ns	-0.6464 **	0.4364 ns
Brachiaria híbrido 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 maximum cv. Massai	0.4728 *	0.4157 ns	0.4631*	-0.1328 ns	0.5941**
Pennisetum purpureum Schum.	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 Pers	0.1099 ns	0.0866 ns	0.5244 *	0.1275 ns	0.2405 ns
Sorghum bicolor (L.) Moench	0.6534 **	0.4639 ns	0.7207 **	-0.2698 ns	0.1608 ns

** Significant at $P<0.01$; ***** Significant at $P< 0.05$; ns not significant. T-test, with linear correlation.

Conclusions

Canopy height seldom correlates well with light interception and leaf area index across a range of warm-season grasses. Environmental condition may lead to different light interception and leaf area index, for a plant canopy at a given height. Other measurements on the canopy, either directly as herbage mass or indirectly as disk settling height, could be alternative measurements to correlate with light interception from tropical grasses.

References

Brougham RW (1956). Effects of intensity of defoliation on regrowth of pastures. *Australian Journal of Agricultural Research* **7**, 377-387.

Brown RH, Blaser RE (1968). Leaf area index in pasture growth. *Herbage Abstracts* **38,** 1-9.

Engel RK, Moser LE, Stubbendieck J, Lowry SR (1987). Yield accumulation, leaf area index, and light interception of smooth bromegrass. *Crop Science* **27**, 316-321.

Franzblau A (1958). *A Primer of Statistics for Non-Statisticians.* Harcourt, Brace & World, New York.

Falster DS, Westoby M (2003). Leaf size and angle vary widely across species: what consequences for light interception? *New Phytologist* **158**, 509–525.

Galzerano L, Malheiros EB, Morgado ES, Ruggieri AC, Raposo E, Nepomuceno DD, Silva VC (2010). Altura do dossel e índice de área foliar em capim Áries. In: Congresso de pós-graduação. Anais. Congresso de pós-graduação, 2010. (CD)