Better Pasture, Better Crop, Better Systems

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ABSTRACT

A rotation experiment including two pasture management packages and one grain legume followed by a wheat crop (1:1) was established in 1995 on a red-brown clays soil at Cunderdin, Western Australia. The optimum pasture management package included sowing medics at the beginning of the rotation, weed and insect control, and focused grazing management. The control management package consisted of unimproved pasture that was set-stocked throughout and spraytopped in spring. The grain legume (either field pea or faba bean) was managed using district practice. Although pasture with improved management produced greater legume biomass than the control in most years, a significant improvement in crop performance was only found in the 4th year (1999). Crop following grain legumes performed similarly to that following improved pastures in most years. Ongoing assessments will confirm the consistency of these results. Results from this study support the view that better management will result in better pastures. However, external factors can have a greater influence than pasture improvement on the subsequent crop performance.

KEY WORDS

Farming system, crop, pasture, rotation, medic.

INTRODUCTION

In a ley farming system, one of the major benefits from a good legume pasture is improved performance of subsequent crops resulting from increased nitrogen fixation and greater opportunities for weed and disease control (1). However, traditional pasture management practice has limitations in maintaining a pasture with high and stable legume content and therefore can not take full advantage of all the benefits (1).

Development, evaluation and adoption of appropriate management strategies for pastures in the ley farm system are critical in increasing the legume content in a pasture. This should enhance the performance of subsequent cereal crops, both in terms of yield and quality, and lead to more sustainable production.

Materials and methods

A long-term pasture-crop rotation experiment was established in 1995 at Cunderdin (31°40’S, 117°16’ E), WA. The site has a red-brown clay soil with an average annual rainfall of 366 mm (274 mm, May-Oct). The actual rainfall of the site in 1996, 1997, 1998, 1999 was 356 (307, May-Oct), 376 (294), 312 (266), and 434 (309) mm, respectively. Three 1:1 rotations were tested: optimum pasture-wheat, control pasture-wheat, and grain legume-wheat. The optimum pasture management package included sowing burr medic (*Medicago polymorpha* cv. Santiago) in the first year, chemical control of grass weed and insect, grazing managed to enhance seed set (spring) and conserve seed reserves (summer). The control pasture management package consisted of an unimproved pasture with inputs limited to set-stocking and spraytopping to control grass seed set (spring). Plot size was 50m ? 28m for the pasture plots and 50m ? 14m for grain legume plots. All rotations were replicated three times in space and twice in year. For the optimum management package, pastures were not grazed in the years that medic was sown (1995 & 1996) and grazing was stopped during summer when seed reserves fell to about 400 kg/ha. The grain legume used in the grain legume-wheat rotation was field pea (cv Dundale) in 1995 and 1996, and faba bean (cv Fiord) in 1997, 1998 and 1999 sown at 120 and 150 kg/ha respectively. The wheat varieties Amery (1996, 1997, 1998) and Carnamah (1999, 2000) were sown at a rate of 60 kg/ha with 120 kg/ha superphosphate, with 40 kg/ha nitrogen as urea (1996 & 1997) and without nitrogen application (1998, 1999, 2000). Each pasture-wheat phase was treated as one unit and data from five such units have been collected (Table 1 and 2).

Results

Rotation started in 1995

1995 pasture – 1996 crop. The pasture with optimum management in 1995 produced significantly more biomass and had a higher legume content than the control pasture (Table 1). This indicated an immediate effect of sowing medics in increasing pasture production and quality. However, crop performance in the following year was similar among all treatments, with the exception of the wheat crop following field pea that produced a higher protein content than the crops following pastures.

1997 pasture – 1998 crop. In 1997, pasture production was poor due to a disease problem (*Fusarium sp.*), which caused a decline in medic content in the optimum pastures. Biomass production and legume content were similar in both optimum and control pastures. However, the composition of the legumes was different between the improved and the control, with the control pasture having a higher proportion of volunteer trifoliums (mostly *Trifolium glomeratum* L., data not shown). The crop yield following pastures and grain legumes was again similar among all treatments.

1999 pasture – 2000 crop. Pasture with the optimum package produced much more biomass and had a higher legume content than the control. Data on crop performance following the pasture will become available at the conference presentation. However, a response of crop performance to previous pastures is expected.

Rotation started in 1996

1996 pasture – 1997 crop. The effect of sowing medics and improved management on pasture performance was repeated in 1996, with the sown pasture producing more biomass and a higher legume content (Table 2). Crops following pasture did not respond to differences in pasture performance. Protein content in the wheat crops was also similar among all treatments.

1998 pasture – 1999 crop. Optimum pasture management resulted in significantly higher pasture production than the control and a legume content twice as high as the control management (Table 2). Crop performance in the following year responded favourably to the improved pasture performance. The wheat following improved pastures produced nearly 50% more grain than the control. However, protein content in that year was generally low and there was no difference between the treatments. There were no obvious weed and disease problems in the crops.

DISCUSSION

Generally, data collected from this experiment supports the hypothesis that better pasture management will result in better pastures and that better pastures can be followed by better crops. However, the improvement in crop performance was unreliable and only occurred in a small proportion of years. It was particularly notable that there was never any crop response in the year immediately following the start of pasture improvement.

The lack of response of wheat to improved pasture performance at the beginning of the rotation could be caused by the release pattern of nitrogen fixed by the pasture. There is evidence that a large proportion of the nitrogen fixed could be stored in the seeds and other plant parts that need time to become available for plants to take up (2, 3). This will especially be the case in the first year of the rotation when grazing is limited in order to maximise seed production. This will slow down the mineralisation of nitrogen compared with that consumed by sheep and passed out as urine and faeces. The application of fertiliser nitrogen in 1996 and 1997 could also have suppressed the potential response of the wheat crop to pasture improvement.

The response of wheat to previous pasture management could also be affected by the prevailing conditions of the year. Above average rainfall (as in 1999) is important for high crop yields but this potential can only be reached when soil fertility levels are not limiting. Consequently any crop response to higher legume contents in pastures will be most notable in years with favourable rainfall.

The results also highlight problems that can be faced with a legume monoculture. One catastrophic event (such as fungal disease) can pose a serious threat to pasture legume production and future crop performance. The use of diverse legume species mixture may help overcome this problem (4).

Crop following grain legumes generally performed equally as well as crops following the improved pasture, indicating that they can provide similar benefits to the system. However, as there is often a larger amount of nutrient removal from systems with grain legumes than with pastures, there may be some negative effects with grain legumes that would not be noticed in the short-term. These effects may start to show up with further cycles of the rotation (5).

CONCLUSION

The improved pasture management can result in better pasture performance. However, better pastures may not always result in better crops as expected. External events (such as season and disease) which growers have less control over can often over-ride the benefits from improved pasture management. Grain legumes can contribute similarly as improved pastures to the system in terms of the performance of following crops. Whether to improve pasture performance or to include grain legumes as an alternative in the system will depend on the farmer’s economic considerations and the overall farm management plan. However, considering over 50% of the land or rotation in the wheatbelt are under pastures, improved pasture management to increase the production and legume content will be a worthwhile strategy for attaining a system sustainable at a higher level.

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Table 1. Pasture phase started in 1995. Total biomass and legume content of pastures and their effects on grain legumes and grain yield and protein content of the following wheat crops.

Year	1995		1996		1997		1998		1999		2000	
Phase	Sown legume		Wheat (Amery, 25-June)		Regenerating pasture or sown grain legume		Wheat (Amery, 09-June)		Regenerating pasture or sown grain legume		Wheat cv. (Carnamah, 26-June)	
Legume phase	Biomass t/ha	Legume %	G. yield t/ha	Protein %	Biomass t/ha	Legume %	G. yield t/ha	Protein %	Biomass t/ha	Legume %	G. yield t/ha	Protein %
Optimum	3.9	99	3.7	10.0	3.1	31	2.3	9.0	9.4	78	*To be collected*	
Control	2.1	<1	3.7	9.1	3.2	31	2.5	8.6	4.8	10		
Grain legume	5.0 (field pea)	100	3.5	11.7	4.0 (faba bean)	100	2.1	9.8	9.0 (faba bean)	100		
lsd 0.05	1.05	0.01	ns	0.92	0.73	30.3	ns	ns	2.2	26.6		

Table 2. Pasture phase started in 1996. Total biomass and legume content of pastures and grain legumes and their effects on grain yield and protein content of the following wheat crops.

Year	1996		1997		1998		1999	
Phase	Sown legume		Wheat (Amery, 05-June)		Regenerating pasture or sown grain legume		Wheat (Carnamah, 10-June)	
Legume phase	Biomass t/ha	Legume %	G. yield	Protein %	Biomass t/ha	Legume %	G. yield t/ha	Protein %
Optimum	3.2	87	2.4	10.7	5.3	98	4.5	8.9
Control	1.9	<1	2.7	10.1	1.9	48	3.0	8.5
Grain legume	4.9 (field pea)	100	2.1	10.9	N/A (faba bean)	100	4.1	8.5

lsd 0.05	1.52	N/A	ns	ns	0.51	19.4	0.25	ns

N/A – not available; ns – non significant.