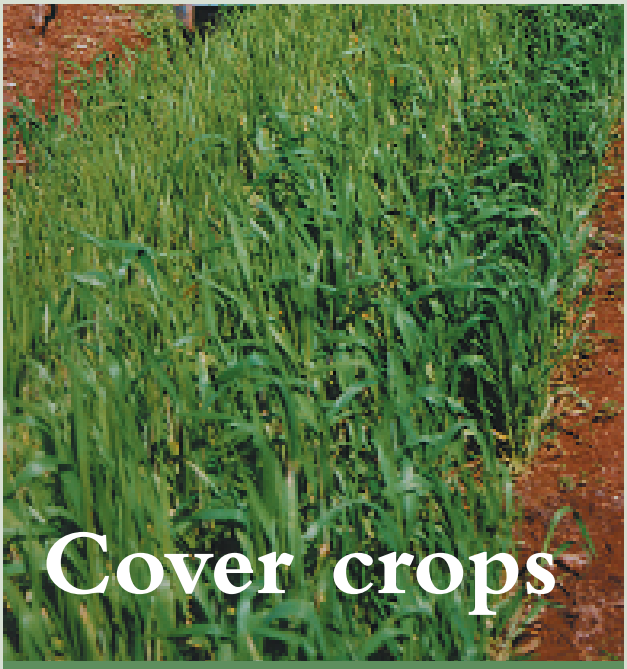

Cover crops

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Introduction

In Australia, cover crops have traditionally been planted in vineyards in autumn and cultivated into the soil about the time of vine budburst, to reduce the risk of frost damage and competition for soil water and nutrients. More recently there has been a trend away from cultivation towards mowing the cover crop prior to budburst and suppressing further growth by mowing or applying one or more herbicide sprays. There has also been greater use of annual regenerating cover crops and in some situations, perennial swards are grown.

Cover crops provide many benefits including:

Soil improvement

- Reduced surface crusting.
- Improved soil structure both from the break up of existing hardpans by roots and reduced compaction from traffic.
- Increased organic matter.
- Higher levels of soil micro-organisms and earthworms.
- Addition of nitrogen where legumes are used.
- Increased levels of soil nutrients when organic matter decays.
- Increased water infiltration and drainage.
- Reduced erosion, particularly on sloping land.
- Better access to the vineyard following rain or irrigation.

Improved vineyard environment

- Increased humidity and cooler soil surface temperatures where the cover crop is growing.
- Lower soil temperatures and evaporation losses, where a thick dead mulch is left on the surface in summer (Figure 3-1).
- Reduced sunburn damage to grapes in some situations.
- Wind protection in young vineyards.

Weed and pest control

- Suppression of weeds both while the cover crop is growing and during summer if it is left as a surface mulch.
- Provision of a more favourable environment for the build-up of beneficial predators of insect pests of vines by creating a better microclimate, shelter, food and reduced dust.

Vineyard cover crop terminology

Cover crop refers to any plant population which has been established in the inter-row area of vines (irrespective of species and management).

Sward (alternatively sod) refers to ground cover, whether grass, legume or other plant species. Swards can be annual or perennial, volunteer or sown species.

Biomass is the total sward availability at any given time measured in kg/ha. It is described as either fresh weight (for un-dried green matter, weighed at time of sampling), or dry weight (oven dried weight of the same sample).

Green manure refers to an annual cover crop, re-sown each autumn and grown for maximum spring biomass production. This bulk matter can be mown, and/or incorporated at an appropriate time, usually prior to budburst in late winter or early spring.

Annual regenerating sward consists of plant species which set seed in spring prior to senescence and regenerate from this seed in the following autumn. Examples include annual medics and subclovers.

Perennial sward consists of perennial species such as perennial ryegrass, fescues, cocksfoot, lucerne, white clover and strawberry clover. Swards of these species persist over summer and can provide year round green growth.

Beneficial insect swards used to provide a continuous bloom over spring and summer and a haven for a range of insect species. They may provide a source of nourishment for beneficial species, such as ladybirds, lacewings and parasitic wasps.

Seeding rate refers to the weight of seed distributed over a sown hectare. Within a vineyard, the area sown to a cover crop is approximately half the total vineyard area. Hence 15 kg of seed would be required to sow a cover crop in 1 ha of vineyard at an effective seeding rate of 30 kg/ha.

Figure 3-1. Thick mulch left on the soil surface in summer reduces soil temperatures and evaporative losses.

Choosing a cover crop

Factors to consider

Cover crops vary widely in their characteristics (Table 3-1) and a range of factors must be considered when choosing a cover crop.

Site factors

These include:

- **Climate**—particularly the total and annual distribution of rain over the season.
- **Topography**—e.g. the need to control erosion on a sloping site.
- **Soil characteristics**—e.g. depth, texture, pH, salinity, or waterlogging.
- **Irrigation system**—e.g. there are specific requirements for drip irrigation (establishment under potentially dry conditions) and furrow irrigation (small seeds can be washed away).

Choice of cover crop may vary within a vineyard, e.g. for different topography or soil types.

Vineyard management

Impact on the management program:

- Benefits/cost analysis.
- Availability of tillage, seeding and mowing equipment.
- Cover crop competition for water and nutrients (particularly for those that grow in spring and summer) and possible need for increased irrigation and fertiliser.
- Requirement for use of insecticides to control pasture pests, e.g. red-legged earth mite.

Cover cropping strategies

Suitability for the chosen cover cropping strategy:

- The required cover cropping system, e.g. annual (re-sown or regenerating) or perennial.
- Biodiversity, e.g. some mixtures may produce significantly more biomass than monocultures.
- Rotations to overcome a possible decline in cover crop productivity from a build up of pests and diseases due to the use of only one cover crop.

Desired characteristics

Consider cover crop characteristics such as:

- Time of maturity (seed set) and senescence (when it hays off). Timing may be important in relation to budburst and frost control—particularly in frost prone areas.
- Biomass production and sward height. A high sward may be required to mow and throw under the vine or a low sward for minimal mowing prior to budburst.
- Persistence of the mulch into the following autumn.
- Use of a legume to supply soil nitrogen.
- Ability to suppress weeds.
- Possible requirement to suppress vine vigour.
- Resistance of the cover crop to pests and diseases.

Undesirable characteristics

Characteristics that may make species undesirable include:

- They negatively impact on vine productivity by competing for water and nutrients.
- Growth onto the vinebank, e.g. by running (medic) or lodging (vetch or field pea) and interference with water distribution from under-canopy sprinklers and microjets.
- They are hosts for lightbrown apple moth (LBAM), where this has been a problem in the past, e.g. medics and subclovers and the volunteer weeds dock, capeweed and ribwort are hosts (but oats, faba bean, field peas, lupins, fodder radish and mustard are less preferred by LBAM).
- They are hosts for garden weevil, e.g. some volunteer weeds.
- They may allow build up of undesirable weed species in the vineyard such as spiny emex, spiny burrgrass, caltrop, skeleton weed or soursob.
- They encourage a build up of the snail population.
- They are a host for vine damaging nematodes, e.g. some legumes.

Table 3-1. Characteristics of cover crops

	Annual rainfall (mm)	Sowing time	Sowing depth (cm)	Seeding rate[1] (kg/sown ha)	Inoculation strain	Relative growth[2] A	W	Sp	Su	Biomass production
Green manure										
Oats	250	March–April	3–5	60–100	–	2	2	4	0	High
Barley	250	March–April	4–7	60–100	–	2	2	4	0	High
Cereal rye	250	March–April	5–6	60–100	–	2	2	4	0	High
Triticale	250	March–April	3–5	100–200	–	2	2	4	0	High
Faba bean	400	Late March–April	3–4	100–200	E	2	3	3.5	0	High
Field peas	400	Late March–April	3–5	100–150	E	2	2	3	0	Moderate
Vetches	250	Late March–April	2.5–5	25–35	E	1	1.5	4	0	Moderate
Lupins	300	Late March–April	2–4	80–100	G	2	3	3	0	Moderate
Berseem clover	600	Late March–April	1–2	15–25	B	2	2	3.5	0	Moderate
Persian clover	550	Late March–April	1	2–5	O	1	2	4	2	Moderate
Italian ryegrass	550	Late March–April	1–2	15–25	–	2	3	3.5	0	Moderate
Forage blends[3]	300	Late March–April	–	–	–	2	3	5	0	Very high
Fodder radish	400	Late March–May	2–3	15–20	–	2	2.5	5	0	High
Oilseed mustard	300	Late March–April	1–3	6–12	–	2	2	4	0	High
Rape	350	Late March	1–3	4–8	–	1.5	1.5	2	2	Moderate
Annual regenerating swards										
Medics	250	Late March–April	1–2	15–25	AM	1	1	2.5	0.5	Moderate
Subclovers	450	Late March–April	1–2	15–20	C	1	1	2	0	Low
Crimson clover	500	Late March–April	0.5–1.5	18–22	C	1	2	3	0.5	Moderate
Annual rye grass	450	Late March–April	1–2	20–25	–	2	2.5	3.5	0	Moderate
Perennial swards										
Perennial rye	500	April–May	1–2	20–30	–	1.5	2	3	1–2	Moderate
Tall fescue	500	April–May	0.5–1.5	20–30	–	1.5	1	2.5	3.5	Moderate
Cocksfoot	450	April–May	1–2	10–15	–	1	1	2.5	3	Moderate
Strawberry clover	500	Autumn or Spring	<1	1–4	B	1	1	2	3	Low
White clover	700	Autumn or Spring	<1	2–5	B	1.5	2	2.5	2.5	Moderate
Lucerne	250	Autumn or Spring	1–2	3–6	AL	1.5	1	3	3	Moderate

Key to table

1. These are suggested rates and may be higher than broadacre rates. They are for use with a seed drill, when broadcasting they may need to be higher. The rates are a guide only and may need to be varied for different locations
2. A=Autumn, W=Winter, Sp=Spring, Su=Summer, 1=Low, 5=High
3. Forage blends consist of cereals and legumes

Green manure

Traditionally, green manure cover crops have been planted in autumn and incorporated using a rotary hoe or disc harrows in spring, just before budburst and the frost risk period. Although this results in an initial build up of organic matter, it is mostly lost again with subsequent cultivation which may be needed to control weeds.

An alternative method is to mow the cover crop prior to budburst in frost risk areas, or leave it till later if frost risk is low and there is adequate soil water. Clippings may be left in the inter-row or mown and thrown as a mulch beneath the vines (Figure 3-2). The most persistent mulch will be provided when stem material has lignified prior to mowing, although a compromise may be necessary in frost situations. Placement of clippings onto the vine bank with a side-throw mower is most efficient where the inter-row is flat and the bank is weed free.

Any regrowth of the cover crop can be burnt off with a CDA herbicide sprayer (Section 4.4.2) to minimise moisture and nutrient competition with the vines.

Green manure cover crops are usually comprised of cereals or legumes or blends of these. There has also been some recent interest in the use of brassicas.

Cereals

Cereals are easy to grow and manage and can often be established where other crops have failed. Their main growth occurs over the winter months.

- Cereal seed is readily available and cheap.
- They grow faster and yield more dry matter than most legumes.
- They have fibrous root systems that make them particularly useful in building soil structure, and providing erosion control (Figure 3-3).
- Incorporation of mature cereals is generally more beneficial to soil permeability than most legumes.
- Cereals take up nitrogen and stop it from being leached through the soil—especially at sandy sites.
- Cereal straw breaks down more slowly than legumes, particularly if it is allowed to mature. The straw has a low nitrogen content (1–2% dry weight) and after incorporation, micro-organisms draw on soil nitrogen until the straw is broken down. This may result in temporary competition with vines for soil nitrogen (Section 2.7.1).

Figure 3-2. Front mounted side throw mower throws mulch onto the vine bank.

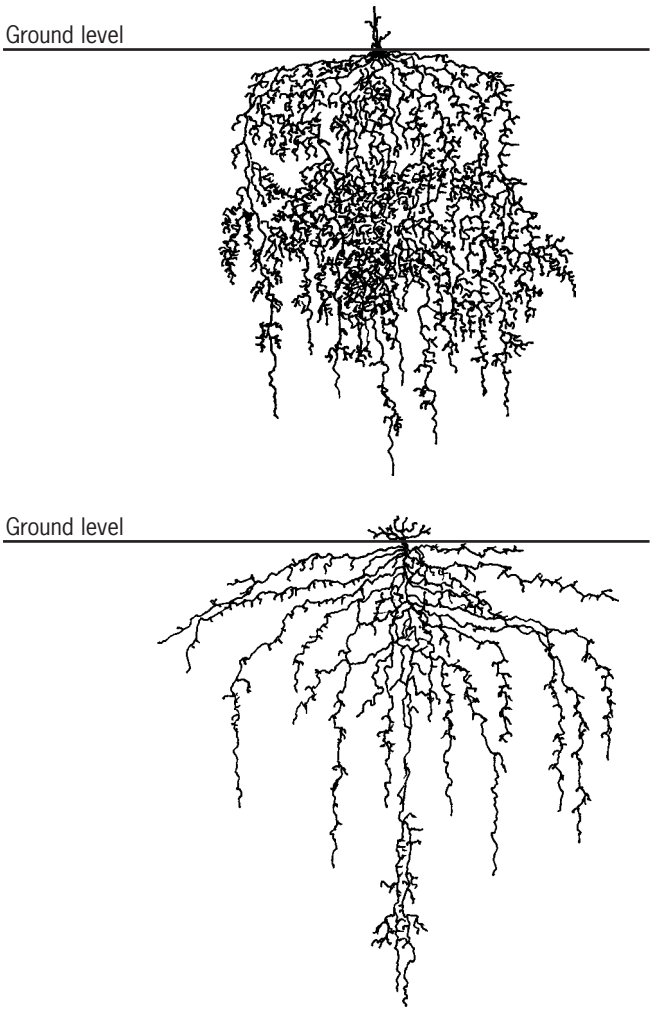

Figure 3-3. Root system of wild oat with rooting depth 90 cm (top) and common vetch with rooting depth 80 cm (bottom), from Bugg and van Horn (1998).

Oats

Oats, *Avena sativa*, have slow early growth when compared with other cereals, but make tall upright growth in late winter.

- **Soil types**—adapted to a wide range of soils, from sands to clays with pH_{Ca} 4.5–8.5.
- **Uses**—green manure, mowing and mow and throw. Oats are more suitable than barley as a companion crop with legumes.
- **Cultural practices**—oats must be sown in early autumn to achieve the best stands. They are normally mown prior to budburst where frost risk is high. Regrowth can be re-mown or sprayed out with a CDA sprayer.
- **Varieties used**—include Swan, Bulban, Cooba and Coolibah. These have grazing tolerance and so are suitable for mowing. Coolibah has shown resistance to the build up of rootknot nematodes.

Barley

Barley, *Hordeum vulgare*, establishes quickly, but does not grow as tall as cereal rye or oats. It tillers to a greater extent, resulting in heavier growth (and greater biomass if planted late) than other cereals.

- **Soil types**—does not grow well where soil pH_{Ca} is less than 5.5. It has less tolerance to waterlogging than oats, but is more salt tolerant and can be used in reclamation of moderately saline soils.
- **Uses**—green manure, mowing and mow and throw. Barley can be used to produce a dense cover crop that is very competitive with weeds and can be used to prevent erosion.
- **Cultural practices**—normally mown before budburst.
- **Varieties used**—include Cape Barley, Beecher and Yagan.

Figure 3-4. Cereal rye cover crop growing in the Murray Valley region.

Cereal rye

Cereal rye, *Secale cerale*, produces tall upright growth (Figure 3-4). As it evolved in cool regions, it produces quick early growth especially in cold situations.

- **Soil types**—cereal rye will tolerate soils of pH_{Ca} 4.5–8.0. It grows well in dry situations and is suited to marginal, infertile and sandy soils, where it may produce better growth than other cereals. It has less tolerance to waterlogging than oats.
- **Uses**—green manure, mowing and mow and throw. Its extensive fibrous root system makes it good for improving soil structure—better than oats. The straw is slower to breakdown than many other cereals and this assists mulch retention in summer. In areas of low frost risk, cereal rye can be left to hay off naturally and form a straw windbreak to reduce wind and sand blast on young vines.
- **Cultural practices**—normally mown before budburst.
- **Varieties used**—SA Commercial, Ryesun and Bevy.

Triticale

Triticale has been developed from crosses between wheat and cereal rye.

- **Soil types**—like cereal rye, it has a more aggressive root system than barley or oats. It is better adapted to marginal soils with pH_{Ca} 4.5–8.0, including acid soils with high aluminium, and soils with low fertility, high boron or waterlogging.
- **Uses**—green manure and mowing. It has an even more persistent straw residue than cereal rye and if a high seeding rate is used (200 kg/ha), it can provide a good annual supply of straw suitable for mow and throw. Triticale is useful in problem soils or where a better competitor with weeds than barley or oats is required.
- **Cultural practices**—normally mown before budburst.
- **Varieties used**—include Currency, Tahara, Abacus and Madonna, which is suited to higher rainfall districts.

Legumes

Legumes can fix atmospheric nitrogen in root nodules in association with rhizobia bacteria.

- A legume cover crop can add 100 kg of nitrogen per hectare of cover crop to the soil. However, if supply of nitrogen is the only consideration, it may be cheaper to apply nitrogen as fertiliser. Nitrogen fertiliser will be available sooner, but this may or may not be desirable in particular situations.

- Legume plants have a high nitrogen content (2–5% dry weight) and generally break down readily after incorporation providing a relatively rapid boost to the soil nitrogen level. However, legume cover crops are now often not incorporated and there will be less of the nitrogen produced ultimately available to the vine.
- The contribution of nitrogen by legumes decreases when soil nitrogen is built up by applying fertiliser. Thus nitrogen fertiliser is generally withheld during growth of a legume cover crop, although a small application may be beneficial to begin with, as it takes at least two weeks for nitrogen fixation to start.
- Legume root systems are typically dominated by a single taproot or strong vertical roots.
- In vineyards where vine roots do not extend far into the inter-row, legume nitrogen may be largely unavailable to the vine.
- Legumes tend to be harder to establish than cereals as they are more prone to insect and disease attack and are more sensitive to moisture stress.

Faba bean

Faba bean, *Vicia faba*, is a winter growing annual legume, which grows to 1 m or more in height, with stemmy growth (Figure 3-5). It has a thick tap root extending to 50 cm or more and produces a dense root system.

- **Soil types**—faba bean is better suited to loams and clays, than light textured soils where moisture stress may occur if not irrigated. It can grow in soils pH_{Ca} 5.0–9.0. Nodulation may be impaired if seed is not inoculated in acid soils and it is sensitive to aluminium and manganese toxicity in these soils. Faba bean can withstand moderate waterlogging.
- **Uses**—green manure. It is easily established, makes rapid growth and quickly shades out inter-row weeds. Its tap roots may be used to open up heavy soils. After incorporation, faba bean residue persists longer than many other legumes. It is one of the most popular legumes in the Murray Valley region.
- **Cultural practices**—not suitable for mowing.
- **Varieties used**—there are various types of faba beans, e.g. tick beans and broad beans. Tick beans are most commonly used in vineyards, particularly the early maturing variety Fiord and Ascot, a selection of Fiord.

Figure 3-5. Faba bean cover crop.

Field peas

Field peas, *Pisum sativum*, are winter growing annual legumes, which climb to 1 m in height.

- **Soil types**—loams to clay loams; they can tolerate soils of pH_{Ca} 4.5–8.5, but nodulation may be impaired if seed is not inoculated in acid soils. Field peas have a shallow root system making them susceptible to erosion and moisture stress when they are grown in sandy soils. They are susceptible to salinity and also to root rot in water logged sites.
- **Uses**—green manure. They can be planted alone or mixed with oats (or less commonly rye) to allow the peas to climb.
- **Cultural practices**—not suitable for mowing.
- **Varieties used**—include Dundale (an early maturing selection of Early Dun), Alma and the powdery mildew resistant Glenroy.

Vetches

Common vetch, *Vicia sativa*, purple vetch, *Vicia benghalensis* and woollypod vetch, *Vicia dasycarpa*, are available commercially. Vetches are highly productive, winter and spring growing annual legumes, which can reach 60 cm in height (or 150 cm if allowed to climb using their tendrils). They may have tap roots, but most roots are usually in the top 40 cm of soil (Figure 3-3).

- **Soil types**—adapted to a wide range of soils from sands to clays and pH_{Ca} 4.5–8.5.
- **Uses**—green manure and mowing. They establish easily, have a high nitrogen fixing ability and a growth habit that smothers most weeds.
- **Cultural practices**—can be mown to 10–15 cm or if they are grown without mowing, their height can be controlled by running a roller or similar object over the stand. Vetches can be mixed with oats or cereal rye to allow them to climb. This will help overcome the problem of the vetch climbing up vines causing problems in the vineyard. They are best incorporated prior to pod formation in spring.
- **Varieties used**—common vetch varieties are preferred for use in vineyards, because of their soft seeded nature. Varieties include Languedoc (which is suited to

250–450 mm rainfall and is winter productive and early maturing, making it preferable for early incorporation in a frost situation) and Blanchefleur (suited to over 400 mm and is winter–spring productive and mid maturing). Woollypod vetch varieties, e.g. Namoi are less suited for use in vineyards due to their hard seeded nature, i.e. if they are allowed to set seed, they may germinate in future years when they are no longer needed.

Figure 3-6. Bigbee berseem clover regrowth six weeks after second mowing.

Figure 3-7. Italian ryegrass, Persian clover and berseem clover mixture used for multiple mow and throw operations to build up mulch on the vine bank.

Lupins

Lupins, *Lupinus* spp., are winter growing annual legumes, which grow to 1 m in height.

- **Soil types**—adapted to sands and loams with pH_{Ca} 4.0–7.5. They will not tolerate free lime greater than 4%. Lupins are susceptible to waterlogging and grow poorly in hard-setting or shallow soils.
- **Uses**—green manure. Lupins have a deeper tap root and larger root system than faba beans, so are useful for opening up compacted soils.
- **Cultural practices**—require a very specific G strain rhizobium bacteria to form active root nodules.
- **Varieties used**—early flowering, narrow leaf varieties (*L. angustifolius*) are preferred, e.g. Danja, Gungurra or Merrit.

Berseem clover

Berseem clover, *Trifolium alexandrinum*, is a winter annual legume which grows vigorously to 30–90 cm and requires annual sowing. It has a taproot system which extends to 60 cm.

- **Soil types**—adapted to soils of pH_{Ca} 5.0–8.0. Prefers loams to sands and has tolerance to salinity and moderate waterlogging.
- **Uses**—green manure, mowing and mow and throw.
- **Cultural practices**—multicut varieties resprout vigorously following mowing, so can be mown each time they reach 40 cm. At least 2 mowings are possible in the growing season (Figure 3-6). Berseem clover can be grown in combination with oats, cereal rye or Italian ryegrass.
- **Varieties used**—include Multicut, Bigbee and Elite II.

Persian clover

Persian clover, *Trifolium resupinatum*, is a winter and spring growing annual legume, which grows to a height of 50 cm and requires annual sowing.

- **Soil types**—adapted to a moderately acid to alkaline soils. It has very good waterlogging tolerance and moderate tolerance to salinity.
- **Uses**—green manure, mowing and mow and throw. It can be grown in mixtures with Italian ryegrass for mow and throw and with medics.
- **Cultural practices**—mowing can continue into spring if irrigated or the soil moisture is adequate.
- **Varieties used**—Maral and Kyambro.

Blends

Sward biodiversity allows greater adaptability to the site and usually produces a more consistent and greater biomass. The species chosen should have complementary growth habits. Cereal/legume mixes are used extensively in Australian vineyards, e.g. oats/vetch, oats/field pea and oats/medic.

Italian ryegrass

Italian ryegrass, *Lolium multiflorum*, is a winter annual which grows to 90–120 cm in height. It withstands intensive mowing and may compete excessively with vines unless it is mown.

- **Soil types**—adapted to fertile soils with pH_{Ca} 5.0–8.0. It tolerates heavy waterlogged soils, is drought tolerant and moderately salt tolerant.
- **Uses**—green manure, mowing and mow and throw. Can be used in mixtures with Persian and berseem clovers (Figure 3-7).
- **Cultural practices**—Italian ryegrass can be mown to 5 cm.
- **Varieties used**—include the tetraploid Tetila.

Brassicas

Some brassicas contain volatile substances (glucosinolates) which when released into the soil following incorporation for green manure, are toxic to nematodes and some soil fungal pathogens, i.e. they have biofumigant properties. Glucosilonates are found in the roots of fodder radish and the stems of fodder rape and oil seed mustard. The concentration of glucosinolates in stems may diminish as the plant matures, making time of incorporation important. Brassicas should be sprayed with herbicide or incorporated to prevent seed set (and hence regeneration) before they reach 5% flowering.

The economic benefit of using inter-row brassicas for nematode control is not likely to be high—particularly in a drip irrigation situation, where vine roots are mostly close to the vines.

Fodder radish

Fodder radish, *Raphinus sativus*, has good early vigour making establishment easy, and grows to a height of 150 cm. Its roots are resistant to the build up of most nematodes.

- **Soil types**—loams to clay loams. It does not tolerate waterlogged soil.
- **Uses**—green manure, normally in rotation with cereals and/or legumes. It is an good competitor with weeds, including many that are a problem, e.g. soursob. Its very large taproot is good for breaking up hardpans. Where lower seeding rates are used to enable larger taproots to develop, there will be less suppression of weeds.
- **Cultural practices**—can be mown to a height of 30 cm to delay maturity and increase biomass production. Nitrogen requirement is high and an application of nitrogen fertiliser in early winter may be needed for high productivity.
- **Varieties used**—include Weedcheck.

Oil seed mustard

Oil seed mustard, *Brassica juncea*, (Figure 3-8) grows to a height of 150 cm and is generally early maturing. When incorporated, it is not as good at improving soil structure as cereals.

- **Soil types**—sandy loams to loams.
- **Uses**—green manure, in rotation with cereals and/or legumes.

Figure 3-8. Oil seed mustard cover crop.

- **Cultural practices**—irrigation greatly assists early autumn establishment and it requires good winter rainfall for satisfactory biomass production. Nitrogen requirements are similar to fodder radish. It is normally incorporated prior to budburst.
- **Varieties used**—include Nemfix.

Rape

Rape, *Brassica napus*, grows to a height of 120 cm.

- **Soil types**—loams to clay loams, with pH_{Ca} of 4.5–8.5. It has a low to moderate tolerance of waterlogging.
- **Uses**—green manure.
- **Cultural practices**—responds well to irrigation for early establishment in autumn. It has a high requirement for nitrogen and phosphorus and is sensitive to red-legged earth mite attack. It is late maturing and is normally mowed or incorporated in spring.
- **Variety used**—Rangi.

Annual regenerating swards

Self-seeding annuals are planted in early autumn, grown and usually mown in winter (and mown in spring where necessary to reduce frost risk) and allowed to mature and set seed (this may require irrigation). This seed is available to grow in the following autumn to produce another stand, thereby saving the seed cost. Any regrowth can be suppressed by mowing or applying low rates of one or more sprays of a post-emergence herbicide, e.g. glyphosate using a CDA herbicide sprayer.

This system overcomes the detrimental effect of cultivation on soil structure and biological conditions. During summer the resulting surface mulch also lowers soil temperature and reduces evaporation loss from the soil. Low growing legumes and grasses are usually preferred.

Figure 3-9. Annual medic (Mogul) cover crop mown prior to budburst.

Figure 3-10. Crimson clover.

Medics

Annual medics, *Medicago* spp, are winter growing legumes with dense growth to a height of about 25 cm. They are suited to lower rainfall areas. Their taproot system makes them more drought tolerant than subclovers.

- **Soil types**—suited to sandy to clay soils. Most varieties prefer neutral to alkaline soils (pH_{Ca} greater than 6.5). They have low tolerance to waterlogging.
- **Uses**—ideal for use as annual regenerating swards as they produce a high percentage of hard seeds, which take from 1–5 years to soften and then germinate. Medics can also be incorporated as green manure.
- **Cultural practices**—can be mown once to 10–15 cm (Figure 3-9) to improve competitiveness with weeds and stimulate flowering and seed production. They may require a post-emergence herbicide spray to stop growth onto the vine bank. The sward should not be sprayed until seed pods are dry if regeneration is required.
- **Varieties used**—these include Paraggio barrel medic, Sava snail medic and Santiago burr medic. Paraggio medic is presently considered the superior variety in warm irrigated areas. It produces sufficient soft seeds to allow good regeneration in the second year and regeneration persists for up to 4 years. Paraggio is tolerant to blue-green aphid and spotted alfalfa aphid. Mogul is a possible replacement for Paraggio. It can produce more dry matter and has stronger seedling vigour.

Clovers

Subclovers

Subterranean clovers (or subclovers), *Trifolium subterraneum*, are winter–spring annuals with a prostrate growth habit (15–20 cm high) and a fibrous root system. Subclovers have the ability to set seed and bury the seed-head in the ground. They produce hard seeds which assist annual regeneration.

- **Soil types**—they prefer sandy loam to clay soils. Varieties vary, but most prefer acid to neutral soils.
- **Uses**—annual regenerating swards, very tolerant to mowing.
- **Cultural practices**—subclovers are poor competitors with many other plants. Weeds or mixed swards can be mown to 5–10 cm during establishment to help the subclover compete.
- **Varieties used**—many are available with a wide range of characteristics, so the most suitable should be selected for particular site requirements. Suitable varieties include: for 350 mm rainfall, Daliak; 450 mm rainfall, Junee, York, Clare (atypical in that it is suited to neutral to alkaline soils) and Gosse (suitable for intermittently waterlogged areas); 500 mm rainfall, Nuba (similar to Clare); and 650 mm rainfall, Denmark.

Crimson clover

Crimson clover, *Trifolium incarnatum*, is a winter–spring annual legume with early vigour which enables easy establishment (Figure 3-10). It is self regenerating, although hard seed content is relatively low. It reaches 25–60 cm in height, has a taproot system and is susceptible to blue green aphid and spotted alfalfa aphid.

- **Soil types**—adapted to sandy to loam soils of pH_{Ca} of 5.5–7.5. Does not tolerate poorly drained soil, particularly if it is calcareous.
- **Uses**—suitable for annual regenerating swards. It can be planted in mixtures with cereals, vetches and annual ryegrass.
- **Cultural practices**—can be mowed to about 10 cm, but as flower heads are produced above the foliage, 3–4 weeks regrowth should be allowed before maturity. Re-seeding will only occur where high moisture conditions allow the seeds to mature. It has striking red flowers which make it aesthetically appealing in the vineyard.
- **Varieties used**—Dixie, Contea and Caprera.

Annual ryegrass

Annual ryegrass, *Lolium rigidum*, is a winter–spring growing annual, which is similar to Italian ryegrass. It is very competitive and fast growing with upright growth to a height of 70–90 cm and has an extensive fibrous root system. Annual ryegrass may compete excessively with vines unless it is intensively mown. It produces copious amounts of windborne pollen, which can be a severe allergen to hayfever sufferers.

- **Soil types**—adapted to most soils with pH_{Ca} 5.0–8.0. It tolerates heavy, waterlogged soils, is drought tolerant, moderately salt tolerant and, in contrast to Italian ryegrass, it grows well in low fertility soils.
- **Uses**—annual regenerating sward or green manure incorporated prior to flowering. It is good for opening up heavy, compacted soils to improve soil structure, aeration and infiltration. It can also be used for quick soil protection in high erosion potential sites. Annual ryegrass can be used in mixtures with autumn seeded annual regenerating legumes, e.g. subclover or crimson clover. Herbicide resistance may cause under-vine escape problems.
- **Cultural practices**—annual ryegrass can be mown to 5 cm, allowing 3–4 weeks without mowing prior to maturity to set seed.
- **Varieties used**—Wimmera and Guard (a selection of Wimmera).

Figure 3-11. Perennial ryegrass.

Figure 3-12. A mixture of summer dormant perennial ryegrass and annual regenerating subclovers.

Perennial swards

Perennial swards are commonly used in cool, high rainfall areas. On some sloping sites, they may provide the only viable option to prevent soil erosion and allow traffic accessibility. However, competition with vines for water can be a major problem in some areas and unless water is available at low cost, it may be necessary to suppress the sward by mowing and applying low rates of post-emergence herbicide from budburst onwards, using a CDA sprayer. Where the sward is mown and thrown beneath the vine to create an under-vine mulch, this will be most persistent where grass dominant swards containing tall fescue, cocksfoot and perennial ryegrass are used.

In areas of high spring rainfall, where vines are too vigorous, a sward may be used to reduce the water available to vines. When sufficient control of vigour has been achieved in late spring or summer, the sward can be mown and sprayed with low rates of herbicide. Irrigations can then be carefully scheduled to control vine vigour. This strategy is only suitable in frost-free areas or where over-canopy sprinklers are used for frost control.

Grasses

Perennial ryegrass

Perennial ryegrass, *Lolium perenne*, is a perennial which lasts several years (Figure 3-11). It grows to a height of 60 cm and has a dense fibrous root system. It goes dormant in summer if soil moisture is low.

- **Soil types**—grows in a wide range of soils, but prefers well drained loams to clay loams and will not tolerate soils of pH_w above 8.0.
- **Uses**—perennial swards alone or in mixtures with other grasses, e.g. fescues, or with annual medics or subclovers (Figure 3-12) or perennial legumes. Medics can be allowed to set seed in October or November and regenerate after rain in the following autumn. Perennial ryegrass can be used to stabilise contour banks and access tracks at sloping sites. It is usually not suited to areas with low rainfall, particularly where they are drip irrigated as it provides too much competition with vines.

- **Cultural practices**—can be mown several times in the growing season.
- **Varieties used**—include Victorian (winter–spring productive), Ellett (autumn–summer productive) and Brumby (winter–spring productive and more drought tolerant than Victorian).

Tall fescue

Tall Fescue, *Festuca arundinacea*, is a persistent perennial grass with a deep taproot. Its main growth is in autumn and spring (and summer if irrigated).

- **Soil types**—suited to a wide range of soils, but prefers those that are medium to heavy textured. It tolerates moderate waterlogging and salinity.
- **Uses**—perennial sward mixtures. It is useful to improve trafficability on sloping ground in high rainfall areas and for reducing vine vigour.
- **Cultural practices**—requires mowing after the second year.
- **Varieties used**—include Demeter, Tribute and Triumph.

Cocksfoot

Cocksfoot, *Dactylis glomerata*, is a moderately persistent perennial grass, which mainly grows in autumn, winter and spring.

- **Soil types**—tolerates infertile and acid soils with high aluminium, but not waterlogging.
- **Uses**—perennial sward mixtures. It can compete excessively with vines.
- **Cultural practices**—tolerates mowing.
- **Varieties used**—include Currie and Porto, which makes more growth in autumn than Currie.

Legumes

Strawberry clover

Strawberry clover, *Trifolium fragiferum*, is a low (20–30 cm), hardy perennial, that spreads by stolons (runners which spread across the soil surface and take root) making it very invasive. It has peak production in spring and summer.

- **Soil types**—grows best in alkaline soils. It tolerates heat, drought, saline soils and waterlogging better than white clover.
- **Uses**—perennial sward mixtures, e.g. with perennial ryegrass.
- **Cultural practices**—tolerates frequent mowing.
- **Varieties used**—include Palestine and O'Connors.

White clover

White clover, *Trifolium repens latum*, is also a low perennial (20–30 cm) that spreads by stolons, but is less invasive than strawberry clover.

- **Soil types**—tolerates a wide range of soils, but prefers sandy loams to clays of pH_{Ca} 6.0–7.0.
- **Uses**—perennial sward mixtures with grasses, e.g. perennial ryegrass or tall fescue.
- **Cultural practices**—tolerates frequent mowing. Mixtures may require continual mowing, so that grasses do not dominate.
- **Varieties used**—include Haifa (winter/spring growing) and Tahora (which tolerates heavy mowing, but performs poorly in alkaline soils). Haifa can be grown in the Murray Valley region, but has a high irrigation water demand to maintain stand density.

Natives

Native plants such as saltbushes, e.g. *Atriplex semibaccata* and grasses, e.g. *Danthonia* spp. (wallaby grasses) and *Chloris* spp. (windmill grasses) are recognised as having cover cropping potential. These perennials are adapted to a wide range of soil types, are drought hardy and will add to the biodiversity of the vineyard floor.

Volunteer swards

The increasing use of drip irrigation in vineyards can make cover crop establishment and maintenance difficult, particularly in low rainfall regions like the Murray Valley. In some years there may be insufficient rainfall for establishment, or the cover crop may grow sparsely after sowing, due to lack of follow up rain. The surviving sward of partly or predominantly volunteer weeds can be managed similar to a sown cover crop. Inter-row areas should be mown or sprayed using a CDA herbicide sprayer, rather than cultivated, to avoid a break down in soil structure and the increased possibility of wind erosion.

In a year when there is sufficient rainfall, it may be possible to establish regenerating species. A medic mix of more drought tolerant varieties like Harbinger AR or Caliph could be combined with a hard seeded variety such as Sava and the more soft seeded Paraggio. These should be allowed to set seed to increase the seed store in the inter-row area and increase medic regeneration as a component of the sward in future years.

The cereal of choice in low rainfall, drip irrigated situations is cereal rye. It has superior drought tolerance and the ability to withstand sand-blast better than other cereals. It also has some self-seeding ability which may be of advantage in a volunteer sward.

Further reading

Brown, A., Smith, M. and Price, T. (1997) Covercrops and weeds as potential hosts for overwintering lightbrown apple moth. *Australian Grapegrower and Winemaker*, **402a**, 72–73, 75.

Bugg, R.L. and Van Horn, M. (1998) Ecological soil management and soil fauna: best practices in California vineyards. In: ASVO *seminar proceedings: viticultural best practice, Mildura 1997*. R. Hamilton, L. Tassie and P. Hayes (eds). Australian Society of Viticulture and Oenology: Glen Osmond, South Australia. pp. 23–34.

Elmore, C.L., Donaldson, D.R. and Smith, R.J. (1998) Weed management. In: *Cover cropping in vineyards. A grower's handbook*. C.A. Ingels, R.L. Bugg, G.T. McGourty and L.P. Christensen (eds). University of California, Division of Agriculture and Natural Resources: Oakland.

Elmore, C.L., Peacock, W.L., Christensen, L.P., Donaldson, D.R. and Graves, W.L. (1992) Vineyard floor management. In: *Grape pest management*. D.L. Flaherty (ed). University of California, Division of Agriculture and Natural Resources: Oakland.

Finch, C. U. and Sharp, W. C. (1981) *Covercrops in California orchards and vineyards*. USDA Soil Conservation Service: Davis, California.

Hillman, M. (ed) (1997) *Southern region winter crop summary*. Department of Natural Resources and Environment: Victoria.

Hirschfelt, D.J. (1998) Soil fertility and vine nutrition. In: *Cover cropping in vineyards. A grower's handbook*. C.A. Ingels, R.L. Bugg, G.T. McGourty and L.P. Christensen (eds). University of California, Division of Agriculture and Natural Resources: Oakland.

Ingels, C.A., Bugg, R.L. and Thomas, F.L. (1998) Cover crop species and descriptions. In: *Cover cropping in vineyards. A grower's handbook*. C.A. Ingels, R.L. Bugg, G.T. McGourty and L.P. Christensen (eds). University of California, Division of Agriculture and Natural Resources: Oakland.

Lamb, J. and Poddar, A. (eds) (1987) *Grain legume handbook*. SA Peagrowers Cooperative: Riverton, South Australia.

Lombard, P., Price, S., Wilson, W., and Watson, B. (1988) Grass cover crops in vineyards. In: *Proceedings of the 2nd International Symposium for Cool Climate Viticulture and Oenology, Auckland*. R.E. Smart, R.J. Thornton and J.E. Young (eds). New Zealand Society of Viticulture and Oenology: Auckland, pp. 152–155.

Ludvigsen, K. (1993) Strategies for the management of cover crops. *Australian Grapegrower and Winemaker*, **352**, 141–143.

Ludvigsen, K. (1996) Advancing mulcher design for better soil management. *Australian Grapegrower and Winemaker*, **390a**, 130–131, 133.

McCarthy, M.G., Dry, P.R., Hayes, P.F. and Davidson, D.M. (1992) Soil management and frost control. In: *Viticulture Volume 2 – Practices*. B.G. Coombe and P.R. Dry (eds). Winetitles: Adelaide, South Australia.

McDonald, W., Duncan, M., Griffiths, N., Bowman, A. and O'Malley, C. (1995) *Recommended pasture varieties 1995–1996*. Agfact P2.1.10. NSW Agriculture.

McLeod, R. (1994) Covercrops and inter-row nematode infestation in vineyards. *Australian Grapegrower and Winemaker*, **369**, 45, 47–48.

McLeod, R., Somers, T. and Gendy, M. (1995) Covercrops and nematodes – some field observations. *Australian Grapegrower and Winemaker*, **381**, 53, 55–57.

McLeod, R.W., Gendy, M.Y. and Steel, C.C. (1998) Observations on brassicas as cover crops and testing of biofumigation in vineyards. *Australian Grapegrower and Winemaker*, **414a**, 83–86.

Miller, P. R., Graves, W. L. and Williams, W. A. (1989) *Covercrops for California agriculture*. Pub. 21471. University of California, Division of Agriculture and Natural Resources: Oakland.

Peacock, W.L. (1995) Cover crops and vine nutrition. *Grape Grower*, August, 16–17, 21.

Porter, R. (1998) Weed suppression using cover crops. *Australian Grapegrower and Winemaker*, **414**, 29–30, 33.

Porter, R. (1999) Vineyard cover crops for maximum herbage production. *Australian Grapegrower and Winemaker*, **422**, 16, 18–19.

Porter, R. and Grow, C. (1997) Covercropping for undervine mulching. *Australian Grapegrower and Winemaker*, **402**, 37–38.

Prichard, T.L. (1998) Water use and infiltration. In: *Cover cropping in vineyards. A grower's handbook*. C.A. Ingels, R.L. Bugg, G.T. McGourty and L.P. Christensen (eds). University of California, Division of Agriculture and Natural Resources: Oakland.

Sanderson, G. (1998) Medic cover crop dry matter production. *Australian Grapegrower and Winemaker*, **410**, 22–23, 25.

Sanderson, G. (2000) Cover cropping and soil organic matter. *Australian Grapegrower and Winemaker*, **434**, 33–34.

Sanderson, G. and Fitzgerald, D. (1999) Cover crop nitrogen – vineyard trials with sultana vines. *Australian Grapegrower and Winemaker*, **422**, 13–15.

Sanderson, G. and Schache, M. (1994) *Improving soil management in Sunraysia*. Technical Report No 212. Victoria Department of Agriculture.

Shanks, L.W., Moore, D.E. and Sanders, C.E. (1998) Soil erosion. In: *Cover cropping in vineyards. A grower's handbook*. C.A. Ingels, R.L. Bugg, G.T. McGourty and L.P. Christensen (eds). University of California, Division of Agriculture and Natural Resources: Oakland.

UC SAREP cover crop database. University of California Sustainable Agriculture Research and Education: Davis. www.sarep.ucdavis.edu/ccrop/.