Native cover crops in viticulture

Mr Chris Penfold and Dr Cassandra Collins
The University of Adelaide
Introduction
The species chosen for cover cropping are generally those that are familiar to the grower and are known to perform well in a particular environment, and for which seed can be cheaply and readily obtained. In the past, this has limited the choice to the standard crops grown in arable agriculture – cereals, grain legumes, oilseeds, pasture grasses and legumes. Over the last decade, however, the potential for substitution of the exotic cover crop species with natives has been investigated, and substantial benefits from their adoption have now been recognised (Penfold 2010a).

Native grasses
In Australia, there are more than 1100 species of native grasses spread across the many environments of the continent. Pollen records show their plentiful status in southeastern Australia from the Quaternary period of about 1.6 million years ago (White 1986, in Reseigh et al. 2009). Over that period of evolution there have been dramatic changes in climate, which have required the species mix to change and species to adapt accordingly. The Australian native species have now evolved to grow in shallow, infertile soils where rainfall is unreliable and the fire frequency is high. Unfortunately, native grassy ecosystems are amongst the most threatened ecosystems in Australia, due to extensive cropping and grazing since European settlement (Benson 1996, in Reseigh et al. 2009). Substituting native for exotic grass cover crops in vineyards is therefore a means of addressing the decline in their abundance, while simultaneously improving ecosystem function.

In southeastern Australia, the native grass genus deemed to be most suitable for use as cover crops in vineyards are the C3 grasses Austrodanthonia (wallaby grass) and Microlaena (weeping grass) and the C4s Chloris (windmill grass) and Dicanthium (Queensland blue-grass). The difference between C3 and C4 grasses lies in their biochemical pathways, with the winter-active C3 grasses fixing carbon in molecules that contain 3 carbon atoms, while the summer-active C4 grasses fix carbon in molecules that contain 4 carbon atoms (Reseigh et al. 2008). In cooler conditions, C3 plants are more efficient at converting CO2 and water to carbohydrates, but the rate of photosynthesis falls rapidly in warm conditions. By contrast, many C4 plants begin to hay off at temperatures below 15°C but grow best in warm, drier conditions (Goodacre & Cluff 1999, in Reseigh et al. 2008).

While there has been some breeding of native grasses in Australia since the mid 1990s, many of the original features and traits have been maintained. Unlike the highly bred cereals, such as wheat, barley and oats, the native grasses still produce seed over several weeks, and once mature the seed shatters and falls to the ground. The floret that contains the seed also consists of structures intended to improve the dispersal and germination of seed. Long awns and fluffy seed coats, which are often light and chaffy, make handling with conventional machinery difficult. Where possible, seed coats are removed (e.g. Themeda spp.) but other species are either pelleted (Danthonia, Dicanthium) or sown with specialised machinery (Figures 1 & 2).

Native grass agronomy
Establishment
Native grass establishment naturally depends on successful germination, but even with this, some species in some years can be quite resistant to establishment. Difficulties with reliable establishment and the high cost of seed have limited the adoption of native grasses in vineyards. Techniques such as the removal of florets and treatment with heat or gibberellic acid (GA) may improve germination in the laboratory but this does not necessarily translate to the field (Clarke et al. 2010). Seed quality is critical to successful establishment, so only seed of known germination should be purchased, with allowance made for poor germination rates if required.

The cultivation of soils and addition of nutrients, especially in higher-rainfall areas, pose a threat to native grasses because these ‘new’ conditions favour exotic weeds (Waters et al. 2001). These authors draw attention to the slow growth

Figure 1: A Taegke seeder from New Zealand, modified to sow native grass. (Photo courtesy of Philip Reilly)  
Figure 2: The hydro-pneumatic seeder uses a polymer carrier to transfer seed from the tank to the soil. (Photo courtesy John Stafford)
rates of native grasses, which may aid survival in stressful environments, but their low vigour disadvantages the grass seedlings when in competition with weeds. Exotic annual weeds grow and reproduce quickly in fertile and disturbed soils. Both soil preparation and herbicides are important in overcoming the potentially lethal competition from annual exotic weeds (Chivers 2006). When establishing native grasses, it is important for them to establish promptly and exert control over reinvading weeds. Waters et al. (2001) recommend that the past history of cropping, fertilisers and herbicides be used as a guide to the potential weed problems of a site. The germinable weed seed load of a site can be tested by watering a topsoil sample under glasshouse conditions; the first emergence should be allowed to dry out and then removed, and the same sample rewetted to discover later weed germination. Winter and summer weed suites may differ from one another. Fifty thousand weed seedlings per square metre is common and poses a formidable level of competition, while less than 100/m² gives a good chance of grass establishment. To reduce the viable weed seed bank in the soil, weed control will be necessary a year or more before planting into a weedy site. Chivers and Raulings (2009) also place considerable emphasis on weed control both pre- and post-planting, preferring to use a cultivated site to ensure intimate contact between the seed and soil. When there is minimal lead time before sowing, direct drilling is the preferred strategy, as weed seeds on the surface are not buried, nor are those deep in the soil brought to the surface where germination is enhanced. Seeding rates are determined according to the desired plant density, seed viability and expected germination rate in the field. As a guide, wallaby grass (5–10 kg/ha as fluffy seed or pelleted), weeping grass (5–10 kg/ha for seed with awns attached), windmill grass (1–2 kg/ha for seed) and Queensland blue grass (5–10 kg/ha as fluffy seed or as pellets) are commonly used seeding rates.

Native grasses are small-seeded, so they must be sown from 0 to 10 mm deep, depending on the species (Greening Australia 2007). Improving the seed-to-soil contact by means of press wheels, or a roller after seeding, will enhance germination in soils with crumbling to small-clod structure. The preferred temperature for germination of both C3 and C4 grasses is in the 20–30°C range (Lodge & Whalley 1981, in Reseigh et al. 2008). The optimum time for seeding is from autumn to spring for the C3 grasses, and from spring to early summer for the C4 grasses, preferably with a significant rainfall event to follow soon after planting. Patience is needed while waiting for emergence, but if all the basic requirements have been attended to, then emergence will eventually occur.

Native grass management
As mentioned earlier, native grasses exhibit poor early vigour, so weed management is required, at least in the first year after planting. Where herbicides can be used, several broadleaf-selective products are available. For example, Jaguar® and Barracuda® (bromoxynil + diflufenican) and Spotlight Plus® (carfentrazone-ethyl) are both registered for use in vineyards and can be used at label rates without damage to Austrodanthonia richardsonii, while Jaguar® also showed no deleterious effect on Chlóris in a glasshouse experiment (Penfold & Stevens 2006). Where weeds are faster to emerge and have grown well above the native grasses, it is possible to use a sponge wiper with a non-selective herbicide to selectively control the taller-growing species (Figure 3).

If it is not possible to use herbicides, strategic mowing or grazing may be required to prevent weed growth and seed set of the weeds while allowing seed set in the perennial grass. This is easier with the C₄ grasses, as their winter dormancy supports weed control and summer weeds may be overcome by competition for moisture. It is a more challenging proposition for the C₃ grasses, putting greater emphasis on site preparation prior to planting.

Native perennial grasses may live for 25 years, which is necessary because recruitment from their own seed may only happen rarely, when the required combination of rainfall, temperature and seed placement occur. The stand must therefore be managed to preserve the established plants. Where sheep grazing is possible, high stocking rates for short periods are preferred strategies for plant recruitment and stand longevity (Sargeant et al. 2009). Care must also be taken that plants are not removed when grazing and mowing. If grazing occurs too early after sowing, stock may pull the grass from the soil. Research by Nie et al. (2009) found that cutting wallaby grass (Austrodanthonia bipartita cv. Bunderra and Austrodanthonia setacea, Woodhouse ecotype) and weeping grass (Microlaena stipoides cv. Bremmer and ecotype Coleraine) to 10 cm above ground maximised both root and shoot biomass, while cutting to 2 cm reduced plant survival. If grown in a frost-prone area, the grasses should be grazed until spring and then have the stock removed, allowing the plants to go to head in early summer (for C₄ grasses). The above-ground growth of grasses is intimately linked with root growth. Allowing the grasses to reach maturity will produce...
the carbohydrates necessary for root development (Trlica 2006), which will improve access to water and nutrients and may ultimately lead to sequestration of CO$_2$ into the soil profile.

As shown by Harradine and Whalley (1981), mowing weekly or monthly severely reduces shoot growth and root development of wallaby grass (*Danthonia linkii*), with most of the roots concentrating in the top 10 cm of soil. Mitchell (2001) found that wallaby grass roots did not reach 100 cm deep. In the vineyard, this would complement vine roots, which in suitable environments will be able to exploit moisture and nutrients from below the cover crop. Mature wallaby grass plants are very tough to cut, so mowing with a sharp-bladed mower is better than with a mulcher, which can readily remove the plants. Mowing at least 10 cm from the ground will protect the crowns of the grass, and throwing the clippings under the vine row will provide a mulch that is slow to break down.

Unless they are growing on very infertile soils, it is unlikely that native grasses will require additional fertiliser. When applied at seeding, nitrogen fertiliser will assist weed growth, so a competitive advantage can be gained for the native grasses by keeping the nutrient status low (Chivers & Raulings 2009). The potential for native grasses to sequester CO$_2$ into soil via the root systems is now being investigated, with early results looking very promising. It is also likely that the inclusion of pasture legumes into an established native grass stand would have productivity benefits but this has not been investigated.

**Saltbush cover crops**

The need for better options for mid-row management extends beyond the medium-to-high-rainfall environments suited to the native grasses. The warm, dry vineyards of Australia’s interior can also benefit substantially from the use of native perennial species as cover crops. The thought of growing saltbush in vineyard mid-rows originally did not appeal to many people, as they associated the term with Old Man Saltbush (*Atriplex nummalaria*), which grows to 3 m tall. There are many species of saltbush within the *Atriplex* genus, of which some are prostrate or short-statured in growth habit (Emms 2008a). *Atriplex semibaccata* (creeping saltbush) and *Atriplex suberecta* (lagoon or Peregrine saltbush) were grown as a mix in trials, and an established sward of *Enchytraea tomentosa* was also investigated. This research (Penfold 2010b) found that while saltbush was highly competitive with the vines in the Barossa and was therefore unsuited to that environment, it worked superbly well in the Riverland and Swan Hill regions. It grew well, outcompeted saltbush (*Tribulis terestris*) and provided habitat for beneficial insects while insulating the soil from harsh summer heat. Yield was unaffected at two of the three vineyards because the vine roots are concentrated under the dripper line and separated from the saltbush roots by the compacted wheel tracks (Figure 4).

John Lazarou (2010), from Mystic Park in Victoria, strongly endorses the benefits of creeping saltbush in their vineyard. While it grows naturally in the area, it was sown as a trial during the drought of 2006–07 and did not germinate until a large spring rain event in 2008. A striking benefit is its capacity to smother saltbush while not having any undesirable impact on the vines. In a trial at Loxton Research Centre in South Australia, the removal of saltbush from the mid-row led to an explosion of saltbush (Figure 5).

Aside from its weed suppression capacity, saltbush was also shown to provide habitat for beneficial insects. Linda Thomson (Centre for Environmental Stress and Adaptation Research, University of Melbourne) investigated the relative abundance of invertebrates associated with conventional and native cover crops in 2008 and 2009. Sentinel cards containing light brown apple moth (LBAM) eggs were placed in the canopy and assessed for predation. As shown in Figure 6 (next page), the level of predation was much greater in the saltbush cover crop treatment, endorsing the plant’s capacity to provide the habitat required for beneficial species.
Saltbush agronomy

Establishment

The three saltbush species investigated in the research program are summer-active, but remain green during the winter period. Lagoon saltbush exhibited very vigorous growth in its first year, and then was overcome by competition from creeping saltbush in the second year. Ruby saltbush has two distinct forms – a woodier type with erect stems to about 40 cm tall, and a prostrate form very similar in habit to creeping saltbush (Hadlow 1986). Individual plants of both prostrate ruby saltbush and creeping saltbush may extend beyond 1.5 m in diameter, forming a thick mat on the soil surface. Both species produce large amounts of seed from February through to April in favourable seasons.

Seeding is usually undertaken during autumn, following a period of weed control (Emms 2008b). Seed is sown complete with the dried outer fruit, but in some cases germination has been enhanced by seed treatment prior to sowing. Christopher Loo (2010, pers. comm.), from Kings Park Botanic Gardens in Perth, suggests that creeping saltbush prefers to germinate in the light, which means planting the seed on the soil surface. Where surface seeding is likely to compromise establishment through moisture shortage, it is recommended that the seed be buried at 5–10 mm. Ruby saltbush, by contrast, prefers to germinate in dark conditions, enabling the seed to be buried at 5–10 mm. The seeding equipment for saltbush does not need to be specialised, as the seed can be sown by a range of planters while still in the bract, provided it has been properly dried. However, it is necessary to have each seeding tynes running independently of the frame, and with a depth wheel attached to ensure optimal seeding depth.

Saltbush management

Broadleaf weed control using herbicides is difficult in saltbush without a sponge wiper (Figure 3). Mowing no closer than 10 cm from the ground can restrict the growth of more erect broadleaf species, while grazing can also be useful, but saltbush is palatable to stock. Grass control is simply achieved with selective herbicides or through mowing and/or grazing.

No additional fertiliser is required when growing saltbush. It has evolved over thousands of years to grow in low-fertility environments, so it is very effective at accessing nitrogen and has low requirements for phosphorus. The saltbush species used in trials at Kingston-on-Murray, Loxton and Mystic Park have an affinity for salt. Sodium levels in the top 10 cm of soil increased under the saltbush compared to the control treatments. The impact of these findings on a vineyard is uncertain. The relocation of salt from deeper in the soil profile to the soil surface enables chenopods (such as saltbush) to survive in saline soils, and is a means of reducing competition from other plants by increasing soil surface salinity and thereby preventing germination or reducing plant growth in their vicinity. As the total salt loading of the soil is not changing, it is unlikely that there will be any adverse impact on the vines due to saltbush in the mid-row, but longer-term monitoring should be undertaken to ensure that this is the case. Changes in the mineral distribution through the soil profile should therefore be of no consequence to the vines, but should instead lead to a stand of greater species purity in the mid-row.

Conclusion

In many viticultural regions, the use of native perennial species for mid-row cover is very appropriate. While high seed costs and unreliable establishment have in the past been deterrents to their use in vineyards, larger seed production areas and increasing knowledge on seed biology are reducing costs. If a native perennial cover crop is viewed as a long-term asset, its establishment cost can be amortised over many years, and once established, maintenance costs are very low. The native perennials also provide ecosystem services such as habitat for beneficial species and weed suppression that are beyond those available from most exotic species, which further strengthens the case for their use as cover crops.

References


Figure 6: Light brown apple moth (LBAM) egg predation was greater with saltbush than with ryegrass as a cover crop at Swan Hill, Victoria, in 2008.


Disclaimer: The Grape and Wine Research and Development Corporation (GWRDC) in publishing this fact sheet is engaged in disseminating information not rendering professional advice or services. The GWRDC expressly disclaims any form of liability to any person in respect of anything done or omitted to be done that is based on the whole or any part of the contents of this fact sheet.