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SHORT COMMUNICATION

THE EFFECT OF LIGHT INTENSITY ON THE CHEMICAL COMPOSITION AND *IN VITRO* DRY MATTER DIGESTIBILITY OF PALISADE GRASS (*BRACHIARIA BRIZANTHA*)

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Abstract: A study investigated the effect of varying light levels on the chemical composition and *in vitro* dry matter digestibility (IVDMD) of palisade grass (*Brachiaria brizantha*). Nine accessions were tested at 3 light levels (100, 62 and 34% of full sunlight). The IVDMD, chemical composition (acid detergent fibre, neutral detergent fibre, acid detergent lignin (ADL), lignin in cell wall, hemicellulose, cellulose and dry matter percentage (DMP)) were measured on whole tops cut on 4 occasions over 8 months. Significant differences in IVDMD, chemical composition and DMP were observed between light levels. IVDMD, ADF, NDF, ADL, lignin in cell wall and DMP showed significant differences between accessions. A reduction in light transmission to 62% had no effect on the IVDMD of palisade grass. The relationships between IVDMD and chemical composition varied with light levels but were stronger at 34% light level than those at full sun. IVDMD was mainly affected by the amount of lignin in cell walls, but was also affected by the ADL.

Key Words: *Brachiaria brizantha*, digestibility, light intensity.

INTRODUCTION

Livestock population and milk and meat production in Sri Lanka have gradually decreased since 1981[1], due to low income from dairying compared with cash crops, scarcity of land due to competition from other enterprises and slow rate of development of forage programmes.[2] Therefore cash or grain crops are given priority over fodder crops in Sri Lanka and most developing countries.

The best option for increasing animal protein production in the densely populated humid tropics is to utilise the large area of tree crops and home gardens for inter-cropping with forages. As the area under tree crops coincides with areas of rapid population increase, the exploitation of inter-cropping potential becomes a matter of high priority. There are perhaps 15 million cattle and buffalo associated with perennial crop cultivation systems in the tropics.[3] Traditionally, cattle have been used as 'sweepers' to keep the grass and weeds short, thus preventing excessive nutrient and moisture competition with tree crops. Although there is a lot known about the effect of light on tropical grasses[4] no experiments

have been done on chemical composition of *Brachiaria brizantha*. Hence as this species is an important grass under tree crops, the following study was carried out. The objective of this study was to investigate the effect of different light levels on the chemical composition and *in vitro* dry matter digestibility of *B. brizantha*.

METHODS AND MATERIALS

The experiment was conducted at the Research Farm, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka, during 1991-92. The average annual rainfall at the site was 3500 mm, evenly distributed except for a period of low rainfall (125-175 mm per month) from December to March. The soil was red-yellow podzolic with a pH of 5.4-5.6.

Nine contrasting accessions of palisade grass were used in this study: 5 from Sri Lanka (RU 127, RU 139, RU 208, RU 288 and RU 297), 2 from United States Department of Agriculture (CPI 15890 and PI 255346) and 2 from Centro Internacional de Agricultura Tropicale (CIAT) (CIAT 6387 and CIAT 6021). Sri Lankan accessions were taken from the germplasm collection maintained by the author at the Research Farm, University of Ruhuna. The accessions were tested at 3 light levels in a split plot design with 3 replicates. The light intensities and accessions were main plots and sub plots, respectively. There were 3 light levels (100, 62 and 34% of full sunlight) which were achieved with shade cloth (polypropylene nets). Light transmission was measured as photosynthetically active radiation (PAR) using 2 integrating PAR meters. One meter measured the incoming radiation over 10 min periods outside the plots in full sun, while the second was moved through the shaded plots to record simultaneous measurements in the shaded plots. Measurements were taken every 4 weeks on reasonably clear days between 1000 h and 1400 h.

Following land preparation, grass tillers of uniform size and age were hand-planted in 1m x 2m plots. The spacing between plants was 10 cm. At pasture establishment, 100 kg/ha urea, 50 kg/ha muriate of potash and 100 kg/ha rock phosphate were applied to all plots.

Three months after crop establishment, all plants were clipped to 5cm height. Subsequently, 4 harvests were taken at 8-weekly intervals. Whole tops were harvested at 5cm height from 0.6 m x 1.6m quadrats. The harvested samples were weighed, dried in a forced air oven at 80°C for 48 h and again weighed to obtain the dry matter percentage (DMP). The dried samples were ground in a stainless steel mill using a 1mm sieve. Samples were analysed (in duplicate) from each plot for quality characteristics and the mean was used for statistical analysis.

The *in vitro* dry matter digestibility (IVDMD) was estimated by pepsin-cellulase assay.[5] The acid detergent fibre (ADF) and neutral detergent fibre (NDF)

were also determined.[6] Acid detergent lignin (ADL) was estimated by a modified method of Van Soest.[7]

Lignin in cell wall was calculated as follows:

Lignin in cell wall (%) = (ADL/NDF)*100.

NDF was considered as cell wall[8]. Hemicellulose and cellulose concentrations were estimated as the difference between NDF and ADF, and ADF and ADL, respectively. All readings were corrected to an oven-dry matter basis and presented as a percentage of dry matter.

RESULTS

Significant differences ($p < 0.05$) in IVDMD, chemical composition and DMP of the forages from palisade grass (*Brachiaria brizantha*) were observed between light levels. The highest IVDMD, ADF, NDF, hemicellulose, and cellulose and the lowest DMP were observed in the forage grown at 62% light level. However, IVDMD was not significantly different ($p > 0.05$) between 62% and 100% light. The highest ADL and lignin in cell wall and the lowest IVDMD were recorded at 34% light. The highest DMP and the lowest ADF, NDF, ADL, lignin in cell wall, hemicellulose and cellulose were recorded in the forages grown in full sunlight (Table 1).

Table1: Chemical composition of *Brachiaria brizantha* under different light levels.

Chemical Composition	Light levels		
	100%	62%	34%
IVDMD	47.12	49.04	44.03
ADF	31.27	38.71	35.83
NDF	52.37	62.14	60.94
Lignin in cell wall	5.06	5.23	6.32
Hemicellulose	21.10	23.43	23.11
Cellulose	28.62	35.46	32.09
Dry matter %	31.37	17.26	18.69

There were significant differences between accessions in IVDMD, ADF, NDF, ADL, lignin in cell wall and DMP. The light level X accession interaction was significant only for IVDMD and lignin in cell wall.

Significant correlations between IVDMD and all other characteristics studied were obtained at 34% light level (Table 2). IVDMD was significantly and negatively correlated with ADF, NDF and lignin in cell wall at each light level. When computed over all light levels, IVDMD had significant correlations only with ADL, lignin in cell wall and DMP (Table 2).

Table 2 : Significant relationships between IVDMD (y) and other quality characteristics (x) of palisade grass at different light levels.

X	r^2	Regression equation	SE_a	SE_b
100% light level (n=9)				
ADF	0.69**	y = 99.46 - 1.71x	1.47	0.44
NDF	0.65**	y = 111.66 - 1.25x	1.55	0.35
Lignin in cell wall	0.55*	y = 62.32 - 3.02x	1.98	0.86
Cellulose	0.62*	y = 98.31 - 1.82x	1.63	0.54
62% light level (n=9)				
ADF	0.85***	y = 102.79 - 1.39x	1.05	0.22
NDF	0.74**	y = 117.35 - 1.10x	1.40	0.25
ADL	0.67**	y = 82.96 - 10.43x	1.31	2.15
Lignin in cell wall	0.79**	y = 94.28 - 4.93x	2.18	0.86
34% light level (n=9)				
ADF	0.84***	y = 97.70 - 1.50x	1.61	0.25
NDF	0.83***	y = 105.44 - 1.04x	1.66	0.18
ADL	0.50*	y = 61.32 - 4.63x	2.85	1.77
Lignin in cell wall	0.83***	y = 72.63 - 3.64x	2.36	1.24
Hemicellulose	0.56*	y = 99.17 - 2.39x	2.65	0.79
Cellulose	0.89***	y = 106.78 - 1.96x	1.35	0.26
DMP	0.93***	y = 77.52 - 1.30x	1.05	0.13
Overall light levels (n=27)				
ADL	0.21**	y = 55.10 - 2.76x	3.18	1.04
Lignin in cell wall	0.36***	y = 62.15 - 2.85x	2.90	0.76
DMP	0.30**	y = 54.29 - 0.32x	3.02	0.10

r^2 = coefficient of determination
SE_a = standard error of the intercept
SE_b = standard error of the slope
$p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

DISCUSSION

The significant differences in quality characteristics between light levels are probably due to the different environmental conditions experienced by the plants during regrowth at different light levels. The air temperature above pasture under shade is reported to be about 2-3^{0}C lower at midday than that above the pasture in the full sun.[9] The soil temperatures differ much more and are as much as 10^{0}C lower under shade than in the open at the soil surface.[4] The effect of environment during the growth of the plant on the quality of forages has been mentioned by many workers.[8,10] There was no significant effect of reducing light intensity to 62% of full sunlight on IVDMD. Similar results were reported by many workers[11,12] , although some workers[13] have reported that IVDMD was decreased under shade. According to the literature, shade has both positive and negative effects on IVDMD, lignin and cell wall concentration and composition.[11]

NDF, ADF, cellulose, hemicellulose and ADL were usually higher under shade compared with full sun, although levels varied with shade intensity (Table 1). Shading usually reduces the total non-structural carbohydrate of grasses[14,15] and therefore increases the cell wall component. Significantly, lower DMP was observed under shade. Evaporative demand is greatly reduced with the lower radiation of a shaded environment. Thus, soil water availability is maintained at a higher level than in the open[4] and leaf water potentials are higher. Therefore, the DMP under shade are lower compared with that under full sun.

The negative correlations of IVDMD with ADF and NDF at each light level (Table 2) were masked when the data were pooled over different light levels. However, significant negative correlations between IVDMD and lignin in cell wall were observed at each light level, as well as over all light levels. This shows that the relationship was strong not only under constant levels of light interception but also between different light levels. Lignin is generally considered to be the overriding factor in the limitation of cell wall digestibility.[16] Normally, cell content is 100% digestible and not affected by the ADL. Cellulose and hemicellulose (the major components of the cell wall) are highly digestible (100 and 90% respectively) in their pure form but, due to the lignification of cell walls, digestibility of those compounds decreases rapidly.[10] Therefore, the lignin in cell wall plays a main role in IVDMD. ADL also showed significantly negative correlations with IVDMD when data were pooled over light levels.

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