NATIVE GRASSES IN THE VINEYARDS

A résumé of native grass establishment.

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Introduction

Reports by early Australian explorers of the luxuriant grass cover they encountered on their overland expeditions bear testimony to the organic fertility of soils that supported these native grasslands prior to European settlement.

Although many years later, having the means to enhance the mineral fertility of our soils, we are at a loss to explain why our ancient and naturally nutrient-deficient soils could have attained such a high biological fertility.

Having inherited soils that have now lost much of their structure from years of cultivation and compaction, many vignerons are turning back the clock in their search for a biologically based soil fertility that can be adopted in their vineyards.

Soil biology & grasses

Perennial grasses are known to be very efficient photosynthetic producers and about 30% of the carbohydrates produced are exuded from their root systems. This readily digestible form of carbon is food for soil microflora that are the essential bottom rung of the soil's biology.

The cyclic growth and decay of the perennial grass root system provides a regular contribution of organic material deep within the A-horizon that is broken down by micro-organisms in fungi and bacteria to form humus.

Aerial biomass from grass is also subject to decay when it is mown and left lying on the topsoil.

The vertical fibrous root systems of perennial grasses significantly enhance the soil's capacity to infiltrate water. A fungal protein secretion called glomalin is a 'super glue' that is believed responsible for binding soil particles into aggregates to also facilitate drainage along with aeration of the soil. The spongy humus retains moisture, thus enhancing the soil's ability to retain water.

All of the above are benefits that the soil can derive from the presence of perennial grasses. With native grasses able to offer greater durability under moisture stress a number of vignerons have chosen them for the purpose of restoring organic fertility and soil structure to their vine midrows.

Choice of grass species

A midrow perennial native grass sward for vineyards should:

- have low water use
- have a low physical profile
- be sourced from local provenance.

Being readily available from local remnant sources, *Austrodanthonia geniculata* was considered to be a grass that would meet the criteria. It grows to a modest height and being a C_3 cool-season species prone to dry off in early summer it should have minimal demand for water.

A flowering crop of *A. geniculata* cultivated by Bob Myers.

While the above might be true, in practice *A. geniculata* has proven difficult to establish. Like other species within the *Austrodanthonia* genus it often fails when sown into soil that has poor structure and correspondingly poor drainage.

A. tenuior proved to be a more reliable species when sown into adverse soil conditions and for this reason has been the most used grass in vineyard plantings to date.

Midrow planting of *A. tenuior* at the Nuriootpa Research Centre.

Chloris truncata is a C_4 warm-season grass and as such it was anticipated to be a strong competitor for soil moisture. Contrary to expectations *C. truncata* has presented less competition to the vines than the cool-season grasses.

Unmown *Chloris* with a head of seed at Nuriootpa Research Centre.

It is not unduly affected by adverse soil conditions but the seed does need to be continually wet for approximately 80 hours under warm conditions for it to germinate.

Other species such as *Microlaena stipoides* and *Enneapogon nigricans* have been tried.

Chloris truncate is compatible with most vineyard management practices.

While dormant in winter it facilitates the infiltration of water down through the soil profile.

Being relatively tolerant of glyphosate, competing winter weeds can be sprayed out in August to provide exposure of the soil for frost control.

It does not begin to use soil moisture until after budburst.

As an active summer-growing groundcover it competes well with nuisance weeds such as caltrop.

Native grass establishment

The core issue of native grass establishment in vineyards is how to get viable seed to the midrows.

Native grass seed in its unrefined floret form does not have to be incorporated into the soil.

Cutting a standing crop of grass when in seed and spreading the hay over the soil is a simple and effective method of seeding.

Native grass harvesting equipment can be as basic as a brush cutter and pitchfork.

Where economic use of the seed is required along with more precise planting (eg, in rows) it is advantageous to strip the seed in the field. This is commonly achieved with a brush harvester.

A reel-over-brush harvester gathering local provenance *Austrodanthonia* seed on the Henschke property in preparation for seeding their Hill of Grace vineyard.

A rotating brush with a tip speed of approximately 500-600 metres/min. is very effective at removing only the mature florets from the seed head.

Irrespective of what type of brush harvester is used the brush invariably manages to gather some stalks along with the seed. A vibrating sieve with apertures ranging from 1mm for *Microlaena* and *Chloris* to 3mm for fluffy seed like *Austrodanthonia,* can be used to separate floret seed from the stalks.

Harvested seed and stalks about to be separated with a vibrating 2x1-metre 3mm mesh sieve.

Discomfort from cleaning dry dusty seed can be avoided by processing the seed immediately after harvest.

Once this is done the seed should be spread out over a wooden floor to enable it to dry before being packaged for storage.

Cleaned *Austrodanthonia* seed being dried on a wooden floor.

When planning the seed harvesting operation some thought should also be given to preparing the site that is to be sown. Good control of weeds is paramount to achieving successful establishment of native grasses.

Where convenient, a chemical fallow commenced in early spring provides opportunity for eliminating the weeds and reducing the soil seed bank before sowing the next year in early winter. To avoid bringing weed seeds to the soil surface it is best not to cultivate the soil in preparation for seeding.

The floret seed that has been harvested, cleaned and dried is not going to perform very well in a conventional seed drill.

This negative grayscale image of an *Austrodanthonia* floret seed with its hairs and awns shows why it is unlikely to flow through a conventional seed drill.

The erect hairs and awns will intermesh and cause the seed to bridge in the hopper thus restricting flow.

One way around this problem is to have the seed coated. When the hairs and awns are encased in a seed coating the seed will flow freely in any conventional seed drill.

A second option is to build a seeding machine where the seed is suspended in water. In this case the water causes the hairs to lie flush with the outside shell.

A polymer is used to thicken the water to enable it to carry the seed when metered out through a suitable pump. This method affords very accurate calibration of seeding rates.

A hydro air seeder being used to sow native grass floret seed into a chemically fallowed paddock.

Drilling native grass seed into wide-spaced rows (eg, 45cm) provides further opportunity for weed control.

Cool-season C_3 grasses like *Austrodanthonia* have very low tolerance of the broad-spectrum herbicides needed to control grassy weeds. However, when the native grass is sown in rows, shielded spraying equipment can be used to spray weeds in the midrow without affecting the native plants.

Spray shields incorporated in the design of the hydro air seeder have enabled it to return and spray out grassy weeds from a recently drilled crop of *Austrodanthonia.*

The sustainability of a native grass is dependent upon its root system. If this is well developed it will withstand stresses imposed by continual mowing, weed competition and drought. A new system of mowing has been designed to cultivate a deep root system in young plants.

Small-diameter rotating flail mowers cut the midrow weeds very short and thereby weaken their root system. Conversely, a second bank of mowers prune the native grasses to a height of 30cm.

Now equipped with foliage well in excess of any adjacent weeds the native grasses are able to develop a substantial root system that provides advantageous vigour.

A prototype sculpture mower in action at the Nuriootpa Research Centre.

Native grass maintenance

The art of managing native grasses is best acquired by learning to appreciate the differences between Australian native grasses and many competing species that have their origin in Europe.

European C_3 grasses are very adept at utilising nitrates and phosphates. When these nutrients abound they are able to draw on soil moisture reserves built up from winter rains and make rapid growth under cool conditions.

Native grasses do not produce the same response to soil nutrients. If they are competing with European species in enriched soil, they will be quickly smothered by the plants that thrive on higher levels of soil nutrients.

Any application of fertiliser to the vines ought to be applied under-vine rather than to the midrow.

An early-winter application of nitrogen and phosphate to *Chloris* growing under the vines has resulted in marshmallow dominating the *Chloris* and eventually smothering it.

If fertiliser needs to be applied to the native grass it is best applied at vine bud burst when the native grasses begin to use soil moisture.

Chloris truncata can persist under low nutrient levels. It is vulnerable to weed invasion in the winter when this C_4 grass is relatively dormant.

Good management of *Chloris* requires that soil nutrients be kept at a low level to minimise competition from winter weeds. If weed control is required, up to 2 litres/ha of glyphosate can be applied early in winter to prevent any smothering of the grass.

Trials with organic herbicides such as BioWeed Control have shown that the soft tissued broadleaf weeds can be controlled with very little impact on the native grasses.

Regular close mowing of erect native grasses like *Austrodanthonia* has been shown to extend soil moisture reserves by up to six weeks. However this is achieved by stunting the root system and thereby making the native grass more vulnerable to moisture stress.

Shorter or more prostrate grasses (eg, *Chloris truncata* or *Microlaena*) are better able to sustain regular mowing.

Native grass ecology

One might assume that Australian native grasses interact with their environment in much the same manner as European species do. But this is not necessarily so.

Under a European-chemo-farming system where mineral nutrients are added to the soil to stimulate the growth of introduced C_3 grass species, the biomass of the grasses and any associated weeds will generally have a low carbon to nitrogen ratio. This ensures that the plant residues are readily broken down to form humus, a vital component of a fertile soil.

Conversely, the native C_4 grasses that once abounded in the naturally low-nutrient Australian soils would have had a significantly higher carbon/nitrogen ratio. This would severely restrict the decay of foliage from a plant like *Themeda triandra.* Add to this the fact that groundcover on the Australian landscape was periodically burned, and one is left to ponder just how any humus was formed within the soil.

Soil organic matter exists in four basic forms:

- organic matter dissolved in water

- very small particles of partly decomposed plant and animal debris

- humus, the product of decayed material

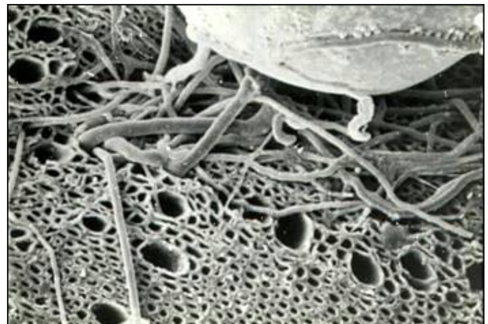
- inert matter, ie, charcoal.

Current Australian farming systems put virtually no charcoal into the soil resulting in a very low charcoal/humus ratio. However it is logical to assume that prior to European settlement the ratio of charcoal to humus in our soils was much higher.

Was charcoal the core organic component of the soil environment that supported native grasses and did these fire-adapted plants maintain its level in the soil?

A C_4 native grass in *Themeda triandra* being consumed by a cool fire. Accumulated dry foliage supports a fire that converts much of the new-season green leaf into charcoal.

Although charcoal is regarded as an inert and therefore very durable substance, it does play a significant role in the ecology of soil microbes. Whereas humus is basically food for microbes, porous charcoal is their home. Not that there is no food in the house. Charcoal produced under low temperatures from native grass high in lignin contains a range of hydrocarbons readily consumed by microbes.



Bacteria are too small to see but fungal hyphae are readily observed in this microscopic view of porous charcoal.

Charcoal also offsets the effect of soil sodicity by raising the cation exchange capacity (CEC).

Australian soils are said to be very old with 30% of our land subject to sodicity. When organic carbon in the form of humus is depleted under reduced soil fertility, the symptoms of a sodic soil soon become evident.

Native rushes growing in this hilltop paddock are a readily observed symptom of soil sodicity. The low CEC resulting from reduced soil fertility (minimal humus) has contributed to declining soil structure and drainage.

organic carbon in charcoal is abundant, the CEC of the soil and associated soil structure is more likely to be maintained under low-nutrient conditions.

The two funnels in this demonstration contain equal portions of a sample of sodic soil. Native grass (lignin) charcoal has been added to the funnel on the right. Equal quantities of water were simultaneously added to each funnel. The higher volume of water in the jar on the right indicates the increased water percolation rate achieved with the charcoal.

In adopting native grasses as vineyard groundcover, some thought could also be given as to how they might be used to re-establish their original soil environment. For instance, instead of merely mowing their foliage could it be charred?

An open grass fire does not normally produce much charcoal as most of the carbon is oxidised to form CO_2. However, if oxygen can be partly excluded from the combustion process (pyrolysis) carbon that is not oxidised will form charcoal.

An experimental mobile pyrolytic converter being used in the field to convert grass biomass into charcoal.

Summary

With a need to address the issues of poor soil structure and poor water infiltration in many vineyards, native grasses and their associated ecology offer a natural solution to these problems. The method and means of delivering this complete solution is still a work in progress.

As more vineyard managers follow the lead of C A Henschke & Co in exploring the use of native grasses to enhance the natural organic fertility of their soils, the original role of native grasses in our landscape could soon be restored.

Henschke vineyard

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