Grass, grass + legume or legume leys: a South African experience

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Abstract

As a result of increasing interest in the potential role of planted pastures as leys in rotational cropping systems, the residual effects of weeping lovegrass (*Eragrostis curvula*) with and without nitrogen, lucerne (*Medicago sativa*) and grass + legume pastures on a following maize crop (*Zea mays*) were compared. In the absence of a continuous maize control, it was notable that maize yields on all treatments were at least 100% better than the regional average. In the first year after ley, the best results were from pure lucerne and mixed pasture, but the latter (lucerne + grass) gave the best results in the second maize crop. It was concluded that combining grass and legumes would have all the advantages of yield and quality with low inputs and reduced bloat risk during the pasture phase, in addition to a more prolonged effect on succeeding crops.

Introduction

South Africa is characterised by a high population density. In a country which receives, on average, less than 500 mm of rainfall per annum and has less than 14% arable soils, national food security is very dependent on the sustainable use of the limited cropping soils. This situation is aggravated by the fact that 66% may be classified as unsuited for continuous cropping.

On the Mpumulanga tableland (altitude > 1600 m.a.s.l.), where this work was done, such marginal soils may be used for perennial ley pastures in rotation with annual row crops. Apart from the theoretical beneficial effects of such leys, they play a vital role in livestock systems in the area. In the latter context, the economic viability of grass + legume or legume pastures was considerably better than that of nitrogen–fertilised grass pasture (Rethman and de Witt 1984).

This report concentrates on the performance of maize crops following grass (with and without nitrogen), grass + legume or legume pastures.

Method

The original pastures were established on an Avalon soil form (McVicar *et al.* 1977) on the Nooitgedacht Research Station at Ermelo on the Mpumulanga tableland and were evaluated in a replicated randomised block design over a 5-year period (Rethman and de Witt 1984). Treatments 1–4 consisted of weeping lovegrass (*Eragrostis curvula*) pastures fertilised with 0, 100, 200 and 300 kg N/ha/annum. This was supplemented with an average of 21 kg P and 60 kg K/ha/annum. Treatments 5–7 consisted of various mixtures of weeping lovegrass and lucerne (*Medicago sativa*), while Treatment 8 was a pure stand of lucerne. Fertilisation of pastures containing lucerne included a single application of 6.5 t/ha dolomitic lime at establishment, with an average of 31 kg P and 80 kg K/ha/annum. These latter pastures received no N fertiliser. At the end of the 5-year pasture phase, during which time they were either harvested for hay or grazed by sheep, the pastures were ploughed out and the area was cropped with maize for 2 successive seasons. The liming, P and K fertilisation of the maize crop was based on soil analyses of each pasture treatment. Each pasture treatment plot was also split for 4 levels of nitrogen (15, 55, 95 and 135 kg N/ha/annum) applied to the maize crop. Unfortunately, the original experimental design (which was not aimed at an evaluation of the pastures as leys) did not include a continuous cropping control.

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Results and discussion

Soil analyses

The average fertility status (see Table 1) of soils previously planted to grass pasture was markedly poorer than that of soils previously planted to pastures containing lucerne. This could be ascribed to the lower fertiliser inputs into grass pastures over the preceding 5 years. On the basis of these results, the soils were differentially limed, with those previously planted to grass receiving 5.0 t dolomitic lime per hectare compared with 2.0 t/ha on those previously planted to lucerne. The first maize crop was planted with minimal inputs (15 kg N, 10 kg P/ha) with the result that the fertility status declined. This depletion of the fertility status continued with the completion of the second maize harvest, which also received minimal inputs (15 kg N, 13 kg P, 9 kg K/ha). It is evident, therefore, that fertility, which had built up during the pasture phase, rapidly became depleted when the subsequent row crops were planted with low inputs. Although the soils were not analysed for nitrogen or organic matter (a major deficiency in this study), the carryover effect of N on the maize crop was assessed.

Table 1. Soil fertility status before and after 2 maize crops.

	Previous pasture	PH (H_2O)	P	K	Ca	Mg
				(mg/kg)		
Before maize crops	Grass	5.1	36	72	165	40
	Legume	6.1	44	134	355	60
After first maize crop	Grass	5.7	25	66	448	101
	Legume	6.8	19	66	437	104
After second maize crop	Grass	5.8	17	53	380	51
	Legume	6.6	13	74	590	84

First maize crop

Although the level of N fertilisation of the preceding grass pasture had no apparent influence (see Table 2) on either the crude protein concentration in leaves or the grain yield of the first maize crop, it appeared that the inclusion of lucerne (in a grass + legume pasture or as a pure legume pasture) had a marked positive effect. With grass pastures (with or without N) having an index of 100, the indices for the mixed pasture and legume pasture were 105 and 109 for crude protein concentration, 131 and 144 for stover yield and 112 and 117 for grain yield, respectively.

Table 2. The effects of previous pasture treatment on the first maize crop following a ley period.

Previous pasture	N applied (kg/ha)	Leaf C.P. (%)	Stover yield (kg/ha)	Grain yield (kg/ha)
Grass	0	5.4		6926
Grass	100	6.0		7667
Grass	200	5.6		6036
Grass	300	6.0		6691
Mean of grass treatments		5.8	5212	6830
Mean of grass + legume treatments		6.1	6827	7646
Legume treatment		6.3	7487	8005

The influence of the current level of N fertilisation (see Table 3) on the crude protein concentrations in leaves at both silage and grain harvest stages followed a predictable pattern with crude protein increasing by 12% and 14%, respectively, as the level of nitrogen was increased from 15 to 135 kg N/ha.

Table 3. The mean effect of level of N fertilisation applied to the first maize crop on the crude protein concentration in leaves.

Current level of N fertilisation applied to maize (kg/ha)	% Leaf C.P.	
	Silage stage	Grain harvest stage
15	6.7	5.7
55	7.0	5.8
95	7.5	6.0
135	7.5	6.5

Second maize crop

The results obtained in the second season following the ley (see Table 4), as measured in terms of grain production, demonstrated quite clearly that, irrespective of what ley pasture preceded the maize, there was a poor response to N topdressing. Grain yields from treatments receiving 15, 55, 95 and 135 kg/ha N were 4.7, 4.8, 4.8 and 4.9 t/ha, respectively. It was most unfortunate that a control maize monoculture treatment was not included in this trial and that the post-ley maize cropping was not continued over an extended period, as experience has generally indicated that response to N topdressing increases with time. The response (or lack thereof) to different ley pastures would appear to indicate that, although the pure lucerne pasture had a marked beneficial effect on the first maize crop (Table 2), this effect was short-lived (Table 4). In the second season, there was a trend for leys, which incorporated grasses(both grass — with and without nitrogen and grass + legume pastures) to have a more prolonged effect. It was unfortunate that this trial did not include measurements of soil nitrogen, organic matter and C:N ratios, at different stages, as such information might have provided an explanation for such results. The relative proportions of grass and legume in the mixed pastures might also have been relevant.

Table 4. The effects of previous pasture, and current level of N fertilisation, on the grain yield (kg/ha) of the second maize crop following the ley period.

Previous pasture	Current N fertilisation (kg/ha)				Mean
	15	55	95	135	
Mean of grass treatments	5183	4861	5008	5068	5030
Mean of grass + legume treatments	5354	5929	5275	5127	5421
Legume treatment	3460	3557	4200	4580	3949
Mean	4666	4782	4828	4925	

Conclusions

Although this trial had the disadvantage of not including a monoculture row crop treatment, having been originally designed to evaluate the potential of replacing N fertilisation of grass pastures with a legume component, it has been successful in illustrating that maize following ley can be very successful. Despite the low inputs into two successive maize crops (15 kg N, 12 kg P and 5 kg K/ha), grain yields averaged 6 t/ha. This was achieved in an area where the farm average is 2.5–3 t/ha. With respect to the type of ley, results reported by Rethman and de Witt (1984) and Rethman *et al.* (1986) have indicated that the cheapest forage and the cheapest protein were produced from mixed pastures. They also reported that maize following pure lucerne did not respond to N fertilisation.

Ley pastures should be included in rational cropping systems on marginal cropping soils of the Mpumulanga tableland. Although well fertilised grass (such as weeping lovegrass) or legume (such as lucerne) may be used for this purpose, a mixed pasture would have the advantages of yield and quality with low inputs, with reduced risk of bloat during the pasture phase and a more prolonged beneficial effect on succeeding row crops.

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