The production and management of annual pasture legumes in ley farming systems of south Australia

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Summary. Research work based at the Waite Institute has shown the dominance of management factors rather than species and cultivar effects in the production and survival of annual pasture legumes in ley farming systems. Management practices determine herbage and seed production, consumption of seed by grazing sheep in summer and autumn, the burial of pasture legume seed by tillage for the cereal crop and regeneration of legumes following a cropping sequence.

Introduction

Australia has some 40 million ha of crop and sown pasture lands that rely on introduced legumes to maintain or improve levels of soil nitrogen and to guarantee the quality and quantity of livestock feed. These legumes, mainly the annual self-regenerating medics *(Medicago* spp.) and clovers *(Trifoliwn* spp.) are worth at least US$2,500 million each year to the crop and livestock industries (2). While these legumes are normally a renewable resource, in recent years many legume stands have deteriorated from poor grazing management, new pasture pests and other causes (13).

Ten years ago Carter *et* (4, 13) drew attention to the very serious decline in the standard of legume pastures in the cereal farming districts of southern Australia. Yet there has been little improvement in most districts because of the disproportionate emphasis on selecting and breeding new cultivars of clovers and medics and far too little attention devoted to management issues. Our research on the soil reserves of pasture legume seeds and the seed-seedling dynamics of medic and subterranean clover pastures has highlighted the impact of sheep grazing, tillage and other farm management practices in depleting seed reserves of medics and clovers on/in the soil in cereal crop - pasture - livestock farming systems. Improving cereal belt pastures depends on improving the legume status of these pastures; if good legume seed reserves are maintained, other problems will decline. Hence our research on annual pasture legumes is seed orientated. Better legume pastures in the cereal-pasture rotation can minimise the incidence of cereal root diseases and maximise nitrogen fixation thereby improving wheat and barley yields and profitability.

Background

Research by Carter with technical assistance and some post-graduate students over the past 15 years involving monitoring of pasture legumes in the cereal belt has shown that typically 8090% of farms don't have sufficient legume seed reserves following a cropping sequence to regenerate a satisfactory legume-based pasture (4, 5). Some 13 reasons for the demise of pasture legumes in the cereal belt (3, 7) are:

Reduced spraying to control red-legged earth mite and lucerne flea. Reduced application of superphosphate to pasture.

Spread of Sitona weevil.

Increased cropping intensity and consequent grazing pressure. Poor grazing management and fodder conservation practices. Increased use of herbicides in the cropping phase of the rotation. Reduced undersowing of medics and clovers into cereal crops. Sowing of medics and clovers too deeply also deep tillage for crops. Rapid spread of pasture aphids (SAA, BGA, CPA).

Increased use of nitrogenous fertilizers.

Apathy and despondency concerning the value of medics and clovers. Wrong choice of medic and clover species, cultivars and mixtures. Poor seasons and droughts.

However, there are some good pastures in all districts and the aim is to transfer the technology of proven techniques and assist farmers to monitor the density and subsequent productivity of legume pastures as a guide to management decisions. Our observations, supported by research, indicate that the most common reasons for failure of legume pastures in the cereal belt are:

Inadequate legume seed reserves resulting from the cumulative effects of varying aspects of mismanagement (4).

Inadequate control of **insect pests** especially red-legged earth mite and lucerne flea at break of season (6).

Inadequate control of weedy grasses and broad-leaved weeds by grazing or spraying (Rovira and Carter, unpublished data).

Inadequate control of **summer-autumn grazing** of medic pods and clover burrs especially on hard-setting soils where sheep may consume 1 t/ha of medic seed (2) or 0.7 Vila of sub clover seed (14) in a few weeks.

Inadequate control of **depth of tillage** which buries excessive amounts of pasture legume seed too deep for seedling emergence in the naturally-regenerating pasture following a cropping sequence (12, 15, 18).

One objective of our research is to teach farmers how to minimise these constraints to production. In particular, with the help of district agronomists, the research aims to identify key groups of motivated cereal farmers in the various districts who can learn to monitor the legume component of their pastures and, by attention to detail, upgrade the legume content of these pastures; then by simple demonstration, show the improved cereal crops resulting from these better legume pastures in a pasture-cereal rotation.

Producing better legume pastures

Carter and Porter have further demonstrated the value of the summer and autumn *in situ* watering technique (11) to predict the emergence of legume pastures following a cropping sequence and also to show the relationship between pasture legume seed reserves and the level of soil nitrogen. Farmer interest in this self-help technique has been outstanding. When the legume seed bank is poor it is not necessarily a case for expensive pasture renovation. It can be much cheaper and easier to use a grass herbicide like Fusilade ? to improve the competitive ability of the legume and increase legume seed production as was the case at Tarlee in 1989 (8; Table 1) and Turretfield Research Centre in 1990 (16) where 400 ml Fusilade per ha improved the quality of both green and dry feed, decreased grass-seed problems in Merino lambs and improved both wool and lamb values.

Table 1. Botanical composition of pasture and seed production, Tarlee, 1989.

	Legume	Grass	Other spp
Unsprayed			
Botanical composition (%)	15	85	trace
Seed production (kg/ha)	121	342	33
Sprayed with Fusilade ®			
Botanical composition (%)	88	10	2
Seed production (kg/ha)	269	5	2

Note: Botanical composition on 3 November 1989 and seed production in December 1989 differed significantly (P<0.001) between herbicide treatments.

In terms of pasture renovation and re-establishment, there is a need for further research on cost-effective ways of establishment. Much more research is needed (replicated in time and space) on the role of seed placement in dry versus wet seed-beds and the role of compaction (using press wheels, etc.) to ensure optimal seed-soil contact for moisture exchange and germination. In view of current low wheat and wool prices, it is time to re-look in the wetter districts at the possible scope for under-sowing legumes in cereal crops as a means of saving money (reduction of crop sowing rates can minimise risk). Furthermore, the scope for 'sowing' medic pods in marginal rainfall areas needs critical evaluation. While haymaking may not affect seed production of subterranean clover, it severely depresses seed production of annual medics, expecially the taller-growing species like *Medicago scutellata* as shown by Carter *et al.* (9) in Table 2.

Table 2. Effects of haymaking in the Waite Institute rotation experiment.

(a) *Effects of haymaking on pasture legume seed production in 1986* (kg/ha).

Treatments	Subclover	Medic
Conventional tillage		
Pasture retention	1,226	1,540
Pasture removal as hay	1,347	795
Direct drilling		
Pasture retention	1,290	1,399
Pasture removal as hay	1,228	773

(b) *Effects of haymaking on medic seed production in 1986* (kg/ha).

	Mown	Not Mown
M. scutellata cv. Sava	127	554
M. truncatula cv. Jemalong	156	150
" " cv. Paraggio	128	134
M. rugosa cv. Sapo	3	4
M. polymorpha cv. Serena	370	627
Total	784	1469

Note: Tillage treatment had no significant effect on subclover or medic seed production but haymaking had a marked effect ($P<0.001$) on medic seed production.

More recently both Ababneh (1) and Muyeko (17) in studies of defoliation of annual medics, have shown dramatic effects of time and frequency of defoliation on herbage and pod production (4-fold range), seeds per pod (2-fold range) and seed yield (9-fold range). Ababneh (1) has re-emphasised the crucial importance of total weight of pure germinating seed in determining productivity of annual medics. In other words, a lower population of seedlings from large-seeded medic can give the same production as a higher population of seedlings from small-seeded medics. Of course, if buried deeply, the larger-seeded medics will give superior emergence to small-seeded medics (6, 15). Squella (19), in studying the ecological significance of seed size on annual pasture legumes, has shown that small-seeded legumes escape ingestion by sheep and also escape damage during the mastication process. Hence under heavy grazing, small-seeded pasture legume species gain a competitive advantage; i.e. these legumes are ecologically more fit (10).

A significant trend in the cereal-livestock zone of South Australia, is to feed-lotting of sheep during summer to protect the medic seed reserves and to reduce damage to the soil caused by grazing bare paddocks. At normal grazing pressure, sheep may consume 1000 kg/ha of medic seed in 8 weeks of summer (2). Clearly this is expensive feed. Valizedah (20) is examining the nutritive value of pods and crop residues as alternative cheap feeds for supplying a maintenance diet for sheep during summer.

There is ample evidence that sowing medic seed too deeply greatly reduces seedling emergence with consequent reduced density and productivity (6). Furthermore, tillage can bury a high percentage of seed too deep to allow emergence of seedlings (12, 15, 18). Table 3 summarises relevant data from Carter *et al.,* (12) which show highly significant differences (P-0.001) between tillage treatments for total seed reserves, medic emergence and medic hard wed reserves in the 0-5cm and 5-15cm soil layers.

Table 3. Effects of tillage in 1986 on medic in 1987.

	Mouldboard ploughed 1986	Scarified 1986
March 1987		
Medic total seed reserves (kg/ha), 0-5 cm soil	63	450
April 1987		
Medic emergence (plants/m²)	178	1173
June 1987		
Medic hard seed reserves (kg/ha)		
0-5 cm soil	32	310
5-15 cm soil	172	31
> 15 cm soil	7	3

The impact of various management practices shown in the tables are but a few examples of the potential for upgrading the quantity and quality of annual legume pastures in ley farming systems of South Australia. Further details are given in one-page summaries of poster presentations at this Conference.

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