ESTABLISHMENT OF SURFACE-SOWN PASTURES ON UNPLOUGHED INFERTILE SOIL

M.H. Campbell

NSW Agriculture, Agricultural Research and Veterinary Centre,
Forest Road, Orange, NSW 2800

Summary. The effect of grazing, herbicide treatment and nitrogen on the establishment of surface-sown pasture species on infertile soil was ascertained at Kerrs Creek NSW in 1994/95. The most effective treatment was 2 sprayings (0.9 kg a.i./ha glyphosate in early autumn to kill native grasses and the same rate after the seasonal break to kill annual weeds) which increased the establishment of all sown species 1 year after sowing. The establishment of *Trifolium subterraneum* and *Phalaris aquatica* was improved by spelling before sowing and the N treatment improved establishment of *P. aquatica,* and *Dactylis glomerata*. Thus to maximise establishment on unploughed infertile soil, spelling before sowing, 2 sprayings of glyphosate and application of nitrogen fertiliser, should be included in the normal aerial spray-sow procedure.

INTRODUCTION

The technology for establishing surface-sown pasture species on non-arable land infested with nitrophilous weeds has been devised and used in New South Wales for the past 20 years (1, 6, 8). This technology entails harsh grazing prior to sowing, applying herbicides after the seasonal break and aerial broadcasting of seeds and fertiliser (4). Establishment and growth of pasture species in these situations is generally fast due to the fertility built up by high rates of fertiliser promoting legume growth and nitrogen input.

These methods have given only moderate results however when surface sowing improved pasture species into native grass pastures on infertile soils (2, 3). This could be due to: removal of the protective litter on the soil surface by heavy grazing; applying herbicide after the seasonal break when native grass foliage has been damaged by frost; and sowing pasture species into a nitrogen deficient soil. Investigations to overcome these deficiencies and promote establishment of surface sown pastures to replace inferior native grasses on infertile soils were undertaken.

MATERIALS AND METHODS

Site

The experiment was located near Kerrs Creek, 40 km north of Orange, NSW at an altitude of 800 m and 750 mm average annual rainfall. The soil, derived from slate and shale, had pH ($CaCl_2$) 4.6, available phosphorous 5.5 mg/g (Bray No. 1), nitrate 1.4 ppm and exchangeable cations (cmol (+)/kg) 2.0 (Ca), 0.7 (Mg), 0.6 (K), 0.1 (Na) and 0.1 (Al). No fertiliser had been applied to the pasture which, at the start of the experiment, consisted of 54% ground cover of perennial grasses (*Bothriochloa macra* 16%, *Microlaena stipoides* 16%, *Danthonia eriantha* 12%, *Aristida vagans* 6%, others 4%), 28% bare ground and litter and 10% broad-leaved plants. The pasture was continuously grazed at 0.7 d.s.e./ha.

Treatments

Three herbicide treatments (nil, one and two sprays) were applied to grazed and ungrazed pasture. The herbicide treatments were each 0.9 kg a.i./ha glyphosate either sprayed after the seasonal break on 6 July 1994 (one spraying) or sprayed on 11 March 1994, when the native grasses were growing well and again after the seasonal break on 6 July 1994 (two sprayings). The grazed treatment was grazed continuously until sowing in July 1994 when stock were removed for the remainder of the experiment. The ungrazed treatment was animal free from June 1993 until June 1995. Dry matter on the grazed and ungrazed treatments in July 1994 was, respectively, 400 and 1900 kg/ha. Seed of *Medicago sativa* cv.

Pioneer 581; *Trifolium subterraneum* cv. Goulburn; *T. repens* cv. Haifa; *Dactylis glomerata* cv. Currie; and *Phalaris aquatica* cvv. Australian commercial and Sirosa was hand broadcast on the soil surface of each treatment on 8 July 1994 at the respective rates of 3, 3, 0.35, 1, 2 and 2 kg/ha. All seed was treated with permethnin to reduce losses due to ants (5) and legume seed was inoculated and lime pelleted. Superphosphate with 0.02% molybdenum trioxide was applied to each treatment at 150 kg/ha and nitram at 50 kg/ha (17 kg N/ha) to half of each treatment at sowing. Plots of 4x5 m were set out in 4 randomised blocks each plot split at random for the nitrogen treatment.

Measurement

Establishment and survival of sown species was measured, respectively, on 22 September 1994 and 23 June 1995, by counting plants on 4 random 0.25 m^2 quadrats/half plot and ground cover was visually assessed per half plot on 31 October 1994.

RESULTS

Herbicide treatment had the greatest effect on establishment of sown species. Two sprayings promoted higher ($P < 0.05$) plant numbers of most species 11 weeks and 1 year after sowing than 1 spray or nil spray (Tables 1 and 2). One spraying resulted in more ($P < 0.05$) plants of *M. sativa, D. glomerata* and *P. aquatica* than nil spraying at 11 weeks(Table 1) but this effect was not evident 1 year after spraying (Table 2). Herbicide spraying, especially the 2 spray treatment, reduced ground cover of native grasses and increased($P < 0.05$) bare ground and litter (Table 3).

Table 1. Effect of grazing, herbicide treatment and nitrogen fertiliser on establishment of pasture species on 22 September 1994, 11 weeks after sowing.

Treatment	Number plants/m^2				
	M. sativa	*T. repens*	*T. subterraneum*	*D. glomerata*	*P. aquatica*
Grazing					
Grazed	5.9 a	1.7 a	8.0 b	10.5 a	4.0 a
Ungrazed	9.7 a	1.7 a	19.5 a	7.5 a	6.8 a
Herbicide					
Nil	1.8 b	0.9 b	8.2 b	0.3 c	0.1 c
1 spraying	8.7 a	1.6 ab	11.5 b	9.9 b	5.2 b
2 sprayings	12.9 a	2.6 a	21.6 a	16.8 a	11.1 a
Nitrogen (kg/ha)					
0	8.0 a	1.7 a	14.7 a	6.9 a	3.6 b
50	7.6 a	1.7 a	12.8 a	11.0 a	7.2 a

Means in columns for the 3 major treatments not followed by a common letter differ ($P < 0.05$).

Table 2. Effect of grazing, herbicide treatment and nitrogen fertiliser on plants present on 23 June 1995, one year after sowing.

Treatment	Number of plants/m^2

	M. sativa	*T. repens*	*T. subterraneum*	*D. glomerata*	*P. aquatica*
Grazing					
Grazed	0.2 a	2.0 a	7.8 b	3.1 a	1.7 b
Ungrazed	0.6 a	1.6 a	31.2 a	3.2 a	4.0 a
Herbicide					
Nil	0 b	0.2 b	6.2 c	0 b	0 b
1 spray	0.1 b	1.0 b	20.3 b	0.6 b	0.4 b
2 sprays	1.9 a	4.1 a	32.0 a	8.9 a	8.2 a
Nitrogen					
-N	0.4 a	1.7 a	18.9 a	1.8 b	2.0 b
+N	0.4 a	1.8 a	20.1 a	4.5 a	3.7 a

Means in columns for the 3 major treatments not followed by a common letter differ (P < 0.05).

Table 3. Effect of herbicide treatment on botanical composition on 31 October 1994, 16 weeks after sowing.

Treatment	Percentage ground cover			
	Native grass	Annual grass	Bare ground and litter	Sown species
Herbicide				
Nil	61.6 a	5.8 b	22.5 c	0.7 b
1 spray	38.3 b	8.7 b	43.0 b	3.4 b
2 sprays	13.2 c	16.1 a	54.0 a	7.7 a

Means in columns not followed by a common letter differ (P < 0.05).

The ungrazed treatment had higher (P < 0.05) numbers of *T. subterraneum* 11 weeks after spraying (Table 1), and higher (P < 0.05) numbers of *P. aquatica* and *T. subterraneum* 1 year after sowing (Table 2) than the grazed treatment. For *P. aquatica*, this effect was only evident (P < 0.05) on the 2 spray treatment (11.5 plants/ m^2 on the ungrazed and 5.0 plants/m^2 on the grazed).

Nitrogen fertiliser increased(P < 0.05) plant numbers of *P. aquatica* 11 weeks and 1 year after spraying and numbers of *D. glomerata* 1 year after spraying (Tables 1 and 2). This effect, one year after spraying, was due to higher (P < 0.05) numbers of grass plants on +N (11.7/m^2 meaned for *D. glomerata* and *P. aquatica*) than on -N (5.4/m^2), and was only evident for the 2 spray treatment.

DISCUSSION

The treatment that resulted in best establishment of sown species on infertile soil in this experiment was 2 sprayings, one to kill actively growing native grasses in early autumn and the other to kill weeds that germinated after the seasonal break. The one-spray treatment applied in July had little effect on the frosted native grasses which provided strong competition for establishing *D. glomerata* and *P. aquatica* in their first spring and summer. Establishment of *D. glomerata* and *P. aquatica* on the nil-spray treatment

was completely suppressed by competition from resident species. The disadvantages of the 2 spray treatment are the high cost and the possible damage to trees from 2 aerial applications of 0.9 kg a.i./ha of glyphosate 4 months apart. In some seasons it could be possible to use 1 spraying when an early seasonal break promoted annual weeds before the native grasses were damaged by frost. However, because the optimum time for aerial sowing pasture seed is late May (1, 4), the earliest the herbicide could be applied would be mid-May.

Improved establishment of *T. subterraneum* in the ungrazed treatment was due to the protection provided by standing dead plant litter during germination and radicle entry. Comparatively large seeded species require more protection during germination and radicle entry than do smaller seeded species (9). The ungrazed treatment also assisted *T. subterraneum* to produce seed in spring 1994 and *P. aquatica* to survive dry periods in summer and autumn 1994/95 (e.g. a total of 8 mm of rain in February, March and April 1995).

Nitrogen fertiliser increased the establishment and survival of grasses by promoting growth in 1994 so that plants were larger going into their first summer and thus survived better (7) than where no nitrogen was applied.

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