Establishment and regeneration of annual pasture legumes in a ley farming system

W.D. Bellotti, A.L. Ewers and E.D. Carter

Department of Agriculture, Turretfield Research Centre, Rosedale SA 5350 Waite Agricultural Research Institute, The University of Adelaide, Glen Osmond SA 5064

Summary. The effects of contrasting sowing methods on the establishment, and subsequent regeneration following a wheat crop, of annual pasture legumes are presented. Results from sowing in only one year (1989) are presented. Sowing after the break of the season and after application of herbicide resulted in greater establishment of sown legumes. The results presented are site- (soil type, seed bank composition) and year- (rainfall sequence, temperature) specific but they provide an example of the response of pasture legumes to sowing method. Knowledge of these responses is essential for the evaluation of pasture establishment options. Other aspects requiring attention include analysis of rainfall probabilities and consideration of resident soil seed banks.

Introduction

Pasture legume seed reserves are low in many ley farming areas (2, 3) and consequently there is a widespread need to sow new improved cultivars. Pasture establishment is expensive the payback period commonly ranges from 3 to 5 years (5). In addition, the risk of failure is often high, despite following recommended sowing guidelines. For the majority of situations sowing guidelines are available (4); however, farmer surveys often rank pasture establishment as a high-priority research topic.

For annual pasture legumes, the term establishment should include the processes of germination, emergence, seedling survival and seed production (3). Where annual pasture legumes are grown in rotation with crops, the critical test of adaptation is the regeneration density of pasture legumes following the crop year (1). In this paper we report the results of a comparison of several sowing methods for their effect on the establishment and subsequent regeneration of subterranean clover and annual *Medicago* spp.

Methods

Fourteen sowing methods were compared for their effect on the establishment, and subsequent regeneration following a wheat crop, of three annual pasture legumes. The experiment was sown at Turretfield Research Centre (average annual rainfall 464 mm) in 1989, cropped to wheat in 1990, and allowed to regenerate as pasture in 1991. A mixture of Rosedale subterranean clover, *Trifolium subterraneum,* Paraggio barrel medic, *Medicago truncatula,* and Paradana balansa clover, *T. michelianum,* was sown at 7.0 kg/ha (ratio by weight 6:3:1) either before or after the break of the season. Treatments were replicated four times and individual plot size was 2.1 x20 m. The experimental site was grazed by sheep for short periods at high stocking rates (25 to 55 dry sheep equivalents/ha) during the pasture growing season and over summer.

The experimental sowings were repeated in 1990, representing both courses (pasture or wheat) of a two-course rotation in each year. Only data from the 1989 pasture sowings will be presented here. Four sowing treatments have been chosen to represent the range of responses resulting from the fourteen treatments. The four treatments were:

- Control, no seed sown, received fertiliser and insecticide (A);
- Cultivated seedbed, seed drilled and harrowed into a dry seedbed (3 April 1989) before the break (B);
- Direct drilled, seed drilled (18 May 1989) after the break, covering chains following sowing tynes (C);
- Herbicide (Roundup at 1.5 L/ha) applied (16 May 1989), seed direct drilled (18 May 1989) after the break, covering chains following sowing tynes (D).

The soil was a hard-setting red-brown earth (pH 6.3 to 7.5). Resident pasture legume seed reserves in the soil prior to imposing treatments were 16 kg/ha comprising largely cvv. Clare, Daliak, and Dinninup subterranean clover and small amounts of spiny burr medic, *M. polymorpha.* No measure of the small-seeded cluster clover, *T. glomeratum,* was made prior to commencement of the experiment.

At each harvest pasture legumes were seperated to species and/or cultivar level. It was not possible to distinguish between seedlings of sown balansa clover and volunteer cluster clover at emergence. For this reason the legume categories referred to in Figure 3 are as follows:

Sown

- Rosedale subterranean clover
- Paraggio barrel medic

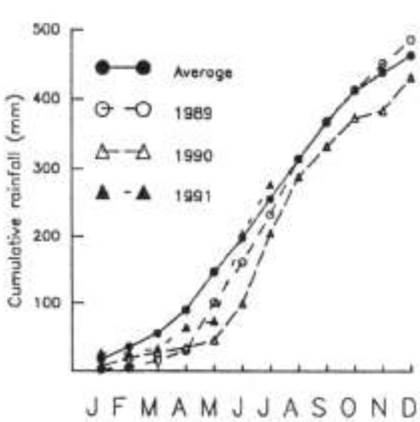
Volunteer

- Clare, Daliak, Dinninup subterranean clover
- spiny burr medic

Results and discussion

In all three years the growing season started late as indicated by the lower than average monthly rainfall in April, May and June (Fig. 1). The observed date of the break in 1989, 1990 and 1991 was 9 May, 26 June, and 1 June respectively. The median date for the break at Turretfield over the past 70 years is 27 April. Despite the late breaks, winters were generally wetter than average resulting in close to average total annual rainfall.

Field comparisons of the effect of sowing time on pasture establishment are strongly dependent on seasonal conditions during the seeding operation and during emergence and early growth (Fig. 2). Seed was sown dry on 3 April and despite several small amounts of rainfall (<5 mm) no emergence was detected until after the break which occurred when 47 mm of rain fell over 7 days centered around 9 May. Following the break, conditions remained favourable for legume growth with regular, small amounts of rainfall and cool, mild temperatures.



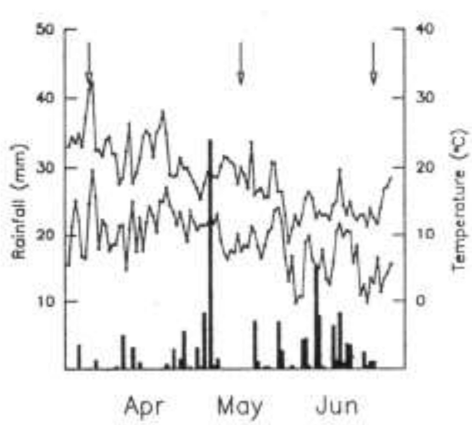


Figure 1. Cumulative monthly rainfall at Turretfield Research Centre for the experimental period and the 83 year average(1908-1990). Figure 2. Daily rainfall, maximum and minimum temperatures for the 1989 sowing and emergence period. Arrows indicate early (3.4) and late (18.5) sowing and emergence counts (27.6).

Sowing method had a marked effect on both sown and volunteer pasture legumes (Fig. 3) (see methods for explanation of these terms). Emergence of sown legumes was greater when they were sown after the break (Fig. 3a, treatments C and D) representing almost 100% of seed sown in treatment D (sown after the break following herbicide application). The relatively low density of sown seedlings in treatment B (sown before the break) may be partly due to loss of seed which germinated, but seedlings failed to emerge following light rain after the early sowing (Fig. 2). Application of herbicide reduced the survival of volunteer legumes emerging from the resident soil seed bank (treatment D).

While total herbage yield of pasture legumes in spring was similar for all four sowing methods, the yield of sown legumes was markedly increased by sowing after the break and using herbicide (Fig. 3b). Suppression of competition from resident vegetation further increased the yield of sown legumes. The volunteer component in Figure 3b includes a significant contribu- tion from the naturalised cluster clover, but does not include the grass and weed components.

Pasture legume seed yields in the year of sowing followed a similar pattern (Fig. 3c). Volunteer legumes in the control (treatment A) produced 232 kg/ha of seed from an initial emergence density of 61 seedlings/m^2. In comparison, sown legumes in treatment D (sown after the break following herbicide application) produced 226 kg/ha of seed from an emergence density of 98 seedlings/m^2. Seed production of volunteer legumes in treatment A (control) was encouraged by a longer growing season as volunteer legumes emerged with the first rains. In treatment D, seed production was enhanced by suppression of competing vegetation which compensated for the shorter growing season.

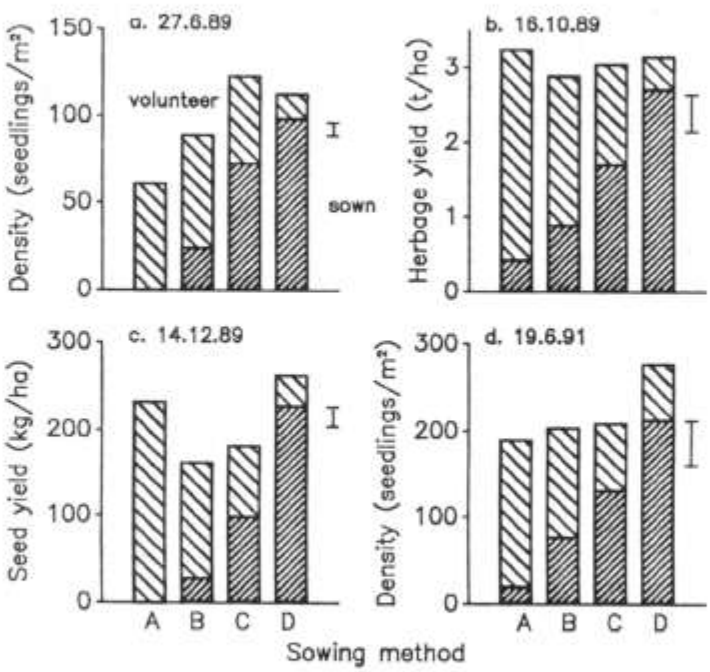


Figure 3. Effect of sowing method (see text) on sown (Rosedale and Paraggio) and volunteer (Clare, Daliak, Dinninup and burr medic) pasture legumes. a) seedling emergence, b) legume herbage yield, c) seed production in the yearof sowing and d) regeneration following a wheat crop. Error bars show the least significant difference (P=0.05) for comparison of sown legume means; upper shaded bars are for volunteer species and lower for lown species.

Regeneration density of pasture legumes in 1991, following a wheat crop in 1990, was more than twice the density of seedlings in the year of sowing (1989) in all treatments (Figs 3a, 3d). Regeneration of sown legumes was highest (212 seedlings/m^2) in treatment D (sown after the break following herbicide application), but the density was much less then the 3000 seedlings/ m^2 needed to maximise early season dry matter production (1).

The close association between attributes presented in Figure 3 emphasises the importance of initial seedbed conditions (including sowing time) created in each sowing treatment. High initial emergence densities led to greater legume herbage in spring which led to greater production of seed of sown legumes. Eventual regeneration densities following a wheat crop reflected previous seed yields but only represented approximately 5% of seed produced in 1989. Losses of seed were attributed to the cumulative effects of grazing by sheep over summer, germination and subsequent death of seedlings due to tillage or herbicides in the crop year, and false breaks in the year of pasture regeneration. Residual hard seed reserves are being determined.

An important feature of the study is the performance of volunteer legumes in the control (treatment A). This demonstrates the potential productivity resulting from nurturing existing seed reserves rather than replacing resident vegetation with newly sown pasture. Benefits associated with treatment A include low input costs (only insecticide and fertiliser in this example) and increased early dry matter production. Obviously, the likelihood of repeating these outcomes is very dependent on paddock history and resident soil seed reserves.

The clear advantage of treatment D in terms of the establishment of sown seed needs to be weighed up against the loss of early feed availability and competition for time when most farmers are giving priority to sowing crops. Also these results are year- (rainfall sequence, temperature, etc) and site- (soil type, resident soil seed reserves) specific; different outcomes have been recorded under other seasonal conditions. Specific results, such as those presented, provide essential relationships which can be used in the development of tactical decision support packages for farmers considering pasture establishment. In some cases, as indicated in the current example, pasture establishment may not be worthwhile. Other important components of a decision support package include an analysis of rainfall probabilities and a consideration of paddock histories and soil seed reserves.

Acknowledgements

The support of the Wool Research and Development Corporation (Project UA26P) is gratefully acknowledged.

References

1. Abd El-Moneim, A.M. and Cocks, P.S. 1986. J. Agric. Sci. 107, 179-186.

2. Carter, E.D. 1982. Proc. 2nd Aust. Agron. Conf., Wagga Wagga, NSW. p. 180.

3. Carter, E.D. 1987. In: Temperate Pastures. (Eds Wheeler, Pearson, and Robards). (AWC and CSIRO) pp. 35-51.

4. Dillon, T. 1986. Dept. Agric. Fact Sheet FS 13/86. Adelaide.

5. Falconer, D., Lowe, M., Ewing, M. and Pannell, D. 1988. Western Australia J. Agric. 29, 3-7.