Pastures for Prime Wheat Production

Libby Roesner
NSW Agriculture
Condobolin Agricultural Research & Advisory Station

Overview:
Lower levels of nitrogen are being fixed in this environment compared to amounts quoted from higher rainfall areas. The total amount of fixed nitrogen measured from the legume pastures varied significantly depending on both the seasonal conditions experienced and the species grown. Increases in soil nitrate were obtained following both a two and three year pasture with a high proportion of legume species and this resulted in significantly higher yields and protein levels in the subsequent wheat crop. Annual ryegrass was found to compete strongly with legume species and was a major reason for the low yields and protein levels in the following wheat crop. The results demonstrate that the returns from the increased yield and protein of the following wheat crop can provide at least $150 and up to $237/ha more for sowing legume pastures and keeping them clean compared with a ryegrass dominant pasture.

Introduction

This project (DAN 380) endeavours to improve the understanding of the nitrogen contributions from pasture legumes to wheat under different management conditions. The outcomes of these investigations should help farmers to understand the best options for managing their pastures to improve the supply of nitrogen from the soil to subsequent crops. The experiments conducted here are continued from the initial project 'Pastures for Prime Wheat Production' (DAN 232) that ran from 1995 to 1998. Field trials at Condobolin have been used to investigate the effects of legume species, phosphorus nutrition and the length of the pasture phase.

Preliminary guidelines developed from the initial results of this project suggest that for the best chance of producing Prime Hard wheat farmers need to:

1. Sow a mixture of inoculated pasture legume species that are suited to the region.

2. Utilise grazing and other strategies to control weeds and keep a high proportion of legumes in the sward.

3. Realise the importance of grass removal.

Preliminary Results

Nitrogen fixation

The total amount of fixed nitrogen measured from the legume pastures varied significantly depending on both the seasonal conditions experienced and the species treatments. Overall, the nitrogen fixation per tonne of dry-matter was considered low (on average 8-10 kgN/t leg DM), especially when compared to other higher rainfall areas (20-25 kgN/t leg DM). The amount of fixed nitrogen accumulated in legume shoot biomass generally parallelled the trends in biomass production. There were seasonal, site and treatment-specific effects on the amount fixed. These are sometimes related to effects on the proportion of legume and non-legume pasture components and consequently the legume yield and N_2 fixation were variably affected by the competition from non-legume species.

Nitrogen fixation results from trial experiments run from 1995 to 1997 show that differences in the amount fixed between years are often greater than between treatments. This is due to both changes in the dry-matter production limited by rainfall and the percent

of nitrogen fixed by the plant which increased over time corresponding to the depletion of soil nitrogen.

The presence of non-legume species in the pasture is one of the main factors contributing to the amount of nitrogen gained from the pasture phase. Competition from vigorous non-legume species in the pasture sward severely restricts the growth of legume species resulting in very low levels of fixation occurring. Annual grasses are particularly competitive.

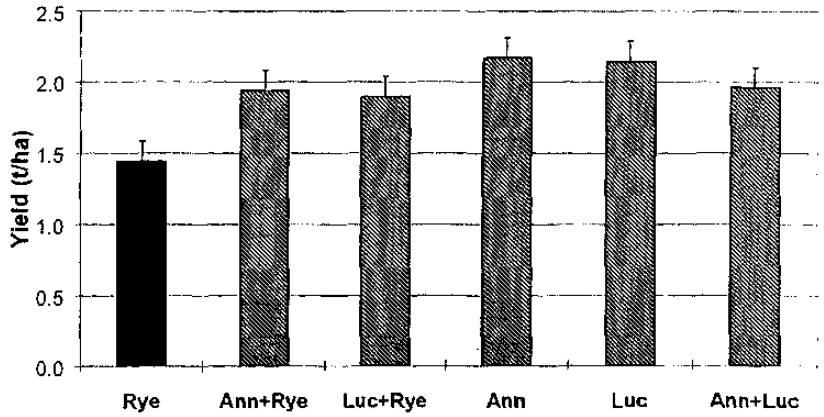
Weed encroachment was a constant problem in most treatments but particularly the pure lucerne plots. This is probably because of the low plant densities in this treatment enabling weeds to grow without competition on the bare soil. Those treatments with a grass component had less invasion of broad-leaved weeds, probably due to the more competitive nature of the annual grasses.

Superphosphate was found to have a significant effect on dry-matter production particularly in wet seasons. The phosphorus increased the amount of dry matter produced in the pasture sward by an average of 0.3 t/ha each year. The effect was more pronounced in the ryegrass treatments than in the pure legume treatments. Although the phosphorus did increase the amount of nitrogen fixed this was not significant.

Soil fertility, wheat yield and quality

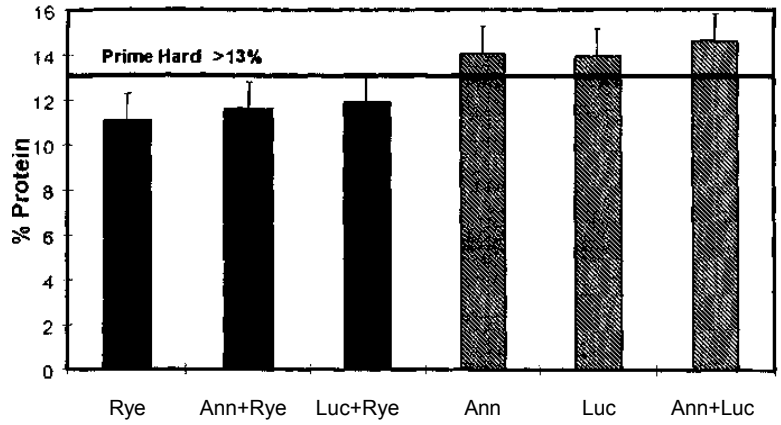
The amount of soil nitrate left in the soil varied significantly among pasture treatments. Results from the soil obtained prior to sowing the 1997 wheat crop in the 'Phase 95' trial showed that pure annual and lucerne treatments provided significantly more available nitrogen than those with a ryegrass component. A strong correlation was measured between wheat protein and soil nitrogen. This was reflected in the protein levels of the harvested wheat in 1997 which reached Prime Hard (>13.5% protein) only after the pure legume treatments (see Figure 2).

Figure 1. The 1997 wheat yield response from different pasture species treatments"



**Treatment abbreviations: Rye - Ryegrass, Ann - Annual legume mixture (Barrel medic, Subterranean clover & Rose clover), Luc - Lucerne.*

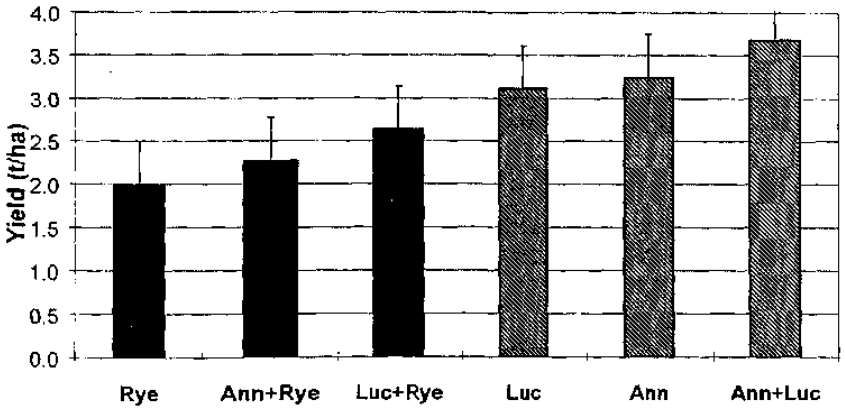
Figure 2. The 1997 wheat grain protein response from different pasture species treatments



"Treatment abbreviations: Rye - Ryegrass, Ann - Annual legume mixture (Barrel medic, Subterranean clover & Rose clover), Luc - Lucerne.

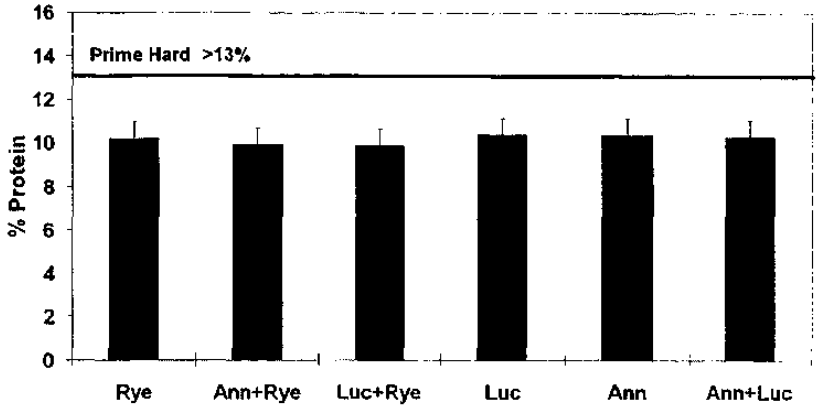
The 1997 wheat harvest from the Phase' trial after the first pasture phase of just two years (Phase 1) yielded well despite the dry year in 1997 (see Figure 1). Yields averaged 1.9 t/ha which is above the district average (1.6t/ha). The best yields came from the pure lucerne and annual mix treatments yielding about 2.2 t/ha. This was followed by the annual and lucerne mixture, the annual/rye and the lucerne/rye treatments all yielding about 2.0 t/ha. The wheat yield after the pure ryegrass treatment was significantly lower at only 1.4 t/ha. The wheat protein reached Prime Hard (>13% protein) only after the pure legume treatments (see Figure 2). On average the protein was 2.5% lower when pastures contained a mixture with ryegrass as opposed to a pure legume stand (see Figure 2).

Figure 3. The 1998 wheat yield response from different pasture treatments*



treatment abbreviations: Rye - Ryegrass, Ann - Annual legume mixture (Barrel medic, Subterranean clover & Rose clover), Luc - Lucerne.

Figure 4. The 1998 wheat grain protein response by pasture treatment*



**Treatment abbreviations: Rye - Ryegrass, Ann - Annual legume mixture (Barrel medic, Subterranean clover & Rose clover), Luc - Lucerne.*

The 1998 wheat harvest from the 'Phase' experiment reflects the results from the same pasture treatments after three years of pasture (Phase 2). The yields this year were significantly higher (2.8 t/ha average) owing to the much wetter and hence 'softer' finish. The highest yields again came from the lucerne and annual mix treatment at 3.7 t/ha. Followed closely by the pure annuals and lucerne treatments, 3.2 and 3.1 t/ha respectively. The treatments of legumes mixed with ryegrass yielded significantly lower at 2.3 and 2.6 t/ha for lucerne and annuals. The pure ryegrass pasture again did the worst with a yield of only 2.0 t/ha. Wheat stubble was examined for the effects of the root specific fungus Take-all, commonly attributed to poor yields following grass pastures, however no evidence of this fungus was evident. Unlike the previous year, the grain proteins measured did not show any difference between treatments, wheat grain from all treatments were measured at around 10%. This effect is not unexpected as it is common in a wet year for the soil nitrogen to converted to yield rather than protein.

Profitability of pastures

In assessing the profitability of the pasture treatments, the average yields and protein contents measured from each treatment were converted into estimated returns using the 1998-9 suggested grower selling prices from Table 1.

The resulting returns for the measured wheat yields and grain proteins for the two years are presented in Table 2.

Table 1. 1998-9 Estimated Silo Wheat Returns - Delivered to Parkes

Grade	% Protein	Price/t
Prime Hard	13%	$192.67
Hard	11.5%	$152.67
APW	10%	$140.17
ASW	<10%	$124.00

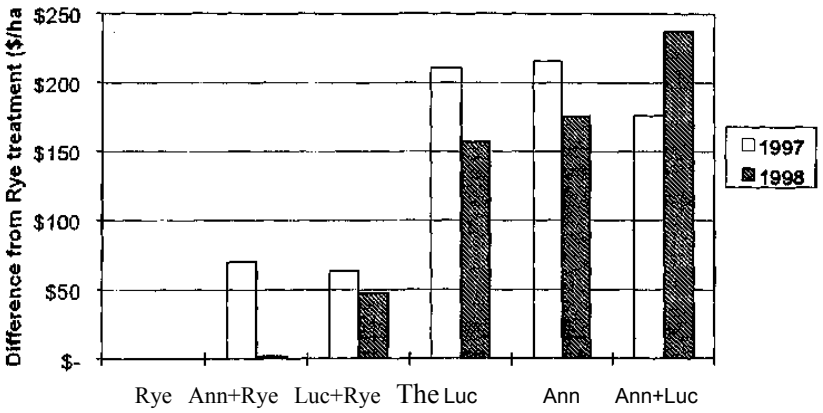
(Source: "The Land" 18/3/99)

Table 2. 1998-9 Estimated Wheat Returns ($/ha) from Phase experiment yields.

Treatment	1997 Harvest	1998 Harvest
Ryegrass	$202	$279
Annual legumes and ryegrass	$272	$281
Lucerne and ryegrass	$266	**$326**
Lucerne	**$413**	**$436**
Annual legumes	$418	**$455**
Annual legumes and lucerne	**$378**	**$516**

Figure 5.

Gross Gain from Legume Pasture



The difference in returns received from the first year of wheat after growing a legume based pasture compared with growing a ryegrass pasture is substantial as can be seen in Figure 5. These results reflect the additional gross return per hectare from the first wheat crop following a legume pasture on top of a straight ryegrass pasture (figures from Table 2). The real differences would have to consider the additional cost of herbicides that are used to keep the pastures clean and any loss of feed associated with cleaning. This figure emphasises the importance of grass removal in pastures prior

to cropping, for herbicide which should cost less that $20/ha, it can result in returns of more that $150/ha. It also indicates the returns achieved when legumes are sown as a component of a grass pasture which can also have a significant financial impact.

Pasture guidelines which will enable farmers to more frequently produce Prime Hard wheat.

Reliable guidelines can only be developed after many years of data have been collated and relationships have been established between field data, farmer surveys and other research. Despite this preliminary guidelines can be suggested from what we have discovered so far in this project:

1. Sow a mixture of inoculated pasture legume species that are suited to the region.

Nitrogen fixation varies widely from species to species depending on the success of establishment and suitability of the climate and location. Sowing a mixture of inoculated species should enable those best suited to survive and fix nitrogen. Herbicide options should be considered when choosing pasture species.

2. Utilise grazing and other strategies to control weeds and keep a high proportion of legumes in the sward.

Removing weeds is important to avoid competition and reduction of the legume population and hence nitrogen fixation.

3. Grass removal is extremely important.

Early wheat yield and protein results have shown that pastures with a high legume proportion and a low grass component have constantly obtained the biggest nitrogen benefits and monetary returns.

Further examination is necessary to determine to what degree winter cleaning in the final pasture year will improve the nitrogen status of the soil. These conclusions will need to be verified over several more seasons before reliable relationships can be confirmed.

Acknowledgments

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