Establishment of surface-sown perennial grasses on the north western plains of New South Wales

M.H.Campbell[1] and A.M.Bowman[2]

[1]NSW Agriculture, Orange Agricultural Institute, Orange NSW 2800
[2]Agricultural Research Centre, Trangie NSW 2823

Mitchell grass once occurred on 4600 km2 in NSW (Orr 1975). However, over the last 100 years large areas of Curly Mitchell grass (Astrebla lappacea) have been replaced by annual weeds. To restore these areas to their former stability it is necessary to re-establish perennial grasses. Aerial sowing may have a place in their establishment because of the large areas involved and because the open structure of dry, self-mulching soils allows easy entry of aerially sown seed. As the principles involved in aerial sowing on the north-western plains had not been investigated, experiments were conducted between 1987 and 1992 to examine the applicability of aerial sowing to this region.

Methods

The site of the experiments on "Birdwood", 10 km east of Walgett, had grey self-mulching clay soil with a pH($CaCl_2$) of 7.7 and an available phosphorous level of 109 mg/kg (lactate). The site on "Fairlands", 5 km south of Walgett, was similar but the soil appeared to be more compacted than the soil at "Birdwood". The average annual rainfall is 460 mm and mean daily maximum and minimum temperatures in January and July are, respectively, 36/21°C and 18/4°C. There are 18 frosts, on average per year, between May and September.

The pasture, once a strong Mitchell grass stand, was destroyed by floods in the 1970s. The sites had never been ploughed and were dominated by Brassica weeds (mainly wild turnip - *Brassica rapa*). The experiments were sown by hand broadcasting seeds of purple pigeon grass cv. Inverell (*Setaria incrassata*) and Bambatsi panic (*Panicum coloratum* var. *maka-rikariense*) and spikelets of Mitchell grass and buffel grass cv. Biloela (*Cenchrus ciliaris*) onto the untreated soil surface. Sowing rate was between 1 to 4 kg/ha and is expressed as number of viable seeds/ m^2 in Table 1. All seeds and spikelets were treated with permethrin (Coopex®) to reduce losses to seed-harvesting ants. No fertiliser was used and herbicides were applied to selected treatments only. The experiments were left ungrazed and each experiment had a randomsed block design with four replications. Establishment of grasses (plants/m^2) was recorded one to five months after sowing depending on when rain fell, and persistence (% ground cover) was recorded for up to five years after establishment. Five experiments were sown at "Birdwood" involving the four grass species cited above and one experiment was sown at "Fairlands" and "Birdwood" involving two varieties of Panicum coloratum (Verde and Selection 75) from USA.

Details of treatments in all experiments are given in Table 1.

Table 1. Times and rates of sowing of perennial grasses and herbicide treatments in experiments on pasture establishment at "Birdwood" (B) and "Fairlands" (F).

Experiment/site	Sowing time	Sowing rates (viable seed/m^2)				Herbicide treatment
		Mitchell grass	Buffel grass	Bambatsi grass	Purple pigeon	
1987/88 (B)	1987: 24 Apr; 30 Jul; 1988: 3 Feb	154	140	96	54	Roundup CT®, 1.5 L/ha immediately before spraying on half the treaments
1990 (B)	1990: 9 Mar	100	100	100	100	2,4-D amine + Ally®, 1 L/ha + 5 g/ha on all treatments after establishment on 14 May 1990
1990/91 (B)	1990: 14 Nov 1991: 7 Feb	150	150	150	150	Nil
1991/92 (B)	1991: 28 Nov 1992: 13 Feb	50	50	50	50	Nil
1992 (B)	1992: 22 Nov	50	50	50	50	Roundup CT®, 1.5 L/ha on all treatments immediately before spraying
		US varieties of *Panicum coloratum*				
1991 (F)	1991: 28 Nov	Verde	110	Selection 75	140	Nil

Results

1987/88 experiment

Grasses established from the November 1987 and February 1988 sowings but not from the April and July 1987 sowings (Table 2). The November 1987 sowing established in summer 1987/88 and the February sowing in April 1988 (190 mm rain). In May 1988 fewer plants were present from the November sowing than from the February sowing (Table 2). However, more of the November sowing survived the 1988 winter than the February sowing which resulted in higher ground cover from the November sowing in the following years (Table 3). The better survival of the November sowing through winter 1988 was due to the plants being larger than those from the February sowing going into winter and therefore being more tolerant to frosts and competition from Brassica weeds.

1990 experiment

Good establishment of the four grasses occurred in May 1990 (Table 2) due to 233 mm of rain in that month. The density of buffel grass was greatly reduced in the following winter and thus it did not persist as well as the other grasses (Table 3).

1990/91 experiment

Seeds sown in November 1990 established well in response to good rain in January, February and March 1991 (Table 2). By April 1991 grass plants were 45 cm high with an abundance of leaves and seedheads; however root growth was slow as the plants were easily pulled out. During establishment there was little competition from weeds because the Brassicas did not germinate in summer. The grasses survived their first winter and persisted for the next five years (Table 3) despite low rainfall in 1992 and 1994 (363 and 280 mm respectively). The ground cover of purple pigeon grass and Bambatsi panic declined over this period but that of Mitchell grass and buffel grass remained high. Seeds sown in February 1991 failed to establish because of insufficient rain (Table 2).

1991 experiment

Establishment of Verde and Selection 75 was higher at "Fairlands" (a mean for the two varieties of 1.9 plants/m^2) than at "Birdwood" (0.6 plants/m^2). Two years later 0.8 plants/m^2 remained at "Fairlands" compared to 0 plants/m^2 at "Birdwood".

1991/92 experiment

Mitchell grass and buffel grass established (Table 2) in response to a fall of 201 mm of rain in one day in December 1991 but most plants died in early 1992 as only 141 mm of rain fell in the first six months. Seeds sown in February 1992 failed to establish due to insufficient rain (Table 2).

1992 experiment

All grasses failed to establish due to dry conditions in summer 1992/93 (Table 2).

Establishment of viable seed

Over all experiments establishment of viable seed varied from 55.1% for purple pigeon grass sown in favourable conditions in March 1990 to 0.1% or less for grasses sown in unfavourable conditions. The respective figures, meaned for the four grasses, for the following successful sowings, November 1987, February 1988, March 1990, November 1990 and November 1991 were 0.2%, 1.5%, 30.5%, 8.5% and 2.9%. Meaned for the above five sowings the respective establishment of purple pigeon, buffel grass, Mitchell grass and Bambatsi panic was 12.4%, 8.7%, 7.5% and 6.2%.

Discussion

Of the 10 sowings made between 1987 and

Table 2. Establishment of surface-sown grasses measured one to five months after sowing and monthly rainfall in the six months after sowing at "Birdwood".

Sowing time	Establishment (plants/m^2)				Monthly rainfall (mm) after sowing					
	Mitchell grass	Buffel grass	Bambatsi grass	Purple pigeon	1	2	3	4	5	6
April 1987	0.1	0	0	0	3	44	41	9	35	2
July 1987	0.1	0	0	0	9	35	2	30	22	66
November 1987	0.2	0.1	0.2	0.2	22	66	27	62	14	190
February 1988	1.1	4.1	0.8	0.8	62	14	190	52	32	68
March 1990	35.7	21.4	22.6	52.9	20	233	63	10	62	11
November 1990	11.5	29.0	3.0	7.5	0	25	141	60	48	0
February 1991	0	0	0	0	60	48	0	27	5	7
November 1991	3.0	2.9	0	0	0	201	33	69	0	27
February 1992	0	0	0	0	50	0	27	5	7	32
November 1992	0	0	0	0	15	54	26	43	21	0

Table 3. Persistence of surface-sown grasses from successful sowings for up to five years at "Birdwood".

Sowing time	Species	Ground cover (%) in the years after sowing				
		1	2	3	4	5
November 1987	Mitchell grass	17	8	15		
	Buffel grass	5	5	5		
	Bambatsi grass	33	23	20		
	Purple pigeon grass	13	2	1		
February 1988	Mitchell grass	9	4	10		
	Buffel grass	7	1	1		
	Bambatsi grass	17	12	10		
	Purple pigeon grass	6	1	1		
March 1990	Mitchell grass	30	25	28		
	Buffel grass	4	3	3		
	Bambatsi grass	45	40	32		
	Purple pigeon grass	36	25	20		
November 1990	Mitchell grass	51	82	66	79	88
	Buffel grass	75	67	57	65	84
	Bambatsi grass	12	29	25	10	9
	Purple pigeon grass	36	51	30	2	2
November 1991	Mitchell grass	18	19	27	15	
	Buffel grass	3	1	1	1	
	Bambatsi grass	0	0	0	0	
	Purple pigeon grass	0	0	0	0	

1992, two were successful, three partly successful and five failed. The major factor influencing success was rainfall. It appears that high rainfall over a number of days in the month of establishment is necessary to wet the soil profile and germinate the seed; moderate rain is then needed in the following two months to allow the seedlings to develop to a stage where they can resist dry periods. Silcock and Johnston (1993) suggest that "fair" establishment in the subhumid to arid tropics of Australia can be achieved with 25 to 75 mm of rain and "good" establishment with 75 to 200 mm. Our results show that their latter assessment is appropriate for surface- sown seed in north western NSW. In addition, Campbell *et al.* (1995) showed that good establishment of surface-sown perennial grasses near Walgett was achieved with 166 mm over three months. However, there is only 14% chance (*ie.* 1 year in 7) of receiving such rainfall.

The most successful establishment of grasses in these experiments occurred in summer because plants that established on summer rainfall flowered prior to winter and were able to withstand frosts. Plants that established in mid to late autumn were severely damaged by frosts, particularly buffel grass. This effect, combined with competition from Brassica weeds in winter and spring, limited the persistence of the grasses. When good establishment occurred in summer, *eg.* from the November 1990 sowing, the grasses germinated before and thus controlled Brassica weeds. Perhaps the best time to sow is in late November because rain is more likely in the following three months than in other months (Campbell and Bowman 1992). Because aerial sowing is relatively cheap, sowing half the seed in late November and half in late January could increase the chance of receiving sufficient rain to facilitate establishment and persistence. If good initial establishment is achieved selective removal of Brassica weeds in the following winter becomes essential.

Mitchell and buffel grasses appeared the easiest to establish and most persistent species to sow at "Birdwood". The decline of Bambatsi panic after the 1990 sowing was not expected but the decline of purple pigeon grass was because of shorter longevity. The soil on which the experiments were conducted was very powdery when dry compared to soil which had been cropped or the soil on "Fairlands". This could partly explain the difficulty in establishing grasses on "Birdwood". Campbell *et al.* (1995) recorded better establishment on soil that had been compacted by cropping than on "Birdwood" and establishment and persistence of Verde and Selection 75 was better on "Fairlands" than on "Birdwood" possibly for the same reason.

In our experiments, there was complete exclusion of grazing animals. However, a stocking rate that allows 30% utilisation favours seed production, recruitment and seedling survival (Orr and Evenson 1991). Using a tactical resting program a poor initial establishment could be improved by facilitating recruitment of seedlings. Mitchell grass responds well to such programs (Campbell *et al.* 1996) as does buffel grass and purple pigeon grass but Bambatsi panic does not recruit well (Campbell *et al.* 1995).

Acknowledgements

We gratefully acknowledge financial assistance from the Australian Wool Research and Promotion

Organisation and provision of the experiment sites by the late Noel Evans, "Birdwood", Walgett and by Greg Webber, "Fairlands", Walgett.

References

Campbell, M.H. and Bowman, A.M. (1992). Aerial sowing perennial grasses on the north west plains of NSW. NSW Agriculture Agnote DPI/61.

Campbell, M.H., Bowman, A.M., Bellotti,W.D., Friend, J.J. and Nicol,H.I. (1995). Esatblishment and survival of pasture grasses surface-sown into wheat stubble in north- western NSW. *Rangeland Journal*, **17:** 37-45.

Campbell, M.H., Bowman, A.M., Bellotti,W.D., Munich, D.J. and Nicol,H.I. (1996). Recruitment of curly Mitchell grass in north-western NSW. *Rangeland Journal*, **18:** 179-187.

Orr, D.M.(1975). A review of Astrebla (Mitchell grass) pastures in Australia. *Tropical Grasslands*, **9:** 21-36.

Orr, D.M. and Evenson, C.J. (1991). Effects of sheep grazing Astrebla grasslands in central western Queensland 111. Dynamics of *Astrebla* spp. under grazing and exclosure between 1975 and 1986. *Rangeland Journal*, **13:** 36-46.

Silcock, R.G. and Johnston, P.W. (1993). Tropical pasture establishment. 9. Establishing new pastures in difficult tropical environments - do we expect too much? *Tropical Grasslands*, **27:** 349-358.