PASTURE SPECIES AND PHASE LENGTH EFFECTS ON RICE GRAIN YIELD.

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Abstract

Four temperate clover species, subterranean clover cv. Trikkala, Persian clover cv. Kyambro, balansa clover cv. Paradana, berseem clover cv. Bigbee and a ryegrass cv. Wimmera control were grown on a heavily cropped site for 1, 2 and 3 seasons and followed by a rice crop. Pasture productivity, soil nitrogen changes and the yield response of the following rice crop were studied. It is unlikely that any of the alternative pasture species tested in this experiment would replace subclover in the rice rotation. None of the alternative species were superior in ease of management, dry matter yield or nitrogen contribution than subclover which is the traditionally grown species.

Key words: rice rotation, nitrogen, legume pasture

Introduction

Rice has traditionally been grown in south-eastern Australia in a rotation of 1 year of rice following 4 - 5 years of annual legume based pasture, with subterranean clover (*Trifolium subterraneum* L.) the predominant species (8). A large increase in the area of rice grown per farm has led to a more intensive rice rotation system. It is now common to grow 2 or 3 consecutive crops of rice followed by a shorter period of pasture and/or winter cereals. This has led to lower soil nitrogen levels and increased application rates of nitrogenous fertilisers.

The length of the pasture phase in the rice rotation and its nitrogen contribution to the following rice crop are important for the fertiliser management of the crop and the economics of the rice farming system. Rice-pasture (subterranean clover) rotation experiments conducted by Heenan (5) showed that a single season short pasture phase (6 months) had no significant effect on rice yield whereas a 2 year pasture phase contributed the equivalent of 40-80 kg/ha of fertiliser N to the soil. Beecher *et al.* (1) showed that pure legume pastures of subterranean or white clover (*T. repens*) increased yields of the following rice crop, but that there was little difference between a 2, 3 or 4 year pasture phase.

Lattimore (6) in a review of pastures for rice growing in southern Australia suggested that several new pasture species and cultivars have potential in rice rotations. This study aimed to determine the suitability of alternative legume pasture species in the rice rotation and monitor their nitrogen contribution to a following rice crop after pasture phase periods of 1, 2 and 3 years.

Method

Four temperate clovers and a ryegrass control were grown on a heavily cropped site for 1, 2 and 3 seasons at Yanco, NSW, on a red-brown earth. The experiment had 3 replicates in a randomised block design, with each sowing year represented in each block. Subterranean clover (*Trifolium subterraneum* var. *yanninicum*) cv. Trikkala (15kg/ha), Persian clover (*T. resupinatum*) cv. Kyambro (9 kg/ha), balansa clover (*T. michelianum* var. *balansae*) cv. Paradana (9 kg/ha), berseem clover (*T. alexandrinum*) cv. Bigbee (20 kg/ha) and ryegrass (*Lolium rigidum*) cv. Wimmera (20 kg/ha) were sown each year for 3 years, giving pasture phase lengths of 1, 2 and 3 years. Treatments not yet sown to pasture were sown to barley (*Hordeum vulgare*) with 200 kg/ha of single superphosphate.

The pastures were established using a triple disc seeder, and regenerated after irrigation in following seasons, except for berseem which was resown each season. New pasture treatments were sown and irrigated in mid March and established treatments first irrigated in late February each season. All pastures were irrigated at a 65 mm evapotranspiration interval. Single superphosphate was applied at 200 kg/ha early in each season, being sown into the soil prior to sowing new treatments and applied to the soil surface for continuing treatments. Pasture DM yield was measured by hand cutting 5 quadrats of 0.25 m^2 in area from each plot when the plant height of the best plots reached 15 cm and at late flowering. The remainder of the pasture was cut to a 3cm height and removed from the plots. During the pasture phase 2,4DB was used to control severe Patterson?s curse infestations and grass weeds were controlled with the herbicide Sertin^R (Sethoxydin).

Commencing in September of the third season (1994), the pastures were sprayed with a knock down herbicide (glyphosphate), the pasture removed and a rice crop established by direct drilling. The rice crop was managed for irrigation and weed control as a traditional direct drilled crop. Three nitrogen rates (0, 60 and 120 kg N/ha) were applied to the rice crop prior to permanent flood.

Soil samples were taken to a depth of 10 cm from all plots prior to nitrogen application and permanent flood being applied to the rice crop. Soil nitrogen (anaerobic incubation ammonium-N) (11) was measured on the air-dried and ground samples. Soil subsamples of 20 g were added to 100 ml distiled water in 250 ml tightly sealed bottles and then incubated at 30^{o}C for 14 days. At the end of the incubation, 100 ml of 4 mol KCl/L was added, the sample shaken for 6 hours and the ammonium content measured.

Results

Pasture yields

Balansa and berseem clover had the highest dry matter yields in the 1992 season followed by Persian, ryegrass and subclover (Table 1). In the 1993 season, berseem yielded the highest, with 10.4 and 10.8 t/ha respectively, for year A and year B sowings, followed by subclover (year A), Persian (year A) and (year B). In the 1994 season, balansa for all sowing years and Persian and berseem sown in year C had poor clover yields due to plant death soon after germination caused by spotted clover aphid. All pastures grown in the 1994 season yielded less due to their reduced growing season as a result of establishing rice in early October. Subclover sown in years A and B achieved the highest dry matter yields in the 1994 season.

Table 1. Total DM yields (t/ha) of 5 annual pasture species established in each of three seasons on a red-brown earth soil in southern NSW.

Harvest Season	1992	1993		1994		
Sowing Year	A	A	B	A	B	C
Subterranean	3.23	5.91	2.44	5.54	6.27	0.59
Persian	4.84	5.35	5.58	0.34	1.74	0
Balansa	6.86	4.08	3.92	0	0	0
Berseem?	6.12	10.43	10.83	2.31	2.27	0
Ryegrass	4.63	1.55	1.19	1.57	1.61	0.9

lsd (P<0.05)	1.87	1.87		0.73

Soil ammonium

The incubation soil ammonium concentration was significantly higher for the year A sown pasture than for the year C sown pasture (Table 2). When meaned over years, the subclover plots had significantly higher levels of soil ammonium than the other 3 legume pastures and all legume pastures were significantly higher than the ryegrass pasture. Within individual years the pasture type did not result in significant differences in soil ammonium.

Rice crop

Grain yield: Rice grain yield at the zero N rate for sub clover sown in years A and B and berseem clover sown in year A, was significantly higher (P<0.1) than all other treatments (Fig. 2). In each pasture phase length the ryegrass treatment yielded less than the legume treatments and although not significant, longer term pastures yielded more than one year of pasture.

Table 2. Anaerobic incubation soil ammonium content (*u*g/g oven dry soil) for pasture species and sowing year. l.s.d. (*P*<0.05) = 10.1 for mean of pasture and 5.4 for mean of year.

Sowing year	A	B	C	Mean of year
Subterranean	93	82	69	81
Persian	82	75	64	73
Balansa	82	67	71	74
Berseem	80	75	69	75
Ryegrass	73	64	64	67
Mean of pasture	82	73	67	

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The rice grain yield following subclover (meaned over pasture phase length) for both the 0 and 60 kg N/ha treatments was significantly higher than all pasture types except for the berseem (Fig. 2). Irrespective of pasture phase length, the application of 60 kg/ha of nitrogen significantly increased yield for all pasture types. All pasture types except subclover significantly increased yield when an additional 60 kg N/ha was applied to give a 120 kg N/ha total application. There was no difference in yield response between the pasture types when 120 kg N/ha of fertiliser was applied.

Discussion

Pasture dry matters obtained in this experiment are lower than would be expected. Beecher *et al.* (1) obtained sub clover yields of 12 to 18 t/ha from a 2nd year regenerated stand under similar management practices. Pasture growth was severely retarded in the autumn of the 1992 and 1993 seasons after spraying with 3.5 L/ha of 2,4DB. Evans *et al.* (4) reported that 2 l/ha of 2,4DB reduced sub and balansa clover DM by 62%. Berseem clover commonly suffers unacceptable damage from 2,4DB at both the seedling and established plant stage (2), while Persian has a variable tolerance, being more susceptible to 2,4DB damage after the seedling stage. Berseem was not sprayed with 2,4DB in the 1993 season. This probably explains the higher yield for berseem in the 1993 season than all other pasture types.

Pastures established in year C produced much lower DM yields than achieved by Lattimore *et al.* (7) with a similar period of growth. Establishment in year C was satisfactory but the plants did not grow, possibly due to a spotted clover aphid (SCA) infestation. Milne (pers. comm.) indicates that SCA were active in the Riverina during 1993-4 and that these species are susceptible to SCA. Murray *et al.* (9) suggest that SCA can reduce pasture growth and change pasture composition in autumn, winter and spring. The subclover sown in years A and B and berseem sown in year A had similar rice grain yields with zero applied nitrogen, but the total pasture dry matter achieve from these treatments is very different (Table 3)

Table 3. Cumulative total dry matter yields (t/ha) of 5 annual pasture species established in each of two seasons, anaerobic incubation soil ammonium content (*u*g/g oven dry soil) and rice crop grain yields (t/ha).

Pasture type	Subclover		Persian		Balansa		Berseem		Ryegrass	
Sowing Year	A	B	A	B	A	B	A	B	A	B
Total clover DM (t/ha)	14.7	8.7	10.53	7.32	10.94	3.92	18.9	13.1	7.75	2.8
Soil NH4 (*u*g/g)	93	82	82	75	82	67	80	75	73	64
Rice grain yield (t/ha)	8.93	9.22	7.63	7.06	7.47	7.06	8.87	7.60	6.79	5.52

The soil nitrogen levels after the different clover species were variable in their relationship to the pasture dry matter production (Table 3). These results differ from the general rule of thumb that 20-25 kg N/ha is fixed for each tonne of legume dry matter produced, regardless of species or environment (10). Subclover appears to be more efficient in fixing nitrogen per unit of pasture dry matter than the other pasture types.

Results obtained in this experiment are in agreement with Heenan (5) who showed that short term (6 month) pastures contributed little nitrogen to the following rice crop and with Beecher *et al.* (1) who showed that there is little difference between a 2 or 3 year pasture phase in N contribution. Dunn and Beecher (3) concluded that a short period of pasture which is green manured prior to rice establishment has the potential to benefit the rice crop.

Despite the N fixing ability of legumes these pastures would not be adequate to supply the total N required by a rice crop since regardless of the pasture type and the period of growth studied, nitrogen fertiliser was necessary to obtain maximum rice yields.

Conclusion

It is unlikely that any of the alternative pasture species tested in this experiment would replace subclover in the rice rotation. None of the alternative species were superior in ease of management, DM yield or nitrogen contribution to a following rice crop than subclover, the traditionally grown species.

This experiment showed that although pasture legumes add N to the system the contribution of a grazed/removed short term (6 month) pasture to a following rice crop is minimal regardless of the pasture legume species grown.

The experiment confirmed that there is little difference in nitrogen benefit between a 2 or 3 year pasture phase and that the N fixed is not adequate to achieve a commercially acceptable yield performance without the addition of fertiliser N.

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