Regeneration and recruitment of curly mitchell grass *(astrebla lappacea)* in degraded pastures in north western New South Wales

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Summary. The dynamics of a severely degraded Mitchell grass pasture were studied in north western NSW from 1986 to 1993. In 1986 the living remains of the Mitchell grass stand were small parts of old tussocks at a density of 0.02/m^2. Three treatments were imposed: (i). ungrazed-unsprayed; (ii). ungrazed-sprayed; and (iii). grazed-unsprayed. By 1993 the total number of mature and young Mitchell grass plants/m^2 on the three treatments were: (i). 1.4.6; (ii). 1.71; and (iii). 0.01. Results showed that Mitchell grass could regenerate providing animals were excluded when the plants were flowering and seedlings and young plants establishing. The rate of regeneration of Mitchell grass depends on the initial density and the frequency of good summer rain.

Introduction

Mitchell grass (Astrebla spp.) pastures once occupied 4,600 km2 of New South Wales (NSW) (3). Severe degradation over the past 100 years has resulted in large areas of Curly Mitchell grass (Astrebla lappacea) being replaced by Mediterranean-type annual- weeds (I) due to floods, overgrazing, drought and cultivation. This paper reports one method of restoring Mitchell grass, i.e., by natural regeneration and recruitment.

Materials and methods

The site of the experiment was a severely degraded Mitchell grass pasture on self-mulching clay soil 10 km east of Walgett. The pasture, once a strong Mitchell grass stand with I to 3 tussocks/m2, was dominated by a Brassica weed association (40% ground cover of Raphistrum rugosum and 7% of other Brassicas and associated weeds in October 1986). Three treatments were imposed: ungrazed-unsprayed; ungrazed-sprayed; and grazed-unsprayed. The ungrazed treatments were fenced in June 1986. The ungrazed-sprayed treatment was sprayed on 18 August 1986 (glyphosate 0.54 kg a.i./ha); and 30 July 1987 and 28 May 1988 (2,4-D amine 0.7 kg a.i./ha); and slashed on 10 September 1990. The grazed-unsprayed treatment was stocked at 0.25 d.s.e./ha as part of the 320 ha paddock adjoining the experiment. The ungrazed treatments (each 30 x 8.3 m) were in a randomised block with 4 replications. The four replications of the grazed-unsprayed treatment (each 15 x 8.3 m) were outside the fence but adjacent to the ungrazed treatments.

Counts of Mitchell grass plants were made in response to major rainfall events in summer and autumn because it was then that seedling recruitment occurred. The terminology in reference to plant size was: mature, large plants with > 70 cm2 basal area; young, developing plants with > 10 leaves, generally 3 to 15 months old; and, seedlings, small plants with I to 10 leaves, generally I to 3 months old. Ground cover of resident plants was recorded each year whilst basal area and seedhead production were recorded intermittently. The number of viable Mitchell grass seeds in the soil was ascertained in February 1988 and August 1992 by taking 10 random soil cores (2 cm diameter x 7.5 cm deep)/33 m^2; also in August 1992, 280 random soil cores were taken in the 10 ha of the paddock surrounding the experiment.

Results

Plant population

In 1986 living Mitchell grass plants were small parts of the original tussocks with a mean basal area of 0.1 cm2/plant and a density of 0.02 plants/m2. The density of apparently dead plants was 0.3/m2. Between 1986 and May 1988 some of these apparently dead plants recovered, thus increasing density of living plants on each treatment (Table 1).

Table I. Effect of protection from grazing and reduction of weed competition (by spraying herbicides) on the density of Mitchell grass plants

Observation date		Plants/m^2					
		Mature[a]			Seedlings/Young plants[b]		
		Unsprayed -ungrazed	Sprayed -ungrazed	Unsprayed -grazed	Unsprayed -ungrazed	Sprayed -ungrazed	Unsprayed -grazed
1986,	Oct	0.02 a[c]	0.03 a	0.02 a	0	0	0
1987	July	0.03 b	0.09 a	0.02 b	0	0	0
1987	Dec.	0.06 a	0.10 a	0.01 b	0	0	0
1988	Feb.	0.09 a	0.12 a	0.02 b	0	0	0
1988	May	0.10 a	0.16 a	0.03 b	0.40 a	0.63 a	0.02 b
1989	Mar.	0.09 a	0.13 a	0.01 b	0.07 b	0.25 a	0.01 c
1990	May	0.19 b	0.29 a	0.01 c	0.13 b	0.26 a	0.01 c
1991	Mar.	0.08 b	0.19 a	0.01 c	0.09 b	0.17 a	0.01 c
1992	Jan.	0.16 b	0.30 a	0.01 c	1.62 b	2.57 a	0.01 c
1993	Apr	0.15 b	0.28 a	0.01 c	1.31 a	1.43 a	0 b

a Mature: large plants with > 70 cm^2 basal area.
b Seedlings: small plants with 1 to 10 leaves, generally 1 to 3 month old. Young plants: developing plants with > 10 leaves, generally 3 to 15 months old.
c Values for mature and seedling/young plants, in rows, not followed by a common letter differ significantly ($P < 0.05$)

Between 1988 and 1993 further increases in density arose from the recruitment of seedlings that survived dry periods, the cold of winter (2) and weed competition. In this period Mitchell grass flowered five times and seedling recruitment occurred on six occasions (Table I) in response to rainfall in autumns 1988, 1989 and 1990 and summers 1991. 1992 and 1993. The large recruitment on ungrazed treatments in January 1992 was due to seed carry over in the soil from previous flowerings and abundant rain (201 mm) in December 1991. Flowering in summer 1992/93 was minimal and the few seedlings that established in December 1992 and January 1993 (0.3/m^2 on the ungrazed treatments) died due to low rainfall (55 mm) in February, March and April 1993. Seedhead production in March 1991 was greater ($P < 0.05$) on the ungrazed-sprayed treatment (8.0 seedheads/m^2) than on the ungrazed-unsprayed treatment (3.9) or the grazed-unsprayed treatment (0.04).

Seed bank

Soil samples taken on the grazed-unsprayed treatment (in February 1988 and August 1992) and in the surrounding paddock (August 1992) revealed no Mitchell grass seed in the top 7.5 cm. However samples taken on the ungrazed treatment (August 1992) showed large numbers of viable seeds (850 and 970 viable seeds/m^2 on the ungrazed-unsprayed and ungrazed-sprayed treatments respectively).

Control of competition

On the ungrazed-sprayed treatment herbicides reduced the ground cover of weeds by a mean of 63% during winter and early spring 1986, 1987 and 1988. However, due to germinations after spraying, weeds provided competition in late spring when conditions were generally dry. Thus Mitchell grass suffered competition even after spraying but it was substantially less than on the unsprayed-ungrazed treatment. Low rainfall in spring 1989, 1991 and 1992 and autumn 1993 reduced competition from annual weeds which assisted the survival of Mitchell grass seedlings and young plants on all treatments.

Combined effects of treatments

The results show that by protecting Mitchell grass from grazing and by controlling weeds, plant density can be gradually increased despite set backs due to dry conditions, e.g. the decrease in density between May 1990 and March 1991 (Table I) due to low rainfall (67 mm) from August to December 1990. The ground cover of Mitchell grass increased from < I% in 1986 to 13% and 18% respectively on the ungrazed-unsprayed and ungrazed-sprayed treatments in April 1993. A high proportion of the seedlings present in January 1992 developed into small plants by April 1993 and provided the majority of this ground cover. In April 1993, these young plants had a mean basal area of 7 cm^2/plant, were 15 cm high with 30 tillers and 35 roots. Basal area of mature Mitchell grass increased during the experiment, from 0.1 cm^2/plant in 1986 to 43 and 62 cm^2/plant in 1992 on the ungrazed-unsprayed and ungrazed-sprayed treatments respectively.

Discussion

The results show that Mitchell grass can regenerate on the self mulching clay soils in north western NSW in ungrazed situations. Protection from grazing allowed resident plants to grow. flower and set seed and prevented resulting seedlings and young plants from being pulled out.

Controlling weeds, by herbicides and slashing. allowed Mitchell grass seedlings and young plants to survive being overgrown by annual weeds in winter when there is little or no growth of Mitchell grass (due to low temperatures; mean maximum 18?C and minimum 5.2?C). However, on the unsprayedungrazed treatment, Mitchell grass seedlings and young plants survived without weed control when dry conditions reduced germination and growth of annual weeds.

Although. in this experiment, virtually no grazing was allowed, a more practical approach would be to remove animals, only at critical periods. to allow flowering of Mitchell grass and seedling recruitment. Queensland results show that controlled grazing (30% utilisation) can give better results than complete exclusion because it stimulates seed production and enhances cohort survival (5). Heavy grazing in a moist winter not only controls annual weeds but can improve the vigour of subsequent Mitchell grass regrowth (Campbell *el al.* unpublished data). Grazing should be avoided when the self-mulching soil is very dry because, under these conditions, animals pull out Mitchell grass plants. Such management would only be practical if a relatively small proportion of a property was treated for regeneration and recruitment at any one time or if forage crops were grown to compensate for the loss of grazing.

The rate of regeneration and recruitment will depend on the number of Mitchell grass plants present when treatment begins and the amount of rain falling in the following summers. Queensland results show that the seasonal pattern of rainfall, as it influences the size and composition of the soil seed bank, is the major factor affecting recruitment of Mitchell grass (4). In our experiment very few plants were present at the start and these were almost dead, thus regeneration and recruitment was slow. Alternatively, if a relatively large number of mature plants were present when treatment began, seedling recruitment would be reduced by competition from the mature plants in dry periods. Competition from mature plants (0.76 to 3.37/m^2) in drought could explain the conclusion that the period between large scale recruitments of Mitchell grass in the Warrego region in Queensland, may be in excess of 40 years (6). It is evident from the results of our experiment and those of (4) and (5) that the period between large scale recruitments in north western NSW and Queensland is much less than 40 years. In fact, if the build up of Mitchell grass plants and the seed bank has been underway for three or four years and good rain falls throughout summer, fast regeneration/recruitment can occur because of the combined contributions of the following components: (i). growth of resident mature plants, their flowering, seed set and seed fall; (ii). growth, flowering, seed set and seed fall of resident young plants; (iii). germination of seed in the seed bank, development of those plants to seed set and seed fall; and, (iv). germination of seed from (i), (ii) and (iii) and development of these plants. This could convert a sparse stand to a dense stand in one bountiful summer.

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