Clover species suiting crop rotations

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Abstract

Four clover species were tested in a 1:1 pasture:crop (P-C) rotation scheme during 1997-2001 at two sites in Victoria. Pasture growth and production as well as grain yields of subsequent wheat or canola crops were measured. A normalised yield parameter was then generated and used to assess the suitability of clovers for growing in rotation with crops. It is suggested that balansa, Persian and arrowleaf clovers showed differential suitability, and one or more of these clovers along with subterranean clover can be incorporated into P-C rotations for high plant productivity.

Key words

Pasture-crop rotation, pasture legumes, dry matter production, normalised yield, wheat, canola

Introduction

The benefits of including pasture legumes in rotations with crops have long been recognised (1). However, convincing data are required to promote pasture-crop (P-C) rotation systems, particularly in higher rainfall, cool temperate areas of southern Australia. This entails the identification and effective use of more productive alternative pasture legumes suited to P-C rotations. In a ley farming system defined by Reeves and Ewing (2), a pasture legume must be able to self-regenerate well after a crop. It is also essential for the pasture to produce high herbage dry matter (DM) and hence symbiotically fix large amounts of atmospheric nitrogen (N), from which a subsequent crop will benefit for grain production in the absence of N fertiliser application (3). This paper reports the test results of the suitability of alternative clover species relative to the common species, subterranean clover, for rotation with wheat and canola crops, in terms of herbage DM production of pasture legumes and grain production of subsequent crops.

Methods

The experiment was conducted at two sites in Victoria: Gnarwarre (38?10'S, 144?15'E) and Streatham (37?41'S, 143?04'E). A one year's pasture phase followed by one year's crop phase was employed for a P-C rotation scheme, as described in Table 1. A randomised complete block design replicated four times was established at both sites. For those plots with pasture treatments, no N fertiliser was applied during the season, while each fallow/crop or continuous crop plot was fertilised with 109 kg urea/ha (equivalent to 50 kg N/ha) when the crop was sown. Fallow/crop is defined as fallow in the pasture phase and N input through fertiliser application in the crop phase.

Table 1. Experimental designs for a P-C rotation scheme involving 4 annual clover species and 2 other treatments of conventional farming practice at Streatham and Gnarwarre (1997-2001). P stands for pasture legumes; P[1], Crimson clover cv. Caprera; and P[2], Persian clover cv. Maral. Wheat varieties used were Declic (1998 and 1999) and Silverstar (2001). Canola variety used was Surpass 400 (2000).

Treatments	1997	1998	1999	2000	2001
Arrowleaf clover cv. Arrotas	P	Wheat	P	Canola	P

Balansa clover cv. Bolta	P	Wheat	P	Canola	P
Persian clover cv. Nitro plus	P	Wheat	P	Canola	P
Subclover cv. Leura	P	Wheat	P	Canola	P
Fallow/crop	P[1]	Wheat	Fallow	Canola	Fallow
Continuous crop	P[2]	Wheat	Wheat	Canola	Wheat

During the pasture phase (1997, 1999 and 2001), herbage DM production was measured on a four weekly basis during the growing season using quadrat cuts, and cumulative DM (t/ha) was calculated. In the crop phase (1998 and 2000), grain yield (GY) of wheat or canola (t/ha) was determined by harvesting 2 m^2 of crop per plot.

Plot data for individual characters were normalised using the highest individual plot yield for any treatment, in a given year, as the maximum (highest yield = 1) and yield fractions were calculated. Once normalised, relative plant production for each treatment across years was combined, giving relative yields for each individual treatment. The range of normalised yields (NY) that a treatment can produce is from 0 to 1: the closer it is to 1, the more effective the treatment. NY data were analysed on a plot mean basis over time and/or characters using ANOVA (Genstat 5.4).

Results

An assessment of the normalised yields (Table 2) indicated highly significant differences ($P < 0.01$) in relative production (i.e. NY-DM, NY-GY and NY-DM/GY) among the six treatments with consistently higher values at Streatham than at Gnarwarre. Overall, balansa clover was the most productive treatment, while fallow/crop was the least. Balansa clover was apparently more effective in relative productivity than Persian clover, which was significantly better than arrowleaf clover or subclover. This result suggests the general suitability of balansa clover for the high rainfall environment. The existence of interactions between site and treatments, however, indicates the specific suitability of some treatments in a particular environmental condition, such as Persian clover at Gnarwarre.

Table 2. Normalised yields of herbage DM (NY-DM), crop grain yield (NY-GY) and their combinations (NY-DM/GY) of six treatments at Streatham and Gnarwarre (1997-2001).
***** *P* ≤ 0.001; ** *P* ≤ 0.01; * *P* ≤ 0.05; *n.s.*, non-significant, *P* > 0.05.**

Treatment	NY-DM (97, 99, 01)		NY-GY (98, 00)		NY-DM/GY (97-01)	
	Streatham	Gnarwarre	Streatham	Gnarwarre	Streatham	Gnarwarre
Arrowleaf clover	0.53	0.29	0.57	0.23	0.54	0.26
Balansa clover	0.65	0.37	0.72	0.40	0.68	0.38
Persian clover	0.58	0.47	0.67	0.34	0.61	0.42

Subclover	0.41	0.36	0.61	0.30	0.49	0.34
Fallow/crop	0.05	0	0.62	0.29	0.28	0.12
Continuous crop	0.11	0.17	0.57	0.23	0.29	0.19
lsd (*P* = 0.05)						
Site	0.038 ***		0.053 ***		0.035 ***	
Treatment	0.066 ***		0.091 **		0.061 ***	
Site by treatment	0.093 ***		0.129 *n.s.*		0.086 *	

Conclusions

Differential suitability was indicated for the four clover species grown in rotation with wheat and canola in high rainfall environments during the past five years. Nevertheless, the normalised yields together with other parameters clearly showed the general suitability of balansa clover in the rotation system and its benefits to subsequent crops.

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References

(1) Karlen, D.L., Varvel, G.E., Bullock, D.G. and Cruse, R.M. 1994. Adv. Agron., 53: 1-45.

(2) Reeves, T.G. and Ewing, M.A. 1993. Proc. of XVII Intern. Grassland Congress. Rockhampton, Australia. Vol. III: 2169-2177.

(3) Peoples M.B., Gault R.R., Scammell G.J., Dear B.S., Virgona J., Sandral G.A., Paul J., Wolfe E.C. and Angus J.F. 1998. .Aust. J. Agric. Res., 49: 459-474.