Hard seed breakdown rates of six tropical ley pasture legumes.

John Lawrence[1], Lindsay Bell[1], Marie Breton[2]

[1] CSIRO Ecosystems Sciences, PO Box 102, Toowoomba 4350 Email Lindsay.Bell@csiro.au or j.lawrence@csiro.au
[2] AgroParisTech, Paris, France Email marie.breton@agroparistech.fr

Abstract

Maintaining a viable seed bank of tropical pasture legumes is important for ensuring legume persistence but also has implications for potential weed problems in crops following ley pastures. In particular the hard seed survival of Burgundy Bean (*Macroptilium bracteatum*) is unknown. This ongoing study examines the hard seed breakdown of six tropical pasture legume varieties since March 2010 and will continue for a further two years. Fresh hard seeds of the varieties were placed in replicated mesh bags at a field site near Toowoomba, Queensland and remaining hard seed was measured periodically. After the first year, 64% of seeds of Desmanthus cv. Marc (*Desmanthus virgatus*) and 46% of seeds of Desmanthus cv. Q 9153 remained hard; 18% of seeds of Burgundy Bean and 16% of seeds of Siratro cv. Aztec (*Macroptilium atropurpureum*) remained hard; only 2% of hard seeds of Butterfly Pea (*Clitoria ternatea*) and 1% of hard seeds of Centrosema cv. Cardillo (*Centrosema pubescens*) remained. After the second year, little additional hard seed of the Desmanthus had softened, but remaining hard seed had reduced to 14% for Burgundy Bean and 12% for Siratro. The majority(>80%) of Burgundy Bean and Siratro seeds softened within the first two years showing that they are unlikely to cause residual weed problems after that time. However, both varieties of Desmanthus had a persistent soil seed bank which could cause weed problems in following crops.

Keywords: Legumes, persistence, hard seed, breakdown rates, weed problem.

Introduction

Understanding seed longevity is important because the hard seed requirements of species differ depending on the type of system in which they are used. In ley pastures the pasture is required to regenerate whereas when followed by a crop this regeneration becomes a weed problem. Sufficient soil hard seed must enable pasture density to be maintained in a long-term ley pasture but a high soil seed reserve may be a disadvantage when a crop is sown after the pasture break. Some studies have shown that hard seeds of some Mediterranean legumes can persist for many years (Taylor and Ewing, 1992) but for many sub-tropical pasture legumes there is no information on their short and long-term softening patterns. The purpose of this study is to compare the breakdown rate of 6 varieties of tropical ley pasture legumes species over four years in order to enhance knowledge of seed longevity in short-term rotations and their potential to cause residual weed problems in subsequent crops.

Methods

Experimental design

This study has run for two years from March 2010 and will continue for a further two years using five sub-tropical pasture legume species including two cultivars of *Desmanthus virgatus* (Table 1).

Table 1. The 6 sub-tropical legumes, cultivars and number of seeds per lot used.

Cultivar/common name	Scientific name	No. Seeds/lot
Desmanthus cv. Marc	*Desmanthus virgatus*	250
Desmanthus cv. Q9153	*Desmanthus virgatus*	200
Burgundy bean	*Macroptilium bracteatum*	100
Siratro cv. Aztec	*Macroptilium atropurpureum*	100
Butterfly pea cv.Milgarra	*Clitoria ternatea*	100
Centrosem cv. Cardillo	*Centrosema pubescens*	50

The initial hard seed content of each species was determined before the field experiment by placing 5 replications of seed lots for each species in Petri dishes filled with moist filter paper for 10 days at 24 ^{0}C. The number of seeds of each species per lot was determined by their size and only initially hard seed was used. Seed mass was calculated by weighing lots of 50, 100, and 200 seeds for each species with 4 replications each. Seed lots were placed into aluminium mesh bags (11 x 6 cm) and the 6 bags were joined together with aluminium wire loops 50 cm in diameter to allow easier identification and sampling of bags in the field. These loops of bags were replicated 5 times for each sampling time or treatment. Fourteen treatments were prepared to enable sampling over the four years of the study. Consequently 70 loops (420 bags) were prepared and on the 19 March 2010 placed in a field with a black vertosol soil at Cawdor, 8 km north of Toowoomba, Queensland (27^{o}28 S, 151^{o}54 E). The loops of bagged lots were fixed on a bare soil surface in a randomised split-plot design at a spacing of 25 cm and covered with a small amount of soil. The soil was kept bare of weeds during the experiment with applications of Glyphosate about 2-3 weeks after a germination event. Surface temperatures on the bare soil were recorded daily throughout the period of softening using a Tinytag data logger attached to a surface thermometer placed in the middle of the experimental site. Rainfall data were recorded by the landowner.

Measurements
Replicates of looped bags were collected from the field at selected dates 40, 70, 101, 200, 248, 325, 437, 618 and 752 days after the trial commenced. On each occasion the bags were separated, opened and the seed spread out on moist filter paper in individual Petri dishes and placed in a germination cupboard at 24^{0} C. Over ten days these dishes were removed and the softened seeds counted. The proportion of initial hard seeds that had softened at each sampling was calculated by subtracting the number remaining from the initial number of hard seeds, and expressing the difference as a percentage of the initial hard seed content.

Results and discussion
The first germination test showed that the initial hard seed content varied between species. The highest hard seed contents were in *Desmanthus virgatus cv. Marc* (95% s.e. 0.6), *Desmanthus virgatus cv. Q9153* (76% s.e. 1.1), *Macroptilium bracteatum* (76% s.e. 0.9) and *Macroptilium atropurpureum* (58% s.e. 4.1) which were consistent with reported values (Burrows *et al*. 1993, Lawrence *et al*. 2008 and Hopkinson 2004). The lowest contents were found in *Centrosema* (36% s.e. 1.8) and *Clitoria ternatea* (19% s.e. 2.9); this last being lower than the reported 30% (Lawrence et al. 2008 and McDonald. 2000). The proportion of initial hard seed that softened over the two year period (Figure 1) shows that *Desmanthus virgatus cv. Q9153* and *Marc* had the most hard seed remaining (63% and 65%) whereas *Macroptilium bracteatum* and *atropurpureum* had far less hard seed remaining (3% and 4%). All the seeds of *Centrosema* and *Clitoria ternatea* had softened either in the field or in the last germination test.

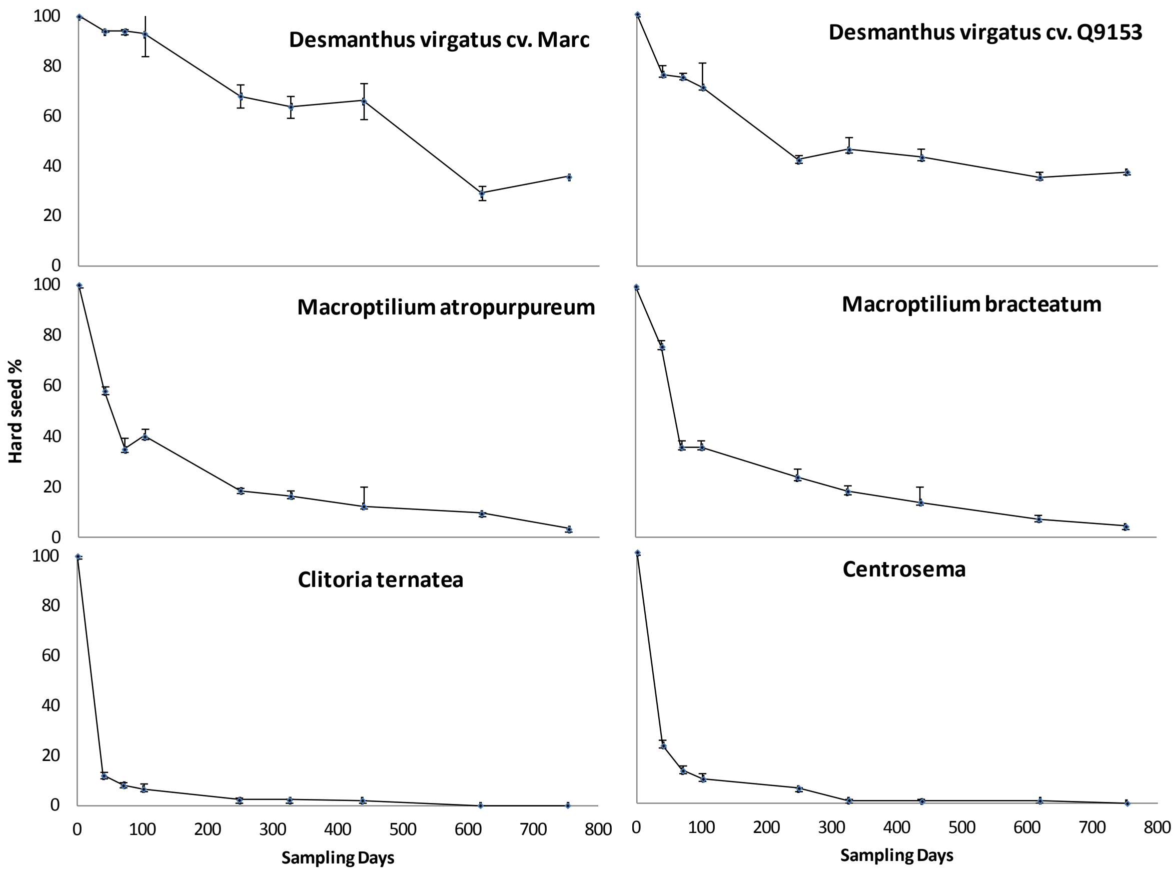

Figure 1. The percentage of initially hard seed remaining at periodical sampling days after the trial commenced.

Over the first three sampling times (up to 100 days) there was no significant decline in hard seed content in *Desmanthus virgatus cv. Marc*, while in the two *Macroptilium* spp. there was a 60% decline, and 90% of hard seeds softened in *Centrosema* and *Clitoria ternatea*. High soil surface temperatures recorded over these first three sampling time (March – May 2010) corresponded with rapid softening of hard seeds in *Macroptilium bracteatum* and M.*atropurpureum*. This is consistent with findings from laboratory experiments, which show softening rates increase with temperature in these species (McDonald. 2000). Taylor and Ewing (1992) underlined that field measurements may differ from those obtained in a laboratory and the day to day variations of temperature in the field would influence the rate of softening. The results obtained for *Clitoria ternatea* might raise a case that the threshold temperature tested by McDonald (50^0C) may have been overestimated. These observations implicate the careful use of these legumes in the pasture cropping systems of Queensland to provide good forage and ley pastures but to avoid them becoming weed problems when the land is returned to cropping.

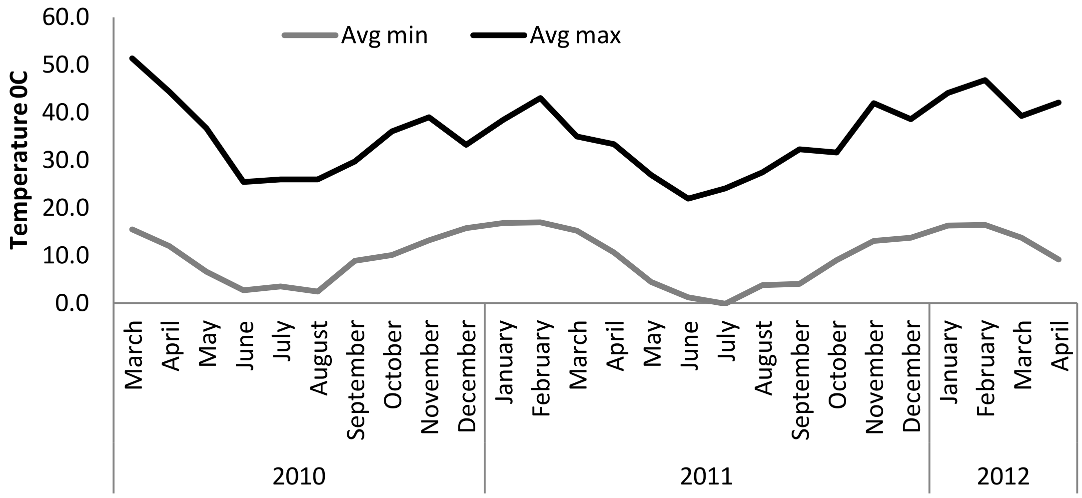

Figure 2. The recorded average minimum and maximum temperature at the soil surface over the period of the trial to date.

Conclusion

There are significant differences in the softening patterns of these six legumes. The results have already shown that *Desmanthus virgatus cv. Q9153* and *Marc* are more suited to longer term (2-4 year) ley pastures than short term forage pastures since its seeds may persist in the soil seed bank for many years and would cause a weed problem after the latter. *Macroptilium bracteatum* and *atropurpureum* are ideally suited to short term (1-2 year) forage pastures due to their seeds ability to soften quickly in autumn but may cause some weed problems in cropping at the end of the pasture phase. Both *Centrosema* and *Clitoria ternatea* have proved ideal for these short term pastures without the risk of future weed problems.

References

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