Selection of *Chamaecrista rotundifolia* by cattle

R.J. CLEMENTS[1], R.M. JONES[1],
L.R. VALDES[2] AND G.A. BUNCH[1]
[1]*CSIRO Division of Tropical Crops and Pastures, Brisbane, Queensland, Australia*
[2]*Instituto de Pastos MINAG, Bauta, La Habana, Cuba*

Abstract

Hereford cattle fistulated at the oesophagus were used to study the proportion of roundleaf cassia (*Chamaecrista rotundifolia*) cv. Wynn in the diet when they were grazing a cassia-green panic (*Panicum maximum* var. *trichoglume*) cv. Petrie pasture during 2 years. The percentage of cassia in the diet was estimated from analysis of carbon isotope ratios of extrusa in both experiments and of faeces in Experiment 2 only.

In the first year, 1986–87, animals rotationally grazed the pasture for 7 months (early summer–early winter) and there was ample opportunity for selection. The cattle ate very little cassia in summer. Although the percentage of cassia in the extrusa increased in autumn to 22%, it failed to reach the percentage of cassia in the top "grazed layer" of the pasture (50–60%). In the second year, 1987–88, grazing was continuous from early autumn to early winter, and the grazing pressure was much higher. The percentage of cassia in the extrusa was again much lower than the percentage in the grazed layer until mid-autumn, but then increased to approximately equal the percentage in the pasture (10–20%). However, the estimate of percentage legume in the diet based on analysis of carbon isotope ratios of extrusa was consistently lower than the same estimate based on faeces. Possible reasons for this are discussed.

Cattle discriminated against cassia in summer and early autumn, especially when there was ample opportunity for selection. Cassia was eaten more readily in late autumn, particularly when grazing pressure was high. The role of plant P and S concentrations in affecting cassia acceptability warrants further study.

Correspondence: Mr R.M. Jones, CSIRO Division of Tropical Crops and Pastures, Cunningham Laboratory, 306 Carmody Road, St Lucia, Qld 4067, Australia

Introduction

Roundleaf cassia (*Chamaecrista rotundifolia*) cv. Wynn was released in 1983 to the grazing industry in Queensland as a tropical pasture legume, after having been evaluated for many years in small plots (Strickland *et al.* 1985; Ahn *et al.* 1988). Special care was taken to ensure that the legume was not toxic (Strickland *et al.* 1987). The description of cv. Wynn in the Register of Australian Herbage Plant Cultivars (Anon. 1990) states that it "is readily eaten by cattle and sheep without any ill effects", but no data on its acceptability to livestock were given. Following reports by graziers of low acceptability on commercial properties, we examined the diet selected by cattle grazing a cassia-tropical grass pasture. Acceptability of some tropical legumes is known to change during the growing season (e.g. Stobbs 1977; Walker *et al.* 1983; Gardener 1984), so the cassia contents of the pasture and the diet were measured from early summer until early winter in the first year (Experiment 1) and from early autumn until early winter in the second year (Experiment 2).

Materials and methods

Experiment 1

The experiment was conducted at Samford Research Station (27°22'S, 152°53'E; mean annual rainfall 1100 mm), on a sandy red earth soil (Gn2.14, Northcote 1979). The pasture was established in 1984 and consisted of Wynn cassia, green panic (*Panicum maximum* var. *trichoglume*) cv. Petrie and, to a lesser extent, setaria (*Setaria sphacelata*) cv. Narok. The 0.5 ha site had been used for previous experiments, and superphosphate fertiliser had been applied on numerous occasions, most recently in the 1985 winter (125 kg/ha).

Two 700 kg Hereford steers, fistulated at the oesophagus, grazed the pasture rotationally (10 d on the experiment/18 d rest on an outside area) from December 1986–June 1987, at a stocking rate equivalent to 1.4 beasts/ha. The experimental pasture was subdivided with an electric fence into a 0.35 ha paddock and a 0.15 ha one. During each 10-d grazing period, the steers were placed in the larger paddock for 7 d (i.e. afternoon of Day 0 — morning of Day 7) in order to re-accustom them to the pasture, and then grazed the smaller paddock for 3 d (i.e. afternoon of Day 7 — afternoon of Day 10) while extrusa samples were taken.

The yield and botanical composition of the herbage on offer in each paddock were measured before and after grazing, from 10 randomly positioned 0.5 m^2 quadrats. On the smaller paddock, the material from sequential 10 cm strata on each sampling site was cut and sorted separately in order to determine the yield and composition of herbage at different heights in the sward. Material was separated into green and dead, as well as into species. Subsamples of cassia from each stratum were taken in April 1987 for chemical analysis (N, P, K and S).

Extrusa samples were collected from the steers on 4 consecutive days during each grazing period. The first sampling was taken when the steers were first placed on the small paddock (afternoon of Day 7), and the fourth sampling immediately before the animals were removed (afternoon of Day 10). The animals were fasted for 4h prior to sampling. One extrusa sample was collected from each steer after 20–60 min grazing on each occasion. Each sample was thoroughly mixed by hand, split into 2–4 subsamples, frozen and stored.

Sections of the frozen subsamples were later cut, thawed and oven dried. Equal weights of dry matter for each subsample for every day for each animal were bulked in Periods 1–4 and 7–8. For Periods 5 and 6, subsamples from each day were bulked, but samples from each day (1–4) were kept separate. The proportion of the C_{13}/C_{12} carbon isotopes (δ^{13} value) in each bulked sample was then measured to estimate the proportion of C_3 and C_4 plants in the diet (Jones *et al.* 1979).

The legume content of the diet was compared with that of the whole pasture (sum of all strata) and of a "grazed layer", defined in this experiment as the uppermost part of the sward that contained *c.* 700 kg herbage/ha. This was usually contained in the top two or three 10 cm strata. It represented the quantity of herbage expected to be eaten on the small paddock in 3 days by the steers at an average daily intake of 2.5% of body weight (2 steers × 3 days × 700 kg liveweight × 2.5% on 0.15 ha = 700 kg/ha).

Experiment 2

The 0.5 ha pasture used for the 1987 study was used again in 1988. The pasture was lightly grazed during the first half of the 1987–88 growing season and was slashed and fertilised with 120 kg/ha single superphosphate on January 20, 1988. There was no further grazing until March 28, when the 2 fistulated steers used in Experiment 1 were placed in the paddock, which was then continuously grazed at a stocking rate equivalent to 4 beasts/ha until the animals were withdrawn in mid-June. When grazing commenced, the pasture was sampled as described for Experiment 1, and this was repeated every 1 or 2 weeks. When the pasture was sampled, the animals were penned for 3h (1200–1500h) during the day for 2 consecutive days and an extrusa sample collected each day after they were released for subsequent afternoon grazing. Each sample was split into 3, so there were 12 subsamples (2 steers × 2 days × 3 samples) for each collection period. Each subsample was frozen. Sections were later cut, thawed, dried and ground. Subsamples from the 2-day grazing period for each animal were bulked and analysed as previously described.

After the extrusa samples were taken on the second day, samples of fresh faeces were collected from 3 dung pats, which had been recently dropped in the pasture, and then bulked. A subsample was dried and the proportion of carbon isotopes determined. Two other subsamples were taken from the bulked faecal sample. One was used to measure moisture content and the other was washed out to recover cassia seeds, using the technique of Jones and Bunch (1988). The objective was to determine if the presence of cassia seed in faeces gave an indication of its acceptability. The seeds were classed by observation into sound (normal) and unsound (abnormal, shrivelled) seed and seed of both types was germination tested.

As there was only a small proportion of C_3 plants in the pasture apart from cassia, usually <3% in 1987 and <1% in 1988, we have attributed the C_3 plants in extrusa or faeces to cassia.

Results

Rainfall and frosting

Rainfall during experimental grazing was above average in Experiment 1, but January–March rainfall in Experiment 2 (290 mm) was below the long-term average (461 mm). The site was lightly frosted in early June in both experiments.

Experiment 1

The green herbage on offer during each grazing period exceeded 3000 kg/ha DM for most of the experiment (Table 1), allowing considerable opportunity for selective grazing. At the February, March and April samplings, the cassia content was always above 40% in the whole pasture and above 50% in the grazed layer. Averaged over summer and autumn, 82% of the green grass was green panic, 10% was setaria and 8% other grass.

Averaging yield over all samplings from January–June, the cassia % in the pasture was higher in the post-grazing sampling (44%) than in the pre-grazing sample (38%), whereas the green panic % was higher in the pre-grazing sample (14%) than in the post-grazing sample (11%).

The percentage of cassia in the ingesta was always less than that in the whole pasture and the grazed layer (Table 1). During summer (December–February), cassia comprised <15% of the diet, compared with 20–50% of the grazed layer. It reached a peak of 22% in the extrusa in autumn (April–May). The 12% concentration of C_3 plants in the diet at the first sampling could reflect some selective grazing of the 1% "other dicot" component in the pasture as animals had been in the pasture for only 2 days prior to sampling. Cassia percentage in the diet was similar for both animals at 11.7 and 13.3%, averaged over all periods. The proportion of dead herbage in the diet, estimated from microscopic examination of extrusa, never exceeded 6% (authors, unpublished data), and was lower than that in the grazed layer in most measurement periods and much lower than that in the whole pasture.

The percentage of green cassia in the diet increased during each grazing period. The combined data for Periods 5 and 6, when cassia was most acceptable, were: Day 7, 5%; Day 8, 20%; Day 9, 24%; and Day 10, 34%. This trend reflected the increasing concentration of cassia at the top of the canopy as animals progressively

Table 1. Herbage yield on offer and the percentage of cassia in the whole pasture, in the grazed layer and in the extrusa samples of grazing cattle for 8 time periods in Experiment 1.

Period	Commencement date	Herbage on offer	Percentage composition[1]					
			Whole pasture[2]			Grazed layer[3]		Cassia in extrusa
			Green grasses	Dead herbage	Green cassia	Dead herbage	Green cassia	
		(kg/ha)				(%)		
1	15.12.86	3900	27	53	19	33	20	12
2	12.01.87	5000	31	39	27	7	39	4
3	09.02.87	6300	25	30	43	1	51	3
4	09.03.87	6900	23	26	48	2	61	9
5	06.04.87	9400	15	38	45	6	53	22
6	05.05.87	9400	17	44	36	12	54	19
7	01.06.87	8400	12	59	27	34	25	14
8	29.06.87	6500	17	59	23	38	22	15

[1]Data for the grazed layer are means of samples taken before and after grazing. Data for diet composition are means of 2 steers for 4 days.
[2]The remaining percentage (1–3%) consisted of other dicots. In Periods 7 and 8, 5% of the dead herbage was frosted cassia.
[3]Uppermost part of the canopy (see text). The remaining percentage consisted of green grass, except during Periods 7 and 8 when 19% and 10%, respectively, of frosted cassia was measured.

removed the grass and decreased the opportunity for further selective grazing. During the same 2 periods, the average cassia percentage in the top layers rose from 39% on Day 7 to 63% on Day 10.

The concentrations of both N and P in cassia were significantly (P<0.01) affected by position in the pasture profile — grazed layer (2.39 and 0.18%, respectively), intermediate layers (2.06 and 0.16%) and the lowest 2–10cm layer (1.54 and 0.12%), but K levels were similar throughout (mean 1.29%). Sulphur concentrations showed little variation — 0.10% in the grazed layer, 0.11% in the intermediate layers and 0.13% in the lowest layer.

Experiment 2

Total and green herbage yields were lower in Experiment 2 than in Experiment 1. This reduced the opportunity for selective grazing, particularly at the end of the grazing period, when there was only 710 kg/ha of green material (Table 2) compared with 2760 kg/ha in Experiment 1 (Table 1). The percentage of cassia in the pasture was again high in mid-autumn, but there was an increase in the percentage of dead material as the season progressed, with a corresponding decline in the percentages of green cassia and green grass. Averaged over all samplings, 83% of green grass was green panic, 11% was setaria and 6% other grass.

The percentage of cassia in the diet, whether estimated from extrusa or faecal samples, increased over the first 2 sampling periods, but was relatively constant thereafter. Cassia was discriminated against until the end of April, by which time the amount of green herbage on offer had fallen to approximately 2000 kg/ha. Averaged over the 9 grazing periods, the percentage of cassia in the diet of the 2 animals was similar (11.0% and 12.5%).

The cassia percentage in the diet, as estimated from faecal samples, was approximately twice that measured in extrusa samples. Both techniques showed that the cassia content of the diet was less than that of the pasture until the end of April. After that time, faecal analyses indicated that the cassia content of the diet exceeded that of the pasture, whereas analyses of extrusa indicated that it was similar.

The levels of sound cassia seed in the diet rose from 0.06 seeds/g OD faeces in the first sampling to about 3 seeds/g in mid-April, and remained at that level until the end of May, when they fell to 0.8 seeds/g (Table 2). The sound seed was 97% viable (60% hardseeded), whereas unsound seed had < 1% germination and no hard seed.

Table 2. Herbage yield on offer and the percentage of cassia in the whole pasture, in the grazed layer and in the diet (estimated from carbon isotope analysis of extrusa samples and faeces) and cassia seed levels in faeces, for 9 sampling dates in Experiment 2.

Period	Date	Herbage on offer	Percentage composition						
			Whole pasture[1]			Grazed layer	Cassia in diet estimated from		Cassia seeds per g OD faeces
			Green grasses	Dead herbage	Green cassia	Cassia	Extrusa samples[2]	Faecal samples	
		(kg/ha)				(%)			
1	28.03.88	5400	29	42	28	35	1	9	0.1
2	12.04.88	4400	20	40	40	41	6	13	0.1
3	19.04.88	5300	12	59	29	39	9	21	3.1
4	26.04.88	4310	17	53	28	na[3]	12	24	3.3
5	09.05.88	3900	22	61	16	na	14	21	3.2
6	23.05.88	3700	13	72	15	na	15	29	3.0
7	30.05.88	3000	16	65	18	na	21	29	2.3
8	07.06.88	3200	14	70	15	na	11	26	1.9
9	14.06.88	3400	11	79	10	na	16	26	0.8

[1]Other dicots never exceeded 1%.
[2]Data are means of 2 steers for 2 days.
[3]Not applicable as pasture was short.

Discussion

Cassia was less acceptable to animals than were the companion grasses throughout Experiment 1 where there was ample opportunity for the cattle to select. The difference between the percentage of cassia in the grazed layer and in the extrusa was greatest during summer and early autumn, but decreased thereafter. An enhanced acceptability of tropical legumes in autumn has also been observed for *Macroptilium atropurpureum* (Stobbs 1977; Walker *et al.* 1983) and *Stylosanthes* (Gardener 1984). However, with those legumes, the percentage legume in the extrusa samples during autumn was always greater than the percentage legume in the pasture. In contrast, while acceptance of cassia increased in late autumn in this experiment, the percentage in the extrusa samples was always less than the percentage in the pasture. Partridge and Wright (1992) also found a higher percentage of cassia in the diet of cattle in early winter than in summer or early autumn, although the differences were not as great as we recorded.

The same seasonal trends occurred in Experiment 2. Cassia was discriminated against until late autumn, but subsequently the percentage of green cassia in the extrusa was as high as, or greater than, that in the pasture. There was a much higher grazing pressure and much less opportunity for selection in this experiment than in Experiment 1.

The percentage of C_3 plants in the diet, as estimated from carbon isotope analysis of faeces, was consistently higher than that estimated from analysis of the extrusa (Table 2). Differences between the diet of resident steers estimated from carbon isotope assay of the faeces and diets of non-resident steers fistulated at the oesophagus have been reported in studies using several tropical legumes (Coates *et al.* 1987; Jones and Lascano 1991). In this study, there was a large difference in the estimates of diet legume using the 2 methods even though the fistulated steers in Experiment 2 were also the resident steers.

The different results from isotopic analyses of faeces and extrusa from the same animals have obvious implications for the use of fistulated animals to measure diet composition. One possible reason for the difference is that there is variation in selection throughout the day. Such variation would not be reflected in the faecal samples but would be reflected in the extrusa samples taken at one point in time. Such diurnal variation has been measured in animals grazing leucaena (R.J. Jones, personal communication). On the few occasions when extrusa samples were taken in the morning and afternoon in Experiment 1, there were no obvious differences (authors, unpublished data). However, these measurements were made only at the start of Experiment 1 when there was little cassia in the extrusa. Another possibility is that the fistulated steers had an atypical selection pattern when released to graze after fasting prior to sampling.

Levels of cassia seed in faeces in Experiment 2 reached a peak of 3 seeds/g oven dry dung during the main seeding period which occurred in late autumn. Other experiments confirm that these levels are reached only when cassia is seeding profusely and there is limited opportunity for selection (R.M. Jones, unpublished data). In pastures where there is more opportunity for selection, even in the presence of high cassia seed loads, levels of seed in faeces are closer to 1 seed/g oven dry faeces, similar to the 0.8 seeds/g measured by Partridge and Wright (1992). These low levels compare with seed levels of 10–100 white clover seeds per g of faeces from cattle grazing good white clover-based pastures in periods of heavy seeding (Jones 1982), even though the soil seed reserves, and presumably seed set, are similar for pastures of white clover and cassia (R.M. Jones, unpublished data). Thus, these data support the finding from extrusa and faecal analyses that, even in mid-to late autumn, cassia will still be avoided if grazing pressure is low.

The preference of cattle for grass rather than cassia in the growing season has important implications for the persistence of cassia in pastures. Clements (1989) showed that, over a wide range of grazing pressures, fewer growing points of cassia were grazed than those of Siratro (*Macroptilium atropurpureum*) and *Centrosema virginianum*. This was partly attributed to growth habit and partly to palatability. This is likely to give cassia a competitive advantage and will also aid seed set of cassia and hence long-term persistence (Jones *et al.* 1993).

Although cassia yielded up to 4 t/ha in Experiment 1, with no visual signs of S deficiency, the S concentration and N:S ratio could be indicative of S deficiency in the plant (Partridge and Wright 1993). In one instance, where cassia was extremely unpalatable in a pasture near Bundaberg, south-east Queensland, cassia plants contained only 0.13% P and 0.12% S and the soil had only 2 ppm bicarbonate extractable P (R. Cheffins, personal communication). The plant P% was lower than we measured, whereas the S levels were similar. This suggests that the different P levels at the 2 sites may have been responsible for the different acceptability of cassia. Low P levels in stylo are known to reduce its palatability (McLean *et al.* 1981). However, S application has also increased acceptability of *Desmodium ovalifolium* (Lascano and Salinas 1982). Thus, although it has been demonstrated that cassia is eaten by animals, and can increase liveweight gain (Partridge and Wright 1993), further study of the effect of P and S on cassia palatability is required.

Acknowledgements

We thank Mr R.F. Needham and Mr A.C. Brooks for valuable technical assistance, Mr R. Le Feuvre for analysis of carbon isotopes, and Mr A.D. Johnson and staff for chemical analyses. Mr Valdes' visit to the CSIRO Division of Tropical Crops and Pastures was financed by FAO.

References

AHN, J.H., ELLIOTT, R. and MINSON, D.J. (1988) Quality assessment of the fodder legume *Cassia rotundifolia. Tropical Grasslands*, **22**, 63–67.

ANON. (1990) *Cassia rotundifolia* Pers. In: Oram, R.N. (ed.) *Register of Australian Herbage Plant Cultivars*. p. 284. (CSIRO: Melbourne).

CLEMENTS, R.J. (1989) Rates of destruction of growing points of pasture legumes by grazing cattle. *Proceedings of the XVI International Grassland Congress, Nice, 1989*. pp. 1027–1028.

COATES, D.B., SCHACHENMANN, P. and JONES, R.J. (1987) Reliability of extrusa samples collected from steers fistulated at the oesophagus to estimate the diet of resident animals in grazing experiments. *Australian Journal of Experimental Agriculture*, **27**, 739–745.

GARDENER, C.J. (1984) The dynamics of Stylosanthes pastures. In: Stace, H.M. and Edye, L.A. (eds) *The Biology and Agronomy of Stylosanthes*. pp. 333–357. (Academic Press: Sydney).

JONES, R.J., LUDLOW, M.M., TROUGHTON, J.H. and BLUNT, C.G. (1979) Estimation of the proportion of C_3 and C_4 plant species in the diet of animals from the ratio of natural ^{12}C and ^{13}C isotopes in the faeces. *Journal of Agricultural Science, Cambridge*, **92**, 91–100.

JONES, R.J. and LASCANO, C.E. (1991) Oesophageal fistulated cattle can give unreliable estimates of the proportion of legume in the diets of resident animals grazing tropical pastures. *Grass and Forage Science*, **47**, 128–132.

JONES, R.M. (1982) White clover (*Trifolium repens*) in subtropical south-east Queensland. I. Some effects of site, season and management practices on the population dynamics of white clover. *Tropical Grasslands*, **16**, 118–127.

JONES, R.M. and BUNCH, G.A. (1988) A guide to sampling and measuring the seed content of pasture soils and animal faeces. *Technical Memorandum No. 59, Division of Tropical Crops and Pastures, CSIRO, Australia*. 13pp.

JONES, R.M., MCDONALD, C.K. and BUNCH, G.A. (1993) Persistence of roundleaf cassia in grazed pastures — a conceptual model. *Proceedings of the XVII International Grassland Congress, Rockhampton, 1993*. pp. 1902–1903.

LASCANO, C. and SALINAS, J.G. (1982) Efecto de la fertilidad del suelo en la calidad de *Desmodium ovalifolium* 350. *CIAT Boletin Informativo de Pastos Tropicales*, **7**, 4–5.

MCLEAN, R.W., WINTER, W.H., MOTT, J.J. and LITTLE, D.A. (1981) The influence of superphosphate on the legume content of the diet of cattle grazing *Stylosanthes* — native grass pastures. *Journal of Agricultural Science*, **96**, 247–249.

NORTHCOTE, K.H. (1979) *A Factual Key for the Recognition of Australian Soils*. 3rd Edn. (Rellim: Adelaide).

PARTRIDGE, I.J. and WRIGHT, J.W. (1992) The value of roundleafed cassia (*Cassia rotundifolia* cv. Wynn) in a native pasture grazed with steers in south-east Queensland. *Tropical Grasslands*, **26**, 263–269.

PARTRIDGE, I.J. and WRIGHT, J.W. (1993) Sulphur responses by legumes on soils derived from granodiorite in south-east Queensland. *Tropical Grasslands*, **27**, 48–52.

STOBBS, T.H. (1977) Seasonal changes in the preference by cattle for *Macroptilium atropurpureum* cv. Siratro. *Tropical Grasslands*, **11**, 87–91.

STRICKLAND, R.W., GREENFIELD, R.G., WILSON, G.P.M. and HARVEY, G.L. (1985) Morphological and agronomic attributes of *Cassia rotundifolia* Pers., *C. pilosa* L. and *C. trichopoda* Benth., potential forage legumes for northern Australia. *Australian Journal of Experimental Agriculture*, **25**, 100–108.

STRICKLAND, R.W., LAMBOURNE, L.J. and RATCLIFF, D. (1987) The palatability, feeding value and apparent toxicity of 150 legume species. *Genetic Resource Communication No. 10, Division of Tropical Crops and Pastures, CSIRO, Australia*. 16pp.

WALKER, B., RUTHERFORD, M.T. and WHITEMAN, P.C. (1983) Diet selection by cattle on tropical pastures in northern Australia. *Proceedings of the XIV International Grassland Conference, Lexington, Kentucky, 1981*. pp. 681–684.

(Received for publication November 18, 1994; accepted April 24, 1996)