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GRAZING MANAGEMENT OF NATIVE AND NATURAL PASTURES ON THE NORTHERN SLOPES OF NEW SOUTH WALES

by

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PREFACE

I certify that the experimental work detailed in this thesis has not already been submitted for any degree and is not currently submitted for any other degree. Any assistance received in the preparation of this thesis, and all sources used, have been acknowledged in the thesis.

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SUMMARY

Native and natural pastures comprise 70% of the 2.9 million ha of agricultural land on the Northern Slopes of New South Wales. These pastures are dominated by warm season frost-susceptible native perennial grasses that have a low availability of winter green forage. Little is known of the grazing value of the individual native perennial grasses, their response to fertility and their ecology and phenology. The responses of individual species to management is largely unknown and there are few objective data on which to assess their desirability or undesirability as pasture species. If valuable native grasses for grazing could be identified in these pastures then management could well be directed at increasing their abundance.

Studies were conducted on the eight dominant native perennial grasses of the region to obtain preliminary data on which to classify the desirability of these grasses as pasture species. The grasses studied were the warm season native perennial grasses Aristida ramosa R.Br. (wiregrass), Bothriochloa macra (Steud.) S.T. Blake (redgrass), Dichanthium sericeum (R.Br.) A. Camus (bluegrass), Sporobolus elongatus R.Br. (slender rat's tail), Eragrostis leptostachya Steud. (lovegrass), and Chloris truncata R.Br. (windmill grass), and the yearlong green native perennial grasses Danthonia linkii Kunth (wallaby grass) and Stipa scabra Lindl. (corkscrew grass).

Native and natural pastures are complex plant communities containing up to 100 species within a single paddock. Many of these species have similar leaf characteristics making accurate identification difficult and often data may need to be collected for both major and minor species in the pasture. Existing techniques for measuring species herbage mass are often inappropriate. Two methods of estimating the herbage mass of native perennial grasses were devised and tested. Both involved the harvesting of individual plants in the field and the measurement of their components of herbage mass (basal area and mass per unit of basal area) and the number of plants per unit area (plant density). Firstly, basal area and herbage mass data collected from individual plants, together with plant density estimates were used to calculate the herbage mass (kg ha^{-1}) of an individual species. For different species different components of herbage mass change in response to management and all three components of mass therefore needed to be measured. These estimates of individual species herbage mass were collected rapidly and

were sufficiently accurate for preliminary evaluation and survey studies. The second, and more accurate method of estimating herbage mass, involved the collection of data from all of the plants of an individual species contained within randomly allocated quadrats. For such data the mean herbage mass and its standard error can be calculated and also the relative importance of plant basal area, mass per unit of basal area and density can be assessed.

If the ecology of these pastures is to be fully understood a greater knowledge of how individual species react to varying fertility conditions is required. The application of phosphorus (P), sulphur (S) and nitrogen (N) in the glasshouse, and superphosphate in the field, positively increased the yield of most of the native grasses examined. Within the native grasses there were significant ($P < 0.05$) yield differences; B. macra, C. truncata and D. sericeum produced up to twice as much herbage mass as either A. ramosa, S. elongatus or E. leptostachya. Hence, herbage mass response to applied fertilizer would depend largely on the species composition of the pasture. P, S and N were all essential for maximum response in some native grasses and large imbalances in the level of these nutrients resulted in seedling mortalities in most species.

Preliminary estimate of the relative grazing value of the different species were obtained from studies of the seasonal growth patterns of different species together with analyses of the total nitrogen (crude protein) and in-vitro digestibility of the forage produced. The preliminary results indicated that D. linkii is potentially valuable for grazing and that A. ramosa is an undesirable pasture species. Of the other grasses tested C. truncata and E. leptostachya may produce some green forage in autumn and winter, but at these times the green forage production of A. ramosa, B. macra, D. sericeum and S. elongatus is limited by low temperatures. These rankings will need to be further confirmed by diet selection and animal production studies. However, A. ramosa occurs commonly in the region whereas D. linkii occurs less frequently. To substantially increase the carrying capacity of these pastures, and increase returns to the producer, grazing management schemes need to be constructed with the aim of increasing the abundance of species such as D. linkii, and decreasing the abundance of A. ramosa.

To construct such grazing systems data was collected on the dormancy and germination of seeds, the emergence and survival of seedlings and the flowering of mature plants of the eight species studied. Laboratory investigations indicated that maximum germinations would occur from late autumn to early spring for the yearlong green species and from late spring to early autumn for the warm season grasses. Freshly harvested seed always showed some germination. Hence, germination of fresh seed would occur in the field if temperature and moisture conditions were suitable. The primary role of dormancy in the survival of these species, therefore, appeared to be to extend the period of germination ensuring that not all seeds germinated with the first occurrence of suitable rainfall. In the field the most favourable period for the successful emergence and establishment of warm season grasses, such as A. ramosa, was from mid-summer to early autumn. Yearlong green native perennial grasses, such as D. linkii, established best from seedlings that appeared from mid-autumn to late winter. In natural pasture only two of the seedlings studied flowered, over 700 days after emergence, and many others after persisting for up to 2 years died without producing seed. Hence, the adult populations of the eight grasses studied were relatively stable with little recruitment occurring.

For all of the grasses studied the inflorescences did not emerge until the average minimum temperature was about 15^{o}C and the actual minimum temperature exceeded 5^{o}C. All of the warm season native perennial grasses, except C. truncata exhibited only one main flowering period, commencing in late spring and summer. However, in C. truncata, S. scabra and D. linkii the appearance of inflorescences in late spring or early summer may be followed by another flowering period in early autumn provided summer rainfall has been adequate. In all species seed fall was generally completed by mid-winter.

A grazing management system was constructed to match the timing and intensity of grazing to the phenology of the species, with the aim of discouraging A. ramosa, and favouring D. linkii plants and seedlings. The system basically consisted of grazing from mid-summer to early autumn and the resting of pasture from grazing from mid-autumn until early summer.

The grazing management system was evaluated from November 1979 to December 1982 at three experimental sites. During this period rainfall was generally below average. These dry conditions would have enhanced the effect of heavy grazing on the abundance of *A. ramosa*, but would have been unfavourable for the seeding and seedling establishment of *D. linkii*.

The first of these studies was designed to investigate the interaction between main plot sheep and cattle grazing treatments and sub-plot treatments of slashing, burning and herbicide applied in either spring 1979 or autumn 1980. Main plots were grazed during the period from November to April each year by sheep and cattle at a rate equivalent to 39.2 dry sheep equivalents (DSE's)/ha/year and by sheep at 4.9 DSE's/ha/year.

Three cycles of heavy grazing by sheep in summer decreased *A. ramosa* herbage mass from around 2000 to zero kg ha^{-1} and reduced plant density from 30 to zero plants m^{-2}. Cattle grazing at the equivalent stocking rate also substantially reduced *A. ramosa* herbage mass, but tended to fragment the *A. ramosa* tussocks leading to an initial increase in plant density. Over the period of the experiment the percentage basal cover of *A. ramosa* decreased from an initial mean level of about 12% to 0.2% and 2.8%, respectively in the high stocking rate (HSR) sheep and cattle plots and to 4.7% in the low stocking rate (LSR) sheep plots. By the end of the experiment *A. ramosa* had been almost eliminated from the HSR sheep grazing treatments, and the plots were dominated by the warm season native perennial grass *B. macra*. However, *A. ramosa* still dominated the LSR sheep plots with a herbage mass of 1200 kg ha^{-1} and a mean plant density of about 25 plants m^{-2}.

Because of the large effect of grazing at high stocking rate the sub-plot treatments could only be examined at the low stocking rate. All of the sub-plot treatments applied in both spring and autumn reduced herbage mass by at least 50% with slashing and burning having the greatest initial effect. Over the period of the experiment there were no consistent effects of treatment on *A. ramosa* plant density. Slashing reduced plant density from 30 to 20 plants m^{-2}; herbicide from 30 to 1[illegible] plants m^{-2} and burning from 32 to 26 plants m^{-2}. Treatment application in all plots in either spring or autumn decreased mean *A. ramosa* basal cover from around 13% to 4%.

In a second experiment grazing for 6 months of the year at stocking rates equivalent to 29.4 DSE's/ha/year also substantially reduced the herbage mass and abundance of *A. ramosa*. Again sheep were more effective than cattle, reducing *A. ramosa* from 900 to 20 kg ha^{-1} of herbage mass and from 20 to nearly zero plants m^{-2}. In this study heavy grazing, particularly by sheep increased the abundance of the yearlong green native perennial grasses, mainly D. linkii. At the start of the experiment the percentage basal cover of the warm season grasses was 11 times greater than that of the yearlong green species. By the end of the experiment, however, the yearlong green grasses were 13 times more abundant than the warm season grasses in the HSR sheep plots. In the LSR sheep plots the percentage basal cover of the warm season grasses was 27 times that of the yearlong green grasses. The different effects of grazing on botanical composition in this and the previous experiment were probably related to the different levels of A. ramosa herbage mass and abundance at the two sites.

In both of the above grazing studies a high rate of stocking with sheep substantially reduced the plant mass, basal area, mass per unit basal area and density of A. ramosa. Plant density and basal area were the only significant ($P < 0.05$) components of A. ramosa herbage mass.

A third experiment investigated the effects of summer and early autumn grazing at a rate of 7.5 sheep/ha/year, and late autumn, winter and spring resting from grazing on the herbage mass and abundance of D. linkii. Continuous grazing at 7.5 sheep/ha/year together with dry conditions reduced the herbage mass and density of D. linkii to a low level in the pasture. Rest-rotational grazing based on D. linkii phenology increased D. linkii herbage mass from 125 to as high as 400 kg ha^{-1}, and density from around 12 to over 50 plants m^{-2}, despite adverse seasonal conditions.

These results indicated that grazing management systems based on a knowledge of species phenology can be used to manipulate species composition in natural pasture, decreasing the abundance of A. ramosa, and increasing the abundance of D. linkii. Further experiments are being conducted in an attempt to achieve similar changes in pasture species composition on a larger scale (paddocks of 50-120 ha) and to assess methods of successfully incorporating this grazing management system into the whole farm situation.

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