YIELD AND DIGESTIBILITY OF FORAGES IN EAST INDONESIA
II. GRASSES

D. Bulo[1], G. J. Blair, A. R. Till[2] and W. Stür[3]

Department of Agronomy and Soil Science
University of New England, Armidale, NSW 2351, Australia

Summary

This study was undertaken at Gowa, South Sulawesi, Indonesia, as part of a larger forage genetic resource evaluation project. The experimental program consisted of a field experiment where grass and legume species were grown in monocultures and the dry matter yield, rumen bag digestibility (RBDMD) and N content of leaf and stem components were monitored in the wet and dry seasons. Eight species of grass (*Brachiaria decumbens* cv. Basilisk, *Panicum maximum* cv. Riversdale, *Urochloa pullulans* CPI 41192, *Imperata cylindrica* from Maiwa, South Sulawesi, *Digitaria milanjiana* CPI 41193, *Cenchrus ciliaris* cv. Malopo, *Heteropogon contortus* and *Setaria sphacelata* cv. Splenda) were studied. *P. maximum* was the highest yielding grass in the wet season and *B. decumbens* in the dry season. The highest RBDMD in the whole plants were *U. pullulans*, *P. maximum*, *S. sphacelata* and *D. milanjiana* after 2 weeks regrowth in cycle 1 and *S. sphacelata*, *B. decumbens*, *D. milanjiana* and *C. ciliaris* in cycle 2. When total digestible DM was calculated for the whole of cycle 1, *P. maximum*, *B. decumbens* and *S. sphacelata* were superior, but *B. decumbens* produced over twice as much as the other species in the dry season (cycle 2). The leaf N concentration of all grasses exceeded 1.0% (6.25% crude protein) in the regrowth in cycle 1 but did not exceed 0.5% in the dry season regrowth (cycle 2).

(**Key Words**: Grasses, DM Yield, Rumen Bag Digestibility)

Introduction

South Sulawesi is an important cattle producing area of Indonesia and has extensive areas of grassland of low productivity. Most livestock farms are small. The smallholders produce cattle, buffalo, horses and goats either as single or mixed enterprises. Herd sizes range from 2 to 30 head per farm. Generally the animals are allowed to graze freely on the natural grasslands during the day, while at night they are kept in pens or yards near the farmer's house.

Most of the natural grasslands of South Sulawesi are dominated by *Imperata cylindrica* (alang-alang), *Axonopus*, *Heteropogon* and *Andropogon* grasses and have low carrying and fattening capacities. The seasonal imbalance between pasture quality and animal requirement remains one of the most serious problems retarding the development of the livestock industry in Eastern Indonesia. The problems associated with these shortages of feed especially in terms of their seasonal availability and quality can potentially be overcome by the introduction of more productive grasses and legumes, together with proper fertiliser and grazing management. This study was undertaken to assess the yield and digestibility of a range of grasses with particular reference to the effect of age of regrowth on digestibility and the ability to maintain yield and digestibility into the dry season.

Materials and Methods

Details of the rumen bag dry matter digestibility (RBDMD) method were presented in Bulo et al. (1992) and a description of the experimental site and management in Bulo et al. (1994). Consequently only a very brief description of the site and methods are presented here. The experimental site was located at the BPT (Balai Penelitian Ternak) experiment station at Gowa, South Sulawesi Indonesia. The soil is a well drained, highly permeable, silty clay loam with pH 6. Mean annual rainfall is in excess of 2,000 mm, most of which falls during the period November to April. The monthly temperature is relatively constant (mean 29℃), but

[1]Present address: Balai Penelitian Ternak, P. O. Box 38, Ujung Pandang, South Sulawesi, Indonesia.

[2]Address reprint requests to Dr. A. R. Till, Department of Agronomy and Soil Science, University of New England, Armidale 2351, Australia.

[3]Present address: Department of Agriculture, University of Queensland, Brisbane, Qld 4072, Australia.

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the mean daily temperature can range from 19.5°C to 35.5°C. This study was part of a larger genetic resource evaluation project from which the eight of the most promising grasses (table 1) were grown as monocultures in 2 m × 5 m plots and cut after varying periods in both the wet and dry season to assess their yield over time and nutritive value. They were grown from vegetative material except for *P. maximum* which was grown from seed. After establishment the plots were fertilised with 200 kg/ha triple superphosphate and 100 kg/ha urea. They were subsequently cut to a height of 12.5 cm above ground level and allowed to grow for 14, 28, 42 and 56 days. At the 56 day harvest the plots were all re-cut to 12.5 cm and the regrowth cycle repeated (cycle 1). The dry season harvest consisted of 157 days regrowth from the area cut at 42 days in cycle 1.

TABLE 1. SPECIES SOWN FOR YIELD AND NUTRITIVE VALUE STUDY

Species name	Cultivars	Abbreviation*
Brachiaria decumbens	cv. Basilisk	B.d.
Panicum maximum	cv. Riversdale	P.m.
Urachloa pullulans	CPI 41192	U.p.
Imperata cylindrica	ex. Maiwa	I.c.
Digitaria milanjiana	CPI 41192	D.m.
Cenchrus ciliaris	cv. Malopo	C.c.
Heteropogon contortus	ex Maiwa	H.c.
Setaria sphacelata	cv. Splenda	S.s.

* Notation used in subsequent figure.

After harvest the plants were separated into leaf and stem fractions, dried in an oven for 48 hours at 65°C, weighed and then ground in a mill to pass through a 2 mm screen, dry matter digestibility and total nitrogen were then determined. Rumen bag digestibility involved the use of dacron bags (7 × 14 cm in size; 44 micron) containing 1-3 g of sample with six bags per goat and an incubation time of 48 hours. Total N (%) was obtained by the autoanalyzer method of Thomas et al. (1967) after digestion in H_2SO_4.

The statistical analysis of the data from the latin square design was carried out using the GENSTAT computer program. Cutting periods were analysed only within cycles, since the length of the periods varied with cycles and no comparisons were possible.

Results

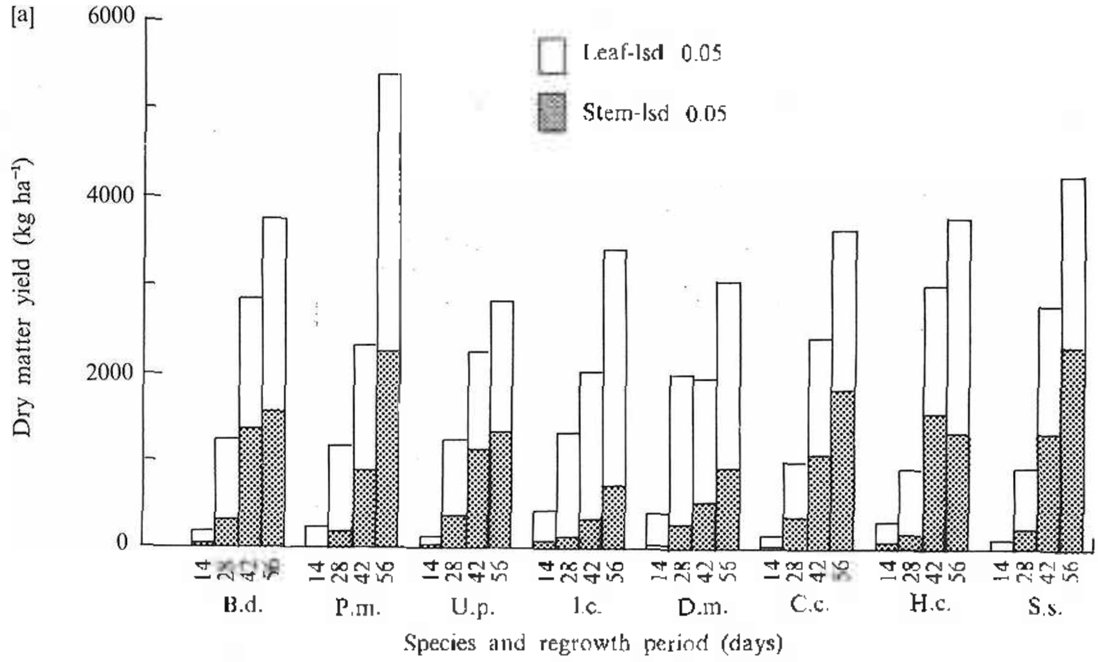
Dry matter yields

Cycle 1

Dry matter yields of all the grass species increased throughout cycle 1 (figure 1a). The highest leaf production at the end of the 56 day growth cycle was recorded in *P. maximum*, followed by *S. sphacelata* and the lowest production was recorded by *U. pullulans*. Leaf yields equalled or exceeded stem yields at all times except at the two low values of 47% for *U. pullulans* after 42 days and *S. sphacelata* after 56 days (table 2). The highest percentage of leaf in Cycle 1 was 90% for *I. cylindrica* at 28 days (table 2). All species had their highest leaf percentages at the 14 or 28 day harvests and lower ratios thereafter except in the case of *I. cylindrica* which was lower at 14 days than at 28, 42 and 56 days (table 2).

TABLE 2. LEAF PERCENTAGES OF GRASS SPECIES IN CYCLE 1 AND 2.

Species	Regrowth time (days) Cycle 1				Cycle 2
	14	28	42	56	157
B. decumbens	76	76	52	58	60
P. maximum	57	84	63	58	76
U. pullulans	74	58	47	52	50
I. cylindrica	78	90	83	80	84
D. milanjiana	57	86	74	72	87
C. ciliaris	78	63	57	50	75
H. contortus	76	82	50	69	87
S. sphacelata	83	75	52	47	57



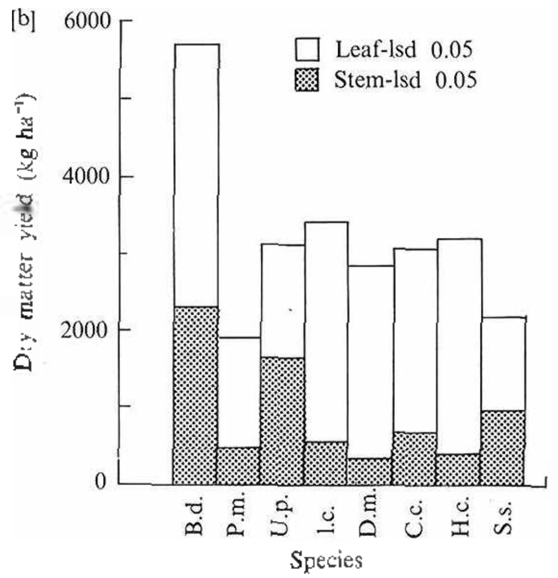


Figure 1. Dry matter yield (kg / ha) of eaf and stem components of grasses in cycle 1 and 2. The numbers on the abscissa of figure 1a show the regrowth periods in days. The cycle 2 regrowth period for figure 1b was 157 days.

Cycle 2

Cycle 2 extended for 157 days, from March 25 to August 30, 1986 and the total rainfall was 550 mm. Rainfall was favourable throughout the period except in the 2 weeks before harvest when no rain was recorded.

The total DM yield of *B. decumbens* was significantly higher ($p < 0.05$) than all other species (figure 1b). *I. cylindrica*, *H. contortus, U. pullulans, C. ciliaris* and *D. milanjiana* were in the second highest yielding group and the lowest yields were from *S. sphacelata* and *P. maximum*. The DM yield for the whole tops ranged from a high of 5,700 kg/ha in *B. decumbens* to a low of 1,910 kg/ha in *P. maximum*. The trends in leaf DM yields were similar to those of the total DM yields with *B. decumbens* having the highest yield. The second highest yielding group included *D. milanjiana, C. ciliaris, I. cylindrica* and *H. contortus* and the lowest yielding group included *U. pullulans, P. maximum* and *S. sphacelata*. There were marked differences in the leafiness of the species after the 157 day regrowth period (table 2) ranging from 50% in *U. pullulans* to 87% in *D. milanjiana*.

Rumen bag dry matter digestibility (% RBDMD)

Cycle 1

There were marked differences between species in RBDMD. At 14 days leaf values ranged from 52.8% in *I. cyclindrica* up to 68.8% in *U. pullulans* (table 3) while for stem the values ranged from

51.9% in *I. cylindrica* up to 62.3% in *H. contortus* (table 3). Leaf RBDMD was higher than stem in all species except *H. contortus* at 14 days (table 3). After 56 days regrowth RBDMD had declined in the leaf and stem of all species. In leaf, this decline ranged from 0.11% day^{-1} in *C. ciliaris* up to 0.24% day^{-1} in *D. milanjiana* (table 3) and in stem from 0.15% day^{-1} in *U. pullulans* and *D. milanjiana* up to 0.33% day^{-1} in *H. contortus*. Calculated rumen bag DMD of the combined leaf and stem at 14 days ranged from 52.6% in *I. cylindrica* to 66.3% in *U. pullulans* while at 56 days the values were 45.1% in *I. cylindrica* and 58.9% in *P. maximum* (table 4). The decline in RBDMD with age ranged from 0.15% day^{-1} in *P. maximum* and *C. ciliaris* up to 0.24% day^{-1} in *U. pullulans*.

Cycle 2

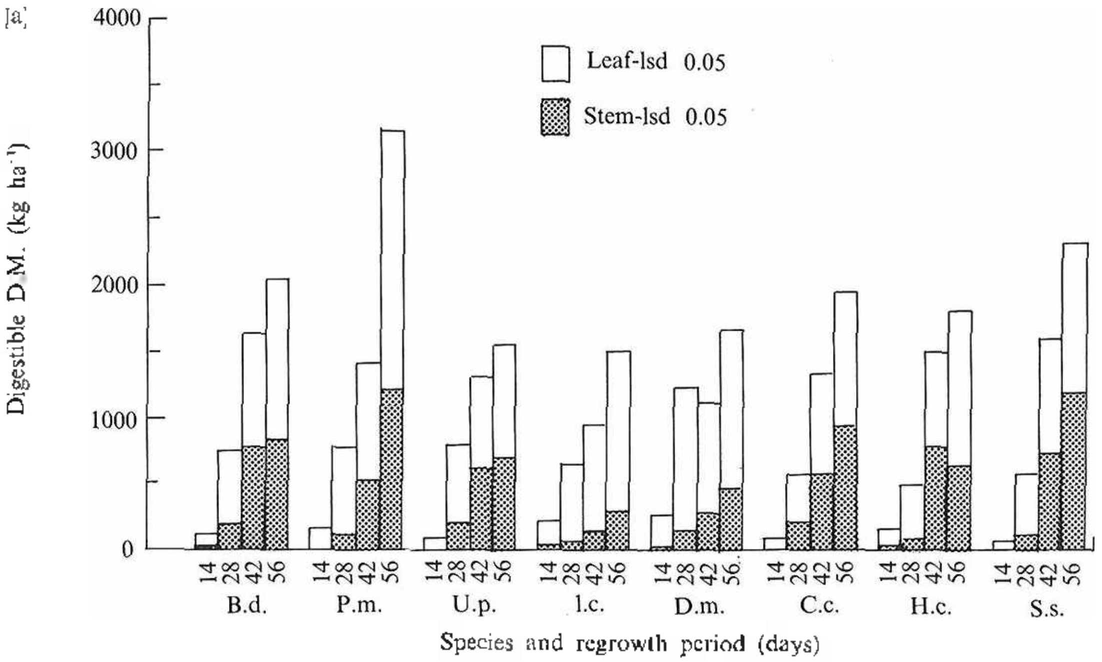
As in cycle 1 there were significant differences between species in RBDMD. In leaf this was between 44.2% in *I. cylindrica* and 64.6% in *B. decumbens*, while for stem it was from 45.7% in *H. contortus* to 55.0% in *S. sphacelata* (table 3). The whole plant values ranged from 43.9% in *I. cylindrica* up to 59.4% in *S. sphacelata* (table 4).

TABLE 3. RUMEN BAG DRY MATTER DIGESTIBILITY OF GRASS LEAF AND STEM IN CYCLE 1 AND 2 AND THE DECLINE BETWEEN 14 AND 56 DAYS

Species	Cycle 1						Cycle 2	
	14 d RBDMD (%)		56 d RBDMD (%)		14-56 d decline (% day^{-1})		157 d RBDMD (%)	
	Leaf	Stem	Leaf	Stem	Leaf	Stem	Leaf	Stem
B. decumbens	62.6	60.5	55.9	53.3	0.16	0.17	64.6	50.6
P. maximum	67.7	62.1	61.4	55.3	0.15	0.16	58.1	52.6
U. pullulans	68.8	59.1	59.4	52.6	0.22	0.15	56.6	52.0
I. cylindrica	52.8	51.9	45.9	41.8	0.16	0.24	44.2	46.8
D. milanjiana	67.3	58.8	57.2	52.2	0.24	0.15	59.4	53.5
C. ciliaris	61.8	59.7	57.1	52.8	0.11	0.16	61.7	46.2
H. contortus	57.0	62.3	49.3	48.6	0.18	0.33	47.6	45.7
S. sphacelata	66.1	60.4	58.1	52.8	0.19	0.18	62.7	55.0
leaf lsd (p = 0.05)			2.8				2.7	
stem lsd (p = 0.05)			2.5				2.2	

TABLE 4. RUMEN BAG DRY MATTER DIGESTIBILITY OF COMBINED LEAF AND STEM OF PLANTS IN CYCLE 1 AND 2 AND THE DECLINE BETWEEN 14 AND 56 DAYS

Species	Cycle 1			Cycle 2
	14 d RBDMD (%)	56 d RBDMD (%)	14-56 d decline (day^{-1})	157 d RBDMD (%)
B. decumbens	62.3	54.8	0.18	59.0
P. maximum	65.3	58.9	0.15	56.8
U. pullulans	66.3	56.2	0.24	54.3
I. cylindrica	52.6	45.1	0.18	43.9
D. milanjiana	63.5	55.8	0.18	58.7
C. ciliaris	61.3	55.0	0.15	57.8
H. contortus	58.3	49.1	0.22	47.4
S. sphacelata	65.1	55.3	0.23	59.4
lsd (p = 0.05)		2.6		2.4



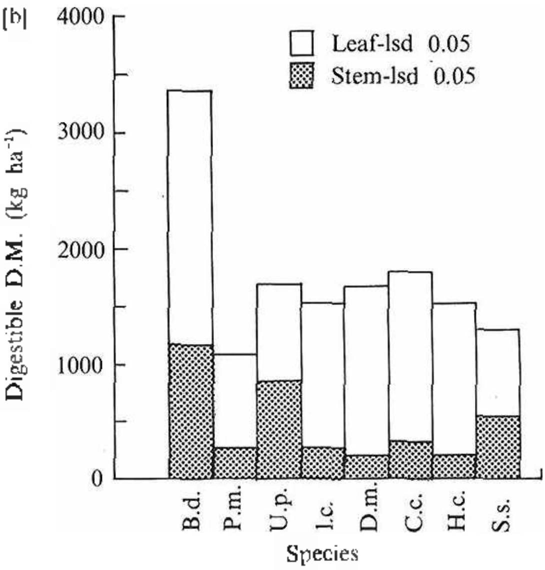


Figure 2. DDM yield (kg / ha) of leaf and stem components of grasses in cycle 1 and 2. The numbers on the abscissa of figure 2a show the regrowth periods of in days. The cycle 2 regrowth period for figure 2b was 157 days.

Yield of digestible dry matter (DDM) of grasses

Cycle 1

In cycle 1 the ranking of species for DDM yield was similar to that of DM yield but *I. cylindrica* become the lowest in DDM yield because of low DMD digestibility in both the leaf and stem (figure 2a). DDM increased throughout the 56 day period in all species. It was highest in *D. milanjiana* after 14 and 28 days regrowth and in *B. decumbens* and *S. sphacelata* after 42 days but after 56 days it was highest in *P. maximum* (figure 2a).

Cycle 2

In cycle 2, which was cut after 157 days, highest leaf and whole plant DDM leaf yield was recorded in *B. decumbens*, which produced almost twice as much as any of the other species. The second highest DDM leaf yielding group included *C. ciliaris, D. milanjiana, H. contortus* and *I. cylindrica* which were not different from each other but significantly higher than the group containing *U. pullulans, P. maximum* and *S. sphacelata* (figure 2b).

Nitrogen concentration in leaf and stem fractions of grasses

For the limited number of samples available at the 14 day sampling, the N concentration in stem and leaf varied from 1% in *B. decumbens* up to 4% in *S. sphacelate* (table 5). At 56 days the only leaf to exceed 1% N was *U. pullulans*, while the stem N contents ranged 0.4-0.8%, the stem %N always being lower than the leaf. After 157 days regrowth (cycle 2) leaf and stem N concentration never exceeded 0.5%.

TABLE 5. NITROGEN CONCENTRATION (%) IN LEAF AND STEM FRACTIONS OF GRASSES IN CYCLE 1 AND 2

Species	Cycle 1				Cycle 2	
	14 d		56 d		157 d	
	Leaf	Stem	Leaf	Stem	Leaf	Stem
B. decumbens	–	1.0	1.0	0.5	0.2	0.2
P. maximum	–	–	1.0	0.4	0.5	0.2
U. pullulans	–		1.2	0.6	0.4	0.3
I. cylindrica	2.0	1.3	1.0	0.7	0.3	0.2
D. milanjiana	3.0	–	1.0	0.8	0.5	0.2
C. ciliaris	3.4	2.1	1.0	0.6	0.3	0.2
H. contortus	–		1.0	0.5	0.3	0.3
S. sphacelata	4.0	–	1.0	0.5	0.4	0.3

–: insufficient sample

Discussion

Dry matter yield

P. maximum was the top ranking grass in the wet season with *B. decumbens* also in the next group while *B. decumbens* was far superior in the dry season. These species were also the highest yielding in studies conducted in N.E. Thailand by Topark-Ngarm and Gutteridge (1985). Of the species evaluated in this study, *B. decumbens* fulfilled the criterion of most even wet and dry season yield considered by Whiteman (1980) to be an important attribute. This advantage appeared to be related to the extensive root system in *B. decumbens* which confers the ability to respond to small amounts of rainfall.

There was less variation in leaf percentage among the grasses than the legume evaluation (Bulo et al., 1994) and the ranking of the species was unaltered by the inclusion of this parameter.

Dry matter digestibility

The lowest RBDMD was recorded for *I. cylindrica* while the highest were *B. decumbens*, *P. maximum*, *U. pullulans* and *S. sphacelata*. The maximum whole plant RBDMD of 66.3% found in *U. pullulans* after 14 days regrowth in cycle 1 is lower than the 81.2% found in 14 day old *B. ruziziensis* by Reid et al. (1973), probably due to a greater stem component in the *Urachloa pullulans*. The lower digestibility of stems than leaves found in this study is in agreement with earlier findings reported by Hacker and Minson (1981), but the mean difference of 5.7% found for *P. maximum* is larger than the 1.0% reported by Laredo and Minson (1973) using sheep to determine RBDMD.

The decline in RBDMD with age found in this study is also in agreement with earlier studies (Hacker and Minson, 1981). The small increase in RBDMD between 14 and 28 days found in *B. decumbens* (data not presented) is similar in magnitude to the increase of 0.8% day^{-1} reported by Grieve and Osbourn (1965). However, the decline in RBDMD between 28 and 56 days more than counteracted this small gain so there was an overall decline during the 56 day regrowth cycle. Minson (1971) recorded a decline of 0.2% day^{-1} in *Panicum* sp. which is similar to the 0.15% day^{-1} decline found in the present study. The decline in RBDMD of 0.15% day^{-1} in *C. ciliaris* found in this study is intermediate between the loss of 0.1% per day reported by Milford and Minson (1968) and the 0.2% day^{-1} reported by Playne (1972).

Yield of digestible DM

Amongst the grasses, *P. maximum* and *S. sphacelata* were best performers in the wet season but *B. decumbens* was clearly superior during the dry season (figure 1). This superiority is due to both the higher DM yield (figure 1) and higher

RBDMD (tables 3 and 4) in cycle 2.

A further difficulty encountered in translating the amount of DDM on offer to animal production is that only a small amount of the DM produced may be eaten (Parsons et al., 1983), and there is likely to be considerable selection of leaf material in preference to stems. Whilst the voluntary intake of temperate forages can usually be related to *in-vitro* DMD (Minson, 1982). Minson (1971) found that large varietal differences in the intake of tropical grasses could not be accounted for by differences in DMD. Laredo and Minson (1973) reported large differences in the slope and intercept of the linear regression between DM intake and DMD with a significant positive relationship for the leaf component but non-significant relationship for the stem in 4 out of the 5 species studied. Since voluntary intake is the prime determinant of potential animal performance and the variability of the relationship between voluntary intake and DMD is so great, the ability to predict animal productivity from a measure of DMD has to be seriously questioned. In forage evaluation programs the best that can be achieved is to select species for animal evaluation that fulfil the criteria of having a satisfactory supply of digestible dry matter, in particular a high proportion of leaf.

The two highest yielding grasses *P. maximum* and *B. decumbens* reinforce the importance of whole year production especially if only one species is being considered for the grass component of a pasture. On the basis of whole plant DDM production, *P. maximum* is clearly the best wet season plant. However, over a whole year *B. decumbens* has a more consistent DDM production (figure 2) and even allowing for a lower proportion of leaf for some of the year it would probably be the better species.

Nitrogen percentage

A consideration of the nitrogen contents (table 5) does little to clarify the choice of species. As pointed out by Leng (1985) a further constraint is that the species must be capable of supplying adequate soluble protein to maintain an active rumen. The critical level of crude protein required in a pasture before intake is reduced by N deficiency has been estimated at between 6.0% and 8.5% (1.09 to 1.28% N) by Blaxter and Wilson (1963), Milford and Minson (1966), and Minson and Milford (1967). Whilst the leaf of the grasses analysed exceeded this lower level of 1.09% after 14 days regrowth all values except *U. pullulans* were below this at the other harvests. The stem component was below 1.09% in all harvests except *C. ciliaris* at 14 days in cycle 1. As for DMD it is impossible to translate these results into animal production because of animal selection traits. In systems where plant protein is deficient urea fed as a supplement may alleviate this deficiency (Alexander et al., 1970).

Conclusions

In the environment under which these studies were undertaken *B. decumbens*. species was assessed as having the most potential. The results of dry matter production, and changes in the proportion in leaf and stem and digestibility of plant parts throughout the year emphasize the importance of evaluating species over the full range of seasonal variables.

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