Sulla (*Hedysarum coronarium*) production sown with cover crops

Carolyn de Koning[1], Peter Schutz[1] and **Jake Howie[2]**

[1]. SARDI, Turretfield Research Centre, Rosedale, South Australia, 5350, Email Carolyn.dekoning@sa.gov.au; peter.schutz@sa.gov.au
[2]. SARDI, Waite Institute Precinct, PO Box 397, South Australia, 5001, Email jake.howie@sa.gov.au

Abstract

Sulla growth can be slow in the first year and production may be lost or greatly reduced adding to the expense of establishment. Under-sowing sulla with a cover crop maybe a way of maximising production during the establishment year by providing winter grazing and/or a grain crop to harvest. But when moisture is limited pasture legume establishment under cover crops can be poor or totally fail. The aim of this experiment was to measure the effect of various cover crop species (wheat, barley and forage brassica) sown at different rates on the dry matter production, seed yield and plant survival of sulla. A key finding of the study was that cereal cover crops enhanced the over summer survival of sulla plants. Cereal cover crops in spring were very competitive with sulla significantly reducing sulla dry matter production by 28% - 53%. Sulla seed yield was unaffected by cover crops. The added advantage of cereal cover crops in this study was their ability to suppress weeds and their capacity to produce enough dry matter for winter grazing.

Key Words

Hedysarum coronarium, sulla, cover crops, cereals and forage brassica

Introduction

Sulla (*Hedysarum coronarium*) is a short-lived perennial forage legume that has provoked a lot of interest in Australia due to its ability to produce non-bloating, good quality, high dry matter forage with reputed anthelmintic properties (Neizen et al. 1995 and 1998). Growth of sulla in the establishment year can be slow (Crocker 2008) and as a consequence production could be lost or reduced during the first year adding to the expense of establishment. The use of cover crops sown with sulla maybe a viable option to establish this species. Nevertheless, cover crops can increase the risk of establishment failure mostly due to competition effects under dry conditions (Norton and Koetz 1998, Dear et al. 2010). In wetter districts the under-sowing of forage legumes with cover crops may be a way of minimising the expense of establishment (Carter et al. 1992). Cover crops could either be grazed in winter and/or grain harvested from them in early summer. Sometimes cover crops are used to protect lucerne seedlings from wind damage (Lattimore 2008). Potentially cover crops may also be used to protect sulla seedlings from the abrasive action of wind-blown sand particles. Very few studies have been done in Australia with cover crops and sulla. Forage oats have been tested as a cover crop with sulla but were found to be too competitive (de Koning et al. 2008). Other cover crop species such as wheat (*Triticum aestivum*), barley (*Hordeum vulgare*) and forage brassica (*Brassica napus*) need to be evaluated and their influence on sulla production and survival measured.

Methods

The experiment was sown at Turretfield Research Centre, Rosedale, South Australia (Long. 138^{o}50'E, Lat. 34^{o}33'S). The soil type was a Red Brown Earth with pH 7.8 (in water). The long-term average annual rainfall is 468 mm with long-term average growing season rainfall of 324 mm (May – Oct.). The total rainfall for 2009 was 464 mm and the growing season rainfall was 347 mm. Three species of cover crop (wheat variety "Yitpi", barley variety "Keel" and forage brassica "Titan") were each sown at three rates. The cereals were sown at 10, 40 and 80 kg/ha and the brassica was sown at 0.5, 1.5 and 3 kg/ha. The highest sowing rate used for the cereals and the forage brassica represent the average rate used in the district for sowing monoculture crops. In mixtures of vetch and cereal the 40 kg/ha sowing rate is

commonly used for the cereals. A cone-seeder (sowing width 1.5 m) with 15cm tine spacing was used to sow the cover crop and sulla on 29 May 2009. Plots were 1.5 x 6m and cover crop species sown in a south to north direction using one sowing width. The “Wilpena” sulla seed (slurry peat inoculated, then lime coated) was sown at 7.5 kg/ha across the cover crop plots in an east to west direction using four sowing widths to complete a 6m plot. There were 10 treatment plots including the control (no cover crop sown) and three replicates (total 30 plots). Treatments were randomised using SpaDes (Spatial Design Generator). Plant numbers of sulla and cover crop were counted on 14 August 2009 using one quadrat (50 x 100cm) per plot. Dry matter of sown species and weeds was measured on 14 August 2009 and 22 October 2009 by cutting herbage to ground level in one quadrat (50 x 100cm) per plot. Individual plant weight was calculated using the dry matter yield per quadrat divided by the number of plants per quadrat taken on 14 August 2009. Samples were hand-sorted separately into sown species and weeds and dried in the oven for 24 - 48 hours at 80^{o}C. Seed yield of sulla and grain yield of cereals was measured by hand-harvesting on 21 December 2009 one quadrat (50 x 100cm) per plot and threshing the component species separately.

Data was analysed using ANOVA in “Statistix 8” and natural logarithm transformation made where appropriate (see Tables 1 and 2).

Results

Significant differences in the number of cover crop plants established were due to differences in sowing rate. This was particularly the case for the cereals (Table 1). There were no significant differences in sulla plant numbers (grand mean = 74 plants/m^2 - data not shown) or sulla dry matter yield in winter (14th August 2009). However, individual sulla plant weight was influenced by cover crops. Sulla plants were lighter when grown with barley sown at 80kg/ha and heavier when sown with brassica at 0.5 kg/ha compared to “no crop” sulla plants. Total dry matter production was greatest for barley cover crop treatments sown at 40 and 80 kg/ha (1902 kg/ha and 1784 kg/ha respectively compared to “no crop” 737 kg/ha). The brassica sowing rates and “no crop” treatments produced the least total dry matter. Plots were not sprayed to control weeds so that the influence of cover crop species and sowing rates could be measured for each treatment. Weed biomass (composed mostly of *Capsella bursa-pastoris*, *Echium plantagineum*, *Hordeum leporinum* and *Lolium rigidum*) was greatest in all three brassica sowings, wheat and barley sown at 10kg/ha and the “no crop” control. Barley sown at 80 kg/ha had significantly suppressed weeds (only 5 kg DM/ha weeds). Wheat at 40 and 80 kg/ha and barley at 40 kg/ha also had good suppression of weeds.

Table 1: Production of sulla and various cover crop species sown at different sowing rates measured on 14 August 2009 at the Turretfield Research Centre, Rosedale, South Australia.

Cover crop/ Sowing rate kg/ha	Sulla g/plant	Crop g/plant	Crop no./m^2	Sulla kg DM/ha	Crop kg DM/ha	Weeds kg DM/ha	Total DM kg/ha
Brassica 0.5	0.68	1.34	9	537	116	246 ^{a}	899
Brassica 1.5	0.50	0.94	27	336	248	133 ^{abc}	717
Brassica 3.0	0.53	0.88	37	387	321	199 ^{ab}	907
Wheat 10	0.61	1.48	31	390	458	201 ^{ab}	1049

Wheat 40	0.40	1.06	77	260	820	49 [bcd]	1129
Wheat 80	0.45	0.78	146	341	1114	57 [d]	1512
Barley 10	0.60	1.51	37	463	543	153 [ab]	1159
Barley 40	0.40	1.54	105	280	1596	26 [cd]	1902
Barley 80	0.31	0.81	187	259	1520	5 [e]	1784
No crop	0.50	0	0	470	0	267 [a]	737
LSD (P=0.05)	0.16	0.62	16	n.s.	280	*	373

* Natural log transformed data, treatments followed by the same superscript letter are not significantly different, back-transformed data presented. n.s = not significant.

Sulla dry matter production in spring was significantly reduced by both cereal species sown at 40 and 80 kg/ha and barley at 10 kg/ha compared to the control (Table 2). Weed dry matter was dramatically reduced by all cereal treatments, particularly wheat and barley sown at 80 kg/ha. The forage brassica treatments had no influence on weed competition. Total dry matter measured in October 2009 was lowest for barley sown at 80 kg/ha (4888 kg/ha) when all other treatments had yielded between 6050– 7496 kg/ha. No significant differences were found in sulla seed yield. Cover crop grain yields were significantly higher where crops were sown at higher rates. Barley was the most productive in grain yield compared to wheat. The forage brassica did not produce seed. Sulla adult plant numbers to survive into autumn 2010 were greatest for all three barley treatments and for wheat sown at 80 kg/ha. There were no significant treatment effects on sulla seedling regeneration in autumn 2010 (Grand mean = 32 seedlings/m^2 - data not shown).

Table 2: Production of sulla and various cover crop species sown at different sowing rates measured on 22 October 2009 at the Turretfield Research Centre, Rosedale, South Australia.

Cover crop/ Sowing rate kg/ha	Sulla DM kg/ha	Cover Crop DM kg/ha	Weeds DM kg/ha	Total DM kg/ha	Sulla seed kg/ha	Cover crop grain kg/ha	Sulla adult plants/m^2
Brassica 0.5	4227	225 [b]	1932 [a]	6384	59	0	2 [d]
Brassica 1.5	3733	290 [b]	2027 [a]	6050	80	0	5 [cd]
Brassica 3.0	4280	231 [b]	2507 [a]	7018	99	0	6 [bcd]
Wheat 10	3520	3248 [a]	728 [b]	7496	44	713 [d]	8 [abc]

Wheat 40	3213	3586 [a]	514 [bcd]	7313	15	1323 [cd]	7 [bcd]
Wheat 80	2733	4234 [a]	339 [cd]	7306	63	1951 [bc]	15 [ab]
Barley 10	3293	2627 [a]	606 [bc]	6526	39	1166 [d]	9 [abc]
Barley 40	2960	3848 [a]	614 [bc]	7422	79	2109 [ab]	13 [abc]
Barley 80	2133	2498 [a]	257 [d]	4888	13	2704 [a]	22 [a]
No crop	4587	0	1910 [a]	6497	72	0	7 [bcd]
LSD (P=0.05)	1181	*	*	1425	n.s.	*	* +

* Natural log transformed data, treatments followed by the same superscript letter are not significantly different, back-transformed data presented. n.s. = not significant, + Adult plants /m^2 counted on the 16.4.10

Discussion

The key finding of this study was that cereal cover crops sown with sulla appeared to enhance the over summer survival of sulla plants. This finding contrast with those of Norton and Koetz (1998). They found cover crops had negative effects on lucerne establishment. Cover cropping will be risky in drier environments and the probability of establishment failure greater (Norton and Koetz 1998, Dear et al 2010). Growing season conditions were favourable during this study possibly leading to increased survival of sulla plants. In addition, cereals may have provided partial shade, acted like mulch or reduced wind therefore reducing transpiration from sulla plants during summer. It should be noted that the cereals in this experiment were not grazed or harvested. Grazed or harvested cereal cover crops may not offer protection to adult sulla plants in summer and this warrants further investigation.

This study also showed that cereal cover crops could provide extra winter feed. Grazing will need to be carefully monitored as sulla is highly palatable and may be grazed in preference to the cereal. Another advantage of cereal cover crops shown was their ability to reduce weed biomass. Similarly, Verano (1976) found that weed numbers were always lower in plots with cover crops of wheat and barley under-sown with lucerne. Cover crops or “nurse crops” are a way to control weeds without the use of herbicides (Lattimore 2008). We did not graze or cut the cover crops in winter. Grazing cover crops in winter may reduce their ability to suppress weeds and this should be tested.

Sulla plants in this study managed to grow to the same height as the cereal cover crop and were green while the cereal plants had senesced (Figure 1). This will present problems if the intention is to harvest the grain from the cereal cover crop. Green sulla plants will be taken into the cereal harvester possibly reducing grain quality and causing problems physically harvesting the crop. Forage brassica at the sowing rates used did not offer any advantages and plots were heavily infested with weeds. Barley was the most productive cover crop by growing the highest quantity of dry matter and yielding the most grain. This is probably due to more barley plants established than wheat. Under favourable seasonal conditions as found in this study a reasonable grain yield can be obtained from the cover crop. Further studies on cover crops with sulla are warranted that include cutting and or grazing the cover crop in winter, trials on lighter textured soils, impact on second year sulla production, wider range of cover crop species, different row spacing and a range of sowing rates for sulla.

Figure 1: Sulla with a barley cover crop in late spring, note the senesced barley and the height of the sulla.

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References

Carter ED, Porter RG, Ababneh MH, Squella F, Muyekho FN and Valizadeh R (1992). The production and management of annual pasture legumes in ley farming systems of South Australia. Proceedings of the 6th Australian Agronomy Conference, Armidale, NSW. Australian Society of Agronomy. www.regional.org.au/au/asa/1992/concurrent/grazing-resources-management/p-04.htm. Accessed 9 June 2010.

Crocker G (2008) Sulla. Primefact 745, NSW Department Primary Industries, 4 pages.

Dear BS, Casburn GR, Li GD, Walker J, Bowden P and Hayes RC (2010). A survey of the use of perennial pastures as part of the pasture crop rotation in the mixed farming zone of southern New South Wales. Future Farm Industries CRC Technical Report 3, Future Farm Industries CRC, Perth Western Australia.

De Koning CT, Crocker G, Schutz P and Edwards N (2008). Developing production systems for the newly released varieties of the biennial forage legume sulla (*Hedysarum coronarium* L.). Proceedings of the 14th Australian Agronomy Conference, Adelaide, SA. Australian Society of Agronomy. www.regional.org.au/au/asa/2008/concurrent/pasture-production/5787dekoningct.htm. Accessed 22 June 2010.

Lattimore M (2008). Chapter 6, Growing a lucerne crop, In Producing quality lucerne hay – a guide for lucerne hay producers. Published by RIRDC & NSW Dept. of Primary Industries, publication no. 08/101 project no. DAN-202A, ISBN 1741516897, ISSN 1440-6845, 136 pages, p. 44.

Niezen JH, Waghorn TS, Charleston WAG and Waghorn GC (1995). Growth and gastrointestinal nematode parasitism in lambs grazing either lucerne (*Medicago sativa*) or sulla (*Hedysarum coronarium*) which contains condensed tannins. Journal of Agricultural Science 125, 281–289.

Niezen JH, Robertson HA, Waghorn GC and Charleston WAG (1998). Production, faecal egg counts and worm burdens of ewe lambs which grazed six contrasting forages. Veterinary Parasitology 80, 15-27.

Norton MR and Koetz EA (1998). Establishment of undersown lucerne in southern NSW. Proceedings of the 9th Australian Agronomy Conference, Wagga Wagga, NSW. Australian Society of Agronomy. www.regional.org.au/au/asa/1998/3/085norton.htm Accessed 17 June 2010.

Verano AE (1976). Weed control by means of cover crops during establishment of lucerne. Cab Abstracts. www.cababstractsplus.org/Abstracts/Abstracts.aspx?AcNo=19792324880. Accessed 17 June 2010.