Early autumn sowing demonstration of hardseeded pods segments of French serradella on sandy soils

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Locations
Lowbank (LB), Woolpunda (WO), Solomon (SO), Warramboo (WA), Wudinna (WU), Mt Springton (MS)

Farmers
Tim Paschke, Warren May, Leon Vietch, Chris Lymn, Chris Tapscott

Groups
AIR EP & Lowbank Ag Bureau

Rainfall
Av Annual/Av. GSR (mm)
2023 Total/2023 GSR (mm)

Solomon
346/246
213/167

Warramboo
310/224
172/134

Wudinna
275/191
218/169

Soil Type
Sandy Soils, pH ranging from 6.4 to 8.1 ($CaCl_2$), organic carbon 0.6 - 0.7 %

Plot size
Large scale demonstrations 10ha at each of the studies

Key messages

- **French serradella, an annual pasture legume, is widely grown in Western Australia (WA) and its adoption is increasing in New South Wales (NSW). Preliminary assessment in South Australia (SA) showed promising potential for growth, particularly on sandy hills.**
- **In 2023, a comprehensive evaluation on early autumn sowing of hardseeded serradella pod segments across low to mid-rainfall regions of SA was conducted. The results revealed that autumn sowing could successfully establish serradella plants.**
- **The nodulation of serradellas sown from pods exhibited a reliance on paddocks with a lupin history, whereas sites devoid of prior lupin cultivation gave suboptimal nodulation.**
- **To obtain the full benefits of autumn sowing of hardseeded pod segments, further investigation is imperative to explore the successful introduction of serradella rhizobia and to enhance effective nodulation.**

Why do the trial?

Hardseeded French Serradella cultivars are widely grown on deep acidic sands in WA and is increasingly being grown on acidic loams in NSW. Recent research in SA and VIC has found that it has the potential to lift pasture production on sandy soils with mildly acidic to mild alkaline pH (EPFS Summary 2016, p. 155; EPFS Summary 2019, p. 230; EPFS Summary 2020, p. 211 and EPFS Summary 2021, p. 197). French serradella pod segments are readily harvested with conventional grain harvesters. However, it is difficult and expensive for the seed industry to remove seeds from the pods, hence making scarified seed expensive relative to other annual pasture legume seed. Hardseeded French serradella cultivars have an unusual seed softening process whereby buried pod segments (i.e. in dark) has much higher rates of seed softening than pods segments on the soil surface (i.e. sunlight inhibits seed softening). This process allows pod segments to be sown at 1-2 cm in late summer to early autumn (ahead of the main sowing time), which is widely practiced by growers in WA and NSW. The seeds will be softened by the fluctuating temperatures in autumn and emerge following the break in the season, which allows for early feed and greater seed set in years with a spring drought. Additionally, the readily harvestable seeds enable farmers to harvest their own low-cost seeds for future use.

South Australia's low rainfall regions frequently have extensive dune-swale systems, which may provide an opportunity for serradella pastures on large sand dunes. Dunes and interdunal swales can have substantial variations in soil textures and pH levels, where soil textures can range from sandy soils on the dunes to loams/clays on the swales, and pH levels can range from neutral to slightly acidic on the dunes to higher alkalinity in the swales. Soil texture and pH have large effects on the performance of pasture legume species. Matching species to parts of the landscape can increase overall pasture production.

Field trials in the Victorian Mallee under the DLPS project demonstrated that serradella could produce 1 to 1.5 t/ha extra biomass compared with vetch on sandy dunes (EPFS Summary 2021, p. 197) and 1 to 1.5 t/ha less biomass in the swale. In 2022, this project sowed 10 ha to a mixture of barrel medic, strand medic and French serradella in paddocks with dune/swale landscape with the serradella outperforming the medics in terms of plant dry matter biomass on the dunes and extending the growing season. Based on this result, we targeted large sandy dunes in 2023 and carried out autumn sowing of serradella pod segments to achieve adequate plant establishment and optimum levels of nodulation.

Successful nodulation - a key factor in nitrogen fixation presents unique challenges when dry-sown in late summer to early autumn as serradella pod segments would remain in dry soil for too long and may compromise rhizobia survival. While serradella has its own rhizobia group (S), it is fully compatible with lupin rhizobia (G). Evidence from trials in Victorian mallee sands had suggested that serradella pasture establishments were more successful on sites where lupins had been grown (EPFS Summary 2020, p. 211). In WA, late summer sown French serradella crops usually nodulate well in soils with a previous history of lupin (Loi and Revell 2021), although it is still recommended to inoculate seeds. A deeper understanding of the rhizobium history and dynamics is required for serradella adaptation in SA, where lupin production is relatively limited. This is because sowing serradella pod segments at sites without prior lupin production will need to depend solely on the effective inoculation of pod segments at sowing to obtain optimum nodulation. To bridge this knowledge gap, we conducted extensive field trials targeting sandy dunes with and without a history of lupin cultivation in SA's low to mid-rainfall regions. Lupin history in the paddock was determined by asking host farmers and by using the newly available Predicata rNod test for presence or absence of S/G rhizobia. This study aims to determine if hardseeded pods segments of serradella could be sown in early autumn to achieve high plants numbers that are well nodulated.

How was it done?

In collaboration with local farm managers, farming systems groups AIR EP, Lowbank Ag Bureau, and Barossa Improved Farming Group, we established seven 10 ha pasture demonstration sites in low rainfall areas, including Lowbank and Woolpunda in Murray Mallee (2 sites), Solomon, Waramboo and Wudinna on Eyre Peninsula (3 sites), and Mt. Springton in the Adelaide Hills (2 sites), which falls under medium rainfall region. At each of these sites, 300 kg of serradella pods (@ 30 kg/ha) and 100 kg/ha of Alosca dry granular inoculant (@ 10 kg/ha) were sown together by host farmers using their seeding equipment on sand dunes from March to April 2023 (Table 1). Soil samples prior to sowing were tested for presence of S/G rhizobia using Predicta rNod. Plant emergence counts were conducted in May 2023. Root nodulation inspections were conducted 10 to 12 weeks after emergence and continued throughout the growing season.

What happened?

Summer sown serradella pods emerged after opening rains which occurred within 1 to 1.5 months after sowing at all sites. Pods sown at the two Mt. Springton sites emerged within a week due to 6 mm of rain that fell immediately after sowing. Plant emergence varied from 58 to 102 plants/m^2 in low rainfall areas and 261 to 295 plants/m^2 in high rainfall area (Table 1).

Table 2 presents Predicta rNod tests results, lupin history and the percentage of plants nodulated. Two out of the seven sites had lupin/serradella rhizobia present.

Table 1. Demonstration sites established across SA showing their location, region with sowing date and plant emergence counts.

Region	Location	Sowing date	Plant emergence plants/m^2 (mean ± SD)
Murray Mallee	Lowbank	11/04/2023	91.1 ± 6.9
	Woolpunda	24/03/2023	84.4 ± 49.1
Eyre Peninsula	Solomon	27/04/2023	57.8 ± 40.8
	Warramboo	27/03/2023	63 ± 21.7
	Wudinna	23/04/2023	101.8 ± 42.3
Mt Springton, Adelaide Hills	Upper paddock	24/03/2023	294.5 ± 148.7
	Lower paddock	24/03/2023	261 ± 87

Mt Springton had a rhizobia level of 3 and Solomon had a level of 1 (Table 2). Both sites with a lupin history had 100% of plants nodulated with a mean of 10.3 ± 1.0 nodules per plant (Figure 1). The remaining five paddocks without a lupin history had mean plant nodulation rate of 41% ranging from 5% to 81% (Table 2) and a mean of 0.7 ± 0.2 nodules per plant (Figure 1).

Other plant biophysical measurements showed significantly higher shoot growth and shoot and root dry weight biomass in lupin history sites than non-lupin sites. Root length did not differ between the two groups.

Plant observation 3-4 months after emergence identified yellowing and less biomass production in non-nodulated plants compared with nodulated plants (Figure 2).

Table 2. rNod test on soils prior to sowing showing rhizobia levels and report interpretation. Paddock's lupin-growing history were collected from farm owners and root nodulation status observed in the field.

Region	Location	Last Lupin crop	Log10 Rhizobia G/S levels	Nodulation status	% of plants nodulated
Murray Mallee	Lowbank	None	0	poor	5
	Woolpunda	None	0	poor	46.4
Eyre Peninsula	Solomon	>12 yrs	1	good	100
	Warramboo	None	0	poor	61.5
	Wudinna	None	0	poor	11
Mt Springton, Barossa	Upper paddock	2021	3	good	100
	Lower paddock	None	NA	average	81.2

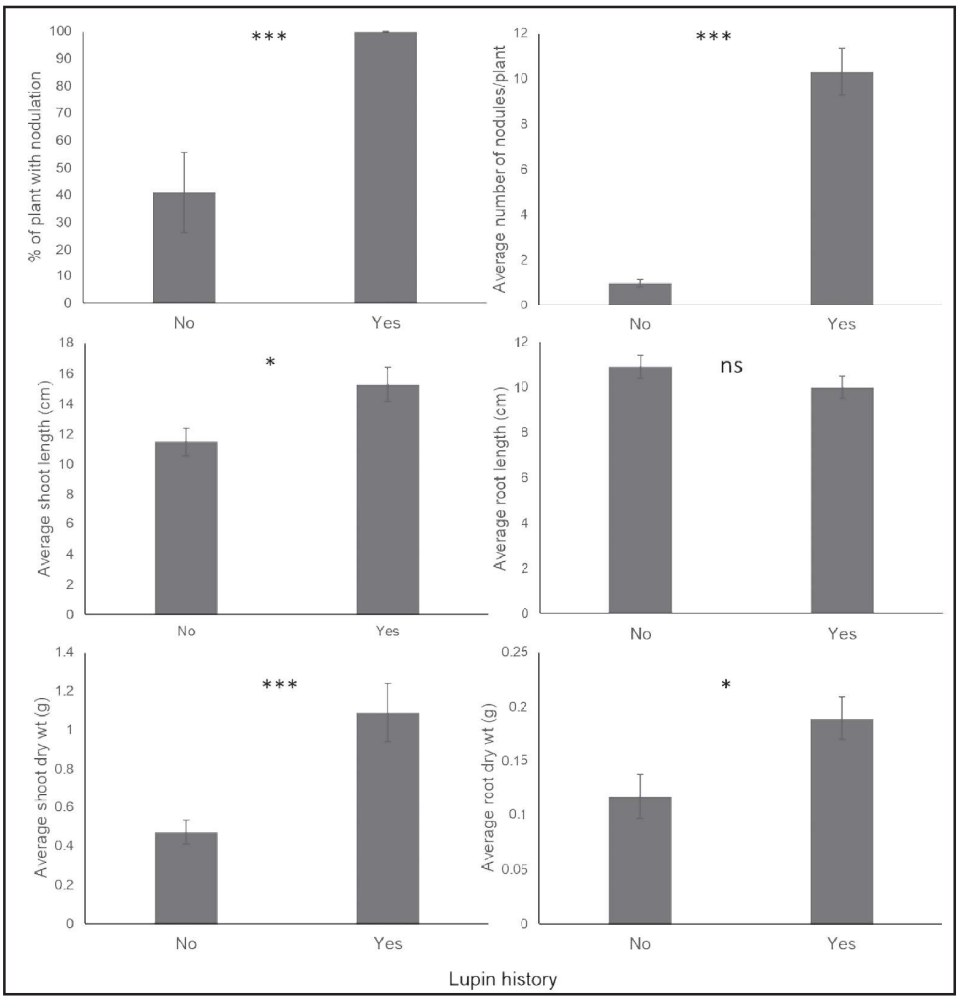

Figure 1. Comparison of root nodulation and other biophysical measurements (percent of plant nodulation, shoot length, root length, shoot dry weight and root dry weight) between sites with and without lupin history. No are sites without a lupin history and Yes are sites with a lupin history. Bar represents standard error of the mean. *, *** and ns are statistical significance levels (p ≤ 0.05, p ≤ 0.001 and not significant) of group comparison using ANOVA test.

Figure 2. Comparison of nodulated and non-nodulated Serradella plants.

What does this mean?

French serradella is a promising species for neutral sandy soils of SA. Hardseeded pod segments can be sown in early autumn in SA as plants are able to quickly establish following the opening rains. For the seeds to soften, they need to be sown at 1-2 cm deep into the soil for the correct diurnal temperature fluctuation to occur. Plant emergence counts were adequate in all trial sites, despite some sites were sown in late April (Table 1). The currently recommended sowing time of hardseedeed pod segments is in February to early March (EPFS Summary 2021, p. 200). More trials are required on yearly climatic variations before April sowing can be widely recommended.

In this project, the pod segments were inoculated with 10 kg/ha of clay granules at all sites. Even though autumn sowing achieved adequate plant numbers, the root nodulation of plants at sites without a lupin history was sub-optimal, indicated by the percentage of plants nodulated and number of nodules per plant. This means that the inoculum might have assisted the Solomon site (low rNod scores) to achieve good nodulation levels, but it did not assist sites without a lupin history to achieve a good nodulation status. The serradella plants without nodulation were yellow and produced less biomass, which resulted from a lack of nitrogen in the system due to no nodulation. Further research is still required on how to inoculate autumn sown pods segments on paddocks without a lupin history, also on determining if other forms (peat, freeze dried) can achieve high nodulation with late summer - early autumn sowing. It is also of industry importance to investigate inoculating the last cereal crop with serradella/lupin rhizobia to introduce rhizobia into the soil in the future.

In WA and NSW, farmers grow a nursery paddock and harvest pod segments which they utilize with a late summer/early autumn sowing program to provide increased early feed and higher seed set in years with low spring rainfall. Like pulse and canola crops, serradella is susceptible to budworm attacks, which needs to be managed for successful seed set. French serradella has the potential to increase pasture production on sandy soils without high pH values. Furthermore, serradella growth is indeterminate, which allows it to extend the growing season in wet years. In conclusion, harvesting pod segments and sowing early autumn can achieve adequate plant numbers, but to achieve good nodulation, rhizobia inoculated lupins need to have been grown previously.

Therefore, if growers would like to adapt French serradella into their local farming systems, they should incorporate lupins into the crop rotation, where profitable, to achieve the required rhizobial level for French Serradella plants to successfully nodulate in soil and contribute to long-term agricultural sustainability. Alternatively, they can sow inoculated (Farquharson *et al*., 2022) soft seed at the break of the season. Otherwise, growers are advised to wait for more research results to become available prior to sowing hardseeded pod segments into soils without a prior lupin cultivation. For the assessments of presence of group G/S rhizobia levels in soil, rNod is a rapid and useful tool that can be used by growers and consultants.

We recommend initially trialling serradella on relatively small areas for growers who are interested. A good overview of using serradella in WA is provided by Loi and Revell (2021). Cultivars can be soft or hard, with currently available hardseeded cultivars being margurita and frano (~ten days earlier). Both soft-scarified seeds, suitable for sowing near or after the break, as well as hardseed pod segments, ideal for late summer or early autumn sowing, are available for commercial purchase. When cultivating serradella, it is crucial to understand the type of seeds acquired and when to sow them.

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