Pasture legume production severely reduced when co-sown with winter forage cereals

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Abstract

First year productivity of pasture legumes is lower than subsequent years due to low soil seed bank (in annual species such as medics) or because of slow early vigour (in perennial legumes such as lucerne and sulla). Establishing legumes into existing summer-growing grass pastures in autumn is difficult because of low soil moisture and the established grass competes strongly with emerging seedlings. This study examined the effects on establishment, early productivity and persistence of a range of sown pasture legumes when co-sown with winter-growing cereal forage crops. Five winter-sown legume species (snail medic, barrel medic, strand medic, sulla and lucerne) were sown alone and in combination with forage barley (Clifton, southern Qld) or oats (Warialda, northern NSW) at full (50 kg/ha) and half seeding rate (25 kg/ha). Competition from the forage cereals at both sowing rates reduced the growth of the pasture legumes by 80-98% in all species, but forage cereal production was not reduced by the legumes. Of the legumes sown alone, sulla was the most productive (>4.5 t DM/ha), but this was still about 50% of the forage cereal yield. While growers often establish pasture legumes under cereal grain crops sown at reduced densities, doing so with forage varieties sown at higher rates (>25 kg/ha) is liable to reduce seed set of annual species and establishment density of perennial species resulting in unviable pasture populations in subsequent years.

Introduction

A major limitation to increased use of temperate ley legumes in the northern cropping zone is their low and unreliable yield in their establishment year. The ongoing productivity of the pasture may be compromised if a low soil seed bank is developed in annual species such as medics, or if unsatisfactory densities of in perennial legumes such as lucerne and sulla are established (Singh et al. 2009). Also establishing legumes into existing summer-growing grass pastures in autumn is difficult because of low soil moisture and the established grass competes strongly with emerging seedlings. While under-sowing winter legumes with cereal grain crops is common (Lloyd et al. 1991), this study aimed to assess the potential to increase forage production in the legume establishment year by co-sowing legumes with a forage cereal. This approach might also be useful for establishing a soil seed bank of a legume pasture a year prior to sowing a summer-growing grass the following summer. The effects on establishment, early productivity and persistence of a range of winter sown pasture legumes when co-sown with a winter-growing cereal forage crop were evaluated in 2011 at two sites; Warialda, NSW and Clifton, Queensland in the northern mixed farming zone.

Methods

Three replicates of five different winter-sown legume species (Table 1) were sown alone and in combination with forage barley cv. Urambie (at Clifton site) and oats cv. Warrego (at Warialda) sown at full (50 kg/ha) and half rate (25 kg/ha). A 'blank' treatment of forage barley or forage oats sown alone was also included. Experiments were sown on 20 May at Clifton site about 45 km south of Toowoomba, and 22 May 2011 at Warialda site, about 25 km north of Warialda, NSW. Recommended sowing rates for the legumes were used (Table 1).

Table 1. Pasture legume cultivars, seeding rates and emerging seedling densities 4 weeks after sowing.

Species/cultivar	Sowing rate (kg/ha)	Plant establishment (plants/m^2)	
		Clifton	Warialda
Snail medic cv. Sava	5	22	23
Barrel medic cv. Jester	3	16	27
Strand medic cv. Angel	3	15	34
Lucerne cv. UQL-1	3	23	28
Sulla cv. Wilpena	5	20	40

Biomass was sampled from two 0.5 m^2 quadrats in each plot and partitioned into forage cereal, legume and weed components on 12 September (114 days after sowing) at Clifton and 20 October (150 days after sowing) at Warialda (weed component was removed at Warialda but not dried). Legume pods were separated from biomass at Warialda to derive a Harvest Index (HI = pod yield/biomass yield) for the annual medics to estimate the legume pod yield at the Clifton site.

Results and Discussion

There was no difference in initial seedling emergence between legumes sown alone or in combination with forage cereals. Initial emergence densities taken 4 weeks after sowing showed reasonable plant densities were present for all legumes (Table 1).

Figure 1 shows that the competition from the forage cereals greatly reduced the growth of the pasture legumes. When co-sown with the forage cereals at either rate, legume biomass was reduced by 80-98% in all species, but forage cereal production was not reduced or enhanced by the legumes. The reduction was least in the annual medics (barrel, snail and strand) compared to the perennial legumes (sulla and lucerne). At Clifton, the lower barley seeding rate (25 kg/ha) reduced legume production less but also reduced cereal forage production by 1.4 t DM/ha. However, at the Warialda site the lower oats seeding rate produced more biomass at the time of sampling.

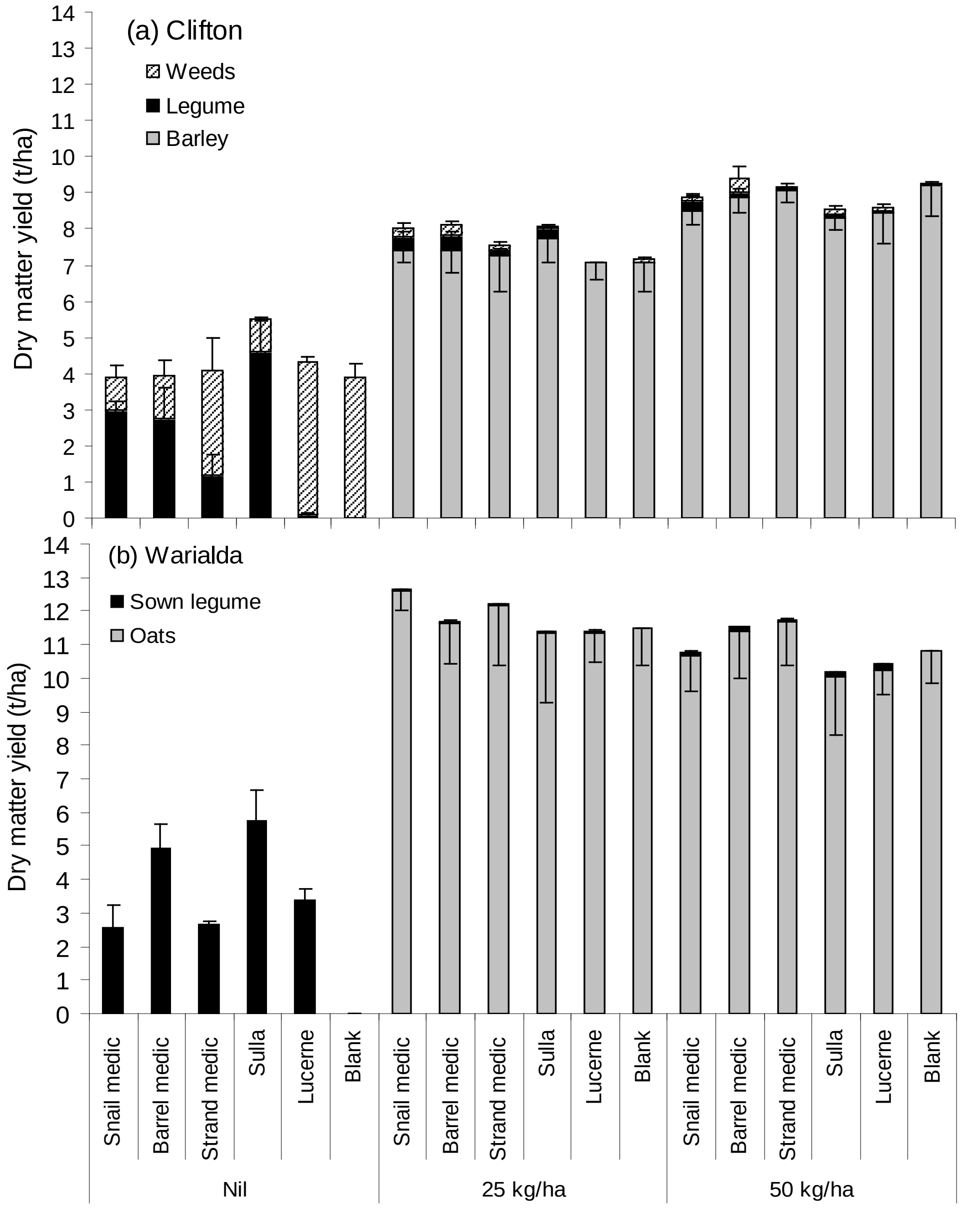

Figure 1. Biomass production of pasture legumes, winter-growing forage cereal and weeds (at Clifton only) when legumes are sown alone or co-sown with forage cereals at half (25 kg/ha) and full rate (50 kg/ha) at (a) Clifton and (b) Warialda. Upward bars indicate standard errors of mean for legumes and weeds, downward arrows for cereal forages.

Of the legumes sown alone, sulla was the most productive (>4.5 t DM/ha), followed by barrel medic (3.0-4.5 t DM/ha). Lucerne had grown little over the first winter by the time of sampling at Clifton, which was prior to optimal lucerne growth conditions in spring. Angel medic performance was inferior to the other annual medics. Neither site had a history of sulfuron urea use where Angel strand medic's higher tolerance of residual levels of these chemicals might have given it an advantage compared to the other medics.

Table 2 shows the estimated pod yields for the annual medics when sown alone or in combination with a forage cereal. This shows that the competition from the forage cereal would have greatly reduced the capacity of the legumes to establish a robust seed bank in their first year. This estimation also assumes similar allocation to pods and seed number per pod in all treatments, when it is likely that competition for light and water from the forage cereals may have also reduced further the ability of the annual legumes to set seed compared to when they are sown alone.

Table 2. Estimated pod yield (kg/ha) of annual medics when sown alone or co-sown with forage cereals at 25 and 50 kg/ha at Clifton and Warialda. Pod yield estimated as biomass x harvest index (barrel medic = 0.46, snail medic = 0.38, strand medic = 0.26)

Site/treatment	Barrel medic	Snail medic	Strand medic
Clifton			
Nil	1257 ± 380	1148 ± 84	315 ± 143
25 kg/ha	201 ± 44	142 ± 56	37 ± 13
50 kg/ha	73 ± 51	109 ± 52	27 ± 18
Warialda			
Nil	2245 ± 334	988 ± 255	463 ± 284
25 kg/ha	19 ± 12	15 ± 9	16 ± 1
50 kg/ha	52 ± 5	38 ± 2	19 ± 5

Large weed populations were present at both sites (50 plants/m^2 of mainly buckwheat (bindweed) at Clifton and 43 plants/m^2 of mainly broadleaf weeds at Warialda), which produced significant weed biomass in all legumes (>0.9 t DM/ha). Weed growth was greatest in the less competitive legumes, with sulla producing the least weed biomass. Weed growth was largely suppressed by the forage cereal crops. In the absence of suitable chemical controls, the inability of the legumes to compete with weeds may also be a potential problem for their reliable establishment and a disincentive for their use in cropping systems.

It appears that early competition imposed by the vigorous forage cereals swamped the less vigorous legumes reducing seedling numbers and their productivity. While various studies have shown that pasture legumes can be successfully co-sown with reduced densities of grain wheat or barley crops (Brownlee and Scott 1974; Lloyd et al. 1998), doing so with forage varieties sown at higher rates (>25 kg/ha) is not recommended as it is likely to reduce seed set of annual species and establishment density of perennial species resulting in unviable pasture populations in subsequent years. Impacts of forage cereal competition on legume regeneration and/or survival in subsequent years remains to be measured.

Grazing was withheld in this study while grazing of the forage crop may reduce the competition from the forage cereal allowing legumes to compete more successfully. Dear et al. (2007) showed that in clover seed set was reduced by competition for light in spring from accompanying pastures, hence it would be expected that grazing might reduce light competition and improve legume seed production. Grazing can also slow the rate of water use by cereal forages (Virgona et al. 2006) and hence enable greater access to soil water by the legumes.

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