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SEASONAL DISTRIBUTION OF HERBAGE GROWTH FROM SANDPLAIN MULGA COUNTRY, CHARLEVILLE

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Abstract

Soil moisture may be adequate for rapid plant growth for prolonged periods at any time of year in the Charleville district. However, in pastures growing on mulga soils (acid, red earths), the majority of herbage is produced during the warm summer season (October 1 - March 31). Winter rains have to be well above average for herbage grown during these months to exceed 50% of annual production. The predominance of summer-growing (C_4) grasses and absence of cool season grasses in the regional flora is the main reason for this pattern.

The density of mulga scrub has no effect on seasonal distribution of herbage production despite major differences in botanical composition. Increased tree density reduced herbage yields but increased the protein and mineral content of this fodder.

Introduction

Management in Australia's rangelands would be easier if pastoralists could predict the likely feed supply at key times of the year. This is possible in the far north (e.g., Julia Creek, Katherine) when 90% of the year's rain falls between October and March (Fitzpatrick and Nix, 1970), and in the south (e.g., Peterborough, Kalgoorlie) where effective rains and temperature combine to restrict most pasture growth to the period April to September. Nonetheless, southern rangelands receive about half their total annual rainfall during the summer (October to March).

At intermediate latitudes (24-32° S), where good rains can occur in both summer and winter, the expected pattern of growth may not be predicted as easily. At Charleville and Alice Springs, about 70% of the annual rain falls between October and March. However, less rainfall is needed in the cooler months for effective plant growth because evaporative demand is lower then. Good pasture growth could theoretically occur in any month except during unusually cold periods in mid-winter (Silcock, 1973).

In these mid-latitude zones, species which are comparatively insensitive to temperature will grow in summer and winter, given adequate soil moisture, e.g., mulga (*Acacia aneura*) (Nix and Austin, 1973), parakeelya (*Calandrinia* spp.) and many chenopods. Some important mulga grasses — mulga Mitchell (*Thyridolepis mitchelliana*), mulga oats (*Monachather paradoxa*) and greybeard grass (*Amphipogon caricinus*) — have this capacity also. In contrast, the dominant grass in the Mitchell grasslands, *Astrebla* spp. are strongly winter dormant (Christie, 1981). Hence, property managers in the mulga lands of SW Queensland may be justified in expecting a less strongly seasonal pattern of pasture growth through the year, despite contrary existing evidence from short term studies on grasses (Christie, 1978).

This paper reports results from regular herbage samplings taken on exclosures in mulga country at Charleville from 1970 to 1976, plus some data from the wet 1981 winter. They indicate that the method used for assessing future carrying capacity on Mitchell grass pastures (Beale, 1983), also holds for mulga pastures in South-West Queensland.

Methods

Two sites about 2 km apart on the same soil (1.5 m deep, sandy red earth - Gn2.12) were fenced to exclude all herbivores except rabbits. Site 1 was undisturbed dense mulga (1,200 trees ha^{-1}) supporting a sparse understorey of grasses and herbs. Site 2 was an induced grassland where regenerating mulga shrubs were regularly bulldozed out and all remaining young shrubs were removed by hand at the start of the trial.

Each site was pegged out to provide eight replicate, one metre square plots for six defoliation treatments as part of another experiment (Silcock, 1973). Only one treatment is reported here. Every two months, the same eight plots at each site were cut using hand shears, and the herbage harvested was sorted into grasses and non-grasses, oven dried and weighed. Harvests were taken from June 1970 until August 1976.

Twelve random 1 m^2 quadrats were also harvested from an unstocked native pasture in September 1981 following an excellent winter growing season (Table 1). These quadrats were located in a treeless paddock close to Site 1. Similar adjacent paddocks sown in 1975 to adapted grasses were also sampled where the grasses of interest (*T. mitchelliana* and *Cenchrus ciliaris* Q10077) were growing in patchy, but dense monospecific stands. All these paddocks had been grazed to ground level in March 1981 and then left stock-free. These data were collected to indicate the potential winter herbage yield of cleared mulga country.

Table 1. Monthly precipitation/pan evaporation (expressed as a percentage) for Charleville from 1968 to 1984 inclusive. Months with P/E 50% are in bold type. (Raw data supplied by Commonwealth Bureau of Meteorology).

Year (Oct-Sept)	OCT	NOV	DEC (SUMMER)	JAN	FEB	MAR (MONTH)	APR	MAY	JUN (WINTER)	JUL	AUG	SEP
1967/68				19	15	25	32	49	19	23	15	1
1968/69	0	2	11	15	2	36	0	18	10	8	5	4
1969/70	7	11	15	12	8	25	8	0	1	0	3	**51**
1970/71	3	6	14	17	25	28	6	2	2	31	31	32
1971/72	5	16	**55**	5	3	5	0	39	0	0	4	5
1972/73	0	26	6	7	**121**	4	25	1	4	**88**	31	22
1973/74	29	49	17	**91**	5	8	30	7	19	0	41	12
1974/75	24	11	5	16	24	31	2	0	31	19	35	6
1975/76	18	1	**60**	**64**	**114**	28	0	49	1	26	2	9
1976/77	9	7	14	27	31	**82**	17	**70**	33	1	0	2
1977/78	4	3	4	26	9	4	4	**74**	**73**	**108**	**71**	42
1978/79	11	14	9	4	37	15	9	33	24	1	3	16
1979/80	7	3	1	11	14	15	4	17	3	48	12	0
1980/81	47	6	16	10	11	11	13	**79**	**92**	**51**	1	1
1981/82	19	12	3	20	0	**60**	3	10	0	1	0	4
1982/83	3	0	6	12	14	22	**113**	**217**	42	8	28	3
1983/84	2	**51**	19	**85**	6	12	10	1	12	**137**	4	5

Results

Herbage yields were much lower at Site 1 than Site 2, often by a factor of ten or more until late 1973. At best, early herbage yields at Site 1 were half those at Site 2 over a two month period in the wet 1973-74 summer (Fig. 1). However, after the 1973-74 summer, most *Aristida* spp. died out at Site 2 under this 2-monthly clipping regime and did not regenerate quickly. Summer yield peaks were consistently greater than winter ones over the period 1970-76 and little herbage was produced in the comparatively wet 1973 winter (214 mm). Summer rainfall was always greater than that of the succeeding winter but its effectiveness was not necessarily greater when expressed as a percentage of evaporative demand, e.g., 1970-71 and 1974-75 (Table 1). Hence, gross moisture conditions do not seem to be strongly controlling pasture production in the Charleville region.

Prolonged high soil moisture supplies appear to be needed in winter for large dry matter yields to be produced (P/E values greater than 50 compared to about 30 in summer months). Such conditions did occur in the winters of 1978, 1981 and 1983. By September 1981, mean herbage yield of natural mulga pastures in the treeless paddock close to Site 1 was 225 gm^{-2} (S.E. ×19), of which only 3.4% was contributed by grasses, mostly *Aristida* spp. (wiregrass). Annual forbs such as *Haloragis odontocarpa* (mulga nettle) and *Velleia glabrata* (smooth velleia) contributed most of this herbage. In pure stands, each of these two forbs produced up to 280 g DMm^{-2} over restricted areas. By comparison, isolated small (1-3 m^2) areas of pure *Thyridolepis mitchelliana* (mulga mitchell) and *Cenchrus ciliaris* Q10077 (buffel grass) had grown only 190 gm^{-2} and 90 gm^{-2} respectively, in the same period. Where the density of grass tussocks was high (4-5% basal cover), forb growth was lower.

Table 2. Proportion of the annual (October to September) dry matter produced during summer (October to March) from two mulga pastures at Charleville between 1970 and 1976.

Year	Percentage of dry matter grown during summer (Oct-Mar inclusive) Site 1	Site 2	Summer (Oct-Mar) rainfall (mm)	Winter (Apr-Sep) rainfall (mm)
1970/71	82.5	78.8	288	153
1971/72	84.5	93.5	306	89
1972/73	61.2	66.1	459	214
1973/74	98.4	92.4	514	145
1974/75	98.7	93.3	292	110
1975/76	95.0	95.5	568	97
Mean	86.7	86.6	404	135
Mean annual yield (1970-76)	(12.5 gm^{-2})	(64.9 gm^{-2})	(330)*	(154)*

* Long-term (1881-1980) Charleville mean seasonal rainfall.

Table 3. Nitrogen and phosphorus contents of bulked herbage on two occasions from plots on mulga pastures that had been clipped regularly every two months. Standard deviations are given in parenthesis. Where no SD is shown, there was insufficient material for more than one chemical analysis.

	Site 1 %N	Site 1 %P	Site 2 %N	Site 2 %P
Clipping date 5th April, 1971				
Grasses	1.84	0.10	1.03) (±0.02)	0.08 (±0.007)
Dicotyledons	2.59	0.12	1.74	0.11
Clipping date 3rd August, 1973				
Grasses	1.94 (±0.01)	0.08 (±0.0)	1.47 (±0.05)	0.10 (±0.007)
Dicotyledons	2.47 (±0.08)	0.12 (±0.0)	1.98 (±0.06)	0.10 (±0.007)

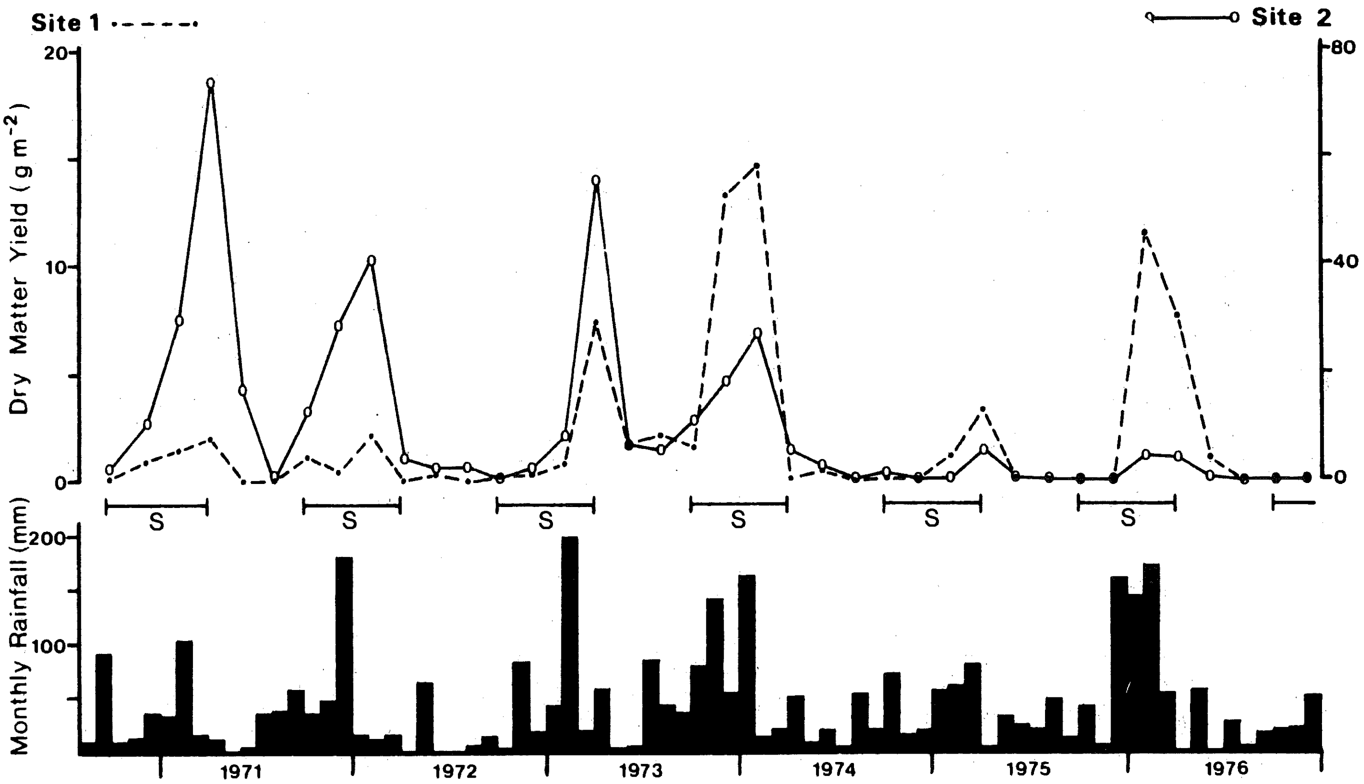

Fig. 1. Herbage dry matter production at two-monthly intervals from exclosed plots on two sites near Charleville, south-western Queensland.
Site 1 (under mulga scrub) ----
Site 2 (**Aristida** grassland on mulga soil) ——
Monthly rainfall (August 1970 to November 1976) at Charleville is shown as a histogram below. S indicates the summer period.

Hence, good winter pastures came mostly from ephemeral forbs, not perennial grasses. Unfortunately, yields of these forbs were not great except in prolonged wet winters. Thus, most of the herbage produced each year from 1970 to 1976 came from summer growth irrespective of seasonal conditions (Table 2). Botanical composition did not affect the result; 55% (minimum 9%) of the dry matter from Site 1 came from non-grasses (dicots) (mostly *Sida* spp., *Hibiscus sturtii* and *V. glabrata*) while at Site 2, dicots contributed an average of only 3% (0-12%, mostly *Muelleranthus trifoliolatus* and *Sida* spp.). The site and botanical composition did, however, influence the quality of the herbage grown (Table 3). Protein levels were higher in the herbage growing under the shade of mulga trees in both winter and late summer. The grasses always had lower protein content than the companion dicotyledons.

Discussion

Despite a different soil and vegetation type, the guideline for southern Mitchell grass downs - that about 90% of annual forage is grown in summer - (Beale, 1983) also applies to mulga country. There will be important exceptions, e.g., 1972-73, 1977-78, 1980-81 and 1982-83, but these are abnormal winters for Charleville. However, most of the ephemeral herbage produced in good winters withers and either crumbles or becomes unpalatable to animals once hot weather returns. By comparison, the summer growth is predominantly by grasses which hay-off in autumn and remain standing as a drought reserve. Also, unlike the annual winter herbage species, many of the grasses are perennial and can make limited winter growth if good rains fall (Wilcox, 1973 and this paper).

The reason that summer rainfall is more effective at producing pasture growth in the Charleville region needs elucidation. Nix and Austin (1973) consider that mulga will not grow where effective rains are strongly seasonal. Table 1 reinforces this opinion and shows that between 1967 and 1984, winter rains were apparently as biologically available as summer rains. Depth of soil moisture recharge may be greater in summer than winter due to the greater amount of rain which often falls in summer. However, total recharge of the 1.5 m deep profile of sand plain mulga lands in this region (and even super-charging where hard pans exist) requires only about 150 mm of water and is known to occur sporadically from both summer and winter rains (Silcock, unpublished data). Therefore, the greater effectiveness of summer rains for producing pasture growth appears to be related more to the botanical composition of the pastures rather than soil moisture availability.

Perennial winter-active/summer-dormant grasses are unknown on Mitchell grass country and the relatively rare *Stipa scabra* is the only such species found on mulga country in the region. However, in mulga country, there are three major perennial grasses which, though growing most rapidly in summer, can also produce significant winter growth if soil moisture is available. These are *T. mitchelliana, M. paradoxa* and *A. caricinus* and, like *S. scabra*, they are C_3-type grasses. The vast majority of the other grass species are C_4 types (Hattersley, 1983) which grow very rapidly in summer. If all forage production came from grasses, a summer dominance would automatically follow given the species present.

However, the grasses did not always dominate the vegetation, especially under dense mulga at Site 1 (av. 55% non-grasses). Here, perennial C_3 herbs such as *Sida* sp., *H. sturtii* and *Cheilanthes sieberi* (mulga fern) were dominant except in very wet winters when the annual forbs assumed dominance. Nonetheless, these C_3 perennial herbs also grow dry matter at a much faster rate in summer than in winter, although peak yields of about 200 kg ha^{-1} yr^{-1} are well below those of the grasses (O'Donnell *et al.*, 1973). Only in prolonged wet winters do the annual forbs on both mulga and Mitchell grass country get a chance to produce in excess of 1,000 kg ha^{-1} of dry matter before seeding and dying.

Hence, the summer-growing C_4 perennial grasses are the ones best situated to regularly contribute significant amounts of forage, especially from sporadic falls of rain. The major ones on mulga country are *Aristida* species (especially *A. armata* and *A. jerichoensis*), *Digitaria* species, *Eriachne* spp., *Panicum* spp. and *Eragrostis* spp. These can yield over 1,000 kg ha^{-1} in one average growing season (O'Donnell *et al.*, 1973; Ross, 1977; Pressland and Lehane, 1980). On Mitchell grass country where yields may often exceed 1,500 kg ha^{-1}, *Astrebla lappacea* (curly Mitchell) and *A. elymoides* (hoop Mitchell) dominate, but common grasses include *Aristida latifolia*, (feathertop), *Aristida leptopoda* (white spear) and *Dicanthium sericeum* (Qld bluegrass). In an environment where good winter growth is possible and perennial forbs are common, why are there no common winter-active perennial grass such as the *Agropyron* and *Stipa* species which occur on the American prairies?

Hattersley (1983) has documented the richness of C_4 species in the grass flora of the region (167 native C_4 grasses and only 17 C_3 ones). He postulates that this is probably because the normally dry spring conditions in the area do not favour growth of C_3 grasses. Seed production, so vitally important to the persistence of rangeland species, would be particularly severely affected by regularly dry spring weather. However, species richness and dry matter production are not related parameters, so this explanation is not complete. A single, adapted perennial C_3 grass species could produce good winter dry matter yields in appropriate years, just as *Stipa variabilis* does in southern New South Wales. Persons undertaking plant introduction work in the future, should not lose sight of these apparent anomalies in their search for adapted pasture species.

There is also the possibility that summer droughts in the area are so severe when they do occur, that the biochemistry of typical cool growing-season grasses cannot withstand the combination of high temperatures and high moisture stress. The reverse, i.e. low ambient temperatures and high moisture stress does not seriously affect many warm-season grasses, e.g. *Eragrostis* and *Astrebla* spp.

Thus, the dominance of summer active grasses in determining annual forage production overrides seasonal rainfall patterns except in prolonged wet winters. An assessment of available forage at the end of summer on all classes of country in western Queensland is sufficient to allow a manager to decide on the number of adult stock which can be run safely in the next 12 months. When unusually wet (bonus?) winters do occur, projected alterations in stock numbers can be delayed until spring or the bonus may be reaped in better breeding performance or by a greater turn-off of fat stock. There appears to be little advantage in purchasing extra stock to reap the benefits of an exceptionally good winter.

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