Medics in southern Queensland: Effects of sowing method, weed control and phosphorus application on plant population and biomass.

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Abstract
Declining sown pasture productivity as a result of a tie-up in plant available soil nitrogen is an ongoing constraint to grazing production across the brigalow bioregion of central and southern Queensland. Research suggests that legume establishment offers the most cost effective long-term remediation strategy for improving pasture quality and yield. Within southern Queensland, medics (*Medicago spp*.) can provide valuable winter contributions to dietary protein and soil nitrogen, however establishment and yields are frequently poor and soil phosphorus often limiting. An experiment was established across two soil types (brigalow clay and poplar box red loam) 70 km north of Goondiwindi, Queensland to investigate the effects of sowing method, weed control and phosphorus fertiliser application on the establishment and yield of a mix of three medic cultivars (*Medicago truncatula cv. Jester & cv. Caliph and Medicago orbicularis cv. Bindaroo Gold*). On both soil types, plant population and biomass were significantly improved via direct drilling of seed as compared to broadcasting. On the loam, drilling increased average populations by between 519 and 1,900% above those recorded in broadcast treatments and improved biomass by between 144 and 315%. On the clay soil, drilling increased populations by between 339 and 983% above those measured in broadcast treatments. Clay soil drilling showed biomass improvements of between 124 and 1,368%. No significant biomass or legume population treatment effects were observed on the clay soil. No significant treatment effects were observed for yield on the loam soil. This study implies that medic establishment, plant populations and biomass can be greatly improved through the application of seed drilling.

Keywords
Agronomy, grazing, buffel grass, yield, zero-till, fallow

Introduction

Declining sown pasture productivity as a result of a tie-up in plant available soil nitrogen is an ongoing constraint to grazing production across the brigalow bioregion of central and southern Queensland (Peck *et al.*, 2011). Research suggests that legume establishment offers the most cost effective long-term remediation strategy for improving pasture quality and yield (Peck *et al.*, 2011). Within southern Queensland, medics can provide valuable winter contributions to dietary protein and soil nitrogen; however, establishment and yields are frequently poor and soil phosphorus often limiting (Peck *et al.*, 2011).

An experiment was established across two vegetation - soil associations (brigalow clay and poplar box red loam) to investigate the effects of weed control, sowing method (drill v broadcast), and phosphorus fertiliser application on the establishment and yield of a mix of three medic cultivars (*Medicago truncatula cv. Jester & cv. Caliph and Medicago orbicularis cv. Bindaroo Gold*).

Methods

Two experimental sites were selected on a mixed farming enterprise 70 km north of Goondiwindi, Queensland. One site was a brigalow clay soil, while the other was a poplar box red loam. Both sites

were dominated by buffel grass (*Pennisetum ciliare*). The sites consisted of four replicated treatment plots, each 20m x 5m in size.

Both sites were fallowed for a period of six months via either zero-till herbicide application or cultivation. The seedbed fallow preparations can be summarised as follows:

- Zero-till with post-emergent selective herbicide.
- Cultivation with Spinnaker® 700 post-emergent herbicide.
- Cultivation with phosphorus applied at 20kg/ha.
- Cultivation with phosphorus applied at 20kg/ha and Spinnaker® 700 post-emergent herbicide.

Zero-till herbicide applications were conducted using a mix of Roundup® at 2L/ha and LI-700® wetting agent at 250ml/ha. Post-emergent selective herbicide plots were treated as required with either Basagran® at 1L/ha with LI-700® at 200ml/100L or Verdict 520® at 100mls/ha with LI-700® at 200ml/100L. In the cultivation treatments that received post-emergent herbicide, Spinnaker® was applied at a rate of 50g/ha. Chemical active constituents are summarised for all applied herbicides in Appendix 1.

Each plot was divided in half and each half randomly assigned to be planted via either broadcast or drilling means, in late April 2014. An equally weighted mix of three medic cultivars (*Medicago truncatula cv. Jester & cv.Caliph and Medicago orbicularis cv. Bindaroo Gold*) was sown at a total seeding rate 3kg/ha. Drilling was conducted using a single disc planter with seeds planted to a shallow depth (<10mm). Broadcasting was done by hand. Phosphorus was applied at the time of planting at a rate of 20kg/ha in the form of superphosphate via shallow tines to the relevant plots. Rigid mesh grazing exclosures (2m x 1m) were erected in in the centre of each half of each plot (one in the broadcast end and one in the drilled end). Plots were measured within the grazing exclosures for plant population and total medic dry matter using 1m x 1m quadrats at the end of September 2014.

Results & Discussion

Plant population and biomass data for both soil types is presented in figures 1 and 2. Table 1 summarises treatments for which significant differences in plant population and biomass were measured. As previous work and industry observation have shown yields and populations were higher on the clay soil than on the loam (Table 1, Figure 1 and Figure 2) (Lawrence and French, 1992 , Peck *et al.*, 2011). On both soil types, total plant population and biomass were significantly improved with direct drilling of seed as compared to broadcasting (Table 1, Figure 1 and Figure 2). On the loam, drilling increased average populations by between 519 and 1,900% above those recorded in broadcast treatments and improved biomass by between 144 and 315%. On the clay soil, drilling increased populations by between 339 and 983% above those measured in broadcast treatments. Clay soil drilling showed biomass improvements of between 124 and 1,368%. Loam soil broadcasted legume populations were significantly higher on cultivated seedbeds as compared to zero-till seedbeds. Cultivation, in combination with Spinnaker® post-emergent weed control produced significantly higher legume populations than all other loam soil treatments. No significant biomass or legume population treatment effects were observed on the clay soil. No significant treatment effects were observed for yield on the loam soil.

Observation of graphically presented mean data for yield and biomass (Figure 1 and Figure 2) appears to hint at other possible interactions which may warrant further investigation. For instance on the loam, phosphorus application appears to benefit biomass production. On the clay soil, Spinnaker® may have had an antagonistic effect on legume biomass and population. Neither of these observations are statistically verifiable with the existing data set, however given the limited degrees of freedom within the statistical analysis (3 for treatment and 4 for sowing method), future experiments could be better designed to investigate these factors further.

Table 1: Summarised mean legume numbers (plants/m2) and biomass (kg/ha) for clay and loam soil types. Treatments demonstrating significant difference are nominated.

		Loam		Clay	
Treatment	**Sowing method**	**Mean Plants/m2**	**Mean Biomass (kg/ha)**	**Mean Plants/m2**	**Mean Biomass (kg/ha)**
Zero-till, post-em. Herbicide	Broadcast	0.7a	231	7.8	260
Cult, Spinnaker®	Broadcast	4.3ab			
Cult, P	Broadcast	5.3ab			
Cult, P, Spinnaker®	Broadcast	4.0ab			
Zero-till, post-em. Herbicide	Drill	13.3b	704.5	47.3	915
Cult, Spinnaker®	Drill	46.3d			
Cult, P	Drill	33.0c			
Cult, P, Spinnaker®	Drill	27.0c			
	LSD:	9.94	503.35	12.46	516.65
	P value:	0.015	0.021	<0.001	0.016

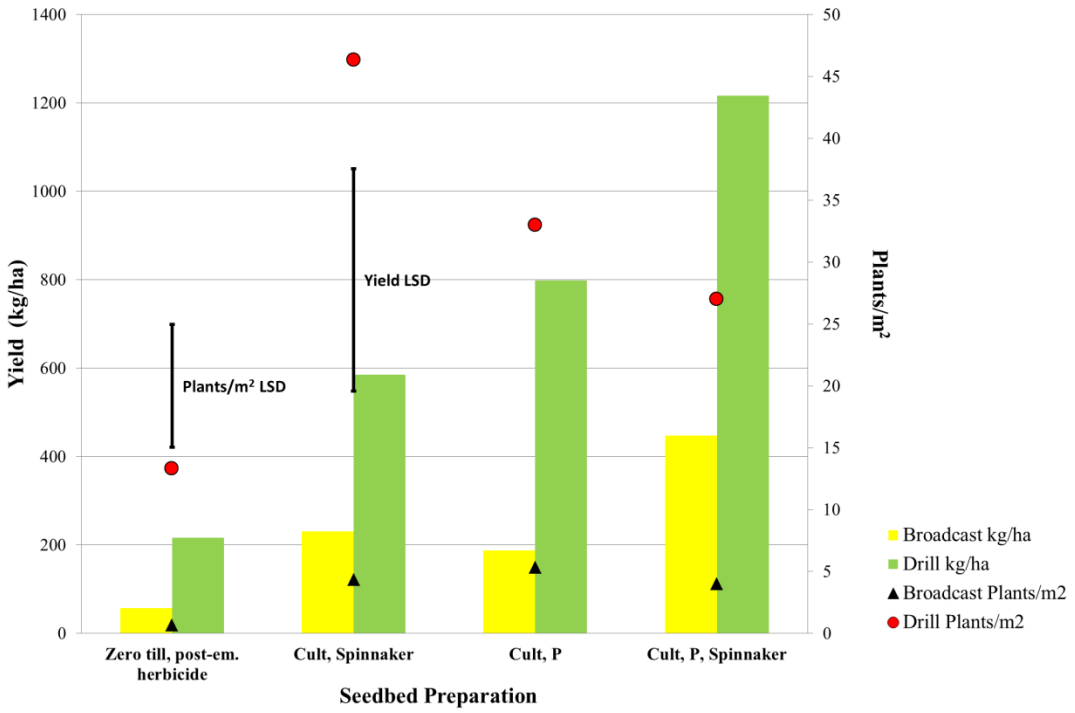

Figure 1: Average total medic dry matter yield (kg/ha) and plant population (plants/m^2) responses to varying seedbed treatments at the loam site.

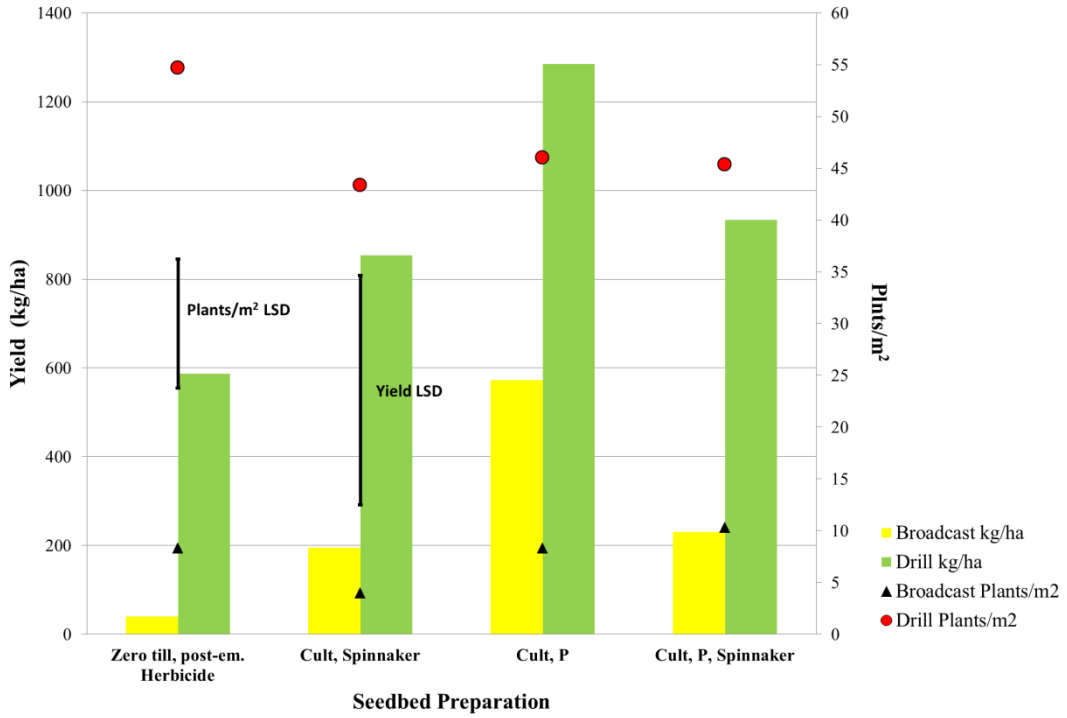

Figure 2: Average total medic dry matter yield (kg/ha) and plant population (plants/m^2) responses to varying seedbed treatments at the clay site.

Conclusions

Medic dry matter yields and populations were higher on the clay soils as expected. On both soil types, medic population and biomass were strongly improved with direct drilling of seed as opposed to broadcasting. Although not statically verifiable, medic responses to phosphorus on the loam soil may warrant further investigation. Spinnaker® application may produce antagonistic effects on legume biomass production on heavier clay soils and this may also hold merit as a topic of future investigation.

References

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Appendix

Appendix 1: Active constituents of herbicide chemicals applied in the study.

Chemical Trade Name	Active Constituent
Roundup®	540 g/L glyphosate (present as the potassium salt)
LI-700®	350g/L soyal phospholipids, 350g/L Proprionic acid
Basagran®	480 g/L bentazone (present as sodium salt)
Verdict 520®	520 g/L haloxyfop present as the haloxyfop-R methyl ester
Spinnaker®	700 g/kg imazethapyr