Developing production systems for the newly released varieties of the biennial forage legume sulla (*Hedysarum coronarium* L.)

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Abstract

Wilpena and Moonbi, are the first Australian developed varieties of *Hedysarum coronarium* L. (sulla). This novel forage legume species was specifically developed for cereal-livestock and grazing systems in sub-tropical and Mediterranean Australia. The species is noted for its biennial habit, high biomass, deep taproot and bio-active ingredients (anthelmintic and non-bloating). However, the best use of the new varieties as part of the forage feed base in grazing or mixed cereal-livestock enterprises is yet to be determined. Numerous issues need to be explored and guidelines developed such as planting densities; herbicide and pesticide options; livestock production from sulla based pastures; timing and intensity of grazing for forage yield and seed set; and seasonal and growth stage variations in quality. A series of trials were designed to address these issues. Trials were established during 2007 at the Turretfield Research Centre, SA and the Tamworth Agricultural Institute, NSW. Results to date indicate; a productive stand of sulla can arise from 5 – 10 kg/ha sowing rates; there are some safe herbicide options for use on sulla; oats are too competitive to use as a cover crop and summer graze sulla residues with caution to facilitate seedling regeneration.

Key Words

Sulla, *Hedysarum coronarium*, non-bloating, anthelmintic

Introduction

Sulla (*Hedysarum coronarium* L.) is a native of temperate Europe and the Mediterranean basin. It is widely used for fodder and hay in Europe, North America and New Zealand. Sulla is a short-term, cool-season deep-rooted herbaceous perennial legume that grows from 0.5 to 1.2 metres tall and is capable of very high dry matter production. More than 20t DM/ha has been measured in spring in SA and northern NSW and 12t DM/ha in southern Qld (de Koning *et al*. 2003). Furthermore, winter production of over 5t DM/ha has been measured in all three States. Sulla has high nutritive value with leaf protein levels exceeding 25% and DM digestibility up to 70%. The forage contains moderate levels of condensed tannins which prevent bloat and reported to possess anthelmintic properties (Molan *et al.* 2000). New Zealand studies have shown that sheep grazing sulla were found to have increased ovulation rates (Charlton 2001), live-weight gains, wool production (Burke *et al.* 2002) and reduced worm burdens (Niezen *et al.* 1995, 1998). New Zealand studies also claim a reduction in fly strike of sheep grazing sulla, which was attributed to a reduction in scouring sheep (Niezen *et al.* 1996).

Sulla will also benefit cropping systems. Not only does sulla fix nitrogen but also it has a well developed tap root which, following the death of the plant, creates bio-pores in the soil allowing better infiltration of rainfall and reduced runoff (Chisci *et al.* 2001). Currently, there is little use of sulla in Australia and so the potential role of sulla in Australian farming systems is unclear and issues such anthelmintic properties, animal performance and agronomic suitability are unknown in this environment. A series of trials have been designed to address issues such as establishment, sowing rates and cover crops; grazing management and nutritive value; herbicide tolerance and fit with cropping activities. The information generated will be used to formulate a management package outlining the best utilisation of the newly

released Australian varieties (Wilpena, Moonbi and Flamenco). This paper reports some of the findings generated to date.

Methods

Trials sites were established either at the Turretfield Research Centre (TRC), SA or at the Tamworth Agricultural Institute (TAI), NSW.

Grazing management and nutritive value - TRC

Sulla pasture is being compared to a control pasture comprised of regenerating barley grass (*Hordeum leporinum*), annual rye-grass (*Lolium rigidum*), annual *Medicago* species and subterranean clover (*Trifolium subterraneum*). Each treatment has four replicates; treatment paddock size is 1 hectare; 4 control paddocks and 4 sulla paddocks; a total of 8 hectares. Control and sulla paddocks were top-dressed in April 2007 with single super phosphate at 80 kg/ha. Sulla paddocks were sown on the 24 and 25 May 2007 at a rate of 10kg/ha inoculated seed.

Summer grazing on sulla commenced on 25 Feb. 2008. A corner of each sulla paddock was fenced off ($612m^2$) and 12 lambs/corner paddock grazed the stubble until it had been knocked down (4 days grazing). Before and after grazing seed yield was measured. Seed in sheep faeces was assessed by collecting faeces in 10 quadrats (40x40cm)/corner paddock and extracting the seed from sheep pellets by gently rubbing out on rubber corrugated mat. Adult plant survival and seedling regeneration was compared to non-grazed areas after the break of season.

Ewe hoggets (average live weight 37 kg) commenced winter grazing 26 June 2008. Young sheep were used so that growth rather than just change in animal condition will be measured. Sheep will be weighed at 2 weekly intervals during grazing. In addition, wool production and quality will be measured using dye-bands. As a simple guide to possible anthelmintic properties of sulla, faecal egg counts will be undertaken in control and sulla-grazed animals prior to grazing and then again at the end of the grazing period. Nutritive value and botanical composition of sulla and the control pasture were measured before grazing.

Herbicide tolerance - TAI

Two rates of pre-emergent herbicides; Treflan, Dual Gold, Spinnaker, Stomp, and Simazine were applied 10 days before sowing. Plots were sown on 23 May 2007 at 10 kg/ha with Wilpena sulla seed to examine the effects of these herbicides on emergence and establishment. Plots were 4 x 3m and a 3 metre strip was sprayed in the middle of each plot.

The same plot size and sprayed area was used for the post-emergent herbicide. Two rates were applied of 9 herbicides (Spinnaker, Broadstrike, Brodal, Basagran, Bromoxynil, Jaguar, Lontrel, Raptor and 24-DB) plus 2 control plots. Plots were sprayed when the sulla had 3-5 true leaves, approximately 10 weeks after sowing (plots sown 23 May 2007).

Sowing rates - TAI

The main aim was to determine which sowing rates are the most productive and economic for a sulla stand. The following sowing rate treatments of Wilpena sulla were sown 23 May 2007 with 150 kg/ha super-phosphate; 1, 2.5, 5, 7.5, 10 and 15 kg of viable inoculated seed/ha. Establishment and DM yield will be measured over at least 2 years.

Cover crop - TAI

A cover crop trial examined the effect of 3 rates of oats on establishment, growth and production of Wilpena sulla, sown at 4 rates in alternate rows with oats. The machine had sown 5 rows of sulla and 4 rows of oats alternately with a row spacing of 19 cm. The sulla was sown at 1, 2, 4, 8 kg/ha while the oats

was sown at 10, 20, 30 kg/ha. The plots were 2 x 10m with 3 replicates. Pure stands of oats were sown at 10, 20, 40 and 60 kg/ha and pure sulla at 2, 4, 8 and 12 kg/ha at 19cm row spacing in 2 x 10m plots. The sulla was inoculated at the time of sowing. This trial was sown on the 15 May 2007 with nitrogen fertiliser applied to the oat rows at 45kg N/ha, P at 13kg/ha and S at 27.5kg/ha.

Results

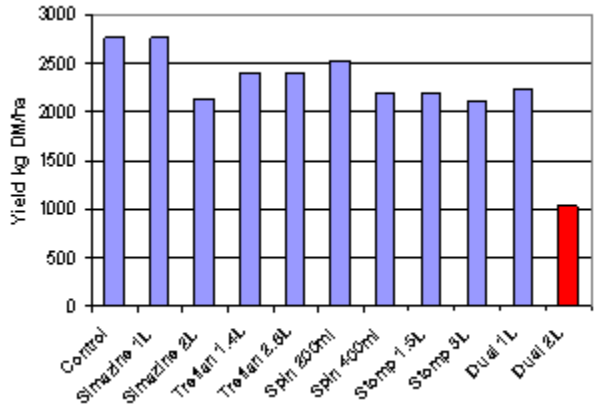
Grazing management and nutritive value

Establishment of sulla in 2007 averaged 133 seedlings/m^2. However, growth was slow for both the sulla and control pasture due to dry cold weather followed by dry hot conditions. Grazing was therefore delayed until 2008. Only the very best parts of the sulla paddock yielded 2.5 t DM/ha during 2007. Botanical composition measured on the 14 Sept. 2007 showed on average the sulla paddocks were 45% sulla, 35% grass and the balance made up of broadleaf weeds, subclover, and annual medic. Grass content was high despite selectively spraying for annual ryegrass. In contrast control pasture paddocks were 72% grass, 17% subclover with the remainder annual medic and broadleaf weeds.

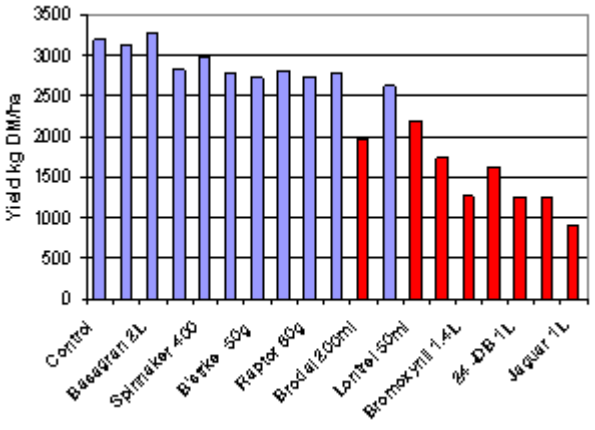
On average sulla yielded 48 kg/ha clean seed. Seed yield was much reduced due to adverse seasonal conditions. Lambs grazing sulla during summer targeted the sulla seed heads within the first 24 hours. Over the course of 4 days grazing, the lambs had consumed on average 37kg/ha seed, almost 78% of total seed. Only 0.35kg/ha seed was passed through in the faeces. There were no differences in adult plant survival between summer grazed areas and non-grazed areas measured on 14 April 2008. However, double the number of seedlings regenerated on summer grazed areas compared to non-grazed (174 seedlings/m^2 and 80 seedlings/m^2 respectively, p=0.014), non-grazed areas were mown to knock seed heads to the ground. Results from the 2008 winter grazing will be presented at the conference.

Herbicide tolerance

Establishment numbers in pre-emergent herbicide treatments were taken on 10 July 2007, seven weeks after sowing. Establishment ranged from 91 to 133 seedlings/m^2, but no treatments were significantly different from the control. The phytotoxicity effect ratings indicated that both rates of Dual Gold (1 & 2L/ha) and 400 ml/ha of Spinnaker produced damage symptoms, while both rates of Stomp (1.5 & 3L), Treflan (1.4 & 2.8L) and Simazine (1 & 2L) and 200 ml/ha of Spinnaker appeared safe and were not different from the control ratings. Dry matter yields at the end of October 2007 showed a significant suppression only from the application of 2L of Dual Gold (Figure 1a).



a)



b)

Figure 1a. Sulla dry matter yield kg/ha (31 Oct 2007) following the application of pre-emergent herbicides in early May 2007. Figure 1b. Sulla dry matter kg/ha (31 Oct 2007) following the application of post-emergent herbicides 12 weeks earlier. Herbicides are arranged in increasing order of damage. Graph labels name only the higher rate of herbicide with the lower rate first (not shown). The lower rate is half the higher rate. Red bars are significantly less than the control.

Phytotoxicity effects of post-emergent herbicides showed that both rates of Jaguar, 24-DB, Bromoxynil, Lontrel, Brodal and the higher rate of Raptor (60 g/ha) all caused significant plant damage when scored on 29 August 2007, 3 weeks after spraying. These effects were largely reflected in yields when taken at the end of October, but sulla recovered from earlier damage evident in the Lontrel (25ml/ha), Brodal (100ml/ha) and Raptor (both rates) treatments. However, the higher rate of Lontrel (50ml/ha)and Brodal (200ml/ha) still yielded significantly less than the control treatment (Figure 1b).

Sowing rates

The number of plants established with increasing seeding rate followed a linear trend ($y=16.56x$, $r^2 = 0.994$). All rates were significantly different from each other except 1 & 2.5 kg/ha. Dry matter yield taken on 31 Oct 2007 ranged from 275 to 1845 kg DM/ha. This low maximum yield was a reflection of the dry spring. Sowing rates of between 5 and 10 kg/ha were considered the best compromise considering yield gain and cost of seed

Cover crop

When oats were sown alone they yielded between 13 - 16 t DM/ha depending on seeding rate (10 - 60 kg/ha), while sulla alone yielded 0.7 - 1.7t DM/ha (sown at 2 - 12 kg seed/ha). When oats was used as a cover crop the best total yield of oats was 7.3 t/ha but there was poor survival of sulla under oats and insufficient biomass for a yield sample.

Conclusion

Caution may be needed when grazing dry sulla residues during summer as sheep appear to prefer the seed heads. This preference along with low passage rate of the seed in the faeces may affect seedling regeneration. Careful grazing management during summer may enhance seedling regeneration by knocking some seed to the ground followed by trampling into the soil surface by sheep. Summer grazing does not appear to affect the adult plant survival.

There appear to be some safe pre- and post-emergent herbicide options for use on sulla. Some herbicides produced phyto-toxic effects from which the sulla plants did recover with minimal dry matter reductions. However, some herbicides had devastating effects on sulla and these include 2L/ha of Dual Gold (pre-emergent) and the post-emergent herbicides Jaguar (1L & 500ml/ha), 2,4DB (1L & 500ml/ha), Bromoxynil (1.4L & 700ml/ha), Lontrel (50ml/ha) and Brodal (200ml/ha). No herbicide recommendations can be made at this stage and no herbicides are registered for use in sulla.

A productive stand of sulla can be established with between 5 – 10kg/ha seeding rate. Rates higher than 10kg/ha will become un-economic due to the cost of seed.

All cover cropping rates of oats were far too competitive for sulla and an attempt to manage oats to assist sulla only reduced the contribution from oats. It is strongly recommended that oats and sulla be sown in separate areas and managed accordingly. Other less competitive cereal crops such as barley have yet to be tried.

Work on defining best agronomic strategies for growing sulla in Australia is continuing and more results will be available within 12 months on the productivity of livestock on sulla crops. This work will also highlight other issues that require further investigation.

Acknowledgements

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References

Burke JL, Waghorn GC and Brookes IM (2002). An evaluation of sulla (*Hedysarum coronarium*) with pasture, white clover and lucerne for lambs. Proceedings of the New Zealand Society of Animal Production. 62, 152 – 156.

Charlton D (2001). Pasture – Condensed tannins a livestock tonic. Australian Farm Journal, December 2001, 45 – 48.

Chisci GC, Bassoffi P, Pagliai M, Papini R, Pellegrini S and Vignossi N (2001). Association of sulla and *Atriplex* shrub for the physical improvement of clay soils and environment protection in central Italy. Agricultural Ecosystems and Environment 84 (1), 45 – 53.

De Koning C, Lloyd D, Hughes S, McLachlan D, Crocker G, Boschma S and Craig A (2003). *Hedysarum*, a new temperate forage legume with great potential – Field evaluation. Proceedings of the 11th Australian Agronomy Conference, Geelong, Victoria 2003. www.regional.org.au/au/asa/2003/c/14/dekoning.htm. Accessed 31 March 2008.

Molan AL, Waghorn GC, Min-Beyng R and McNabb WC (2000). The effect of condensed tannins from seven herbages on *Trichostrongylus colubriformis* larval migration *in vitro*. Folia Parasitologica Ceske Budejovice 47(1), 39 – 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(2), 281 – 289.

Niezen JH, Charleston WAG, Hodgson J, Mackay AD and Leathwick DM (1996). Controlling internal parasites in grazing ruminants without recourse to antihelminthics: Approaches, experiences and prospects. International Journal for Parasitology 26(8-9), 983 – 992

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(1), 15 – 27.