Improving the reliability of establishing legumes into grass pastures in the sub-tropics.

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Poor establishment is the most common reason for failure of pasture legumes sown into existing grass pastures on commercial farms in the sub-tropics. Although good establishment is recognised as critical to the long term productivity and persistence of legumes, most producers use low-cost and low-reliability establishment techniques such as broadcasting out of planes after either no or minimal pasture disturbance (e.g. fire); one-pass cultivation with seed spread at the same time; or severe soil disturbance and a rough seed bed behind a blade plough used primarily for controlling woody regrowth. This paper reports the results of a trial designed to test the impact of different fallow periods (medium – 4 months; short – 2 months; disturb at plant and no disturbance); seed-bed preparation (cultivation or zero tillage); drilling or broadcasting seed and post emergence herbicides when establishing legumes into existing grass pastures. The most common, commercially used establishment techniques of sowing legume seed into grass pastures with no disturbance or single pass cultivation treatments at plant all resulted in establishment failure. Spraying at plant resulted in adequate numbers of legumes. Short or medium fallows resulted in similar densities of legume plants with between all treatments, however treatments with greater control of the grass and post emergence weed control grew better which resulted in more seedling recruitment in the subsequent year. At 25months after sowing only fallowed treatments with Spinnaker post-emergence weed control achieved legume numbers above benchmark figures for establishment success. The trial demonstrates that agronomic practices commonly used for grain cropping (such as fallowing to store soil moisture) can improve the reliability of establishing legumes into existing grass pastures.

Introduction

Commercially, pasture legumes have not established reliably in existing sown grass pastures in the sub-tropics. Although good establishment is recognised as critical to the long term productivity and persistence of pasture legumes, most producers use low-cost and low-reliability establishment techniques such as broadcasting out of planes after either no or minimal pasture disturbance (e.g. fire) or one-pass cultivation where seed is sown at the same time or severe soil disturbance and a rough seed bed behind a blade plough used for controlling woody regrowth (Peck *et al.*, 2011). In the black spear grass zone of central and southern Queensland, surface sowing legumes has been shown to be unreliable with an 80% failure rate (Cook *et al.*, 1992); it is likely that sowing into competitive sown grass grass pastures like buffel grass in lower rainfall areas have even higher failure rates. This paper reports early results of 2 establishment trials near Wandoan in southern inland Queensland.

Methods

Two trial sites, both with existing buffel grass pastures were established with 2 replicates of 16 treatments. One trial is on a sandy loam alluvial box soil, the other a brigalow grey cracking clay. The trials are designed with 5.5m wide by 20m long plots with 4.5m of grass left between each plot. Fourteen of the treatments have split plots where half of the plot (10m long by 5.5m wide) was drilled using a single disc opener planter while the other half was broadcast onto the soil surface; the one-pass cultivation treatments described below did not have split plots as graziers would most likely spread seed at the same time as cultivation as opposed to drilling seed as part of a second operation. The trials were planted on the 13th to 15th February 2013. Seeding rates were: clay soil site – 6kg seed/ha Progardes variety desmanthus (*Desmanthus spp.*); loam soil site – 6 kg/ha fine-stem stylo (*Stylosanthes guinensis var. intermedia*) and 2 kg/ha Progardes desmanthus.

Treatments are a combination of fallow period, seedbed preparation (zero tillage or cultivated) and post-emergent weed control as follows:

- No disturbance of the grass pasture (ie 1 treatments).
- Grass pasture disturbed at plant; seedbed treatments were slashing, one-pass cultivation with tynes; one-pass cultivation with a deep ripper and herbicide spray (glyphosate) with no post-emergent weed control (ie 4 treatments).

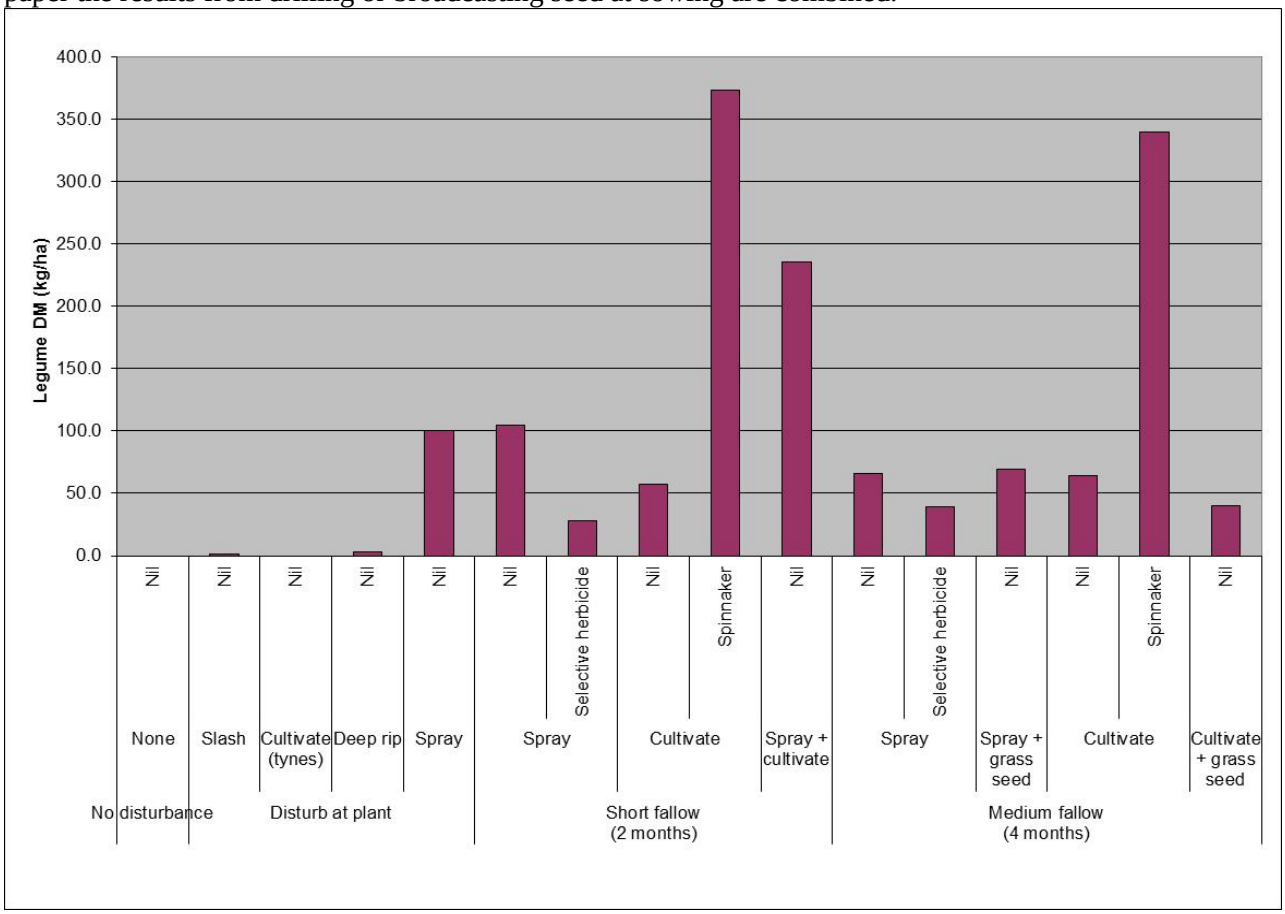
- Short fallow of approximately 2 months. Seedbed treatments were zero tillage (herbicide spray) with and without post-emergence herbicide; cultivate with and without Spinnaker; and a spray followed by cultivation at plant. That is 5 treatments in total.
- Medium fallow of approximately 4 months. Seedbed treatments were zero tillage (herbicide spray) fallow with and without post-emergence herbicide; cultivated fallow with and without Spinnaker; sprayed fallow with both grass and legume sown; cultivated fallow with both grass and legume sown. That is 6 treatments.

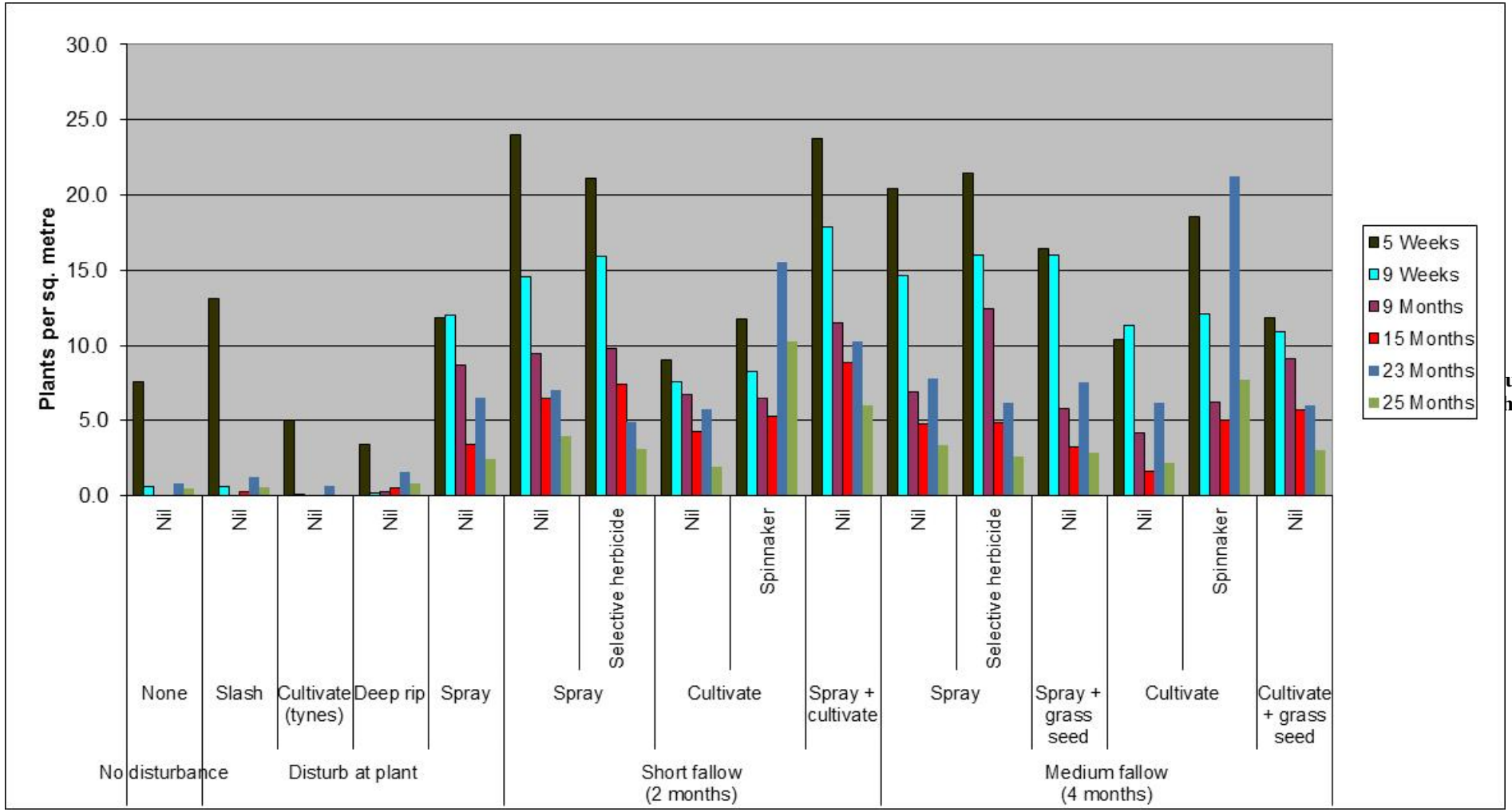
At 5 and 9 weeks; and 9, 15, 23 and 25 months after sowing legume numbers were recorded. At 15 months and 25 months legume numbers and dry matter production of both grass and legume were recorded. The trial sites were grazed during winter after pasture measurements were taken in autumn.

Results

The sites had a very dry spring and early summer leading up to plant which resulted in relatively low amounts of stored soil moisture in fallowed treatments and reduced the efficacy of the sprayed fallows. The sites received very good germinating rains and close to average rainfall in the nine weeks after planting. The good early season was followed by a very dry spring and early summer and heavy grazing by wallabies at the loam site. The combined effect of the dry weather and heavy grazing by wildlife resulted in the loam site being abandoned at 9 months after sowing, therefore only results from the clay soil site are presented in the figures for this paper.

Legume growth at 15 months after sowing is shown in figure 1. Legume numbers at the different recording periods are shown in figure 2. The un-disturbed grass, slashed grass, deep ripped or cultivated at plant (with a tyned implement) treatments all resulted in low numbers of plants that were poorly grown. Sprayed or cultivated fallows resulted in good plant numbers and moderate to good plant size. Medium length cultivated fallows resulted in the best plant size at 9 weeks after planting, most likely from better nutrient availability from greater mineralisation of soil organic matter. Drilling seed dramatically improved plant numbers for zero tillage treatments on the sandy loam soil but had no significant effect on the clay soil, therefore in this paper the results from drilling or broadcasting seed at sowing are combined.




Plants per sq. metre
30.0
25.0
20.0
15.0
10.0
5.0
0.0
5 Weeks
9 Weeks
9 Months
15 Months
23 Months
25 Months
Nil
Selective herbicide
Spinnaker
None
Slash
Cultivate (tynes)
Deep rip
Spray
Cultivate
Spray + cultivate
Spray + grass seed
Cultivate + grass seed
No disturbance
Disturb at plant
Short fallow (2 months)
Medium fallow (4 months)

Discussion

For the purposes of this study, the benchmark target for plant density for these legumes in this environment to be considered successful establishment is greater than 4 plants per square metre. Using this benchmark, the establishment techniques most commonly used by industry of either no disturbance of the existing grass pasture or one-pass cultivation treatments all resulted in low plant numbers (<1 plant/m^2), that is establishment failure. At 15 months after planting, all fallowed treatments and the spray at plant treatment were close to this benchmark of establishment success for plant density. However, by 25 months for most treatments there has been a decline in plant numbers with increasing time since sowing with the exception of the Spinnaker and spray plus cultivate treatments which are above the benchmark.

One year after sowing there was a dramatic difference in legume dry matter (DM) production with Spinnaker treatments and the spray plus cultivated short fallow treatment having more DM; no disturbance and disturb at plant with cultivation treatments having very low DM; and other treatments being intermediate. The greater legume productivity of the Spinnaker and spray plus cultivate treatments is presumably due to a greater reduction in competition from the existing grass pasture. The greater legume productivity flowed through to these treatments having greater recruitment (23 month recording), to increased legume number by 25 months and being the only ones to end up with >5 plants/ m^2. Given that nitrogen fixation and animal production are directly related to legume production, these three treatments with greater DM production are the only ones that are considered successful at 25 months. The establishment techniques that resulted in more moderate plant numbers and DM production may still end up being successful but they will take longer to reach their production potential which reduces their economic returns due to future earnings being discounted.

The 23 month measurements recorded recruitment of legume seedlings across all treatments. For the treatments with very poor legume growth in the previous year (i.e. no disturbance, slash and cultivate at plant treatments) this increase in plant numbers would be dominated by softening of hard seed that was originally sown. For other treatments that grew greater amounts of legume the increase in legume numbers would be a combination of both softening of sown seed and seed set by the legume in the previous summer growing season. The much greater recruitment of the Spinnaker treatments reflects the much greater DM production compared to other treatments and presumably greater seed production. This greater productivity has led to these being the only treatments to meaningfully increase legume numbers from the 15 month to the 25 month measurements.

The spray at plant treatment has produced much greater legume numbers and DM production than the cultivate at plant treatments. The spray treatment produced a particularly good kill of the grass pasture as it was timed when the grass was very leafy and actively growing. There was very good germinating rain and follow up rain within a fortnight after planting which also contributed to the success of this treatment. In other years this treatment is likely to be less successful if the initial kill and follow up rain do not occur. In subsequent trials this treatment has resulted in low plant numbers in the first season after sowing due to the challenges of timing the spray and sowing treatment (authors' un-published data).

Conclusions

Poor establishment is the most common reason for failure of pasture legumes in existing commercial grass pastures, however the most commonly used methods by graziers are low cost and low reliability. Fallowing to store soil moisture and control competition from the existing grass pasture improve establishment. Greater control of competition through the use of post-emergence herbicides like Spinnaker can increase establishment success. Industry needs to adopt more reliably successful establishment techniques when introducing legumes into existing grass pastures for them to realise their potential to improve productivity and economic returns in the sub-tropics.

References

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