Seed propagation of two native Australian species important for land restoration©

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INTRODUCTION

There has been substantial investment in revegetation and restoration of native biodiversity in eastern Australia in recent decades (Close and Davidson, 2003). Incentive programs run through agencies such as Catchment Management Authorities encourage community-based management of natural resources and restoration of native vegetation communities to support biodiversity conservation (Hallett et al., 2014; Local Land Services, 2014). However, more effort is required to achieve restoration at landscape scales. The main limitations to landscape-scale restoration are associated with costs, incompatibility with existing agricultural practices, deficiency of straight financial profits from restoration activities, and inappropriate incentives to change the land management practices (Morrison et al., 2008).

Successful revegetation requires an understanding of species biology and ecological requirements. Large scale revegetation can be achieved using tubestock planting of seedlings, and direct seeding. Direct seeding is more convenient than other methods as it is cost-effective due to less investment of work and material costs and permits use of a diverse seed mix incorporating a range of plant species and growth forms (Dalton, 1994; Gibson-Roy et al., 2007; Hallett et al., 2014). However, direct seeding for restoration requires sufficient ecological knowledge of seed collection, quality, viability, persistence, storage, germination, and other ecological aspects for a wide variety of species.

There are many knowledge gaps to be addressed in order to increase the success of direct seeding revegetation (Baskin and Baskin, 2004; Budelsky and Galatowitsch, 1999; Hossain et al., 2014; Long et al., 2015). These knowledge gaps include effective treatments to break dormancy, seed responses under different seasons and environmental conditions, and suitability of seed to be direct seeded. As a preliminary attempt to fill some of these gaps, we present the results of viability and germination studies of two native plant species with ecological and economic value: *Eremophila debilis* and *Capparis lasiantha*.

Eremophila debilis has a broad geographic range and importance in ecological communities of the arid zones, where it is often dominant or codominant of wide areas. It is drought, fire, frost, salinity, and grazing tolerant and palatable to stock despite its low growth habit. However, its germination is unreliable and that limits its use in direct seeding revegetation programs (Cunningham et al., 2011). Two factors are assumed responsible for unreliable germination in this species: (A) Inappropriate environmental conditions and inability to overcome physical dormancy; (B) A chemical inhibitor of the seed, seed coat, or fruit (Richmond and Chinnock, 1994).

Capparis lasiantha is palatable to livestock and native fauna and has cultural value in aboriginal communities as its fruit is palatable to man (Cunningham et al., 2011). This species appears to be adaptable to abandoned farming fields and is a key component of several important ecological communities in Australia, including some endangered ecological communities (Department of Environment and Heritage, 2006; Fensham and Fairfax, 1997). *Capparis lasiantha* is drought tolerant (Walters, 2015). Studies done on other species from this genus show that the physical constraint imposed by the seed coat may be responsible for seed dormancy and removing it partially will allow germination (Pascual et al., 2004; Sozzi and Chiesa, 1995).

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METHODOLOGY

Viability

Seeds of *E. debilis* were manually extracted from fruit after cracking the fruits using a vice grip. Seed coats of *C. lasiantha,* were removed after cracking the seed coat and peeling it off. Seed viability was tested using the standard tetrazolium staining technique (ISTA, 2003). Three seed lots were tested for each species with three replicates of 30 seeds per seed lot. Seeds were obtained from Field's Native Nursery®, in Uralla, NSW. *Capparis lasiatha* were collected on 2012 (SL1), 2013 (SL2), and 2014 (SL3) test and *E. debilis* seeds were approximately 1 year old. Both were stored in a cool room until test.

Pre-treatments and germination

Germination experiments were carried out using the seed lot with the highest viability (according to the tetrazolium test) for each species. All seeds with evidence of damage were discarded. Three replicates of 50 seeds were used for each treatment and control.

Trials with seeds of *E. debilis* consisted of two treatments: (1) the fruit was manually nicked by cutting the apex of the fruit horizontally with a blade to permit water and oxygen to reach the seed and allow imbibition; and (2) naked seed were obtained from the fruit. This was done by cracking the hard fruit with a vice and posterior manual extraction of the seed from the release locules. The control consisted of untreated seeds within the fruit.

Capparis lasiantha seeds also had two treatments: (1) seed coats were punctured using a dissecting needle, punctures were placed at an edge of the wider section of the seed to avoid damaging the embryo, and (2) seed coats were completely removed from the seed. The control consisted of complete untreated seeds.

Seeds were placed on moistened filter papers over wettex sponges in petri dishes and incubated in growth cabinets, with temperatures set at 25/15°C for *C. lasiatha* and 35/25°C for *E. debilis* at 12 h light/darkness. Temperature regimes were set based on previous results and bibliographic records that suggest the regimes employed here provide the best germination results for these species. The seeds and fruits were irrigated with 10 mL of tap water at the start of the experiment and when required. When naked seed was used, only healthy plump firm seeds were selected for the germination tests. Germination was recorded daily over a 4-week period in the case of treated seed and 8 and 12 weeks for untreated seed of *C. lasiantha* and *E. debilis,* respectively.

RESULTS

Viability

The three different lots of *E. debilis* had apparent similar mean viability results (Figure 1). Up to eight seeds were recovered per fruit within the four locules, however differences among seedlots are statistically significant ($p=0.01$).

Two seed lots of *C. lasiantha* collected in past years had no or very low viability and although the tetrazolium test of the third (fresh) seed lot collected the same year indicated 100% viability of the seed tested, 25% of the seeds had to be discarded due to damage or incomplete seeds, and this lowered the apparent viability. Differences among the seedlots were highly significant $p>0.001$ (Figure 1).

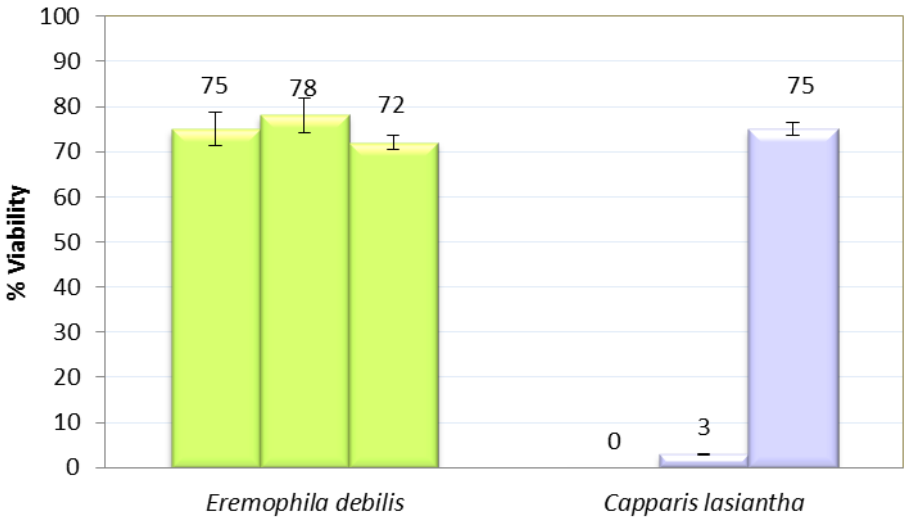

Figure 1. Mean percent viability of three different seed lots (SL) of *Eremophila debilis* and *Capparis lasiantha.*

Germination

The highest germination of *E. debilis* was obtained from naked seed, it was also the fastest as it took an average of 8 days for seeds to germinate compared to the 24 days and up to 80 days for the cutting treatment and control, respectively. The cutting treatment improved germination compared to the control, but had lower germination than the naked seed. In contrast, *C. lashiantha* had low germination from naked seed and highest when seed was punctured. The germination of the control treatment was also noteworthy based on the accepted standard for seed germination of 80% (Association of Official Seed Analysts, 2005). However, these results were obtained by using only healthy-looking seed. Germination percent per treatment was significantly different ($p>0.01$) in both species (Table 1).

Table1. Mean percent germination of two species after two seed pre-treatments and control.

Treatment	Germination (%)	
	Eremophila debilis	*Capparis lasiantha*
Fruit/seed section	42	98
Naked seed	81	65
Control	24	91

DISCUSSION

Plant propagation from seed is encouraged whenever possible because of time and cost savings and to preserve genetic biodiversity (Gibson-Roy and Delpratt, 2014). However, knowledge of seed ecology of native Australian plants can be a limitation for many species. Furthermore, some procedures used to prepare seed and increase germination are time consuming and unrealistic for large scale plantings. Both scientific knowledge of plant physiology and specific technical skills acquired through experience are vital to determine cost effective methods for seed treatment and germination. This implies involvement of scientists, academics, field personnel, nursery managers, and others involved in all aspects of growing and planting native plants.

Previous research with other species of *Eremophila* (Richmond and Ghisalberti, 1994) and *Capparis* (Pascual et al., 2004) suggest that mechanical scarification will give similar results to treatments involving partial cutting of the hard fruit or seed coat like those investigated here. A possible practical approach could be to conduct seed scarification using

mechanic scarifiers that have already been successfully implemented in species of commercial importance (Liu, 2007).

Although dormancy breaking mechanisms for various species are better understood, further research in the direction of practical applications for large scale direct seeding and plant production is required to achieve appropriate outcomes.

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