

## **Twin Sowing: a new technique to reduce the costs of pasture establishment.**

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### **Abstract**

Twin sowing is a new technique for sowing legume pastures utilising hard seed undersown with a grain crop. Using serradella (*Ornithopus* spp.) as an example, pods produced on-farm can be undersown with a cereal or oil seed crop. Without intervention the seeds in the pod are almost 100% hard and little germination occurs under the crop. During the summer and autumn after the crop, the hard seed of the legume will breakdown to form a pool of seeds that will germinate under favourable conditions. The serradella will establish as a regenerating pasture from this pool thereby avoiding a separate sowing operation. This technique has the potential to reduce the cost of pasture legume establishment, particularly for species such as serradella where it is difficult to enhance the germination of the seeds (hard seeds) by artificial means. Its success, when applied to a particular species or cultivar, will require access to low cost seed (or pod), appropriate hard seed breakdown pattern, effective rhizobial inoculation, and weed management. This technique could be applied to a range of legume species with the capacity for on-farm production of low cost seed (e.g. bladder clover (*Trifolium spumosum*) and biserrula (*Biserrula pelecinus*)).

### **Key words**

Pasture legumes, hard seed, rhizobium, undersowing, serradella.

### **Introduction**

Incorporating a legume based pasture-ley rotation provides many agronomic benefits in a mixed farming system. However, the grazing of livestock has lost economic value relative to the production of crops in low and medium rainfall regions. To encourage the continued use of pasture legumes in mixed farming systems the cost of establishment needs to be reduced and the benefits to rotational crops maximised. New pasture legume species that can be directly harvested by conventional machinery have had a major impact over the past decade, due to the capacity for on-farm seed production and the availability of low cost seed (Nutt and Loi, 1999; Loi *et al.* 2005; Nichols *et al.* 2007). Cadiz French serradella (*Ornithopus sativus*) has been the most successful of this new type of pasture legume, due in part to the production of a high proportion of soft seed that requires no further processing after harvesting to enhance seed germination. Soft seeded cultivars however can exhibit poor persistence where summer rainfall causes premature germination. This has led to the development of new cultivars with much higher levels of hard seed. The described technique for pasture establishment is being evaluated as a means of combining the improved persistence associated with hardseededness (seed coat impermeability) with on-farm seed production and minimal seed processing.

We introduce the term 'twin sowing' to describe the under-sowing in grain crops of hard seeds of pasture legume species. The examples presented are based on the use of hard seeded forms of French serradella and yellow serradella (*O. compressus*), which are easily produced on-farm and where seeds in the pods are 95-98% hard. Little germination occurs under the crop with this level of hard seed, but during the following summer and autumn (under the crop stubble), the hardseededness of the legume will break down, providing a pool of seed that can germinate at the break of season and establish the pasture legume. This paper presents results from preliminary evaluations of the twin sowing technique.

## Material and methods

### *Site details*

The field study was conducted over two years at two sites in the central wheatbelt of Western Australia as follows: (i) Department of Agriculture and Food Western Australia, Northam (120 km east of Perth) sown in 2005 and (ii) Western Australian No-Tillage Farmers Association trial site, Meckering (150 km east of Perth) sown in 2006. Both sites have a typical Mediterranean climate. The Northam site is a fine textured soil, with a pH (H<sub>2</sub>O) of 6.2 and the Meckering site is on an acidic sandy soil with a pH (H<sub>2</sub>O) of 5. Monthly rainfall for both sites is shown in table 1. The experiment at Northam was sown on the 11<sup>th</sup> of May 2005 and the experiment at Meckering was sown on the 10<sup>th</sup> of May 2006.

#### *(i) Northam*

Three yellow serradella cvs. Santorini, Charano and Yelbini and two hard seed French serradella, cvs. Erica and Margurita were spread onto the uncultivated soil surface in May as hard seed at 60 kg/ha of unthreshed pods. Each treatment plot was 10 by 2.4 m and the experiment was arranged in a randomized block design of three replicates. The plots were ameliorated at the same time with 10kg/ha of Group S ALOSCA<sup>?</sup> granules (Carr *et al.* 2006). The entire site was then direct drilled with wheat at 80 kg/ha with 85 kg/ha MacroPro Extra (9.7%N, 11.2%P, 11.2%K 9.8%S, 0.10%Zn) on the 11<sup>th</sup> May 2005. The wheat was sprayed in July with Dicamba (200g/L) to control broadleaf weeds and a very small percentage of germinated pasture legumes. The wheat was sprayed with 1.5 L/ha of Glyphosate (450 g/L) at the anthesis stage (in spring) to avoid seed set. After senescence, the wheat was slashed and excess stubble material removed to simulate summer grazing.

The plots were allowed to regenerate naturally in 2006 and the number of regenerating seedlings of the target legumes was measured within 3 quadrats of 0.05 m<sup>2</sup> placed randomly in each plot. Available dry matter was estimated on the 20<sup>th</sup> of September from material cut with knives from two randomly placed quadrats of 0.1 m<sup>2</sup> in each plot and dried at 60°C. Seed yield (pod) was estimated by hand harvesting from 2 randomly placed quadrats of 0.1 m<sup>2</sup> per plot.

#### *(ii) Meckering site*

Pods of the hard seeded French serradella cv. Margurita were sown at 50 kg/ha with wheat at 80 kg/ha on 10<sup>th</sup> May 2006. Two application methods were used: (1) broadcasting the serradella pods onto the soil surface prior to the sowing of the wheat or (2) with the serradella drilled together with the wheat (same box). Pods of serradella for both methods were buried at the depth of 1-2 cm. The soft-seeded French serradella cv. Cadiz was sown at 20 kg/ha of pods in 2007 as a comparator treatment. In all cases the serradella plots were spread with 10 kg/ha of Group S ALOSCA<sup>?</sup> granules at the same time as the pod sowing (2006 with Margurita and 2007 with Cadiz). All wheat plots were fertilised with 85 kg/ha MacroPro Extra. Cadiz French serradella plots were fertilised with 85 kg/ha Super Phosphate (20%) at sowing. No fertiliser was applied to the under-sown pastures in 2007. Each treatment plot was 15 by 2.2 m and the experiment was arranged in a randomized block design with three replicates.

The Cadiz treatment was sown after the application of a knockdown herbicide and all treatments were treated with Spinnaker<sup>?</sup> (300 ml/ha) on the 18 of May 2007. Plant density and available dry matter on the 19<sup>th</sup> of September were assessed in a similar way as described for the Northam site.

**Table 1. Monthly average rainfall (mm) for the site of Northam (2006) and Meckering (2007) in Western Australia (year of regenerating pasture)**

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
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Northam	130.8	37.4	1.2	17.8	8.6	16.2	28.4	63.0	57.2	5.4	10.6	10.2	386.8
Meckering	20.0	3.2	0.0	19.6	25.6	18.4	76.4	30.0	25.2	16.4	0.0	49.4	284.2

## Results

The established plant density in 2006 of the 5 cultivars of serradella sown with wheat in 2005, at the Northam site, is summarised in Table 2. No differences between the species or cultivars were found. No legume emergence was recorded during the month of January and February. The dry conditions in May at this site may have contributed to the low seedling counts and to minimal weed competition (Table 1). The serradella plants that did successfully establish grew well and yielded 3 to 5.5 t/ha of legume dry matter by mid-spring, despite the limited rain received during the rest of the season (May to October, 178 mm). All cultivars yielded over 1 t/ha of pods.

**Table 2. Pod size, plant densities, dry matter and pod yields of five serradellas sown at 60 kg/ha of pods at the Northam site. (Standard errors are in brackets).**

Cultivars/Species	Seed/pod size	Regeneration	Dry matter yield	Pod yield
	(mg)	(Plant/m <sup>2</sup> )	(t/ha)	(t/ha)
Erica ( <i>O. sativus</i> )	3.68 (0.06)	28 (11)	3.2 (0.5)	1.4 (0.4)
Margurita ( <i>O. sativus</i> )	4.45 (0.09)	24 (10)	5.5 (1.4)	1.1 (0.3)
Yelbini ( <i>O. compressus</i> )	6.86 (0.23)	27 (7)	3.0 (0.8)	1.8 (0.4)
Charano ( <i>O. compressus</i> )	8.54 (0.30)	24 (7)	3.0 (0.4)	1.3 (0.4)
Santorini ( <i>O. compressus</i> )	6.59 (0.18)	26 (7)	4.5 (0.6)	1.8 (0.2)

At the Meckering site there was consistent rainfall from April to July and this is reflected in the plant densities established in the twin sown cv. Margurita plots being comparable to those recorded in the newly sown cv. Cadiz at 20 kg/ha. The drilled treatment had a slightly higher plant establishment density compared to the broadcast treatment (Table 3). The dry matter production was much higher in the cv. Cadiz treatment (8.8 t/ha) but this may be due to the additional phosphate fertilizer that was applied to this treatment when it was sown in 2007. The plants were all effectively nodulated at both sites.

**Table 3. Plant densities and dry matter yields at the Meckering site. Cadiz was used as comparator in the regeneration year (2007). (Standard errors are in brackets).**

Cultivars/Species	Sowing rate	Sowing type	Plant density	Dry matter yield
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	(Kg/ha pods)	(Year)	(Plant/m <sup>2</sup> )	(t/ha)
Margurita ( <i>O. sativus</i> )	50	Broadcast (2006)	115 (40)	5.0 (0.6)
Margurita ( <i>O. sativus</i> )	50	Drilled (2006)	143 (32)	5.1 (1.0)
Cadiz ( <i>O. sativus</i> )	20	Traditional sowing (2007)	162 (12)	8.8 (1.0)

## Conclusions

The preliminary results presented here suggest that twin sowing may be an effective technique to introduce hard seeded pasture legumes in a crop-pasture ley rotation. It has the advantages of not requiring a separate sowing operation and avoids conflict with the cropping program in terms of the timing of sowing. It also provides the pasture legumes with the opportunity to utilize the full growing season. An essential feature of the twin sowing technique will be seed production of the pasture legume on-farm because of the sowing rates that are likely to be required. This will attract both direct and opportunity costs that will require an analysis against economic benefits.

The twin sowing technique will particularly suit species where processing to high levels of seed germination is problematic. Yellow serradella and hard seeded forms of French serradella have traits which allow easy pod harvesting with conventional machinery. However, the pod in these species is tightly bound around the seed and requires specialist machinery to remove without seed damage. The process also attracts a considerable cost. If the pod is not removed the seed is not accessible for scarification to enhance germination and the high levels of hard seed will be maintained under normal storage conditions. In this form excessive rates of sowing would be required with a traditional pasture establishment method. With the twin sowing technique pods are buried for almost one year therefore the hardseededness of the legume will break down to a greater extent (40-50% compared to 5% on the surface), providing a pool of seed that can germinate at the break of season and establish the pasture legume using low sowing rates (Revel *et al.* 1998, Loi *et al.* 1999).

Our results to date show that twin sowing could be used to establish a long term rotational pasture. The pod yields measured at the Northam site were in excess of 1 t/ha, and this is sufficient for a competitive legume regeneration after an intervening crop. The twin sowing technique may also be used to produce legume content in a “disposable” pasture that is green or brown manured prior to seed set of the legume and weed species. It may also be useful for topping up pastures that have low legume content due to drought or a prolonged period of cropping.

The twin sowing technique may also be applied to other hard seeded pasture legumes. Species such as bladder clover (*Trifolium spumosum*), gland clover (*T. glanduliferum*), *Lotus ornithopodioides*, and *Trigonella balansae* have all shown potential for on-farm seed production and harvesting using conventional crop machinery. Other species with high capacity for seed production such as biserrula (*Biserrula pelecinus*) could also be purchased as un-scarified seed at a cost effective price for use with the twin sowing technique.

The success of twin sowing will be reliant upon the introduction of effective symbiotic strains of rhizobia. New alternatives to the traditional peat slurry inoculation of seed with longer shelf life such as the ALOSCA<sup>2</sup> dry granules (Carr *et al.* 2006) used in these experiments may be an effective inoculant to be used with the twin sowing technique. The twin sowing technology will also need to incorporate strategies for weed management as the technique does not provide an opportunity for the application of a knockdown herbicide. The success of the technique may also be improved by particular hard seed breakdown patterns and there may be an opportunity to select new cultivars of targeted species with hard seed breakdown patterns better suited to twin sowing.

Further experiments are currently underway to address optimal seeding rates, seed distribution, rhizobial inoculation techniques and weed control in the regenerating year of the pasture.

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