Arabidopsis FLC gene into canola, the canola flowers late. We then isolated genes similar to *FLC* from canola. We inserted them into *Arabidopsis* and flowering was delayed. This suggests that *Brassica* also uses an *FLC*-like mechanism to control its flowering. If we use a line of *Brassica* that requires vernalisation to flower, we find that the level of *FLC* activity is very high and when the *Brassica* plant is vernalised the level of *FLC* activity drops and the plant flowers early. Apparently *Brassica* uses *FLC* genes to control flowering time and respond to vernalisation. We are now in the process of looking at other plants to see if they do use *FLC* as a method of controlling flowering time.

The process of vernalisation occurs in many families of plants both monocot and dicot and has similar characteristics suggesting that it works through a similar mechanism. We need to extend our studies more widely to determine if *FLC* activity is manipulating flowering in these other species.

The ability to control flowering time may be of great significance in crop, forestry, and horticulture - either to cause flowering at an appropriate time or to prevent flowering.

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Native Grass Seed Germination©

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This presentation is a summary of the project “Native Grass Restoration in the Australian Capital Territory Water Catchment. Maximising Seed Germination”. The full report can be found at <http://www.anbg.gov.au/hort.research/grass-project>. The project was funded initially by the Community Grasses Project for the Murray Darling Basin and ACTEW and later by the Natural Heritage Trust through the ACT Government.

OBJECTIVES

The objectives were to find practical, reliable, and cost-effective methods for revegetation using local provenance native perennial grasses through:

- Faster germination of seed.
- More synchronous germination of seed.
- Increasing the amount of germinable seed.
- Developing better strategies for seedling establishment.

SPECIES SELECTION, SEED QUALITY, AND SEED SUPPLY

Seven species were studied. They were all native, perennial, and deep rooted and from a range of habitats. Both summer—and winter—(C_3 and C_4) growing species were represented. The seed was collected locally.

Some species of grass have many sterile flowers, which produce no seed. The seeds on native grass heads ripen gradually so at harvest many under-ripe seed units may be collected and many ripe seeds may have already been shed. The result is a lower yield of viable seed than might be expected in some species. Seed quality is also reduced by insect activity. The yield is dependent on seasonal weather conditions with little or no seed produced in drought years.

Although seed may be viable, seeds of some species are dormant when harvested or develop dormancy during storage and require treatment to break the dormancy.

METHODS

Storage. Dry seed was stored at 4, 10 or 15, and 20°C in sealed containers. All species were stored with the seed coats intact.

Germination Tests in Vitro. Germination trials were done for storage temperature, storage time, and physical and chemical pre-treatment. These were conducted in 9-cm glass petri dishes containing damp towelling and paper. Full seed was selected by hand. For pale-coloured seeds soaking in water made the seed coat transparent. Sometimes the seed coat was removed. After preliminary trials 20°C was chosen as a suitable growing temperature. To control fungi and bacteria from the seeds a range of chemical treatments was tried and Plant Preservative Mixture (PPM) supplied by Austratec Pty Ltd was found to be reasonably successful at reducing contamination at a concentration that did not damage the emerging seedlings.

RESULTS AND RECOMMENDATIONS

***Austrodanthonia caespitosa* (syn. *Danthonia caespitosa*), wallaby grass. Bare seeds were used for most tests.**

- At 6 months of storage the best germination was from seed stored at 20°C; at 16 and 28 months germination was faster at the lower temperatures.
- 100% germination rates were achieved in 4 to10 days given suitable conditions.
- Removal of seed coats increased speed of germination by 4 to 5 days but not final percent.
- No effect of light/dark.
- Smoke treatment increased the speed and percent germination in fresh seed, but not in stored seed.

***Austrostipa scabra* subsp. *falcata* (syn. *Stipa scabra* subsp. *falcata*), spear grass. Tests were done with seed coats intact and awns cut short.**

- At 6 months of 20°C storage gave the fastest and most successful germination.
- After storage of 16 months at all temperatures most seeds were dormant and only about 20% were germinable.
- By 26 months most seed was germinable, especially after storage at the higher temperatures.
- Germination rates of nearly 90% were found in 5 days under suitable conditions.
- Removal of seed coats increased germination (%) but not speed.
- No effect of light/dark.
- Smoke treatment increased the speed but not percent germination in fresh seed but there was no effect in stored seed.

***Bothriochloa macra*, red grass and redleg grass. Bare seed was used for most tests.**

- No effect of storage temperature.
- No dormancy detected.
- Germination rate of 100% in 3 days under suitable conditions.
- Removal of seed coat speeded germination but not final percent germination.
- No effect of light/dark or of smoke.

***Microlaena stipoides* (syn. *Ehrharta stipoides*), meadow rice grass and weeping grass. Bare seed was used for most tests.**

- No effect of storage temperature.
- No dormancy detected.
- Germination rate of 100% in 3 days under suitable conditions.
- Removal of seed coat speeded germination but not final percent germination.
- No effect of light/dark or of smoke.
- Seed can be stored until the following year without becoming dormant or losing viability.

***Joycea pallida* (syn. *Chionochloa pallida*), red anther wallaby grass. Bare seed was used for most tests.**

- After 5 months storage at 20°C there was faster germination but similar final percent germination.
- Germination was reduced after 15 months storage at all temperatures.
- Germination rose to almost 100% after 25 months storage at all temperatures.
- Removal of seed coat speeded germination greatly but not final percent germination.
- No effect of light/dark.
- Smoke treatment increased the speed and percent germination in fresh seed. There was no effect in stored seed.

***Poa labillardierei*, tussock grass. Seed coats were left on for most tests.**

- After 33 days storage at 20°C only 4% of seed germinated.
- After 14 months storage the germination was low: 4% at 4°C, 2% at 15°C, and 0% at 20°C.
- After 23 months seed stored at all temperatures had 100% germination.
- Seed coat removal reduced the germination time from 20 to 7 days but the small size of the seed means that this is not feasible.
- No effect of light/dark.
- There was no effect of smoke in stored seed; fresh seed was not tested.

***Themeda triandra* (syn. *T. australis*), kangaroo grass. For most tests the seed coats were left on and the awns removed.**

- After storage for 5 months at 20°C, 30% germinated with less at the lower temperatures.

- After 15 months storage there was no germination.
- After 23 months storage at 20°C there was 30% germination with little at the lower temperatures.
- Removal of the awns had no effect on germination.
- Removal of the seed coat of 8-month-old seed gave a three-fold increase in percent germination and an increase in speed, but the germination was still low.
- Variable effect of light/dark and UV light.
- Reduced germination with moist-chilling.
- No effect of pre-heating treatments or orientation of seed.
- No effect of smoke on fresh or stored seed.
- No effect of boron or potassium nitrate.
- Trichopel (containing *Trichoderma*, a beneficial fungus), gibberellic acid (GA_3), and complete tissue culture nutrients gave an increase in speed and percent of germination.
- Acid scarification reduced germination severely.

RECOMMENDATIONS AND FUTURE DIRECTIONS

It must be emphasised that these recommendations apply specifically to one region.

- For sunny positions the easiest species to germinate is *Bothriochloa macra*. It is a C_4 grass and spring sowing is probably advisable. *Austrodanthonia caespitosa* exhibits more dormancy than *Bothriochloa* but could be sown in spring or autumn after storage. *Austrostipa scabra* can be used if storage is managed for seasonal variations in germination.
- In semi-shade or moist positions *Microlaena stipoides* is the most reliable and is probably suitable for autumn or spring sowing. For semi-shade the second choice is *Joycea pallida*. *Poa labillardierei* can be used if managed for seasonal variations in germination.
- *Themeda triandra* cannot be recommended for reliable establishment, although recent improvements in harvesting and cleaning techniques may improve its performance. Further work is needed on this species.
- A potentially useful strategy would be to develop seed mixes that include a range of species. This would increase diversity in the sward and allow the difficult species to germinate opportunistically.
- Additional trials are recommended on the use of fertilisers, machinery for seed cleaning and seed coat removal, the use of herbicides to control weeds, and seed production under irrigation.
- Seed coating could be used to add germination enhancing chemicals and reduce insect predation.
- Monitoring germination rates is useful to predict the amount of seed to be sown.