FINAL REPORT

VOLUME 1

The Role of Inter-Row Ground Covers to Improve the Management and Sustainability of Soils in Australian Vineyards

PROJECT REFERENCE NUMBER: SEE 93/1

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1. EXECUTIVE SUMMARY

1.1 Introduction

Project SEE 93/1 commenced in January 1994. A need for the proposed research and extension programme was identified by industry, which observed problems resulting from non sustainable soil management practices employed in Australian vineyards.

Observed problems and symptoms of less than optimal management include:

- increased soil salinity
- a deterioration of soil structure and texture
- poor water quality
- declining soil fertility, and
- a proliferation of herbicide "escape" weeds

1.2 Project Objectives

The project was devised to enable the adoption of more sustainable soil management practices across the range of grape growing regions of South Eastern Australia, and to determine the most appropriate temperate plant species and cover crop systems to employ in each of these regions. Primary objectives of the project were:

- to raise the profile of cover cropping as a tool for vignerons; and
- to provide growers with an information package describing optimal cover crop species, systems and management techniques.

1.3 Methodology

To achieve these objectives, an extensive variety screening programme was devised to compliment various extension activities through the course of the project. In total, 95 temperate plant species and cultivars were screened in seventy field trials in three states over three seasons. Crops were assessed on their ability to fit the criteria as either a green manure or permanent sward. In particular the productivity, establishment and seasonal vigour, weed suppression ability and persistence of swards were parameters monitored in field trials. Results have been extended to grape growers via the following methods:

1. Seminars and grower meetings;
2. Field days and demonstrations;
3. Printed brochures;
4. Magazine and journal articles;
5. Conference presentations; and
6. Direct grower contact

1.4 Project Achievements

Dominic Schiccatano was appointed to the position of Project Manager, Cover Crop Technology in 1994. The first project milestone was to prepare a Literature Review, which is included in the Attachments section (see Attachment 16.6 ***Cover Crop Technology in Vineyards*** *A Preliminary Literature Review*).

Four major field trial sites were sown in winter 1994 with the objective of screening a wide variety of temperate pasture and crop species for their application and suitability as a cover crop. These trials were established at Rowland Flat in the Barossa Valley, Padthaway in the South East of South Australia, Mildura in the Sunraysia region, and at Griffith in the Murrumbidgee Irrigation Area (M.I.A.). A fifth, and smaller, secondary site was planned for Picola in Victoria. Due to a lack of rainfall in most areas during the 1994 growing season, minimal significant data was gleaned from this first season of field trials. During this time the Project Manager undertook a survey of grape growers around the country in an attempt to identify existing vineyard cultural practices and management techniques. A total of 1000 questionnaires were posted to growers in October 1994, of which 235 responses were received. The results of this survey are contained in the Attachments section of this report (see Attachment 16.5 ***1994 Cover Crop Questionnaire***).

In summary, the survey provided the following information:

1. The majority(60%) of vineyards in Australia fell in the 5-20 ha range, with just 15.3% of holdings greater than 100 ha in size.
2. Almost 89% of Australian vineyards were irrigated, with 84% of irrigated vineyards having drippers, and 12% sprinklers.
3. 75% of Australian vineyards had a cover crop planted as the regular soil management practice.
4. Of those growing a cover crop, 44% of growers slashed the mid row to provide a weed mulch compared to 17.7% who either mulched or ploughed the cover crop into the ground.

Richard Porter was appointed to the position of Project Manager in March 1995 after the resignation of Dominic Schiccatano. During the autumn of 1995, four major variety screening trials, and six secondary sites were established. The list of trial site locations are summarised in Table 1.1 below. During 1995, a brochure was published to raise the profile of the project and the principles of cover cropping. A copy of this brochure is included in the Attachment section of this report (see Attachment 16.1 *Cover Crops For Sustainable Vineyard Management*). This publication summarised the potential benefits of utilising a cover crop, and highlighted some of the soil management problems confronting vignerons in Australia. Five thousand of these brochures were printed and were distributed through seed retailers, Department of Agriculture offices, research organisations and education facilities.

Results from 1995 field trials identified cover crop species and cultivar blends which were consequently screened at replicated field trial sites established in 1996 and 1997. (Table 1.1 below lists the location of trial sites in the 1995-97 seasons).

1995 Field Trial Locations	1996 Field Trial Locations	1997 Field Trial Locations
Rowland Flat, Barossa Valley	Clare, South Australia	Clare, South Australia
Coonawarra, South Australia	Auburn, South Australia	Auburn, South Australia
Mildura, Sunraysia	Waikerie, South Australia	Riverland,South Australia (4 sites)
Griffith, M.I.A.	Nuriootpa, South Australia	Nuriootpa, South Australia
Eden Valley	Angaston, South Australia	Angaston, South Australia
Clare Valley	Eden Valley, South Australia	Eden Valley, South Australia
Qualco, Riverland SA	Adelaide Hills, South Australia	Adelaide Hills, South Australia
Great Western, Victoria	Mclaren Vale, South Australia	Mclaren Vale, S.A. (3 sites)
Rutherglen, Victoria	Padthaway, South Australia	Padthaway, South Australia
Charles Sturt University,	Langhorne Creek, South Australia	Langhorne Creek, South Australia
Wagga Wagga NSW	Coonawarra, S.A. (2 sites)	Coonawarra, South Australia
	Great Western, Victoria	Great Western, Victoria
	Sunraysia, Victoria (2 sites)	Sunraysia, Victoria (4 sites)
	Griffith, M.I.A., NSW (2 sites)	Rutherglen, Victoria
	Rutherglen, Victoria	Mitchelton, Victoria
	Mitchelton, Victoria	Griffith, M.I.A., NSW (2 sites)
		Cowra NSW (3 sites)
		CSU, Wagga Wagga, NSW
		Margaret River, WA

Table 1.1 Location of field trial sites established in 1995,1996 and 1997

In February 1996 the Project Manager undertook a three week study trip to California and South Africa. The objective of this study tour was to observe cover crop techniques and meet with researchers and growers to share their experience and knowledge of cover cropping. A total of 2 weeks was spent in California, including 3 days at the Davis campus of the University of California, and a week based in Capetown, South Africa.

An extensive field day programme was undertaken in 1996 involving over 350 growers at 15 locations, and a comprehensive field day report covering these events is included in the Attachments (see Attachment 16.7 ***Cover Crop Technology 1996 Field Day Report***).

In March 1997, a cover crop extension guide, based on trial observations in the first two seasons, was compiled and published, which provided interim information on cover crop species selection for four grape growing regions of South Eastern Australia. The ***1997 Cover Crop Guide for Australian Vineyards*** (Attachment 16.2) was distributed to growers via Seedco, seed retailers and research institutions in the Coonawarra, Sunraysia, Riverland and M.I.A. regions.

The culmination of this GWRDC and Seedco collaborative research effort was the publication and distribution in March 1998 of "**Cover Crops-*A guide to species selection and sward management***" (Attachment 16.3). A total of 7000 copies of this brochure were produced, covering the regions listed in table 1.2 below.

Cover Crop Guide-Regions	Number Printed	Cover Crop Guide-Regions	Number Printed
Clare Valley	250	Coonawarra	250
Barossa Valley	500	Riverland	1500
Eden Valley	250	Sunraysia	1500
Adelaide Hills	250	MIA	750
McLaren Vale	250	North East Victoria	250
Langhorne Creek	250	Yarra Valley	250
Padthaway	250	Goulbourn Valley	250
Central Victoria	250		

Table 1.2 Cover Crop Extension Kits and number of each printed and distributed

These brochures were distributed via seed retailers, Research Institutions, State Department of Agriculture offices, and direct mail out from Seedco to over 1100 growers. A copy of charts specific to each of the nominated regions above are presented in the appendices of this report (see Appendix **15.1-15.15)**

In addition to the variety screening trials, field trials were established in 1997, which addressed the following specific issues:

1. The impact of ground cover treatment on the incidence and severity of frost in Coonawarra;
2. Soil moisture depletion rates under various grass swards in a vineyard at Padthaway;
3. A comparison of vigour and persistence of over thirty perennial and annual grass species at Padthaway;
4. The impact of ground cover on insect pest and predator populations in a vineyard at Yarra Valley; and
5. The potential application of Australian native grasses as mid row swards in the Barossa and Eden Valleys.

In 1998, three field trial sites were established in vineyards at Auburn, McLaren Vale and Rowland Flat to compare crop species, seeding rates and fertiliser application regimes for the purpose of producing optimum amounts of mulch for side throw mowing.

2. BACKGROUND

Commercial grape production in Australia is an intensive practice, with productivity often maximised by the use of high cost chemical inputs, such as pesticides and fertilisers. In response to changing community attitudes regarding environmental issues and food production, the viticultural industry will need to better utilise available soil and water resources and apply vineyard soil management which enhance rather than degrade these resources. As a consequence, there exists a need for self-sustaining, low input, diversified and energy efficient agricultural systems, which remains the challenge for researchers, growers, and policy makers in Australia.

In an assessment of the components of a good vineyard soil management system, Davidson (1990) included the following:

a) minimal or no soil cultivation;
b) the addition of humus/organic matter to the soil;
c) good irrigation management;
d) maintenance of surface soil as aggregates, i.e. good soil structure;
e) stabilising the subsoil and avoiding the development of hardpans; and
f) reduced salinity build up.

Each of these components is significantly affected by cover crops, in that they contribute to sustainable vineyard operations.

Cover crops:

a) reduce the leaching of fertilisers (nitrates) as well as supplying nitrogen to the economic crop, Freeman (1989);
b) provide a source of soil organic matter and a substrate for soil biological activity, Bruce et al (1991);
c) prevent soil erosion and water run-off on sloping sites, Glen (1990);
d) improve the soil organic matter level, McCarthy et al (1992a);
e) provide a better climate for biological control of pests, (McCarthy et al (1992a); Beckingham 1998);
f) improve water infiltration and assist the drying out and stabilising of the soil in wet areas, (McCarthy et al 1992a, Beckingham 1998; Lavin and Kogan 1989);
g) improve soil aggregate stability, Burns and Davies (1986);
h) ameliorate compacted soils, (Hulugalle et al 1986; Jordan et al 1956);
i) reduce nematode infestations (Resck et al 1982, Reddy et al 1986, Mojtahedi et al 1991);
j) improve vineyard trafficability in areas prone to water logging, Beckingham (1988);
k) provide wind protection in young vineyards; and
l) harbour beneficial insects that are used to control insect pests, McCarthy et al (1992a).

To successfully apply a cover crop, it should:

a) be easy to establish;
b) have a rapid growth rate so as to provide quick ground cover;
c) produce a sufficient quantity of dry matter for maintenance of residues;
d) not act as a host for relevant pests of the cash crop;
e) be easy to eliminate if desired; and
f) be economically viable.

There are a number of factors which influence the selection of a particular species or cultivar for use in a cover crop sward. This selection process is be guided by:

a) the environment – governed by annual rainfall and its seasonal distribution, vineyard soil type and fertility status;
b) the objective (s) for planting a mid row sward (i.e. for weed suppression, mulch production, erosion control etc);
c) plant characteristics of the cover crop itself (eg.time of maturity, growth habit); and
d) vineyard production objectives (yield and quality)

3. OBJECTIVES

The overall aim of this project was to provide the viticultural industry with a grower extension kit, designed to assist the grower in making decisions on how to employ cover cropping technology and what benefits may be expected to accrue. The extension guide allows particular species/cultivars to be selected according to region, and explains the management techniques required to optimise any potential benefits.

The primary aim of this project's trial program was to evaluate a diverse range of species/cultivars, and to identify those which have application as a cover crop. This screening work pre-empted a more detailed characterisation of a smaller number of species and varieties which showed prospects for use as cover crops in vineyards.

4. INTRODUCTION

Cover crops are defined as crops grown specifically for covering the ground to protect the soil from erosion and loss of plant nutrients through leaching and run off (Parker 1915, Pieters and McKee 1938). Although the utilisation of cover crops can provide numerous potential benefits, as described previously, there are also some less desirable impacts, including:

1. competition with the cash crop for water and nutrients;
2. an increased frost risk in some areas;
3. the capital cost incurred to plant and manage a mid row sward; and
4. the potential pest hosting abilities, including nematodes, light brown apple moth (LBAM), and phytoplasmas which may be associated with diseases such as Australian Grapevine Yellows (AGY).

A cover crop is the preferred mid row management option where long term sustainability is a conscious objective of the grower. Cover crops can be used for the maintenance or modification of the basic building block for a vineyard, ie *the soil*. The long term objective of the grower should be to provide a medium (soil) suitable for sustained vine growth and health for an indefinite period. To achieve this, growers must be encouraged to continually assess their own practices, and to employ soil management strategies which contribute to the achievement of this goal.

Cover crops in Australian vineyards can be divided into two main types, or systems: (i) Green Manure, and (ii) Permanent Sward.

4.1 Green Manure Crops

This is the most commonly used cover crop system in Australia (refer to Attachment 16.6 – '***Cover Cropping Technology in Vineyards – A preliminary literature review***'). These crops, consisting of annual legumes, cereals and brassicas, are most often sown in autumn, and terminated prior to bud burst in most districts. The reasons for incorporating annual crops at this time include: minimising the risk of frost damage to vines, which is best achieved by creating a bare, damp and compacted soil surface (McCarthy, 1992a), and; reducing the competition for available moisture and nutrients between the mid row sward and vines. In circumstances where frost is not a major problem, these swards can be allowed to persist beyond budburst, so long as soil moisture levels are adequate. Total sward biomass production can increase if an annual crop is allowed to grow beyond budburst, providing additional organic matter to the soil. Similarly, where frost is not a major concern, the sward may be mowed and/or sprayed instead of being incorporated.

The objective of growing such a cover crop is to provide organic matter to the soil. McCarthy et al (1992a) summarised that increases in soil organic matter:

1. results in stable soil aggregates and structures;
2. provides fabric to sandy soils;
3. adds to the water holding capacity of the soil;
4. provides a reservoir of nutrient elements;
5. lowers soil bulk density; and
6. provides a substrate for micro organisms and soil fauna.

4.2 Permanent Sward Cover Crops

Such swards consist of perennial and annual pasture species, which are established in autumn and persist/regenerate in subsequent seasons from either exiting roots or seed set in the preceding spring/early summer period. These swards are most often employed to:

1. ameliorate soil erosion problems which may occur in undulating, higher rainfall areas;
2. improve trafficability in the mid row where access to apply pesticides and fungicides in a timely manner may otherwise be restricted, most often due to a combination of excessive soil moisture and undulating topography;
3. suppress undesirable volunteer plant growth on the vineyard floor;
4. improve water infiltration rates and soil water holding capacity; and
5. encourage the proliferation of soil fauna such as earthworms which contribute to soil porosity and nutrient cycling.

5. METHODOLOGY

The species and cultivars initially used in this trial program were selected upon their deemed suitability for use as cover crops. The plant characteristics that were considered when the species/cultivar suitability was assessed included:

a) plant growth habit i.e. prostrate or erect
b) growth period
c) green and dry matter production
d) time of flowering (maturity)
e) drought tolerance
f) persistence
g) availability of seed

The species/cultivars were selected from the agronomic information generated by the literature review (see Attachment 16.6 – '*Cover Cropping Technology in Vineyards – A preliminary literature review*'). These species/varieties were divided into two groups based upon their fit as either:

a) a green manure, or
b) permanent sods

In 1994 and 1995 the species/varieties were sown and evaluated at four (primary) sites, each representative of the major grape growing regions of South Eastern Australia (See Table 3.1.2). Site selections were made in consultation with industry representatives, suppliers and researchers, particularly CSIRO (refer to Appendix **15.16 and 15.19** for lists of species screened in 1994 and 1995 respectively).

Secondary sites were established in various regions in these initial seasons which assessed a small number of cover crop species.

The cover crop trial program in 1996 consisted of twenty four replicated trial sites, established using a small plot coneseeder in autumn. The trials each consisted of four replicates of thirty three treatments in a randomised complete block design.

During the 1997 growing season, monitoring of remaining trials established in previous years continued, in addition to the establishment of demonstration trials in most districts (for extension purposes), and several sites for specific cultivar characterisation - for example a comparison of a diverse selection of perennial and annual grasses at Padthaway.

Three cover crop trial sites were established in 1998 to determine yield effects achieved by varying the seeding rates of some cover crops, and sward fertiliser application regimes.

6. RESULTS

6.1 1994 Field Trials

6.1.1 Trial Site Locations and Descriptions

Refer to Appendix 15.16 for a list of the plant species and varieties screened in the 1994 trials. Table 6.1.1 below lists locations and details of the trial sites.

Details	Barossa Valley, SA	Padthaway, SA	Mildura, VIC	Griffith, NSW	Picola, VIC
Company	Southcorp Wines	Southcorp Wines	Private Grower	Private Growers	Mildara Blass
Field name	Koonunga Hill Blk 54	Quarry Block	A & S Chisari	L Pellizer	Tisdalls Vineyards
Plot size	5m x 2m	5m x 1.5m	5m x 1.5m		3m x 340m
Seeding Date	GM 1/7/94 PS 4/7/94	3 – 6/6/94 Medics 16 – 17/6/94	21-21/6/94	Not sown	18/7/94
Sowing Method	Hand broadcast & raked in	Connor Shea Disc Seeder; Medics by hand	Hand broadcast & raked in		Hand broadcast & raked in
Soil pH	7.0	4.9 – 6.2	8.5	7.4	6
Soil Type	Red brown earth over clay	Sandy loam over light to medium clay	Sandy loam	Sandy loam	Clay/clay loam; sandy loam on rises

Table 6.1.1: Site locations and details for 1994 trials.

The experimental design was uniform across each site with the design being a randomised design with three replications.

6.1.2 Assessments

1. Flowering time, plant height, stand vigour, fresh weights, weediness and plant numbers were assessed on 19 – 21 October for the green manure plants and 23 – 24 November for the permanent sod plants at the Padthaway site. These characteristics were selected for evaluation because of their direct impact on vineyard management. The methodology employed for plant evaluation is explained below, and results summarised in tables 3.1.4 a

The flowering stages of the different crops were rated according to the following scale. A rating greater than or equal to 3.5 was considered favourable.

Flowering Score			
	1	=	No flowers
	2	=	Flowers
	3.x	=	Flowers and pods x = % plants finished flowering
	4.x	=	Pods only x = % of pods ripe
	5	=	All pods mature

2.0 *Plant Height*

The height of the different species and varieties were rated according to the following scale. A rating equal to or greater than 3 is considered favourable.

Plant Height			
	1	=	0 – 10 cm
	2	=	10 – 30 cm
	3	=	30 – 50 cm
	4	=	50 cm +

3. *Stand Vigour*

The plants were assessed visually and rated from 1 – 10, with 10 being the most vigorous and 1 no vigour. This assessment is used to give an indication of the plants adaptability and suitability to the area. If a sward received a vigour rating equal to or greater than 7 then it was deemed to be an appropriate cover crop in the environment. A rating score of equal to or greater than 7 classified the sward as unsuitable.

4. *Plant Numbers*

This recording was an assessment of seedling density for each sward in the trials. Three (3) randomly placed quadrats (0.0625 m^2) were counted from each plot.

5. *Herbage Production*

The amount of fresh (or dry) matter produced by a cover crop has a direct effect on the amount of organic matter and nitrogen returned to the soil. An assessment was made of the above-ground biomass by hand harvesting vegetation contained within three quadrats (0.0625 m^2) randomly placed in each plot.

6. *Statistical Treatments*

By using the numerical data generated by the evaluations, differences between varieties within a species group were assessed using a Nested Analysis of Variance.

In addition, visual assessments of each plot were made as to the ultimate suitability of the plant species/varieties for cover cropping use. Features noted were tillering; vegetative cover by the crops, i.e. whether the plant showed an erect or prostrate growth habit; maturity stages and general plant vigour. The plots were given a √ or X based on these characteristics. Suggested species and varieties for further evaluation in 1995 cover crop trials were made by combining the ANOVA results and the visual assessments.

6.1.3 Griffith Trial

Due to the late start to the season and poor winter rains, this site was not sown.

6.1.4 Mildura and Picola Trials

Drought conditions affected most of Southern and Eastern Australia in 1994. This, in addition to the frosts received throughout Victoria during the months of July and August, resulted in poor germination of most species at the Mildura and Picola sites.

Refer to plates 12.1,12.2 and 12.3 in the **Illustrations** *section*

6.1.5 Barossa Valley Trial

Despite a number of workings to prepare a weed free seed bed, the site was overgrown with soursob (*Oxalis spp.*). This weed has rapid germination and very thick, prostrate growth. This growth habit prevented or inhibited the germination and growth of the cover crop species. Because of the very nature of the trial, involving many different species and varieties, it was impossible to select a herbicide treatment to control the soursob without also harming some of the desired species. However, in an attempt to gather some information from this site, a herbicide application was applied to one replicate of each treatment. Plots were predominantly soursob with the desired species severely shaded out. Sprayseed (a contact, non-selective herbicide) was applied at 500 ml/ha (1/9/94) in an attempt to suppress the growth of the soursob long enough to allow the desired species to overcome the competition and possibly outgrow the weed. Unfortunately, the concentration of Sprayseed used had very little effect on the soursob and it continued to outgrow the desired species. No valid or significant information could be extracted from this site.

6.1.6 Padthaway Trial

Sufficient rains were received at Padthaway, which enabled screening of the species and varieties to occur. (Refer to Appendices **15.17 and 15.19** for results). During sowing, 50 mm of rain was received which delayed the sowing of the medics by two weeks. This had no effect on the results achieved because no comparisons between species were made, only within species. The site was sprayed two times for Red Legged Earth Mite (RLEM) using Dimethoate (400 g.a.i / L) at 75 ml/ha in 100 L of water. The site was also sprayed with 2,4 – DB for Wireweed/Hogweed (*Polygonum aviculare*) control. Slight chemical damage was observed, however, this was of no significance to the overall results received.

Refer to plates 12.4- 12.7 in the **Illustrations** *section*

Discussion of results from 1994 Padthaway trial

Stand Vigour, Fresh Weights and Plant Numbers

As a result of the variability across the trial site, and also within and between the plots, no statistically sound differences could be found between cultivars within a species group. For example, the variation between the three replications of one oat variety, resulted in a quadrate harvest weight range of between 37.68 gms to 114.32 grams. Similar ranges were noted for other species, and also other evaluation parameters. The variability in soil conditions could have been overcome by trial design. The 1994 trial layout was based upon a completely randomised design. Subsequently, it was recommended that further trials be arranged in completely randomised blocks.

Plant Height

The growing season for annual resown cover crops in most grape growing areas is short, with swards terminated prior to budburst in most situations. Consequently plant species recommended for use as a green manure must have a short growing season and/or very good winter vigour. When evaluating species/varieties suitability for use as green manures, plant height is not relevant, as the cover crop is terminated just prior to vine bud burst so that any frost risk is minimised. However, the species/varieties that are grown for permanent sod use, where in most cases the cover crop doesn't seed until after bud burst, a prostrate or semi prostrate growth habit is desirable.

No significant differences between species/varieties could be determined from the data collected in this trial in 1994 (due to large between replicate variability) and so the evaluation and screening of the species/varieties suitability was made using the visual assessments. If the variety received two or more √'s then it was accepted for further trialing in 1995. See Tables 6.1.3 and 6.1.4. overleaf.

Variety	Visual rating of the 3 reps	Accept or Reject	Variety	Visual rating of the 3 reps	Accept or Reject
Paraponto	X X X	Reject	Kyambro	X X X	Reject
Kelson	√ √ X	**Accept**	Balansa	√ ? √	**Accept**
Highlander	Not sown	**Repeat**	Arrowleaf	X X ?	Reject
Ampus	√ ? X	Reject	Attila	√ ? X	Reject
Meteora	X X X	Reject	Multicut	X √ √	**Accept**
Maugio	X √ √	**Accept**	Bigbee	? √ ?	Reject
Salernes	X ? ?	Reject	Maral	X X X	Reject
Echidna	X X X	Reject	Leeton	√ X √	**Accept**
Mortlock	√ √ ?	**Accept**	Laser	√ X √	**Accept**
Coolabah	√ √ √	**Accept**	Palestine	X √ √	**Accept**
Bulban	√ √ √	**Accept**	O'Connor	X X ?	Reject
Namoi	√ ? √	**Accept**	Tamar	√ X X	Reject
Popany	√ X √	**Accept**	Tahora	? X X	Reject
Languedoc	X X √	Reject	Waverley	X X X	Reject
Blanchefleur	? ? √	Reject	Gosse	√ √ ?	**Accept**
Topcut	√ √ √	**Accept**	Stem Her	Not sown	**Repeat**
Glenroy	√ √ ?	**Accept**	Oat/Topcut	√ √ √	**Accept**
Alma	√ ? √	**Accept**	Oat/Balansa	Not sown	**Repeat**
Dundale	X X ?	Reject	Oat/Icarus	X ? √	Reject
Laura	Not sown	**Repeat**	Oat/Serradella	X X X	Reject
Icarus	X ? X	Reject	Oat/Glenroy	√ ? X	Reject
Fiord	X X ?	Reject	Oat/Rangi	Not sown	**Repeat**
Ascot	√ √ √	**Accept**	Oat/Mustard	X X X	Reject
Cereal Rye	√ ? √	**Accept**	Oat/Radish	X X X	Reject
Tyrell Tall Wheat	X X X	Reject	Glenroy/Kelson	Not sown	**Repeat**
Pauite Cocks	Not sown	**Repeat**			
Claret Mustard	X X X	Reject			
Ruby Mustard	X X X	Reject			
Topas Mustard	X X X	Reject			
Nemfix	X X X	Reject			

Table 6.1.3: Green Manure Assessments of treatments at Padthaway, 1994

Variety	Visual rating of the 3 reps	Accept or Reject	Variety	Visual rating of the 3 reps	Accept or Reject
Paraponto	X X ?	Reject	Maral	? X √	Reject
Kelson	√ ? X	Reject	Salinas	Not sown	Repeat
Mogul	√ √ X	Accept	Palestine	√ √ √	Accept
Harbinger AR	√ √ √	Accept	O'Connor	? ? √	Reject
Highlander	Not sown	Repeat	Grassland Huia	X ? ?	Reject
Caliph	√ √ X	Accept	Waverley	√ √ √	Accept
Paraggio	√ √ √	Accept	Tamar	√ √ ?	Accept
Parabinga	√ ? ?	Reject	Tahora	X ? X	Reject
Sava	√ √ √	Accept	Grassland Kopu	X X √	Reject
Rivoli	X √ ?	Reject	Hykon	√ √ √	Accept
Santiago	√ X √	Accept	Haifa	√ √ X	Accept
Polygraze	Not sown	Repeat	Irrigation	? ? X	Reject
Ampus	X X X	Reject	Redquin	X ? X	Reject
Meteora	X X X	Reject	Kyambro	√ X √	Accept
Maugio	√ √ √	Accept	Balansa	√ √ √	Accept
Salernes	√ X X	Reject	Laser	√ √ √	Accept
Manesty	Not sown	Repeat	Leeton	√ √ √	Accept
Sapo	X X ?	Reject	Tribute	√ ? √	Accept
Zodiac	√ √ √	Accept	Demeter	? √ √	Accept
Carpet	Not sown	Repeat	Thoroughbred	X X X	Reject
Leura	√ √ √	Accept	Victorian Rye	√ √ ?	Accept
Dalkeith	√ √ √	Accept	Embassy Rye	√ X ?	Reject
Clare	√ √ √	Accept	Ellet Rye	√ √ √	Accept
Denmark	√ √ √	Accept	Grassland Nui	√ √ √	Accept
Goulbourn	√ √ √	Accept	Skippy Rye	√ √ √	Accept
Woogenellup	? √ √	Accept	Matilda Rye	√ √ √	Accept
Trikkala	X X √	Reject	Yatsyn	√ √ √	Accept
Esperence	√ √ √	Accept	Veldt Grass	X X X	Reject
Gosse	√ √ √	Accept	Porto Cocksfoot	√ ? √	Accept
Geraldton	√ √ √	Accept	Currie Cocksfoot	√ ? X	Reject
Junee	√ √ ?	Accept	Grassland Wana	X ? X	Reject
Enfield	√ ? √	Accept	Cajun	? X √	Reject
Nuba	√ √ X	Accept	Tama/Persian	X ? X	Reject
Nungarin	X X X	Reject	Tetila/Persian	√ X X	Reject
Rosedale	√ √ √	Accept	Holdfast/Haifa	X X X	Reject
Seaton Park	√ √ √	Accept	Holdfast/strawberry	? X X	Reject
Australian	X X X	Reject	Holdfast/Gosse	X X X	Reject
Holdfast	√ √ X	Accept	Demeter/strawberry	X X X	Reject
Sirolan	√ X X	Reject	Demeter/Gosse	X ? √	Reject
Sirosa	X √ X	Reject	Demeter/Kyambro	? X X	Reject
Tama Rye	? X √	Reject	Currie/Haifa	X X X	Reject
Tetila Rye	? ? √	Reject	Currie/Gosse	X ? √	Reject

Table 6.1.4: Permanent Sod Assessments of treatments at Padthaway, 1994

Key: √ = keep cultivar for further evaluation, X = reject cultivar, ? = inconclusive result

Three symbols per cultivar represent an assessment for each of the three replicated plots in the trial. An overall assessment of acceptance or rejection (column 3) is based on the three individual plot marks.

Species/Cultivars rejected

In order to reduce the number of species and prevent the repetition of unnecessary work, information gathered from the Padthaway site was used when species and varieties were selected for the 1995 primary screening and evaluation trials at Coonawarra, Griffith, Barossa Valley and Mildura.

From the initial list of species and varieties for screening, it was suggested that the following varieties be withdrawn based on the information obtained from the Padthaway data.

1. Annual Ryegrasses
2. Coriander
3. Sulla + mixes
4. Serradella + mixes
5. Meteora, Salernes and Ampus (French Cold Tolerant Medics)

6.2 1995 Field Trials

6.2.1 Trials Site Locations and Descriptions

Species/cultivars selected for the variety screening trials in 1995 were based upon the literature review and observations/conclusions from 1994 trials. A full list of species and cultivars assessed in these field trials appears in the appendices (See Appendix **15.19**). Site details appear in Table 6.2.1 below.

Details	Barossa Valley, S.A.	Coonawarra, S.A.	Mildura, Vic.	Griffith, NSW.
Company	Orlando Wyndham	Mildara Blass Wines	Private Grower	Orlando Wyndham
Vineyard	Lyndoch	Richardson's Block	David Littore	S. Gugliemino
Plot Size	10m x 1.2m	10m x 1.5m	10m x 1.5m	13m x 1.5m
Seeding Date	27 April 1995	12 May 1995	13 April 1995	20 April 1995
Sowing Method	Cone Seeder	Cone Seeder	Cone Seeder	Cone Seeder

Table 6.2.1 : Major Screening trial locations and site details

Four major sites were established in April/May 1995 at Mildura (private grower), Griffith (Orlando Wyndham), Rowland Flat (Orlando Wyndham) and Coonawarra (Mildara Blass). At each location, approximately 85 cultivars, covering 40 species, were sown in two adjacent blocks, i.e. permanent sod and green manure, each comprising three replicates in a completely randomised block design. These trials were all sown using small plot cone seeders which enabled precise sowing rates, uniform plot length and accurate seed placement.

Refer to plate 12.8 in the **Illustrations** *section*

Secondary Sites

Six sites were established in 1995 with the assistance of growers for the purpose of providing regional information on the adaptability of a small number of cultivars selected for a specific purpose. Species and cultivars screened and site details are included in the appendices. These secondary sites, containing up to 20 cultivars, were established at Clare (Southcorp), McLaren Vale (Southcorp), High Eden (Yalumba), Qualco (Yalumba), Rutherglen (Pfeiffers), Great Western (Southcorp) and Wagga Wagga (Charles Sturt University). Evaluation of these trials was conducted throughout the 1995 season.

Refer to plates 12.20 and 12.21 in the **Illustrations** *section*

6.2.2 Assessments

The following assessments were planned for the 1995 sown screening trials. Table 6.2.1 details the proposed schedule of observations for these trials.

1. *Sward Vigour Rating*

   A visual assessment was made of each plot using a scale of 0 to 10, where 0 = no plant growth and 10 = the most vigorous plot in the trial, based on plant growth, density, vigour, and ground cover. A judgement was also made whether to keep (k), discard (d), or undecided (?) about retaining cultivars for further evaluation in subsequent trials.

2. *Plant Density*

   Plant numbers were counted as soon as practicable after emergence using a 0.25m x 0.40m quadrat. Three quadrats were randomly placed within each plot and plant numbers counted. The mean was used to calculate the number of emerged plants per square metre. At some sites, the number of emerged seedlings per linear metre of row was counted instead of using a quadrat.

3. *Plant Height*

   Sward height was determined using a ruler to measure average plant height (cm) in each plot at critical times of the growing season.

4. *Herbage Production*

The amount of dry matter produced by a cover crop has a direct effect on the amount of organic matter and nitrogen returned to the soil. Yield of the above-ground biomass was estimated by hand harvesting vegetation contained within three quadrats (0.1 square metre) randomly placed in each plot. Harvested samples were hand separated and the sown species portions oven dried for 24 hours at 80 degrees prior to weighing. Results are given in kg/ha dry weight.

Cultivar Assessments

Time of Assessment	*Data Collected*
June/July	Sward vigour rating Seedling density
August/September	Botanical composition Biomass production Percentage ground cover Sward vigour Sward height
October/November	Sward vigour Flowering percentage Sward height Percentage ground cover
January	Sward vigour (perennial spp.) Visual rating of dry residue Rating of seed set
May/June 1996	Regeneration Density of Swards
November 1997, April 1998	Permanent Sward vigour

Table 6.2.1 Timing of Assessments for 1995 sown variety screening trials.

6.2.3. 1995 Coonawarra field trial

This trial was established in a very well prepared seed bed, and growing conditions were such that good results were achieved. A full list of Species and Cultivars screened at this site are included in the appendices (see Appendix **15.19**). Cultivar performance was clearly defined and consistent across the replicates, and results appear in full in the appendices (see Appendix **15.20**). Tables **6.2.3.1** and **6.2.3.2** below summarise sward vigour ratings for the highest ranked permanent sward and green manure cultivars respectively in the Coonawarra trial.

Date	11-Jul-95	4-Sep-95	12-Jan-96	11-Jul-96	11-Sep-96	13-Nov-97	28-Apr-98
Medics							
Kelson	7.0	6.3	0.0	7.0	6.3	7.0	3.0
Paraggio	7.0	7.3	0.0	5.3	7.5	2.0	6.0
Santiago	5.0	5.8	0.0	4.5	7.0	7.0	6.0
Sub Clovers							
Argeles	5.5	5.8	0.0	6.5	6.2	7.5	7.5
Seaton Park	4.7	4.7	0.0	5.3	7.3	7.0	6.5
Gosse	3.7	4.3	0.0	4.5	7.3	9.0	6.0
Clare	5.3	4.8	0.0	4.5	7.8	8.5	7.5
White Clovers							
Tamar	4.8	4.5	5.0	6.0	8.5	5.0	1.0
Tahora	0.3	1.0	2.5	4.7	5.5	5.0	0.0
Perennial Grasses							
Porto Cocksfoot	5.2	4.2	4.7	6.5	5.8	8.5	9.0
Demeter Fescue	5.7	5.7	5.8	6.8	7.7	8.0	8.5
Tribute Fescue	5.5	4.0	5.7	6.5	8.7	9.1	8.5
Currie Cocksfoot	3.0	2.7	3.8	5.0	7.0	9.0	8.0
Ellet Ryegrass	7.8	6.2	4.7	8.0	7.8	8.5	7.5
Victorian Ryegrass	7.7	5.5	3.3	7.0	6.8	8.5	7.0

Table 6.2.3.1. Sward Vigour ratings for Permanent Swards in the 1995 sown Coonawarra site

	Sward Vigour Rating	*Sward Vigour Rating*	*Sward Vigour Rating*	*Herbage Yield Dry Wt (kg/ha)*
Vicia Species	***11-Jul-95***	***4-Sep-95***	***12-Jan-96***	***04-09-95***
Icarus Broad Bean	5.8	4.8	0.0	1375
Rossa Faba Bean	6.8	5.3	0.0	1330
TopCut Vetch	5.3	6.0	0.0	650
Ascot Faba Bean	6.0	4.3	0.0	610
Languedoc Vetch	6.2	6.0	0.0	565
Field Peas				
Laura	7.7	5.3	0.0	2910
Dundale	7.0	5.0	0.0	1715
Cereals				
Tahara Triticale	6.8	4.8	0.0	1560
Coolabah Oats	8.0	5.8	0.0	760
Echidna Oats	6.8	4.3	0.0	630
Brassicas				
Claret Mustard	5.5	4.0	0.0	505
Nemfix	6.7	3.8	0.0	340
Rangi Rape	8.2	4.2	1.3	80

Table 6.2.3.2. Sward Vigour ratings and Herbage Yield for high ranked Green Manure Swards in the 1995 sown Coonawarra site

A field walk for growers was held on 10 November 1995, with twenty participants Significant feedback from growers was received with regards to their own preferences for cover crop growth habit, plant height and maturity. Results are presented in full in the appendices.

Refer to plates 12.12 and 12.13 in the **Illustrations** *section*

6.2.4 1995 Barossa Valley field trial

The site was sown initially in late April 1995. A full list of Species and Cultivars screened at this site are included in the appendices (see Appendix **15.19**). A dense population of *Oxalis* (soursob) had established prior to seeding, but was not sprayed with Glyphosate prior to tillage as had been requested and subsequently a high density of soursob re-established in May 1995, smothering all but the large seeded varieties. As a result it was decided to spray half of the blocks with the systemic knockdown herbicides Roundup® (Glyphosate) and Goal® (Oxyfluorfen) in early June (*Refer to plates 12.14,12.15 and 12.16 in the* **Illustrations** *section).* These sprayed plots were resown on June 26 1995. Results from the late sowing were inconclusive, however the early sowing provided data on some green manure cover crop cultivars which had displaying good early vigour. The entire site was sprayed with Glyphosate in spring, and the majority of rows tilled with a rotary hoe.

Results are summarised in Tables **6.2.4.1 and 6.4.2.2** below, and are presented in full in the appendices (refer to Appendix **15.21**)

	Sward Vigour Rating	*Plant Density (#/square M)*	*Percent Ground Cover*	*Sward Height cm*
	30-08-95	*30-08-95*	*30-08-95*	*30-08-95*
Medics				
Paraggio	5.3	133	23.3	3.0
Caliph	4.3	97	6.7	2.7
Kelson	4.2	77	20.0	4.3
Santiago	4.0	60	8.3	2.0
Sub Clovers				
Clare	5.3	93	13.3	1.5
Denmark	4.8	113	13.3	1.7
Gosse	4.8	87	11.7	1.8
Rosedale	4.3	67	8.3	1.7
Leura	4.2	133	15.0	1.3
Argeles	3.8	73	20.0	1.3
Perennial Grasses				
Vedette Ryegrass	5.3	153	25.0	4.7
Ellet Ryegrass	4.8	163	26.7	7.3
Victorian Ryegrass	4.7	177	6.7	6.0
Skippy Ryegrass	3.8	183	15.3	5.3

Tables 6.2.4.1 Summary of the high ranked Permanent Sward cultivars at the 1995 sown Barossa Valley site.

	Sward Vigour Rating	*Plant Density (#/square M)*	*Percent Ground Cover*	*Sward Height cm*	*Herbage Yield(kg/ha) Dry Wt*
	30-08-95	*30-08-95*	*30-08-95*	*30-08-95*	*30-08-95*
Cereals					
Tahara Triticale	5.3	120	46.7	17.0	3537
Echidna Oats	6.2	147	46.7	18.3	3280
Coolabah Oats	3.7	110	36.7	12.3	3280
Brassicas					
Nemfix	4.8	140	33.3	5.7	1955
Rangi Rape	5.5	180	46.7	9.0	1345
Field Peas					
Laura	4.0	40	20.3	17.3	5860
Glenroy	4.2	50	31.7	19.0	5539
Dundale	3.0	40	20.0	15.0	5477
Vicia Species					
Icarus Broad Bean	1.0	17	1.0	7.3	7023
Ascot Faba Bean	3.0	30	20.3	13.3	5680
TopCut Vetch	2.7	37	6.7	8.0	3780
Popany Vetch	3.2	37	5.3	10.7	3150
Blanchefleur Vetch	4.2	60	25.0	8.3	1060

Tables 6.2.4.1 Summary of the high ranked Green Manure Cultivars at the 1995 sown Barossa Valley site.

6.2.5 1995 Griffith field trial

Excess rain in early winter made it inaccessible until spring for the purpose of collecting data. (*Refer to plates 12.9,12.10 and 12.11 in the* **Illustrations** *section.*). This trial was tilled by the vineyard owner in late summer 1995/96, and no data on regeneration was collected.

Results are summarised in tables 6.2.5.1 and 6.2.5.2 below, and are presented in full in the appendices (see Appendix **15.22**).

	Sward Vigour Rating	*Sward Vigour Rating*	*Sward Vigour Rating*	*Percent Ground Cover*
	18-8-95	*14-9-95*	*12-1-96*	*18-8-95*
Perennial Grasses				
Cajun Cocksfoot	3.0	2.5	5.0	20.0
Sirosa Phalaris	4.0	5.3	4.2	13.3
Sirolan Phalaris	5.2	3.8	3.5	8.3
Vedette Ryegrass	4.7	4.7	3.0	23.3
Victorian Ryegrass	6.0	5.8	2.3	30.0
Skippy Ryegrass	5.7	5.2	2.2	38.3
Medic Species				
Paraggio	5.8	5.3	0.0	50.0
Kelson	4.3	4.7	0.0	36.7
Parabinga	4.7	4.2	1.7	33.3
Maugio	4.0	4.2	3.2	15.0
Santiago	4.0	3.8	0.0	23.3
SubClovers				
Clare	7.5	8.0	0.0	93.3
Argeles	7.5	7.5	2.8	91.7
Nuba	6.0	5.8	5.5	63.3
White Clover				
Tamar	6.3	5.5	1.0	60.0
Waverley	5.3	5.2	0.0	36.7

Table 6.2.5.1 Summary of observations for high ranked Permanent Sward cultivars in the 1995 sown Griffith field trial.

Cultivar	*Sward Vigour Rating* *14-09-95*	*Herbage Yield(kg/ha) Dry Wt* *14-09-95*	*Percent Ground Cover* *18-08-95*	*Sward Height cm* *14-09-95*
Rossa Faba Bean	6.2	2963	63.3	63
Icarus Faba Bean	4.0	2407	18.3	47
Glenroy Field Pea	5.2	2913	36.7	48
Dundale Field Peas	6.0	2727	65.0	53
Clare Subclover	8.0	2820	93.3	27
Argeles Subclover	7.5	2710	91.7	25
Nungarin Subclover	5.5	2420	68.3	15
Elite Berseem Clover	7.8	2343	70.0	43
Paradana Balansa Clover	7.2	2600	93.3	40
Topcut Vetch	8.5	2780	83.3	40

Table 6.2.5.2 Summary of observations for high ranked Green Manure cultivars in the 1995 sown Griffith field trial.

6.2.6 1995 Mildura field trial

A good early establishment was achieved at this site, generating good data for the growing season. The vineyard in which this trial was conducted was redeveloped in early 1996, and no further data was generated. *Refer to plates 12.17,12.18 and 12.19 in the* **Illustrations** *section.*

Results are summarised in the tables 6.2.6.1 and 6.2.6.2 below and are presented in full in the appendices (Refer to Appendix **15.23**).

	Sward Vigour Rating *14-6-95*	*Sward Vigour Rating* *15-8-95*	*Percent Ground Cover* *15-8-95*	*Sward Height cm* *15-8-95*
Medic Species				
Parabinga	4.7	7.0	36.7	9
Zodiac	6.0	6.3	51.7	7
Harbinger AR	7.3	6.2	53.3	3
Santiago	5.2	6.0	50.0	5
Caliph	5.2	5.7	50.0	6
SubClovers				
Denmark	3.8	5.3	41.7	14
Goulburn	4.3	5.2	30.0	2
Seaton Park	3.2	5.0	40.0	2
Junee	3.8	4.8	33.3	2
Nungarin	3.7	4.0	11.7	2
White Clover				
Tamar	5.3	5.8	38.3	5
Tahora	4.0	4.0	26.7	3
Perennial Grasses				
Vedette Ryegrass	5.3	6.7	43.3	3
Ellet Ryegrass	6.0	6.5	36.7	3
Skippy Ryegrass	5.8	6.5	36.7	4
Victorian Ryegrass	6.2	6.3	35.0	3
Porto Cocksfoot	6.0	5.3	18.3	2
Currie Cocksfoot	4.0	4.7	10.0	3
Sirosa Phalaris	5.5	3.7	16.7	3
Demeter Fescue	4.3	3.0	trace	2

Table 6.2.6.1 Summary of observations for high ranked Permanent Sward cultivars in the 1995 sown Mildura field trial.

	Sward Vigour Rating	*Herbage Yield(kg/ha) Dry Wt*
	14-6-95	*15-8-95*
Cultivar		
Laura Field Pea	1.8	6950
Glenroy Field Pea	2.5	2900
Dundale Field Pea	2.3	2800
Gisilba White Mustard	1.7	4526
Nemfix	5.3	2853
Ascot Faba Bean	6.3	4243
Icarus Faba Bean	4.0	2467
Rossa Faba Bean	7.7	3363
Coolabah Oats	8.0	3706
Echidna Oats	5.0	3675
Sala Oat	6.2	2643
Popany Vetch	4.5	2933
Rangi Rape	4.0	3733
Paradana Balansa Clover	3.5	1793
Kelson Snail Medic	4.8	1550

Table 6.2.6.2 Summary of observations for high ranked green manure cultivars in the 1995 sown Mildura field trial.

6.2.7 Conclusions And Recommendations From 1995 Field Trials

Trial results in 1995 highlighted several factors for consideration in future trial planning and cover crop management.

1. *Timing of sowing*

   A major objective should be to ensure all trial seeding is completed by the end of April. Early districts, such as the Riverland should be sown by mid April to take advantage of warm soil temperatures and overhead irrigation to establish crops early. Cover crops sown after mid May generally have reduced winter productivity.

2. *Seeding rates*

   One of the benefits derived from cover crops is the ability to block-out weeds, in winter and/or summer. Higher sowing rates ensure higher plant densities and hence improved winter production and more rapid establishment. Not only does this confer better weed suppression, but also enhances top soil protection and improves trafficability. As a result, sowing rates were adjusted upwards for 1996 trials, with the increment varying according to the district and species.

3. *Fertiliser*

   A priority apparent from observations in 1995 trials is to ensure adequate fertiliser is applied to the mid-row either prior to cover crop seeding, or shortly there after. Deficiencies were obvious at several sites in 1995, with crops such as Rangi Rape particularly sensitive to a lack of nutrients. These deficiencies indicated the need to consider topdressing of cover crops in winter, particularly in seasons of high winter rainfall, on lighter soils, or where a low nutrient status exists.

4. *Blends*

   A number of cultivar mixtures were formulated to address specific management requirements in each district in 1996. A full list of these blends is described for each trial site later in this report. Seed blends were created to address the following scenarios:

   a) Annual regenerating sward (dry land and irrigated)
   b) Perennial permanent sward (dry land and irrigated)
   c) Annual green manure (single cut)
   d) Annual mulch producer (multi cut for undervine mulching)
   e) Bio fumigant swards
   f) Beneficial/insectary blend

5 *Maturity/Dormancy*

Common practice in high frost risk districts is mowing/spraying of swards followed by cover crop incorporation prior to budburst in early spring. Such a practice does not allow for any regeneration of cover crop species, regardless of maturity, and winter/spring productivity is the major issue with such crops. In a minimum or zero tillage system, a regenerating sward not requiring re-sowing each year may be preferred to a green manure crop. Where bud damage from frost is not a high risk, early maturity/dormancy of self regenerating species is a desirable trait, as competition for water and nutrients between the cover crop and vines post bud burst should be minimised. Hence maturity of cover crop species should be matched to the growing season of the district, and the need to describe the frost/spring sward management interaction, as well as the water/nutrient balance associated with a permanent cover crop sward.

6. *Pests and Disease*

Consideration needs to be given to potential pests and the hosting ability of the cover crop. Insects such as Light Brown Apple Moth (LBAM), soil borne nematodes, phytoplasmas, viral diseases and fungal pathogens all have potential for diminishing grape yield and quality. As a result, care needs to be taken when suggesting particular cover crops where pest or disease pressure is high. Conversely, cover crops may play a role in integrated pest management systems, and confer benefits regarding control or suppression of pests and/or disease.

6.3 1996 Trial Results

6.3.1 Trial Site Locations

Sites for trials in 1996 were identified in January of that year, and contact made with growers and retailers willing to assist in the promotion of field days and seminars of spring 1996. A total of eighteen major sites were established in Autumn of 1996 covering three states and most of the major wine growing areas within. Details of sites are listed in table 6.3.1 below. Sowing commenced at the completion of vintage in March-April 1996 and again utilised small plot cone seeders where possible. In addition, five secondary sites were sown with co-operator assistance, and were used for project extension purposes only, and are listed in table 6.3.2. Monitoring of regeneration and persistence of cover crop swards in 1995 trials continued in 1996.

Region/Location	State	Co operator	Assessed
Adelaide Hills	South Australia	Private Grower	√
Eden Valley	South Australia	Private grower	√
Angaston	South Australia	Yalumba	√
Nuriootpa	South Australia	Mildara Blass	X
Auburn	South Australia	Private grower	√
Clare Valley	South Australia	Southcorp	√
Langhorne Creek	South Australia	Orlando Wyndham	√
McLaren Vale	South Australia	Seaview	X
Padthaway	South Australia	BRL Hardy	√
Coonawarra	South Australia	Southcorp	√
Coonawarra	South Australia	Hollicks	X
Great Western	Victoria	Southcorp	X
Mitchelton	Victoria	Petaluma	√
Rutherglen	Victoria	Pfeiffers	√
Yenda	New South Wales	Private Grower	√
Hanwood	New South Wales	McWilliams Winery	√
Mildura	Victoria	Private Grower	√
Mildura	Victoria	Private Grower	X
Waikerie	South Australia	Southcorp	√

Table 6.3.1 List of 1996 major trial sites

Region/Location	State	Co operator
Robe	South Australia	Cape Jaffa Wines
Renmark	South Australia	Private Grower
Loxton	South Australia	Private Grower
Padthaway	South Australia	Orlando Wyndham
Clare	South Australia	Southcorp

Table 6.3.2 List of secondary/demonstration trial sites for 1996

6.3.2 Assessments

Agronomic data from trials sown in 1996 was collected during the growing season. A list of the assessments conducted across the various 1996 trials appear in table 6.3.3 below. Not all assessments were conducted at all sites.

Timing of Assessment	Assessments Made
Early Winter	Sward vigour rating Emergence density
Early Spring	Sward vigour rating Sward height Percentage ground cover Biomass production (kg/ha dry wt
Mid Summer	Residue persistence Sward vigour rating Percentage ground cover Sward height

Table 6.3.3 Summary of Assessments Conducted in 1996 Cover Crop Trials

6.3.3 1996 Adelaide Hills Trial

Site details

Co operator/Vineyard:	New Era Vineyard
Contact:	Pat Wark
Address:	PO Box 239, Woodside SA 5244
Soil Type:	Clay loam
Soil pH:	Acidic
Irrigation Method:	Dripper
Mean Annual Rainfall:	700 mm
Grape Variety::	Cabernet Sauvignon

SEEDING DETAILS

Date Sown:	24 April 1996
Fertiliser:	Fertilized at the time of seeding with 100 kg/ha of DAP
Seed Bed Preparation:	Disced
Additional Comments:	Refer to Appendix **15.24** for a list of treatments included in the 1996 screening trial. A moderate burden of phalaris and wire weed residues impeded the passage of the seeder through the vineyard. The soil surface was quite uneven and inconsistent, and consequently seed placement was erratic with regards depth of burial and rate of application.

RESULTS AND DISCUSSION

Most of the above treatments included in this trial appeared to have little application in vineyards in the higher rainfall areas of the Adelaide Hills. Annual resown cover crops are not desired where medium to high rainfall is combined with steep or sloping topography. The reasons for this include: increased erosion potential, poor spring and summer trafficability, and the desire for zero or minimum tillage systems. Fescues are often the preferred perennial grass in this area according to feedback from growers at the 1996 Field day, as they apparently provide greater traction for vehicles traversing the mid rows. Other perennial grasses such as ryegrass and cocksfoot also have application and good adaptation in these areas. A legume component is not always desired in this area, with concerns over Light Brown Apple Moth hosting ability, and the potential to cause wheel slip in steeper country. Swards containing a combination of perennial grasses and annual subclovers do have application in vineyards where this wheel slip problem is not a concern.

CONCLUSIONS

Essentially only perennial swards should be applied in Adelaide Hills vineyards.
The objectives of this mid row option include weed suppression and trafficability, as well as soil structure maintenance and improvement.

RECOMMENDATIONS

Turf type fescues, perennial ryegrasses and cocksfoot cultivars all have application in areas of the Adelaide Hills. Available cultivars include Demeter, Tribute and Triumph fescues, Victorian, Ellet and Roper ryegrass, and Porto and Currie cocksfoot. Suitable sub clover varieties include Denmark, Gosse and Clare. Perennial clovers are not deemed suitable for this area. Cereals such as ryecorn can be combined with perennial seed prior to seeding, subsequently providing vigorous early ground cover to protect the soil surface in early winter without inhibiting the growth and development of the less vigorous pasture species. Rates of Ryecorn or Oats should not exceed 30 kg per sown hectare.

Perennial grasses with summer dormancy are desired in drip irrigated vineyards in the "drier" parts of this region. Annual tillage must be avoided, and swards maintained at low heights to preserve plant density and optimise weed suppression and erosion prevention. Where vine rows run up a slope, it may be preferable to broadcast seed as opposed to drilling seed in rows, as this can cause rilling when run off occurs.

6.3.4 1996 Eden Valley Trial

Site details

Co operator/Vineyard:	Mildara Blass
Contact:	Gil Rogers
Address:	Flaxmans Glen Props EDEN VALLEY SA 5235
Soil Type:	Heavy Grey Clay/Loam
Soil pH:	5.5
Irrigation Method:	Dripper
Rainfall:	600mm

SEEDING DETAILS

Date Sown:	26 April 1996
Fertiliser:	DAP at 100 kg/ha applied post sowing
Seed Bed Preparation:	Tilled mid row
Additional Comments:	Refer to Appendix **15.24** for a list of treatments included in the 1996 screening trial. Four mm rainfall received on the day of seeding. A very high Red Legged Earth Mite pressure existed. Two applications of Le Mat were applied at the time of seeding, plus 3 weeks later. Plots 125 to 133 were oversown with oats several weeks after trial establishment. The soil at this site is very acidic, and lime was applied in previous seasons to ameliorate this problem.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	19 September 1996
Sward Height	19 September 1996
Ground Cover Percentage	19 September 1996

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 19-Sep*	*SWARD HEIGHT 19-Sep*	*PERCENT GROUND COVER 19-Sep*
BLEND 'H'	8.5	71.7	96.7
ROSSA FABA BEAN	7.9	87.5	92.5
COOLABAH/TOPCUT	6.7	60.0	88.3
POPANY	7.9	43.8	83.8
BLEND 'F'	8.3	21.8	82.5
BLEND 'G'	6.3	70.0	81.7
SANTIAGO	7.0	13.7	78.3
BLEND 'D'	6.7	19.0	73.3
BLEND 'E'	7.9	95.0	72.5
TRITICALE	9.0	93.8	68.8
ADAGIO	9.2	123.3	65.0
COOLABAH	6.8	65.0	53.3
GLENROY	5.9	72.5	50.0
CLARE/NUBA/VICTORIAN	5.3	13.8	50.0
TOPCUT/ELITE/NITRO PLUS	4.0	15.3	50.0
BLEND 'A'	6.4	17.3	41.8
CLARE	4.2	4.7	38.3
RANGI RAPE	4.8	24.3	37.5
PALESTINE/DEMETER	6.5	14.7	36.7
COOLABAH/KELSON	5.2	54.7	35.0
COOLABAH/BLANCHEFLEUR	3.3	41.7	35.0
BLEND 'B'	4.7	50.0	28.3
BLEND 'J'	4.0	13.5	27.5
TAMAR/ELLET	5.0	11.3	25.0
WAVERLEY/ELLET	3.0	14.0	23.4
BLEND 'C'	3.5	53.3	21.7
BLEND 'I'	2.0	21.3	15.0
GOULBURN	3.0	3.0	13.3
NEMFIX	3.0	46.7	8.3
GUNGURRU/FENUGREEK	3.0	25.0	8.3
SANTIAGO/SERENA	2.8	7.0	8.0
PARABINGA/PARAGGIO	0.5	1.3	1.3
MOGUL	0.0	0.0	0.0
LSD(95%)	0.8	6.7	9.2

BLEND 'A': CURRIE/VICTORIAN/MATILDA
BLEND 'B': COOLABAH/ELITE/MARAL/NITRO PLUS
BLEND 'C': COOLABAH/NEMFIX/SEATON PARK
BLEND 'D': NUNGARIN/SEATON PARK/MATILDA
BLEND 'E': TRITICALE/BLANCHEFLEUR/POPANY/TOPCUT
BLEND 'G': GLENROY/COOLABAH/ROSSA FABA BEAN/BLANCHEFLEUR/POPANY/ARGELES/SANTIAGO
BLEND 'H': GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO
BLEND 'I': BLANCHEFLEUR/HIGHLANDER/HYKON/WAVERLEY/FENUGREEK/PROLIFIC/CURRIE/SEATON PARK
BLEND 'J': TAMAR/WAVERLEY/ELLET/CURRIE

Table 6.3.4.1 Summary of observations of treatments at the Eden Valley trial site sown in 1996.

This site was sprayed out in October 1996, and oversown in autumn 1997, and no further data was gleaned from it. Refer to Appendices **15.26** for results. The trial area became severely waterlogged in mid winter, and surviving species were deemed to be more tolerant of these circumstances. September assessments identified annual resown species with good adaptation to this area, and the performed better pasture varieties and blends.

CONCLUSIONS

Triticale performed better than oats in this water logged trial area. Vicia species, namely vetch and faba bean also provided good bulk and ground cover. Fodder radish produced good amounts of biomass and ground cover at this trial site. Pasture species tolerant of acidic, water logged soils, wet winters and high levels of red legged earth mite infestation. Better performed species include fescue, white clover and perennial ryegrass.

RECOMMENDATIONS

Cold wet winters in this region can inhibit sward establishment and growth. Seeding prior to the end of May is preferred. Optimal green manure cover crops should contain some Vicia species and triticale. The longer season vetch varieties such as Popany and Topcut provide good growth, but these cultivars must be incorporated to terminate growth in September, thus avoiding seed set. Escape plants of these varieties can be invasive and are difficult to control with herbicides such as glyphosate. Soft seeded varieties such as Blanchefleur are preferred. Fodder radish is an option for growers in this region if weed suppression is desired.
Pasture varieties such as Gosse and Denmark subclover, and Santiago medic appeared to tolerate the growing conditions the best. Tthese species should be grown in combination with perennial ryegrass varieties such as Ellet, Roper and Matilda.
Specific attention must be paid to the control of Red Legged Earth Mite both in autumn and in spring to avoid loss of seedlings, and to maximise seed set and regeneration.

6.3.5 1996 Angaston Trial

Site details

Co operator/Vineyard:	Yalumba Winery
Contact:	Robin Nettlebeck
Address:	Yalumba Wines PO Box 10 ANGASTON SA 5353
Soil Type:	Clay Loam
Soil pH:	7.0
Irrigation Method:	Micro Sprinkler (for waste water), and dripper
Rainfall:	500 mm

SEEDING DETAILS

Date Sown:	26 April 1996
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	Direct Drill
Additional Comments:	The site did not establish well in the first winter, and vigour and growth was very poor for all treatments. Annual green manure treatments did not successfully establish at this site, however, by mid summer of 1996/97, all permanent sward type plots were well established and relatively free of weed burden. These permanent swards still exist, and continue to be monitored at the time of writing this report.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	28/9/96, 6/2/97, 17/8/97, 16/1/98
Summer Residue Density	6/2/97
Ground Cover Percentage	6/2/97
Summer Weed Density Rating	6/2/97

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 28-Sep-96*	*SWARD VIGOUR RATING 6-Feb-97*	*SWARD VIGOUR RATING 17-Aug-97*	*SWARD VIGOUR RATING 16-Jan-98*	*RESIDUE DENSITY 6-Feb-97*	*WEED DENSITY 6-Feb-97*	*PERCENT GROUND COVER 6-Feb-97*
CURRIE/VICTORIA/MATILDA	5.0	8.6	9.5	7.0	2.1	0.3	68.8
CLARE/NUBA/VICTORIAN	7.5	7.1	9.2	6.5	2.6	0.8	51.3
CLARE	8.0	0.5	7.8	0.0	2.6	1.3	4.3
DEMETER	6.0	6.8	7.2	6.0	0.8	1.5	43.8
DENMARK/GOSSE/ELLET	7.5	7.1	7.0	5.2	2.8	0.3	56.3
ARGELES	6.0	0.5	7.0	0.0	2.6	0.5	3.8
BLEND 'F'	5.0	8.3	6.5	5.5	2.6	0.5	68.8
DENMARK	3.5	0.5	6.0	0.0	2.5	0.7	2.3
CINDY RED FESCUE	4.0	6.0	5.8	6.0	0.7	2.0	31.7
PALESTINE/DEMETER	5.5	5.8	5.5	6.2	1.2	0.8	30.0
CALIFORNIAN BROME	4.0	4.8	4.5	1.0	1.5	2.0	17.5
GOULBURN	3.0	0.3	4.5	0.0	2.3	1.4	0.3
SANTIAGO/SERENA	1.0	0.0	3.0	0.0	1.3	1.5	0.0
CALIPH	5.5	0.0	3.0	0.0	0.6	3.0	0.0
SANTIAGO	2.5	0.0	2.5	0.0	1.2	1.1	0.0
PARAGGIO/PARABINGA	4.0	0.0	2.0	0.0	0.8	2.0	0.3
POPANY	5.0	0.0	2.0	0.0	1.3	1.4	0.0
BLANDO BROME/PALESTINE	3.0	1.0	2.0	0.0	2.7	1.5	10.0
BLANDO BROME	5.0	0.0	1.0	0.0	1.9	1.3	0.0
BLEND 'A'	4.5	0.0	0.0	0.0	2.4	1.2	0.0
RANGI RAPE	1.0	3.4	0.0	0.0	0.9	0.8	18.8
GLENROY	2.8	0.0	0.0	0.0	0.8	2.3	0.0
COOLABAH	6.0	0.0	0.0	0.0	2.6	1.3	0.0
TRITICALE	6.5	0.0	0.0	0.0	3.4	0.5	0.0
BLEND 'B'	4.0	0.0	0.0	0.0	2.6	0.6	0.0
BLEND 'C'	6.0	0.0	0.0	0.0	2.7	0.8	0.0
COOLABAH/BLANCHEFLEUR	5.0	0.0	0.0	0.0	2.9	1.2	0.0
FENUGREEK	2.0	0.0	0.0	0.0	0.9	1.4	0.0
ADAGIO	5.0	0.2	0.0	0.0	1.8	1.5	1.0
BLEND 'D'	7.0	0.1	0.0	0.0	2.2	1.0	0.5
ROSSA FABA BEAN	3.0	0.0	0.0	0.0	1.1	1.3	0.0
COOLABAH/TOPCUT	6.0	0.0	0.0	0.0	1.8	1.2	0.0
BLEND 'E'	4.0	0.3	0.0	0.0	2.7	1.2	1.3
NEMFIX	2.0	0.0	0.0	0.0	1.8	1.5	0.0

BLEND 'A' COOLABAH/ELITE II/ MARAL/ NITRO PLUS
BLEND 'B' COOLABAH/ NEMFIX/ SEATON PARK
BLEND 'C' TRITICALE/BLANCHEFLEUR/TOPCUT/POPANY
BLEND 'D' GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO
BLEND 'E' GLENROY/COOLABAH/ROSSA FABA BEAN/BLANCHEFLEUR/POPANY/ARGELES/SANTIAGO
BLEND 'F' TAMAR/WAVERLEY/ELLET/CURRIE

Table 6.3.5.1 Summary of observations of cover crop treatments at the Yalumba Winery, Angaston site sown in 1996.

The swards based on Currie cocksfoot and Victorian and Matilda ryegrasses persisted well into the second year, and provided excellent summer weed suppression, as did the Victorian ryegrass plus annual subclover treatment. Perennial grasses appear well adapted to this vineyard site. Cocksfoot is demonstrably slow to establish, exhibiting low winter vigour in the year of seeding. However, high vigour was exhibited in the summer and subsequent winters. Demeter fescue persisted well in the second year also. Cindy creeping red fescue grew well in the second year, however these swards suffered from a low plant density.

Clare, Argeles and Denmark subclovers regenerate well in the second year.

Of the green manure treatments, those ranking highly in the first year were oats and triticale, and blends of these two cereals and legumes such as beans and vetch. Monocultures of beans and brassica species did not perform well at this site.

6.3.6 1996 Nuriootpa Trial

Site details

Co operator/Vineyard:	Mr Wayne Rohrlach
Address:	PO Box 180 NURIOOTPA SA 5355
Soil Type:	Light Sand
Soil pH:	8.2
Irrigation Method:	Dripper
Rainfall:	

SEEDING DETAILS

Date Sown:	26 April
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	Rotary Hoe
Additional Comments:	A very sandy site which was overgrown with soursob in winter. Site was green manured in August negating opportunities for continued monitoring and field days.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	8 July 1996
Sward Height	8 July 1996
Ground Cover Percentage	8 July 1996

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 8-Jul*	*PERCENT GROUND COVER 8-Jul*	*SWARD HEIGHT 8-Jul*
GLENROY	7.5	50.0	30.0
BLEND 'B'	6.9	50.0	30.0
ADAGIO	7.1	80.0	25.0
COOLABAH/KELSON	6.8	30.0	15.0
BLEND 'C'	6.3	40.0	15.0
BLEND 'E'	6.3	50.0	15.0
COOLABAH/TOPCUT	5.8	35.0	15.0
BLEND 'D'	5.5	20.0	15.0
BLEND 'A'	5.0	35.0	15.0
ROSSA FABA BEAN	6.8	30.0	11.0
COOLABAH	6.6	20.0	10.0
POPANY	6.1	25.0	10.0
TOPCUT	5.4	20.0	8.0
RANGI RAPE	6.4	45.0	7.0
BLEND 'F'	5.3	20.0	5.0
DENMARK/GOSSE/ELLET	4.9	40.0	5.0
PARABINGA/PARAGGIO	4.1	30.0	5.0
PALESTINE/DEMETER	3.8	15.0	5.0
NUNGARIN/SEATON PARK/MATILDA	3.8	30.0	5.0
MATILDA	3.5	25.0	5.0
CURRIE/VICTORIAN/MATILDA	5.3	30.0	4.0
CLARE	5.3	70.0	4.0
FENUGREEK	4.6	25.0	4.0
CALIPH	4.5	40.0	4.0
HARBINGER AR	3.9	40.0	4.0
SANTIAGO	3.8	35.0	4.0
DEMETER	3.1	15.0	4.0
MOGUL	4.5	30.0	3.0
CLARE/NUBA/VICTORIAN	4.4	20.0	3.0
GOULBURN	3.1	25.0	3.0
SANTIAGO/SERENA	2.9	20.0	3.0
HIGHLANDER	2.5	15.0	3.0
ZODIAC	1.9	10.0	2.0

BLEND 'A': GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO
BLEND 'B': TRITICALE/BLANCHEFLEUR/POPANY/TOPCUT
BLEND 'C': GLENROY/COOLABAH/ROSSA FABA BEAN
BEAN/BLANCHEFLEUR/POPANY/ARGELES/SANTIAGO
BLEND 'D': COOLABAH/ELITE/MARAL/NITRO PLUS
BLEND 'E': COOLABAH/NEMFIX/SEATON PARK/PARAGGIO
BLEND 'F': TAMAR/WAVERLEY/ELLET/CURRIE

Table 6.3.6.1 Observations of cover crop treatments at the Nuriootpa trial site, established in 1996

The site was terminated in August 1996 by the grower without consulting the Project Manager, restricting the data obtained from this site. The annual species which established the best at this site included Glenroy peas, Adagio fodder radish, triticale, and vetch blend and faba beans. The alkaline nature of the soil meant that annual medics were better performed than other pasture species. The best annual medics appeared to be Caliph, Harbinger AR and Santiago. Clare sub clover demonstrated an adaptation to the sandy, alkaline soil type. Adagio fodder radish established rapidly, providing maximum ground cover early in winter.

RECOMMENDATIONS

Due to the light sandy soil, the preferred cover crop system in this scenario will be annual resown. Fodder legume swards appeared to provide optimal growth in this trial, and should be included in forage blends in combination with either triticale or oats to maximise green manure production. Early maturing medics such as Santiago may have an application where an annual regenerating swards is desired. Such a cover crop must be maintained at a low height to maximise seed set. A light incorporation of pods each autumn may be required after initial establishment to promote germination and establishment. This can be facilitated by drilling an annual species such as oats or triticale in to the area prior to the opening rains.

6.3.7 1996 Auburn Trial

Site details

Co operator/Vineyard:	Private Grower
Contact:	Nick Zwiersen
Address:	Stanley Street AUBURN SA 5451
Soil Type:	Clay Loam
Soil pH:	6.5
Irrigation Method:	Dryland
Rainfall:	550 mm

SEEDING DETAILS

Date Sown:	22 April 1996
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	Cultivated
Additional Comments:	The block in which this trial was sown was tilled in early summer of 1996. Consequently, no data was obtained from this site after the first year.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	24/7/96, 2/9/96
Sward Height	24/7/96, 2/9/96
Ground Cover Percentage	24/7/96, 2/9/96
Percent flowering	2/9/96
Fresh Weight Yield	2/9/96

RESULTS AND DISCUSSION

CULTIVAR	*VIGOUR SWARD RATING 24-Jul*	*VIGOUR SWARD RATING 2-Sep*	*SWARD HEIGHT 24-Jul*	*SWARD HEIGHT 2-Sep*	*GROUND PERCENT COVER 24-Jul*	*GROUND PERCENT COVER 2-Sep*	*PERCENT FLOWER 2-Sep*
BLANCHEFLEUR	4.2	8.4	8.0	23.0	15.0	78.8	0.0
CLARE	4.6	8.3	20.0	26.0	20.0	77.5	0.0
ADAGIO	7.9	8.1	16.0	17.3	37.5	57.5	0.3
BLEND 'C'	4.7	8.0	15.0	18.8	15.0	56.3	0.0
DENMARK	1.6	8.0	1.0	34.3	5.0	63.8	2.5
ARGELES	3.1	7.9	6.5	31.8	6.5	72.5	0.8
PARAGGIO/PARABINGA	4.6	7.9	6.5	27.0	15.0	75.0	0.0
NUNGARIN/JUNEE/MATILDA	2.5	7.6	4.0	20.5	10.0	65.0	0.0
TRITICALE	6.8	7.6	25.0	31.3	25.0	63.8	0.0
COOLABAH/KELSON	5.1	7.4	14.0	20.8	30.0	65.0	0.0
PARADANA	2.3	7.4	1.0	34.5	2.0	55.0	0.0
NEMFIX	7.9	7.3	13.0	15.5	95.0	60.0	1.3
BLEND 'A'	6.8	7.2	20.0	19.7	50.0	38.3	0.0
SANTIAGO/SERENA	4.5	7.1	11.5	20.5	22.5	45.0	2.5
RANGI RAPE	5.4	7.1	7.5	26.3	27.5	70.0	0.0
GLENROY	6.0	7.1	20.0	11.3	10.0	60.0	0.0
COOLABAH/NEMFIX/JUNEE	7.8	7.1	15.0	25.5	60.0	51.3	6.3
BLEND 'B'	3.9	7.0	20.0	25.3	15.0	57.5	0.0
GOSSE	3.5	7.0	1.0	25.5	8.0	47.5	6.8
CURRIE/VICTORIAN/MATILDA	5.3	7.0	12.5	30.5	32.5	56.3	0.3
JUNEE	2.0	6.9	1.0	21.8	8.0	35.0	0.0
PALESTINE/DEMETER	2.3	6.8	1.0	31.3	2.0	41.3	2.5
BLEND 'D'	8.5	6.8	18.0	6.8	40.0	60.0	0.0
TAMAR/VICTORIAN	4.6	6.6	4.0	35.3	10.0	56.3	0.5
DENMARK/GOSSE/ELLET	4.5	6.4	7.0	19.3	15.0	47.5	0.0
CLARE/NUBA/VICTORIAN	4.6	6.4	4.0	4.8	15.0	62.5	0.0
TOPCUT	2.2	6.3	8.0	11.3	5.0	43.8	0.0
DEMETER	3.5	6.0	5.5	7.5	17.5	48.8	0.0
NUBA	3.4	5.9	2.0	19.5	25.0	33.8	1.3
COOLABAH	4.5	5.6	1.0	12.5	7.0	41.3	0.0
POPANY	6.0	5.1	12.0	15.8	20.0	35.0	1.3
ROSSA FABA BEAN	5.1	5.0	10.0	10.0	20.0	51.7	0.0
WAVERLEY/VICTORIAN	5.2	4.9	4.0	21.0	10.0	42.5	0.0
LSD(95%)	0.6	1.2		12.1		20.5	

Table 6.3.7.1 Summary of results and observations made at the Auburn trial site established in 1996.

GREEN MANURE CROP	*FRESH WEIGHT YIELD (MT/HA)*
ADAGIO	62.5
NEMFIX	51.7
COOLABAH	46.7
BLEND 'A'	40.4
BLANCHEFLEUR	38.8
RANGI RAPE	31.7
COOLABAH/NEMFIX/JUNEE	29.6
ROSSA FABA BEAN	25.4
BLEND 'D'	24.1
BLEND 'C'	21.7
GLENROY	20.1
BLEND 'B'	19.6
TRITICALE	17.9
POPANY	13.8
COOLABAH/KELSON	12.5
TOPCUT	6.7

Table 6.3.7.2 Summary of fresh weight yield data from harvest taken in green manure treatments on the 2 September 1996 at the Auburn trial site.

CONCLUSIONS

All treatments established with good vigour at this site. The weed burden was low and all species were expressed in blends. Adagio fodder radish achieved the highest herbage yield at this site. Another brassica species, Nemfix mustard, achieved the second highest fresh weight yield, followed by Coolabah oats and the blend of oats, mustard and annual medic. Monocultures of faba beans and oats proved relatively ineffective at this site. Of the annual regenerating pasture legumes, the cultivars of subclover which proved most effective were Clare, Denmark and Argeles.

The sward consisting of Parabinga and Paraggio barrel medics performed well in the year of establishment. Unfortunately this site was tilled in early summer 1996, and an annual cover crop established in autumn which prevented the logging of persistence and regeneration data.

6.3.8 1996 Langhorne Creek Trial

Site details

Co operator/Vineyard:	Orlando Wyndham
Contact:	Caroline Shaw
Address:	PO Box 846 LANGHORNE CREEK SA 5255
Soil Type:	Sandy Loam
Soil pH:	8.5
Irrigation Method:	Dripper
Rainfall:	350 mm

SEEDING DETAILS

Date Sown:	19 April 1996
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	Rotary Hoe
Additional Comments:	A very sandy site with a high population of soursob and winter weeds, as well as couch. Accuracy of seeding depth was difficult because of the high weed and trash burden which continually blocked the seeder. A high winter weed population developed in this trial, and assessments were made of weed suppression ability of various swards. Entire trial area was accidentally sprayed with Glyphosate in late spring 1996, hence no further monitoring of treatments at this site was possible.

ASSESSMENTS CONDUCTED

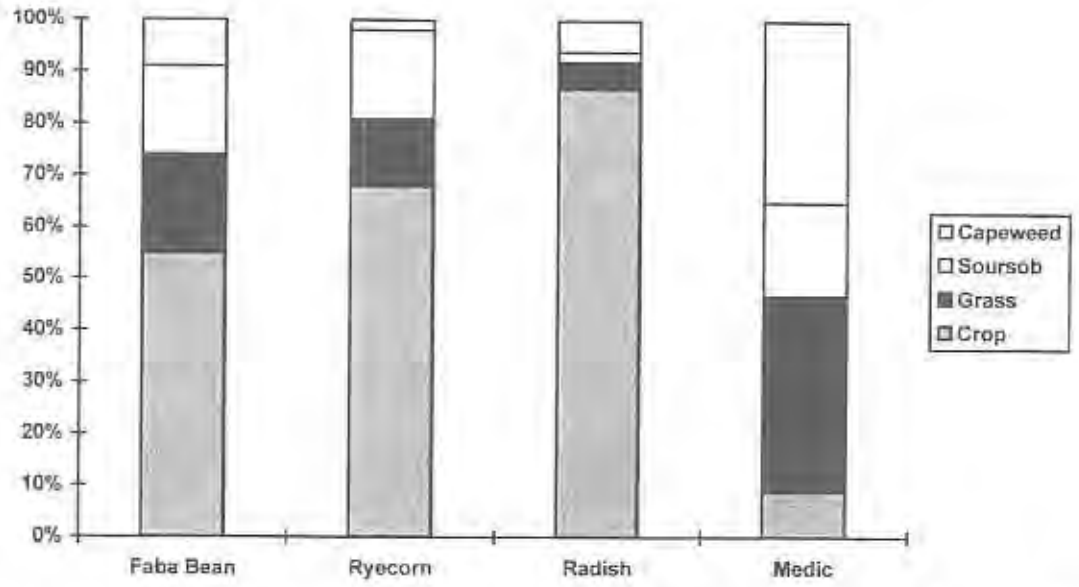
Assessments conducted	Date
Vigour Rating	27 June 1996, 2 September 1996
Sward Height	27 June 1996, 2 September 1996
Ground Cover Percentage	27 June 1996, 2 September 1996
Biomass Production	2 September 1996

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 27-Jun*	*SWARD VIGOUR RATING 2-Sep*	*PERCENT GROUND COVER 27-Jun*	*PERCENT GROUND COVER 2-Sep*	*SWARD HEIGHT 27-Jun*	*SWARD HEIGHT 2-Sep*
BLANCHEFLEUR	6.0	10.0	53.8	80.0	35.0	52.5
BLEND 'A'	5.8	8.7	45.0	93.3	25.0	120.0
BLEND'C'	6.1	8.5	37.5	92.5	32.5	90.0
COOLABAH	4.8	8.0	40.0	60.0	16.7	112.5
RANGI RAPE	7.0	7.5	55.0	47.5	42.5	105.0
ROSSA FABA BEAN	5.3	7.0	62.5	77.5	31.3	75.0
ADAGIO	4.5	6.5	25.0	60.0	27.5	60.0
COOLABAH/KELSON	7.6	6.5	78.8	55.0	38.8	75.0
CLARE/NUBA/VICTORIAN	1.5	6.5	5.0	50.0	2.0	27.5
NEMFIX	4.1	6.3	36.3	60.0	25.0	80.0
LANGUEDOC	2.3	6.0	9.3	52.5	9.0	35.0
NITRO PLUS	1.0	6.0	2.0	40.0	2.0	22.5
SANTIAGO	2.3	6.0	7.5	37.5	5.0	32.5
PARABINGA	1.9	5.8	1.5	65.0	1.3	10.0
CEREAL RYE	3.6	5.5	11.3	43.3	11.3	43.3
GLENROY	4.3	5.5	13.0	37.5	6.3	20.0
JUNEE	3.3	4.8	25.0	55.0	16.3	90.0
BLEND 'B'	5.6	4.5	23.8	25.0	32.5	55.0
HARBINGER AR	0.1	3.5	0.3	35.0	0.3	10.0
MOGUL	4.6	3.5	18.8	25.0	16.3	45.0
POPANY	0.8	3.3	2.5	20.0	1.3	15.0
O'CONNORS/MATILDA	1.5	3.0	3.8	25.0	2.0	5.0
NUNGARIN/JUNEE/MATILDA	1.0	3.0	1.8	20.0	2.3	12.5
PARAGGIO	1.7	3.0	4.7	12.5	3.7	30.0
TAMAR/MATILDA	3.3	2.5	5.8	5.0	6.0	1.5
PARAGGIO/PARABINGA	0.1	2.0	0.3	20.0	0.3	1.5
NUNGARIN	1.1	1.5	2.0	5.0	2.0	7.5
CLARE	2.3	1.0	3.3	5.0	7.8	7.5
JINDERA	0.0	0.0	0.0	0.0	0.0	0.0
ZODIAC	0.0	0.0	0.0	0.0	0.0	0.0
DEMETER	0.1	0.0	0.3	0.0	1.3	0.0
SANTIAGO/SERENA	1.3	0.0	2.5	0.0	2.8	0.0
MATILDA	2.5	0.0	5.5	0.0	5.5	0.0
LSD(95%)	1.0		10.4		5.4	

BLEND 'A': COOLABAH/NEMFIX/PARABINGA
BLEND 'B': COOLABAH/ELITE/MARAL/NITRO PLUS
BLEND 'C': GLENROY/COOLABAH/ROSSA FABA BEAN/BLANCHEFLEUR/POPANY/ARGELES/SANTIAGO

Table 6.3.8.1 Summary of results and observations from the 1996 cover crop trial at Langhorne Creek.



Weed species included soursob (*Oxalis pes-caprae*), capeweed (*Arctotheca calendula*), barley grass (*Hordeum vulgare*) and ryegrass (*Lolium rigidum*).

Table 6.3.8.2 Botanical Composition in September as determined by dry weights of sward components of four cover crops at Langhorne Creek, S.A. in 1996

Species with good winter weed suppressing ability performed best at this site. Adagio fodder radish was particularly effective against the volunteer population of soursob, capeweed and grasses, as demonstrated in the above graph. Fodder Radish, Ryecorn, oats, fodder rape and forage blends of cereals and forage legumes were the fastest establishing of the treatments at this site. This attribute of rapid ground cover is most important early in the season, when the soil surface is most exposed to potential losses via wind and water erosion. By September, the fodder rape and oat based swards were the most effective green manure swards. Mustard seeding rates were observed as being too high in this trial in all treatments.

CONCLUSIONS

Essentially, green manure swards will be most often utilised in the Langhorne Creek region, unless overhead irrigation is utilised. Subsequently, the most productive swards should be recommended for organic matter addition to the soil, with oat based cover crops the best option. Brassica crops such as forage rape and fodder radish have application for nematode suppression and/or weed control. Ryecorn establishes quickly, and has an application for wind blast protection of young vines on sandy soil. Annual regenerating swards should be based on Parabinga and Santiago medic in neutral to alkaline soils, and Santiago and Junee clover in slightly acidic soils.

RECOMMENDATIONS

There is a need to identify a summer dormant perennial grass to compliment the early maturing pasture legumes which are well adapted to this area. Perennial ryegrasses and currently available cultivars of cocksfoot will not persist in this environment. Additionally, there is a need to identify annual species which will tolerate the waterlogged soils which result from the flooding of the Braemer river over winter, and survive to produce a spring flush of growth.

Brassica swards performed relatively poorly in this trial. Adagio fodder radish established well early, but suffered from lack of nutrition in late winter/ spring, and did not provide a high ranking result.

Of the green manure swards, 'Blend G' was the best treatment. This blend provided a very high level of ground cover in mid winter, and continued into spring. Coolabah Oats plus Kelson Snail medics was the other highly ranked green manure treatment at this trial site.

By mid summer of 97/98, the perennial swards with greatest vigour were those with a currie cocksfoot component. Of the ryegrasses, Matilda was showing good persistence and moderate summer vigour, Victorian was persistent and slightly more dormant than Matilda. However, Ellet ryegrass was not persisting well, and reduced plant density in these swards were providing invasive weeds opportunities for colonisation.

6.3.9 1996 Padthaway Trial

Site details

Co operator/Vineyard:	BRL Hardy
Contact:	Chris Greig
Address:	NARACOORTE SA 5217
Soil Type:	Sandy Loam
Soil pH:	
Irrigation Method:	Dripper
Rainfall:	520 mm

SEEDING DETAILS

Date Sown:	9 May 1996
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	Direct Drilled
Additional Comments:	A moderate burden of couch grass and phalaris was still persisting at the time of seeding. The seeder used for establishing this site was not suited to direct drilling, having poor trash clearance, and hence seeding depth was erratic. Many plots had below optimum plant densities at emergence, and this was reflected by sward productivity.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	11/10/96, 20/1/97
Summer Residue Density	20/1/97
Sward Height	11/10/96
Ground Cover Percentage	11/10/96, 20/1/97
Percent flowering	11/10/96

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 11-Oct-96*	*SWARD VIGOUR RATING 20-Jan-97*	*SWARD HEIGHT 11-Oct-96*	*PERCENT GROUND COVER 11-Oct-96*	*PERCENT GROUND COVER 20-Jan-97*	*PERCENT FLOWER 11-Oct-96*	*RESIDUE RATING 20-Jan-97*
ADAGIO	9.5	0.0	123.3	88.3	0.0	100.0	2.0
BLEND 'G'	8.9	0.0	103.3	96.7	0.0	0.0	4.0
BLEND 'D'	8.4	0.0	106.7	100.0	0.0	0.0	2.0
ROSSA FABA BEAN	7.9	0.0	80.0	79.7	0.0	100.0	1.5
BLEND 'C'	7.5	0.0	100.0	100.0	0.0	0.0	3.0
BLEND 'A'	7.3	0.0	86.3	67.5	0.0	66.7	4.0
PARAGGIO/SANTIAGO	7.1	0.0	33.3	80.0	0.0	100.0	4.0
SANTIAGO	6.9	0.0	30.0	68.5	0.0	100.0	2.0
CARPET	6.9	0.0	23.0	70.0	0.0	100.0	1.0
COOLABAH	6.8	0.0	78.3	40.0	0.0	100.0	3.0
COOLABAH/KELSON	6.5	0.0	70.0	68.3	0.0	0.0	3.0
ARGELES	6.4	0.0	25.8	71.3	0.0	8.8	3.0
TRITICALE	6.3	0.0	105.0	20.0	0.0	100.0	3.0
GLENROY	5.9	0.0	67.5	76.3	0.0	100.0	3.0
CLARE/NUBA/VICTORIAN	5.8	3.0	20.7	60.0	20.0	0.0	5.0
NUBA	5.8	0.0	26.7	45.0	0.0	66.7	5.0
DENMARK	5.5	0.0	13.5	48.8	0.0	36.3	3.0
GOULBURN	5.3	0.0	13.3	45.0	0.0	100.0	3.0
BLEND 'E'	5.1	0.0	43.3	60.0	0.0	0.0	0.0
BLEND 'B'	5.0	0.0	80.0	70.0	0.0	0.0	5.0
DENMARK/GOSSE/ELLET	4.4	3.0	10.0	26.7	20.0	0.0	3.0
YORK	4.3	0.0	11.7	40.0	0.0	100.0	2.5
GOSSE	4.0	0.0	13.0	36.3	0.0	100.0	2.0
SANTIAGO/SERENA	3.8	0.0	15.7	26.7	0.0	66.7	1.8
RANGI RAPE	3.8	0.0	30.0	15.0	0.0	1.7	0.0
PARAGGIO	3.5	0.0	12.5	35.0	0.0	75.0	1.0
BLEND 'F'	3.5	4.0	17.5	25.0	20.0	0.0	3.0
WAVERLEY/VICTORIAN	2.3	4.0	12.5	12.5	20.0	0.0	0.0
TAMAR/VICTORIAN	2.0	3.0	12.3	16.7	20.0	0.0	2.0
NUNGARIN/YORK/MATILDA	1.8	1.0	8.8	21.3	5.0	0.0	1.0
CURRIE/VICTORIAN/MATILDA	1.5	4.0	11.7	9.0	25.0	0.0	2.0
NEMFIX	0.8	0.0	30.0	5.0	0.0	25.0	1.0
PARAGGIO/CALIPH	0.5	0.0	0.0	0.0	0.0	0.0	2.0
LSD(95%)	1.1		10.9	13.6			

BLEND 'A': COOLABAH/NEMFIX/PARAGGIO
BLEND 'B': COOLABAH/ELITE/MARAL/NITRO PLUS
BLEND 'C': TRITICALE/LANGUEDOC/POPANY/TOPCUT
BLEND 'D': GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO
BLEND 'E': BLANCHEFLEUR/HIGHLANDER/FENUGREEK/HYKON/PROLIFIC/WAVERLEY/CURRIE/NUNGARIN
BLEND 'F': WAVERLEY/TAMAR/ELLET/CURRIE
BLEND 'G': GLENROY/COOLABAH/ROSSA FABA BEAN/TOPCUT/POPANY/LANGUEDOC/ARGELES/SANTIAGO

Table 6.3.9.1 Summary of results and observations from the 1996 trial at Padthaway.

Adagio fodder radish ranked very highly as a green manure treatment in the year of establishment. This was also the tallest sward included in this trial and provided a percentage ground cover equivalent to the best treatment in the trial. Residue of this cover crop was not highly persistent over the early summer period of 1996/97.
The blend of oats and grain legumes, Blend G, ranked highly also, providing close to 100% ground cover. The mulch of this crop was relatively high in persistence over the early summer period. A similar blend minus the oat component gave very good results in terms of vigour and ground cover, however the mulch was not high in persistence, as would be expected from a legume cover crop. Residue

persistence has implications as far as under vine mulch production is concerned. The highest level of mulch persistence through the summer period was achieved by the oats plus annual fodder legume treatment, Blend B.

Santiago and Carpet medics provided good levels of ground cover in the first year, and ranked highest of the medicago species. Another high ranking annual pasture legume was Argeles sub clover. Most annual subclovers ranked poorly in the year of establishment.

Permanent swards at this site suffered from a lack of plant density, attributable to poor seed bed preparation, cover crops in this trial were direct drilled into mid rows which had a moderate population of Phalaris persisting. Subsequently, control of seeding depth was poor, and most small seeded species established with low vigour and low plant density. Equivalent results were obtained by permanent swards based on perennial ryegrass at this site.

6.3.10 1996 Coonawarra Trial

Site details

Co operator/Vineyard:	Southcorp Wines
Contact:	Paula Benson
Address:	C/- Coonawarra Post Office COONAWARRA SA 5263
Soil Type:	Sandy Clay Loam, EC=0.14, SAR=0.17
Soil pH:	7.7
Irrigation Method:	Overhead Sprinkler
Rainfall:	650 mm

SEEDING DETAILS

Date Sown:	9 May 1996
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	Rotary Hoe
Additional Comments:	Seed was sown in to a well prepared seed bed, free of weed growth and trash. Emergence of all plots was very even (refer to photographs).

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	16/7/96, 27/9/96, 20/1/97, 20/1/98
Sward Height	16/7/96, 27/9/96
Ground Cover Percentage	16/7/96, 27/9/96, 20/1/97
Percent flowering	27/9/96
Sward Residue rating	20/1/97

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 16-Jul-96*	*SWARD VIGOUR RATING 27-Sep-96*	*SWARD VIGOUR RATING 20-Jan-97*	*SWARD VIGOUR RATING 20-Jan-98*	*PERCENT GROUND COVER 16-Jul-96*	*PERCENT GROUND COVER 27-Sep-96*	*PERCENT GROUND COVER 20-Jan-97*
CARPET	8.5	8.5	0.0	0.0	40.0	100.0	0.0
CLARE/NUBA/VICTORIAN	8.4	8.5	1.1	7.0	45.0	95.0	3.8
BLEND 'G'	9.0	8.5	0.0	0.0	73.8	92.5	0.0
MOGUL	8.3	8.1	0.0	0.0	38.8	100.0	0.0
BLEND 'D'	6.8	7.5	0.0	0.0	46.3	100.0	0.0
PARAGGIO	6.4	7.3	0.0	0.0	28.3	95.0	0.0
COOLABAH/KELSON	9.3	7.3	0.0	0.0	48.8	80.0	0.0
BLEND 'C'	7.0	7.1	0.1	0.0	46.3	67.5	0.0
TAMAR/VICTORIAN	6.8	7.1	4.1	7.5	27.0	50.0	31.3
BLEND 'F'	7.0	7.0	3.5	7.5	30.0	60.0	30.0
GOSSE	6.3	6.9	0.0	0.0	28.8	92.5	0.0
SANTIAGO/SERENA	5.0	6.9	0.0	0.0	18.8	87.5	0.0
PARAGGIO/SANTIAGO	7.0	6.9	0.0	0.0	32.5	85.0	0.0
SANTIAGO	5.6	6.9	0.0	0.0	20.0	80.0	0.0
GLENROY	8.6	6.9	0.0	0.0	37.5	70.0	0.0
ROSSA FABA BEAN	9.0	6.8	0.0	0.0	37.5	62.5	0.0
DENMARK/GOSSE/ELLET	7.4	6.5	1.1	6.0	32.5	80.0	5.3
WAVERLEY/VICTORIAN	5.9	6.4	2.6	7.0	22.5	50.0	13.8
ARGELES	6.5	6.1	0.0	0.0	26.3	77.5	0.0
TRITICALE	8.4	5.8	0.0	0.0	51.3	22.5	0.0
BLEND 'E'	5.5	5.6	1.9	8.5	26.3	95.0	8.8
CURRIE/VICTORIAN/MATILDA	6.8	5.6	1.4	0.0	30.0	30.0	5.3
GOULBURN	4.3	4.9	0.0	0.0	13.0	62.5	0.0
COOLABAH	8.8	4.9	0.0	0.0	51.3	27.5	0.0
ADAGIO	8.0	4.8	0.0	0.0	55.0	17.5	0.0
BLEND 'B'	7.3	4.6	1.0	0.0	37.5	35.0	6.3
BLEND 'A'	8.1	4.5	0.0	0.0	58.8	52.5	0.0
PARAGGIO/CALIPH	3.0	4.0	0.0	0.0	8.3	75.0	0.0
DENMARK	3.3	4.0	0.0	0.0	16.3	57.5	0.0
NUNGARIN/YORK/MATILDA	6.1	3.3	0.5	8.0	22.5	27.5	0.3
NEMFIX	6.9	3.0	0.0	0.0	50.0	7.5	0.0
YORK	4.0	2.8	0.0	0.0	13.8	30.0	0.0
RANGI RAPE	7.4	2.5	1.3	0.0	51.3	22.5	2.8
LSD(95%)	0.7	0.8	0.5		4.7		4.3

CULTIVAR	SWARD HEIGHT 16-Jul-96	SWARD HEIGHT 27-Sep-96	PERCENT FLOWER 27-Sep-96	SWARD RESIDUE RATING 20-Jan-97
CARPET	3.5	25.0	100	2.5
CLARE/NUBA/VICTORIAN	5.8	10.0	0	2.9
BLEND 'G'	19.8	75.0	0	2.8
MOGUL	3.0	28.5	100	2.9
BLEND 'D'	12.5	55.0	0	2.0
PARAGGIO	3.5	17.5	100	2.6
COOLABAH/KELSON	15.3	55.0	0	2.5
BLEND 'C'	24.0	102.5	0	2.5
TAMAR/VICTORIAN	5.5	9.0	0	2.3
BLEND 'F'	5.7	7.0	0	2.1
GOSSE	1.5	4.5	10	1.9
SANTIAGO/SERENA	2.3	17.5	100	1.8
PARAGGIO/SANTIAGO	3.5	11.0	0	2.2
SANTIAGO	2.3	11.0	100	2.0
GLENROY	16.5	42.5	100	2.4
ROSSA FABA BEAN	9.5	56.5	100	0.8
DENMARK/GOSSE/ELLET	6.0	11.0	0	2.5
WAVERLEY/VICTORIAN	6.0	7.0	0	2.2
ARGELES	2.0	6.0	0	2.1
TRITICALE	25.5	80.0	100	2.3
BLEND 'E'	6.3	47.5	0	1.7
CURRIE/VICTORIAN/MATILDA	6.8	9.5	0	2.1
GOULBURN	1.0	3.5	5	1.6
COOLABAH	16.5	42.5	0	2.2
ADAGIO	9.8	70.0	100	0.5
BLEND 'B'	13.0	45.0	0	3.1
BLEND 'A'	14.5	50.0	0	2.8
PARAGGIO/CALIPH	2.0	5.5	20	1.9
DENMARK	1.3	2.5	0	1.5
NUNGARIN/YORK/MATILDA	5.0	11.0	0	1.6
NEMFIX	4.5	47.5	100	1.0
YORK	1.0	3.0	100	1.0
RANGI RAPE	7.5	9.0	0	0.4
LSD(95%)	1.0			0.3

BLEND 'A': COOLABAH/NEMFIX/PARAGGIO
BLEND 'B': COOLABAH/ELITE/MARAL/NITRO PLUS
BLEND 'C': TRITICALE/LANGUEDOC/POPANY/TOPCUT
BLEND 'D': GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO
BLEND 'E': BLANCHEFLEUR/HIGHLANDER/FENUGREEK/HYKON/PROLIFIC/WAVERLEY/CURRIE/NUNGARIN
BLEND 'F': WAVERLEY/TAMAR/ELLET/CURRIE
BLEND 'G': GLENROY/COOLABAH/ROSSA FABA BEAN/TOPCUT/POPANY/LANGUEDOC/ARGELES/SANTIAGO

Tables 6.3.10.1 and 6.3.10.2 Summary of results and observations in the Coonawarra trial sown in 1996.

Carpet medic was a highly ranked cultivar at this site in 1996. By September 27th 1996 it provided 100% ground cover. Only two other cover crop treatments achieved this level of cover: Mogul medic, and a green manure crop (Blend D). Generally, medic species performed better than annual subclovers at this site. Barrel medics (Medicago truncatula) varieties were high ranking, namely Carpet, Mogul and Paraggio. Of the subclovers, Gosse provided the best result in the year of establishment.

Perennial grasses did not provide high levels of vigour at this site, which the overhead irrigation was used for frost protection only. Low vigour ratings for ryegrasses in January reflect dormancy. Higher ratings were achieved by swards consisting of blends of ryegrass and white clover.

6.3.11 1996 Great Western Trial

Site details

Co operator/Vineyard:	Southcorp Wines
Contact:	Fiona Wigg
Address:	Southcorp Wines Great Western Vineyards Moysun Road GREAT WESTERN VIC 3377
Soil Type:	Loam. EC=1.06, SAR=0.01
Soil pH:	5.8
Irrigation Method:	Dripper
Rainfall:	500 mm

SEEDING DETAILS

Date Sown:	18 April 1996
Fertiliser:	200 kg/ha single super post sowing (broadcast)
Seed Bed Preparation:	Rotary Hoe
Additional Comments:	Following seeding of this trial area, a lack of rain severely impeded the establishment of all plant species. 10 mm of rain was received on the 12th of May, however this was preceded and followed by extended dry periods. The result was a significant loss of seedlings, as evidenced by the photograph taken on 3rd June, 1996. No useful data was gleaned from this trial, although the impact of seeding too early in a vineyard without mid row irrigation was clearly demonstrated.

Refer to plate 12.22 in the **Illustrations** *section*

As can be seen by this photograph, the effect of a false break was devastating to the cover crop. The lack of follow up rains following emergence of the swards resulted in nearly 100% loss of seedlings. This example demonstrates the need to balance the desire to sow green manure crops early, and the necessity to sow at a time when regular rainfall can reasonably be expected. Where no irrigation of the mid row is possible, I suggest that seeding of all cover crops be deferred until the beginning of May in districts such as Great Western.

6.3.12 1996 Goulburn Valley Trial

Site details

Co operator/Vineyard:	Mitchelton Wines (Petaluma)
Contact:	John Beresford and Wayne Oliver
Address:	Mitchellstown via Nagambie, Victoria 3608
Soil Type:	Grey Clay/Loam. EC=0.08, SAR=0.02
Soil pH:	5.8
Irrigation Method:	Overhead Sprinkler for frost and Drip
Mean Annual Rainfall:	600mm
Grape Variety::	Cabernet Sauvignon

SEEDING DETAILS

Date Sown:	17 April 1996
Fertiliser:	Fertilised in late April with the following: Chicken Manure 1MT/ha Gypsum 2MT/ha Lime 2MT/ha
Seed Bed Preparation:	Rotary hoed
Additional Comments:	This trial was seeded using the Winery's own John Shearer coulter tyne drill. Initial proposed site was covered with a dense residue of wireweed which impeded the seeder to the point that an alternative site was located in the vineyard. The second site was relatively weed free at seeding, with some wireweed evident. The seed bed was well prepared. The original randomisation was disrupted due to the seeding of 45 plots on the original area.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	30/5/96,6/7/96,12/9/96,18/1/97,6/7/97,30/9/97,20/1/98
Density	30/5/96
Sward Height	30/5/96,30/9/96
Ground Cover Percentage	12/9/96
Percent flowering	12/9/96
Dry Weight Yield	12/9/96

RESULTS AND DISCUSSION

CULTIVAR	SWARD VIGOUR RATING 30-May-96	SWARD VIGOUR RATING 12-Sep-96	SWARD VIGOUR RATING 19-Jan-97	SWARD VIGOUR RATING 6-Jul-97	SWARD VIGOUR RATING 30-Sep-97
ROSSA FABA BEAN	6.3	9.4	0.0	0.0	0.0
CEREAL RYE	9.0	9.3	0.3	0.0	0.0
DENMARK/GOSSE/ELLET	6.5	8.8	6.5	8.0	9.5
ADAGIO	8.0	8.8	0.0	0.0	0.3
NEMFIX	6.3	8.6	0.0	0.0	0.0
COOLABAH	4.0	8.6	0.0	0.0	2.0
RANGI RAPE	4.5	8.5	6.8	2.0	1.0
BLEND 'E'	3.2	8.4	0.0	0.0	3.0
COOLABAH/NEMFIX/JUNEE	4.8	8.3	0.0	0.0	3.3
SANTIAGO	1.8	7.9	0.3	5.0	4.7
CLARE/NUBA/VICTORIAN	4.0	7.7	7.3	8.0	8.8
COOLABAH/KELSON	5.3	7.6	0.0	0.0	0.0
NUBA	5.3	7.5	0.0	7.0	8.1
BLEND 'D'	7.0	7.0	0.1	0.0	0.7
GOSSE	3.0	6.9	0.0	9.0	9.5
PARAGGIO	2.0	6.9	0.0	0.5	2.7
WAVERLEY/VICTORIAN	3.5	6.8	7.5	7.5	8.2
CURRIE/VICTORIAN/MATLDA	4.3	6.5	7.6	10.0	8.0
ARGELES	2.5	5.9	0.0	4.0	7.8
CURRIE	0.5	5.8	7.5	9.0	8.0
BLEND 'C'	0.0	5.7	0.0	0.0	7.5
TAMAR/VICTORIAN	1.0	5.5	7.1	7.0	5.5
CLARE	2.0	5.1	0.0	8.0	8.7
FENUGREEK	5.8	4.5	0.0	0.0	0.0
BLEND 'A'	6.3	4.5	0.3	0.0	0.0
DENMARK	2.8	4.3	0.0	7.5	6.3
GLENROY	4.5	4.3	0.0	0.0	0.0
DEMETER	4.5	4.0	7.0	7.0	6.3
TAMAR	0.5	3.5	2.9	3.0	3.7
JUNEE	4.8	3.3	0.0	5.0	5.2
GOULBURN	0.0	3.0	0.0	0.0	4.5
WAVERLEY	4.3	0.8	2.8	2.0	5.0
BLEND 'B'	2.0	0.0	1.0	0.0	5.0
LSD(95%)		1.0	0.7		

BLEND 'A': COOLABAH/ELITE/MARAL/NITRO PLUS
BLEND 'B': BLANCHEFLEUR/HIGHLANDER/PARADANA/PROLIFIC/FENUGREEK/WAVERLEY/CURRIE/JUNEE
BLEND 'C': GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO
BLEND 'D': CEREAL RYE/LANGUEDOC/POPANY/TOPCUT
BLEND 'E': GLENROY/COOLABAH/ROSSA FABA BEAN/BLANCHEFLEUR/POPANY/ARGELES/SANTIAGO

Table 6.3.12.1 Summary of vigour ratings in the cover crop trial at Mitchelton winery in 1996. Full results are presented in the appendices.

Fodder radish and ryecorn were again the fastest to establish, and showed most vigour in the seedling stage. By September, these species together with faba beans, oilseed mustard, oats, fodder rape and a forage blend of oats and legumes were the most productive and vigorous. The blend of Denmark and Gosse sub clover and Ellet ryegrass displayed good potential as a permanent sward. Santiago medic displayed good vigour and ground cover in the first year of establishment, but did not persist or regenerate in the second and subsequent years. Nuba was another sub clover to show potential for use in a permanent sward. By mid summer in the first year, the Victorian ryegrass based swards were displaying the greatest summer weed suppression abilities and ground cover. The sward consisting of Victorian and Matilda ryegrasses in combination with Currie cocksfoot was the best of the permanent sward

treatments. This same treatment was again rated the best in winter of the second year. Annual pasture legumes which regenerated well in the second season included Gosse, Clare and Denmark sub clovers. Persistent grasses included Currie cocksfoot and Victorian perennial ryegrass. These same species ranked highest again in spring of the second year.

CONCLUSIONS

The data indicates that some perennials will survive and persist in drip irrigated vineyards in this environment. Victorian perennial ryegrass and Currie cocksfoot are two of the better cultivars for use as permanent swards. Fodder radish and ryecorn would appear to be the best options for winter weed suppression, with Oats, Forage blends, Faba beans and fodder rape providing good alternatives as green manure cover crops.

RECOMMENDATIONS

More work needs to be done to assess the most appropriate range of grass cultivars as persistent permanent swards, whilst not competing excessively for available soil moisture with the vine crop. Summer dormant, early maturing perennial grass varieties are desired for this and similar areas. Annual medics do not persist well unless a suitable mowing regime is employed. Mowing swards in late winter will encourage prostrate growth and a low setting of pods which are not totally removed with subsequent mowings.

6.3.13 1996 Rutherglen Trial

Site details

Co operator/Vineyard:	Pfeiffers Winery
Contact:	Greg Harker
Address:	PO Box 35 WAHGUNYAH VIC 3687
Soil Type:	Alluvial Sand, EC=0.03, SAR=0.03
Soil pH:	6.2
Irrigation Method:	Overhead Sprinklers
Rainfall:	550 mm

SEEDING DETAILS

Date Sown:	16 April 1996
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	Rotary Hoe
Additional Comments:	A very sandy site with a high population of nutgrass and couch. Rabbits heavily grazed approximately one third of the total trial area. The site became very water logged in late winter, which impacted on some treatments. This site was not retained for persistence/regeneration data.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	2/6, 11/9,22/1
Sward Height	2/6, 11/9
% Ground Cover	2/6, 11/9
% Flowering	11/9

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 2-Jun-96*	*SWARD VIGOUR RATING 12-Sep-96*	*SWARD VIGOUR RATING 22-Jan-97*	*EMERGE DENSITY #/SQ M 2-Jun-96*	*SWARD HEIGHT 2-Jun-96*	*SWARD HEIGHT 12-Sep-96*	*PERCENT GROUND COVER 12-Sep-96*
BLANCHEFLEUR	3.1	9.7	0.0	6.3	6.0	51.7	82.8
BLEND 'A'	3.3	8.5	0.0	13.3	11.0	63.3	68.3
TOPCUT	4.5	8.1	0.0	9.8	11.8	40.0	73.8
GLENROY	3.6	8.0	0.0	5.3	15.5	61.3	42.5
MATILDA	5.9	7.4	6.0	35.0	6.0	8.3	56.3
COOLABAH/BLANCHEFLEUR	5.3	7.4	0.0	16.3	13.8	47.5	70.0
ADAGIO	5.6	7.0	0.0	12.0	11.8	70.0	36.3
COOLABAH/NEMFIX/JUNEE	6.6	6.9	0.0	33.3	13.8	50.0	58.8
COOLABAH/TOPCUT	6.1	6.9	0.0	15.0	11.8	42.5	76.3
CURRIE	1.0	6.5	0.0	35.5	2.8	7.8	37.5
VICTORIAN	5.8	6.4	4.0	40.8	6.3	7.5	45.0
ELLET	6.0	6.3	6.7	43.3	7.3	6.5	35.0
NUNGARIN	1.8	6.3	0.0	15.0	1.1	5.8	72.5
ROSSA FABA BEAN	4.8	6.3	0.0	7.3	11.5	48.8	43.8
NUBA	2.3	6.1	0.0	9.5	1.6	15.5	52.5
DENMARK/GOSSE/ELLET	5.1	6.0	8.0	42.5	5.8	5.5	52.5
ARGELES/NUBA/VICTORIAN	5.0	6.0	3.5	40.8	5.8	9.8	67.5
ARGELES	2.0	5.8	0.0	14.8	1.1	9.5	60.0
GOSSE	1.6	5.4	0.0	12.0	1.3	14.5	46.3
GOULBURN	1.6	5.4	0.0	11.8	1.0	11.8	28.8
COOLABAH	5.3	5.1	0.0	18.8	11.8	32.5	40.0
DEMETER	3.3	5.0	8.0	29.3	5.0	6.0	32.5
TAMAR/VICTORIAN	4.5	4.9	4.0	41.8	5.0	4.3	52.5
JUNEE	1.6	4.9	0.0	11.8	1.0	7.8	43.8
ELLET/NITRO PLUS/ELITE	5.3	4.6	8.0	44.0	5.0	7.0	36.3
GUNGURRU	3.0	4.6	0.0	6.3	7.5	30.8	27.5
DENMARK	1.8	4.5	0.0	12.5	1.3	5.3	60.0
COOLABAH/KELSON	4.6	4.4	0.0	18.5	9.5	30.0	40.0
PALESTINE/DERBY	3.6	4.3	6.5	47.3	3.8	3.8	46.3
NEMFIX	5.3	4.1	0.0	25.5	3.8	52.5	18.8
POPANY	1.3	3.8	0.0	6.5	3.8	15.0	16.7
RANGI RAPE	6.0	3.5	0.0	34.0	6.0	11.0	36.3
FENUGREEK	3.6	1.7	0.0	9.0	4.5	13.3	3.3
LSD(95%)	0.7	0.7		4.7	1.0	4.1	9.3

BLEND 'A': GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO

Table 6.3.13.1 Summary of results from the cover crop trial sown in 1996 at Pfeiffers vineyard, Rutherglen. Results are presented in full in the appendices.

Vetch based swards provided very good results at this site, particularly the cultivars Blanchefleur and Topcut. Blanchefleur vetch provided not only a significantly higher spring vigour rating than other swards, but also the highest percent ground cover in spring. Adagio fodder radish provided a good result at this site, although the other brassica crops screened, Nemfix and rangi rape, rated poorly.

Of the perennial grass species, the greatest summer vigour was exhibited by Demeter fescue and Ellet ryegrass. Victorian ryegrass, which is susceptible to rust, was less vigorous than Ellet and Matilda ryegrasses in this flood irrigated trial site in the summer of 1996/97. Perennial swards based on Victorian ryegrass plus pasture legumes did not rate as highly as swards consisting of Ellet ryegrass plus legumes due to the vigour suppression of the ryegrass as a result of disease incidence.

Nungarin, Nuba and Argeles were the highest ranked annual sub clover cultivars at this site.

6.3.14 1996 Hanwood (M.I.A.) Trial

Site details

Co operator/Vineyard:	McWilliams
Contact:	Jeff Dance
Address:	C/- McWilliams Winery, McWilliams Road HANWOOD NSW 2680
Soil Type:	Hard Setting alluvial clay
Irrigation Method:	Flood

SEEDING DETAILS

Date Sown:	14 April 1996
Fertiliser:	nil
Seed Bed Preparation:	Rotary Hoed
Additional Comments:	Alternate rows were sown, plots were 25 metres long. As a result of the flood irrigation, the soil was almost sodic, and became waterlogged over winter. Soil was moist at seeding. No irrigation was applied to the area after seeding, and a significant loss of seedlings occurred due to six weeks of nil rain after seeding. The site became quite weedy during the course of the growing season, with the dominant species being capeweed, shepherds purse, wireweed and euphorbia.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	31 July 1996, 11 September 1996, 23 January 1997, 8 July 1997

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 31-Jul-96*	*SWARD VIGOUR RATING 11-Sep-96*	*SWARD VIGOUR RATING 23-Jan-97*	*SWARD VIGOUR RATING 8-Jul-97*
ADAGIO	7.5	7.5	0.0	0.0
PARADANA	5.8	7.3	0.0	0.0
COOLABAH	8.8	7.2	0.3	0.0
NEMFIX	6.2	7.0	0.0	0.0
BLEND 'E'	6.3	7.0	0.0	0.0
KELSON	5.0	6.7	0.0	0.0
ROSSA FABA BEAN	2.7	6.3	0.0	0.0
BLEND 'D'	5.0	5.5	6.8	8.0
POPANY	5.7	5.2	0.0	0.0
DERBY/PALESTINE	5.8	5.0	7.8	9.0
BLEND 'C'	6.2	5.0	7.0	8.5
PARABINGA	3.7	5.0	0.0	0.0
TOPCUT	3.3	5.0	0.3	0.0
BLEND 'B'	7.0	4.8	7.8	9.5
NUBA	2.3	4.8	0.0	0.0
RANGI RAPE	5.3	4.7	3.0	0.0
TAMAR/VICTORIAN	4.7	4.5	6.0	9.0
CLARE	5.5	4.5	0.0	0.0
PARAGGIO	5.2	4.5	0.0	0.0
BLEND 'F'	4.8	4.2	6.0	9.0
ARGELES	2.0	3.8	0.0	0.0
PROLIFIC	2.5	3.8	0.0	0.0
BLANCHEFLEUR	4.3	3.7	0.0	0.0
SANTIAGO	1.8	3.5	0.0	0.0
WAVERLEY/VICTORIAN	4.5	3.2	6.5	9.5
GLENROY	5.3	3.0	0.0	0.0
ELITE	2.0	2.5	0.0	0.0
BLEND 'A'	5.2	2.3	7.8	9.0
WAVERLEY	1.2	2.3	5.0	0.0
GOULBURN	0.8	2.0	0.0	0.0
MARAL	1.2	1.8	0.5	0.0
NUNGARIN	2.8	1.5	0.0	0.0
TAMAR	2.2	0.7	5.0	1.0
LSD (95%)	0.6	1.0	1.1	

BLEND 'A': NUNGARIN/YORK/MATILDA
BLEND 'B': DENMARK/GOSSE/ELLET
BLEND 'C': CURRIE/VICTORIAN/MATILDA
BLEND 'D': CLARE/NUBA/VICTORIAN
BLEND 'E': COOLABAH/ELITE/MARAL
BLEND 'F': TAMAR/WAVERLEY/VICTORIAN/DEMETER

Table 6.3.14.1 **Summary of results from the cover crop trial established at McWilliams Winery, Hanwood NSW.**

Green manure treatments which ranked highly include Adagio fodder radish, balansa clover, oats, mustard and oats in combination with annual clovers.
This was a flood irrigated site, and no annual regenerating treatments persisted through to the second year, possibly due to the germination of seed over the summer period and loss of subsequent seedlings due to dessiccation. Medic pods and clover burr were also noted to have 'washed' out of the mid row area with the application of irrigation water.

Perennial grass based swards all performed well in the second year. Blends of grass and white clover provided a very vigorous sward in the second year, although monocultures of white clover did not persist in to the second season.
Perennial ryegrass appears well adapted to survival as a midrow sward in this environment under flood irrigation. Of the annual pasture legumes, Trifolium species generally provided a better result than medicago species, although Kelson snail medic provided a vigorous sward in the first year. Nuba, Clare and Argeles were the best performed sub clover cultivars at this site in 1996.
Adagio fodder radish and Nemfix were brassica cover crops which were highly ranked annual cover crops in this trial.

6.3.15 1996 Yenda (M.I.A.) Trial

Site details

Co operator/Vineyard:	Peter Dickie
Address:	Woods Road, Yenda NSW
Soil Type:	Medium Clay, EC=0.09, SAR=0.1
Soil pH:	6.7
Irrigation Method:	MIA Twin Furrow Irrigation
Rainfall:	375 mm

SEEDING DETAILS

Date Sown:	15 April 1996
Fertiliser:	100 kg/ha DAP post sowing
Seed Bed Preparation:	Rotary Hoe and Disc post vintage
Additional Comments:	A site where the soil surface is prone to sealing, as evidenced by photograph 12.23 (refer **Illustrations**). Significant levels of winter and summer weeds were apparent in this area. Although waterlogged for much of the first winter, most treatments successfully established, and monitoring of the swards was possible through out the growing season of 1996. Permanent sward treatments were allowed to persist and regenerate in 1997, before the area was tilled in early 1998.

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	29/5/96,10/9/96,22/1/97
Density	29/5/96
Sward Height	10/9/96
Ground Cover Percentage	10/9/96
Crop Residue Yield	22/1/97

RESULTS AND DISCUSSION

CULTIVAR	*SWARD VIGOUR RATING 29-May*	*SWARD VIGOUR RATING 10-Sep*	*SWARD VIGOUR RATING 22-Jan*	*EMERGE DENSITY #/METRE 29-May*	*PERCENT GROUND COVER 10-Sep*	*SWARD HEIGHT 10-Sep*	*RESIDUE DENSITY kg/ha 22-Jan*	*WEED DENSITY % COVER 22-Jan*
BLEND 'C'	4.4	9.7	0.1	13.3	100.0	96.7	1414	62
TOPCUT	3.8	9.3	0.0	8.3	100.0	42.8	833	72
ROSSA FABA BEAN	4.0	9.1	0.0	6.0	96.3	87.5	379	70
BLEND 'A'	4.0	8.9	0.3	11.3	100.0	92.5	2121	39
DENMARK/GOSSE/ELLET	3.1	8.5	9.3	23.8	93.8	17.3	2348	8
BLEND 'B'	2.6	8.3	0.0	10.5	97.5	63.8	985	74
BLEND 'G'	5.0	8.1	9.0	35.0	68.5	38.0	2045	0
COOLABAH/KELSON	4.8	7.8	0.4	15.0	81.3	92.5	1793	62
BLEND 'F'	2.1	7.6	7.0	20.0	80.0	19.3	1995	22
BLANCHEFLEUR	3.5	7.5	0.0	6.3	85.0	45.0	884	78
SANTIAGO/SERENA	1.9	7.3	0.0	9.0	73.3	23.3	631	71
PARABINGA	1.1	7.2	0.0	7.8	70.0	27.7	682	56
COOLABAH/NEMFIX/JUNE E	3.8	7.1	0.4	18.5	50.0	97.5	1843	27
ARGELES	1.6	7.0	2.5	8.0	82.5	16.0	2121	33
ADAGIO	6.0	6.9	0.0	16.3	55.0	90.0	758	92
NUBA	2.3	6.8	0.0	6.3	73.8	20.8	1995	59
NEMFIX	5.9	6.8	0.0	26.5	36.3	102.5	909	49
COOLABAH/ELITE/MARAL	3.0	6.4	0.4	9.8	71.3	81.3	2273	54
RANGI RAPE	7.9	5.8	2.5	28.8	70.0	28.8	657	56
VICTORIAN	0.9	5.8	8.8	9.5	50.0	10.0	1515	1
CLARE	2.4	5.5	0.0	7.3	66.7	14.0	1641	62
TAMAR/VICTORIAN	1.1	5.3	8.2	5.5	47.5	12.5	1389	11
ELLET	0.3	4.9	8.8	4.0	46.3	11.3	1136	7
GUNGURRU	2.9	4.5	0.0	5.8	23.8	43.8	505	77
PARAGGIO	1.9	4.3	0.0	10.0	78.3	13.0	884	82
DENMARK	1.9	4.3	0.0	11.0	47.5	4.3	1515	67
DEMETER	0.9	4.3	9.4	12.8	31.3	16.8	1212	4
BLEND 'E'	0.9	4.1	8.3	10.3	31.3	10.5	1263	11
BLEND 'D'	0.1	3.7	6.8	3.3	30.0	22.3	657	31
WAVERLEY	0.3	3.3	4.4	1.3	21.3	9.8	985	67
MARAL	0.4	2.7	0.5	3.0	18.3	23.3	1566	58
CURRIE	0.0	2.3	5.8	0.0	5.0	5.7	556	42
PARADANA	0.0	1.3	0.0	0.0	5.0	5.7	0	96
LSD(95%)	1.33	0.98	0.91	5.55	12.22	9.27	484	16.82

BLEND 'A' COOLABAH/ BLANCHEFLEUR/ POPANY/ TOPCUT
BLEND 'B' GLENROY/ ROSSA FABA BEAN/ BLANCHEFLEUR/ ARGELES/ PARAGGIO
BLEND 'C' GLENROY/ COOLABAH/ ROSSA FABA BEAN/ BLANCHEFLEUR/ POPANY/ ARGELES/ PARABINGA
BLEND 'D' TAMAR/ WAVERLEY/ VICTORIAN/ DEMETER
BLEND 'E' CURRIE/VICTORIAN/MATILDA
BLEND 'F' ARGELES/NUBA/VICTORIAN
BLEND 'G' ELLET/PARADANA/CLARE

Table 6.3.15.1 Summary of results from the 1996 cover crop trial at Yenda, NSW

Green manure treatments consisting of blends of oats and legumes provided the best results in terms of dry weight yield at this site. Of interest was the fact that two permanent sward treatments out yielded all other swards at the time of sampling in September.
Green manure blends incorporating beans, and the Rossa Faba Bean treatment, although ranked highly in the visual assessment, did not record highly ranked dry weight yields. Such was the case with other legumes such as vetch varieties at this site also.

The oats plus Persian and Berseem clover provided a good result. This being a M.I.A. twin furrow irrigated vineyard, in which a water logged soil is often evident to which these species are well adapted.
Of the perennial grasses, Demeter Fescue and Ellet, and Victorian ryegrass provided good results in January. Currie cocksfoot did not establish as quickly as the other grasses. The blend of perennial ryegrass and annual clover provided the maximum level of summer weed suppression. Summer weed density was not correlated to crop residue density in the case of annual cover crops. However, there appears to be a relationship between crop species, impact on nutrient status, and summer weed density. High weed populations colonised mid row areas following N-fixing legume crops, whilst nutrient depleting brassica crops reduced summer weed levels in comparison.

Summer weed suppression by perennial cover crops was observed in the CCT variety screening trial in 1996 at Yenda in the M.I.A. and results appear in table 6.3.15.2 below.

COVER CROP	*SEEDING RATE (KG/HA) 15 APRIL*	*MEAN SWARD VIGOUR RATING 29 MAY*	*MEAN SWARD VIGOUR RATING 10 SEPT*	*MEAN SWARD VIGOUR RATING 22 JAN*	*SUMMER WEEDS % GROUND COVER 22 JAN*	*SWARD PLANT RESIDUE KG/HA 22 JAN*
NEMFIX MUSTARD	20	5.9	6.8	0.0	35.7	909
COOLABAH OATS/ANNUAL CLOVERS	80	3.0	6.4	0.0	39.4	2273
ROSSA FABA BEAN	150	4.0	9.1	0.0	50.9	379
CLARE SUB CLOVER	25	2.4	5.5	0.0	45.2	1641
PARAGGIO MEDIC	22	1.9	4.3	0.0	59.3	884
WAVERLEY WHITE CLOVER	12	0.3	3.3	4.4	48.3	985
PERENNIAL RYEGRASS/ANNUAL CLOVER	15+15	5.0	8.1	9.0	0.0	2045
VICTORIAN RYEGRASS	20	0.9	5.8	8.8	1.1	1515
PERENNIAL RYEGRASS/COCKSFOOT	16+5	0.9	4.1	8.3	7.9	1263
CURRIE COCKSFOOT	10	0.0	2.3	5.8	30.5	556

Vigour ratings: 0= non existent 10= maximum vigour/growth

- Ground cover expressed as a percentage of the soil surface covered by weed growth
- All swards were mowed in spring (no mid rows were tilled). Sward residues estimated by collecting dry plant matter from quadrates placed on plots in the mid row.
- Summer weeds included wireweed (*Polygonum aviculare*), common sowthistle (*Sonchus oleraceus*), pigweed (*Portulaca oleracea*) and fleabane (*Conyza spp*).

Table 6.3.15.2. Sward vigour and summer weed suppression in a cover crop comparison trial at Yenda, NSW.

From Table 6.3.15.2 it can be seen that, of the annual cover crops, the oats and mustard swards had lower weed pressure in January than any of the leguminous species assessed. Faba beans, although very productive in spring, did not provide a high level of persistent dry matter, and allowed for a relatively high incidence of summer weeds. The annual medic did not establish with vigour, and performed relatively poorly in spring, allowing for the highest level of summer weed colonisation. The best summer weed suppression was achieved by the blend of perennial ryegrass and annual sub clover, which also provided a large amount of dry plant residue. The perennial ryegrass cover crop provided excellent summer weed suppression, although surface dry mulch was less than the grass/clover blend. The cocksfoot monoculture was not as effective in competing with weeds in the year of establishment, whilst the blend of ryegrass and cocksfoot was moderately effective. The perennial white clover offered little competitive value and is not recommended as a permanent cover in this region. From the results shown above it would appear that sub clover is well adapted to the particular region, producing a large amount of persistent dry matter.
In general, optimal weed suppression is achieved by establishing dense populations of well adapted, vigorous species. The competitive ability of a sward is improved by the adequate application of fertiliser, and by employing a mowing regime which maintains permanent swards at a height of less than 20cm, thus promoting tillering of grass species and prostrate growth of pasture legumes. Monocultures of pasture legumes can promote summer weed activity, but can also compliment perennial grasses in a permanent sward.

Refer to plates 12.23 and 12.24 in the **Illustrations** *section*

6.3.16 1996 Mildura Trial

Site details

Co operator/Vineyard:	Private Grower
Contact:	Also Chisari
Address:	PO Box SOUTH MILDURA VIC 3500
Soil Type:	Sandy Loam
Soil pH:	8.5
Irrigation Method:	Overhead Irrigation
Rainfall:	350 mm

SEEDING DETAILS

Date Sown:	13 April 1996
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	Rotary Hoed
Additional Comments:	

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	28/5/96, 29/8/96, 17/12/96
Density	28/5/96
Sward Height	17/12/96
Ground Cover Percentage	28/5/96, 29/8/96, 17/12/96
Percent flowering	29/8/96
Dry Weight Yield	29/8/96

RESULTS AND DISCUSSION

CULTIVAR	SWARD VIGOUR RATING 28-May	SWARD VIGOUR RATING 29-Aug	SWARD VIGOUR RATING 17-Dec	EMERGE DENSITY # per SQM 28-May	PERCENT GROUND COVER 29-Aug	PERCENT GROUND COVER 17-Dec	DRY WT PROD. KG/HA 29-Aug	SWARD HEIGHT 17-Dec	PERCENT FLOWER 29-Aug
BLEND 'B'	4.8	9.3	1.2	17	100	0	8036	0	0
COOLABAH/KELSON	4.9	8.0	2.0	21	78	1	5328	4	0
CURRIE/VIC/MAT	2.3	7.8	5.6	68	58	39	710	9	0
BLEND 'A'	6.0	7.6	2.8	60	88	11	6046	13	0
ROSSA FABA BEAN	1.7	7.6	0.1	7	64	0	3038	0	93
BLEND 'C'	2.6	7.3	5.0	111	54	32	548	13	0
TOPCUT	2.3	6.9	0.6	26	69	1	2289	3	0
POPANY	1.8	6.6	2.3	8	71	12	1991	14	0
SANTIAGO/SERENA	1.1	6.6	0.5	23	70	0	1159	1	0
KELSON	2.5	6.6	0.7	13	60	1	683	3	0
NEMFIX	4.1	6.5	0.0	64	45	0	4479	0	79
LANGUEDOC	2.3	6.5	1.6	61	58	9	1810	2	90
PARAGGIO/PARABINGA	1.5	6.5	2.2	24	75	13	701	3	5
VICTORIAN/TAMAR	1.9	6.4	5.8	210	55	47	493	13	0
PARAGGIO	1.4	6.1	0.1	30	60	0	632	0	3
COOLABAH/ELITE/NITRO PLUS	4.5	6.0	3.0	14	54	18	2620	9	0
CLARE	2.5	5.8	0.0	28	65	0	315	0	0
PALESTINE/DERBY	1.7	5.8	6.4	60	29	43	62	11	0
GLENROY	3.4	5.4	0.3	11	63	1	1680	2	68
PARABINGA	1.7	5.4	0.1	23	66	0	396	0	19
COOLABAH	7.0	5.3	0.1	24	49	2	1720	5	0
HARBINGER AR	1.3	5.3	1.9	24	44	1	337	1	10
PARADANA	1.1	5.1	0.0	110	54	0	258	0	0
RANGI RAPE	4.5	5.0	2.5	66	75	21	1816	12	0
SANTIAGO	1.4	4.0	0.5	20	46	1	318	3	15
ADAGIO	3.8	3.3	1.1	19	31	2	540	9	48
TAMAR	2.0	3.0	3.8	110	9	48	7	19	0
CURRIE/WAVERLEY	0.8	2.9	1.6	99	8	29	9	14	0
ZODIAC	1.0	2.8	0.0	12	23	0	43	0	0
GOULBURN	1.3	2.5	0.4	35	17	1	14	3	0
DENMARK	1.8	2.5	0.3	39	20	0	12	0	0
HIGHLANDER	1.5	2.0	0.3	17	30	0	33	0	25
JUNEE	0.7	1.5	0.2	31	7	0	2	0	0
LSD(95%)	0.41	1.32	1.43		18.5				

BLEND'A' COOLABAH/NEMFIX/PARAGGIO
BLEND 'B' GLENROY/COOLABAH/ROSSA FABA BEAN/ LANGUEDOC/POPANY/SANTIAGO/CLARE
BLEND 'C' NUNGARIN/YORK/MATILDA

Table 6.3.16.1 Summary of results from the 1996 cover crop trial at Mildura.

Green Manure treatments which ranked highest at this site were all blends of cultivars which included COOLABAH oats. The highest yielding green manure treatment was 'Blend B', which out yielded the next best treatment, 'Blend A', by almost 2MT /ha. Oats plus snail medic provided the third highest dry matter yield in this trial. Oats blended with grain legumes ('Blend B') more than doubled the yield of faba beans, and was more than four times greater than the yield achieved with monocultures of either oats or field peas.

Perennial sward treatments which ranked highly included the blend of Currie cocksfoot plus Victoria and Matilda perennial ryegrasses, and perennial ryegrass plus white clover.

Such perennial swards require mid row irrigation to persist over summer. Blends of ryegrass plus white clover provided a more appealing alternative than a monoculture of white clover.

Of the medic swards, Kelson snail medic and the blend of Santiago and Serena burr medics were the highest ranked. As this was a flood irrigated site, some annual legume seed set in Spring had germinated with irrigation by December. The ability of annual regenerating species to persist in flood irrigated mid rows is thus reduced.

Regeneration of treatments at this site was not logged due to the grower reworking the midrows in late summer.

6.3.17 1996 Waikerie Trial

Site details

Co operator/Vineyard:	Southcorp Wines
Contact:	Ray Klavens
Address:	PO Box SM 2 SOUTH MILDURA VIC 3500
Soil Type:	Sandy Loam
Soil pH:	8.5
Irrigation Method:	Overhead Irrigation
Rainfall:	350 mm

SEEDING DETAILS

Date Sown:	April 1996
Fertiliser:	100 kg/ha DAP presowing
Seed Bed Preparation:	
Additional Comments:	

ASSESSMENTS CONDUCTED

Assessments conducted	Date
Vigour Rating	28/5/96, 29/7/96, 28/8/96
Density	28/5/96
Sward Height	28/5/96
Ground Cover Percentage	28/8/96
Percent flowering	28/8/96

RESULTS AND DISCUSSION

CULTIVAR	SWARD VIGOUR RATING 28-May	SWARD VIGOUR RATING 29-Jul	SWARD VIGOUR RATING 28-Aug	EMERGE DENSITY #/METRE 28-May	SWARD HEIGHT 28-May	PERCENT GROUND COVER 28-Aug	PERCENT FLOWER 28-Aug
NUNGARIN/YORK/MATILDA	5.9	5	10.0	41	5	*	0.0
DENMARK	4.5	7	10.0	19	1	30.0	0.0
GOULBURN	4.4	8.5	10.0	23	2	70.0	0.0
JUNEE	5.5	6	10.0	20	2	55.0	0.0
RANGI RAPE	7.4	3	10.0	51	15	60.0	0.0
CLARE/NUBA/VICTORIAN	6.8	9	10.0	30	10	100.0	0.0
POPANY	5.5	8	9.5	13	15	80.0	0.0
COOLABAH/KELSON	5.9	7	9.5	12	20	90.0	0.0
NEMFIX	5.5	3	9.0	26	20	85.0	90.0
ZODIAC	4.8	6.5	9.0	15	2	50.0	0.0
COOLABAH/ELITE/NITRO PLUS	5.8	6	9.0	6	20	70.0	10.0
ADAGIO	7.5	7	9.0	18	20	95.0	100.0
CLARE	5.1	6.5	8.5	21	2	55.0	0.0
MARAL	3.3	5	8.5	11	1	12.5	0.0
ELITE	4.6	5	8.5	36	3	10.0	0.0
BLEND 'C'	7.6	4	8.5	45	15	85.0	0.0
SERENA	5.3	5	8.0	34	2	*	0.0
PARABINGA	6.1	7	8.0	34	3	*	0.0
PARADANA	3.0	7	8.0	28	1	45.0	5.0
HARBINGER AR	5.0	8	8.0	33	2	100.0	*
GLENROY	6.7	8	7.5	10	30	65.0	90.0
KELSON	4.6	7	7.5	12	3	100.0	0.0
TOPCUT	5.5	5	7.0	14	10	55.0	0.0
SANTIAGO/PARAGGIO	5.1	7	7.0	32	2	100.0	0.0
BLEND 'B'	6.6	6	6.5	34	5	50.0	0.0
SANTIAGO	5.0	8	6.0	33	1	100.0	100.0
LANGUEDOC	5.8	6.5	6.0	11	15	75.0	70.0
YORK	5.1	6.5	6.0	42	2	50.0	0.0
BLEND 'A'	6.5	10	6.0	30	30	100.0	90.0
ROSSA FABA BEAN	5.3	*	5.0	8	30	80.0	20.0
PARAGGIO	6.3	8	5.0	28	3	100.0	0.0
COOLABAH	6.9	7.5	2.5	24	20	50.0	0.0
CONTROL	0.0	0	0.0	0	0	0.0	0.0
LSD(95%)	0.5						

BLEND 'B':CURRIE/VICTORIAN/MATILDA
BLEND 'A': GLENROY/ROSSA FABA BEAN/LANGUEDOC/PARAGGIO
BLEND 'C': COOLABAH/NEMFIX/PARAGGIO

* = missing data

Table 6.3.17.1 Summary of results from the 1996 cover crop trial at Southcorp Wines vineyard, Qualco SA.

Annual medics have previously been grown successfully in the Riverland region. High ranked cultivars in this trial include Kelson, Harbinger AR, Santiago and Paraggio. Of these cultivars, Santiago was the earliest flowering. Rangi fodder rape and Adagio fodder radish established well at this site. Of the green manure treatments, cultivar blends ranked highly, including Oats plus snail medic, 'Blend A' and 'Blend C'. Oats based swards provided excellent ground cover in late winter. Monocultures of oats and grain legumes such as Faba bean, Peas and vetch did not provide high levels of ground cover and in most cases were outranked by cultivar blends.

Perennial ryegrass based swards provided good spring ground cover and subsequent weed suppression (anecdotal). Sub clover established well at this site, however the soil type is too alkaline for continued persistence. Perennial ryegrass based permanent

swards, either with or without an annual medic component, appear to be a viable option in this district, provided the midrow area is irrigated.

Popany vetch was a high ranked green manure treatment, however the abilities of this cultivar to set hard seed, regenerate after mowing in spring, and tolerate applications of knockdown herbicide are undesirable characteristics for use in a vineyard. These plant characteristics enable this variety to set seed in late spring, and regenerate in the following autumn. Popany vetch is difficult to control in the undervine area, and can use the vine as a trellis to grow upon.

6.4 1997 Variety Screening Trials

6.4.1 1997 Research and Extension Field Trial Locations and Descriptions

Monitoring of existing trial sites continued in the 1997 growing season, in addition to the establishment of new sites which were specifically aimed at promoting the project and the concept of cover cropping. Sites for 1997 trials were identified in January, and contact made with growers and retailers willing to assist in the promotion of field days and seminars later in 1997. A total of thirty major sites (listed in table 6.4.1) were established in Autumn of 1997, and covered four states and most of the major wine growing areas within. A site was established by Seedco trading partners at Voyager Estate, Western Australia, and provided an opportunity for the project to extend to the Western Australian regions for the first time. Sowing commenced at the completion of vintage in April using a Shearer vineyard seeder at most sites. Co operator's own seeders were utilised in Phylloxera districts such as Rutherglen and Mitchelton. In each of these demonstration trials, the most suitable cover crops for each area were displayed, and in each instance, two replicates of each treatment were planted.

In addition to these demonstration areas, a grass species comparison trial was established at BRL Hardy's vineyard, Padthaway. This screening field trial provided the opportunity to compare a range of annual and perennial grass species and cultivars for their persistence and productivity at a site marginal for permanent sward utilisation.

Beneficial Blends were established at sites in Coonawarra and Yarra Valley, with the objective of monitoring insect species diversity and predator/pest population dynamics. Monitoring of insect predator and pest populations was conducted by Sharmeen Tabatabai of the Institute of Horticultural Development, Melbourne.

A trial was conducted at Majella Winery in Coonawarra to compare the impact of ground cover treatment on the incidence and severity of frost. The objective of this work was to determine whether or not a significant difference in the incidence or severity of frost existed between areas of vineyard in which the mid row was managed differently. Mid row management treatments compared in this trial were a mowed sward, a tilled and rolled mid row and a rotary hoed mid row without compaction.

In response to grower inquiry, several sites were also sown to Australian native grasses. Some Californian and alternative pasture varieties were also included at some of these sites, with the objective of determining the adaptability of the growth habit of these species for use as a mid row ground cover in vineyards.

Location	State	Co operator	
Auburn	South Australia	Taylors Wines	√
Clare	South Australia	Southcorp	√
Angaston	South Australia	Mildara Blass	√
Nuriootpa	South Australia	PISA centre	√
Eden Valley	South Australia	Mildara Blass	√
Adelaide Hills	South Australia	The Deanery	√
McLaren Vale	South Australia	Richard Hamilton Wines	√
Padthaway	South Australia	BRL Hardy	√
Coonawarra	South Australia	Southcorp	√
Qualco	South Australia	Yalumba Oxford Landing	X
Barmera	South Australia	Private Grower	X
Loxton	South Australia	Ausvin	√
Renmark	South Australia	Angoves	X
Berri	South Australia	BRL grower	√
Mildura	Victoria	Private Grower	X
Merbein	Victoria	Private Grower	√
Irymple	Victoria	Private Grower	X
Redcliffs	Victoria	Private Grower	X
Great Western	Victoria	Southcorp	√
Nagambie	Victoria	Mitchelton	√
Rutherglen	Victoria	Pfeiffers	X
Barooga	New South Wales	Southcorp	X
Wagga Wagga	New South Wales	CSU	X
Cowra (3 sites)	New South Wales	Richmond Grove	√
Yenda	New South Wales	Private Grower	X
Griffith	New South Wales	Private Grower	X
Margaret River	Western Australia	Voyager Estate	X

√= assessments presented in this report. X= trial used for extension purposes, valid data not gleaned from trial.

Table 6.4.2 1997 Trial Site Locations and Co operators

6.4.2 Assessments

Agronomic data from trials sown in 1997 was collected during the growing season. A list of the assessments proposed for the 1997 trials appear in table 6.3.3 below. Not all assessments were conducted at all sites.

Timing of Assessment	Assessments Made
Early Winter	Sward vigour rating Emergence density
Early Spring	Sward vigour rating Sward height Percentage ground cover Percentage bare ground Biomass production(kg/ha dry wt.)
Mid Summer	Residue persistence Summer growth vigour rating Percentage ground cover Sward height

Table 6.3.3. Summary of Assessments Conducted in 1997 Cover Crop Trials

6.4.3 Auburn Extension Trial

Site details

Co operator/Vineyard:	Taylors Wines
Contact:	Ken Noack
Soil Type:	Clay Loam
Soil pH:	6.5
Irrigation Method:	Drip
Rainfall:	550 mm

SEEDING DETAILS

Date Sown:	30 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Cultivated, clear of weeds and trash, soil moist

TREATMENTS

Table 6.4.3.1 below describes the treatments assessed in the trial established at Taylors Wines vineyard in April 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Perennial and Annual Regenerating Swards		
1. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	32
2. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
3. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
4. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	55:20:20:5	35
5. Victorian Ryegrass+Paraggio medic	70:30	30
6. Crimson Clover	*	30
Green Manure Swards		
7. Fodder Radish	*	20
8. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	35:30:20:5:10	132
9. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	135
10. Coolabah Oats	*	100
11. Fiord Faba Beans	*	150
12. Tahara Triticale	*	150

Table 6.4.3.1 Cover Crop treatments included in the 1997 trial at Auburn

RESULTS AND DISCUSSION

Table 6.4.3.2 below summarises the observations made in the trial conducted at Taylors Wines, Auburn in 1997.

TREATMENT	VIGOUR RATING 28/6/97	VIGOUR RATING 12/9/97	VIGOUR RATING 12/8/98	VIGOUR RATING 29/9/98	FRESH WEIGHT YIELD (KG/HA 12/9/98
1	10	7	1	1	*
2	10	10	6.5	8.5	*
3	10	8.5	4	3.5	*
4	10	8.5	5	3	*
5	8	9	6	6	*
6	10	7	2	1	*
7	8	7	0	0	35700
8	9	8.5	0	0	36900
9	10	10	0	0	52600
10	9	9	0	0	33500
11	8	7.5	0	0	27000
12	9	9	0	0	30200

TREATMENT	% GROUND COVER 28/6/97	% GROUND COVER 8/11/97	% GROUND COVER 29/9/98	SWARD HEIGHT (CM) 28/6/97	SWARD HEIGHT (CM) 8/11/97
1	40	65	5	7	50
2	40	98	80	6	27
3	45	62	25	6	55
4	45	65	35	6	70
5	35	80	65	7	27
6	25	70	10	3	25
7	60	10	0	10	50
8	15	10	0	20	10
9	60	5	0	15	30
10	50	7	0	15	30
11	10	*	0	10	0
12	20	5	0	25	40

Table 6.4.3.2 Results from 1997 trial at Auburn

Yield was determined by hand harvesting six 0.1 square metre quadrates placed at random in the sward on 12/9/98.

All cover crops seeded in this trial established well, with good vigour and good plant density.
All Green Manure Blends achieved high ratings in June and September of 1997. Fodder radish and the blend of oats and grain legumes provided the maximum ground cover early in the growing season. Contrastingly, the mix of triticale and grain legumes provided poor ground cover early, as did the monoculture of faba beans. Triticale grew tall quickly, but offered little in terms of ground cover. As such this species offers potential as a suitable companion crop when establishing permanent species on sloping ground where the potential for run off and erosion is high. The best green manure cover crop in spring time was the blend of oats and grain legumes. Fodder radish showed a lot of early vigour which was not sustained through to spring, with nutrient deficiency symptoms evident at this time. Topdressing these swards with N fertiliser in June may improve performance. Most of the other treatments were approximately equivalent, except for the monoculture of faba beans.

Of the permanent and annual regenerating swards, the perennial ryegrass based treatments were the only ones to offer significant performance in the second year. From the results it would appear that the ability of Italian ryegrass (Dargo) to regenerate is limited. Most of the clover varieties used in this trial persisted well. The Paraggio medic component of treatment 5 did not regenerate strongly. Crimson clover did not regenerate from seed in high density.

A field day was held for local growers on 12/9/97 which attracted over thirty people. Sponsorship was provided by IAMA and local machinery resellers.

CONCLUSIONS

Annual resown cover crops are most often used in this district, however from the results it is possible to see that perennial species can persist in this environment. Application of permanent swards will be limited in this area however to areas of excessive spring soil moisture. Optimum green manure treatments consisted of cultivar blends, not monocultures.

6.4.4 Clare Valley Extension Trial

Site details

Co operator/Vineyard: Southcorp Wines

Contact: John Matz

Soil Type: Clay Loam

Soil pH: 6.5

Irrigation Method: Drip

Rainfall: 550 mm

SEEDING DETAILS

Date Sown: 29 April 1997

Fertiliser: 100 kg/ha DAP at seeding

Seed Bed Preparation: Cultivated, moderate burden of weeds and trash, soil dry

TREATMENTS

Table 6.4.4.1 below describes the treatments assessed in the trial established at Taylors Wines vineyard in April 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Fodder Radish	*	20
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	35:30:20:5:10	132
3. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	135
4. Ryecorn	*	100
5. Tahara Triticale	*	200
Perennial and Annual Regenerating Swards		
6. Crimson Clover	*	30
7. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
8. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	55:20:20:5	35
9. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
10. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	32

Table 6.4.4.1 Cover Crop treatments included in the 1997 trial at Clare

RESULTS AND DISCUSSION

Table 6.4.4.2 below summarises the observations made in the trial conducted at Southcorp Wines, Clare in 1997.

TREATMENT	*VIGOUR RATING 28/6/97*	*VIGOUR RATING 12/9/97*	*% GROUND COVER 28/6/97*	*% GROUND COVER 12/9/97*	*SWARD HEIGHT (CM) 28/6/97*	*WEED SPECIES % GROUND COVER 12/9/97*	*FRESH HERBAGE YIELD KG/HA 12/9/97*
1	7	8.5	30	80	10	20	32600
2	7	8	10	35	18	40	28500
3	7.5	9.5	25	50	18	50	41900
4	8	6	28	25	22	60	15500
5	9	8.5	23	30	20	35	30200
6	4	4	10	15	2	80	*
7	3	8	7	40	2	60	*
8	8.5	6	10	60	6	25	*
9	7	6.5	10	50	8	30	*
10	8.5	7	12	60	12	25	*

Table 6.4.4.2 Results from 1997 trial at Clare

Yield was determined by hand harvesting six 0.1 square metre quadrats placed at random in the sward on 12/9/98.

All treatments established well with good vigour, except for crimson clover and the permanent sward blend of perennial ryegrass and sub clover. This trial provided a clear demonstration of the difference in establishment vigour between perennial ryegrass and annual Italian ryegrass. Crimson clover continued to show a lack of vigour through to spring, unlike the permanent sward blend. The highest ground cover percentage at 28/6/97 was achieved by the fodder radish treatment. This species consistently provided good early and late winter ground cover, and provided the greatest weed suppression of the treatments on the 12/9/97 assessment date.

Dargo ryegrass based swards established with god vigour and provided good winter weed suppression. No differences were evident between the annual clovers used in combination with the ryegrass, with respect to adaptation at this site.

Ryecorn provides good early winter vigour without high ground cover. Such attributes recommend it for use as a companion crop for establishing permanent swards. However, its performance as a green manure crop alternative in this region is exceeded by triticale and oats, and blends of these cereals with grain legume species. The sward of oats plus beans, peas and vetch was rated the best green manure sward in this demonstration trial. This sward exceeded the fresh weight yield of the triticale plus legume sward by almost fifty percent.

CONCLUSIONS

Fodder radish is well adapted to this region.
Green manure swards based on oats blended with annual legumes achieved the greatest yield in this trial.
Crimson clover did not establish well at this site.
Ryecorn is not a suitable alternative as a green manure sward in this region.
Dargo Italian ryegrass grows well in the winter and spring period in this region, and may offer an alternative as an annual resown cover crop for side throw mowing and under vine mulch production.

6.4.5 Angaston Extension Trial

Site details

Co operator/Vineyard:	Mildara Blass Wines
Contact:	Syd Kyloh
Soil Type:	Light Sandy Loam
Soil pH:	7.5
Irrigation Method:	Drip
Rainfall:	600 mm

SEEDING DETAILS

Date Sown:	5 June 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Deeply tilled mid row free of weeds and trash, soil moist and of very fine tilth.

TREATMENTS

Table 6.4.5.1 below describes the treatments assessed in the trial established at Mildara Blass' Dorrien vineyard in June 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	135
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	35:30:20:5:10	132
3. Fodder Radish	*	20
4. Ryecorn	*	100
5. Tahara Triticale	*	175
6. Fiord Faba Beans	*	200
7. Coolabah Oats	*	100
8. Rangi Rape	*	5
Perennial and Annual Regenerating Swards		
9. Kasbah Cocksfoot	*	30
10. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
11. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	55:20:20:5	35
12. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
13. Victorian Ryegrass+Paraggio Medic	70:30	30
14. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	30

Table 6.4.5.1 Cover Crop treatments included in the 1997 trial at Angaston

RESULTS AND DISCUSSION

Table 6.4.5.2 below summarises the observations made in the trial conducted at Southcorp Wines, Angaston in 1997.

TREATMENT	*VIGOUR RATING 21/8/97*	*VIGOUR RATING 19/9/97*
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	3	6
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	4.5	7
3. Fodder Radish	2	4
4. Ryecorn	6	9
5. Tahara Triticale	4	5
6. Coolabah Oats	2	3
Perennial and Annual Regenerating Swards		
7. Kasbah Cocksfoot	1	1
8. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	4	4.5
9. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	5	5

Table 6.4.5.2 Results from 1997 trial at Angaston

This site was sown late due to a delay in seed bed preparation and availability of seeding equipment. Consequently the vigour of all swards in August was suppressed. Only the ryecorn established well enough to provide a high vigour by mid September. Ryecorn appears to out perform other cereal species on light, sandy soil types.

None of the ryegrass based swards established successfully. This may have been in part due to the lack of control of seeding depth at this site. The soil had been rotary hoed prior to seeding, and the resulting light, low bulk density of the soil meant that some seed was buried up to 8cm deep, which is excessive for pasture species.

Fodder radish did not perform well at this site, with nutrient deficiency symptoms being evident at the August field inspection. There appeared little difference between the oats based and triticale based green manure blends at this site (treatments 1 and 2).

CONCLUSIONS

Ryecorn is the preferred cereal cover crop option for light, sandy soils.

Delayed seeding of cover crops resulted in poor sward vigour and lack of spring herbage production. Early seeding is recommended, particularly for green manure treatments which are terminated in late August or early September.

Ryegrass based swards are not suited to delayed establishment on light, sandy soils.

Fodder radish should be top dressed with N fertiliser in mid winter to alleviate nutrient deficiency, or be sown with higher rates of fertiliser.

6.4.6 Nuriootpa Extension Trial

Site details

Co operator/Vineyard:	Primary Industries of South Australia
Contact:	Tony Gerlach
Soil Type:	Clay Loam
Soil pH:	7.5
Irrigation Method:	Drip
Rainfall:	600 mm

SEEDING DETAILS

Date Sown:	13 May 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Tilled and sprayed mid row. Moderate burden of trash and weeds.

TREATMENTS

Table 6.4.6.1 below describes the treatments assessed in the trial established at the Nuriootpa Research Centre vineyard in June 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	130
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	35:30:20:5:10	130
3. Fodder Radish	*	20
4. Fiord Faba Beans	*	200
5. Coolabah Oats	*	100
Perennial and Annual Regenerating Swards		
6. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
7. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	55:20:20:5	35
8. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
9. Victorian Ryegrass+Paraggio Medic	70:30	30
10. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	30

Table 6.4.6.1 Cover Crop treatments included in the 1997 trial at Angaston

RESULTS AND DISCUSSION

Table 6.4.6.2 below summarises the observations made in the trial conducted at the PISA centre, Nuriootpa in 1997.

TREATMENT	*VIGOUR RATING*	*VIGOUR RATING*	*HERBAGE YIELD KG/HA*
Green Manure Swards	*21/8/97*	*19/9/97*	*19/9/97*
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	3	4	7500
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	4.5	7	10800
3. Fodder Radish	2	4	3600
4. Fiord Faba Beans	6	5.5	7100
5. Coolabah Oats	4	6	5000
Perennial and Annual Regenerating Swards			
6. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	2	5	*
7. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	2.5	3	*
8. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	4	4.5	*
9. Victorian Ryegrass+Paraggio Medic	3	5	*
10. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	2.5	3	*

Table 6.4.6.2 Results from 1997 trial at Nuriootpa

Fresh weight yield was determined by hand harvesting 6 X 0.1 square metre quadrants.

Seed bed preparation at this site was poor. The mid rows were not tilled prior to seeding, and a large burden of wire weed residue on the soil surface severely impeded the seeding process. In addition, a Connor Shea seeder was used which had poor seeding rate control, and so seeding rates were very approximate.
There were no stand out treatments in this under performing trial. The site was sprayed with a knockdown herbicide in spring and no regeneration or persistence data was therefore available.
Poor nutrition was evident at this site, and this impacted severely on the performance of the non legume varieties, particularly the fodder radish. The triticale based green manure sward appeared to be slightly better adapted to the conditions at this site than the oats based green manure blend.
All of the perennial and annual regenerating swards established with low vigour, and were suffering from weed invasion in September.

CONCLUSIONS

Very few conclusions could be drawn from this poor trial.

6.4.7 Eden Valley Extension Trial

Site details

Co operator/Vineyard:	Mildara Blass Wines
Contact:	Gil Rogers
Soil Type:	Heavy Grey Clay/Loam
Soil pH:	5.5
Irrigation Method:	Drip
Rainfall:	600 mm

SEEDING DETAILS

Date Sown:	13 May 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Tilled mid row, free of trash and weeds.

TREATMENTS

Table 6.4.7.1 below describes the treatments assessed in the trial established at Mildara Blass' Eden Valley vineyard in May 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa Faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	137
2. Coolabah Oats	*	106
3. Tahara Triticale	*	200
4. Fodder Radish	*	25
Perennial and Annual Regenerating Swards		
5. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
6. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	55:20:20:5	35
7. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
8. Victorian Ryegrass+Paraggio Medic	70:30	30
9. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	30
10. Crimson Clover	*	20
11. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	70:20:10	36
12. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	70:25:5	34

Table 6.4.7.1 Cover Crop treatments included in the 1997 trial at Eden Valley

RESULTS AND DISCUSSION

Table 6.4.7.2 below summarises the observations made in the trial conducted at Eden Valley in 1997.

TREATMENT	*VIGOUR RATING 21/8/97*	*VIGOUR RATING 19/9/97*	*HERBAGE YIELD KG/HA 19/9/97*
Green Manure Swards			
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	9	9	35800
2. Coolabah Oats	5	4	18000
3. Tahara Triticale	7.5	8	33700
4. Fodder Radish	6	5	17300
Perennial and Annual Regenerating Swards			
5. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	6.5	8	*
6. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	5	5	*
7. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	6	7	*
8. Victorian Ryegrass+Paraggio Medic	5	5	*
9. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	6.5	7	*
10. Crimson Clover	2	1	*
11. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	8	8.5	*
12. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	4	3	*

Table 6.4.7.2 Results from 1997 trial at Eden Valley

Fresh weight yield was determined by hand harvesting 6 X 0.1 square metre quadrants.

Tahara triticale and the blend of oats and grain legumes provided the best fresh weight yields of the green manure treatments at this trial site. The blend, treatment 1, established with greatest vigour. Coolabah oats and fodder radish performed poorly at this site. Triticale appeared to be a better cereal option at this site in which the soil became water logged for an extended period through late winter. Fodder radish and oats did not appear to tolerate these conditions well.

Crimson clover did not tolerate the water logged conditions, and failed to establish successfully. Of the perennial grasses, the Derby supreme ryegrass and Cindy creeping red fescue appeared to have lowest vigour in winter, which carried through to spring. The annual clovers which appeared best adapted to this vineyard were Gosse sub clover, Elite Berseem and Laser Persian clover. Dargo ryegrass established reasonably well at this cold, wet site. Ellet ryegrass appeared to establish with greater vigour than Victorian ryegrass. The persistence of the annual regenerating and perennial species could not be monitored as this site was accidentally sprayed out by vineyard staff in late spring.

CONCLUSIONS

Triticale appears a good option as a cereal green manure in this vineyard, as it appeared to tolerate the water logged conditions better than oats.
Fodder radish does not appear to tolerate water logged soils well.
Derby Supreme turf type ryegrass appears to have lower vigour at establishment than the forage varieties such as Ellet and Victorian.
Gosse sub clover, Laser Persian and Elite II Berseem clovers appear to tolerate cold, wet winter conditions better than the other cultivars in this trial.
Crimson clover does not appear adapted to these conditions.

6.4.8 Adelaide Hills Extension Trial

6.4.8.1 Sward Comparison Trial

Site details

Co operator/Vineyard:	The Deanery
Contact:	Alan Dean
Soil Type:	Clay Loam
Soil pH:	6.5
Irrigation Method:	Drip
Rainfall:	650 mm

SEEDING DETAILS

Date Sown:	13 April 1997
Fertiliser:	90 kg/ha DAP at seeding
Seed Bed Preparation:	Tilled but uneven mid row, with a dense burden of Phalaris and wireweed residue.

TREATMENTS

Table 6.4.8.1 below describes the treatments assessed in the trial established at The Deanery vineyard, Balhannah, in April 1997.

COVER CROP TREATMENT	COVER CROP COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Perennial and Annual Regenerating Swards		
1. Crimson Clover	*	12
2. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers (Blend 1)	55:15:15:15	35
3. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover (Blend 2)	55:20:20:5	35
4. Victorian Ryegrass+Paraggio Medic (Blend 3)	70:30	30
5. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers (Blend 'B')	80:10:5:5	30
6. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers (Blend 4)	55:15:15:15	35
7. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover (Blend 5)	70:20:10	36
8. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover (Blend 6)	70:25:5	34
9. Victorian ryegrass, Demeter fescue, Haifa white clover, Palestine strawberry clover and Paraggio medic (Blend 7)	40:40:5:3:12	35
10. Demeter fescue	*	35

Table 6.4.8.1 Cover Crop treatments included in the 1997 trial at Balhannah

RESULTS AND DISCUSSION

Table 6.4.8.2 below summarises the observations made in the trial conducted at The Deanery vineyard, Balhannah in the Adelaide Hills in 1997.

TREATMENT	*VIGOUR RATING 22/7/97*	*VIGOUR RATING 19/9/97*	*VIGOUR RATING 15/12/97*	*SWARD HEIGHT (cm) 22/7/97*	*SWARD HEIGHT (cm) 15/12/97*	*GROUND COVER% 22/7/97*	*GROUND COVER% 15/12/97*
Perennial Swards							
1. Crimson Clover	1	1	0	0	0	trace	0
2. Blend 1	8	8	10	7.5	18	85	90
3. Blend 2	7	10	10	22	40	75	20
4. Blend 3	8	5	7	22	30	75	10
5. Blend 4	9	9	10	7	17	25	80
6. Blend 'B'	6.5	8	9	30	35	80	20
7. Blend 5	6	5	7	3	12	35	60
8. Blend 6	5	7	8.5	8	20	60	85
9. Blend 7	8	7	8	7	18	60	70
10. Demeter Fescue	3	3	10	5	23	5	20

Table 6.4.8.2 Results from 1997 sward comparison trial at Balhannah

The crimson clover did not establish well at this site, due mainly to the high levels of weed infestation and the presence of Red Legged Earth Mite. Most of the perennial grass based swards established well. Fescue is relatively slow to establish but by mid summer provided a vigorous sward.

The Victorian ryegrass/sub clover blend provided the greatest level of ground cover in December as well as in July.
The annual ryegrass based swards established with vigour, but do not provide equivalent weed suppression.

6.4.8.2 Efficacy of broad leaf weed control measures at Balhannah, 1997

In addition to the plant species comparison trial, two broadleaf selective herbicides were applied to three different mid row swards for the purpose of controlling the high density of capeweed (*Arctotheca calendula*), common sow thistle (*Sonchus oleraceus*) and wild geranium (*Erodium spp*) weeds which established at the site. An assessment was made of the efficacy of Igran™ (Terbutryn 485 mls/L active ingredient) and Jaguar™ (Bromoxynil 250mls/L plus Diflufenican 25mls/L) in controlling the weeds present, as well as any phyto toxic effects on the sown species. The results of this work appear in Table 6.4.7.3 below.

Aim: To compare the effects of applying broadleaf herbicides to first year cover crop swards. To compare the efficacy of two commercial herbicides in controlling broadleaf weeds.

Trial details

Spray Date: 11 June 1997 **Time of Spray:** 1600-1630

Temperature: 14 degrees Celsius **Wind Conditions:** Slight North to North Westerly

Boom Width: 1.5 m **Sprayed Width:** 2.0 m

Spray Volume: 250L/Ha **Ground Speed:** 1.0 m per second.

Plot Size: 30 metres x 2 metres

TREATMENT	APPLICATION RATE
JAGUAR	1.0 Litres/Ha
IGRAN	500 mls/Ha
CONTROL	*

The above treatments were applied to three mid row swards, namely Demeter Fescue, Crimson Clover and a blend of perennial ryegrass and sub clover (Rebound 1).

	THISTLE CONTROL	*THISTLE CONTROL*	*C/WEED CONTROL*	*C/WEED CONTROL*	*DOCK CONTROL*	*DOCK CONTROL*	*ERODIUM CONTROL*
TMT	*22/7/97*	*20/10/97*	*22/7/97*	*20/10/97*	*22/7/97*	*20/10/97*	*20/10/97*
CONTROL	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JAGUAR	10.0	9.5	10.0	9.8	8.7	9.5	8.3
IGRAN	0.0	0.0	9.7	3.2	0.0	4.3	7.5
LSD(95%)	**0.1**	**0.4**	**0.4**	**0.1**	**0.8**	**0.1**	**0.84**

Table 6.4.8.3 Mean Efficacy of two herbicides on sow thistle, capeweed, Dock and Erodium species at Balhannah, 1997.

Refer to plates 12.25,12.26 and 12.27 in the **Illustrations** *section* for photographs demonstrating the visual differences in levels of weed control between the treatments.

CONCLUSIONS

Jaguar provided very good control of common sow thistle, capeweed and dock at 1.0 l/ha. Moderate control of erodium was achieved using this treatment.
The level of control of the weeds present was significantly higher using Jaguar at 1.0l/ha compared to Igran at 500mls/ha, except for erodium where no significant difference in the level of control was observed between the two treatments.
Igran provided no control or suppression of common sow thistle. Capeweed control was initially good (22/7/97), however this effect was not sustained to 20/10/97. Conversely, no initial effect on dock was noted with this treatment, though partial suppression was achieved by 20/10/97. Moderate control of erodium species was achieved by Igran at 500mls/ha in this trial.

RECOMMENDATIONS

Once registered for use in vineyards in Australia, Jaguar is a product which will provide a good level of control of some problem broad leaf weeds such as capeweed.
Application rates less than 1.0 litres/ha should provide control of weeds if applied at an earlier stage of weed development.
Igran did not appear to provide adequate levels of control of the weeds present in this trial, and does not appear to be an alternative to capeweed control.

6.4.9 McLaren Vale Extension Trial

Site details

Co operator/Vineyard:	Richard Hamilton Wines
Contact:	Adam Jacobs
Soil Type:	Medium-Heavy Red Brown Earth
Soil pH:	5.5
Irrigation Method:	Drip
Rainfall:	600 mm

SEEDING DETAILS

Date Sown:	24 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Tilled mid row, moderate burden of trash, free of weeds.

TREATMENTS

Table 6.4.9.1 below describes the cover crop treatments included in the trial established at Richard Hamilton Wine's McLaren Vale vineyard in May 1997. Two replicates of each treatment were sown, with a plot size of one whole mid row (approximately 250 metres in length).

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	137
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	35:30:20:5:10	132
3. Coolabah Oats	*	100
4. Rossa Faba Beans	*	186
5. Fodder Radish	*	20
Perennial and Annual Regenerating Swards		
6. Victorian Ryegrass+Paraggio Medic	70:30	30
7. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
8. Crimson Clover	*	20
9. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
10. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	35

Table 6.4.91 Cover Crop treatments included in the 1997 trial at McLaren Vale

RESULTS AND DISCUSSION

Table 6.4.9.2 below summarises the observations made in the trial conducted at Richard Hamilton's vineyard McLaren Vale in 1997.

TREATMENT	*VIGOUR RATING 16/6/97*	*VIGOUR RATING 19/8/97*	*GROUND COVER % 19/8/97*	*SWARD HEIGHT 19/8/97*
Green Manure Swards				
1. Coolabah Oats+Rossa Faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	7	9	85	100
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	5	4	20	110
3. Coolabah Oats	5.8	8	85	95
4. Rossa Faba Beans	6	2	10	80
5. Fodder Radish	7.8	8.5	95	70
Perennial and Annual Regenerating Swards				
6. Victorian Ryegrass+Paraggio Medic	1	0	0	0
7. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	3	0	0	0
8. Crimson Clover	0	0	0	0
9. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	2	0	0	0
10. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	3	0	0	0

Table 6.4.9.2 Results from 1997 trial at McLaren Vale. The above table includes sward vigour ratings, height and ground cover percentages.

TREATMENT	*DRY WT (KG/HA)*	*BIOMAX YIELD ADVANTAGE*	*SEED COST/HA*	*$/MT DRY WT*
Rossa Faba Beans	3331	+70%	67.50	20.26
Coolabah Oats	2888	+93%	33.00	11.42
Biomax	5563	-	84.50	15.18
Fodder Radish	5824	-4%	90.00	15.45

Table 6.4.9.3 Comparison of dry weight yields and seed costs for three green manure cover crops at the McLaren vale site in 1997.

Conversion Factors for the above cover crops were: Red Beans=17.7%; Oats=20.3%; Biomax=17.8%, and; Fodder Radish=12.8%.

TREATMENT	*CROP YIELD FRESH WT (MT/HA)*	*WEED YIELD FRESH WT (MT/HA)*	*TOTAL YIELD FRESH WT (MT/HA)*	*SWARD COMPOSITION % CROP*	*SWARD COMPOSITION % WEED*
Rossa Faba Beans	18.8	35.9	54.7	34.4	65.6
Coolabah Oats	14.2	18.1	32.3	43.8	56.2
Oats/Beans/Peas/Vetch	31.2	20.9	52.1	59.8	40.2
Fodder radish	45.5	14.2	59.7	76.2	23.8

Table 6.4.9.4 Fresh weight yield comparisons and botanical composition of green manure swards at the McLaren Vale trial 1997.

When the site was first inspected on 16/6/97, there was a moderate weed pressure existing in the sown rows. Weed species included soursob, capeweed, wild radish and salvation jane. The sour sob appeared to have a negative impact on pasture legume emergence, and very few established clover seedlings were identified in the treatment areas. This was demonstrated by the complete absence of crimson clover seedlings, and may suggest losses due to insect attack, though no surviving populations of red legged earth mite were noted on the day of assessment. Dargo Italian ryegrass was noted to have established with good vigour, and was successfully competing with the weed populations. The perennial ryegrasses were noted to be competing with less vigour, and appeared to have established less successfully.
In general, the large seeded green manure treatments were the most vigorous, and all of these treatments appeared to have competed successfully with the weeds at emergence.

By the second assessment on 19/8/97, all of the annual regenerating swards had been colonised by the weed populations. All of the green manure treatments had competed effectively to some degree.

Four of the green manure cover crops were selected for a yield and cost comparison analysis. Each of the two rows for each treatment were divided into two transects and three quadrants per transect were harvested on the 19th of August. A table of results is presented in full in the appendices for these assessments. The herbage samples were split into crop and weed segments to determine fresh weights of crop yield and sward composition. Samples of plant material were retained at harvest and oven dried, and were subsequently used to formulate a conversion factor such that yield could be presented as kilograms of dry weight per sown hectare.

The data in **Table 6.4.9.4** demonstrates the ability of fodder radish to compete effectively with winter weeds, and clearly achieved both highest fresh weight yield and the greatest percentage botanical composition (crop component). Faba beans do not compete effectively with winter weeds and produced a relatively low crop yield and low crop component in the botanical composition assessment. Coolabah oats did not yield a high amount of fresh weight and weed species comprised the majority of the botanical composition of the sward. Actual weed yield, however, was reduced considerably (approximately 50%) in the oat crop compared to the bean crop. However, the green manure blend of oats, beans vetch and peas ("Biomax"), was able to produce both a moderate result in terms of crop component in the botanical composition study, and a moderate fresh weight crop yield.

Table 6.4.9.3 demonstrates the potential yield benefit and cost effectiveness which may not be realised if seed cost per hectare is the parameter a grower uses in cover crop selection decisions. "Biomax" and fodder radish, although having a relatively high seed cost per hectare, both return a moderately good result in terms of return per dollar invested in seed if dry weight yield is used as the indicator of cover crop performance. The data in this table suggests that the higher priced Biomax and fodder radish cover crops can prove a more cost efficient option than a monoculture of faba beans. The oat cover crop proved to be the most cost effective of the crops used in this comparison, however as table 6.4.9.4 demonstrates, oats may not always provide the best result, depending on the parameter(s) used to determine cover crop effectiveness.

RECOMMENDATIONS

Seed cost per sown hectare should not be the only criteria used to determine the most appropriate cover to use. Total yield may also be misleading, and growers should look at potential net benefit(s) per dollar invested before discounting the use of higher priced cover crop products such as Biomax and fodder radish.

Substantial variation was evident in the ability of annual crops to suppress certain weeds. A monoculture of faba beans appeared less able to effectively compete with the weeds at this site than a monoculture of oats or a blend of oats, beans, peas and vetch. The sward consisting of a monoculture of fodder radish was the most effective in competing with the annual weeds at this site.

The non performance of annual regenerating and perennial swards at this site demonstrated the need to plan for the establishment of such cover crops. The high density of weed species smothered the establishing cover crop species and prevented an effective sward from developing. In such circumstances, where high weed populations are known to exist, these is a requirement for effective weed control using cultural, chemical and crop rotation tools. Problem weed species must be controlled after their emergence in autumn, prior to seeding the permanent sward. In situations where high seed banks of weed seeds are likely to occur, a rotation of annual cover crops over a period of time should be employed which reduce such pressure in subsequent years. Permanent sward establishment is benefited by a prepared seed bed which is free of competing weeds, and which provides minimal obstacles to cover crop establishment.

6.4.10 Padthaway Extension Trial

Site details

Co operator/Vineyard:	BRL Hardy Wines
Contact:	Chris Greig
Soil Type:	Medium Grey Clay/Loam
Soil pH:	Slightly acid to neutral
Irrigation Method:	Drip
Rainfall:	550 mm

SEEDING DETAILS

Date Sown:	23 April 1997
Fertiliser:	130 kg/ha 15:13:0:10 of N:P:K:S at seeding (180 kg/ha for brassica cover crops)
Seed Bed Preparation:	Tilled mid row, free of trash and weeds.

TREATMENTS

Table 6.4.10.1 below describes the treatments assessed in the trial established at BRL Hardy's Padthaway vineyard in April 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	137
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	35:30:20:5:10	132
3. Rangi Rape	*	5
4. Fodder Radish	*	20
5. Nemfix	*	10
6. Triticale+Popany vetch+Blanchefleur vetch	80:10:10	102
Perennial and Annual Regenerating Swards		
7. Victorian Ryegrass+Paraggio Medic	70:30	30
8. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
9. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	70:20:10	36
10. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	70:25:5	34
11. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
12. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	35

Table 6.4.10.1 Cover Crop treatments included in the 1997 trial at Padthaway

RESULTS AND DISCUSSION

Tables 6.4.10.2 and 6.4.2.3 below summarise the observations made in the trial conducted at Padthaway

COVER CROP TREATMENT	VIGOUR RATING 20/5/97	VIGOUR RATING 17/7/97	VIGOUR RATING 5/9/97
Green Manure Swards			
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	9	6	4
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	5	6	4
3. Rangi Rape	2	2	0
4. Fodder Radish	8	5	5
5. Nemfix	4	2	2.5
6. Triticale+Popany vetch+Blanchefleur vetch	7	5	4
Perennial and Annual Regenerating Swards			
7. Victorian Ryegrass+Paraggio Medic	3	2	3
8. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	3	3	4
9. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	2	2	4
10. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	0	2	3
11. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	4.5	7	7
12. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	8	7	6.5

Table 6.4.10.2 Sward vigour ratings from 1997 trial at Padthaway

COVER CROP TREATMENT	SWARD HEIGHT 5/9/97	GROUND COVER % 5/9/97
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	30	50
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	25	20
3. Rangi Rape	0	0
4. Fodder Radish	30	25
5. Nemfix	17	5
6. Triticale+Popany vetch+Blanchefleur vetch	50	10
Perennial and Annual Regenerating Swards		
7. Victorian Ryegrass+Paraggio Medic	8	15
8. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	7	25
9. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	8	7
10. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	6.5	5
11. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	22	50
12. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	18	50

Table 6.4.10.3 Sward height and ground cover assessments from the 1997 trial at Padthaway

RECOMMENDATIONS

Rangi rape failed to establish successfully at this site. Best results are generally achieved from seeding rangi rape in to a well tilled seed bed, and rolling post sowing. The other brassica species included in this trial, fodder radish and oilseed mustard, are generally easier to establish, and performed moderately well in this trial. Fodder radish is the preferred choice of brassica cover crop in this region due to its ease of establishment and consistency of performance.

Treatments containing Dargo ryegrass were the best cover crop swards in this trial. These swards achieved the highest rankings for vigour, as well as ground cover in mid spring.

Most of the green manure crops established well in May, but did not result in highly productive swards in spring. Fodder radish and the cereal/legume blends were ranked equivalently at this time.

All swards based on perennial grasses appeared equivalent in this trial.

6.4.11 Coonawarra Extension Trial

Site details

Co operator/Vineyard:	Southcorp Wines
Contact:	Max Arney
Soil Type:	Terra Rossa
Soil pH:	Neutral
Irrigation Method:	Drip
Rainfall:	650 mm

SEEDING DETAILS

Date Sown:	22 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Tilled mid row, free of trash and weeds.

TREATMENTS

Table 6.4.11.1 below describes the treatments assessed in the trial established at Southcorp's Coonawarra vineyard in April 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	137
2. Coolabah Oats	*	106
3. Tahara Triticale	*	200
4. Fodder Radish	*	25
Perennial and Annual Regenerating Swards		
5. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
6. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	55:20:20:5	35
7. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
8. Victorian Ryegrass+Paraggio Medic	70:30	30
9. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	30
10. Crimson Clover	*	20
11. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	70:20:10	36
12. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	70:25:5	34

Table 6.4.11.1 Cover Crop treatments included in the 1997 trial at Coonawarra

RESULTS AND DISCUSSION

Tables 6.4.11.2 and 3 below summarises the observations made in the trial conducted at Southcorps vineyard, Coonawarra in 1997.

TREATMENT	VIGOUR RATING 21/8/97	VIGOUR RATING 19/9/97	VIGOUR RATING 20/1/98	VIGOUR RATING 27/10/98
Green Manure Swards				
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	9	9	0	0
2. Coolabah Oats	5	4	0	0
3. Tahara Triticale	7.5	8	0	0
4. Fodder Radish	6	5	0	0
Perennial and Annual Regenerating Swards				
5. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	6.5	8	9.5	9.5
6. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	5	5	3	3
7. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	6	7	5	5
8. Victorian Ryegrass+Paraggio Medic	5	5	8.5	8.5
9. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	6.5	7	3	3
10. Crimson Clover	2	1	0	0
11. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	8	8.5	6.5	6.5
12. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	4	3	7.5	7.5

TREATMENT	SWARD HEIGHT 20/1/98	PERCENT GROUND COVER 20/1/98
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	0	0
2. Coolabah Oats	0	0
3. Tahara Triticale	0	0
4. Fodder Radish	0	0
Perennial and Annual Regenerating Swards		
5. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	10	50
6. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	20	10
7. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	0	0
8. Victorian Ryegrass+Paraggio Medic	7	12
9. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	0	0
10. Crimson Clover	0	0
11. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	7.5	10
12. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	7	12

Tables 6.4.11.2 -3 Results from 1997 trial at Coonawarra

Triticale and the blend of oats, beans, peas and vetch appeared to be the best options as green manures in this trial. Oats and fodder radish did not appear to perform well in spring despite establishing with good vigour. Nutrient deficiency symptoms appeared in these trials in spring. Triticale appeared to produce better results in these circumstances. Unfortunately these swards were mowed prior to an opportunity to determine relative yields, however the residue resulting from the mowing of the oats and legume blend persisted through the summer period, and significant amounts of residue remained on the undervine soil surface during the following season.

Of the permanent sward treatments, the Victorian ryegrass appeared better adapted than either Ellet or Derby Supreme in this trial. Derby supreme and Cindy creeping red fescue establish with very low vigour in early winter. The Victorian ryegrass and sub clover blend provided 50% ground cover over summer in 1997/98 which excluded all summer weed growth, which mainly consisted of *Scabiosa spp.*

Dargo ryegrass did not regenerate in the second season from seed, and appears to be an annual resown species, not a self regenerating option.

White clover did not persist in to the second year, unlike the strawberry clover in treatment 12 which persisted well.

Crimson clover failed to establish in either season at this site. Subclovers appear better adapted to this vineyard than the annual medic in treatment 8.

Growers were taken to this demonstration site during Vititec 97.

CONCLUSIONS

Victorian perennial ryegrass appears well adapted to this vineyard. This cultivar persists well over summer and regenerates strongly in autumn.
Dargo ryegrass is an annual resown variety, not an annual regenerating option.
Crimson clover failed to establish successfully at this site despite being sowed at 20 kg/ha.
Derby Supreme ryegrass establishes with significantly lower vigour than forage varieties.

6.4.12 Loxton Extension Trial

Site details

Co operator/Vineyard:	Ausvin
Contact:	David Olssen
Soil Type:	Red Sandy Loam
Soil pH:	7.5-8
Irrigation Method:	Drip
Rainfall:	200 mm

SEEDING DETAILS

Date Sown:	16 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Direct Drilled. Moderate weed burden (desiccated prior to seeding)

TREATMENTS

Table 6.4.12.1 below describes the treatments assessed in the trial established at Mildara Blass' Eden Valley vineyard in May 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	137
2. Ryecorn	*	106
3. Faba Beans	*	186
4. Fodder Radish	*	25
5. Nemfix	*	10
7. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	55:15:15:15	130
8. Triticale+Nemfix	95:5	100
9. Paraggio Medic	*	22

Table 6.4.12.1 Cover Crop treatments included in the 1997 trial at Loxton

RESULTS AND DISCUSSION

Table 6.4.12.2 below summarises the observations made in the trial conducted at Loxton

TREATMENT	VIGOUR RATING 14/8/97	% GROUND COVER 19/9/97	SWARD HEIGHT 19/9/97
Green Manure Swards			
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	7	40	120
2. Ryecorn	8	4	4
3. Faba Beans	7	15	100
4. Fodder Radish	2	5	10
5. Nemfix	0.5	0	0
7. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	5.5	25	150
8. Triticale+Oilseed Mustard	7.5	30	150
9. Paraggio Medic	4	5	2

Table 6.4.12.2 Results from 1997 trial at Loxton

Frost impacted significantly on the performance of cover crops at this site. Of the vetch species, the Popany appeared to tolerate frost better than Blanchefleur, and appeared more productive. Low rainfall in this region in combination with drip irrigation will limit the options for cover crops. Of the cover crop trialled, the ryecorn, oats and the forage blend containing oats appeared to provide the best result in what could be described as an average season. Without mid row irrigation and significant winter rainfall, the brassica species are limited in performance and have little application, as good results will only be achieved in seasons of above average rainfall.

6.4.13 Berri Extension Trial

Site details

Co operator/Vineyard:	Private grower
Contact:	Leon Rosenzweig
Soil Type:	Red Sandy Loam
Soil pH:	7.5
Irrigation Method:	Overhead sprinkler
Rainfall:	600 mm

SEEDING DETAILS

Date Sown:	16 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Tilled mid row, free of trash and weeds.

TREATMENTS

Table 6.4.13.1 below describes the treatments assessed in the trial established at the Berri trial site in 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean-Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	137
2. Ryecorn	*	106
3. Cape Barley	*	86
4. Fodder Radish	*	25
5. Nemfix	*	10
7. Triticale+Ascot Faba Bean-Laura Peas+Popany and Blanchefleur Vetches	55:15:15:15	130
8. Triticale+Oilseed Mustard	95:5	100
9. Paraggio Medic	*	22
Perennial and Annual Regenerating Swards		
10. Victorian Ryegrass+Paraggio Medic	70:30	30
11. Tetila Ryegrass	*	32
12. Kasbah Cocksfoot+Paraggio Medic	70:30	30

Table 6.4.13.1 Cover Crop treatments included in the 1997 trial at Berri

RESULTS AND DISCUSSION

Table 6.4.13.2 below summarises the observations made in the trial conducted at Berri

TREATMENT	VIGOUR RATING 26/6/97	% GROUND COVER 26/6/97	SWARD HEIGHT 26/6/97
Green Manure Swards			
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	10	60	30
2. Ryecorn	10	50	35
3. Cape Barley	8	70	17
4. Fodder Radish	9	50	20
5. Nemfix	6	40	10
7. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	9.5	40	40
8. Triticale+Oilseed Mustard	7	10	35
9. Paraggio Medic	10	85	7
Perennial and Annual Regenerating Swards			
10. Victorian Ryegrass+Paraggio Medic	10	50	10
11. Tetila Ryegrass	10	40	15
12. Kasbah Cocksfoot+Paraggio Medic	8	35	5

Table 6.4.13.2 Cover Crop treatments included in the 1997 trial at Berri

Most cover crops performed well at this site. The vines were only two years old at the time of the trial, having been planted on cleared scrub land. All leguminous swards showed evidence of nitrogen deficiency in late winter/early spring, which may have been in part due to the lack of fertiliser history. Generally legume cover crops outperform cereal and brassica cover crops in vineyards where rootstocks are used.

Considerable time was spent in seed bed preparation at this site, with a weed free soil of fine tilth presented at seeding. This resulted in very even and dense establishment of all cover crop treatments and a lack of competing winter weeds through the growing season.

6.4.14 Merbein Extension Trial

Site details

Co operator/Vineyard:	Neil Bennett
Soil Type:	Red Sandy Loam
Soil pH:	8.0
Irrigation Method:	Over Head Sprinler
Rainfall:	250 mm

SEEDING DETAILS

Date Sown:	17 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Tilled mid row, moderate levels of trash of trash, few weeds.

TREATMENTS

Table 6.4.14.1 below describes the treatments assessed in the trial established at Neil Bennett's vineyard in April 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Annual Swards		
1. Indian Mustard	*	10
2. Fodder Radish	*	20
3. Triticale+Nemfix	95:5	100
4. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetchs	35:30:20:8:7	137
5. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetchs	55:15:15:15	130
6. Paraggio Medic	*	20
7. Mogul Medic	*	20
8. Kelson Medic	*	35

Table 6.4.14.1 Cover Crop treatments included in the 1997 trial at Merbein

RESULTS AND DISCUSSION

Table 6.4.14.2 below summarises the observations made in the trial conducted at the Merbein trial.

	VIGOUR RATING	PERCENT GROUND COVER	SWARD YIELD KG/HA
	Aug 97	Aug 97	Aug 97
Green Manure Swards			
1. Nemfix	7	90	6400
2. Fodder Radish	5	30	3500
3. Triticale+Oilseed Mustard	4.5	10	1580
4. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	9.5	90	7900
5. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	7	30	4500
6. Paraggio Medic	9	75	4200
7. Mogul Medic	8	60	4400
8. Kelson Medic	9	80	6300

Table 6.4.14.2 Results from 1997 trial at Merbein.

Only green manure type swards were included in this trial. Of these treatments, the forage blend containing oats sward provided the best result in terms of dry matter yield per hectare. The best three treatments in this trial were the forage blend containing oats, Nemfix and Kelson annual medic. The fodder radish did not yield as well as the mustard in this trial, which is consistent with the performance of these brassicas on the light soil types in lower rainfall, sprinkler irrigated vineyards. The blend of triticale and mustard did not provide a good result, and the results achieved with this blend have been too erratic for it to be recommended to growers with confidence. The general impression gleaned from observations has been that mustard does not compete well in a blend with other vigorous cultivars.
Paraggio medic provides good ground cover and presented excellent vigour in late winter, but has greater application as a regenerating sward rather than a green manure cover crop due to the fact its seasonal production/late winter yield is most often exceeded by other swards. Kelson medic demonstrates high dry weight yields in late winter as a mono culture, and has good application generally ion combination with cereals such as oats or triticale.

RECOMMENDATIONS

Oilseed mustard is the preferred brassica crop for light, sandy soils in the Sunraysia region.
Kelson medic has application as a green manure cover crop, either as a component in a blend with cereals, or in monoculture.
Biomax 1 provided the highest dry weight yield in this trial, and may provide the most consistent and productive green manure option in the Sunraysia.
Paraggio medic appears to have good adaptation to the Sunraysia region as an annual regenerating sward.

6.4.15 Great Western Extension Trial

Site details

Co operator/Vineyard:	Southcorp Wines
Contact:	Fiona Wigg
Soil Type:	Medium Grey Clay/Loam
Soil pH:	5.5
Irrigation Method:	Drip
Rainfall:	500 mm

SEEDING DETAILS

Date Sown:	22 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Tilled mid row, light burden of of trash and weeds.

TREATMENTS

Table 6.4.15.1 below describes the treatments assessed in the trial established at Southcorp's Great Western vineyard in April 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Fodder Radish	*	20
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	55:15:15:15	130
3. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	137
4. Coolabah Oats	*	106
5. Tahara Triticale	*	175
6. Ryecorn	*	100
7. Nemfix	*	10
8. Triticale+Nemfix	95:5	100
Perennial and Annual Regenerating Swards		
6. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	55:20:20:5	35

Table 6.4.15.1 Cover Crop treatments included in the 1997 trial at Great Western.

RESULTS AND DISCUSSION

Table 6.4.15.2 below summarises the observations made in the trial conducted at Great Western in 1997.

TREATMENT	VIGOUR RATING 5/7/97	VIGOUR RATING 30/9/97	% GROUND COVER 5/7/97
Green Manure Swards			
1. Fodder Radish	5.5	1	45
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	6	1	10
3. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	7	7	35
4. Coolabah Oats	6	2	15
5. Tahara Triticale	8.5	2	35
6. Ryecorn	9.5	4	40
7. Nemfix	3	1	10
8. Triticale +Nemfix	7	0	10
Perennial and Annual Regenerating Swards			
6. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	6	5	10

Table 6.4.15.2 Results from 1997 trial at Great Western

Fodder radish established with vigour at this site, however plant density was low, providing for significant colonisation of the mid row area by winter weeds such as soursob and cape weed. The soil varied through the trial area, and the radish appeared better adapted to the heavier soil than the lighter, sandy loam. In comparison, the mustard did not appear to be affected by variation in the soil across the site, and established with good plant vigour and good density, however weed growth did restrict sward productivity. In the mix of triticale and mustard, the mustard was not able to establish successfully. The triticale in this treatment grew well early, however this does not appear to be a viable blend of species.

Of the forage blends, the oats based mixture appeared to be more productive in late winter, as the triticale based sward appeared low in plant density. Weed populations in both treatments was high. The triticale based sward performed best on the heavier soil type, and the oats based sward gave better results on the lighter soil in this trial, and regrowth after mowing in early September was quite vigorous, as evidenced by the observations in late September.

The annual regenerating sward of annual ryegrass and sub clovers performed moderately well, but did not appear to be of sufficient density and vigour to provide weed suppression, or to regenerate strongly from seed.

CONCLUSIONS

This was the first trial to successfully establish at this location during the course of the project. Climatic factors appear to limit options, as rainfall is erratic and winter chill restricts growth and sward productivity. Annual resown swards may be the best option in this area, with cereals offering the greatest tolerance of the sometimes adverse conditions. Triticale would appear the best option on the heavier soil types, oats on the light to medium soils, whilst ryecorn may have application as a wind break and will offer protection for young vines from sand blast damage on the lighter soils.

6.4.16 Nagambie Extension Trial

Site details

Co operator/Vineyard:	Mitchelton Wines
Contact:	John Beresford
Soil Type:	Medium Clay/Loam
Soil pH:	6.0-6.5
Irrigation Method:	Over Head Sprinkler
Rainfall:	600 mm

SEEDING DETAILS

Date Sown:	20 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Direct Drilled, moderate levels of trash, no weeds.

TREATMENTS

Table 6.4.16.1 below describes the treatments assessed in the trial established at Mitchelton's vineyard in April 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	35:30:20:8:7	137
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	55:15:15:15	130
3. Nemfix	*	10
4. Fodder Radish	*	25
Perennial and Annual Regenerating Swards		
5. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
6. Dargo Ryegrass+Denmark and Goulburn sub clovers+Nitro Persian clover	55:20:20:5	35
7. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
8. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	30
9. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	70:20:10	36
10. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	70:25:5	34

Table 6.4.16.1 Cover Crop treatments included in the 1997 trial at Mitchelton

RESULTS AND DISCUSSION

Table 6.4.16.2 below summarises the observations made in the trial conducted at the PISA centre, Nuriootpa in 1997.

TREATMENT	VIGOUR RATING	GROUND COVER %	DRY WT YIELD KG/HA
Green Manure Swards	6/7/97	6/7/97	25/9/97
1. Coolabah Oats+Rossa faba Bean+Glenroy Peas+Blanchefleur and Languedoc Vetches	9.5	80	14200
2. Triticale+Ascot Faba Bean+Laura Peas+Popany and Blanchefleur Vetches	10	50	10500
3. Nemfix	6	30	1800
4. Fodder Radish	8	40	3900
Perennial and Annual Regenerating Swards			
5. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	7	15	*
6. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	4	10	*
7. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	4	10	*
8. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	8	20	5600
9. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	7	20	*
10. Derby Supreme ryegrass+Cindy creeping red fescue+Palestine strawberry clover	0	0	*

Table 6.4.16.2 Results from 1997 trial at Mitchelton

Green Manure Swards

The forage blend containing oats (treatment 1) achieved the highest dry weight yield in this trial. Neither of the two brassica cover crops (Mustard and radish) performed well at this site, though of these two treatments, the fodder radish would appear to have the better adaptation. The triticale based sward yielded well, however the oats and red bean components provided a greater yield contribution in Biomax 1 than the triticale and Ascot bean components of the forage blend containing triticale.

Permanent Swards

The Derby supreme/Cindy fescue blend failed to establish. This trial was direct drilled, which as a method does not appear to provide optimal results in terms of establishment of pasture species. Other forage ryegrass based swards were established more successfully, as was the Dargo annual ryegrass. Small seeded pasture species such as persian and berseem clovers established with low vigour. A moderate result in terms of dry weight yield was achieved by the blend of annual ryegrass and persian and berseem clovers at this site, however this was no comparison to the Biomax 1 treatment. Persistence of these swards in future seasons will determine the most appropriate combination as a permanent sward in this region.

RECOMMENDATIONS

The forage blend containing oats provides an excellent result in terms of dry weight yield, and is highly recommended as a green manure option in this region.
Permanent swards will most often benefit from seeding into a prepared seed bed rather than being direct drilled, particularly as was the case at this site, where the soil surface was compacted and difficult to penetrate with the seeder.
Brassica crops may also benefit from being sown into a tilled seed bed, as the performance of these crops was disappointing at this site.

6.4.17 Cowra Extension Trials

Site details

Co operator/Vineyard:	Richmond Grove
Contact:	Mark Sims
Soil Type:	Light to medium Clay/Loam
Soil pH:	6-7.5
Irrigation Method:	Drip
Rainfall:	600 mm

SEEDING DETAILS

Date Sown:	18 April 1997
Fertiliser:	100 kg/ha DAP at seeding
Seed Bed Preparation:	Direct Drilled, free of trash and weeds.

TREATMENTS

Table 6.4.17.1 below describes the treatments assessed in the trial established Orlando Wyndham's Richmond Grove vineyard in April 1997.

COVER CROP TREATMENT	COMPONENT RATIO (%)	SEEDING RATE (kg/ha)
Green Manure Swards		
1. Nemfix	*	10
2. Rangi rape	*	4
3. Fodder Radish	*	20
Perennial and Annual Regenerating Swards		
4. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
5. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	55:20:20:5	35
6. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	55:15:15:15	35
7. Victorian Ryegrass+Paraggio Medic	70:30	30
8. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	80:10:5:5	30
9. Santiago Medic	*	20
10. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	70:20:10	36

Table 6.4.17.1 Cover Crop treatments included in the 1997 trial at Cowra

RESULTS AND DISCUSSION

Tables 6.4.17.2-3 below summarises the observations made in the trials conducted at the Cowra in 1997.

TREATMENT	VIGOUR RATING Aug/97	GROUND COVER % Aug/97	SWARD HEIGHT Aug/97
Green Manure Swards			
1. Nemfix	7	35	17
2. Rangi rape	5	15	15
3. Fodder Radish	8	30	22
Perennial and Annual Regenerating Swards			
4. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	8	75	9
5. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	10	20	11
6. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	9	75	16
7. Victorian Ryegrass+Paraggio Medic	7	10	9
8. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	7	15	14
9. Santiago Medic	8	60	6
10. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	5	20	5

Table 6.4.17.2 Results from Site 1 1997 trial at Cowra

TREATMENT	VIGOUR RATING Aug/97	GROUND COVER % Aug/97	SWARD HEIGHT Aug/97
Green Manure Swards			
1. Nemfix	4.5	10	10
2. Rangi rape	4.5	10	10
3. Fodder Radish	6	30	15
Perennial and Annual Regenerating Swards			
4. Victorian Ryegrass+Clare, Nuba and Gosse sub clovers	4.5	25	8
5. Dargo Ryegrass+Denmark and Goulburn subclovers+Nitro Persian clover	5.5	20	10
6. Dargo Ryegrass+Clare, Nuba and Gosse sub clovers	5.5	25	10
7. Victorian Ryegrass+Paraggio Medic	4.5	10	6
8. Dargo Ryegrass+Elite II Berseem,Laser Persian and Bolta Balansa Clovers	*	*	*
9. Santiago Medic	3	25	5
10. Ellet ryegrass+Currie Cocksfoot+Waverley White Clover	2	5	3

Table 6.4.17.3 Results from Site 2 1997 trial at Cowra

Fodder radish appeared to provide the more consistently good result of the brassica species across the two sites at Cowra. Rape established with only moderate-poor effect at both sites, with swards lacking vigour and ground coverage. Fodder radish did not provide the expected level of ground cover based on observations of this sward at other sites.

Most permanent swards established well at the first site apart from the white clover based treatment. However growth and vigour appeared restricted at the second site which was more elevated. The first site was located in a block in which soil moisture remained high for much of the season, whilst the second site was well drained. Persistence of these permanent swards will determine the most appropriate cover crop treatment.

RECOMMENDATIONS

Brassica crops appear to be limited in growth in late winter. Establishment vigour and density of plants was good, however nutrition may have been lacking, and the application of additional fertiliser may be required to achieve optimal results from these swards.
The nature of the rainfall distribution through the year would indicate that this region is well adapted to having permanent swards in the mid row. Perennial grasses such as ryegrass and cocksfoot should be well adapted, and persistence of the sown swards at this site will determine the most appropriate treatments.

6.4.18 Majella Frost Comparison Trial

Of major concern to grape growers in many parts of Australia is the potential for crop loss due to frost damage. Levitt(1980) noted that the degree of frost damage/injury depends upon:-

a) the minimum temperatures reached;

b) how fast the day and night temperature falls, and;

c) the amount of time the temperature is below the critical damage limit.

McCarthy et al (1992) indicated that an air temperature of: -3.5° C or less will damage buds at the woolly bud stage; -1° C or less will damage buds at early budburst; -0.5° C or less will damage shoots to 15 cm in length, and; below 0 ° C will damage shoots longer than 15 cm.

Most cultural practices for frost control are aimed at increasing the amount of radiation absorbed and stored by the soil during the day. This effect is optimised by having a bare, damp and compact soil surface (McCarthy et al 1992). Both moisture content and compaction improve the thermal storage capacity and conductivity of the soil.

Generally it has been perceived that a cover crop can increase the potential for frost damage by:

1) shading/insulating the soil surface, reducing the interception of solar radiation and release of heat from the soil;

2) raising the level of the cold air (otherwise at ground level) to nearer the vine canopy, and;

3) depleting the moisture content of the topsoil.

Reduction in cover crop height, bulk and activity may therefore be desirable to reduce frost risk. This may be achieved in several ways, including maintaining a bare mid row area via cultivation or herbicide application, incorporating green manure crops in late winter/early spring, or mowing mid row swards prior to budburst, thus exposing the maximum soil surface area to heat absorption, and lowering the coldest air strata to ground level. The mowed sward is often the most sustainable option from a soil management perspective.

Objective

A trial was established at the Majella Vineyard in Coonawarra to determine the differences in temperature at ground level and canopy height within and between three different ground cover treatments. Specifically, the objectives were to determine whether:

- applying a particular ground cover treatment increased the potential for frost damage to the vine crop.
- the air temperature varied between ground level and canopy height, and
- if the temperature was influenced by a ground cover treatment x height interaction.

Method

A uniform vineyard block was selected in which Fodder Radish (20 kg/ha) and Triticale (150 kg/ha) had been established in alternate mid rows in May 1997. Three mid row soil management treatments were each applied to a block of six adjacent midrows. The three ground cover treatments were: a mowed mid row sward; a tilled and rolled midrow, and; a tilled midrow, which were applied in early September 1997.

CoxLYNX temperature recorders were placed at both cordon height and ground level in the middle of each treatment block, and air temperature logged every ten minutes during the period 27/9/97 to 7/10/97. Half hour temperature means were calculated, as were daily maximum and minimum temperatures for each treatment.

Exploratory data Analysis

A time series was plotted for each combination of treatment and height for the 11 days, where time refers to 11 (days) x 48 (half hour intervals) x 3 (treatments) = 15,400 half hourly temperature measurements.

The day to day temperature variation appeared to follow a reasonably smooth cyclic pattern with some occasional random jumps in temperature over the time period. This pattern appeared typical for each combination of height and treatment.
Frost is most likely to occur between midnight and 7 am when the temperature falls below zero degrees Celsius. Using this information together with the time series, it is apparent that for all treatment combinations, a frost was likely to occur on the mornings of the 29th and 30th of September and the 4th of October.

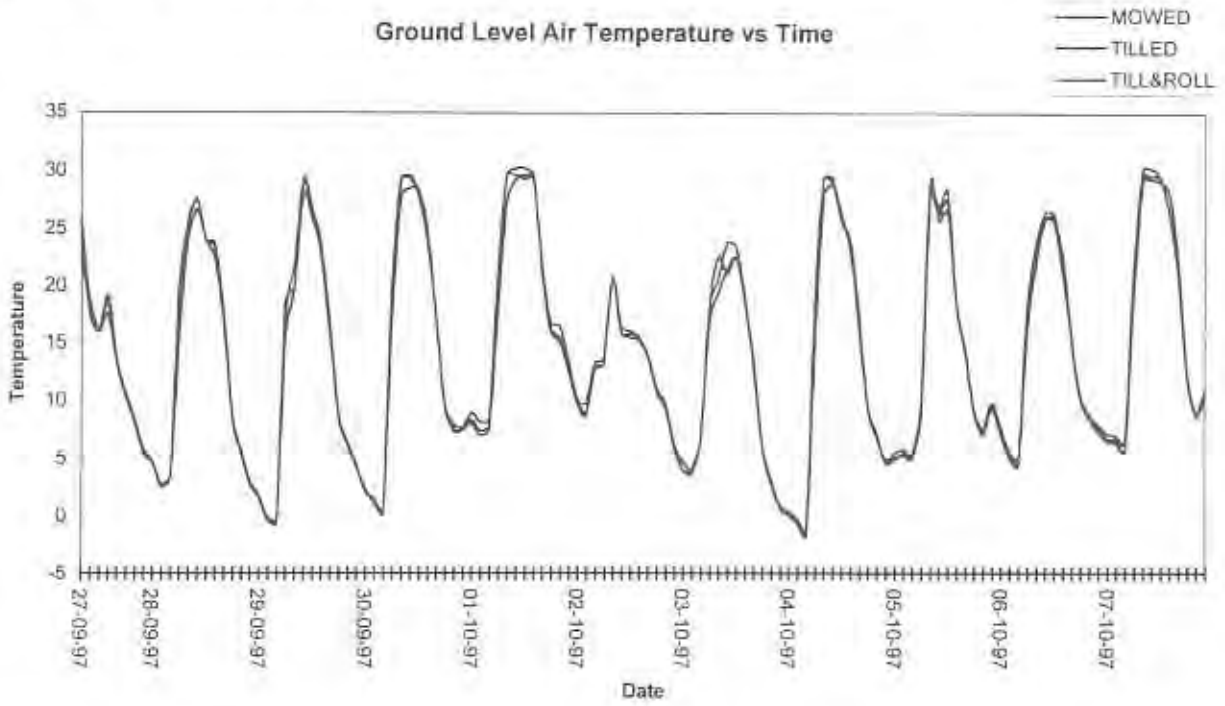
Statistical Modelling

The previous day's temperatures will influence recorded temperatures on any given day. Therefore all half-hour temperature means over the 11 day period were included in the analysis.

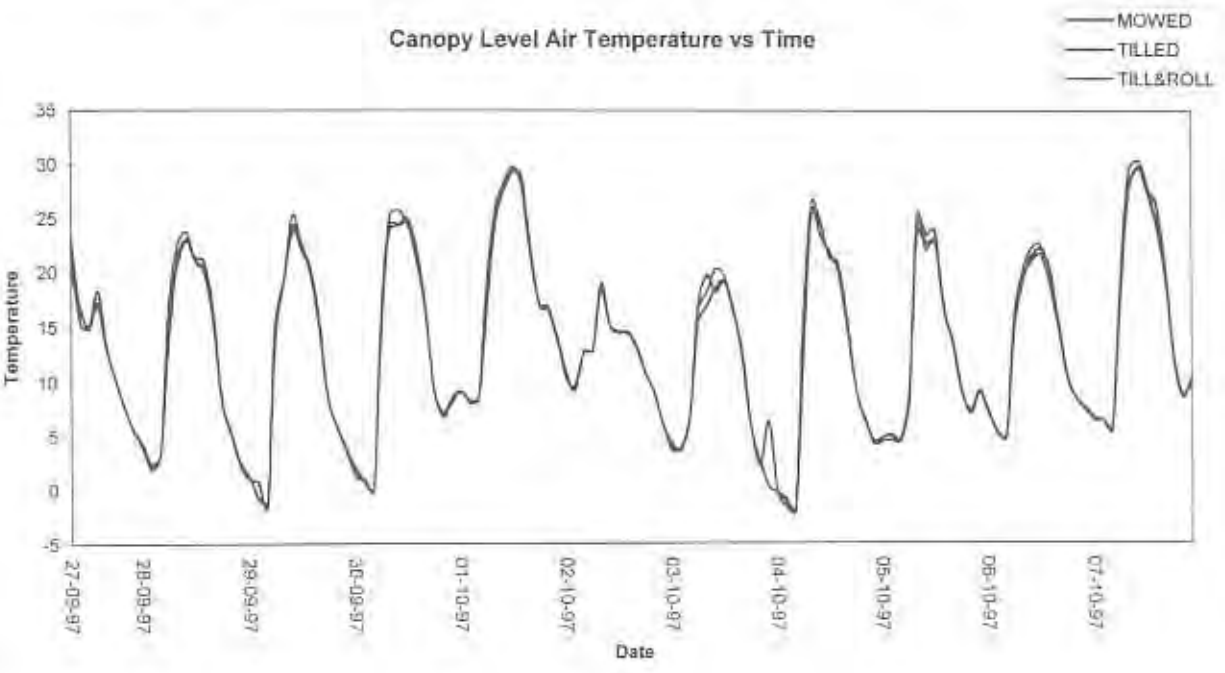
A flexible statistical model known as a mixed model, was used to describe the relationship between temperature and time for each ground cover treatment and recorder height combination. The model is considered as mixed since it consists of fixed effects (treatment effects such as recorder height and ground cover treatment) and random effects, which help explain the variation in the data.

Results

Plot 1. Plot of ground level air temperature vs time for the three ground cover treatments.



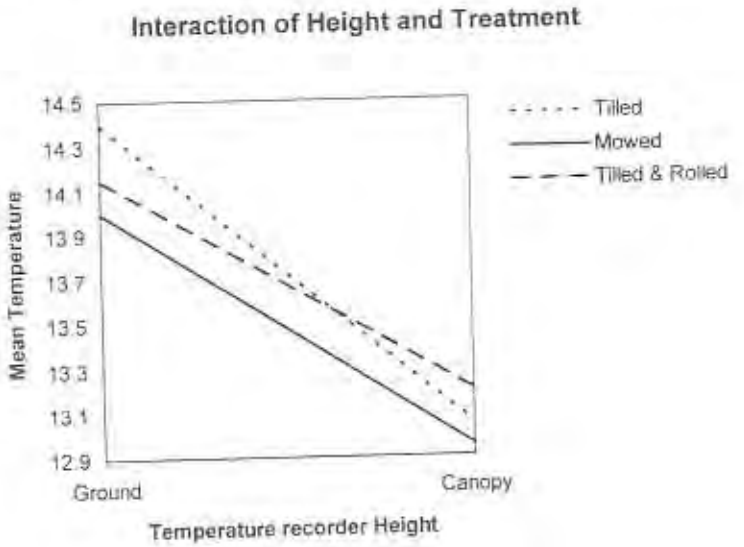
Plot 2. Plot of canopy height air temperature vs time for the three ground cover treatments.



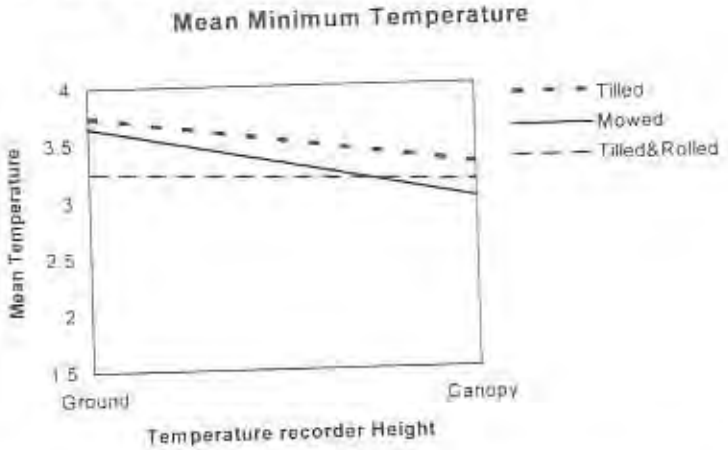
The time series, illustrated in plots 1 and 2 above, indicate that the temperature falls below zero when the minimum temperature of the previous day occurs just before midnight.

There is evidence of a significant interaction between height and treatment, ignoring time. A plot of the interaction between height and treatment is presented in Plots 3,4 and 5. The plots show that, on average, temperatures at the cordon height are lower than those recorded at ground level. Less of a fall in temperature was recorded (on average) in the Till and Roll treatment compared to Mowed and Tilled treatments. The Mowing treatment recorded the lowest average temperatures at both ground level and cordon height.

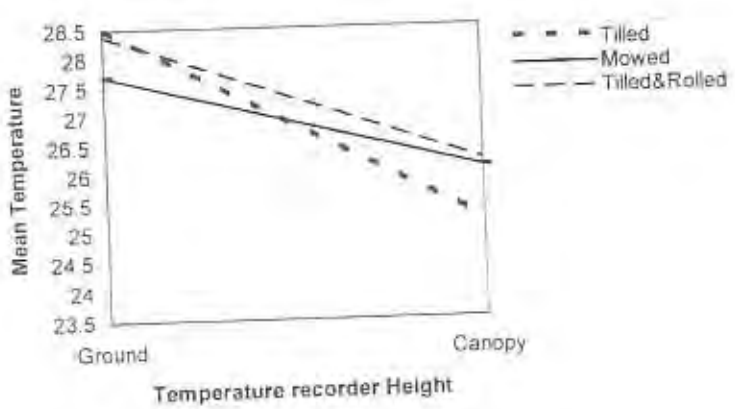
Plot 3. Plot of Mean Temperature for three treatments at two heights



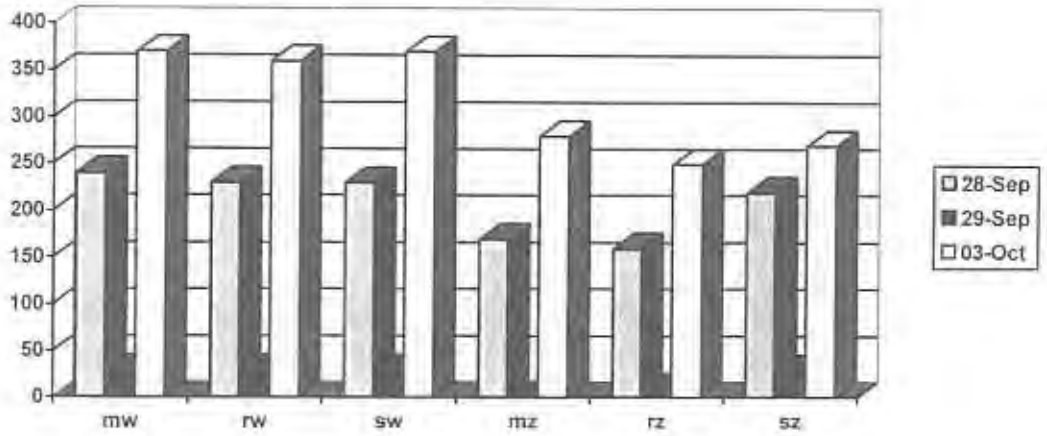
Plot 4. Plot of Mean Minimum Temperature for three treatments at two heights



Plot 5. Plot of Mean Maximum Temperature for three treatments at two heights



Plot 6. Graph of time spent below 0 degrees as recorded in three treatments, at two heights, on three occasions when a frost was likely to occur during the recording period.



mw= cordon height in the mowed tmt
rw= cordon height in the tilled tmt
sw= cordon height in the tilled and rolled tmt
mz= ground level in the mowed tmt
rz= ground level in the tilled tmt
sz= ground level in the tilled and rolled tmt

Conclusions

There is an interaction between height and treatment, with recorders placed at cordon height recording lower temperatures than those at ground level, for all treatments. The mowed ground cover treatment recorded lower temperatures (on average) than the other treatments at both ground level and cordon height.

The tilled treatment caused the lowest mean maximum temperature at canopy height, whilst the mowed treatment caused the lowest mean maximum temperature at ground level. The mowed treatment also resulted in the lowest mean minimum temperature at canopy height.

In terms of frost, the trial recorded only three days where a frost was likely to occur. There appears to be an indication of variation between treatments with regard to time spent below zero degrees. However, due to such a small sample, it is difficult to make sound conclusions regarding conditions which reduce the incidence of frost. The general conclusions drawn with regards to the interaction between the height and temperature do apply when the temperature falls below zero degrees celsius, and hence the mowed ground cover treatment appears to be slightly more susceptible to frost at both cordon height.

6.4.18 Majella Frost Comparison Trial

References

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6.4.19 Padthaway Grass Comparison Trial

One of the major constraints limiting the use of perennial swards in areas such as the Barossa and Clare Valleys, Padthaway and Coonawarra is the competition that can exist between vines and cover crops for available soil moisture and nutrients. Grape vines begin root activity several weeks prior to budburst, which is in late winter in most of these districts. To ensure maximum fruit set, moisture should not be limiting in the period between the initiation of vine root activity and flowering in November. Consequently, unless rainfall and/or irrigation is sufficient to sustain both the vine and cover crop in late spring, growers will elect to terminate the growth of cover crops prior to budburst, placing them in the situation of having to employ a green manure mid row system.

The additional water required by a viticultural system in which a permanent cover crop is difficult to quantify. Initial investigations were commenced in 1997 to attempt to compare the water usage of a several cover crop systems in a drip irrigated vineyard. Results are presented in the graphs below, which demonstrate the differences in soil moisture depletion rates between various grass swards.

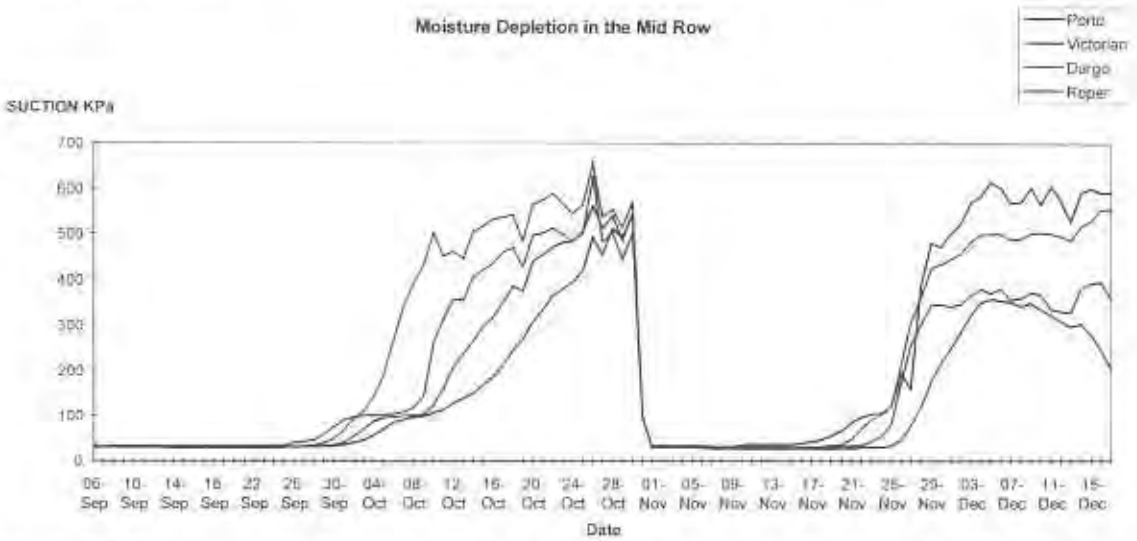

Figure 6.4.19.1 **Soil moisture depletion under four swards, as monitored at 20cm depth using gypsum blocks at Padthaway in 1997.**

Figure 6.4.19.1 above demonstrates the differences between, and within, grass species with regards the rate of soil moisture depletion at Padthaway in spring/summer 1997. Soil moisture was at field capacity until the end of September, when a spell of warm weather (see figure 6.4.19.2) resulted in a drying out of the topsoil. This rate of drying out varied, and could be seen to be representative of sward root development. There is a differential of some 14 days between Roper perennial ryegrass (*Lolium perenne)* depleting moisture levels to 300 KPa, and Victorian perennial ryegrass reaching this same point. All varieties approached the monitoring limit of the gypsum blocks prior to a significant rainfall event at the end of October (see figure 16.4.19.3) which restored the mid row soil to field capacity. After this event the differential rate of soil moisture depletion was again demonstrated. The Porto cocksfoot *(Dactylis glomerata)* had developed a more mature root system at this stage and depleted the soil moisture content at a faster rate than any of the other grasses. Victorian perennial ryegrass (*Lolium perenne* again is less aggressive than Roper, and it's dormancy is reflected by the slow down in moisture depletion in early December.

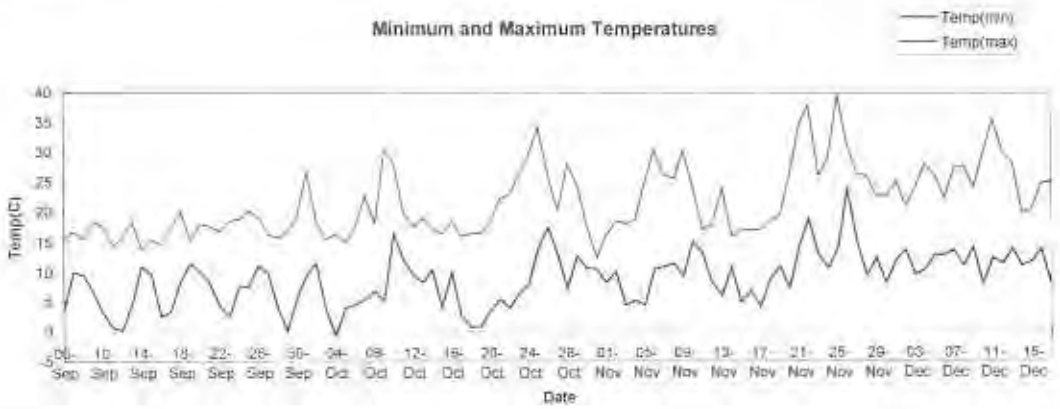

Figure 6.4.19.2 **Minimum and Maximum temperatures recorded for the monitoring period. Note the impact of high temperatures on the depletion of soil moisture in the mid row.**

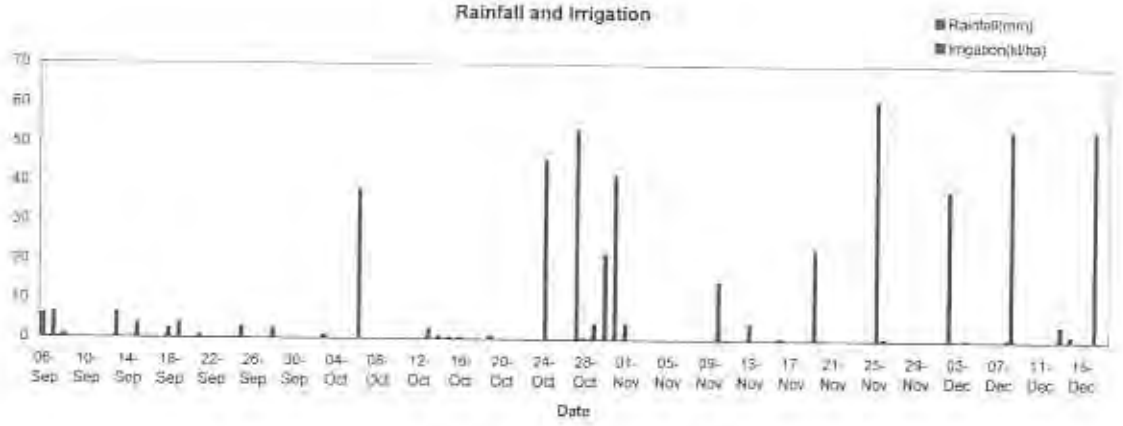

Figure 6.4.19.3. Irrigation and rainfall at the Padthaway trial site, 1997.

The application of irrigation (via drippers) did not impact on mid row soil moisture content. (Further work was commenced in 1998 to determine the differences between tilled and mulched mid rows, annual grass swards, and perennial sods).

1997 CCT								
CULTIVAR	05-09-97 RATING	12-10-97 RATING	25-04-98 RATING	05-09-97 SWARD HEIGHT	12-10-97 SWARD HEIGHT	05-09-97 % GROUND COVER	12-10-97 % GROUND COVER	12-10-97 WEED SUPPRESS
CINDY	6.5	5.9	2.7	2.5	49.5	17.5	45.0	3.5
DARGO LOW	7.9	7.5	2.3	21.8	100.0	71.3	50.0	7.5
ROPER	**8.3**	**8.7**	**8.0**	**14.0**	**55.0**	**62.5**	**68.3**	**6.0**
VIC HIGH	**8.4**	**6.8**	**5.7**	**12.3**	**39.7**	**66.3**	**60.0**	**8.0**
PROLONG	8.1	8.4	6.3	13.0	71.3	62.5	78.8	9.5
ELLET LOW	7.8	7.6	6.3	13.5	40.0	55.0	75.0	8.0
GENERATOR	7.3	7.5	8.0	12.0	51.3	52.5	67.5	7.5
MATILDA	7.0	8.5	6.4	15.0	41.7	55.0	71.7	6.0
NUI	5.5	6.8	3.8	12.0	30.0	42.5	46.3	5.5
GREENSTONE	7.0	7.0	3.3	11.5	32.5	56.3	66.3	5.0
CURRIE	5.0	6.3	4.3	7.3	42.5	35.0	46.3	2.5
KASBAH	6.3	4.7	7.5	9.5	51.7	37.5	36.7	0.5
DEMETER	5.0	6.5	4.0	9.7	63.8	16.7	53.8	4.5
WIMMERA	6.9	6.5	8.0	19.5	62.5	69.3	70.0	7.3
BLANDO BROME	7.0	7.0	0.0	13.5	66.3	61.3	42.5	6.0
ROBERTA	5.3	5.0	5.0	15.0	57.5	40.0	32.5	1.5
CAMEL	6.9	6.0	5.8	11.7	34.5	50.0	42.0	3.0
DERBY	6.6	5.3	5.0	5.5	48.0	36.3	31.7	2.5
VIC LOW	7.8	6.8	6.3	10.5	51.3	58.8	55.0	2.5
DARGO HIGH	**7.6**	**7.5**	**9.0**	**21.5**	**98.8**	**66.3**	**65.0**	**8.0**
ZORRO	7.4	7.0	6.8	5.0	41.3	43.8	60.0	4.7
NEW TETILA	7.3	7.6	6.3	16.3	65.5	57.5	77.5	7.5
DARGLE	6.1	7.5	6.5	15.3	71.7	43.8	81.7	7.0
ELLET HIGH	7.6	7.9	6.3	13.5	56.3	52.5	76.3	7.8
U3496404	7.8	6.7	3.3	13.0	39.3	52.5	53.3	4.0
CALIFORNIAN BROME	6.8	5.3	3.3	15.0	57.5	50.0	41.3	8.0
GUARD	7.7	6.1	3.8	17.0	33.0	63.3	34.5	1.5
PORTO	**7.0**	**7.8**	**5.0**	**8.0**	**40.0**	**41.3**	**77.5**	**7.5**

Table 6.4.19.4 Summary of results and Observations at the Padthaway Grass Species Comparison Trial in 1997.

Demeter fescue does not establish with great vigour in the first year, lacks ground cover and does not compete well with volunteer species in the mid row, compared to ryegrasses.

Wimmera and Dargo ryegrasses both appeared to be regenerating well after opening rains in April 1998. Dargle and Guard annual ryegrasses did not appear to be regenerating as strongly. Blando brome did not appear to regenerate at all, which is largely due to a severe infestation of loose smut noted in this treatment the previous spring (ie little viable seed resulted). Dargo ryegrass at both seeding rates provided the greatest sward height, and would appear to achieve the highest level of production of the treatments in this trial.
Cindy red fescue is slow to establish and lacks weed suppression abilities, however does appear to have persisted well. Establishment in high densities in the first year may provide the key to growing this species as a low mowing, persistent perennial sward.

Dargo ryegrass regenerated better from a high density planting in the first season compared to the low seeding rate treatment. Apart from this factor, little difference between the two Dargo treatments was noted in terms of vigour, weed suppression and ground cover.
Roper ryegrass gave excellent persistence and good weed suppression at this site. This cultivar appears to be deep rooted, and may compete at a greater level for moisture with the vine at depth, resulting in greater persistence and growth activity over summer.
Porto cocksfoot appeared to have greater vigour, persistence and weed suppression ability than Currie at this site.
Persistence of these species over several years will provide a key to grass adaptation.

6.4.20 Native Grasses

A species comparison trial was established at Henschke's Eden Valley vineyard on June 12 1997. Ten grass treatments, including native and commercial pasture species, were sown in three replicates of plots measuring 5 metres X 2 metres in the mid row. The objective of this work was to assess the suitability of some native grass species as mid row ground covers in a vineyard, and compare the growth habit and persistence with commercial species under a typical management system.

Table 6.4.20.1 below details the species and seeding rates used in this trial.

Grass Species	Seeding Rate kg/ha
Microlaena stipoides	20
Danthonia setacea	10
Poa hookeri	10
Californian Brome *Bromus carinatus*	20
Zooro Fescue *Vulpia myuros*	10
Blando Brome *Bromus mollis*	20
Kasbah Cocksfoot	15
Dargo Italian ryegrass	20
Roper perennial ryegrass	20
Ellet perennial ryegrass	20

Table 6.4.20.1 Treatments included in the trial sown at Eden Valley

Microlaena stipoides, or weeping rice grass is a tufted perennial which remains green all year round. It reportedly responds well to heavy grazing and mowing, and can grow up to 70 cm tall. It responds well to the application of fertiliser, and is moderately tolerant of glyphosate once established, allowing for in row weed control options. The limiting factor for this species is the price of $350.00 /kg recommended retail.

Danthonia setacea , or small flowering wallaby grass, is an erect perennial growing to 70 cm in height, shows good summer dormancy, and retails for around $250.00/kg.

Poa Hookeri is a grey-green tufted perennial grass growing to 50cm in height which flowers in summer and is well adapted to moist conditions and high altitudes. This plant grows naturally south of Goulburn, and retails for around $275/kg.

Seed was broadcast by hand onto a tilled seed bed which had been sprayed with a knockdown herbicide to eliminate weed growth. Seed was incorporated by raking the soil surface.

Unfortunately this trial failed to establish, which may have been due to the late seeding which resulted from delays in seed delivery. As can be seen, the price of seed for the native grass species is extraordinarily high, and at current levels remains prohibitive to uptake by most growers, even if good adaptation of the species was to be identified in future trial work.

FINAL REPORT

VOLUME 2

The Role of Inter-Row Ground Covers to Improve the Management and Sustainability of Soils in Australian Vineyards

PROJECT REFERENCE NUMBER: SEE 93/1

PRINCIPAL RESEARCHER: RICHARD PORTER

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7 TECHNICAL SUMMARY

7.1 Cover Crop Application

Figure 7.1 below summarises the adaptation of the two major cover crop types (perennial sward and green manure) to mean annual rainfall and vineyard irrigation system combinations for South Eastern Australia. This graph provides only an approximate guide, and other considerations such as insect pest pressure, disease incidence (eg. AGY), soil erosion potential, weed pressure, availability of irrigation water and fruit production objectives should also be considered when determining the most appropriate cover crop sward for a particular vineyard.

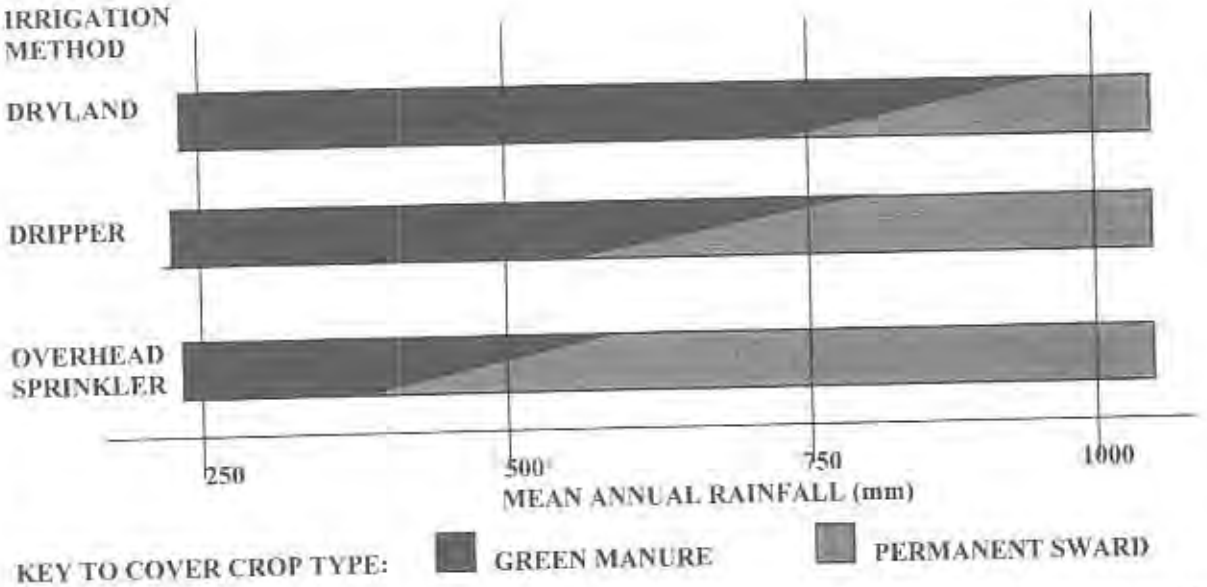

Figure 7.1 **Adaptation of cover crop types to irrigation method X mean annual rainfall combinations in South Eastern Australia. The figure is based on results and observations in field trials conducted in the course of this project.**

In many situations, a botanically diverse sward provided greater benefit when compared to a monoculture. Examples include permanent swards containing more than one species of grass and/or pasture legume, and a green manure crop consisting of a combination of forage legume and cereal species. This conclusion was based on observations in many of the 1996 trials. Complimentary growth habits of component plants in a diverse sward seemed to contribute to increased weed suppression, greater biomass production and broader sward adaptation across different regions when compared to monocultures (single species swards).

Results and Observations from the four years' cover crop trial work are summarised on the following pages.

Summary categories are defined by rainfall and include one or more grape growing regions.

Higher Rainfall Regions

Region: Adelaide Hills, Yarra Valley

Predominant Cover Crop Types: Permanent Sward

Rainfall: 750mm-1000mm

High Performing Cultivars:

Perennial ryegrass:

Cultivars include Victorian and Ellet. Other cultivars with application potential include Roper and Matilda. Optimal seeding rate 25-30 kg/ha in monoculture. Preferable to include at least two cultivars in a mix, in which case the combined total seeding rate should be 25-30 kg/ha.

Annual legumes:

Gosse, Nuba, Clare sub clovers. Other cultivars with application include Denmark. Optimal seeding rate is 15 kg/ha in combination with a grass (sub clovers do not have wide application in monoculture as a cover crop).

Perennial grasses:

Fescue-Demeter, Triumph. Fescues should be sown at 30-35kg/ha minimum. Have application as a perennial in steep country, as this species has a reputation for improved trafficability over and above ryegrass. Ability to compete with weeds less than ryegrass, and is also more summer active in growth.

Annual cover crops:

Little application, due to desire for zero tillage systems to prevent erosion in this higher rainfall region with predominately undulating-steep topography. Annual crops such as ryecorn are often used as a mother crop for establishing perennial species.

Regional Recommendations and Comments

High rainfall regions with moderate to high light brown apple moth pressure, and in some cases an emerging garden weevil problem.

Legumes will not be favoured in these regions due to the LBAM pressure, and the wheel slip issue on steep country.

Major issues relate to establishment, with the need to prepare a seed bed challenged by the need to protect against erosion. The use of mother crops to assist in this is encouraged.

Grey field slugs and red legged earth mites are problems in the first year for some cover crops, and monitoring of pests is essential after germination. Growers may need to be educated about the use of effective RLEM and slug control.

Broadcast seed which is incorporated into a tilled, weed free and flat seed bed is an option for growers at establishment to prevent the development of rills by water run-off which has been observed where cover crops are drilled and plants emerge in discrete rows down a slope.

Narrow row spacings also limits the machinery necessary for sward maintenance in some vineyards.

Medium Rainfall Regions

Region: McLaren Vale, Clare Valley, Padthaway, Great Western, Barossa and Goulbourn Valleys

Predominant Cover Crop Types: Green Manures, some perennial sward application

Rainfall: 500-600mm

High Performing Cultivars:

Perennial ryegrass:

Cultivars include Victorian and Matilda. Other cultivars with application potential include Camel and Roper. Optimal seeding rate 25-30 kg/ha in monoculture. Preferable to include at least two cultivars in a mix, in which case the combined total seeding rate should be 25-30 kg/ha.

Other Perennial grasses:

Cocksfoot-cultivars such as Currie and Porto. Currie has application as a component of a permanent sward in combination with perennial ryegrass and annual legumes in the 500-650 mm rainfall regions. Porto is generally regarded as being better adapted to the 650mm+ regions, though it can be useful in areas such as McLaren Vale for competing with vines where excess soil moisture during late spring/early summer is a problem in portions of vineyards. Phalaris has similar potential for application. Cocksfoot should comprise ideally 50% of the seed in a blend with perennial ryegrass, and be sown at 10 kg/ha (20 kg/ha blend total). Price of seed will in most cases limit this proportion.

Annual legumes:

Gosse, Nuba, and Clare sub clovers. Other cultivars with application include Denmark and Junee. Annual medics include Paraggio and Santiago. Other cultivars with potential application include Mogul, Serena and Kelson. Optimal seeding rate is 15 kg/ha in combination with a grass (annual legumes do not have wide application in monoculture as a cover crop in these regions).

Annual cover crops:

Soil types vary considerably across and within these regions, from Biscay clays to light sands, and as such adaptations of cover crops will vary also.

Cereals:

Triticale is well adapted to the heavier soil types, and should be sown at 150 kg/ha. Oats(100 kg/ha) are best grown on medium to lighter soil types, whilst ryecorn(80kg/ha) has greatest application potential on light soils, particularly where it can be used as a standing stubble to protect young vines from wind and sand blast damage. Coolabah and Swan oats have reported benefits as far as root knot nematodes are concerned, and are hence the recommended varieties for regions where this pest can be an issue. Tahara and Currency triticale are appropriate cultivars for these regions, whilst Abacus is a new variety which offers good productivity potential.

Legumes:

Faba beans are often still used as a monoculture cover crop. Results indicate that dry weight yield of these swards is not as great as that achieved with cereals or legumes in combination with cereals. Peas and vetch offer little scope for use as a mono culture cover crop, since peas do not tolerate traffic well, and vetch tends to lodge in dense swards whilst achieving maximum growth in late September in most cases. Concerns over root knot nematode in some areas also restricts the use of legume monocultures.

Forage Blends:

The most productive green manure swards consisted of blends of cereals and grain legumes, such as oats plus beans, peas and vetch. The performance in terms of productivity, varied from season to season and site to site, which demonstrated the benefit of having more than one plant species in a mix. Generally the dry weight yields of these mixtures exceeded that of component monocultures.

Brassicas:

Fodder radish has application as a weed suppressant as well as offering scope as a potential biofumigant. Weedcheck fodder radish is best adapted to heavier soils. Nemfix oilseed mustard yielded well at some sandy sites, and offers potential biofumigant activity.

Regional Recommendations and Comments

Most of these medium rainfall regions have moderate light brown apple moth and some have root knot nematode issues, as well as an emerging garden weevil problem.

Green manure swards will be used in approximately 75 % of vineyards. Perennials have application where some competition with the vine for moisture and nutrients is tolerated or desirable. Most perennial grasses recommended for these regions will mature and set seed in mid December if the swards are not mowed after early October.

Dargo annual ryegrass has been used to reasonable effect in some vineyards in McLaren Vale for reducing soil moisture through to the late spring and early summer period. This species responds well to mowing in late winter, early spring, and provides reasonable weed competition. The species senesces naturally in November, and can be re sown each season at 25 kg/ha.

Problems associated with establishment include the high soursob populations inherent in many vineyards and its ability to smother perennial cover crops in the year of cover crop establishment. Programs aimed at reducing problem weed populations including vigorous annual green manure crops and glyphosate applications after weed emergence should be encouraged prior to seeding low vigour pasture type species.
Red legged earth mite can be devastating to emerging cover crops, and growers must be encouraged to protect vulnerable swards against this pest after sowing.

Top dressing of cereal and brassica cover crops in June may be necessary to achieve optimal dry matter yields in early spring, especially on some lighter soils.

Faba beans and triticale appear to be the best green manure options for the heavy biscay type soils which occur in the McLaren Vale region.

Medium-Higher Rainfall Regions

Regions: Coonawarra and Eden Valley

Predominant Cover Crop Types: Green Manures and perennial swards

Rainfall: 600-750mm

High Performing Cultivars:

Perennial ryegrass:

Cultivars include Victorian and Matilda. Other cultivars with application potential include Roper, Ellet and Nui. Optimal seeding rate 25-30 kg/ha in monoculture. It is preferable to include at least two cultivars in a mix, in which case the combined total seeding rate should be 25-30 kg/ha.

Annual legumes:

Gosse, Nuba and Clare sub clovers. Other cultivars with application include Denmark. Annual medics include Paraggie and Santiago. Other cultivars with potential application include Mogul and Kelson. Optimal seeding rate is 15 kg/ha in combination with a grass (annual legumes do not have wide application in monoculture as a cover crop in this region).

Perennial grasses:

Cocksfoot-Porto is the preferred cultivar. Porto has application as a component of a permanent sward in combination with perennial ryegrass and annual legumes in the 650 mm+ rainfall regions. Cocksfoot should comprise ideally 50% of the seed in a blend with perennial ryegrass, and be sown at 10 kg/ha (20 kg/ha blend total). Price of seed will in most cases limit this proportion. Demeter fescue has some potential for use as does phalaris for assisting with "drying out" of wet soils in late spring/early summer. Holdfast phalaris should be sown at 10 kg/ha and be mowed to maintain a sward height of between 10 and 30 cm to maintain plant density and to restrict the growth of weeds.

Annual cover crops:

Cereals:

Triticale is well adapted to the heavier soil types, and should be sown at 150 kg/ha. Oats(100 kg/ha) are best grown on medium to lighter soil types. Coolabah and Swan oats are the preferred varieties for this region. Tahara and Currency triticale are appropriate cultivars for this region, whilst Abacus is a new variety which offers good productivity potential.

Legumes:

Faba beans are often still used as a monoculture cover crop. Results indicate that dry weight yield of these swards is not as great as that achieved with cereals or legumes in combination with cereals. Peas and vetch offer little scope for use as a mono culture cover crop, since peas do not tolerate traffic well, and vetch tends to lodge in dense swards whilst achieving maximum growth in late September in most cases.

Forage Blends:

The most productive green manure swards consisted of blends of cereals and grain legumes, such as oats plus beans, peas and vetch. The performance in terms of productivity, varied from season to season and site to site, which demonstrated the benefit of having more than one plant species in a mix. Generally the dry weight yields of these mixtures exceeded that of component monocultures.

Regional Recommendations and Comments

Light brown apple moth pressure in these medium to high rainfall regions is generally moderate to high, thus impacting on the desirability of some legumes as cover crops.

Green manure swards will be used in approximately 60 % of vineyards. Perennials have application where some competition with the vine for moisture and nutrients is tolerated or desirable. Such perennials will be used where weed suppression and low management benefits are sought. Perennials must be drought tolerant or have good summer dormancy to persist through the hot summers in this region. Most perennial grasses recommended for this region will mature and set seed in mid December if the swards are not mowed after early October.

Timing of cover crop establishment can be critical in these regions, as little growth can be expected after the onset of winter until August. Cover crops in these areas are susceptible to red legged earth mites at establishment, and may need to be tolerant of water logged soils over winter.

Lower Rainfall Regions

Region: Riverland and Sunraysia

Predominant Cover Crop Types: Green Manures, some perennial swards

Rainfall: 200-350mm

High Performing Cultivars:

Annual cover crops:

Annual legumes:

Annual medics include Paraggio, Mogul, Caliph, Kelson and Santiago. Other cultivars with potential application include Parabinga and Carpet. Optimal seeding rate is 20kg/ha as a monoculture, or a total of 10 kg/ha in combination with perennial grasses (20kg/ha).

Cereals:

Ryecorn(80 kg/ha) has adaptation for use as a wind break and to provide young vines with protection from wind and sand blast damage on lighter soils. Oats(100 kg/ha) are best grown on medium to lighter soil types. Coolabah and Swan oats are the preferred varieties for this region due to concerns over root knot nematode.

Legumes:

Faba beans are often still used as a monoculture cover crop. Results indicate that dry weight yield of these swards is not as great as that achieved with cereals or legumes in combination with cereals. Peas and vetch offer little scope for use as a mono culture cover crop, since peas do not tolerate traffic well, and vetch tends to lodge in dense swards whilst achieving maximum growth in late September in most cases.

Forage Blends:

The most productive green manure swards consisted of blends of cereals and grain legumes, such as oats plus beans, peas and vetch. The performance in terms of productivity, varied from season to season and site to site, which demonstrated the benefit of having more than one plant species in a mix. Generally the dry weight yields of these mixtures exceeded that of component monocultures.

Brassicas:

Nemfix oilseed mustard yielded well at most sites in these regions, and offers potential biofumigant activity. Fodder radish has application as a weed suppressant as well as offering scope as a potential biofumigant. Weedcheck fodder radish is best adapted to heavier soils.

Perennial ryegrass:

Only where overhead irrigation is used. Cultivars include Victorian and Matilda. Other cultivars with application potential include Camel. Optimal seeding rate 25-30 kg/ha in monoculture. It is preferable to include at least two cultivars in a mix, in which case the combined total seeding rate should be 25-30 kg/ha.

Other Perennial grasses:

Cocksfoot-Currie is the preferred cultivar. Currie has application as a component of a permanent sward in combination with perennial ryegrass and annual legumes in these lower rainfall regions. Cocksfoot should comprise ideally 50% of the seed in a blend with perennial ryegrass, and be sown at 10 kg/ha (20 kg/ha blend total). Price of seed will in most cases limit this proportion.

Regional Recommendations and Comments

Light brown apple moth is not the issue it is in other regions, however root knot nematode, and formally AGY, provide concerns and implications for the use of cover crops.

Green manure swards will be used in approximately 90 % of vineyards.

Perennials have application where overhead irrigation provides adequate water for a permanent sward to survive through summer, and provide weed suppression and trafficability. Unlike other regions it is not necessary for these swards to set seed in early summer to persist.

Many cover crops are sown immediately after vintage in these regions, and are watered in. Subsequently very good green manure cover crops can be grown in these regions. Reducing the amount of tillage however remains a significant task.

Lower to Medium Rainfall Regions

Region: MIA and Langhorne Creek

Predominant Cover Crop Types: Green Manures, some perennial swards

Rainfall: 350-425mm

High Performing Cultivars:

Annual cover crops:

Annual legumes:

Annual medics include Paraggio, Mogul, Caliph, Kelson and Santiago. Other cultivars with potential application include Parabinga and Carpet. Optimal seeding rate is 20kg/ha as a monoculture, or a total of 10 kg/ha in combination with perennial grasses (20kg/ha). Junee, Goulbourn and Gosse subclovers have application on acidic soil types.

Cereals:

Triticale is well adapted to the heavier soil types, and should be sown at 150 kg/ha. Oats(100 kg/ha) are best grown on medium to lighter soil types. Coolabah and Swan oats are the preferred varieties for this region. Tahara and Currency triticale are appropriate cultivars for this region, whilst Abacus is a new variety which offers good productivity potential.

Legumes:

Faba beans are often still used as a monoculture cover crop. Results indicate that dry weight yield of these swards is not as great as that achieved with cereals or legumes in combination with cereals. Peas and vetch offer little scope for use as a mono culture cover crop, since peas do not tolerate traffic well, and vetch tends to lodge in dense swards whilst achieving maximum growth in late September in most cases.

Forage Blends:

The most productive green manure swards consisted of blends of cereals and grain legumes, such as oats plus beans, peas and vetch. The performance in terms of productivity, varied from season to season and site to site, which demonstrated the benefit of having more than one plant species in a mix. Generally the dry weight yields of these mixtures exceeded that of component monocultures.

Perennial ryegrass:

Cultivars include Victorian and Matilda. Other cultivars with application potential include Camel. Optimal seeding rate 25-30 kg/ha in monoculture. Preferable to include at least two cultivars in a mix, in which case the combined total seeding rate should be 25-30 kg/ha.

Perennial grasses:

Cocksfoot-Currie is the preferred cultivar. Currie has application as a component of a permanent sward in combination with perennial ryegrass and annual legumes in the 500-650 mm rainfall regions. Cocksfoot should comprise ideally 50% of the seed in a blend with perennial ryegrass, and be sown at 10 kg/ha (20 kg/ha blend total). Price of seed will in most cases limit this proportion.

Region Specific Recommendations and Comments

Green manure swards will be used in approximately 90 % of vineyards.

In the MIA flood irrigation is still widely practised, with annual reworking of channels limiting the application of permanent swards.

Green manure cover crops are favoured whilst perennials have application where some competition with the vine for moisture and nutrients is tolerated or desirable. Perennials will be used where weed suppression and low management benefits are sought. Permanent swards must have good summer dormancy to persist through the hot summers in the MIA region. Most perennial grasses recommended for this region will mature and set seed in mid December if the swards are not mowed after early October.

Reducing the amount of tillage however remains a significant task.

8 RECOMMENDATIONS

Australian Viticulture was estimated at 78,000 ha in 1996, with an increase in that year of approximately 6,600 ha (see figure 8.1). The five largest viticultural regions Australia, in descending order, are Sunraysia (VIC, NSW), Riverland (SA), South East South Australia (including Coonawarra, Robe, and Padthaway), the Barossa Valley and the MIA. South Australia remains the most important grape growing state, followed by Victoria and New South Wales (see figure 8.1), and also has the highest level of expansion in the past three years (Source Australian Bureau of Statistics). The area of vineyards in Australia is expected to reach 100,000 ha by the turn of the century.

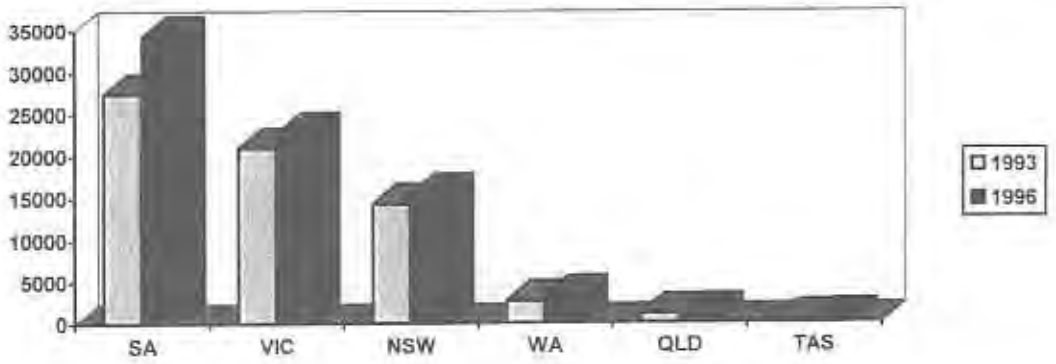

Figure 8.1 Hectares of Vineyard by State (1996)

The vast majority of cover crops in Australian viticulture are annually resown, as shown in Figure 3.1 and Table 3.2. The percentage of each cover crop type was derived from the cover crop survey, conducted by Dominic Schiccitano in 1994. (This survey will potentially be repeated this season by the CRCV, which will enable a comprehensive review of the effectiveness of the CCT project). Based on current recommended seeding rates, it is possible to estimate the cover crop seed requirements assuming the same proportional distribution of cover crop type utilisation as identified by Schiccitano and the area under vines in Australia as per 1996 ABS statistics. The cereal/legume component represents a cover crop rotation of Faba beans and Cereals. It has been assumed here that permanent swards consisting of grasses with or without pasture legumes have a lifespan of five years before renovation is required. Pure swards of pasture legumes have an assumed lifespan of three years based on grower feedback. In some cases this can be reduced to one year.

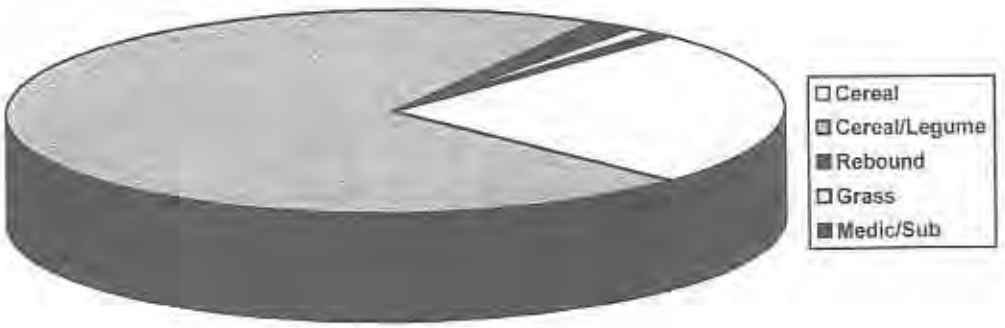

Figure 10.2 Proportions of Vineyard Cover Crop Seed Required Annually (MT)

Cover Crop Seed	MT Required 1998	Est.Wholesale Value
Oats/Ryecorn/Triticale	550	$200,000
Legume-Cereal Rotation/Forage Blend	1550	$700,000
Rebound/Blockout type blends	40	$120,000
Ryegrass/Cocksfoot	25	$75,000
Medic/Sub clover	20	$45,000
	Estimated Total	**$1,140,000**

Table 10.3 MT of Cover Crop Seed Required Nationally and Wholesale Value

Based on the observations of the Project Manager, many of the viticulturists overseeing the management of corporate vineyards are essentially young and well educated, who wish to remain technically informed of new management techniques and current research findings. As trained viticulturists, not agronomists, cover cropping is an area in which these people often lack knowledge, and thus they are dependent on advice and information from retailers and consultants. Ground cover management is a relatively low priority in

most vineyard situations, and good, reliable advice is often sought. The quality and timely delivery of information is crucial. The three critical times for grower contact are at the formulating of budgets in January/February (when decisions on cover crops are made), at seeding time in Autumn, and in late winter/early spring prior to budburst, when the effectiveness of current practices should be evaluated. This observation is based on the level and nature of inquiry received by the Project Manager over the past three seasons.

The information viticulturists most often seek is related to: the options that are available, what is new and relevant to their situation, any potential negatives associated with plant species (e.g. pest hosting ability), cost, when and how to establish the cover crop, insect pest control, when and how to terminate or mow cover crops, suitable fertiliser application and the diagnosis of nutrient deficiency and/or disease problems.

Continued extension of new information and research findings via forums such as industry magazines and seminar presentations is deemed essential to maintain grower interest and awareness of optimal mid row sward management.

PERCEIVED IMPEDIMENTS TO ADOPTION OF COVER CROPPING

The following describes some of the impediments to greater cover crop utilisation in the Australian viticultural industry, and the efforts being made to overcome them.

Pest and Disease Hosting Ability

- Australian Grapevine Yellows (AGY)

  Grapevine Yellows is a disease caused by a phytoplasma which blocks the movement of phloem in grapevine stem tissue and was first reported in 1975 (Magarey and Wachtel 1983). International experience has shown that phyotplasmas are generally spread by insect vectors, and are transmitted from an alternative host plant species. In Australia the specific insect vectors and alternate hosts of the phytoplasma causing AGY have not been defined.
  A number of symptoms are associated with AGY, which can be confused with other problems, such as nutrient deficiency, RSG, potentially leading to misdiagnosis. To maintain the integrity of some broad leaf cover crops, it is important that vignerons are kept fully informed of developments in research regarding this issue. A phytoplasma which induces a yellows disease in France has been shown to be also harboured in white clover, and although the phytoplasma causing AGY has been shown to be a different organism, the safest option has been to discourage the use of perennial clovers (such as *Trifolium repens*) in Australian vineyards until the situation is clarified.

- Light Brown Apple Moth *(Epiphyas postvittana)*

  In South Eastern Australia at least, Light Brown Apple Moth (LBAM) is the most significant insect pest of vines. A point for concern with respect to cover crops is that many broadleaf plants, including pasture legumes, are hosts for over wintering larvae of this particular pest. Although some plants such as capeweed are the more preferred hosts, sub clover and annual medics have been shown to be moderate hosts. As such, there is some hesitation to include legumes in cover crops, particularly perennial swards, in cool climate, high LBAM pressure regions such as the Yarra Valley. Often it is not the damage caused by feeding larvae that is of concern to growers, but the fact that feeding sites become points of infection for Botrytis (*Botrytis cinerea*), a potentially devastating bunch rot disease.
  The contribution of N by a legume cover crop to the vineyard system and improved soil fertility may be of such benefit to management that the potential for increased spring populations of LBAM is outweighed. (*It has thus far not been determined what, if any, net increase in LBAM populations result from having a host mid row cover crop in a vineyard).

  Current research initiated by the Project Manager includes the assessment of **Beneficial** swards for the suppression of LBAM and the promotion of predators and overall insect diversity. Collaborative efforts with IHD, Melbourne staff continue to assess the effectiveness of these swards in achieving desirable outcomes.

  In high pest pressure regions, an assessment of LBAM pressure and the level of risk of botrytis infection should be made to determine whether or not it is prudent to include legumes in mid row ground cover or not, as well as identifying the need for broad leaf weed control.

- Nematodes

  A major issue confronting viticulturists in some Australia regions is the impact of soil borne nematodes, in particular root knot (*Meloidogyne spp.*), Citrus (*Tylenchus sp.*), and root lesion (*Pratylenchus spp*) nematodes. Research has shown that grape yield losses of up to 60% can occur where root knot nematodes exist.
  A diversity of Brassica species are currently being reviewed and assessed by researchers such as Walker, Kirkegaard and Mathieson in Australia for their application as 'Biofumigants' - that is, for their ability to suppress a range of soil borne pathogens and pests such as nematodes, pythium, and weevils.

  Numerous brassica cultivars and species were submitted to relevant researchers to obtain information relating to their efficacy and efficiency with respect to suppression of specific pests, and to assess their potential application as a Biofumigant. From the results provided by these researchers, it was found that there existed significant variation in terms of glucosilinate concentration and spectrum, both within and between species. *Brassica juncea* is a species identified as generally having a high potential for biofumigation. See table 8.2 below.

  Stephens observed in 1996 in his investigations that incorporation of oilseed mustard plant material caused a flush of pythium for a 6-8 week period. This in turn can significantly impact on vine take and performance, especially in nursery situations. Additionally, the ability for these species to host particular pests prior to the expression of biofumigation may cause a net increase in populations over time(McLeod) See table 8.3. In-field efficacy tests will have a large bearing on the future utilisation of brassicas as biofumigants, and results of these studies should emerge in 1998/99.

Species/cv	Shoot GSL Propenyl	Butenyl	Root GSL Propenyl	Butenyl	Phenylethyl
B. juncea					
Var a	35	0	8	0	15
Var b	12	46	1	8	25
Var c	8	28	3	11	14
Var d	56	0	10	0	12
S.alba					
Var e	15	3	7	4	3

Table 10.2. Concentration of major Glucosilinates in plant tissues of *B. juncea* and *S. alba* (umoles/gram of freeze dried tissue). Data provided by Kirkegaard, 1996.

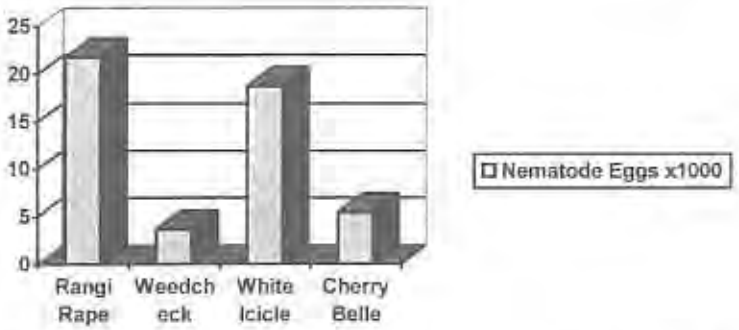

Figure 10.3 Egg production by rootknot nematode *Meloidogyne javanica* on some varieties of radish. Data derived from pot experiments and is provided by Dr Rod McLeod.

Predictive sampling is used to estimate the risk of nematode damage prior to planting a vineyard. The options available to growers pre plant are soil fumigation with a chemical such as Methyl Bromide, which has a limited span of effectiveness, or to select rootstock planting material with resistance to specific nematodes. If the second option is taken, the resistance to nematodes is permanent and relatively cheap, and the nematode hosting ability of subsequent cover crops is inconsequential. (There is however an influence of rootstock on cover crop performance to be considered, as legume cover crops perform much better than non legumes where rootstocks are used).
Where vines are established on own roots in nematode infested soils, post planting applications of the chemical Nemacur 400 can reduce populations. In such instances it is also important that non host cover crops are used, such as Coolabah or Swan oats(McLeod, 1997), and some Brassicas such as Weedcheck(see Figure 8.3). The other alternative is to utilise a bare earth policy which has obvious long term sustainability problems.

10.4 Garden Weevil(*Phlyctinus callosus*)

Predominately a problem in Western Australia, this insect is suspected of having a wide host range, which includes almost all plant species used as cover crops. Investigations are continuing to determine if the use of brassica crops reduces the populations of these insects, and to what extent the populations are exacerbated by the use of host plant cover crops. Again, research findings must be conveyed to growers to ensure continued use of appropriate cover crops. There has been some indication that subclover cover crops are effective in restricting garden weevil populations, based on observations in field trials in Western Australia in 1997 (Personal communications with Dianna Fisher).

10.5. Cost Effectiveness

Cover crops do not generally provide a cash return to growers. Benefits usually relate to long term sustainability and improved efficiencies in the vineyard. Hence decisions on mid row management will sometimes be based on the overall costs rather than optimum potential benefit. Growers may elect to sow cheap, uncertified, farm saved seed in preference to certified seed, or to use cheap alternatives to optimum, proprietary products.
For growers to be willing to pay a premium for a particular cultivar or seed blend, a defined benefit must be demonstrated, such as improved weed suppression or increased mulch productivity.

Data in tables 8.4.1 and 8.4.2 below demonstrate the productivity of various green manure cover crops, grown in replicated trials at McLaren Vale and Coonawarra in 1997. At both sites, Biomax significantly out yielded the alternative annual crops. A cost analysis appears for both trials comparing the cost of seed per sown hectare. This seed cost is then converted to a cost per MT of dry matter produced to enable a cost:benefit comparison.

COVER CROP	DRY WT (KG/HA)	INCREMENT	SEED COST/HA	$/MT DRY WT
FABA BEANS	3331	+70%	67.50	20.26
OATS	2888	+93%	33.00	11.42
BIOMAX™	5563		84.50	15.18

Table 8.6 **A yield and cost comparison for Green Manure cover crops grown at Richard Hamilton Wines, McLaren Vale in 1997.**

COVER CROP	DRY WT (KG/HA)	INCREMENT	SEED COST/HA	$/MT DRY WT
FIELD PEAS	7097	+38%	63.00	8.87
FABA BEANS	5707	+71%	67.50	11.82
OATS	3400	+189%	33.00	9.70
BIOMAX™	9814		84.50	8.61

Table8.7 **A yield and cost comparison for Green Manure cover crops grown at Southcorp Wines, Coonawarra.**

- Cultural and Traditional Practices

A visit to the Riverland during winter soon demonstrates that the traditional local practice of maintaining a bare, cultivated soil surface at all times is still an often utilised one. Such a method of mid row soil management has been passed on from generation to generation, and as a custom is difficult to alter. Language barriers also limit the transfer of any new technology. Only through the identification of innovative growers representative of each cultural group, and collaborating with them to demonstrate any new technology will gradual acceptance be achieved. ABS statistics show that 12% of Australian viticulturists are born in southern Europe, with the majority of these based in SA's Riverland, the Sunraysia, and the MIA.

Management Issues

Aspects of sward management can also impact significantly on cover crop performance and persistence as well as vine growth and grape yield.

1. There is scope to improve upon existing cover crop establishment techniques and seed bed preparation methods in numerous vineyards across South Eastern Australia. Optimal seeding conditions are provided by a firm, flat, uniform, moist, and weed free seed bed with a low trash burden and of such a tilth as to provide maximum seed to soil contact. The objective of providing such an environment is to enable accurate and consistent seed placement, with the least amount of competition and impediment for emerging cover crop seedlings.

2. Seeding time is also an important issue. Seeding in winter, when ground temperatures are lowest, inhibits the rate of establishment and seasonal production of cover crops. Conversely, seeding too early can expose the seed to potential losses through the advent of a false break. Where mid row areas can be irrigated (e.g. under Overhead Irrigation Systems), cover crops can be sown in March/April, following the completion of vintage. Significant growth is observed in autumn in such cases, and this is amplified in winter/spring, and consequently green manure cover crops mature and can be terminated earlier, and generally produce a greater biomass prior to incorporation. The timing of seeding must be tempered with the need or desire to control winter weeds prior to cover crop establishment, the need for appropriate seed bed preparation, and the availability of vineyard resources for cover crop establishment.

3. Seeding rates are often a contentious issue for growers, with some failing to recognize the improved weed suppressant and dry matter yield advantages of employing high plant densities. Cover crop seeding rates are higher than broad acre rates, where the objective is to produce optimal seed yield at the end of the growing season, not maximum ground cover or biomass production prior to budburst, as is the case with vineyard swards.

4. Mowing and spray regimes will not only impact on the ability of swards to persist and set seed, but may also influence vine performance by determining the frequency and severity of frosts, the degree of moisture competition, and canopy temperatures in summer.

5. Adequate application rates of appropriate fertilisers is paramount to achieve optimal cover crop performance, which can include topdressing swards with N in mid winter.

9 INTELLECTUAL PROPERTY

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10 EXTENSION ACTIVITIES

The Project Manager was involved in a variety of extension activities over the duration of the project. The following list describes these activities.

- 1995 Australian Wine Industry Technical Conference, Adelaide. *Poster display and attendance at seminar sessions.*
- 1998 Australian Wine Industry Technical Conference, Sydney. *Poster display, presentation of poster break out session and attendance at seminars.*
- 1995 Vititec Field Day, Coonawarra. Attendance at Seminar and presentation of a trade display.
- 1996 Vititec Field Day, Coonawarra. Attendance and presentation at Seminar plus trade display.
- 1997 Vititec Field Day, Coonawarra. Attendance at Seminar , presentation of break out session and trade display.
- Cover Crop Field Day at Coonawarra Field Site 1995.
- Presentation to Barossa Landcare group.
- Seedco 1996 cover crop field days-refer to attachments for full report.
- Presentation to Loxton Ag Bureau 1997.
- Presentation to Waikerie Ag Bureau 1996.
- Presentation to Adelaide Hills Ag Bureau 1998.
- Presentation to Berri Ag Bureau and CCW members 1998.
- Presentation at 1997 South Australian Viticultural Technical Conference.
- 1997 Vinetec Field Day at Cowra: Attendance at Seminar and presentation of a trade display.
- IPM workshop at McLaren Vale: Weeds section presentation.
- South Australian Farmers Federation (SAFF) workshop, McLaren Vale February 1998. Presentation to growers.
- Powdery Mildew Seminar, Charles Sturt University, Wagga Wagga, 1995. Presentation to growers.
- Western Australia, August 1997. Presentation to growers at Pemberton and Margaret River.
- SAFF growers day 1998. Presentation of trade display.
- 1997 Riverland Field days. Presentation of trade display.

11 TECHNICAL COLLABORATION

The Project Manager collaborated with various other researchers over the duration of the project. The following is a description of the nature of this collaborative work.

- Drs Judy Eastham and Alfred Cass (CRC Soil and Land Management): *Soil Characterisation for 1994, 1995 and 1996 trial sites.*
- Dr Mark Smith and Alison Brown (IHD, Knoxfield): *Light Brown Appple Moth monitoring in swards at Coonawarra, Mitchelton and Sunraysia.*
- Rod McLeod (NSW Ag): *Analysis of hosting ability of various brassica species and monitoring of nematode populations at various trial sites.*
- Dr John Kirkegaard (CSIRO) and John Mathieson (AgWA): *Glucosilinate screening of a variety of brassica species identified in field trials as having application as cover crops.*
- Dr Alfred Cass and William Besz (CRC Soil and Land Management): *Soil moisture monitoring at Padthaway in 1997.*
- Dr DeAnn Glenn (IHD, Knoxfield): *Insect population monitoring in swards and vines at Yarra Valley in 1997.*
- Graham Sanderson (Dareton Research Station): *Medic species as cover crops in Sunraysia.*

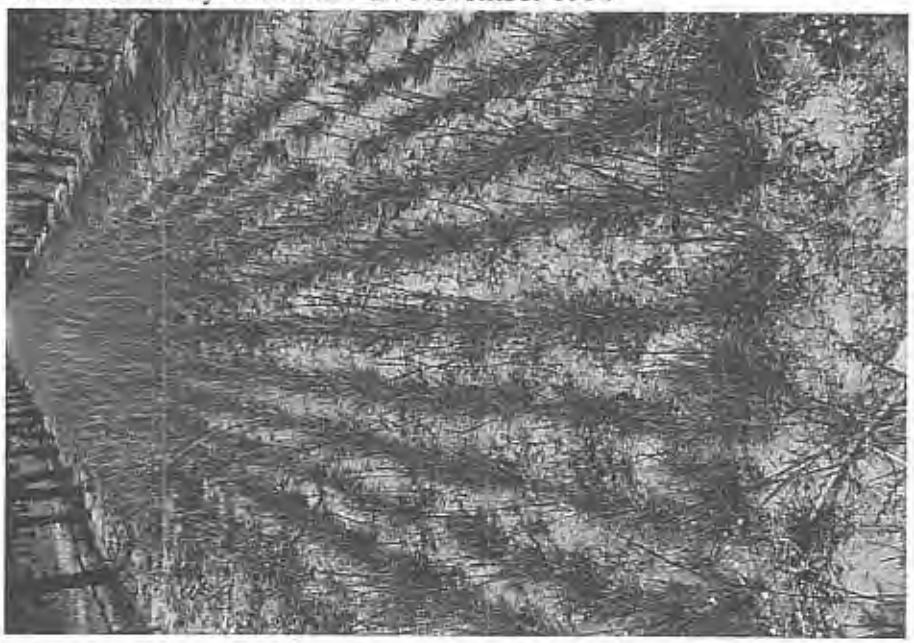
12.1 1994 Mildura Trial Site - August 1994

12.2 Paraponto Medic
1994 Mildura Trial Site - August 1994

12.3 Glenroy Peas
1994 Mildura Trial Site - August 1994

12.4 Berseem Clover showing effects of od drought and 2,4 DB
1994 Padthaway Trial Site - August 1994

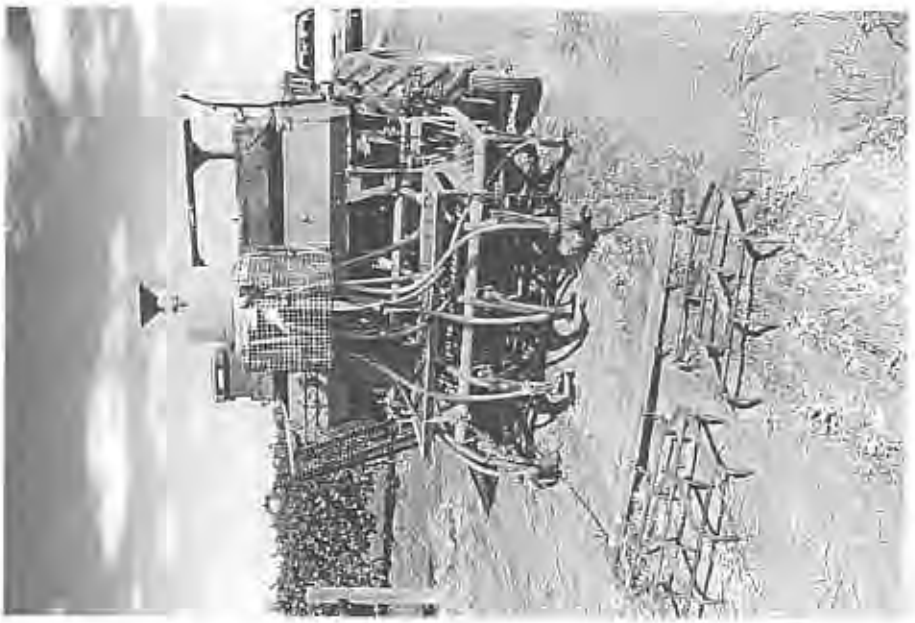
12.5 Ellet Perennial Ryegrass
1994 Padthaway Trial Site - 24 November 1994



12.6 Bulban Oats
1994 Padthaway Trial Site - 24 November 1994

12.7 Balsana Clover
1994 Padthaway Trial Site - 24 November 1994

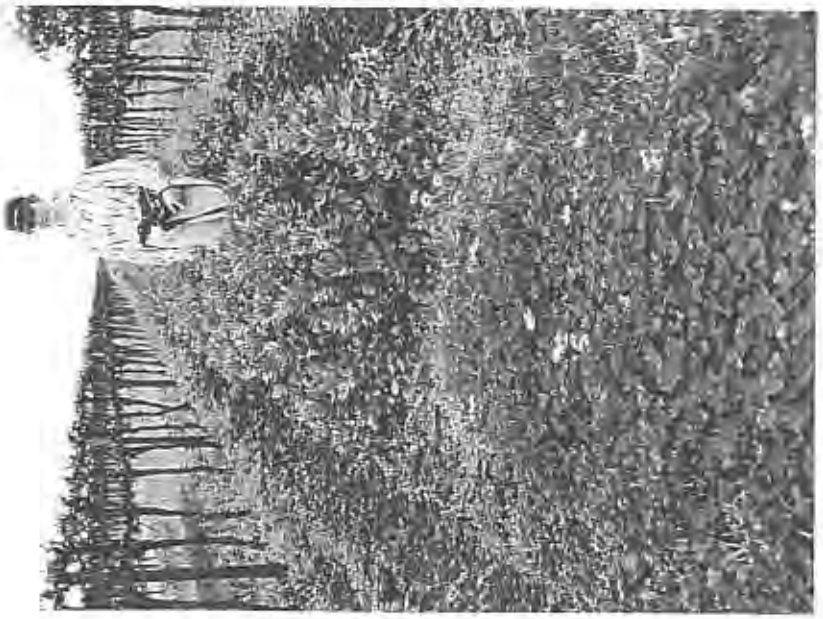
12.8 Small Plot Coneseeder used to seed Griffith Trial Site
20 April 1995



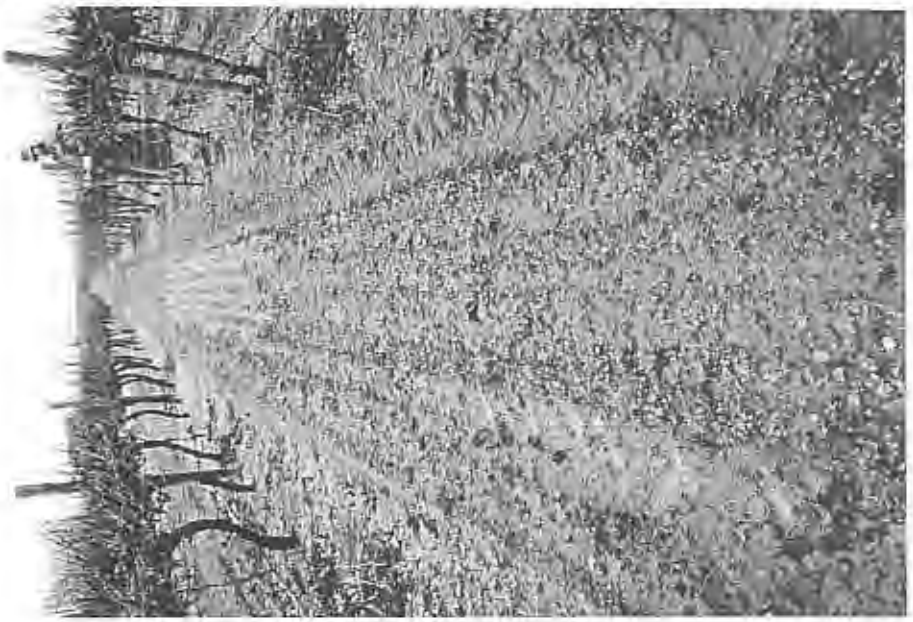
12.9 Seed bed after seeding 1995
20 April 1995

12.10 Water logged and Inaccessible
1995 Griffiths Trial Site - 15 June 1995

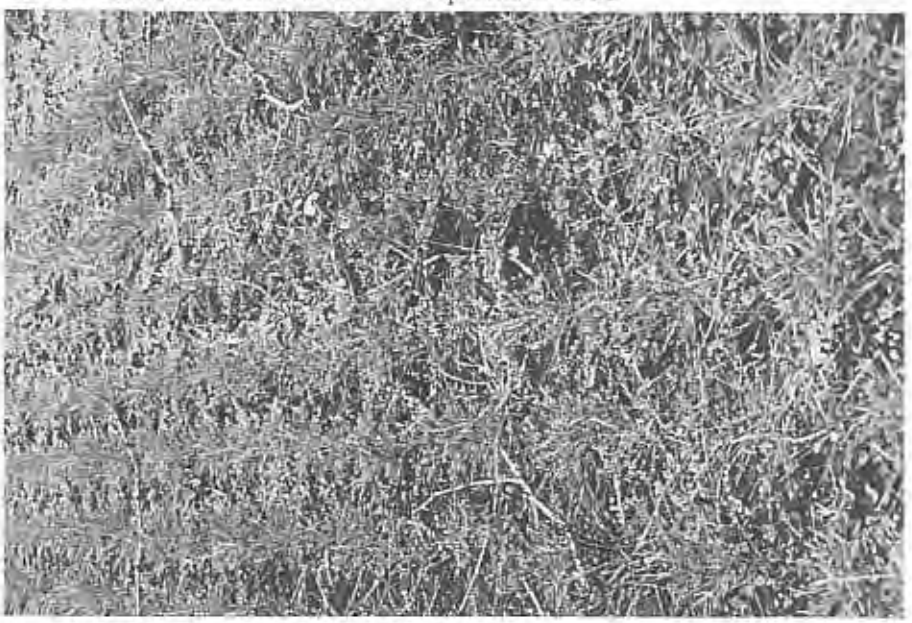
12.11 Sub clover (foreground) and Faba Beans
1995 Griffiths Trial Site - 14 September 1995



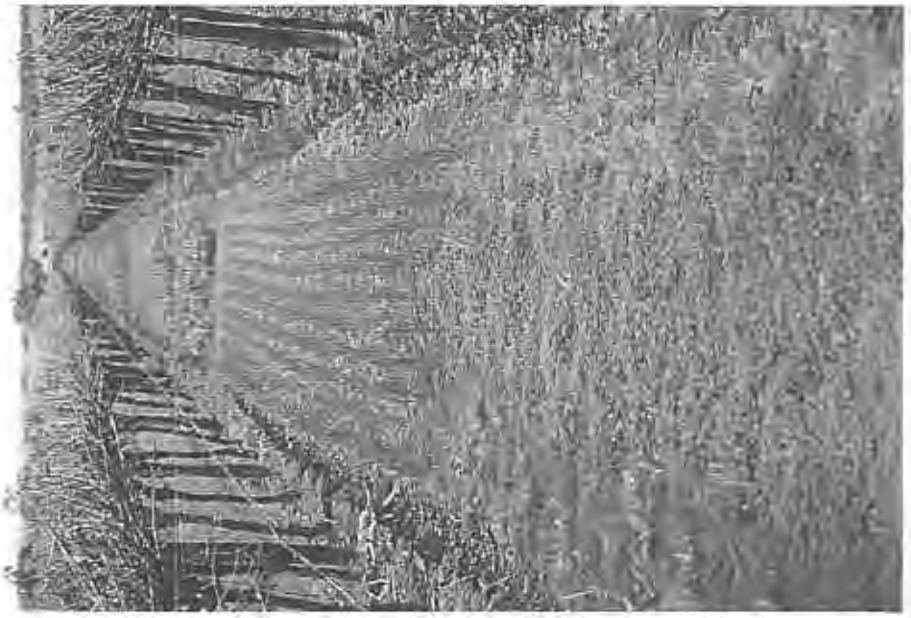
12.12 1995 Coonawarra Trial Site
Emerging Cover Crops - June 1995



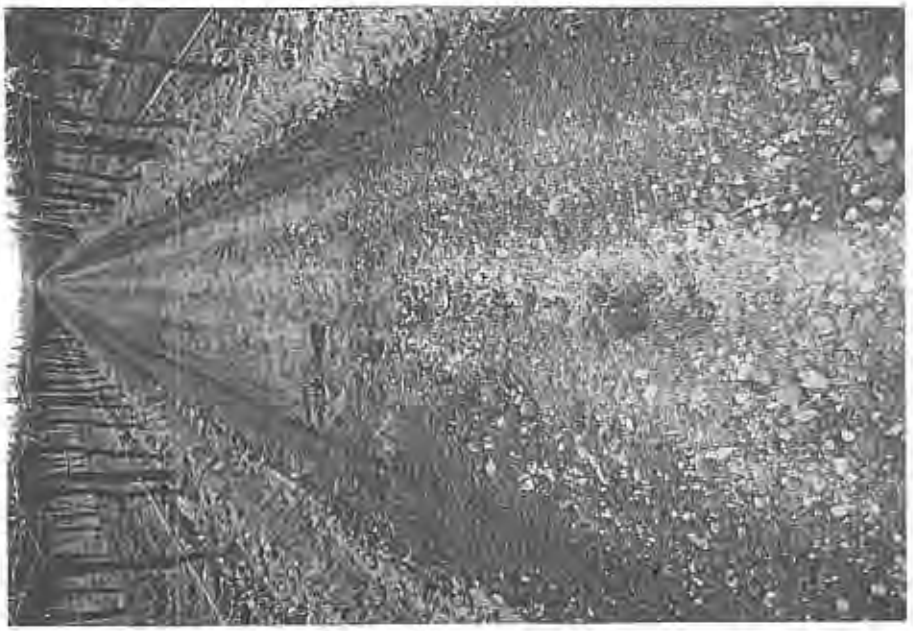
12.13 Blend of Denmark subclover and Victorian Ryegrass
1995 Coonawarra Trials site - 4 September 1995



12.14 Soursob smothering cover crops
1995 Rowland Flat Trial Site - 7 July 1995



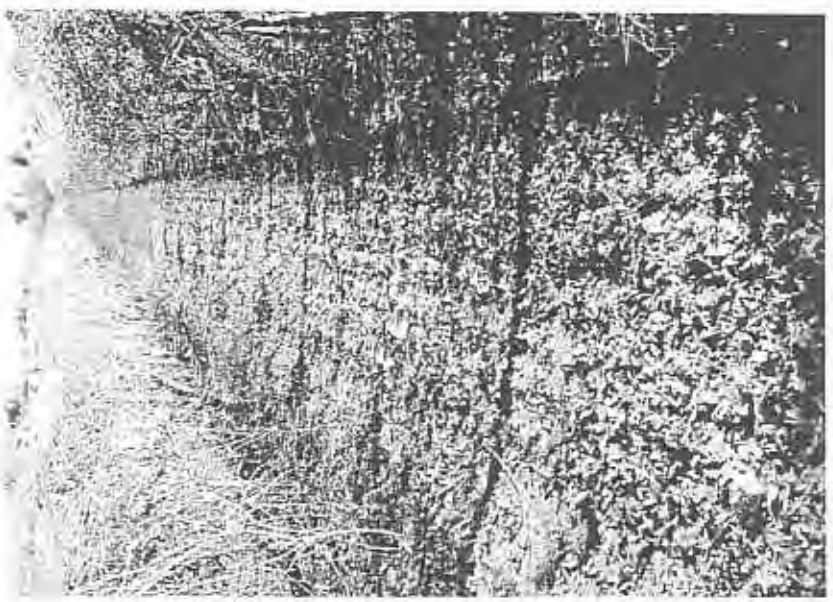
12.15 Resown plots
1995 Rowland Flat Trial Site -26 June 1995



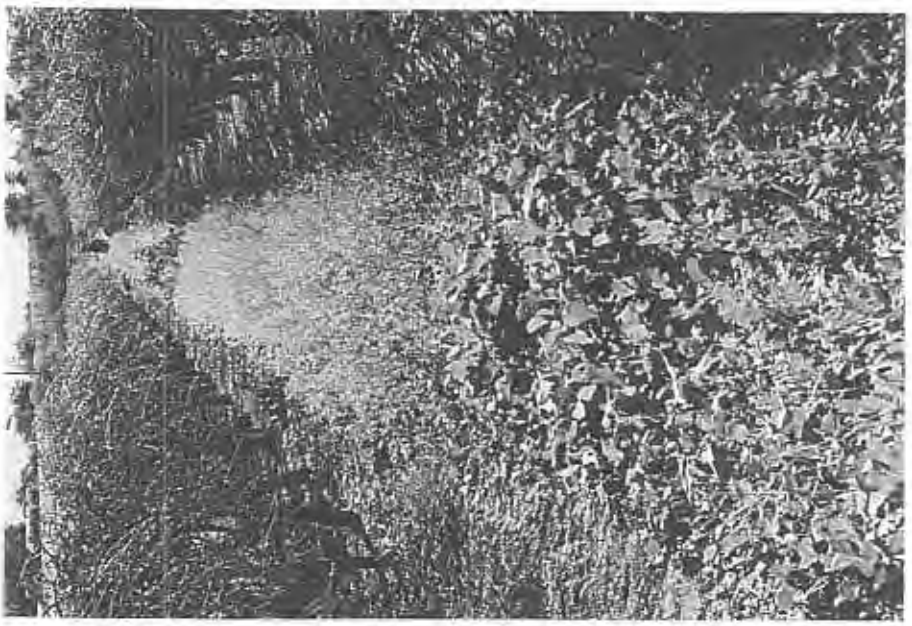
12.16 Green Manure Cover Crops, form the foreground: Popany vetch, Coolibah Oats, Dundale Peas and White Mustard, 1995 Rowland Flat Trial Site - 21 September 1995

12.17 Soil after Seeding, 1995 Mildura Trial Site - 13 April 1995

12.18 Establishing cover crops
1995 Mildura Trial Site - 14 June 1995



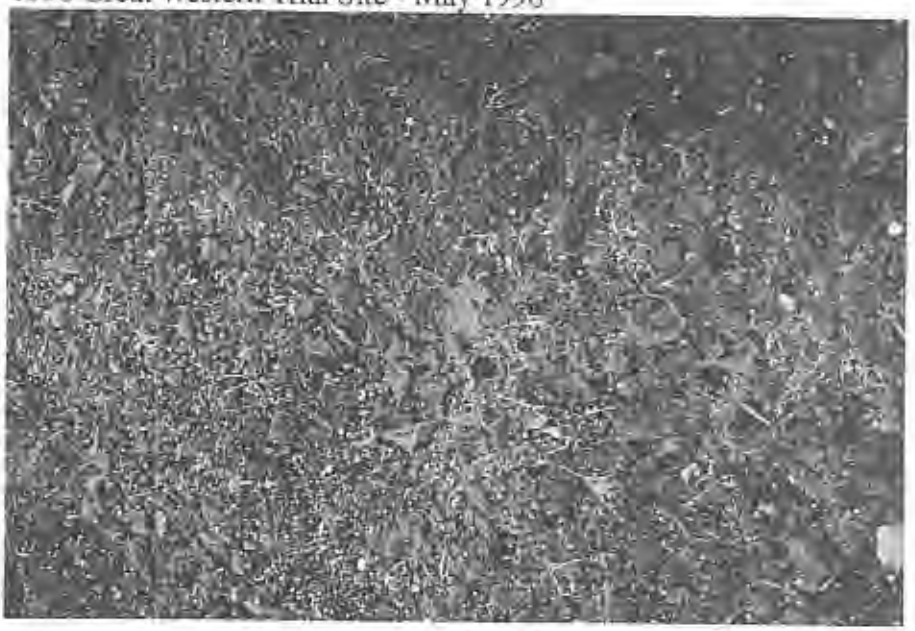
12.19 Established Green Manure crops
1995 Mildura Trial Site - 15 August 1995



12.20 Pigeons and RLEM restricted cover crop establishment and productivity
1995 Seaview Trial site, five weeks after seeding - 6 July 1995

12.21 Red Legged Earth Mite (RLEM) on a Salvation Jane
(*Echium plantagenium*) leaf

12.22 The effect of a false break on seedling survival
1996 Great Western Trial Site - May 1996



12.23 A sealed soil surface in a continuously tilled, flood irrigated vineyard
1 month after cover crop seeding 1996 Yenda Trial Site - May 1996

12.24 Sward of perennial ryegrass and subclover
1996 Yenda Trial Site - August 1996

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1. "Spotlight on Cover Crops" published in *The Grower* (Rural Press Ltd.) October 1995.

2. "The role of cover crops to improve soil management" published in the *Australian Grapegrower and Winemaker Annual Technical Issue*(No.390a) (Ryan Publications), June 1996.

3. "Seedco releases cover crop guide for SE Australia" published in *GrapeGrowers* (Rural Press Ltd.) April/May 1997.

4. "Cover cropping for undervine mulching" published in the *Australian Grapegrower and Winemaker* (No.402) (Ryan Publications), June 1997.

5. "Cover crop trial aims to eliminate vineyard tillage" published in *GrapeGrowers* (Rural Press Ltd.) October/November 1997.

6. "Assess ground cover effectiveness now" published in *Australian Viticulture* (Winetitles) Volume 1 Issue no.2, 1997.

7. "Room for improvement in Cover Crop Management" published in *GrapeGrowers* (Rural Press Ltd.) December/January 1997/98.

8. "Establishing vineyard cover crops" published in the *Australian Grapegrower and Winemaker* (No.410) (Ryan Publications), February 1998.

9. "Adaptable seeder will ensure a uniform cover crop is established" published in *GrapeGrowers* (Rural Press Ltd.) February/March 1998.

10. "Cover crop extension guide released" published in the *Australian Grapegrower and Winemaker* (No.412) (Ryan Publications), April 1998.

11. "Weed suppression using cover crops" published in the *Australian Grapegrower and Winemaker* (No.414) (Ryan Publications), June 1998.

12. "The impact of ground cover treatment upon frost incidence and severity" published in the *Australian Grapegrower and Winemaker Annual Technical Issue* (No.414a) (Ryan Publications), June 1998.

13. "Cover crop guide provides all the answers" published in *GrapeGrowers* (Rural Press Ltd.) June/July 1998.

15 APPENDICES

15.1 COVER CROP OPTIONS FOR *THE ADELAIDE HILLS*

COVER CROP TYPE	RECOMMENDED CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
ANNUAL REGENERATING SWARDS					
Sub Clovers	Gosse (D) Denmark (D)	15 15	10-15 10-15	At Seeding 18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Sow into a prepared seed bed after the break of season. Apply type C inoculum. Usually sown in a blend with grasses, in which case the total rate of sub clover should not exceed 10 kg/ha. Gosse will tolerate soil pH 5.0-6.5 and water logging. Denmark is a more prostrate sub clover with good persistence in higher rainfall regions. Sub clovers are very tolerant of close mowing in spring, and will set seed in late November. Sub clovers leave a dense plant residue capable of suppressing summer weeds.
Perennial Ryegrass	Victorian Matilda	25-30	10-15	At Seeding 18:20:0 NPK 100 kg/ha Top Dress with 18:20:0 100 kg/ha	These ryegrasses will mature and set seed in late November if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides a moderate amount of biomass plus good weed suppression and trafficability.
PERENNIAL SWARDS					
Perennial Grasses (Forage types)	Ellet Ryegrass Vedette (D) Rye Roper (D) Ryegrass Demeter Fescue Porto Cocksfoot	30 30 30 35 10	10-15	At Seeding 18:20:0 NPK 100 kg/ha Top Dress with 18:20:0 100 kg/ha	The New Zealand type ryegrasses are less summer dormant than Victorian and Matilda, and generally require a higher rainfall (700mm<) to persist. Fescues provide greater tolerance to drought conditions than ryegrass, and are relatively summer active, providing year round trafficability. Cocksfoot, like Fescue, is a deep rooted grass, best used in a blend with ryegrass. These species can form large crowns if plant density is low. Fescues are best adapted to heavy clay soil types, whilst cocksfoots are the preferred option for lighter, less fertile soils. Turf type ryegrasses, such as Cutter and Derby Supreme, are more prostrate in growth habit than forage type ryegrasses, and require less frequent mowing. These ryegrasses can be used in combination with the shorter fescues, such as Triumph, or creeping red fescues, such as Cindy, to provide low growing, summer active perennial swards. Annual topdressing is recommended for these swards. Sow in combination with a companion crop such as cereal rye (20kg/ha) where erosion is a concern.
Perennial Grasses (Turf types)	Cutter ryegrass Derby Supreme rye Triumph fescue Cindy fescue	30 30 35 15			

15.2 COVER CROP OPTIONS FOR *THE BAROSSA VALLEY*

COVER CROP TYPE	RECOMMENDED CULTIVAR	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for dryland and drip irrigated vineyards.**
Triticale	Tahara Currency Abacus (D)	150	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Sow in early May, top dress if necessary. Good weed suppression and biomass production. Can be used in a blend with vetch in a 4:1 ratio seeded at 100 kg/ha. Rotate with Faba beans, oats or brassica cover crops. If left as a standing stubble, will provide good wind protection for young vines. Most suitable for side throw mowing to create a persistent undervine mulch.
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Top dress if deficiency symptoms are evident or if vigour is lacking. Use in rotation with Triticale, legumes, brassicas. Can be mixed with Snail medic (ratio of 3:1) or Vetch (ratio of 5:2) & sown at 70 kg/ha.
Faba Beans Field Peas	Fiord Rossa™ Glenroy Dun	150 120	30-40 30	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type inoculum if no bean or pea crop has been grown in the previous 2 seasons or if no inoculum previously used. Top dressing not normally required. Rossa beans have some resistance to Chocolate Spot *(Botrytis fabae)* and Ascochyta *(Aschochyta fabae)*. Rotate with Triticale, Oats or Brassicas.
Forage Blends	Biomax™	130	20-35	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium. Top dressing in winter is not normally required. Can be grown for 2-3 consecutive seasons in rotation with Ryecorn, Triticale or Brassica crops. Seed in mid autumn after the break of season.
Brassicas	Weedcheck™ (Fodder Radish) Nemfix™ (Oil Seed Mustard)	12-20	20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 of NPKS 120 kg/ha	Fodder Radish recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Soil surface should be rolled after seeding in early May to promote seed-soil contact. Top dress in June. Rotate with legumes and cereals, suggested interval of 1-2 seasons between brassica crops. Mustard is suited to lighter soil types.
ANNUAL REGENERATING SWARDS					**Suitable for use in irrigated vineyards only.**
Sub Clovers	Gosse (D) Clare York (D)	14-16 15-20 12-15	10-15 10-15 10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Sow in to a prepared seed bed after the break of season. Apply type **C** inoculum. Usually sown in a blend with grasses. Sub clovers are very tolerant of close mowing in spring, and will set seed in mid-late November. Sub clovers leave a dense plant residue capable of suppressing some summer weeds.
Medic	Kelson Santiago Paraggio Mogul (D)	20-25 12-15 15-20 15-20	20 10-15 10-15 10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Inoculate with type **AM** Rhizobium. Use a prepared seed bed. Medics have moderate early vigour but do not tolerate low mowing, especially after the commencement of flowering. Kelson is very productive in late winter/early spring. Medic seed pods should be incorporated each autumn to promote germination. Adapted to soil pH 6.5-8.0.
Grasses	Victorian Rye Matilda Rye Roper (D) Rye Demeter fescue	25 25 25 30	10-15 10-15 10-15 10-15	18:20:0 NPK 100 kg/ha Top Dress annually with 18:20:0 NPK	Suitable if rainfall is over 550mm and vines are irrigated. Fescue is not as persistent as rye, but is deeper rooted, and more summer active. Allow grasses to set seed in November and keep sward height below 15cm to maintain plant densities.

15.3 COVER CROP OPTIONS FOR *CLARE VALLEY*

COVER CROP TYPE	CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for Dryland and irrigated vineyards.**
Triticale	Tahara Currency Abacus (D)	150	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Good weed suppression and biomass production. Can be used in a blend with vetch in a 4:1 ratio sown at 100 kg/ha. Rotate with Faba beans, oats or brassica cover crops. Sow in early May. If left as a standing stubble, will provide good wind protection for young vines. Top dress in June if necessary. Best option for side throw mowing to create a persistent under vine mulch.
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Use in rotation with Triticale, legumes, or brassicas. Can be mixed with Snail medic (ratio of 3:1) or Vetch (ratio of 5:2) and sown at 70 kg/ha. Top dress if deficiency symptoms are evident or if vigour is lacking. Moderately tolerant of water logged conditions.
Faba Beans	Fiord Rossa™	150	30-40	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with **E** type inoculum if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Rossa beans have some resistance to Chocolate spot and ascochyta. Rossa beans have some resistance to Chocolate Spot (*Botrytis fabae*) and Ascochyta (*Aschochyta fabae*). Top dressing in winter is not normally required.
Forage blends	Biomax™	130	20-30	18:20:0 NPK 120 kg/ha	Inoculate seed with **E** type Rhizobium. Top dressing in winter is not normally required. Can be grown for 2-3 consecutive seasons before rotating with Ryecorn, Triticale or Brassica crops. Seed in mid autumn after the break of season.
Brassicas	Weedcheck™ (Fodder Radish) Rangi Rape	12-20 4	20 20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 120 kg/ha	Top dressing is recommended for these swards in June. Soil surface should be rolled, after seeding in early May, to promote seed-soil contact. Fodder Radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Rotate with legumes and cereals. Suggested interval of 2 seasons between brassica crops.
ANNUAL REGENERATING SWARDS					**Irrigated vineyards only.**
Sub Clovers	Gosse (D) Clare York (D) Daliak	14-16 15-20 12-15 12-15	10-15 10-15 10-15 10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Gosse will tolerate pH 5.0-6.5, water logged soils. Clare is adapted to soils of pH 6.0-7.5, and has good seedling vigour. York and Daliak are earlier maturing sub clovers adapted to acid soils. Sub clovers are very tolerant of close mowing in spring, and will set mature seed in November. Sow in to a prepared seed bed after the break of season. Use type **C** inoculum.
Medic	Kelson Santiago	20-25 12-15	20 10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Kelson is very productive in late winter/early spring. Pods must be incorporated each autumn to promote germination. Medics have moderate early vigour but do not tolerate low mowing, especially after the commencement of flowering. Inoculate with type **AL** Rhizobium. Adapted to soils of pH 6.5-8.0.
Perennial Ryegrass	Victorian Matilda	25-30	10-15	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 120 kg/ha	These ryegrasses will mature and set seed in late November if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides moderate amounts of biomass, year round weed suppression, and good trafficability in all seasons.

15.4 COVER CROP OPTIONS FOR *THE COONAWARRA REGION*

COVER CROP TYPE	CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
					Suitable for Dryland and irrigated vineyards.
GREEN MANURES					
Triticale	Tahara Currency Abacus (D)	150	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Good weed suppression and biomass production. Can be used in a blend with vetch in a 4:1 ratio sown at 100 kg/ha. Rotate with Faba beans, oats or brassica cover crops. Sow in early May. If left as a standing stubble will provide good wind protection for young vines. Top dress in June if necessary. Best option for side throw mowing to create a persistent under vine mulch.
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Use in rotation with triticale, legumes, or brassicas. Can be mixed with Snail medic (ratio of 3:1) or vetch (ratio of 5:2) and sown at 70 kg/ha. Top dress if deficiency symptoms are evident. Moderately tolerant of water logged soils.
Faba Beans	Fiord Rossa™	150	30-40	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Rossa beans have some resistance to Chocolate Spot *(Botrytis fabae)* and Ascochyta *(Aschochyta fabae)*. Rotate with cereals or brassicas.
Forage blends	Biomax™	130	20-30	18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium. Top dressing in winter is not normally required. Can be grown for 2-3 consecutive seasons before rotating with ryecorn, triticale or brassica crops. Seed in mid autumn after the break of season.
Brassicas	Weedcheck™ (Fodder Radish)	12-20	20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 120 kg/ha	Top dressing is recommended for these swards in June. Soil surface should be rolled, after seeding in early May, to promote seed-soil contact. Fodder radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Rotate with legumes and cereals. Suggested interval of 2 seasons between brassica crops.
					Irrigated vineyards only.
PERENNIAL/ REGENERATING SWARDS					
Sub Clovers	Gosse (D) Denmark (D) Clare Junee	* * * * Use in a mix, total 15 kg/ha	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Gosse will tolerate pH 5.0-6.5, water logged soils. Denmark is later maturing but prostrate, and has good seedling vigour. York is an earlier maturing sub clover adapted to acid soils. Sub clovers are very tolerant of close mowing in spring, and will set mature seed in November. Sow in to a prepared seed bed after the break of season. Use type C inoculum. Seed in a 2:1 grass:clover mix.
Medic	Paraggio Santiago Mogul	15 12 15	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Pods should be incorporated each autumn to promote germination. Medics have moderate early vigour but do not tolerate low mowing, especially after the commencement of flowering. Inoculate with type AM Rhizobium. Adapted to soils of pH 6.5-8.0. Either monoculture or mixed with grasses.
Perennial Grasses	Victorian Rye Matilda Rye Ellet Rye Porto cocksfoot Demeter fescue	25 10 30	10-15	18:20:0 NPK 150 kg/ha Top Dress annually with DAP at 100 kg/ha	Ryegrass will mature and set seed in December if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides moderate amounts of biomass, year round weed suppression, and good trafficability in all seasons. Fescue and cocksfoot are moderately summer active, rye is more dormant.

15.5 COVER CROP OPTIONS FOR *THE COWRA REGION*

COVER CROP TYPE	CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for Dryland and irrigated vineyards.**
Triticale	Tahara Currency Abacus (1)	150	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Good weed suppression and biomass production. Can be used in a blend with vetch in a 4:1 ratio sown at 120 kg/ha. Rotate with Faba beans, oats or brassica cover crops. Sow in early May. If left as a standing stubble will provide good wind protection for young vines. Top dress in June if necessary. Best option for side throw mowing to create a persistent under vine mulch.
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Use in rotation with triticale, legumes, or brassicas. Can be mixed with Snail medic (ratio of 3:1) or vetch (ratio of 5:2) and sown at 70 kg/ha.. Top dress if deficiency symptoms are evident. Moderately tolerant of water logged soils.
Faba Beans	Fiord Rossa™	150	30-40	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Rossa beans have some resistance to Chocolate Spot *(Botrytis fabae)* and Ascochyta *(Aschochyta fabae)*. Rotate with cereals or brassicas.
Forage blends	Biomax™	130	20-30	18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium. Top dressing in winter is not normally required. Can be grown for 2-3 consecutive seasons before rotating with ryecorn, triticale or brassica crops. Seed in mid autumn after the break of season.
Brassicas	Weedcheck™ (Fodder Radish)	12-20	20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 120 kg/ha	Top dressing is recommended for these swards in June. Soil surface should be rolled, after seeding in early May, to promote seed-soil contact. Fodder radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Rotate with legumes and cereals. Suggested interval of 2 seasons between brassica crops.
PERENNIAL/ REGENERATING SWARDS					**Irrigated vineyards only.**
Sub Clovers	Gosse (1) Denmark (1) Clare Junee	* * * * Use in a mix, total 15 kg/ha	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Gosse will tolerate pH 5.0-6.5, water logged soils. Denmark is later maturing but prostrate, and has good seedling vigour. York is an earlier maturing sub clover adapted to acid soils. Sub clovers are very tolerant of close mowing in spring, and will set mature seed in November. Sow in to a prepared seed bed after the break of season. Use type C inoculum. Seed in a 2:1 grass:clover mix.
Medic	Paraggio Santiago Mogul	15 12 15	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Pods should be incorporated each autumn to promote germination. Medics have moderate early vigour but do not tolerate low mowing, especially after the commencement of flowering. Inoculate with type **AM** Rhizobium. Adapted to soils of pH 6.5-8.0. Either monoculture or mixed with grasses.
Perennial Grasses	Victorian Rye Matilda Rye Ellet Rye Porto cocksfoot Demeter fescue	25 10 30	10-15	18:20:0 NPK 150 kg/ha Top Dress annually with DAP at 100 kg/ha	Ryegrass will mature and set seed in December if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides moderate amounts of biomass, year round weed suppression, and good trafficability in all seasons. Fescue and cocksfoot are moderately summer active, rye is more dormant.

15.6 COVER CROP OPTIONS FOR *THE EDEN VALLEY REGION*

COVER CROP TYPE	CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for Dryland and irrigated vineyards.**
Triticale	Tahara Currency Abacus (D) Madonna	150	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Good weed suppression and biomass production. Can be used in a blend with vetch in a 4:1 ratio sown at 100 kg/ha. Rotate with Faba beans, oats or brassica cover crops. Sow in early May. If left as a standing stubble will provide good wind protection for young vines. Top dress in June if necessary. Best option for side throw mowing to create a persistent under vine mulch.
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Use in rotation with triticale, legumes, or brassicas. Can be mixed with Snail medic (ratio of 3:1) or Vetch (ratio of 5:2) and sown at 70 kg/ha. Top dress if nutrient deficient. Moderately tolerant of water logged soils.
Faba Beans	Fiord Rossa™	150	30-40	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Rossa beans have some resistance to Chocolate Spot *(Botrytis fabae)* and Ascochyta *(Aschochyta fabae)*. Rotate with cereals or brassicas.
Forage blends	Biomax™	130	20-30	18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium. Top dressing in winter is not normally required. Can be grown for 2-3 consecutive seasons before rotating with ryecorn, triticale or brassica crops. Seed in mid autumn after the break of season.
Brassicas	Weedcheck ™ (Fodder Radish)	12-20	20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 120 kg/ha	Top dressing is recommended for these swards in June. Soil surface should be rolled, after seeding in early May, to promote seed-soil contact. Fodder radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Rotate with legumes and cereals. Suggested interval of 2 seasons between brassica crops.
PERENNIAL/ REGENERATING SWARDS					**Irrigated vineyards only.**
Sub Clover Annual Medic	Gosse (D) York (D) Denmark (D) Clare Santiago	Use these legumes in a mix with grasses. Total legume component should be 15kg/ha	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Gosse will tolerate pH 5.0-6.5, water logged soils. Denmark is later maturing but prostrate, and has good seedling vigour. York is an earlier maturing sub clover adapted to acid soils. Clare and Santiago are adapted to soils of pH 6.5-8. Sub clovers are very tolerant of close mowing in spring, and will set mature seed in November. Sow in to a prepared seed bed after the break of season. Use C type inoculum for subs, AM for medic. Seed in a 2:1 grass:legume mix.
Perennial Grasses	Ellet Rye Matilda Rye Porto cocksfoot Demeter fescue	30 30 10 30	10-15	18:20:0 NPK 150 kg/ha Top Dress annually with DAP at 100 kg/ha	Ryegrass will mature and set seed in December if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides moderate amounts of biomass, year round weed suppression, and good trafficability in all seasons. Fescue and cocksfoot are moderately summer active, rye is more dormant.

15.7 COVER CROP OPTIONS FOR *LANGHORNE CREEK*

COVER CROP TYPE	RECOMMENDED CULTIVARS	SEEDING RATE (KG/HA)	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for dryland and drip irrigated vineyards.**
Ryecorn	Commercial Bevy™	80	20-30	18:20:0 NPK 120 kg/ha minimum Top Dress with Urea 120 kg/ha	Sow in early May, top dress only if necessary. Provides good winter weed suppression. Rotate with Faba beans, oats or brassica cover crops. If left as a standing stubble, will provide good wind protection for young vines. Well adapted to light, sandy soils. Preferred option to Triticale and Oats if seeding in June.
Triticale	Tahara Currency Abacus (D)	140	20-30	18:20:0 NPK 120 kg/ha minimum Top Dress with Urea 120 kg/ha	Sow in early May, top dress only if necessary. Good weed suppression and biomass production. Can be used in a blend with vetch in a 4:1 ratio seeded at 130 kg/ha. Rotate with Faba beans, oats or brassica cover crops. If left as a standing stubble, will provide good wind protection.
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha minimum Top Dress with Urea 120 kg/ha	Top dress all cereals in June if deficiency symptoms are evident, or if vigour is lacking. Use in rotation with Triticale, legumes or brassicas. Can be mixed with Snail medic (ratio of 2:1) or Vetch (ratio of 3:2) and sown at 70 kg/ha to provide good bulk. Oats are moderately tolerant of water logged conditions.
Forage Blend	Biomax™	120	20-30	18:20:0 NPK 120 kg/ha minimum	Inoculate seed with **E** type iRhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Top dressing in winter not normally required. Can be grown for 2-3 consecutive seasons in rotation with Ryecorn, Triticale or Brassica crops. Seed in mid autumn after the break of season.
Faba Beans	Fiord Rossa™	150	40-50	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with **E** type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Top dressing in winter not normally required. Rossa beans have some resistance to Chocolate Spot *(Botrytis fabae)* and Ascochyta *(Aschochyta fabae)*. Rotate with Triticale, Oats or Brassicas.
Brassicas	Weedcheck™ (Fodder Radish) Nemfix™ (Oil Seed Mustard)	12-20 4	20 20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 of NPKS 120 kg/ha	Fodder Radish is recommended for weed suppression and disruption of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Soil surface should be rolled after seeding in early May to promote seed-soil contact Top dressing with Nitrogen based fertiliser is recommended for these swards in June Rotate with legumes and cereals. Suggested interval of 1-2 seasons between brassica cover crops.
ANNUAL REGENERATING SWARDS					**Suitable for use in irrigated vineyards only.**
Medic	Paraggio Mogul (D) Santiago Kelson	15 15 12-15 20-25	10-15 10-15 10-15 20	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Inoculate with type **AM** Rhizobium. Seed in to a prepared seed bed. Medics have moderate early vigour. Seed set/autumn regeneration can be affected by low mowing in spring, especially after the commencement of flowering. Kelson is very productive in late winter/early spring. Medic seed pods can be incorporated in autumn to stimulate germination.. Can be sown in combination with perennial ryegrass such as Victorian or Matilda (only if irrigation of the midrow over summer is possible).

15.8 COVER CROP OPTIONS FOR *THE M.I.A.*

COVER CROP TYPE	RECOMMENDED CULTIVAR	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
					Suitable for dryland and irrigated vineyards.
GREEN MANURES					
Oats	Coolabah Swan	80	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Top dress in winter with urea if deficiency symptoms are evident, or if vigour is lacking. Use in rotation with legumes or brassicas. Can be mixed with snail medic (ratio of 3:1) or vetch (ratio of 5:2) and sown at 70 kg/ha to produce a productive forage blend. Oats are moderately tolerant of water logged soils.
Forage Blends	Biomax™	120	20-30	18:20:0 NPK 120 kg/ha minimum	Inoculate seed with E type Rhizobium if necessary. Top dressing in winter not normally required. Can be grown for 2-3 consecutive seasons in rotation with ryecorn, triticale or brassica crops.
Lupins	Gungurru Danja Illyarrie (D)	80	20-30	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate with G type Rhizobium. Tolerant of acid soils. Gungurru is the variety most tolerant of water logged soils, however, Danja and Illyarrie are more productive. Top dressing is not normally required. Rotate with cereals and brassicas.
Faba Beans	Fiord Rossa™	130	40-50	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type inoculum if no bean or pea crop has been grown in the previous 2 seasons or if no inoculum previously used. Top dressing is not normally required. Rossa beans have some resistance to Chocolate Spot (*Botrytis fabae*) and Ascochyta (*Aschochyta fabae*). Rotate with cereals or brassicas.
Brassicas	Weedcheck™ (Fodder Radish) Rangi (Fodder Rape) Nemfix™ (Oil Seed Mustard)	12-20 4 8	20 20 20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 NPKS 120 kg/ha	Fodder radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Soil surface should be rolled after seeding in early May to promote seed-soil contact. Top dressing is recommended for these swards in June. Rotate with legumes and cereals, suggested interval of 1-2 seasons between brassica crops.
ANNUAL REGENERATING SWARDS					**Suitable for use in irrigated vineyards only. Perennials may only be used if mid row area is irrigated.**
Medic	Paraggio Santiago Kelson Snail	15 12 20	10-15 10-15 20	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Inoculate with type AM Rhizobium. Seed into a well prepared seed bed. Medics have moderate early vigour. Seed set and autumn regeneration can be affected by low mowing in spring, especially after the commencement of flowering. Kelson is very productive in late winter/early spring. Snail medic seed pods should be incorporated in autumn to stimulate germination. Can be sown in combination with perennial ryegrass. Suited to alkaline soil types.
Sub Clovers	Clare Gosse (D) York (D) Nuba (D	15-20 14-16 12-15 15-18	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Gosse will tolerate pH 5.0-6.5, water logged soils. Clare and Nuba are adapted to soils of pH 6.0-7.5, and have good seedling vigour. York is an earlier maturing sub clover adapted to acid soils. Sub clovers are very tolerant of close mowing in spring, and will set seed in mid -late November. Sow in to a prepared seed bed after the break of season. Use type C inoculum.
Perennial Grasses	Victorian ryegrass Matilda ryegrass Roper ryegrass Demeter fescue	25	10-15	18:20:0 NPK 100 kg/ha Top Dress with 18:20:0 100 kg/ha	The ryegrasses will mature and set seed in December if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides a moderate amount of biomass plus good weed suppression and traffic ability. Fescues are relatively drought tolerant and generally will produce more growth in summer than ryegrasses.

15.9 COVER CROP OPTIONS FOR *GOULBOURN VALLEY AND NE VICTORIAN REGIONS*

COVER CROP TYPE	CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for Dryland and irrigated vineyards.**
Triticale Ryecorn	Tahara Currency Commercial Bevy	150 80	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Good weed suppression and biomass production. Triticale can be used in a blend with Blanchefleur vetch in a 4:1 ratio sown at 120 kg/ha. Rotate with Faba beans, oats or brassica cover crops. Sow in early May. If left as a standing stubble will provide good wind protection for young vines. Top dress in June if necessary. Triticale is the best option for side throw mowing to create an undervine mulch.
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Use in rotation with triticale, legumes, or brassicas. Can be mixed with Snail medic (ratio of 3:1) or vetch (ratio of 5:2) and sown at 70 kg/ha. Top dress if deficiency symptoms are evident. Moderately tolerant of water logged soils.
Faba Beans	Fiord Rossa™	150	30-40	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Rossa beans have some resistance to Chocolate Spot *(Botrytis fabae)* and Ascochyta *(Aschochyta fabae)*. Rotate with cereals or brassicas.
Forage blend	Biomax™	130	20-30	18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium. Top dressing in winter is not normally required. Can be grown for 2-3 consecutive seasons before rotating with ryecorn, triticale or brassica crops. Seed in mid autumn after the break of season.
Brassica Crops	Weedcheck™ (Fodder Radish) Rangi (Fodder Rape)	12-20 4	20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 120 kg/ha	Top dressing is recommended for these swards in June. Soil surface should be rolled, after seeding in early May, to promote seed-soil contact. Fodder radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Rotate with legumes and cereals. Suggested interval of 2 seasons between brassica crops.
PERENNIAL/ REGENERATING SWARDS					**Irrigated vineyards only.**
Sub Clovers	Gosse (D) Denmark (D) Goulbourn (D) Junee	* * * * Use in a mix, total 15 kg/ha	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Gosse will tolerate pH 5.0-6.5, water logged soils. Denmark is later maturing but prostrate, and has good seedling vigour. York is an earlier maturing sub clover adapted to acid soils. Sub clovers are very tolerant of close mowing in spring, and will set mature seed in November. Sow in to a prepared seed bed after the break of season. Use type C inoculum. Seed in a 2:1 grass:clover mix.
Medic	Paraggio Santiago Kelson™	15 12 15	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Pods should be incorporated each autumn to promote germination. Medics have moderate early vigour but do not tolerate low mowing, especially after the commencement of flowering. Inoculate with type AM Rhizobium. Adapted to soils of pH 6.5-8.0. Either monoculture or mixed with grasses.
Perennial Grasses	Victorian Rye Matilda Rye Ellet Rye Porto cocksfoot Demeter fescue	25 10 30	10-15	18:20:0 NPK 150 kg/ha Top Dress annually with DAP at 100 kg/ha	Ryegrass will mature and set seed in December if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides moderate amounts of biomass, year round weed suppression, and good trafficability in all seasons. Fescue and cocksfoot are moderately summer active, rye is more dormant.

15.10 COVER CROP OPTIONS FOR THE *MCLAREN VALE REGION*

COVER CROP TYPE	CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURE					**Suitable for dryland / drip irrigated vineyards.**
Triticale	Tahara Currency Abacus (b)	150	20-30	18:20:0 NPK 120 kg/ha minimum Top Dress with Urea 120 kg/ha	Sow in early May, top dress if necessary. Good weed suppression and biomass production. Triticale can be used in a blend with vetch in a 4:1 ratio seeded at 100 kg/ha. Rotate with Faba beans, oats or brassica cover crops. If left as a standing stubble, will provide good wind protection. Provides persistent undervine mulch. Ryecorn is best suited to light, sandy soils. Ryecorn rather than triticale should be used when sowing from June onwards.
Ryecorn	Commercial Bevy	80	20-30		
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha minimum Top Dress with Urea 120 kg/ha	Top dress all cereals in June if deficiency symptoms are evident or if vigour is lacking. Use oats in rotation with triticale, legumes or brassicas. Oats can be mixed with Snail medic (ratio of 3:1) or vetch (ratio of 5:2) and sown at 70 kg/ha.
Faba Beans	Fiord Rossa™	150	40-50	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Top dressing not normally required. Rossa beans have some resistance to Chocolate Spot (*Botrytis fabae*) and Ascochyta (*Aschochyta fabae*). Rotate with triticale, oats, brassicas.
Forage Blends	Biomax™	130	20-30		
Brassicas	Weedcheck™ (Fodder Radish)	12-20	20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 of NPKS 120 kg/ha	Fodder radish is recommended for weed suppression and disruption of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Soil surface should be rolled after seeding in early May to promote seed-soil contact. Top dressing is recommended for these swards in June. Rotate with legumes and cereals, suggested interval of 1-2 seasons between brassica crops. Use mustard on light, sandy soils.
	Nemfix™ (Oil Seed Mustard)	8-10	20		
ANNUAL REGENERATING SWARDS					**Suitable for use in irrigated vineyards only, or where vine vigour suppression is desirable.**
Sub Clovers	Gosse (b) Clare York (b)	14-16 15-20 12-15	10-15 10-15 10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Sow in to a prepared seed bed after the break of season. Apply type C inoculum. Usually sown in a blend with grasses, max. 15 kg/ha clover content. Gosse will tolerate pH 5.0-6.5, water logged soils. Clare is adapted to soils of pH 6.0-7.5; good seedling vigour. York is an earlier maturing sub clover adapted to acid soils. Sub clovers are very tolerant of close mowing in spring, and will set seed in mid -late November. Sub clovers leave a dense residue which can suppress summer weeds.
Medic	Kelson™ Paraggio	20-25 15-20	20 10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Inoculate with type AM Rhizobium. Use a well prepared seed bed. Medics have moderate early vigour but do not tolerate low mowing, especially after the commencement of flowering. Kelson is very productive in late winter/early spring. Medic seed pods should be incorporated each autumn to promote germination. Adapted to soil pH 6.5-8.0.
Perennial Ryegrass	Victorian Matilda	25-30	10-15	18:20:0 NPK 100 kg/ha Top Dress with 18:20:0 100 kg/ha	These ryegrasses will mature and set seed in late November if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides a moderate amount of biomass, good weed suppression and trafficability.

15.11 COVER CROP OPTIONS FOR *THE PADTHAWAY REGION*

COVER CROP TYPE	CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
					Suitable for Dryland and irrigated vineyards.
GREEN MANURES					
Triticale	Tahara Currency Abacus (D	150	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Good weed suppression and biomass production. Can be used in a blend with vetch in a 4:1 ratio sown at 100 kg/ha. Rotate with faba beans, oats or brassica cover crops. Sow in early May. If left as a standing stubble will provide good wind protection for young vines. Top dress in June if necessary. Best option for side throw mowing to create a persistent under vine mulch.
Ryecorn	SA Commercial Bevy	80			
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Use in rotation with triticale, legumes, or brassicas. Can be mixed with Snail medic (ratio of 3:1) or vetch (ratio of 5:2) and sown at 70 kg/ha. Top dress if deficiency symptoms are evident. Moderately tolerant of water logged soils.
Faba Beans	Fiord Rossa™	150	30-40	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Rossa beans have some resistance to Chocolate Spot (*Botrytis fabae*) and Ascochyta (*Ascochyta fabae*). Rotate with cereals or brassicas.
Forage blends	Biomax™	130	20-30	18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium. Top dressing in winter is not normally required. Can be grown for 2-3 consecutive seasons before rotating with ryecorn, triticale or brassica crops. Seed in mid autumn after the break of season.
Brassicas	Weedcheck™ (Fodder Radish)	12-20	20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 120 kg/ha	Top dressing is recommended for these swards in June. Soil surface should be rolled, after seeding in early May, to promote seed-soil contact. Fodder radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Rotate with legumes and cereals. Suggested interval of 2 seasons between brassica crops.
					Irrigated vineyards only.
PERENNIAL/ REGENERATING SWARDS					
Sub Clovers	Gosse (D York (D Clare Junee	* * * * Use in a mix, total 15 kg/ha	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Gosse will tolerate pH 5.0-6.5, water logged soils. Clare is later maturing and has good seedling vigour. York is an earlier maturing sub clover adapted to acid soils. Sub clovers are very tolerant of close mowing in spring, and will set mature seed in November. Sow in to a prepared seed bed after the break of season. Use type C inoculum. Seed in a 2:1 grass:clover mix.
Medic	Paraggio Santiago Mogul	15 12 15	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Pods should be incorporated each autumn to promote germination. Medics have moderate early vigour but do not tolerate low mowing, especially after the commencement of flowering. Inoculate with type **AM** Rhizobium. Adapted to soils of pH 6.5-8.0. Either monoculture or mixed with grasses.
Perennial Grasses	Victorian Rye Matilda Rye Currie cocksfoot Demeter fescue	25 25 10 30	10-15	18:20:0 NPK 150 kg/ha Top Dress annually with DAP at 100 kg/ha	Ryegrass will mature and set seed in December if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides moderate amounts of biomass, year round weed suppression, and good trafficability in all seasons. Fescue and cocksfoot are moderately summer active, rye is more dormant.

15.12 COVER CROP OPTIONS FOR *THE RIVERLAND*

COVER CROP TYPE	CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for dryland and irrigated vineyards.**
Ryecorn	Commercial Bevy™	70	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Sow in autumn, top dress in winter if necessary. Good winter weed suppression and moderate biomass production. Rotate with faba beans, oats or brassica cover crops. If left as a standing stubble, will provide good protection against wind and sand blast damage of young vines. Ryecorn is preferred to oats when seeding in winter.
Oats	Coolabah Swan	80	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Top dress in winter with urea if deficiency symptoms are evident, or if vigour is lacking. Use in rotation with ryecorn, legumes or brassicas. Can be mixed with snail medic (ratio of 3:1) or Languedoc vetch (ratio of 5:2) and sown at 70 kg/ha for a productive forage blend.
Barley	Cape Schooner	80	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Top dress in winter with urea if deficiency symptoms are evident, or if vigour is lacking. Use in rotation with ryecorn, oats, legumes or brassicas. Not as productive as oats. Non host for root knot nematodes.
Forage Blends	Biomax™	100-120	20-30	18:20:0 NPK 120 kg/ha minimum	Inoculate seed with E type iRhizobium if necessary. Top dressing in winter not normally required. Can be grown for 2-3 consecutive seasons before rotating with ryecorn, triticale or a brassica crop.
Faba Beans	Fiord Rossa™	130	20-35	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons, or if no inoculum previously used. Top dressing not normally required. Rossa beans have some resistance to Chocolate spot (*Botrytis fabae)* and Ascochyta (*Aschochyta fabae)*. Rotate with triticale, oats or brassica crops.
Brassicas	Weedcheck™ (Fodder Radish) Rangi (Fodder Rape) Nemfix™ (Oil Seed Mustard)	12-20 4 8	20 20 20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 NPKS 120 kg/ha	Fodder radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Soil surface should be rolled after seeding in early May to promote seed-soil contact. Top dressing is recommended for these swards in June. Rotate with legumes and cereals, suggested interval of 1-2 seasons between brassica crops.
ANNUAL REGENERATING SWARDS					**Suitable for use in irrigated vineyards only. Perennials may only be used if mid row area is irrigated.**
Medic	Paraggio Mogul (D) Parabinga Santiago Kelson™ Snail	15 15 15 12 20	10-15 10-15 10-15 10-15 20	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Inoculate with AM type Rhizobium. Seed in to a well prepared seed bed. Medics have moderate early vigour. Seed set/autumn regeneration can be affected by low mowing in spring, especially after the commencement of flowering. Kelson is very productive in late winter/early spring. Medic seed pods can be incorporated in autumn to stimulate germination. Can be sown in combination with perennial ryegrass.
Perennial Grasses	Victorian Ryegrass Matilda Ryegrass Demeter Fescue Currie Cocksfoot	25 25 30 10	10-15	18:20:0 NPK 100 kg/ha Top Dress with 18:20:0 100 kg/ha	Ryegrasses have greater summer dormancy and give better weed suppression, are faster to establish and have more winter vigour than fescue or cocksfoot. Fescue is better adapted to heavy soils than cocksfoot, which does well on light, infertile soils. These grasses have moderate tolerance to heat and drought stress, and can be blended to broaden adaptations.

15.13 COVER CROP OPTIONS FOR *THE SUNRAYSIA*

COVER CROP TYPE	RECOMMENDED CULTIVAR	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for dryland and irrigated vineyards.**
Ryecorn	Commercial Bevy™	70	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Sow in autumn, top dress in winter if necessary. Good winter weed suppression and moderate biomass production. Rotate with faba beans, oats or brassica cover crops. If left as a standing stubble, will provide good protection against wind and sand blast damage of young vines. Ryecorn is preferred to oats when seeding in winter. Triticale will produce the best straw for undervine mulch.
Triticale	Currency Tahara	140	20-30		
Oats	Coolabah Swan	80-100	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Top dress in winter with urea if deficiency symptoms are evident, or if vigour is lacking. Use in rotation with ryecorn, legumes or brassicas. Can be mixed with snail medic (ratio of 3:1) or vetch (ratio of 5:2) and sown at 70 kg/ha to produce a productive forage blend.
Barley	Cape Schooner	80	20-30	18:20:0 NPK 120 kg/ha Top Dress with Urea 120 kg/ha	Top dress in winter with urea if deficiency symptoms are evident, or if vigour is lacking. Use in rotation with ryecorn, oats, legumes or brassicas. Not as productive as oats. Non host for root knot nematodes.
Forage Blends	Biomax™	120	20-30	18:20:0 NPK 120 kg/ha minimum	Inoculate seed with E type Rhizobium if necessary. Top dressing in winter not normally required. Can be grown for 2-3 consecutive seasons in rotation with ryecorn, triticale or brassica crops..
Faba Beans	Fiord Rossa™	130	20-35	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with E type inoculum if no bean or pea crop has been grown in the previous 2 seasons or if no inoculum previously used. Top dressing not normally required. Rossa beans have some resistance to Chocolate Spot (*Botrytis fabae*) and Ascochyta (*Aschochyta fabae*). Rotate with cereals or brassicas.
Brassicas	Weedcheck™ (Fodder Radish)	12-20	20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 NPKS 120 kg/ha	Fodder radish is recommended for weed suppression and disturbance of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Soil surface should be rolled after seeding in early May to promote seed-soil contact. Top dressing is recommended for these swards in June. Rotate with legumes and cereals, suggested interval of 1-2 seasons between brassica crops.
	Rangi (Fodder Rape)	4	20		
	Nemfix™ (Oil Seed Mustard)	8	20		
ANNUAL REGENERATING SWARDS					**Suitable for use in irrigated vineyards only. Perennials may only be used if mid row area is irrigated.**
Medic	Paraggio	15	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Inoculate with type AM Rhizobium. Seed in to a well prepared seed bed. Medics have moderate early vigour. Seed set and autumn regeneration can be affected by low mowing in spring, especially after the commencement of flowering. Kelson is very productive in late winter/early spring. Medic seed pods can be incorporated in autumn to stimulate germination. Can be sown in combination with perennial ryegrass.
	Mogul (h)	15	10-15		
	Parabinga	15	10-15		
	Santiago	12	10-15		
	Kelson Snail	20	20		
Perennial Ryegrass	Victorian Matilda	25	10-15	18:20:0 NPK 100 kg/ha Top Dress with 18:20:0 100 kg/ha	These ryegrasses will mature and set seed in December if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides a moderate amount of biomass plus good weed suppression and traffic ability. Permanent swards can be used to dry out waterlogged areas.

COVER CROP OPTIONS FOR *THE CENTRAL VICTORIAN REGIONS*

COVER CROP TYPE	CULTIVARS	SEEDING RATE (KG/HA)	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
GREEN MANURES					**Suitable for dryland and drip irrigated vineyards.**
Ryecorn	Commercial Bevy	80	20-30	18:20:0 NPK 100 kg/ha minimum Top Dress with Urea 100 kg/ha	Sow in early May, earlier if the midrow is irrigated. Provides good winter weed suppression. Rotate with beans, oats or brassica cover crops. If left as a standing stubble, will provide good wind protection for young vines. Ryecorn is well adapted to light, sandy soils and low rainfall areas.
Triticale	Tahara Currency	140			
Oats	Coolabah Swan	100	20-30	18:20:0 NPK 120 kg/ha minimum Top Dress with Urea 100 kg/ha	Top dress all cereals in June if deficiency symptoms are evident, or if vigour is lacking. Use oats in rotation with triticale, legumes or brassicas. Can be mixed with Snail medic (ratio of 3:1) or vetch (ratio of 5:2) and sown at 70 kg/ha to provide good bulk. Oats are moderately tolerant of water logged soils.
Forage Blend	Biomax™	120	20-30	18:20:0 NPK 100 kg/ha minimum	Inoculate seed with **E** type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons or if no inoculum previously used. Top dressing in winter not normally required. Can be grown for 2-3 consecutive seasons in rotation with ryecorn, triticale or brassica crops. Seed in mid autumn after the break of season.
Faba Beans	Fiord Rossa™	150	40-50	Super 180 kg/ha or 18:20:0 NPK 120 kg/ha	Inoculate seed with **E** type Rhizobium if no bean or pea crop has been grown in the previous 2 seasons or if no inoculum previously used. Top dressing in winter not normally required. Rossa beans have some resistance to Chocolate spot (*Botrytis fabae*) and Ascochyta (*Aschochyta fabae*) Rotate with triticale, oats or brassicas.
Brassicas	Weedcheck™ (Fodder Radish) Nemfix™ (Oil Seed Mustard)	12-20 8	20 20	18:20:0 NPK 150 kg/ha Top Dress with 34:0:0:12 of NPKS 120 kg/ha	Fodder radish is suggested for weed suppression and disruption of hard pans. Use the lower seeding rate if large tap root development desired, or the higher rate for maximum weed suppression. Soil surface should be rolled after seeding in early May to promote seed-soil contact. Top dressing with Nitrogen based fertiliser is suggested for these swards in June. Rotate with legumes and cereals. Suggested interval of 2 seasons between brassica cover crops.
ANNUAL REGENERATING SWARDS					**Suitable for use in irrigated vineyards only.**
Medic	Paraggio Mogul (D) Santiago Kelson™	15 15 12-15 20-25	10-15 10-15 10-15 20	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Medics are adapted to alkaline soils. Santiago can tolerate slightly acid soils. Inoculate with type **AM** Rhizobium. Seed in to a prepared seed bed. Medics have moderate early vigour. Seed set and autumn regeneration can be affected by low mowing in spring, especially after the commencement of flowering. Kelson is very productive in late winter/early spring. Medic seed pods can be incorporated in autumn to stimulate germination. Can be sown in combination with perennial ryegrass such as **Victorian** or **Matilda** (only if irrigation of the midrow over summer is possible, or if annual rainfall is above 550 mm).
Sub clover	Gosse (D) York (D) Clare Junee	15 15 18 12	10-15	18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Adapted to acid soils. Inoculate with type **C** inoculum. York and Junee are early-mid maturity subs. Gosse is tolerant of water logged soils. Clare has good early vigour and is tolerant of alkaline soils. Sub clovers are generally sown in a blend with ryegrasses (as above), in which case the total rate of clover should not exceed 15 kg/ha.

15.15 COVER CROP OPTIONS FOR *THE YARRA VALLEY*

COVER CROP TYPE	RECOMMENDED CULTIVARS	SEEDING RATE KG/HA	SEEDING DEPTH (MM)	SUGGESTED FERTILISER	MANAGEMENT AND APPLICATION
ANNUAL REGENERATING SWARDS					
Sub Clovers	Gosse (1) Denmark (1)	15 15	10-15 10-15	At Seeding 18:20:0 NPK 100 kg/ha Top Dress annually with Goldphos 20 100 kg/ha	Sow in to a prepared seed bed after the break of season. Apply type C inoculum. Usually sown in a blend with grasses, in which case the total rate of sub clover should not exceed 10 kg/ha. Gosse will tolerate soil pH 5.0-6.5, and water logging. Denmark is a more prostrate sub clover with good persistence in higher rainfall regions. Sub clovers are very tolerant of close mowing in spring, and will set seed in late November. Sub clovers leave a dense plant residue capable of suppressing summer weeds.
Perennial Ryegrass	Victorian Matilda	25-30	10-15	At Seeding 18:20:0 NPK 100 kg/ha Top Dress with 18:20:0 100 kg/ha	These ryegrasses will mature and set seed in late November if not mowed after mid October. After seed set, sward can be mowed and spray topped if necessary to reduce water use. Provides a moderate amount of biomass plus good weed suppression and trafficability.
PERENNIAL SWARDS					
Perennial Grasses	Ellet Ryegrass Vedette (1) Ryegrass Demeter Fescue Tribute Fescue Triumph Fescue Porto Cocksfoot	30 30 30 30 30 10	10-15	At Seeding 18:20:0 NPK 100 kg/ha Top Dress with 18:20:0 100 kg/ha	The New Zealand type ryegrasses are less summer dormant than Victorian and Matilda, and generally require a higher rainfall (>700mm) to persist. Fescues provide greater tolerance to drought conditions than ryegrass, and are relatively summer active, providing year round trafficability. Cocksfoot, like fescue, is a deep rooted grass, best used in a blend with ryegrass. This species can form large crowns if plant density is low. Fescues are best adapted to heavy clay soil types, whilst cocksfoots are the preferred option for lighter, less fertile soils. Some turf type ryegrasses, such as Cutter and Derby Supreme, are more prostrate in growth habit than forage type ryegrasses, and require less frequent mowing. These ryegrasses can be used in combination with the shorter fescues, such as Triumph, or creeping red fescues, such as Cindy, to provide low growing, summer active perennial swards. Annual topdressing is recommended for these swards. Sow in combination with a companion crop such as cereal rye (20kg/ha) where erosion is a concern.
Chicory	Puna (1)	4-5	10	18:20:0 NPK 120 kg/ha Top Dress with 18:20:0 100 kg/ha	Perennial herb with strong growth in autumn and spring. Minimum rainfall required is 600mm. Establishment is best attempted in spring in frost prone districts. Establishment is aided by rolling the soil both before and after seeding. Adapted to a range of soil types, from sandy loams to heavy clays, pH levels 5.5-8. Requires a well drained soil of good fertility. Very deep rooted, with application to reduce excess vine vigour. Keep the sward mowed to a height of 5-10 cm to maintain plant densities.

Genus / Species	Variety	Sown in Green Manure (G) or Permanent Sod (P) or Both (B)	Sowing Rate (kg/ha)
Medicago scutellata	Sava	P	40
	Kelson	B	40
Medicago truncatula	Mogul	P	40
	Parabinga	P	40
	Paraggio	P	40
	Caliph	P	40
	Salernes	B	40
	Carpet	P	Not sown
Medicago littoralis	Harbinger AR	P	40
Medicago rugosa	Paraponto	B	40
Medicago tornata	Rivoli	P	40
	Sapo	P	40
Medicago polymorpha	Polygraze	P	Not sown
	Santiago	P	40
	Maugio	B	40
Medicago rigidula	Meteora	B	40
	Ampus	B	40
Medicago aculleata	Manesty	P	Not sown
Medicago murex	Zodiac	P	40
Medicago rotata	Highlander	B	Not sown
Trifolium subterraneum	Leura	P	13.5
	Dalkeith	P	13.5
	Clare	P	13.5
	Denmark	P	13.5
	Goulburn	P	13.5
	Woogenellup	P	13.5
	Trikkala	P	13.5
	Esperance	P	13.5
	Gosse	B	13.5
	Geraldton	P	13.5
	Junee	P	13.5
	Enfield	P	13.5
	Nuba	P	13.5
	Nungarin	P	13.5
	Rosedale	P	13.5
	Seaton Park	P	13.5
Trifolium resupinatum	Maral	B	7
	Kyambro	B	7
	Laser	B	7
	Leeton	B	7
Trifolium fragiferum	Salinas	P	Not sown
	Palestine	B	7
	O'Connors	B	7
Trifolium repens	Grasslands Huia	P	7
	Waverley	B	7
	Tamar	B	7
	Grasslands Tahora	B	30
	Grasslands Kopu	P	7
	Haifa	P	7
	Irrigation White	P	7
Trifolium hirtum	Hykon	P	20
Trifolium pratense	Redquin	P	7
Trifolium michaelaniume	Balansa	B	7
Trifolium vesiculosum	Arrowleaf	G	30
Trifolium alexandrium	Attila	G	30
	Multicut	G	30
	Bigbee	G	30

Genus / Species	Variety	Sown in Green Manure (G) or Permanent Sod (P) or Both (B)	Sowing Rate (kg/ha)
Avena sativa	Echidna	G	60
	Mortlock	G	60
	Coolabah	G	60
	Bulban	G	60
Vicia faba	Icarus	G	125
	Fiord	G	125
	Ascot	G	125
Dactylis glomerata	Porto	P	6.5
	Currie	P	6.5
	Grassland Wana	P	6.5
	Cajun	P	13.5
Festuca arundinacea	Tribute	P	13.5
	Demeter	P	13.5
	Thoroughbred	P	13.5
Phalaris aquatica	Australian	P	7
	Holdfast	P	7
	Sirolan	P	7
	Sirosa	P	7
Vicia dasycarpa	Namoi	G	20
Vicia benghalensis	Popany	G	20
Vicia sativa	Languedoc	G	20
	Blanchefleur	G	20
	Topcut	G	30
P sativum	Glenroy	G	125
P sativum	Alma	G	125
	Dundale	G	125
	Laura	G	Not sown
Brassica nigra	Claret	G	7
	Ruby	G	7
	Topas	G	7
	Ebony	G	7
Mixtures	Echidna/Topcut	G	2:1 (60)
	Echidna/Balansa	G	Not sown
	Echidna/Icarus	G	1:3 (65)
	Echidna/Serradella	G	1:1 (50)
	Echidna/Glenroy	G	1: (65)
	Echidna/Mustard	G	Not sown
	Echidna/Adagio	G	Not sown
	Glenroy/Kelson	G	Not sown
	Holdfast/Haifa	P	2:1 (7)
	Holdfast/O'Connor	P	2:1 (7)
	Holdfast/Gosse	P	2:1 (7)
	Demeter/O'Connor	P	2:1 (13.5)
	Demeter/Gosse	P	2:1 (13.5)
	Demeter/Kyambro	P	2:1 (13.5)
	Currie/Haifa	P	2:1 (6.5)
	Currie/Gosse	P	2:1 (6.5)
	Attila/Tama	P	20:15
	Attila/Tetila Rye	P	20:15
Lolium perenne	Victorian	P	13.5
	Embassy	P	13.5
	Ellet	P	13.5
Lolium perenne	Grasslands Nui	P	13.5
	Skippy	P	13.5
	Matilda	P	13.5
	Yatsyn	P	13.5

Genus / Species	Variety	Sown in Green Manure (G) or Permanent Sod (P) or Both (B)	Sowing Rate (kg/ha)
Fodder Crops	Coriander	G	30
	Adagio Radish	G	20
	Ultimo Radish	G	20
	Yellow Serradella	G	30
	Rangi Rape	G	7
	Lotus	G	10
	Sulla	G	20
Ehrharta calycina	Veldt grass	P	12
Lolium multiflorum	Aristocrat	Not sown	
	Tetila	P	30
Thinopyrum elongatum	Tyrell Tall Wheat grass	G	10
	Cereal Rye	G	100

PLOT	Var. No.			Plant Height	Flowering	% Weeds	Stand Vigour	Plant Numbers			Fresh Weights		
								No 1	No 2	No 3	No 1	No 2	No 3
1	4	Bulban	OAT	3	2	50	8	8	6	2	54.8	93.69	26.67
2	60	Claret-mustard	MUSTARD	3	2.5	80	3	2	6	3	22.7	18.43	21.95
3	3	Coolabah	OAT	3	2.3	20	8	8	9	8	118.06	155.28	127.29
4	9	Topcut	VETCH	3	2.3	20	10	2	9	4	76.2	121.18	148.99
5	51	OAT / Balansa	MIXTURE	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
6	55	OAT / Rangi	MIXTURE	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
7	57	OAT / Radish	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
8	33	Arrowleaf	CLOVER	1	1	80	1	12	9	1	14.52	13.87	8.48
9	40	Palestine	CLOVER	1	2	50	5	8	16	11	19.43	12.35	18.65
10	36	Bigbee	CLOVER	1	1	30	8	9	5	20	12.35	11.87	16.11
11	59	CONTROL	CONTROL	1	1	100	0	0	0	0	25.98	64.05	63.04
12	52	OAT / Icarus	MIXTURE	3	2.5	80	5	5	3	0	43.17	37.5	14.16
13	26	Coriander	FODDER CROP	2	2.2	80	1	2	6	5	8.34	12.07	5.63
14	30	Hull Serradella	FODDER CROP	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
15	11	Kelson	MEDIC	2	2.1	20	8	2	2	2	11.72	17.08	31.25
16	37	Maral	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
17	9	Topcut	VETCH	3	2.5	0	10	5	4	3	172.51	134.2	89.46
18	50	OAT / Topcut	MIXTURE	3	2.5	0	10	5	3	1	145.25	230.76	71.62
19	31	Kyambro	CLOVER	1	1	95	1	0	3	0	10.94	18.05	11.83
20	46	Stem Her Persian clover	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
21	24	Yellow Serradella	FODDER CROP	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
22	12	Paraponto	MEDIC	1	1	95	1	2	0	1	10.46	11.94	8.87
23	5	Namoi	VETCH	2	2.5	0	8	2	1	2	78.05	36.73	60.51
24	29	Lotus	FODDER CROP	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
25	10	Highlander	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
26	60	Claret-mustard	MUSTARD	4	2.5	95	2	1	0	1	23.68	24.28	22.6
27	42	Tamar	CLOVER	2	1	30	8	20	11	5	26.24	27.56	19.8
28	8	Blanchefleur	VETCH	2	2.5	50	7	3	3	1	35.43	52.42	34.86
29	5	Namoi	VETCH	2	2.5	10	7	2	2	1	27.29	47.18	14.8
30	13	Ampus	MEDIC	1	1	50	7	6	7	2	17.96	15.93	13.88
31	16	Meteora	MEDIC	1	1	80	2	3	7	5	7.61	20.57	13.84

32	17	Glenroy	PEA	3	2.5	80	6	0	1	1	14.73	44.66	38.81
33	53	OAT / Serradella	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
34	25	Rangi Rape	FODDER CROP	2	1	30	5	9	5	7	28.94	13.72	18.12
35	2	Mortlock	OAT	2	2.5	10	10	5	6	3	49.86	81.36	27.16
36	36	Bigbee	CLOVER	2	1	30	5	17	21	5	14.26	21.88	7.28
37	20	Laura	PEA	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
38	20	Laura	PEA	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
39	45	Gosse	CLOVER	1	1	50	6	3	0	1	40.40	25.55	8.2
40	27	Fodder Radish	FODDER CROP	3	2.5	80	5	2	1	7	25.6	9.97	51.57
41	30	Hull Serradella	FODDER CROP	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
42	47	Cereal Rye	GRASS	3	2.5	0	10	10	8	7	40.99	41.38	28.78
43	16	Meteora	MEDIC	1	2	90	2	7	4	3	13.4	6.18	10.21
44	33	Arrowleaf	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
45	2	Mortlock	OAT	3	2.5	0	10	5	4	4	114.32	37.68	62.92
46	60	Claret-mustard	MUSTARD	3	2.5	95	1	0	1	2	9.68	8.09	32.84
47	54	OAT / Glenroy	MIXTURE	3	2.5	5	10	5	4	3	35.59	25.01	29.26
48	17	Glenroy	PEA	3	2.5	0	10	3	1	1	148.9	83.92	35.12
49	14	Mauguio	MEDIC	1	1	80	1	9	5	5	9.02	5.39	15.85
50	39	Laser	CLOVER	2	2	5	10	9	7	5	20.03	19.28	26.44
51	22	Fiord	FABA BEAN	2	2.5	95	2	0	1	0	7.27	46.59	12.91
52	26	Coriander	FODDER CROP	2	2	80	3	11	3	6	16.68	9.84	12.04
53	11	Kelson	MEDIC	2	2.2	20	6	2	9	4	13.7	53.56	24.14
54	48	Tyrell Tall wheat	GRASS	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
55	63	Ebony-mustard	MUSTARD	4	2.5	20	10	7	5	4	32.8	57.72	33.12
56	56	OAT Mustard	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
57	38	Leeton	CLOVER	2	1	0	10	3	7	5	22.58	47.74	56.99
58	57	OAT / Radish	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
59	49	Pauite Cocksfoot	GRASS	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
60	42	Tamar	CLOVER	1	1	90	1	6	6	4	6.64	6.45	10.9
61	38	Leeton	CLOVER	2	2	0	10	9	7	10	22.32	25.78	60.11
62	14	Mauguio	MEDIC	1	3.4	0	10	10	10	10	123.71	77.1	75.82
63	45	Gosse	CLOVER	1	1	30	10	5	5	1	132.03	120.73	35.37
64	43	Tahora	CLOVER	1	1	50	3	8	8	20	7.83	12.5	9.9
65	23	Ascot	FABA BEAN	2	3.6	20	8	3	1	1	114.97	176.72	55.47
66	46	Stem Her Persian clover	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

102	51	OAT / Balansa	MIXTURE	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
103	61	Ruby-mustard	MUSTARD	4	3.8	80	5	2	5	8	24.47	12.65	39.69
104	55	OAT / Rangi	MIXTURE	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
105	62	Topas-mustard	MUSTARD	4	4	80	5	4	3	4	28.71	17.68	20.87
106	8	Blanchefleur	VETCH	2	3.9	20	8	1	3	4	63.54	68.85	99.12
107	1	Echidna	OAT	2	4	20	2	8	6	6	29.12	27.49	8.61
108	61	Ruby-mustard	MUSTARD	4	2.5	40	1	4	6	6	7.95	8.78	9.83
109	37	Maral	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
110	12	Paraponto	MEDIC	1	4	70	3	4	1	5	14.64	10.35	16.38
111	54	OAT / Glenroy	MIXTURE	2	2.5	-2	4	6	12	1	32.03	38.91	32.73
112	39	Laser	CLOVER	1	1	30	8	8	2	10	56.63	55.96	8.82
113	40	Palestine	CLOVER	1	1	30	6	2	7	5	14.12	22.85	23.17
114	3	Coolabah	OAT	2	2.5	10	8	5	5	4	33.61	38.37	68.51
115	14	Mauguio	MEDIC	1	3.9	0	10	4	5	5	20.98	52.73	157.42
116	13	Ampus	MEDIC	1	3.3	60	2	6	0	0	14.11	23.74	19.83
117	57	OAT / Radish	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
118	45	Gosse	CLOVER	1	1	30	5	4	2	2	45.24	44.88	36.01
119	21	Icarus	FABA BEAN	2	2.5	95	1	0	0	0	0	0	0
120	59	CONTROL	CONTROL	1	1	100	0	0	0	0	10.85	13.03	19.09
121	34	Attila	CLOVER	1	1	50	3	2	7	7	14.07	10.42	21.53
122	24	Yellow Serradella	FODDER CROP	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
123	15	Salernes	MEDIC	1	3.3	50	4	12	4	7	31.76	10.19	8.18
124	6	Popany	VETCH	2	2.3	30	5	1	1	1	23.99	22.88	17.72
125	37	Maral	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
126	63	Ebony-mustard	MUSTARD	4	3.1	50	4	3	3	8	19.92	28.57	46.44
127	31	Kyambro	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
128	7	Languedoc	VETCH	2	3.8	50	4	4	2	3	67.36	16.53	40.28
129	17	Glenroy	PEA	2	3.1	70	7	1	0	2	27.39	6.56	45.21
130	11	Kelson	MEDIC	1	1	80	1	3	2	3	10.5	14.63	8.38
131	35	Multicut	CLOVER	1	1	80	2	5	7	3	11.3	16.71	12.63
132	47	Cereal Rye	GRASS	4	2.5	10	7	3	5	3	51.31	19.19	25.07
133	46	Stem Her Persian clover	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
134	7	Languedoc	VETCH	2	4	80	3	0	1	2	8.72	7.51	43.29
135	41	O'Connor	CLOVER	1	1	90	4	7	5	3	10.18	16.36	18.53
136	4	Bulban	OAT	3	2.5	0	10	3	4	3	86.66	77.96	46.84

137	18	Alma	PEA	2	3.2	90	4	2	2	2	33.13	54.43	34.75
138	24	Yellow Serradella	FODDER CROP	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
139	35	Multicut	CLOVER	2	1	30	6	4	7	8	19.54	29.58	14.4
140	56	OAT Mustard	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
141	20	Laura	PEA	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
142	28	Fodder Mustard	FODDER CROP	3	3.2	80	2	6	2	0	36.42	13.69	9.69
143	9	Topcut	VETCH	2	2.4	90	6	3	0	0	41.81	14.69	10.84
144	35	Multicut	CLOVER	1	1	20	1	13	2	5	8.6	7.54	13.58
145	23	Ascot	FABA BEAN	3	3.8	40	5	1	0	2	74.43	6.3	62.48
146	31	Kyambro	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
147	48	Tyrell Tall wheat	GRASS	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
148	4	Bulban	OAT	3	1	10	5	5	9	3	18.73	23.41	8.82
149	5	Namoi	VETCH	2	2.5	0	10	2	3	3	99.62	76.09	143.24
150	7	Languedoc	VETCH	3	4	10	8	2	2	1	157.99	107.11	75.07
151	36	Bigbee	CLOVER	2	1	30	4	24	4	14	39.36	16.1	21.29
152	22	Fiord	FABA BEAN	2	3.5	80	3	1	1	0	15.54	42.49	8.57
153	47	Cereal Rye	GRASS	4	4	10	7	8	5	6	21.9	13.79	21.63
154	15	Salernes	MEDIC	1	3.5	20	4	6	6	5	16.19	16.69	23.96
155	26	Coriander	FODDER CROP	2	2	70	1	3	3	3	8.96	8.63	11.33
156	53	OAT / Serradella	MIXTURE	2	3.1	50	3	4	1	4	18.56	34.22	25.12
157	21	Icarus	FABA BEAN	2	3.1	50	5	1	0	1	101.11	8.04	82.06
158	25	Rangi Rape	FODDER CROP	1	1	80	1	5	9	18	10.69	21.26	28.63
159	29	Lotus	FODDER CROP	2	1	30	5	12	3	5	24.27	20.18	12.06
160	19	Dundale	PEA	2	3.8	80	2	0	2	1	30.93	59.64	21.88
161	15	Salernes	MEDIC	1	3.6	10	5	9	2	4	43.74	9.03	27.37
162	21	Icarus	FABA BEAN	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
163	6	Popany	VETCH	2	3.8	-2	8	1	1	0	46.59	61.58	15.67
164	40	Palestine	CLOVER	1	1	60	5	4	6	6	6.84	13.33	13.22
165	44	Waverley	CLOVER	1	1	60	5	3	2	6	6.95	11.31	10.66
166	49	Pauite Cocksfoot	GRASS	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
167	59	CONTROL	CONTROL	0	1	100	0	0	0	0	9.91	16.47	7.72
168	55	OAT / Rangi	MIXTURE	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
169	51	OAT / Balansa	MIXTURE	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
170	44	Waverley	CLOVER	1	1	30	6	11	4	4	14.93	9.6	25.15
171	62	Topas-mustard	MUSTARD	4	4	70	3	1	4	4	21.79	8.93	12.26

172	10	Highlander	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
173	52	OAT / Icarus	MIXTURE	2	3.5	70	4	13	0	7	70.67	25.3	11.84	
174	27	Fodder Radish	FODDER CROP	3	3.7	60	4	6	7	3		40.26	16.48	
175	18	Alma	PEA	3	3.6	50	7	2	0	0	32.51	4.37	4.59	
176	44	Waverley	CLOVER	1	1	80	3	N/A	N/A	N/A	N/A	N/A	N/A	
177	27	Fodder Radish	FODDER CROP	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	
178	52	OAT / Icarus	MIXTURE	2	3.5	30	6	4	5	3	52.2	95.62	90.89	
179	34	Attila	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
180	2	Mortlock	OAT	2	4	0	7	10	6	7	15.83	16.31	17.41	
181	54	OAT / Glenroy	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	
182	38	Leeton	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	
183	63	Ebony-mustard	MUSTARD	4	3.2	60	2	6	7	0	36.21	41.27	24.82	
184	50	OAT / Topcut	MIXTURE	3	2.5	5	7	5	6	4	56.15	109.58	106.43	
185	12	Paraponto	MEDIC	2	3.9	80	3	0	3	1	3.22	11.34	8.89	
186	43	Tahora	CLOVER	1	1	60	1	3	2	7	5.49	5.76	7.9	
187	48	Tyrell Tall wheat	GRASS	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	
188	61	Ruby-mustard	MUSTARD	4	4	40	4	5	4	8	19.07	12.74	11.41	
189	19	Dundale	PEA	3	3.2	80	7	0	2	1	9.61	117.34	9.48	

PLOT	Var. No			Plant Height	Flowering	% Weeds	% Ground Coverage	% Bare Ground	Stand Vigour	Plant Numbers			Fresh Weight		
										No 1	No 2	No 3	No 1	No 2	No 3
1	51	Sirolan	PHALARIS	2	1	10	90	0	2	15	12	4	8.04	7.46	21.55
2	49	Australian	PHALARIS	2	1	30	70	0	1	10	0	7	12.15	2.89	3.43
3	57	Fescue/SUB	MIXTURE	1	4	90	10	0	1	1	0	3	14.01	2.59	4.99
4	73	Grasland Hui	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
5	7	Paraggio	MEDIC	1	4.5	30	70	0	8	5	2	3	16.86	8.12	11.61
6	41	Victorian	PERENNIAL RYEGRASS	1	2	10	90	0	5	6	7	5	9.35	16.29	8.51
7	61	Porto cocksfoot	COCKSFOOT	2	1	20	*	*	4	6	4	3	14.67	9.76	8.87
8	55	Holdfast/SUB	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
9	23	Clare	SUBCLOVER	1	4.5	20	*	*	7	2	2	2	15.08	17.66	23.05
10	65	Pauite	COCKSFOOT	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
11	62	Currie cocksfoot	COCKSFOOT	1	2	30	*	*	3	2	4	7	11.87	5.45	11.35
12	44	Grasslands Nui	PERENNIAL RYEGRASS	1	3.2	10	*	*	4	4	6	6	7.55	7.61	8.23
13	67	Demeter	FESCUES	1	1	20	*	*	2	6	6	4	9.38	9.53	9.39
14	72	O'Connor	CLOVER	1	1	40	*	*	4	5	2	2	22.7	9.96	13.9
15	38	Tetila	ITALIAN RYEGRASS	4	3.5	10	*	*	7	3	2	4	30.99	12.29	34.23
16	36	Seaton Park	SUBCLOVER	1	4.5	0	90	10	8	1	1	1	15.17	18.67	22.31
17	72	O'Connor	CLOVER	1	1	40	*	*	3	1	0	1	12.07	12.29	9.33
18	23	Clare	SUBCLOVER	1	4.5	20	*	*	7	2	1	2	14.08	10.73	20.09
19	64	Cajun	COCKSFOOT	1	1	40	40	20	2	4	8	1	14.83	17.04	12.39
20	73	Grasslands Huia	CLOVER	1	2	30	40	30	3	4	3	3	22.67	17.43	14.71
21	15	Mauguio	MEDIC	1	4.8	20	80	0	9	5	4	4	30.3	34.66	21.8
22	16	Salernes	MEDIC	1	4.2	10	80	10	6	4	3	2	32.13	39.82	14.41
23	15	Mauguio	MEDIC	1	4.8	20	80	0	9	7	4	7	25.79	28.49	29
24	60	Currie/SUB CLOVER	MIXTURE	1	1	30	50	20	2	8	3	2	22.31	11.38	29.63
25	6	Caliph	MEDIC	2	4.5	10	80	10	9	3	3	2	25.45	22.59	42.18
26	30	Geraldton	SUBCLOVER	1	5	10	80	10	9	5	4	5	32.45	27.95	28.67
27	76	Tahora	CLOVER	1	2	30	30	40	2	5	8	6	26.22	16.47	23.13
28	65	Pauite	COCKSFOOT	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
29	34	Nungarin	SUBCLOVER	1	5	40	30	30	2	1	0	3	18.31	26.34	23.67

30	53	Holdfast/Haifa	MIXTURE	1	1	50	20	30	1	4	1	1	26.41	19.05	24.81
31	10	Rivoli	MEDIC	1	3.2	40	40	20	6	4	1	3	30.34	28.03	12.17
32	18	Sapo	MEDIC	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
33	21	Leura	SUBCLOVER	2	2	0	100	0	8	7	7	1	163.04	133.25	114.42
34	6	Caliph	MEDIC	1	4.5	10	80	10	7	5	4	2	36.76	37.68	31.26
35	58	Fescue/Kyambro	MIXTURE	2	2	20	50	30	5	5	7	6	19.61	26.5	10.77
36	61	Porto cocksfoot	COCKSFOOT	2	1	10	40	50	4	9	7	6	21.09	16.7	17.23
37	83	Anatole-persian	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
38	72	O'Connor	CLOVER	1	1	20	60	20	6	5	4	5	39.61	40.92	32.1
39	12	Polygraze	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
40	18	Sapo	MEDIC	1	5	70	20	10	4	4	2	2	19.92	15.97	14.16
41	60	Currie/SUB CLOVER	MIXTURE	1	1	30	40	30	5	3	4	3	24.54	17.28	10.39
42	23	Clare	SUBCLOVER	1	4.5	5	90	5	9	3	2	1	42.73	38.95	31
43	37	Tama	ITALIAN RYEGRASS	4	2	10	70	20	8	10	7	1	21.84	19.92	30.54
44	77	Grasslands Kopu	CLOVER	1	1	80	10	10	2	2	3	3	41.88	27.52	45.99
45	57	Fescue/SUB	MIXTURE	1	1	30	50	20	3	2	7	5	18.02	37.37	80.83
46	64	Cajun	COCKSFOOT	1	1	50	20	30	2	4	7	5	23.43	19.68	25.38
47	66	Tribute	FESCUES	1	1	10	50	40	3	5	5	6	13.76	15.14	34
48	69	Maral	CLOVER	3	2	80	10	10	8	1	1	0	20.88	36.79	15.68
49	63	Grasslands Wana	COCKSFOOT	1	1	40	40	20	2	5	4	7	20.56	18.63	12.4
50	58	Fescue /Kyambro	MIXTURE	1	1	30	40	30	2	2	6	4	13.16	16.64	24.05
51	86	Laser	CLOVER	3	2	80	10	10	9	2	3	2	58.3	52	28.37
52	20	Carpet	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
53	52	Sirosa	PHALARIS	2	1	70	20	10	2	3	7	4	25.25	15.85	23.08
54	20	Carpet	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
55	77	Grasslands Kopu	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
56	44	Grasslands Nui	PERENNIAL RYEGRASS	1	3.5	10	60	30	2	6	9	7	34.06	18.24	18.41
57	40	Tetila/Persian	ITALIAN RYEGRASS	4	2	10	70	20	7	9	6	7	24.48	28.85	23.12
58	58	Fescue/Kyambro	MIXTURE	1	1	20	40	40	4	5	7	2	11.9	31.14	13.09
59	71	Palestine	CLOVER	1	2	10	70	20	7	6	3	4	27.84	18.68	24.04
60	76	Tahora	CLOVER	1	2	20	70	10	5	6	7	8	10.36	13.41	21.54
61	4	Harbinger AR	MEDIC	2	3.9	10	80	10	8	4	3	3	36.55	41.88	45.93

62	86	Laser	CLOVER	2	2	60	30	10	3	1	6	3	18.26	19.89	116.2
63	17	Manesty	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
64	7	Paraggio	MEDIC	1	4.5	40	40	20	5	2	3	0	16.23	24.28	29.99
65	59	Currie/ White clover	MIXTURE	1	1	70	10	20	1	1	3	2	19.16	22.34	28.72
66	25	Goulburn	SUBCLOVER	1	3.9	30	60	10	5	2	2	3	44.68	50.51	28.32
67	69	Maral	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
68	65	Pauite	COCKSFOOT	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
69	74	Waverley	CLOVER	1	2	20	80	0	5	4	6	6	21.33	25.66	54.04
70	31	Junee	SUBCLOVER	1	4	0	100	0	8	3	3	4	45.13	73.58	52.45
71	84	Balansa	CLOVER	1	5	10	90	0	8	4	3	3	24.46	25.61	25.96
72	79	Haifa	CLOVER	1	2	20	50	30	4	4	4	7	20.25	14.16	54.56
73	3	Mogul	MEDIC	1	4.8	5	90	5	7	3	2	2	40.55	38.04	67.84
74	1	Paraponto	MEDIC	1	5	90	5	5	1	1	0	0	22.76	13.71	12.91
75	43	Ellet	PERENNIAL RYEGRASS	1	2	20	50	30	7	7	5	5	19.7	21	17.79
76	39	Tama/Persian	ITALIAN RYEGRASS	4	2	10	70	20	6	7	7	7	26.06	29.92	30.13
77	84	Balansa	CLOVER	1	5	20	80	0	8	2	*	2	17.38	18	15.97
78	44	Grasslands Nui	PERENNIAL RYEGRASS	3	2	20	60	20	6	4	2	4	24.32	22.44	23.92
79	20	Carpet	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
80	82	Kyambro	CLOVER	2	3.2	30	50	20	7	1	2	0	44.05	31.53	12.73
81	38	Tetila	ITALIAN RYEGRASS	4	3.5	0	70	30	8	3	4	5	43.15	8.93	26.42
82	61	Porto cocksfoot	COCKSFOOT	2	2	15	60	25	6	6	4	5	18.78	21.35	13.9
83	49	Australian	PHALARIS	2	1	30	60	10	2	4	4	5	20.68	12.48	19.33
84	70	Salina	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
85	33	Nuba	SUBCLOVER	1	4.1	0	100	0	7	3	1	4	52.77	64	60.22
86	67	Demeter	FESCUES	1	1	20	50	30	2	7	4	5	15.03	16.92	9.79
87	67	Demeter	FESCUES	1	1	20	50	30	2	2	2	3	10.86	24.59	16.48
88	45	Skippy	PERENNIAL RYEGRASS	4	4	20	60	20	7	5	5	4	22.21	14.84	19.83
89	1	Paraponto	MEDIC	1	5	90	5	5	1	0	1	1	18.15	28.32	20.08
90	30	Geraldton	SUBCLOVER	1	5	80	10	10	7	2	0	1	28.14	16.76	19.76
91	47	Yatsyn	PERENNIAL RYEGRASS	3	3.5	20	70	10	6	5	6	4	33.37	32.97	37.18

92	48	Veldt grass	PERENNIAL RYEGRASS	-2	-2	-2	-2	-2	-2	-2		-2	-2	-2	-2	
93	73	Grasslands Huia	CLOVER	1	2	20	60	20	4	3	3	4	15.59	24.1	17.75	
94	46	Matilda	PERENNIAL RYEGRASS	3	4	10	60	30	7	5	5	4	24.47	23.25	19.91	
95	40	Tetila/Persian	ITALIAN RYEGRASS	4	2	20	70	10	5	5	5	5	37.29	32.58	32.93	
96	51	Sirolan	PHALARIS	2	1	30	40	30	4	3	2	3	31.64	17.71	33.25	
97	32	Enfield	SUBCLOVER	1	5	10	90	0	8	4	2	3	41.31	36.21	33.56	
98	5	Highlander	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
99	13	Ampus	MEDIC	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	
100	6	Caliph	MEDIC	1	4.2	80	10	10	5	1	5	1	32.84	24.98	45.97	
101	2	Kelson	MEDIC	2	4.2	30	30	40	4	1	1	1	38.94	19.19	23.2	
102	10	Rivoli	MEDIC	1	4.5	30	50	20	8	2	3	3	24.74	23.03	26.4	
103	24	Denmark	SUBCLOVER	1	4	0	100	0	9	3	2	3	39.52	63.13	41.88	
104	78	Hykon	CLOVER	2	4	50	30	20	8	0	4	3	9.76	31.86	45.33	
105	66	Tribute	FESCUES	1	1	30	40	30	2	4	2	3	15.39	5.63	12.82	
106	14	Meteora	MEDIC	1	2	40	20	40	1	0	1	0	13.69	28.21	23.13	
107	32	Enfield	SUBCLOVER	1	5	10	80	10	7	4	2	3	24.83	19.56	30.31	
108	59	Currie/ White clover	MIXTURE	1	2	30	50	20	6	1	2	5	24.36	16.14	19.71	
109	85	Leeton	CLOVER	3	3	10	80	10	8	4	4	3	56.77	58.51	48.86	
110	59	Currie/ White clover	MIXTURE	1	1	10	60	30	6	5	4	5	15.76	17.76	17.22	
111	34	Nungarin	SUBCLOVER	1	5	50	30	20	6	2	0	3	23.84	11.54	32.36	
112	43	Ellet	PERENNIAL RYEGRASS	3	4.1	10	50	40	7	2	3	4	28.79	13.68	12.58	
113	71	Palestine	CLOVER	1	2	20	70	10	3	5	7	4	14.27	10.54	17.65	
114	34	Nungarin	SUBCLOVER	1	4.5	40	40	20	2	5	4	0	26.85	24.48	17.62	
115	19	Zodiac	MEDIC	1	4.5	30	60	10	6	4	4	2	20.03	33.91	20.46	
116	4	Harbinger AR	MEDIC	2	4.5	0	100	0	9	3	6	2	26.83	45.63	28.49	
117	18	Sapo	MEDIC	1	5	70	20	10	7	3	1	0	33.22	6.79	2.66	
118	1	Paraponto	MEDIC	1	5	80	10	10	5	2	1	0	11.65	19.31	15.94	
119	15	Mauguio	MEDIC	1	5	0	100	0	9	6	6	5	45.08	39.81	54.01	
120	22	Dalkeith	SUBCLOVER	1	5	30	50	20	7	2	2	2	30.85	26.63	22.35	
121	52	Sirosa	PHALARIS	2	1	20	60	20	4	7	5	3	13.58	11.27	19.54	
122	35	Rosedale	SUBCLOVER	1	4	10	80	10	6	2	2	3	22.06	19.34	47.41	

123	36	Seaton Park	SUBCLOVER	1	4	10	80	10	8	2	2	2	66.6	29.44	45.61
124	69	Maral	CLOVER	3	3	40	40	20	7	4	1	0	92.52	22.38	24.09
125	9	Sava	MEDIC	2	4.5	10	80	10	7	2	4	2	76.81	45.08	36.27
126	56	Fescue/ Strawberry	MIXTURE	2	1	20	60	20	8	5	10	4	34.84	20.57	11.93
127	75	Tamar	CLOVER	1	2	20	70	10	7	2	0	4	31.9	13.69	57.63
128	50	Holdfast	PHALARIS	2	1	10	80	10	8	3	3	4	26.75	21.71	28.36
129	85	Leeton	CLOVER	3	2	50	40	10	8	0	4	1	13.74	104.9	37.71
130	12	Polygraze	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
131	35	Rosedale	SUBCLOVER	1	4.5	10	80	10	7	2	2	2	28.41	27.12	29.66
132	55	Holdfast/SUB	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
133	26	Woogenellup	SUBCLOVER	1	4	0	100	0	8	3	2	4	41.61	32.37	49.57
134	60	Currie/SUB CLOVER	MIXTURE	2	1	20	60	20	5	3	5	5	24.01	33.65	10.63
135	50	Holdfast	PHALARIS	2	2	20	70	10	5	4	4	2	19.29	16.08	25.48
136	46	Matilda	PERENNIAL RYEGRASS	3	4	10	60	30	6	2	4	3	16.88	20.3	16.85
137	45	Skippy	PERENNIAL RYEGRASS	3	4	10	60	30	6	7	3	4	15.78	18.89	21.51
138	40	Tetila/Persian	ITALIAN RYEGRASS	3	2	10	40	50	3	5	7	5	12.45	23.57	41.83
139	43	Ellet	PERENNIAL RYEGRASS	3	4	10	70	20	6	6	2	6	10.82	22.9	17.3
140	47	Yatsyn	PERENNIAL RYEGRASS	2	4	10	70	20	6	4	5	4	12.87	15.72	21.5
141	39	Tama/Persian	ITALIAN RYEGRASS	3	3	10	80	10	6	9	6	5	31.78	30.32	27.87
142	74	Waverley	CLOVER	2	3	10	80	10	7.5	2	2	3	41.48	66.05	112.57
143	70	Salina	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
144	25	Goulburn	SUBCLOVER	1	5	30	50	20	6	2	3	3	21.02	26.74	21.22
145	2	Kelson	MEDIC	1	4.5	80	20	0	4	1	2	2	63.38	11.48	24.28
146	31	Junee	SUBCLOVER	1	4	70	30	0	6	2	2	1	24.91	28.25	32.65
147	63	Grasslands Wana	COCKSFOOT	1	1	40	20	40	5	4	3	0	12.87	12.69	5.78
148	33	Nuba	SUBCLOVER	1	4	0	100	0	8	2	2	2	51.91	72.43	48.69
149	41	Victorian	PERENNIAL RYEGRASS	3	4	10	60	30	7	5	4	4	10.26	8.44	27.47
150	27	Trikkala	SUBCLOVER	1	4	30	40	30	5	4	2	1	27.92	19.87	12.47
151	48	Veldt grass	PERENNIAL RYEGRASS	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2

152	5	Highlander	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
153	42	Embassy	PERENNIAL RYEGRASS	2	4	10	70	20	7	6	4	5	14.77	36.37	17.53
154	27	Trikkala	SUBCLOVER	1	5	80	10	10	2	2	1	1	21.55	35.95	21.99
155	88	CONTROL	CONTROL	-2	-2	-2	-2	-2	-2	-2	-2	-2	12.14	19.58	9.87
156	55	Holdfast/SUB	MIXTURE	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
157	62	Currie cocksfoot	COCKSFOOT	1	2	40	40	20	6	1	3	0	13.51	13.17	17.64
158	31	Junee	SUBCLOVER	1	4.8	30	60	10	5	3	2	3	31.97	23.53	19.98
159	82	Kyambro	CLOVER	1	2	60	20	20	5	2	1	1	26.8	20.4	14.52
160	88	CONTROL	CONTROL	-2	-2	-2	-2	-2	-2	-2	-2	-2	11.09	17.8	14.27
161	78	Hykon	CLOVER	1	4	60	40	0	6	7	5	3	33.17	32.88	19.04
162	49	Australian	PHALARIS	1	1	80	10	10	1	4	1	7	19.7	16.9	15.43
163	28	Esperance	SUBCLOVER	1	4.5	10	90	0	7	2	4	2	57.8	18.87	14.21
164	5	Highlander	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
165	80	Irrigation	CLOVER	1	2	70	20	10	6	1	1	3	19.15	47.26	44.74
166	7	Paraggio	MEDIC	1	5	0	90	10	9	3	5	5	51.72	44.68	57.41
167	88	CONTROL	CONTROL	-2	-2	-2	-2	-2	-2	-2	-2	-2	14.66	9.66	6.05
168	11	Santiago	MEDIC	1	5	10	80	10	7	2	1	1	16.83	23.19	17.04
169	14	Meteora	MEDIC	1	2	70	10	10	2	0	2	2	18.85	26.95	47.2
170	57	Fescue/SUB	MIXTURE	2	1	10	90	0	5	4	5	3	28.4	62.71	63.38
171	26	Woogenellup	SUBCLOVER	2	4.2	0	100	0	8	1	1	1	105.54	88.54	75.65
172	24	Denmark	SUBCLOVER	1	4	10	90	10	7	5	5	6	69.69	49.68	90.18
173	86	Laser	CLOVER	2	2	10	80	10	8	5	3	1	54.36	41.26	46.45
174	28	Esperance	SUBCLOVER	1	5	10	90	10	6	2	3	3	26.48	31.35	34.15
175	66	Tribute	FESCUES	1	1	20	50	30	2	4	3	6	17.04	8.15	13.46
176	71	Palestine	CLOVER	1	1	30	60	10	7	2	4	4	22.56	91.09	32.86
177	45	Skippy	PERENNIAL RYEGRASS	2	4	10	60	30	6	5	5	5	24.08	19.63	17.36
178	41	Victorian	PERENNIAL RYEGRASS	2	4	10	60	30	7	4	8	6	6.85	17.32	23.45
179	3	Mogul	MEDIC	1	4.5	10	80	10	7	0	4	4	6.98	25.84	23.1
180	10	Rivoli	MEDIC	1	3.5	20	60	20	4	4	3	1	23.04	36.61	31.46
181	78	Hykon	CLOVER	1	4	10	60	30	7	3	6	5	17.13	27.8	55.03
182	29	Gosse	SUBCLOVER	1	4	20	70	10	6	2	2	3	19.27	29.51	37.74
183	29	Gosse	SUBCLOVER	1	4	20	70	10	6	3	3	2	37.26	51.09	18.34

184	46	Matilda	PERENNIAL RYEGRASS	3	4	10	60	30	5	5	4	4	16.68	15.49	13.69
185	12	Polygraze	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
186	3	Mogul	MEDIC	1	5	70	10	20	3	4	2	1	8.09	8.12	13.46
187	42	Embassy	PERENNIAL RYEGRASS	1	2	20	60	20	7	3	4	6	12.75	8.44	13.33
188	35	Rosedale	SUBCLOVER	1	4.5	10	90	0	7	2	1	2	46.63	44.23	49.58
189	54	Holdfast/ Strawberry	MIXTURE	2	1	20	60	20	5	5	4	3	48.41	15.92	31.04
190	11	Santiago	MEDIC	1	5	50	30	20	3	1	3	3	14.16	19	11.77
191	37	Tama	ITALIAN RYEGRASS	4	4	5	60	35	6	3	3	5	11.49	14.35	23.96
192	40	Tetila/Persian	ITALIAN RYEGRASS	3	2	10	60	30	2	4	4	3	24.59	20.87	20.67
193	16	Salernes	MEDIC	1	5	20	40	40	4	4	1	4	22.41	16.65	20.63
194	42	Embassy	PERENNIAL RYEGRASS	1	2	10	70	20	6	3	4	4	13.95	18.79	20.05
195	8	Parabinga	MEDIC	1	4.5	20	60	20	7	3	3	1	7.34	12.58	13.78
196	32	Enfield	SUBCLOVER	1	5	20	70	10	6	5	4	2	16.99	24	25
197	19	Zodiac	MEDIC	1	4.1	10	70	20	7	4	2	4	34.41	16.63	38.72
198	17	Manesty	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
199	81	Redquin	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
200	70	Salina	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
201	2	Kelson	MEDIC	2	4.3	50	20	30	5	4	1	0	70.77	26.14	20.65
202	24	Denmark	SUBCLOVER	1	3	20	80	0	6	1	2	2	49.61	19.88	49.49
203	14	Meteora	MEDIC	1	2	40	20	40	4	3	4	0	23.74	40.64	20.01
204	8	Parabinga	MEDIC	1	5	30	50	20	5	3	4	2	18.76	17.14	16.75
205	8	Parabinga	MEDIC	1	5	30	50	20	5	3	4	3	18.37	20.92	11.44
206	48	Veldt grass	PERENNIAL RYEGRASS	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
207	11	Santiago	MEDIC	1	5	20	70	10	7	2	5	3	26.09	23.42	29.74
208	4	Harbinger Ar	MEDIC	2	5	10	90	0	8	4	4	4	25.77	11.09	18.1
209	28	Esperance	SUBCLOVER	1	4.5	10	90	0	8	2	2	2	37.11	23.87	22.21
210	9	Sava	MEDIC	2	4.5	0	90	10	8	7	4	3	50.42	38.58	37.2
211	81	Redquin	CLOVER	2	1	60	40	0	8	2	1	1	32.59	38.89	21.01
212	80	Irrigation	CLOVER	1	1	40	60	0	4	2	3	*	26.75	22.72	15.19
213	56	Fescue/ Strawberry	MIXTURE	1	1	10	60	30	6	8	2	6	15.17	12.66	16.59

214	79	Haifa	CLOVER	1	2	20	70	10	4	3	4	5	26.71	32.47	29.95
215	87	Sulla Seed	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
216	75	Tamar	CLOVER	2	2	0	100	0	10	3	4	2	170.47	191.36	110.93
217	68	Thoroughbred	FESCUES	1	1	70	30	0	3	2	3	2	8.92	8.61	9.37
218	82	Kyambro	CLOVER	1	3	60	40	0	8	3	2	0	23.2	35.76	8.41
219	77	Grasslands Kopu	CLOVER	1	1	30	40	30	4	5	1	2	35.14	16.45	21.39
220	76	Tabora	CLOVER	1	2	30	60	10	5	5	2	3	12.45	10.99	12.41
221	17	Manesty	MEDIC	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
222	64	Cajun	COCKSFOOT	2	1	10	60	30	7	3	5	5	12.07	18.39	19.57
223	47	Yatsyn	PERENNIAL RYEGRASS	1	3	10	60	30	6	4	6	5	12.16	15.03	21.83
224	21	Leura	SUBCLOVER	1	3.5	20	80	0	7	2	2	3	27.4	27.25	35.99
225	9	Sava	MEDIC	2	5	20	60	20	7	3	1	4	40.7	17.75	23.41
226	27	Trikkala	SUBCLOVER	1	4.3	20	70	10	6	2	1	2	25.34	17.04	18.16
227	54	Holdfast/ Strawberry	MIXTURE	2	1	30	50	20	3	6	8	3	35.39	12.63	13.28
228	83	Anatole-persian	CLOVER	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
229	25	Goulburn	SUBCLOVER	1	4.5	20	70	10	7	3	3	2	28.32	30.52	27.67
230	74	Waverley	CLOVER	1	2	20	70	10	5	2	4	5	23.11	29.1	39.45
231	22	Dalkeith	SUBCLOVER	1	5	10	90	0	8	3	2	2	22.61	28.32	22.59
232	53	Hold/Haifa	MIXTURE	2	1	50	30	20	3	4	1	0	14.86	13.88	15.16
233	13	Ampus	MEDIC	1	4	80	10	10	2	0	1	1	8.8	15.92	6.27
234	54	Holdfast/ Strawberry	MIXTURE	1	1	40	40	20	5	4	2	2	27.15	29.65	18.58
235	50	Holdfast	PHALARIS	2	1	30	30	40	3	2	3	2	9.94	22.77	13.96
236	16	Salernes	MEDIC	1	4.3	50	30	20	3	0	0	1	18.48	14.4	18.07
237	62	Currie cocksfoot	COCKSFOOT	1	1	80	20	0	2	2	2	3	9.77	18.8	14.22
238	81	Redquin	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
239	38	Tetila	ITALIAN RYEGRASS	4	4	10	60	30	7	5	5	4	23.24	19.27	33.96
240	53	Holdfast/Haifa	MIXTURE	2	1	40	40	20	3	6	5	0	23.68	18.44	21.14
241	84	Balansa	CLOVER	2	5	30	70	0	7	1	1	0	23.07	14.1	15.71
242	87	Sulla Seed	CLOVER	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
243	21	Leura	SUBCLOVER	1	3.5	10	90	0	7	5	3	3	37.56	37.85	29.43
244	75	Tamar	CLOVER	1	2	30	70	0	7	3	3	5	27.19	20.95	35.14
245	29	Gosse	SUBCLOVER	1	4.5	40	60	0	6	2	3	1	17.53	25.24	23.33

Genus / Species	Variety	P= Permanent. Sod B= Green Manure	Sowing Rate (kg/ha)
Medicago scutellata	Kelson	B	15
Medicago truncatula	Mogul	P	15
	Parabinga	P	15
	Paraggio	P	15
	Caliph	P	15
	Salernes	B	15
Medicago littoralis	Harbinger AR	P	15
Medicago tornata	Rivoli	P	15
Medicago polymorpha	Polygraze	P	15
	Santiago	P	15
	Mauguio	P	15
Medicago murex	Zodiac	P	15
Medicago rotata	Highlander	B	15
Trifolium subterraneum	Leura	P	15
	Dalkeith	P	15
	Clare	P	15
	Denmark	P	15
Trifolium subterraneum	Goulburn	P	15
	Trikkala	P	15
	Gosse	P	15
	Junee	P	15
	Nuba	P	15
	Argeles	P	15
	Nungarin	P	15
	Rosedale	P	15
	Seaton Park	P	15
Trifolium resupinatum	Maral	B	7
	Prolific	P	7
	Nitro Plus	P	7
	Persian clover	P	7
	Kyambro	B	7
	Laser	B	7
	Leeton	B	7
Trifolium fragiferum	Palestine	B	7
	O'Connor	B	7
Trifolium repens	Grasslands Demand	P	7
	Waverley	B	7
	Tamar	B	7
	Tahora	P	7
	Grasslands Kopu	P	7
	Haifa	P	7
	Irrigation	P	7
Trifolium hirtum	Hykon	P	15
Trifolium pratense	Redquin	P	7
Trifolium balansae	Balansa clover	P	7
	Paradana	B	7
Trifolium vesiculosum	Arrowleaf	B	15
Trifolium alexandrium	Attila	P	15
	Multicut	P	15
	Elite	P	15
	Bigbee	P	15

Avena sativa	Echidna	B	60
	Saia	B	60
	Coolabah	B	60
Vicia faba	Icarus	B	100
	Fiord	B	100
	Rossa Faba Bean	B	100
	Ascot	B	100
Dactylis glomerata	Porto	P	7
	Currie	P	7
	Cajun	P	15
Festuca arundinacea	Tribute	P	15
	Demeter	P	15
Phalaris aquatica	Holdfast	P	7
	Sirolan	P	7
	Sirosa	P	7
Vicia dasycarpa	Namoi	B	20
Vicia benghalensis	Popany	B	20
Vicia sativa	Languedoc	B	20
	Blanchfleur	B	20
	Topcut	B	20
P sativum	Glenroy	B	100
	Dundale	B	100
	Laura	B	100
Brassica juncea	Claret	B	7
	Ebony	B	7
Sinapis albus	Gisilba	B	7
Lolium perenne	Victorian	P	15
	Ellet	P	15
	Skippy	P	15
	Vedette	P	15
Brassica napus	Rangi Rape	B	15
Lotus spp	Lotus	B	7
Ehrharta calycina	Veldt grass	P	12
Thinopyrum elongatum	Tyrell Tall Wheat grass	B	10
	Biserulla	P	7
	Fenugreek	B	20
	Seedco Millet	P	20
Medicago sativa	Jindera	P	7
	Cereal Rye	B	100

COONAWARRA CCT TRIAL 1995 RESULTS

CULTIVAR	SWARD VIGOUR RATING 11-Jul-95	SWARD VIGOUR RATING 4-Sep-95	SWARD VIGOUR RATING 12-Jan-96	SWARD VIGOUR RATING 11-Jul-96	SWARD VIGOUR RATING 11-Sep-96	SWARD VIGOUR RATING 13-Nov-97	SWARD VIGOUR RATING 28-Apr-98	KIDS RATING 11-Jul-95	KIDS RATING 4-Sep-95	KIDS RATING 28-Oct-95	PLANT DENSITY # per sq M 11-Jul-95	DRY WT BIOMASS PRODN KG/HA 4-Sep-95	PERCENT GROUND COVER 4-Sep-95	PERCENT GROUND COVER 28-10-95	PERCENT GROUND COVER 12-Jan-96	SWARD HEIGHT CM 4-Sep-95	SWARD HEIGHT CM 28-10-95	SWARD HEIGHT CM 12-Jan-96
Medicago spp																		
Kelson	7.0	6.3	0.0	7.0	6.3	7.0	3.0	K	K	K	233	670	53	58	0	13	35	0
Paraggio	7.0	7.3	0.0	5.3	7.5	2.0	6.0	K	K	K	342	1090	62	97	0	11	27	0
Santiago	5.0	5.8	0.0	4.5	7.0	7.0	6.0	K	K	K	225	1120	65	73	0	6	8	0
Maugio	4.3	6.0	0.0	4.5	6.7	5.0	6.0	K	K	K	333	940	72	80	0	5	11	0
Salernes	5.5	5.2	0.0	4.0	7.3	6.5	0.0	K	K	K	375	425	50	90	0	4	10	0
Zodiac	4.8	5.7	0.7	3.0	4.2	3.0	7.0	D	K	K	342	725	67	83	7	3	17	0
Mogul	6.2	5.7	0.5	3.0	6.0	5.0	9.0	K	K	?	433	865	67	60	10	5	12	0
Parabinga	7.2	7.2	0.0	1.5	3.3	4.0	8.0	K	K	K	458	0	75	93	0	10	11	0
Caliph	7.7	7.2	0.0	0.5	2.7	3.0	5.0	K	K	K	475	215	56	88	0	9	20	0
Harbinger AR	5.7	5.0	0.0	0.5	3.7	4.0	6.0	K	K	K	308	880	48	87	0	7	17	0
Rivoli	4.5	5.3	0.0	0.5	4.3	2.0	3.0	D	K	K	142	540	52	87	0	5	17	0
Highlander	5.8	6.7	0.0	0.5	4.3	1.0	1.0	K	K	K	500	645	33	70	0	10	25	0
Polygraze	7.2	7.5	0.0	0.0	0.3	0.0	6.5	K	K	K	517	1145	87	100	0	9	23	0
Jindera	0.0	0.0	1.2	0.0	1.7	2.0	0.0	D	D	D	0	0	0	0	4	0	0	10
Subterraneum spp																		
Argeles	5.5	5.8	0.0	6.5	6.2	7.5	7.5	K	K	K	308	455	62	93	0	4	10	0
Seaton Park	4.7	4.7	0.0	5.3	7.3	7.0	6.5	?	?	D	250	1035	43	43	0	3	4	0
Gosse	3.7	4.3	0.0	4.5	7.3	9.0	6.0	K	?	K	167	710	38	88	0	3	9	0
Clare	5.3	4.8	0.0	4.5	7.8	8.5	7.5	K	K	K	258	450	48	55	0	2	5	0
Trikkala	2.7	3.5	0.0	4.3	6.7	8.0	7.0	D	?	D	125	0	27	47	0	1	3	0
Rosedale	4.5	4.7	0.0	3.5	6.8	8.0	3.0	D	?	D	142	365	32	33	0	4	5	0
Nuba	3.5	4.5	0.0	3.5	8.0	9.5	8.0	D	K	K	258	890	40	80	0	2	8	0
Denmark	4.3	5.3	0.0	3.3	7.0	8.7	8.5	D	K	K	317	620	43	83	0	2	5	0
Leura	3.2	3.7	0.0	2.5	4.3	3.0	9.0	K	?	K	242	0	32	60	0	7	3	0
Junee	3.3	5.2	0.0	2.5	7.2	8.0	8.0	D	K	K	217	510	53	77	0	2	5	0
Goulburn	1.8	2.0	0.0	2.5	7.5	9.1	9.0	D	D	D	100	0	15	43	0	1	3	0
Nungarin	2.0	3.2	0.0	0.5	1.7	4.0	4.0	D	D	D	83	60	16	0	0	2	0	0
Hykon	0.0	0.0	0.0	0.0	1.3	2.0	1.0	D	D	D	0	0	0	0	0	0	0	0
Dalkeith	2.7	2.3	0.0	0.0	3.0	5.0	2.0	D	D	D	92	0	23	0	0	1	0	0
White Clovers																		
Tamar	4.8	4.5	5.0	6.0	8.5	5.0	1.0	K	K	?	667	0	40	35	47	5	5	10
Tahora	0.3	1.0	2.5	4.7	5.5	5.0	0.0	D	D	D	0	0	3	5	25	1	1	5
Haifa	0.7	1.7	2.3	4.5	7.0	5.0	0.0	D	D	D	250	0	5	10	23	2	3	8
Waverley	3.3	3.2	5.5	4.5	8.2	5.0	1.0	K	?	K	500	0	28	55	50	2	5	8
Grasslands Kopu	2.2	2.3	4.0	4.5	6.0	3.0	2.0	D	D	D	125	0	13	0	35	2	0	10
Demand	0.7	3.2	3.3	2.8	5.0	1.0	1.0	D	D	D	125	625	12	0	33	2	0	5
Irrigation White	0.0	1.3	1.8	2.5	6.3	7.0	2.0	D	D	D	0	0	7	0	20	1	0	10

Persian Clovers																			
Leeton	1.0	0.7	0.3	0.0	0.0	0.0	0.0	D	D	D	92	0	2	0	7	2	0	0
Prolific	2.2	1.7	0.5	0.5	2.3	0.0	0.0	D	D	D	125	0	3	17	3	6	0	10
Kyambro	3.3	3.2	0.0	0.0	2.3	2.3	0.0	K	?	K	417	460	33	47	0	2	5	0
Maral	1.0	3.8	0.0	0.0	0.0	0.0	0.0	D	D	?	67	345	23	55	0	8	18	0
Persian	2.5	2.7	1.8	0.5	0.3	2.0	5.0	D	D	?	167	275	12	30	8	5	10	10
Laser	1.3	0.7	0.0	0.5	0.0	0.0	0.0	D	D	D	0	0	2	0	0	2	0	0
Trifolium spp																			
Balansa	0.0	0.0	0.7	0.0	0.0	0.0	6.0	D	D	D	0	0	0	2	13	0	1	0
Paradana	1.7	2.5	0.0	1.5	0.7	0.0	0.0	D	D	?	150	0	13	37	0	2	0	0
Balansa																			
Palestine	0.0	1.0	3.7	4.3	7.7	8.0	4.0	D	D	D	0	0	1	0	37	1	0	5
O'Connor	2.0	0.7	3.3	3.0	7.7	8.5	6.0	D	D	D	108	0	2	0	38	1	0	3
Arrowleaf	0.0	0.3	0.0	0.0	0.0	0.0	0.0	D	D	D	0	0	0	0	0	3	0	0
Zulu																			
Attila	3.0	2.5	0.0	0.0	0.0	0.0	0.0	?	D	D	208	0	25	8	0	45	20	0
Berseem																			
Multicut	0.3	2.7	0.0	0.0	0.0	0.0	0.0	D	D	K	0	0	9	60	0	9	45	0
Berseem																			
Redquin Red	0.7	0.7	2.0	1.5	4.5	4.0	1.0	D	D	D	33	0	1	0	20	1	0	20
Vicia spp																			
Icarus	5.8	4.8	0.0		0.0	0.0	0.0	K	K	D	133	1375	43	0	0	30	0	0
Rossa Faba	6.8	5.3	0.0	0.0	0.0	0.0	0.0	K	K	K	142	1330	52	40	0	23	0	0
Bean																			
TopCut	5.3	6.0	0.0	2.0	7.2	5.0	0.0	K	K	K	175	650	50	90	0	17	57	0
Ascot	6.0	4.3	0.0	0.0	0.0	0.0	0.0	K	?	?	150	610	50	0	0	30	0	0
Languedoc	6.2	6.0	0.0	2.5	1.0	0.0	0.0	K	K	?	217	565	67	20	0	25	15	0
Popany	6.2	4.7	0.0	4.5	1.7	1.0	0.0	K	K	K	183	495	47	85	0	17	55	0
Blanchfleur	5.5	4.7	0.0	4.5	3.7	1.0	0.0	K	?	?	117	0	50	70	0	15	35	0
Pisium spp																			
Laura	7.7	5.3	0.0	0.0	0.0	0.0	0.0	K	K	K	183	2910	70	60	0	38	40	0
Dundale	7.0	5.0	0.0	0.0	0.0	0.0	0.0	K	K	K	183	1715	65	60	0	42	30	0
Glenroy	7.2	5.3	0.0	0.0	0.0	0.0	0.0	K	?	K	200	975	57	60	0	43	50	0
Cereals																			
Triticale	6.8	4.8	0.0	0.0	0.0	0.0	0.0	K	K	K	483	1560	33	0	0	33	35	0
Coolabah	8.0	5.8	0.0	0.0	0.0	0.0	0.0	K	K	K	567	760	50	0	0	33	55	0
Echidna	6.8	4.3	0.0	0.0	0.0	0.0	0.0	K	?	D	500	630	32	8	0	25	8	0
Saia	6.7	5.5	0.0	0.0	0.0	0.0	0.0	K	K	K	517	465	47	40	0	22	60	0
Cereal Rye	5.7	4.0	0.0	0.0	0.0	0.0	0.0	K	D	D	458	0	33	17	0	32	3	0
Perennial Grasses																			
Porto	5.2	4.2	4.7	6.5	5.8	8.5	9.0	K	D	D	417	0	32	0	40	5	0	15
Demeter	5.7	5.7	5.8	6.8	7.7	8.0	8.5	K	K	?	600	0	45	60	50	10	18	15
Turf Type	5.5	4.0	5.7	6.5	8.7	9.1	8.5	?	D	K	417	0	33	30	37	5	4	10
fescue																			
Currie	3.0	2.7	3.8	5.0	7.0	9.0	8.0	D	D	D	275	0	23	17	30	6	5	15
Ellet	7.8	6.2	4.7	8.0	7.8	8.5	7.5	K	K	K	708	0	55	75	53	11	23	10
Sirolan	6.3	4.8	1.7	4.0	6.8	7.0	7.5	K	?	?	525	0	35	0	12	12	0	5
Tyrell Tall	4.0	4.2	3.0	5.0	6.0	8.0	7.5	?	?	?	192	0	16	30	17	9	30	15
Wheat																			
Victorian	7.7	5.5	3.3	7.0	6.8	8.5	7.0	K	?	K	750	0	47	75	37	8	13	10
Cajun	5.3	5.2	5.7	7.0	6.7	8.0	7.0	K	K	K	542	0	38	50	47	9	15	15
Sirosa	6.5	4.3	1.8	4.5	6.3	6.3	6.5	K	D	D	375	0	28	0	12	11	0	15
Skippy	7.0	6.0	5.2	6.0	6.0	7.0	6.0	K	K	K	675	0	57	30	50	14	60	10
Holdfast	4.7	4.3	1.0	4.0	6.7	8.0	6.0	?	?	D	542	0	19	13	7	9	4	10

Vedette	7.2	5.7	6.0	6.8	8.0	8.5	5.0	K	K	K	733	250	57	80	57	13	20	10
Veldt Grass	1.7	0.0	0.7	2.0	2.3	1.0	0.0	D	D	D	0	0	0	0	7	0	0	0
Perennial Grass																				
Brassica spp																				
Claret	5.5	4.0	0.0	0.0	0.0	0.0	0.0	K	D	D	250	505	10	0	0	82	0	0
Ebony	6.7	3.8	0.0	0.0	0.0	0.0	0.0	K	D	?	250	340	28	0	0	20	0	0
Rangi Rape	8.2	4.2	1.3	4.0	1.7	1.0	0.0	K	?	?	417	80	43	5	17	11	5	10
Other																				
Biserrula	1.7	2.7	0.7	0.3	0.3	0.5	1.0	D	D	K	250	0	10	73	3	3	11	10
Seedeo	0.0	0.0	0.0	0.0	0.0	0.0	0.0	D	D	D	0	0	0	0	0	0	0	0
Millet																				
Fenugreek	7.2	6.2	0.0	0.0	0.0	0.0	0.0	K	K	K	367	690	58	90	0	20	50	0
Lotus	0.0	0.0	0.7	0.0	3.0	0.0	0.0	D	D	D	0	0	0	0	3	0	0	10

BAROSSA VALLEY CCT TRIAL 1995 RESULTS *CULTIVAR*	*VIGOUR RATING* *30-8-95*	*PLANT DENSITY # per M* *30-8-95*	*PERCENT GROUND COVER* *30-8-95*	*SWARD HEIGHT CM* *30-8-95*	*DRY WT. BIOMASS PRODN KG/HA* *30-8-95*
Medicago spp					
Paraggio	5.3	133	23.3	3.0	0
Caliph	4.3	97	6.7	2.7	0
Kelson	4.2	77	20.0	4.3	3373
Santiago	4.0	60	8.3	2.0	0
Maugio	3.8	97	6.7	1.3	0
Polygraze	3.7	73	13.3	1.3	0
Parabinga	2.7	47	8.7	1.0	0
Zodiac	2.7	40	5.0	1.0	0
Rivoli	2.0	47	3.3	1.0	0
Harbinger AR	1.5	47	3.3	1.0	0
Salernes	1.3	30	2.0	1.3	0
Mogul	1.0	23	1.7	0.3	0
Highlander	0.0	0	0.0	0.0	33
Jindera	0.0	0	0.0	0.0	0
Subterranean spp					
Clare	5.3	93	13.3	1.5	0
Denmark	4.8	113	13.3	1.7	0
Gosse	4.8	87	11.7	1.8	0
Rosedale	4.3	67	8.3	1.7	0
Leura	4.2	133	15.0	1.3	0
Argeles	3.8	73	20.0	1.3	0
Junee	3.7	90	15.0	1.3	0
Seaton Park	3.7	80	20.0	1.3	0
Nuba	3.5	43	3.7	1.7	0
Trikkala	3.5	60	16.7	1.0	0
Goulburn	2.8	70	8.3	1.0	0
Nungarin	2.7	50	5.0	0.7	0
Dalkeith	0.7	20	0.3	0.3	0
Hykon Rose	0.0	0	0.0	0.0	0
White Clover					
Demand	0.7	23	0.3	0.3	0
Tahora	0.0	0	0.0	0.0	0
Haifa	0.0	0	0.0	0.0	0
Irrigation White	0.0	0	0.0	0.0	0
Tamar	0.0	0	0.0	0.0	0
Waverley	0.0	0	0.0	0.0	0
Grasslands Kopu	0.0	0	0.0	0.0	0
Persian Clover					
Balansa	1.0	33	0.7	0.7	0
Leeton	0.7	20	0.7	0.7	0
Prolific	0.0	0	0.0	0.0	0
Kyambro	0.0	0	0.0	0.0	0
Maral	2.7	47	3.7	4.3	0
Laser	3.5	80	5.3	3.3	0
Vicia spp					
Icarus	1.0	17	1.0	7.3	7023
Ascot	3.0	30	20.3	13.3	5680
TopCut	2.7	37	6.7	8.0	3780
Popany	3.2	37	5.3	10.7	3150
Blanchefleur	4.2	60	25.0	8.3	1060
Languedoc	4.3	47	26.7	10.3	140

Trifolium spp					
Attila Berseem	3.2	67	7.3	6.3	83
Elite Berseem	4.0	87	10.0	3.7	0
Multicut Berseem	2.0	37	3.7	2.7	0
Palestine	0.0	0	0.0	0.0	0
O'Connor	0.0	0	0.0	0.0	0
Paradana Balansa	0.0	0	0.0	0.0	0
Persian	0.3	7	0.3	0.0	0
Arrowleaf Zulu	0.3	3	0.3	0.3	0
Redquin	0.3	10	0.3	1.0	0
Pisium spp					
Laura	4.0	40	20.3	17.3	5860
Glenroy	4.2	50	31.7	19.0	5539
Dundale	3.0	40	20.0	15.0	5477
Brassica spp					
Ebony	4.8	140	33.3	5.7	1955
Rangi Rape	5.5	180	46.7	9.0	1345
Claret	0.7	23	1.7	4.0	83
Cereals					
Triticale	5.3	120	46.7	17.0	3537
Echidna	6.2	147	46.7	18.3	3280
Coolabah	3.7	110	36.7	12.3	3280
Cereal Rye	5.2	160	43.3	17.3	0
Perennial Grasses					
Vedette Ryegrass	5.3	153	25.0	4.7	0
Ellet Ryegrass	4.8	163	26.7	7.3	0
Victorian Ryegrass	4.7	177	6.7	6.0	0
Skippy Ryegrass	3.8	183	15.3	5.3	0
Sirosa Phalaris	3.0	67	3.7	3.3	0
Sirolan Phalaris	2.7	103	2.3	4.0	0
Holdfast Phalaris	2.7	83	2.3	5.0	0
Demeter	2.7	77	10.7	5.7	0
Tyrell Tall Wheat	2.5	90	5.0	5.0	0
Turf Type fescue	1.7	37	0.7	2.0	0
Cajun Cocksfoot	1.3	73	0.7	3.3	0
Porto Cocksfoot	0.7	17	0.3	1.0	0
Currie Cocksfoot	0.0	0	0.0	0.0	0
Veldt Grass	0.0	0	0.0	0.0	0
Other spp					
Biserrula	0.0	0	0.0	0.0	0
Seedco Millet	0.0	0	0.0	0.0	0
Fenugreek	5.7	73	23.3	4.7	2057
Lotus	1.0	17	0.3	1.3	0

GRIFFITH CCT TRIAL 1995 RESULTS CULTIVAR	SWARD VIGOUR RATING 18-8-95	SWARD VIGOUR RATING 14-9-95	SWARD VIGOUR RATING 12/1/96	K/D[1] RATING 18-8-95	SWARD HEIGHT 18-8-95	SWARD HEIGHT 14-9-95	SWARD HEIGHT 12/1/96	DRY WT. BIOMASS PRODN KG/HA 14-9-95	PERCENT BARE GROUND 18-8-95	PERCENT GROUND COVER 18-8-96
Medicago spp										
Paraggio	5.8	5.3	0.0	K	7	18	0	1450.0	31.7	50.0
Kelson	4.3	4.7	0.0	D	10	30	0	1326.7	26.7	36.7
Parabinga	4.7	4.2	1.7	?	8	17	0	710.0	56.7	33.3
Maugio	4.0	4.2	3.2	D	4	8	0	476.7	66.7	15.0
Santiago	4.0	3.8	0.0	D	5	12	0	496.7	57.7	23.3
Polygraze	4.8	3.8	0.5	?	6	14	0	480.0	53.3	31.7
Salernes	5.3	3.3	2.8	D	6	6	0	286.7	40.0	36.7
Caliph	4.8	2.8	1.8	D	6	10	0	533.3	50.0	28.3
Harbinger AR	3.3	2.7	0.0	D	3	6	8	243.3	30.0	25.0
Highlander	3.0	2.3	3.8	D	4	5	0	550.0	70.0	6.7
Zodiac	3.3	2.0	0.0	D	3	4	0	333.3	80.0	10.0
Mogul	2.2	1.0	0.0	D	2	3	0	126.7	86.7	8.3
Rivoli	1.3	1.0	0.0	D	1	3	0	33.3	50.0	16.7
Subterranean spp.										
Clare	7.5	8.0	0.0	K	14	27	0	2820.0	3.3	93.3
Argeles	7.5	7.5	2.8	K	8	25	0	2710.0	3.3	91.7
Nuba	6.0	5.8	5.5	K	7	27	0	1503.3	26.7	63.3
Nuba	6.0	5.8	5.5	K	7	27	0	1503.3	26.7	63.3
Seaton Park	6.3	5.8	2.3	K	6	15	0	2193.3	21.7	66.7
Trikkala	5.3	5.7	0.0	K	5	18	0	1860.0	30.0	48.3
Nungarin	5.8	5.5	1.2	?	8	15	0	2420.0	16.7	68.3
Leura	5.7	5.2	2.0	?	5	13	0	1816.7	23.3	56.7
Junee	6.2	5.2	3.0	K	7	17	0	1450.0	16.7	70.0
Dalkeith	6.0	5.2	2.2	?	6	21	0	1640.0	26.7	56.7
Rosedale	4.5	5.0	2.2	?	5	17	0	963.3	53.3	40.0
Denmark	6.2	4.8	2.5	K	6	17	0	2163.3	36.7	63.3
Goulbourn	4.8	4.7	2.5	K	4	12	0	2103.3	33.3	43.3
Gosse	4.7	4.7	2.3	?	5	17	0	1546.7	50.0	36.7
Hykon Rose	3.7	3.2	0.0	D	4	11	0	400.0	53.3	26.7
White Clovers										
Tamar	6.3	5.5	1.0	?	9	23	19	756.7	16.7	60.0
Waverley	5.3	5.2	0.0	?	6	18	16	606.7	46.7	36.7
Haifa	5.3	4.2	1.5	?	4	12	8	323.3	66.7	25.0
Irrigation white	4.0	3.7	1.7	?	4	12	7	150.0	55.0	23.3
Tahora	3.7	3.5	3.7	D	2	4	7	273.3	56.7	23.3
Grasslands Kopu	2.8	3.3	2.2	D	3	38	15	240.0	63.3	6.7
Persian Clovers										
Balansa	5.8	5.7	0.0	K	10	34	0	1480.0	38.3	48.3
Prolific	5.3	4.8	0.0	?	10	27	10	796.7	43.3	43.3
Leeton	6.0	5.5	0.0	K	9	37	0	1656.7	33.3	56.7
Kyambro	4.0	3.2	2.3	D	5	6	0	386.7	63.3	26.7
Maral	6.5	6.3	2.0	K	14	30	0	1520.0	28.3	60.0
Laser	6.5	6.3	0.0	K	17	37	0	1753.3	16.7	71.7
Trifolium spp.										
Attila Berseem	7.7	7.3	0.8	K	32	50	0	2130.7	11.7	76.7
Elite Berseem	7.0	7.8	0.0	K	30	43	0	2343.3	15.0	70.0
Paradana Balansa	7.8	7.2	5.5	K	16	40	0	2600.0	3.3	93.3
Persian	5.8	6.2	0.0	K	11	28	14	1336.7	21.7	58.3
Arrowleaf Zulu	6.0	5.5	1.8	K	13	32	1	970.0	36.7	50.0
Redquin	2.5	3.0	2.3	D	3	12	20	203.3	63.3	15.0
Palestine	3.7	3.7	1.0	?	4	15	5	710.0	50.0	18.3
O'Connor	1.3	2.3	2.3	D	1	5	4	233.3	93.3	3.3
Vicia spp.										
Blanchefleur	7.0	8.0	0.0	K	23	47	0	1973.3	11.7	83.3
Languedoc	6.0	7.3	5.7	K	25	50	7	1950.0	21.7	65.0
Topcut	6.7	8.5	6.2	K	20	40	0	2780.0	10.0	83.3
Popany	5.3	6.7	0.7	?	22	45	0	1356.7	33.3	53.3
Rossa Faba Bean	5.5	6.2	3.0	K	40	63	0	2963.3	33.3	63.3
Ascot	3.3	5.2	4.8	D	32	52	2	1596.7	36.7	23.3
Icarus	3.3	4.0	2.0	D	33	47	0	2406.7	60.0	18.3

Pisium spp.										
Dundale	5.7	6.0	5.2	K	40	53	0	2726.7	31.7	65.0
Laura	3.3	3.2	0.0	?	42	38	0	873.3	50.0	23.3
Glenroy	4.8	5.2	0.0	K	45	48	0	2913.3	40.0	36.7
Brassica spp.										
Gisilba	1.5	2.5	0.0	D	28	53	0	296.7	32.7	2.5
Ebony	4.0	3.0	2.2	?	9	45	0	713.3	63.3	35.0
Claret	3.7	2.2	0.0	D	73	98	0	313.3	76.7	13.3
Rangi Rape	5.0	4.2	2.7	?	12	22	15	1173.3	50.0	41.7
Cereals										
Cereal Rye	4.2	2.0	0.0	D	31	93	0	650.0	56.7	6.7
Saia	5.0	5.3	0.0	?	32	48	0	1636.7	26.7	40.0
Triticale	3.0	2.7	0.0	D	14	25	10	280.0	56.7	13.3
Echidna	3.7	4.2	0.5	?	20	40	0	666.7	76.7	10.0
Coolabah	3.0	2.8	0.7	D	17	30	0	460.0	70.0	8.3
Perennial Grasses										
Sirosa Phalaris	4.0	5.3	4.2	K	12	26	37	663.3	40.0	20.0
Holdfast Phalaris	4.0	3.7	1.7	D	6	12	27	16.7	66.3	13.3
Sirolan Phalaris	5.2	3.8	3.5	K	10	12	23	0.0	75.0	8.3
Skippy	5.7	5.2	2.2	K	6	17	17	0.0	70.0	23.3
Vedette	4.7	4.7	3.0	K	6	10	22	0.0	50.0	30.0
Victorian	6.0	5.8	2.3	?	6	15	12	466.7	46.7	38.3
Ellet	5.5	5.3	0.7	K	6	17	15	0.0	61.7	31.7
Veldt grass	0.0	0.0	0.0	D	0	0	0	0.0	100.0	0.0
Demeter Fescue	4.3	4.3	2.0	D	6	13	23	0.0	51.7	11.7
Turf Type fescue	2.7	3.3	1.3	D	4	4	13	0.0	70.0	20.0
Currie Cocksfoot	2.0	1.2	0.0	D	2	4	22	0.0	66.0	3.3
Porto Cocksfoot	2.7	2.3	0.0	D	3	5	22	0.0	30.0	3.3
Cajun Cocksfoot	3.0	2.5	5.0	D	3	7	25	0.0	51.7	28.3
Tyrrel Tall Wheat	2.0	1.3	1.3	D	3	30	17	0.0	86.7	6.7
Other spp.										
Seedco Millet	0.0	0.0	1.2	D	0	0	0	0.0	100.0	0.0
Fenugreek	5.8	7.2	0.0	K	30	50	0	1286.7	28.3	56.7
Lotus	2.0	1.3	4.5	D	1	3	19	0.0	50.0	5.0

1995 MILDURA (SUNRAYSIA) RESULTS

MILDURA CCT TRIAL 1995 RESULTS CULTIVAR	VIGOUR RATING 14-6-95	VIGOUR RATING 15-8-95	K/D? RATING 14-6-95	K/D? RATING 15-8-95	PLANT DENSITY # per M 15-8-95	SWARD HEIGHT CM 15-8-95	PERCENT GROUND COVER 15-8-95	PERCENT BARE GROUND 15-8-95	PERCENT WEED COVER 15-8-95	DRY WT. BIOMASS PRODN KG/HA 15-8-95
Medicago spp										
Parabinga	4.7	7.0	K	K	>10	9	36.7	4.0	59.3	
Zodiac	6.0	6.3	?	K	10	7	51.7	15.0	33.3	
Harbinger AR	7.3	6.2	K	K	>10	3	53.3	26.7	20.0	
Santiago	5.2	6.0	K	K	>10	5	50.0	31.7	18.3	
Caliph	5.2	5.7	K	K	>10	6	50.0	18.3	31.7	
Mogul	4.7	5.3	K	K	>10	2	38.3	28.3	33.3	
Kelson	4.8	5.3	K	K	>10	10	35.0	36.7	28.3	1550
Parragio	2.7	4.2	D	?	<10	3	16.7	28.3	55.0	
Rivoli	1.8	3.0	D	D	<10	2	5.0	26.7	68.3	
Highlander	3.7	2.7	K	D	>10	9	6.7	20.0	73.3	200
Subterranean spp										
Denmark	3.8	5.3	D	K	<10	14	41.7	36.7	21.7	
Goulburn	4.3	5.2	K	?	>10	2	30.0	16.7	53.3	
Seaton Park	3.2	5.0	K	K	>10	2	40.0	33.3	26.7	
Junee	3.8	4.8	K	?	>10	2	33.3	31.7	35.0	
Nungarin	3.7	4.0	K	D	>10	2	11.7	48.3	40.0	
Dalkeith	4.2	4.0	K	?	>10	2	25.0	36.7	38.3	
Leura	4.0	3.7	K	K	>10	2	30.0	40.0	30.0	
Argeles	4.3	3.7	K	?	>10	2	18.3	30.0	51.7	
Gosse	3.0	3.2	D	D	<10	1	10.0	10.0	80.0	
Clare	1.8	3.2	D	D	<10	1	15.0	10.0	75.0	
Trikkala	3.3	3.0	K	D	10	1	11.7	50.0	38.3	
Hykon	4.7	2.7	?	D	10	2	5.0	33.3	61.7	
Nuba	2.2	2.3	K	D	>10	1	6.7	40.0	53.3	
Rosedale	5.0	2.3	?	D	10	2	5.0	6.7	88.3	
White Clovers										
Tamar	5.3	5.8	K	K	>10	5	38.3	18.3	43.3	270
Tabora	4.0	4.0	K	K	>10	3	26.7	20.0	53.3	1017
Irrigation White	2.3	3.2	K	?	>10	2	11.7	26.7	61.7	
Persian Clovers										
Balansa	3.0	2.5	D	D	10	3	1.7	10.0	88.3	
Prolific	2.7	0.3	K	D	>10	1	1.7	16.7	81.7	
Lecton	3.5	4.0	K	?	>10	4	6.7	20.0	73.3	1210
Laser	2.7	2.8	K	D	>10	4	8.3	46.7	45.0	1100
Maral	4.2	5.3	K	?	>10	6	35.0	41.7	23.3	328
Kyambro	2.8	4.5	K	K	>10	2	30.0	33.3	36.7	443
Trifolium spp										
Attila Berseem	5.0	2.5	K	D	>10	3	3.3	36.7	60.0	233
Elite Berseem	4.7	4.2	K	?	>10	5	18.3	30.0	51.7	
Paradana Balansa	3.5	4.7	D	?	<10	3	35.0	20.0	45.0	1793
Persian	1.0	1.3	D	D	<10	1	6.7	16.7	76.7	
Arrowleaf Zulu	0.7	0.0	D	D	<10	0	0.0	0.0	100.0	80
O'Connor	1.5	0.0	D	D	<10	0	0.0	0.0	100.0	0
Palestine	2.7	3.5	D	D	<10	2	13.3	30.0	56.7	1017
Redquin	4.2	2.7	?	D	>10	1	6.7	10.0	83.3	1000
Vicia spp										
Blanchefleur	2.2	3.0	D	D	<10	5	1.7	10.0	88.3	200
Languedoc	2.2	0.0	D	D	<10	0	0.0	0.0	100.0	60
TopCut	2.8	0.0	D	D	<10	0	0.0	0.0	100.0	967
Popany	4.5	4.0	K	D	>10	54	11.7	40.0	48.3	2933
Rossa Faba Bean	7.7	8.2	K	K	<10	65	85.0	6.7	8.3	3363
Ascot Bean	6.3	6.2	K	?	<10	52	58.3	20.0	21.7	4243
Icarus Beans	4.0	6.0	?	D	<10	50	58.3	31.7	10.0	2467
Pisium spp										
Glenroy	2.5	0*	K	D	>10	10	0.0	0.0	100.0	2900
Dundale	2.3	3.0	K	D	10	0*	0.0	0.0	100.0	2800
Laura	1.8	0.0	K	D	>10	0	0.0	0.0	100.0	6950
Brassica spp										
Claret	7.0	8.0	K	K	>10	108	18.3	20.0	61.7	1533
Ebony	5.3	5.3	K	?	>10	43	56.7	11.7	31.7	2853
Gisilba	1.7	0.0	K	?	<10	0	0.0	0.0	100.0	4526
Rangi Rape	4.0	0.0	K	D	>10	0	0.0	0.0	100.0	3733

Cereals										
Saia Oats	6.2	4.5	K	D	>10	63	26.7	3.3	70.0	2643
Coolabah	8.0	0*	K	D	10	0*	0.0	0.0	100.0	3706
Echidna	5.0	0*	K	D	>10	0*	0.0	0.0	100.0	3675
Triticale	6.0	5.0	?	?	>10	42	40.0	26.7	33.3	517
Cereal Rye	5.3	6.5	K	D	>10	88	10.0	36.7	53.3	
Perennial Grasses										
Vedette Rye	5.3	6.7	K	K	>10	3	43.3	26.7	30.0	
Ellet Rye	6.0	6.5	K	K	>10	3	36.7	23.3	40.0	
Skippy Rye	5.8	6.5	K	K	>10	4	36.7	46.7	16.7	
Victorian Rye	6.2	6.3	K	K	>10	3	35.0	40.0	25.0	
Porto Cocksfoot	6.0	5.3	K	K	>10	2	18.3	53.3	28.3	
Currie Cocksfoot	4.0	4.7	K	D	>10	3	10.0	36.7	53.3	
Sirosa Phalaris	5.5	3.7	K	K	>10	3	16.7	6.7	76.7	
Demeter Fescue	4.3	3.0	K	D	>10	2	0.0	0.0	100.0	
Veldt Grass	2.0	3.0	D	D	10	2	1.7	16.7	81.7	
Cajun Cocksfoot	4.2	2.7	K	D	>10	1	6.7	13.3	80.0	
Turf Type Fescue	3.3	1.7	K	D	>10	1	8.3	10.0	81.7	
Holdfast Phalaris	2.3	0.7	D	D	<10	1	0.3	16.7	83.0	
Sirolan Phalaris	3.3	0.7	K	D	>10	1	0.0	0.0	100.0	
Tyrell Tall Wheat	1.2	0.7	D	D	<10	1	0.0	0.0	100.0	
Other spp										
Seedco Millet	0.2	0.0	D	D	<10	0	0.0	0.0	100.0	0
Fenugreek	0.0	0.0	D	D	<10	0	0.0	0.0	100.0	423
Lotus	1.5	0.0	D	D	<10	0	0.0	0.0	100.0	67

15.24 SPECIES SCREENED IN ADELAIDE HILLS 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medics	Santiago and Serena	11+11	1,58,72,108
Cocksfoot plus Ryegrass	Currie/ Victorian/Matilda	5/10/10	2,48,99,102
Oats plus Clover	Coolabah/Elite/Maral/Nitro Plus	50/7/7/7	3,39,74,128
Brassica	Rangi Rape	22	4,42,92,112
Peas	Glenroy	150	5,46,89,106
Oats	Coolabah	100	6,38,69,129
Medics	Paraggio and Parabinga	11+11	7,66,82,105
Triticale	Tahara	150	8,64,98,101
Oats /Brassica/Clover	Coolabah/Mustard/Junee	60/15/10	9,43,73,117
Ryegrass+Clover	Matilda/Junee/Nungarin	15/8/8	10,60,77,119
Triticale/Vetch	Tahara/Popany/Blanchefleur/Languedoc	60/8/10/10	11,35,79,110
Oats/Vetch	Coolabah/Blanchefleur	60/20	12,56,84,116
Vetch	Popany	30	13,47,88,109
Ryegrass+Clover	Ellet/Denmark/Gosse	15/8/8	14,63,94,111
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/20/20/16	15,54,86,132
Subclover	Clare	25	16,61,96,130
Brassica	Fodder Radish	25	17,52,87,115
Ryegrass+Clover	Victorian/Nuba/Clare	15/8/8	18,36,71,107
Lupins	Gunguru	120	19,41,90,124
Subclover	Goulburn	22	20,60,68,126
White Clover plus Grass	Waverley/Victorian	10/15	21,45,85,118
Peas/Beans/Vetch	Glenroy/Rossa/Blanchefleur	30/30/15	22,51,76,125
Oats/Medic	Coolabah/Kelson	60/25	23,37,91,114
Brassica	Mustard	22	24,49,81,131
White Clover plus Grass	Tamar/Ellet	10/15	25,40,97,122
Beneficial	Vetch/medic/clover/grass/Fenugreek	10/8/6/5/5	26,62,70,104
Medic	Parabinga	22	27,59,93,113
Oats/Vetch	Coolabah/Topcut	60/20	28,55,67,123
White Clover plus Grass	Tamar/Waverley/Ellet/Currie	5/5/10/5	29,65,83,100
Vetch/Clover	Topcut/Elite/Nitro Plus	15/10/7	30,53,78,120
Medic	Santiago	22	31,34,75,127
Strawberry Clover/Grass	O'Connors/Demeter	10/15	32,57,95,121
Faba Bean	Rossa	150	33,44,80,103

15.25 TREATMENTS SCREENED IN EDEN VALLEY 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medics	Santiago and Serena	11+11	1,58,72,108
Cocksfoot plus Ryegrass	Currie/ Victorian/Matilda	5/10/10	2,48,99,102
Oats plus Clover	Coolabah/Elite/Maral/Nitro Plus	50/7/7/7	3,39,74,128
Brassica	Rangi Rape	22	4,42,92,112
Peas	Glenroy	150	5,46,89,106
Oats	Coolabah	100	6,38,69,129
Medics	Paraggio and Parabinga	11+11	7,66,82,105
Triticale	Tahara	150	8,64,98,101
Oats /Brassica/Clover	Coolabah/Mustard/Seaton Park	60/15/10	9,43,73,117
Ryegrass+Clover	Matilda/Seaton Park/Nungarin	15/8/8	10,60,77,119
Triticale/Vetch	Tahara/Popany/Blanchefleur/Languedoc	60/8/10/10	11,35,79,110
Oats/Vetch	Coolabah/Blanchefleur	60/20	12,56,84,116
Vetch	Popany	30	13,47,88,109
Ryegrass+Clover	Ellet/Denmark/Gosse	15/8/8	14,63,94,111
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/20/20/16	15,54,86,132
Subclover	Clare	25	16,61,96,130
Brassica	Fodder Radish	25	17,52,87,115
Ryegrass+Clover	Victorian/Nuba/Clare	15/8/8	18,36,71,107
Lupins/Fenugreek	Gungurru/Fenugreek	60/30	19,41,90,124
Subclover	Goulburn	22	20,60,68,126
White Clover plus Grass	Waverley/Victorian	10/15	21,45,85,118
Peas/Beans/Vetch	Glenroy/Rossa/Blanchefleur	30/30/15	22,51,76,125
Oats/Medic	Coolabah/Kelson	60/25	23,37,91,114
Brassica	Mustard	22	24,49,81,131
White Clover plus Grass	Tamar/Ellet	10/15	25,40,97,122
Beneficial	Vetch/medic/clover/grass/Fenugreek	10/8/6/5/5	26,62,70,104
Medic	Mogul	22	27,59,93,113
Oats/Vetch	Coolabah/Topcut	60/20	28,55,67,123
White Clover plus Grass	Tamar/Waverley/Ellet/Currie	5/5/10/5	29,65,83,100
Vetch/Clover	Topcut/Elite/Nitro Plus	15/10/7	30,53,78,120
Medic	Santiago	22	31,34,75,127
Strawberry Clover/Grass	Palestine/Demeter	10/15	32,57,95,121
Faba Bean	Rossa	150	33,44,80,103

1996 CCT COVER CROP TRIALS *MILDARA BLASS WINES* *EDEN VALLEY* *SOUTH AUSTRALIA* *ANALYSIS AND SUMMARY OF RESULTS* *CULTIVAR*	*SWARD VIGOUR RATING 19-Sep*	*SWARD HEIGHT 19-Sep*	*PERCENT GROUND COVER 19-Sep*
BLEND 'H'	8.5	71.7	96.7
ROSSA FABA BEAN	7.9	87.5	92.5
COOLABAH/TOPCUT	6.7	60.0	88.3
POPANY	7.9	43.8	83.8
BLEND 'F'	8.3	21.8	82.5
BLEND 'G'	6.3	70.0	81.7
SANTIAGO	7.0	13.7	78.3
BLEND 'D'	6.7	19.0	73.3
BLEND 'E'	7.9	95.0	72.5
TRITICALE	9.0	93.8	68.8
ADAGIO	9.2	123.3	65.0
COOLABAH	6.8	65.0	53.3
GLENROY	5.9	72.5	50.0
CLARE/NUBA/VICTORIAN	5.3	13.8	50.0
TOPCUT/ELITE/NITRO PLUS	4.0	15.3	50.0
BLEND 'A'	6.4	17.3	41.8
CLARE	4.2	4.7	38.3
RANGI RAPE	4.8	24.3	37.5
PALESTINE/DEMETER	6.5	14.7	36.7
COOLABAH/KELSON	5.2	54.7	35.0
COOLABAH/BLANCHEFLEUR	3.3	41.7	35.0
BLEND 'B'	4.7	50.0	28.3
BLEND 'J'	4.0	13.5	27.5
TAMAR/ELLET	5.0	11.3	25.0
WAVERLEY/ELLET	3.0	14.0	23.4
BLEND 'C'	3.5	53.3	21.7
BLEND 'I'	2.0	21.3	15.0
GOULBURN	3.0	3.0	13.3
EBONY	3.0	46.7	8.3
GUNGURRU/FENUGREEK	3.0	25.0	8.3
SANTIAGO/SERENA	2.8	7.0	8.0
PARABINGA/PARAGGIO	0.5	1.3	1.3
MOGUL	0.0	0.0	0.0
LSD(95%)	0.8	6.7	9.2

BLEND 'A': CURRIE/VICTORIAN/MATILDA
BLEND 'B': COOLABAH/ELITE/MARAL/NITRO PLUS
BLEND 'C': COOLABAH/EBONY/SEATON PARK
BLEND 'D': NUNGARIN/SEATON PARK/MATILDA
BLEND 'E': TRITICALE/BLANCHEFLEUR/POPANY/TOPCUT
BLEND 'G': GLENROY/COOLABAH/ROSSA FABA BEAN/BLANCHEFLEUR/POPANY/ARGELES/SANTIAGO
BLEND 'G' GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO
BLEND 'I': BLANCHEFLEUR/HIGHLANDER/HYKON/WAVERLEY/FENUGREEK/PROLIFIC/CURRIE/SEATON PARK
BLEND 'J': TAMAR/WAVERLEY/ELLET/CURRIE

15.27 TREATMENTS SCREENED AT ANGASTON 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medics	Santiago/Serena	22	1,58,72,108
Grasses	Currie Cocksfoot/Victorian+Matilda ryegrasses	25	2,48,99,102
Oats/Clovers	Coolabah/Elite/Maral/Nitro Plus	50/7/5/5	3,39,74,128
Fodder Rape	Rangi	20	4,42,92,112
Field Peas	Glenroy	150	5,46,89,106
Oats	Coolabah	100	6,38,69,129
Medics	Parabinga/Paraggio	11/11	7,66,82,105
Triticale	Tahara	150	8,64,98,101
Oats/Mustard/Clover	Coolabah/Ebony/Seaton Park	50/15/10	9,43,73,117
Triticale/Vetch	Tahara/Blanchefleur/Popany/Topcut	60/11/11/11	10,60,77,119
Oats/Vetch	Coolabah/Blanchefleur	60/20	11,35,79,110
Vetch	Popany	30	12,56,84,116
Fenugreek		40	13,47,88,109
Ryegrass+Clover	Clare/Nuba/Victorian	15/8/8	14,63,94,111
Fodder radish	Adagio	30	15,54,86,132
Subclover	Clare	22	16,61,96,130
Beans/Peas/Vetch	Rossa/Glenroy/Blanchefleur/Argeles	30/30/20/15	17,52,87,115
Medic	Santiago	22	18,36,71,107
Faba Bean	Rossa	150	19,41,90,124
Grass/Clover	Demeter Fescue/Palestine Strawberry	15/10	20,60,68,126
Grass	Blando Brome	15	21,45,85,118
Oats/Vetch	Coolabah/Topcut	60/15	22,51,76,125
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/30/20/16	23,37,91,114
Mustard	Ebony	22	24,49,81,131
Grass	Cindy fescue	20	25,40,97,122
Grass/White Clover	Ellet/Currie/Tamar/Waverley	7/7/3/3	26,62,70,104
Subclover	Clare	25	27,59,93,113
Grass	Demeter	25	28,55,67,123
Subclover	Argeles	25	29,65,83,100
Medic	Caliph	22	30,53,78,120
Grass	Californian Brome	25	31,34,75,127
Subclover	Denmark	25	32,57,95,121
Ryegrass-Clover	Denmark/Gosse/Ellet	15/8/8	33,44,80,103

15.28 **1996 ANGASTON RESULTS**

1996 CCT COVER CROP TRIALS YALUMBA WINES ANGASTON SOUTH AUSTRALIA ANALYSIS AND SUMMARY OF RESULTS CULTIVAR	*SWARD VIGOUR RATING 28-Sep-96*	*SWARD VIGOUR RATING 6-Feb-97*	*SWARD VIGOUR RATING 17-Aug-97*	*SWARD VIGOUR RATING 16-Jan-98*	*RESIDUE DENSITY 6-Feb-97*	*WEED DENSITY 6-Feb-97*	*PERCENT GROUND COVER 6-Feb-97*
CURRIE/VICTORIA/MATILDA	5.0	8.6	9.5	7.0	2.1	0.3	68.8
CLARE/NUBA/VICTORIAN	7.5	7.1	9.2	6.5	2.6	0.8	51.3
CLARE	8.0	0.5	7.8	0.0	2.6	1.3	4.3
DEMETER	6.0	6.8	7.2	6.0	0.8	1.5	43.8
DENMARK/GOSSE/ELLET	7.5	7.1	7.0	5.2	2.8	0.3	56.3
ARGELES	6.0	0.5	7.0	0.0	2.6	0.5	3.8
BLEND 'F'	5.0	8.3	6.5	5.5	2.6	0.5	68.8
DENMARK	3.5	0.5	6.0	0.0	2.5	0.7	2.3
CINDY RED FESCUE	4.0	6.0	5.8	6.0	0.7	2.0	31.7
PALESTINE/DEMETER	5.5	5.8	5.5	6.2	1.2	0.8	30.0
CALIF. BROME	4.0	4.8	4.5	1.0	1.5	2.0	17.5
GOULBURN	3.0	0.3	4.5	0.0	2.3	1.4	0.3
SANTIAGO/SERENA	1.0	0.0	3.0	0.0	1.3	1.5	0.0
CALIPH	5.5	0.0	3.0	0.0	0.6	3.0	0.0
SANTIAGO	2.5	0.0	2.5	0.0	1.2	1.1	0.0
PARAGGIO/PARABINGA	4.0	0.0	2.0	0.0	0.8	2.0	0.3
POPANY	5.0	0.0	2.0	0.0	1.3	1.4	0.0
BLANDO/PAL./	3.0	1.0	2.0	0.0	2.7	1.5	10.0
BLANDO BROME	5.0	0.0	1.0	0.0	1.9	1.3	0.0
BLEND 'A'	4.5	0.0	0.0	0.0	2.4	1.2	0.0
RANGI RAPE	1.0	3.4	0.0	0.0	0.9	0.8	18.8
GLENROY	2.8	0.0	0.0	0.0	0.8	2.3	0.0
COOLABAH	6.0	0.0	0.0	0.0	2.6	1.3	0.0
TRITICALE	6.5	0.0	0.0	0.0	3.4	0.5	0.0
BLEND 'B'	4.0	0.0	0.0	0.0	2.6	0.6	0.0
BLEND 'C'	6.0	0.0	0.0	0.0	2.7	0.8	0.0
COOLABAH/BLANCHEFLEUR	5.0	0.0	0.0	0.0	2.9	1.2	0.0
FENUGREEK	2.0	0.0	0.0	0.0	0.9	1.4	0.0
ADAGIO	5.0	0.2	0.0	0.0	1.8	1.5	1.0
BLEND 'D'	7.0	0.1	0.0	0.0	2.2	1.0	0.5
ROSSA FABA BEAN	3.0	0.0	0.0	0.0	1.1	1.3	0.0
COOLABAH/TOPCUT	6.0	0.0	0.0	0.0	1.8	1.2	0.0
BLEND 'E'	4.0	0.3	0.0	0.0	2.7	1.2	1.3
EBONY	2.0	0.0	0.0	0.0	1.8	1.5	0.0

BLEND 'A' COOLABAH/ELITE II/ MARAL/ NITRO PLUS
BLEND 'B' COOLABAH/ EBONY/ SEATON PARK
BLEND 'C' TRITICALE/BLANCHEFLEUR/TOPCUT/POPANY
BLEND 'D' GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO
BLEND 'E' GLENROY/COOLABAH/ROSSA FABA BEAN/BLANCHEFLEUR/POPANY/ARGELES/SANTIAGO
BLEND 'F' TAMAR/WAVERLEY/ELLET/CURRIE

15.29 TREATMENTS SCREENED AT NURIOOTPA 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medics	Santiago and Serena	11+11	1,58,72,108
Cocksfoot plus Ryegrass	Currie/ Victorian/Matilda	5/10/10	2,48,99,102
Medics	Paraggio and Parabinga	11+11	3,39,74,128
Ryegrass+Clover	Victorian/Nuba/Clare	15/8/8	4,42,92,112
Medic	Santiago	22	5,46,89,106
Strawberry Clover/Grass	Palestine/Demeter	10/15	6,38,69,129
Brassica	Rangi rape	18	7,66,82,105
Peas	Glenroy	150	8,64,98,101
Oats	Coolabah	100	9,43,73,117
Vetch	Popany	30	10,60,77,119
Fenugreek		40	11,35,79,110
Brassica	Fodder Radish	25	12,56,84,116
Medic	Caliph	22	13,47,88,109
Subclover	Goulburn	22	14,63,94,111
Medic	Harbinger AR	22	15,54,86,132
Subclover	Clare	25	16,61,96,130
Medic	Highlander	25	17,52,87,115
Oats/Medic	Coolabah/Kelson	60/25	18,36,71,107
Peas/Beans/Vetch	Glenroy/Rossa/Blanchefleur	30/30/15	19,41,90,124
Oats/Vetch	Coolabah/Topcut	60/20	20,60,68,126
Triticale/Vetch	Tahara/Popany/Blanchefleur/Languedoc	60/8/10/10	21,45,85,118
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/20/20/16	22,51,76,125
Oats plus Clover	Coolabah/Elite/Maral/Nitro Plus	50/7/7/7	23,37,91,114
Oats /Brassica/Clover	Coolabah/Mustard/Junee	60/15/10	24,49,81,131
White Clover plus Grass	Tamar/Waverley/Ellet/Currie	5/5/10/5	25,40,97,122
Grass	Demeter	20	26,62,70,104
Ryegrass+Clover	Ellet/Denmark/Gosse	15/8/8	27,59,93,113
Grass	Matilda	20	28,55,67,123
Ryegrass+Clover	Matilda/Seaton park/Nungarin	15/8/8	29,65,83,100
Medic	Zodiac	22	30,53,78,120
Vetch	Topcut	25	31,34,75,127
Faba Bean	Rossa	150	32,57,95,121
Medic	Mogul	22	33,44,80,103

15.30 TREATMENTS SCREENED AT AUBURN 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medic	Serena/Santiago	11/11	1,58,72,105
Oats	Coolabah	100	2,48,99,112
Triticale/Vetch	Tahara/Languedoc/Popany/Topcut	60/10/10/8	3,39,74,128
Vetch	Blanchefleur	25	4,42,92,109
Fodder Rape	Rangi	20	5,46,89,103
Ryegrass+Clover	Matilda/Junee/Nungarin	15/8/8	6,38,69,129
Fodder Radish	Adagio	25	7,66,82,102
Vetch	Topcut	25	8,64,98,113
Oats/Medic	Coolabah/Kelson	50/20	9,43,73,117
Mustard	Ebony	18	10,60,77,119
Beans/Peas/Vetch/Clover	Rossa/Glenroy/Blanchefleur/Argeles	30/30/15/20	11,35,79,107
Triticale	Tahara	150	12,56,84,116
Ryegrass+Clover	Ellet/Denmark/Gosse	15/8/8	13,47,88,106
Grass/Clover	Demeter/Palestine	15/10	14,63,94,108
Faba Bean	Rossa	150	15,54,86,132
Subclover	Clare	22	16,61,96,130
Oats/Clovers	Coolabah/Elite/Maral/Nitro Plus	50/7/5/5	17,52,87,115
Subclover	Argeles	22	18,36,71,107
Vetch	Popany	25	19,41,90,124
Ryegrass+Clover	Clare/Nuba/Victorian	15/8/8	20,60,68,126
Subclover	Nuba	22	21,45,85,118
Subclover	Denmark	25	22,51,76,125
Field Peas	Glenroy	150	23,37,91,114
Subclover	Gosse	22	24,49,81,131
Grass/White clover	Victorian/Waverley	15/10	25,40,114,122
Medic	Parabinga/Paraggio	11/11	26,62,70,104
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/20/20/16	27,59,93,113
Subclover	Junee	22	28,55,67,123
Grass	Currie/Victorian/Matilda	8/10/10	29,65,83,97
Grass/White clover	Victorian/Tamar	15/10	30,53,78,120
Balansa Clover	Paradana	12	31,34,75,127
Oats/Mustard/Clover	Coolabah/Ebony/Junee	50/15/10	32,57,95,121
Fescue	Demeter	25	33,44,80,103

15.31 TREATMENTS SCREENED AT LANGHORNE CREEK 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medics	Santiago	18	1,58,72,108
Field Peas	Glenroy	120	2,48,99,102
Lucerne	Jindera	8	3,39,*,*
Persian Clover	Nitro Plus	10	4,42,92,112
Medics	Santiago/Serena	9/9	5,46,89,106
Medics	Parabinga	18	6,38,69,129
Medics	Parabinga/Paraggio	9/9	7,66,82,105
Oats	Coolabah	100	8,64,98,101
Ryegrass+Clover	Matilda/Junee/Nungarin	15/8/8	9,43,73,117
Medic	Zodiac	18	10,60,77,119
Fescue	Demeter	18	11,35,79,110
Cereal Rye	Commercial	100	12,56,84,116
Medic	Harbinger AR	18	13,47,88,109
Ryegrass+Clover	Clare/Nuba/Victorian	15/8/8	14,63,94,111
Mustard	Ebony	18	15,54,86,132
Vetch	Blanchefleur	25	16,61,96,130
Medic	Paraggio	18	17,52,87,115
Oats/Mustard/Medic	Coolabah/Ebony/Parabinga	50/15/10	18,36,71,107
Fodder Radish	Adagio	22	19,41,90,124
Oats/Clovers	Coolabah/Elite/Maral/Nitro Plus	50/7/5/5	20,60,68,126
Medic	Mogul	18	21,45,85,118
Grass/White clover	Matilda/Tamar	15/10	22,51,76,125
Grass	Matilda perennial ryegrass	18	23,37,91,114
Subclover	Clare	22	24,49,81,131
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/20/20/16	25,40,97,122
Vetch	Languedoc	25	26,62,70,104
Subclover	Junee	22	27,59,93,113
Oats/Medic	Coolabah/Kelson	50/20	28,55,67,123
Subclover	Nungarin	22	29,65,83,100
Grass/Clover	Matilda/Palestine	15/10	30,53,78,120
Fodder Rape	Rangi	20	31,34,75,127
Vetch	Popany	25	32,57,95,121
Faba Bean	Rossa	120	33,44,80,103

15.32 TREATMENTS SCREENED AT PADTHAWAY 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medics	Santiago	18	1,58,72,108
Subclover	Denmark	25	2,48,99,102
Faba Bean	Rossa	150	3,39,74,128
Field Peas	Glenroy	150	4,42,92,112
Triticale	Tahara	150	5,46,89,106
Medic	Santiago/Serena	11/11	6,38,69,129
Subclover	Gosse	25	7,66,82,105
Medic	Carpet	22	8,64,98,101
Fodder Rape	Rangi	20	9,43,73,117
Medic	Paraggio/Caliph	11/11	10,60,77,119
Ryegrass+Clover	Matilda/York/Nungarin	15/8/8	11,35,79,110
Fodder Radish	Adagio	22	12,56,84,116
Oats/Mustard/Medic	Coolabah/Ebony/Paraggio	50/15/10	13,47,88,109
Grass/White clover	Matilda/Waverley	15/10	14,63,94,111
Grass	Currie/Victorian/Matilda	8/10/10	15,54,86,132
Oats/Clovers	Coolabah/Elite/Maral/Nitro Plus	50/7/5/5	16,61,96,130
Oats/Medic	Coolabah/Kelson	50/20	17,52,87,115
Mustard	Ebony	18	18,36,71,107
Oats	Coolabah	100	19,41,90,124
Triticale/Vetch	Tahara/Languedoc/Popany/Topcut	60/10/10/8	20,60,68,126
Beans/Peas/Vetch/Clover	Rossa/Glenroy/Blanchefleur/Argeles	30/30/15/20	21,45,85,118
Grass/White clover	Victorian/Tamar	15/10	22,51,76,125
Ryegrass+Clover	Ellet/Denmark/Gosse	15/8/8	23,37,91,114
Beneficial	Blanchefleur/Medic/Fenugreek/Clovers	10/8/5/15	24,49,81,131
Ryegrass+Clover	Clare/Nuba/Victorian	15/8/8	25,40,97,122
Medic	Paraggio	22	26,62,70,104
Subclover	Argeles	25	27,59,93,113
Subclover	Nuba	25	28,55,67,123
Grass/Clover	Ellet/Currie/Tamar/Waverley	10/5/5/5	29,65,83,100
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/20/20/16	30,53,78,120
Subclover	York	25	31,34,75,127
Medic	Santiago/Serena	11/11	32,57,95,121
Subclover	Goulburn	25	33,44,80,103

15.33 TREATMENTS SCREENED AT COONAWARRA 1996

Cover Crop Species	Cultivar	Seeding Rate (kg/ha)	Plot
Medics	Santiago	22	1,58,72,108
Subclover	Denmark	25	2,48,99,102
Faba Bean	Rossa	150	3,39,74,128
Field Peas	Glenroy	150	4,42,92,112
Triticale	Tahara	150	5,46,89,106
Medic	Santiago/Serena	11/11	6,38,69,129
Subclover	Junee	25	7,66,82,105
Medic	Carpet	22	8,64,98,101
Fodder Rape	Rangi	20	9,43,73,117
Medic	Parabinga/Paraggio	11/11	10,60,77,119
Ryegrass+Clover	Matilda/Junee/Nungarin	15/8/8	11,35,79,110
Fodder Radish	Adagio	22	12,56,84,116
Oats/Mustard/Medic	Coolabah/Ebony/Parabinga	50/15/10	13,47,88,109
Grass/White clover	Victorian/Waverley	15/10	14,63,94,111
Grass	Currie/Victorian/Matilda	8/10/10	15,54,86,132
Oats/Clovers	Coolabah/Elite/Maral/Nitro Plus	50/7/5/5	16,61,96,130
Oats/Medic	Coolabah/Kelson	50/20	17,52,87,115
Mustard	Ebony	18	18,36,71,107
Oats	Coolabah	100	19,41,90,124
Triticale/Vetch	Tahara/Languedoc/Popany/Topcut	60/10/10/8	20,60,68,126
Beans/Peas/Vetch/Clover	Rossa/Glenroy/Blanchefleur/Argeles	30/30/15/20	21,45,85,118
Grass/White clover	Victorian/Tamar	15/10	22,51,76,125
Ryegrass+Clover	Ellet/Denmark/Gosse	15/8/8	23,37,91,114
Beneficial	Blanchefleur/Medic/Fenugreek/Clovers	10/8/5/15	24,49,81,131
Ryegrass+Clover	Clare/Nuba/Victorian	15/8/8	25,40,97,122
Medic	Paraggio	22	26,62,70,104
Subclover	Argeles	25	27,59,93,113
Medic	Mogul	22	28,55,67,123
Grass/Clover	Ellet/Currie/Tamar/Waverley	10/5/5/5	29,65,83,100
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/20/20/16	30,53,78,120
Medic	Caliph	22	31,34,75,127
Medic	Paraggio/Santiago	11/11	32,57,95,121
Subclover	Goulburn	25	33,44,80,103

15.34 TREATMENTS SCREENED AT MITCHELTON 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot/Row
Peas	Glenroy	130	1,31,75,99
Faba Beans	Red	130	12,44,90,105
Oats/Brassica/Subcover	Coolabah/Mustard/Junee	50/15/10	15,53,79,122
Oats/Beans/Peas/Vetch	Coolabah/Red/Glenroy/Blanchefleur	35/20/20/15	23,41,58,119
Beans/Peas/Vetch		30/30/15	49,72,113,127
Ryecorn	Commercial	120	30,66,91,132
Ryecorn/Vetch	Languedoc/Popany/Topcut	50/10/10/8	20,28,62,116
Oats plus Medic	Coolabah/Kelson	60/25	9,34,83,112
Oats plus Clover	Coolabah/Elite/Maral/Nitro Plus	50/7/7/7	22,56,59,98
Brassica	Rangi Rape	22	37,68,101,125
Brassica	Mustard	22	24,40,63,97
Brassica	Fodder Radish	25	10,45,73,107
Beneficial	Vetch/medic/clover/grass/Fenugreek	10/8/6/5/5	48,82,109,131
Fenugreek		25	2,38,61,123
Annual Medic	Paraggio	22	8,35,77,100
Annual Medic	Santiago	22	21,52,69,104
Subclover	Nuba	22	4,47,64,95
Subclover	Junee	22	5,46,67,103
Subclover	Gosse	22	33,85,121,124
Subclover	Denmark	22	19,54,88,106
Subclover	Argeles	30	6,57,60,92
Subclover	Clare	25	18,26,84,110
Ryegrass+Clover	Victorian/Nuba/Clare	15/8/8	27,87,96,128
Ryegrass+Clover	Ellet/Denmark/Gosse	15/8/8	32,86,93,129
Cocksfoot plus Ryegrass	Currie/ Victorian/Matilda	5/10/10	3,43,76,111
Cocksfoot	Currie	15	13,25,81,118
Fescue	Demeter	22	17,51,71,117
White Clover plus Grass	Waverley/Victorian	10/15	14,42,74,102
White Clover plus Grass	Tamar/Victorian	10/15	29,65,108,126
White Clover	Tamar	12	7,39,89,114
White Clover	Waverley	12	11,36,78,120

1996 MITCHELTON RESULTS

1996 CCT COVER CROP TRIALS MITCHELTON WINERY, NAGAMBIE VICTORIA ANALYSIS AND SUMMARY OF RESULTS CULTIVAR	*SWARD VIGOUR RATING 30-May-96*	*SWARD VIGOUR RATING 12-Sep-96*	*SWARD VIGOUR RATING 19-Jan-97*	*SWARD VIGOUR RATING 6-Jul-97*	*SWARD VIGOUR RATING 30-Sep-97*	*SWARD HEIGHT 30-May-96*	*SWARD HEIGHT 12-Sep-96*	*DENSITY EMERGE #/METRE 30-May-96*	*PERCENT GROUND COVER 12-Sep-96*	*PERCENT GROUND COVER 19-Jan-97*	*PERCENT FLOWER 12-Sep-96*	*RESIDUE DENSITY 19-Jan-97*
ROSSA FABA BEAN	6.3	9.4	0.0	0.0	0.0	15.0	100.0	6.5	97.5	0.0	100.0	0.6
CEREAL RYE	9.0	9.3	0.3	0.0	0.0	22.0	147.5	25.5	36.3	0.0	100.0	2.8
DENMARK/GOSSE/ELLET	6.5	8.8	6.5	8.0	9.5	15.0	20.0	16.0	77.5	51.7	0.0	2.1
ADAGIO	8.0	8.8	0.0	0.0	0.3	18.0	107.5	21.0	68.8	0.0	92.5	1.8
EBONY	6.3	8.6	0.0	0.0	0.0	5.0	103.8	36.0	65.0	0.0	57.5	1.8
COOLABAH	4.0	8.6	0.0	0.0	2.0 *		98.3 *		87.1	0.4	15.0	2.1
RANGI RAPE	4.5	8.5	6.8	2.0	1.0	10.0	37.5	11.0	95.0	63.8	0.0	0.5
BLEND 'E'	3.2	8.4	0.0	0.0	3.0	8.0	96.3	15.5	88.8	0.0	0.0	2.1
COOLABAH/EBONY/JUNEE	4.8	8.3	0.0	0.0	3.3	15.0	102.5	48.0	81.3	0.0 *		2.0
SANTIAGO	1.8	7.9	0.3	5.0	4.7	4.0	18.0	23.0	93.8	0.3	61.3	1.7
CLARE/NUBA/VICTORIAN	4.0	7.7	7.3	8.0	8.8	4.0	14.0	64.0	57.3	50.0	0.0	2.3
COOLABAH/KELSON	5.3	7.6	0.0	0.0	0.0	10.5	78.8	21.5	83.8	0.0	0.0	2.0
NUBA	5.3	7.5	0.0	7.0	8.1	2.0	15.0	10.0	88.8	0.0	0.0	2.8
BLEND 'D'	7.0	7.0	0.1	0.0	0.7	6.0	137.5	22.5	61.3	0.3	0.0	2.5
GOSSE	3.0	6.9	0.0	9.0	9.5	5.0	13.3	44.0	53.3	0.0	0.0	2.6
PARAGGIO	2.0	6.9	0.0	0.5	2.7	2.5	17.5	19.0	87.5	0.0	55.0	1.9
WAVERLEY/VICTORIAN	3.5	6.8	7.5	7.5	8.2	3.0	10.5	29.5	61.3	70.0	0.0	1.3
CURRIE/VICTORIAN/ MATLDA	4.3	6.5	7.6	10.0	8.0	6.0	11.0	43.5	62.5	68.8	0.0	0.9
ARGELES	2.5	5.9	0.0	4.0	7.8	1.0	11.8	13.0	67.5	0.0	0.0	2.6
CURRIE	0.5	5.8	7.5	9.0	8.0	0.0	8.8 *		35.0	72.5	0.0	0.5
BLEND 'C'	0.0	5.7	0.0	0.0	7.5 *		55.0 *		58.8	0.0	0.0	1.9
TAMAR/VICTORIAN	1.0	5.5	7.1	7.0	5.5	4.0	7.0	30.0	19.3	57.5	0.0	0.6
CLARE	2.0	5.1	0.0	8.0	8.7	1.0	6.0	11.0	71.3	0.0	0.0	2.8
FENUGREEK	5.8	4.5	0.0	0.0	0.0	8.0	30.0	27.5	38.8	0.0	100.0	0.0
BLEND 'A'	6.3	4.5	0.3	0.0	0.0	21.0	68.8	14.0	45.0	0.0	0.0	1.6
DENMARK	2.8	4.3	0.0	7.5	6.3	1.0	2.3	19.0	36.7	0.0	0.0	1.7
GLENROY	4.5	4.3	0.0	0.0	0.0	12.5	48.8	6.0	30.0	0.0	100.0	0.5
DEMETER	4.5	4.0	7.0	7.0	6.3	0.0	9.8 *		23.8	61.3	0.0	1.3
TAMAR	0.5	3.5	2.9	3.0	3.7	0.5	5.3	4.0	24.5	21.3	0.0	0.8

JUNEE	4.8	3.3	0.0	5.0	5.2	1.0	5.3	12.0	30.0	0.0	0.0	1.3
GOULBURN	0.0	3.0	0.0	0.0	4.5	*	2.0	*	26.8	0.0	0.0	2.2
WAVERLEY	4.3	0.8	2.8	2.0	5.0	3.5	2.0	40.0	2.5	22.3	0.0	1.1
BLEND 'B'	2.0	0.0	1.0	0.0	5.0	*	0.0	*	0.0	2.3	0.0	1.2
LSD(95%)		1.0	0.7				3.2		16.7	10.2		0.4

BLEND 'A': COOLABAH/ELITE/MARAL/NITRO PLUS

BLEND 'B': BLANCHEFLEUR/HIGHLANDER/PARADANA/PROLIFIC/FENUGREEK/PROLIFIC/WAVERLEY/CURRIE/JUNEE

BLEND 'C': GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO

BLEND 'D': CEREAL YE/LANGUEDOC/POPANY/TOPCUT

BLEND 'E': GLENROY/COOLABAH/RED EBAN/BLANCHEFLEUR/POPANY/ARGELES/SANTIAGO

15.36 TREATMENTS SCREENED AT RUTHERGLEN 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Vetch	Topcut	25	1,58,72,108
Fenugreek		25	2,48,99,102
Subclover	Nuba	22	3,39,74,128
Ryegrass	Ellet	25	4,42,92,112
Vetch	Blanchefleur	25	5,46,89,106
Grass/Clover	Derby/Palestine	15/15	6,38,69,129
Ryegrass	Victorian	25	7,66,82,105
Oats/Vetch	Coolabah/Topcut	50/20	8,64,98,101
Oats/Beans/Peas/Vetch	Rossa/Glenroy/Blanchefleur/Argeles	30/30/15/10	9,43,73,117
Subclover	Argeles	22	10,60,77,119
Ryegrass/Clovers	Ellet/Elite /Nitro Plus	15/10/8	11,35,79,110
Ryegrass+Clover	Denmark/Gosse/Ellet	8/8/15	12,56,84,116
Mustard	Ebony	18	13,47,88,109
Vetch	Popany	25	14,63,94,111
Subclover	Junee	22	15,54,86,132
Ryegrass	Matilda perennial ryegrass	25	16,61,96,130
Ryegrass+Clover	Argeles/Nuba/Victorian	10/8/15	17,52,87,115
Oats	Coolabah	100	18,36,71,107
Grass/White clover	Victorian/Tamar	15/10	19,41,90,124
Subclover	Nungarin	22	20,60,68,126
Grass	Demeter	20	21,45,85,118
Oats/Mustard/Clover	Coolabah/Ebony/Junee	50/15/10	22,51,76,125
Faba Bean	Rossa	130	23,37,91,114
Oats/Vetch	Coolabah/Blanchefleur	50/20	24,49,81,131
Subclover	Gosse	22	25,40,97,122
Grass	Currie cocksfoot	50/20	26,62,70,104
Fodder Rape	Rangi	20	27,39,93,113
Field Peas	Glenroy	130	28,55,67,123
Oats/Medic	Coolabah/Kelson	60/25	29,65,83,100
Subclover	Goulburn	22	30,53,78,120
Fodder radish	Adagio	22	31,34,75,127
Subclover	Denmark	22	32,57,95,121
Lupins	Gungurru	120	33,44,80,103

15.37 1996 RUTHERGLEN RESULTS

1996 CCT COVER CROP TRIALS PFEIFFERS WINERY WAHGUNYAH VICTORIA ANALYSIS AND SUMMARY OF RESULTS CULTIVAR	*SWARD VIGOUR RATING 2-Jun-96*	*SWARD VIGOUR RATING 12-Sep-96*	*SWARD VIGOUR RATING 22-Jan-97*	*EMERGE DENSITY #/SQ M 2-Jun-96*	*SWARD HEIGHT 12-Sep-96*	*SWARD HEIGHT 22-Jan-97*	*PERCENT GROUND COVER 12-Sep-96*	*PERCENT GROUND COVER 22-Jan-97*	*PERCENT FLOWER 12-Sep-96*	*SUMMER WEED SUPPRESSION 22-Jan-97*
BLANCHEFLEUR	5.1	9.7	0.0	6.3	6.0	51.7	82.8	0	55.0	10
BLEND 'A'	3.3	8.5	0.0	13.3	11.0	63.3	68.3	0	0.0	10
TOPCUT	4.5	8.1	0.0	9.8	11.8	40.0	73.8	0	0.0	10
GLENROY	3.6	8.0	0.0	5.3	15.5	61.3	42.5	0	85.0	10
MATILDA	5.9	7.4	6.0	35.0	6.0	8.3	56.3	10.75	0.0	8
COOLABAH/BLANCHEFLEUR	5.3	7.4	0.0	16.3	13.8	47.5	70.0	0	0.0	10
ADAGIO	5.6	7.0	0.0	12.0	11.8	70.0	36.3	0	78.8	10
COOLABAH/EBONY/JUNEE	6.6	6.9	0.0	33.3	13.8	50.0	58.8	0	0.0	10
COOLABAH/TOPCUT	6.1	6.9	0.0	15.0	11.8	42.5	76.3	0	0.0	10
CURRIE	1.0	6.5	0.0	35.5	2.8	7.8	37.5	0	0.0	10
VICTORIAN	5.8	6.4	4.0	40.8	6.3	7.5	45.0	12.5	0.0	8
ELLET	6.0	6.3	6.7	43.3	7.3	6.5	35.0	42.5	0.0	4
NUNGARIN	1.8	6.3	0.0	15.0	1.1	5.8	72.5	0	35.0	10
ROSSA FABA BEAN	4.8	6.3	0.0	7.3	11.5	48.8	43.8	0	100.0	10
NUBA	2.3	6.1	0.0	9.5	1.6	15.5	52.5	0	0.0	10
DENMARK/GOSSE/ELLET	5.1	6.0	8.0	42.5	5.8	5.5	52.5	30	0.0	5
ARGELES/NUBA/VICTORIAN	5.0	6.0	3.5	40.8	5.8	9.8	67.5	31.25	0.0	3
ARGELES	2.0	5.8	0.0	14.8	1.1	9.5	60.0	0	0.0	10
GOSSE	1.6	5.4	0.0	12.0	1.3	14.5	46.3	0	0.0	10
GOULBURN	1.6	5.4	0.0	11.8	1.0	11.8	28.8	0	0.0	10
COOLABAH	5.3	5.1	0.0	18.8	11.8	32.5	40.0	0	1.3	10
DEMETER	3.3	5.0	8.0	29.3	5.0	6.0	32.5	15	0.0	8
TAMAR/VICTORIAN	4.5	4.9	4.0	41.8	5.0	4.3	52.5	3.75	0.0	8
JUNEE	1.6	4.9	0.0	11.8	1.0	7.8	43.8	0	0.0	10
ELLET/NITRO PLUS/ELITE	5.3	4.6	8.0	44.0	5.0	7.0	36.3	0	0.0	10
GUNGURRU	3.0	4.6	0.0	6.3	7.5	30.8	27.5	0	68.8	10
DENMARK	1.8	4.5	0.0	12.5	1.3	5.3	60.0	0	0.0	10
COOLABAH/KELSON	4.6	4.4	0.0	18.5	9.5	30.0	40.0	0	0.0	10
PALESTINE/DERBY	3.6	4.3	6.5	47.3	3.8	3.8	46.3	27.5	0.0	5
EBONY	5.3	4.1	0.0	25.5	3.8	52.5	18.8	0	27.5	10
POPANY	1.3	3.8	0.0	6.5	3.8	15.0	16.7	0	0.0	10
RANGI RAPE	6.0	3.5	0.0	34.0	6.0	11.0	36.3	0	0.0	10
FENUGREEK	3.6	1.7	0.0	9.0	4.5	13.3	3.3	0	22.5	10
LSD(95%)	0.7	0.7		4.7	1.0	4.1	9.3			12.1

BLEND 'A' GLENROY/ROSSA FABA BEAN/BLANCHEFLEUR/ARGELES/PARAGGIO

15.38 TREATMENTS SCREENED AT HANWOOD 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medic	Santiago	22	1,58,72,108
Subclover	Nungarin	5/10/10	2,48,99,102
Clover	Maral	50/7/7/7	3,39,74,128
Peas	Glenroy	150	4,42,92,112
Ryegrass+Clover	Matilda/Junee/Nungarin	15/8/8	5,46,89,106
Brassica	Mustard	22	6,38,69,129
Subclover	Clare	25	7,66,82,105
Clover	Elite II	20	8,64,98,101
Medic	Parabinga	22	9,43,73,117
Ryegrass+Clover	Ellet/Denmark/Gosse	15/8/8	10,60,77,119
Balansa Clover	Paradana	15	11,35,79,110
Brassica	Rangi Rape	25	12,56,84,116
Medic	Paraggio	22	13,47,88,109
Subclover	Argeles	30	14,63,94,111
Brassica	Fodder Radish	30	15,54,86,132
Clover	Prolific	15	16,61,96,130
White Clover plus Grass	Waverley/Victorian	10/15	17,52,87,115
White Clover	Tamar	15	18,36,71,107
Cocksfoot plus Ryegrass	Currie/ Victorian/Matilda	5/10/10	19,41,90,124
Faba Bean	Rossa	150	20,60,68,126
Medic	Kelson	30	21,45,85,118
Oats	Coolabah	100	22,51,76,125
Vetch	Blanchefleur	30	23,37,91,114
White Clover	Waverley	15	24,49,81,131
Ryegrass+Clover	Victorian/Nuba/Clare	15/8/8	25,40,97,122
Vetch	Topcut	25	26,62,70,104
Subclover	Nuba	22	27,59,93,113
White Clover plus Grass	Tamar/Victorian	10/15	28,55,67,123
Strawberry Clover/Grass	Derby/Palestine	15/10	29,65,83,100
Oats/Clover	Coolabah/Elite II/Maral	60/8/8	30,53,78,120
White Clover/Grass	Tamar/Waverley/Victorian/Demeter	5/5/10/5	31,34,75,127
Subclover	Goulburn	22	32,57,95,121
Vetch	Popany	30	33,44,80,103

15.39 TREATMENTS SCREENED AT VENDA 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate (kg/ha)	Plot
Medics	Paraggio	22	1,58,72,108
Subclover	Nuba	22	2,48,99,102
Persian Clover	Maral	15	3,39,74,128
Vetch	Topcut	25	4,42,92,112
Balansa	Paradana	15	5,46,89,106
Mustard	Ebony	15	6,38,69,129
Medics	Santiago/Serena	22	7,66,82,105
Oats/Vetch	Coolabah/Blanchefleur/Topcut/Popany	50/8/10/8	8,64,98,101
Medic	Parabinga	22	9,43,73,117
Subclover	Argeles	30	10,60,77,119
Oats/Mustard/Clover	Coolabah/Ebony/Junee	50/15/10	11,35,79,110
Fodder Rape	Rangi	20	12,56,84,116
Beans/Peas/Vetch/Clover	Rossa/Glenroy/Blanchefleur/Argeles	30/30/15/16/10	13,47,88,109
Subclover	Denmark	22	14,63,94,111
Fodder Radish	Adagio	22	15,54,86,132
Vetch	Blanchefleur	25	16,61,96,130
Oats/Medic	Coolabah/Kelson	60/25	17,52,87,115
Subclover	Clare	25	18,36,71,107
Grasses	Currie/Victorian/Matilda	21	19,41,90,124
Faba Bean	Rossa	120	20,60,68,126
White Clover	Waverley	15	21,45,85,118
Oats/Beans/Peas/Vetch	Coolabah/Rossa/Glenroy/Blanchefleur	35/20/20/16	22,51,76,125
Grass/Clover	Ellet/Paradana/Clare	15/5/15	23,37,91,114
Grass	Victorian perennial ryegrass	20	24,49,81,131
Grass/Subclover	Victorian/Argeles/Nuba	15/10/8	25,40,97,122
Grass	Currie cocksfoot	10	26,62,70,104
Grass/Subclover	Ellet/Denmark/Gosse	15/10/8	27,59,93,113
Grass/White clover	Victorian/Tamar	15/10	28,55,67,123
Grass	Demeter	18	29,65,83,100
Oats/Clovers	Coolabah/Elite/Maral/Nitro Plus	50/7/5/5	30,53,78,120
Grass/Clover	Victorian/Demeter/Tamar/Waverley	10/5/5/5	31,34,75,127
Lupins	Gungurru	100	32,57,95,121
Grasses	Ellet	20	33,44,80,103

15.41 TREATMENTS SCREENED AT QUALCO 1996

Cover Crop Species	Cultivar/Blend	Seeding Rate(kg/ha)	Plot
Medics	Santiago	18	1,58,72,108
Subclover	Clare	25	2,48,99,102
Persian Clover	Maral	10	3,39,74,128
Faba Beans	Rossa	150	4,42,92,112
Vetch	Languedoc	25	5,46,89,106
Mustard	Ebony	10	6,38,69,129
Medic	Serena	22	7,66,82,105
Medic	Parabinga	22	8,64,98,101
Balansa	Paradana	10	9,43,73,117
Subclover	York	25	10,60,77,119
Berseem Clover	Elite II	15	11,35,79,110
Vetch	Topcut	25	12,56,84,116
Medic	Paraggio/Santiago	11/11	13,47,88,109
Ryegrass+Clover	Matilda/York/Nungarin	15/8/8	14,63,94,111
Subclover	Denmark	25	15,54,86,132
Medic	Zodiac	22	16,61,96,130
Vetch	Popany	25	17,52,87,115
Beans/Peas/Vetch/Clover	Rossa/Glenroy/Blanchefleur/Paraggio	30/30/15/20	18,36,71,107
Perennial Grass	Currie/Victorian/Matilda	8/10/10	19,41,90,124
Medic	Harbinger AR	22	20,60,68,126
Subclover	Goulburn	25	21,45,85,118
Field Peas	Glenroy	150	22,51,76,125
Untreated Control			23,37,91,114
Subclover	Junee	25	24,49,81,131
Oats/Mustard/Medic	Coolabah/Ebony/Paraggio	50/15/10	25,40,97,122
Medic	Paraggio	22	26,62,70,104
Fodder Rape	Rangi	20	27,59,93,113
Oats	Coolabah	100	28,55,67,123
Medic	Kelson	25	29,65,83,100
Ryegrass+Clover	Victorian/Clare/Nuba	15/8/8	30,53,78,120
Oats/Medic	Coolabah/Kelson	50/20	31,34,75,127
Oats/Clovers	Coolabah/Elite/Maral/Nitro Plus	50/7/5/5	32,57,95,121
Fodder Radish	Adagio	25	33,44,80,103

16 ATTACHMENTS

16.1 ***Cover Crops*** *For Sustainable Vineyard Management*, printed 1995.

The objective of this publication was to create an awareness of the project among grape growers in Australia, and to pre-empt the final cover crop guide.

16.2 ***1997 Cover Crop Guide*** *for Australian Vineyards*, printed in 1997.

Four different versions of this publication were printed, totalling 2000 copies. Versions were printed to provide specific cover crop species and cultivar suggestions for Coonawarra, Sunraysia, Riverland and MIA regions.

16.3 ***Cover Crops*** *A guide to species selection and sward management*, printed in 1998.

Fifteen different versions of this publication were printed, totalling 7000 copies. Versions were printed to provide specific cover crop species and cultivar suggestions for grape growing regions (see appendices for these regional charts)

16.4 *VinEco Product range Technical Information.*

A description of some of the VinEco seed blends/products and their management, printed in 1998 to compliment marketing initiatives and literature.

16.5 ***Cover Crop Questionnaire.***

Compiled by Dominic Scicchatano in 1994, and providing information regarding vineyard size, irrigation methods, cover crop utilisation and sward management techniques in Australian vineyards.

16.6 ***Cover Cropping Technology in Vineyards*** *A preliminary Literature Review.*

Prepared by Dominic Scicchatano at the commencement of the project in 1994.

16.7 ***USA and South Africa Trip Report***

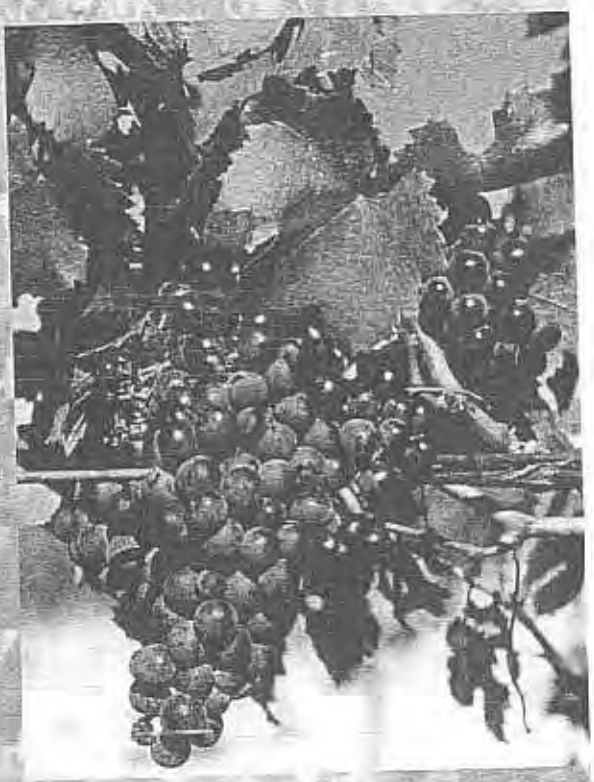
Written by Richard Porter and describing the overseas study tour conducted from the 4th to 29th of February 1996.

16.8 ***Cover Crop Technology 1996 Field Day Report***

Compiled by Richard Porter, reporting on observations, discussions and recommendations arising from a series of field days conducted in spring 1996 at major sites established in autumn of that year in various regions across South Eastern Australia.

16.9 ***Cover crop Selection***

A colour copy of the poster presented at the 10th Australian Wine Industry Technical Conference, Sydney 1998.



Cover Crops

For Sustainable

Vineyard Management

Grape and Wine Research and Development Corporation

seedco

The Quality Seed Company of Australia

Potential for Erosion.

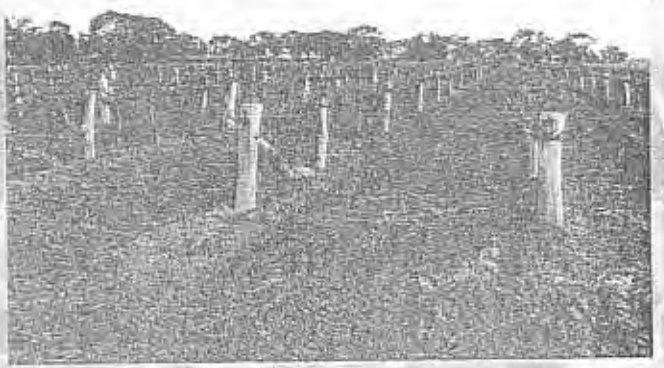
Waterlogging Due to Poor Soil Structure.

High Level of Weed Infestation

PROBLEMS OF VINEYARD MANAGEMENT

Cover Crops are currently being used in vineyards to address a range of management problems including:

- Poor soil structure
- Poor soil fertility
- Poor water use efficiency
- Poor water infiltration
- Low organic matter content in soil
- Poor trafficability/access
- Loss of topsoil through wind and water erosion
- Water and soil salinity
- Hard pans/soil compaction
- High weed population providing habitat for pests
- Increasing incidence of nematodes
- Excessive temperatures in vine canopy
- Nutrient loss through leaching



Potential for Compaction and Erosion due to Continuous Cultivation

BENEFITS OF COVER CROPS

The major long term benefits of cover crops for vineyard management are:

- Improved soil structure resulting in:
  - → Increased water infiltration
  - → Reduced run off
  - → Greater water use efficiency
  - → Improved trafficability/access
  - → Reduced soil compaction
- Increased levels of organic matter in the topsoil
- Improved pest management and vine nutrition
- Reduced tillage
- Protection from wind and water erosion
- Attraction of beneficial insects, spiders and soil borne organisms
- Potential suppression/reduction of some pests
- Reduced weed population
- Protection of young vines from wind blast damage

Cover Crop Establishment

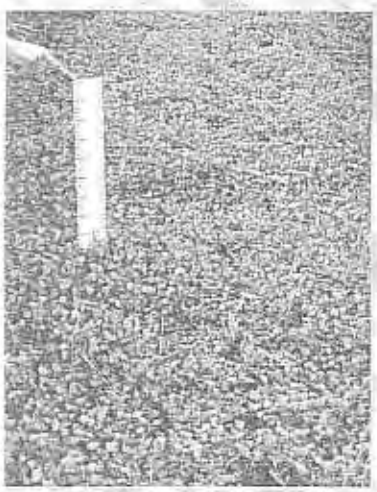
Cover Crop Maintenance

Mowing of Cover Crop.

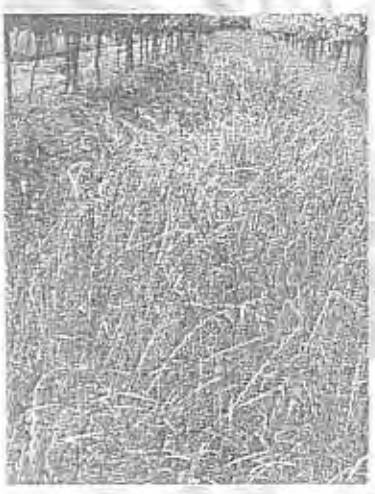
Effective Perennial Ryegrass Cover Crop

Vineyard trial evaluating a broad range of plant types.

Brassica crops have benefits where nematodes are a problem.



An annual legume providing a regenerating, prostrate sward.



Perennial grasses persist for a number of years and contribute significantly to improvements in soil structure and organic matter content.

WHICH COVER CROP TO SELECT?

Ongoing field trials are being conducted by Seedco with assistance from the Grape and Wine Research and Development Corporation. These will provide more information on the regional suitability of a range of crop plants and mixtures to use as green manure or permanent ground cover within diverse management systems.

Possible cover crops include:

ANNUAL *(nitrogen fixing)* LEGUMES

VETCH *(Vicia spp)*
Medium height, dense growth.

SUB CLOVERS *(Trifolium subterranean)*
Dense, low growth. Self regenerating.

MEDICS *(Medicago spp)*
Dense, low growth. Self regenerating, low rainfall regions.

PERSIAN CLOVER *(Trifolium resupinatum)*
Low to medium height, dense growth. Long and short season types.

BALANSA CLOVER *(Trifolium balansae)*
Dense low growing, tolerant of water logging.

FABA BEANS, FIELD PEAS
Medium to tall height.

PERENNIAL *(nitrogen fixing)* LEGUMES

WHITE CLOVER *(Trifolium repens)*
Dense, low growing.

STRAWBERRY CLOVER *(Trifolium fragiferum)*
Dense, low growing. Tolerant of water logging, drought and salinity.

LUCERNE *(Medicago sativa)*
Medium height, deep rooted, persistent.

GRASSES

RYEGRASS *(Lolium spp)*
Annual and perennial species, low to tall types. Tolerant of a wide range of environments.

FESCUES *(Festuca spp)*
Medium to tall types tolerant of waterlogging and salinity.

CEREALS AND OTHER PLANTS

OATS, TRITICALE, RYECORN
Tall, quick growing annuals suitable for mulching.

BRASSICA SPECIES eg. MUSTARD, RADISH, RAPE
Tall, quick growing with ability to biofumigate soil.

seedco

SOUTH AUSTRALIAN
SEEDGROWERS
CO-OPERATIVE LIMITED

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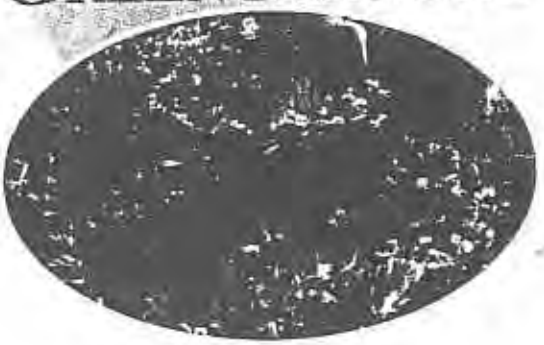
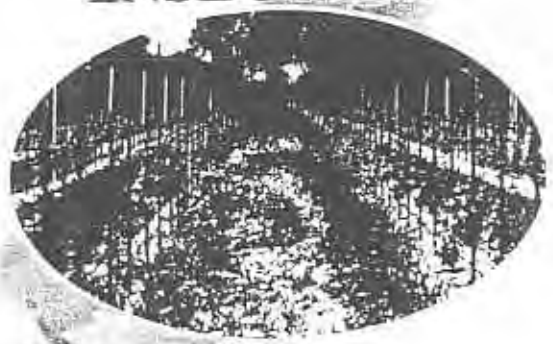
FOR MORE INFORMATION CONTACT YOUR LOCAL DISTRIBUTOR

1997 COVER CROP GUIDE
for
Australian Vineyards

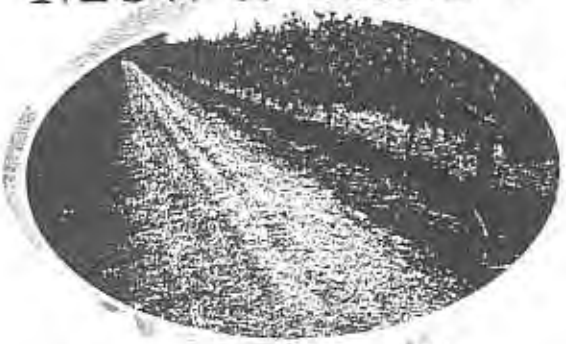
GREEN MANURE



INSECTARY



MOW & THROW



BIOFUMIGANT

ANNUAL SWARDS

PERENNIAL SWARDS

This guide has been produced by SEEDCO with the assistance of the GWRDC.

Grape and Wine
Research and
Development Corporation

seedco

COVER CROP CHARACTERISTICS

COVER CROP OPTION	CROP TYPES	*RELATIVE SEASONAL GROWTH				RELATIVE TOTAL BIOMASS PRODUCTION	RELATIVE SPRING SWARD HEIGHT
		Aut	Win	Spr	Sum		
GREEN MANURE	CEREALS	2	2	4	0	HIGH	TALL
	FABA BEANS	2	3	5.5	0	HIGH	TALL
	FIELD PEAS	2	2	5	0	MODERATE	MEDIUM
	VETCH	1	1.5	4	0	MODERATE	MEDIUM
	+FORAGE BLENDS	2	3	5	0	VERY HIGH	TALL
ANNUAL SWARDS	MEDICS	1	1	2.5	0.5	LOW	LOW
	SUBCLOVER	1	1	2	0	LOW	LOW
PERENNIAL SWARDS	RYEGRASS	1.5	2	3	1-2	MODERATE	LOW-MEDIUM
	FESCUE	1.5	1	3.5	3.5	MODERATE	MEDIUM
	COCKSFOOT	1	1	2.5	3	MODERATE	MEDIUM
	LUCERNE	1.5	1	3	3	MODERATE	MEDIUM
	WHITE CLOVER	1.5	2	2.5	2.5	MODERATE	LOW-MEDIUM
	STRAWBERRY CLOVER	1	1	2	3	LOW	LOW-MEDIUM
BIOFUMIGANT SWARDS	RAPE	1.5	1.5	2	2	MODERATE	MEDIUM
	MUSTARD	2	2	4	0	HIGH	VERY TALL
	FODDER RADISH	2	2.5	5	0	HIGH	VERY TALL

* RELATIVE SEASONAL GROWTH 1=LOW, 5=HIGH

Aut=AUTUMN, Win=WINTER, Spr=SPRING, Sum=SUMMER

+ FORAGE BLENDS WHICH CONSIST OF CEREALS AND LEGUMES

Specific Regional Selection Charts are available which consider critical local criteria such as soil pH, mean annual rainfall and it's distribution, soil type, irrigation method, and frost risk.

DISCLAIMER

Cover crops provide many potential benefits.
However there is potential for some cover crops to host Light Brown Apple Moth or phytoplasmas which are associated with Grapevine Yellows diseases.
Your selection should involve the consideration of incidence and management of these particular problems.
Ongoing research will progressively improve the selection of cover crops, and as such these options are provided in the light of current experience and maybe subject to upgrade over time

POINTERS FOR RELIABLE COVER CROP ESTABLISHMENT

1 SEED BED PREPARATION

The seed bed should provide an even soil surface which will allow accurate seed placement and permit good seed-soil contact.

Minimum soil disturbance is desirable. Keep use of rotary hoes to a minimum, as these machines pulverize the soil, destroying it's structure and creating hardpans.

Direct Drilling is advocated where possible, depending on soil type and suitability of the seeder used.

2 SEEDING DEPTH

Depth of seed burial is related to seed size. Small seeds(clovers, medics, brassicas and grasses) must not be sown deeper than 1/2 inch(10-15mm). Medium sized seeds such as vetch should not be buried deeper than 1/2 to 1 inch (15-25mm). Larger seeds(cereals, beans, peas) should be sown at 1 to 1 and 1/2 inches(20-35mm). Broadcast seed should be incorporated, even lightly with harrows or trailed weldmesh sheet, to provide good seed coverage.

3 FERTILISER

Legume cover crops do not require nitrogen fertilisers. Apply super phosphate at the rate of 150-200 kg/ha. This can be applied prior to or at seeding.

Cereal crops should receive 100-150 kg/ha DAP at the time of sowing, with an additional application of Nitrogen in late winter beneficial for added spring growth.

Brassica crops require 150 kg/ha DAP as a minimum to ensure good biomass production.

Refer to local fertiliser retailer for specific recommendations.

4 INOCULATION

Legumes require inoculation with rhizobium to effectively fix nitrogen. Seed should be treated with the appropriate strain prior to seeding, as indicated in the table below:

LEGUME	**RHIZOBIUM STRAIN**
FABA BEANS, PEAS, VETCH	E
MEDICS	AM
SUB CLOVERS	C
WHITE AND STRAWBERRY CLOVERS	B
LUPINS	G
LUCERNE	AL

5 CONTROL OF INSECT PESTS

Pasture legumes such as medics and sub clovers are very susceptible to insect pests at emergence, and an application of insecticide to control Red Legged Earth Mite may be required after seeding to help ensure a dense sward over winter. Contact your local retailer for recommendations.

DEFINITIONS

Within the viticultural and horticultural industries, there remains some confusion regarding terminology with reference to cover crops. As a means of avoiding this confusion, the following definitions are provided:

Cover Crop - refers to any plant population established in the inter row area of a vine or tree crop, irrespective of the end use of the sward.

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

Green Manure(GM) - refers to an annual cover crop, resown each Autumn, and grown for maximum spring biomass production. This bulk matter can be desiccated or mowed, and/or incorporated at the appropriate time, usually prior to budburst in late winter or early spring.

Annual Regenerating Sward(ARS) - A sward consisting of plant species which set seed in spring prior to senescence, and regenerate from such seed in the following Autumn. Examples include annual medics and sub clovers.

Perennial Sward(PS) - Perennial species such as ryegrass, fescue, cocksfoot, lucerne, and white and strawberry clovers. These swards persist over summer and most often provide year round green growth.

BioFumigant(BF) Swards - consist mainly of brassica species, such as Fodder Radish, Fodder Rape and Oil Seed Mustard. These swards are utilised to suppress soil borne nematode populations and some soil fungal pathogens via the release of Glucosilonates following the incorporation of plant material. Critical management is required to maximise the biofumigant effect achieved.

Beneficial/Insectary Swards - Used to provide a continuous bloom over spring and summer. Utilised as a haven for a range of insect species, and to provide a source of nourishment for beneficial or predatory species, such as Lacewings and Trichogramma wasps.

Seeding Rate - refers to the weight of seed distributed over a given area of coverage. Within a vineyard, the area sown to a cover crop is approximately half the total 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.

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

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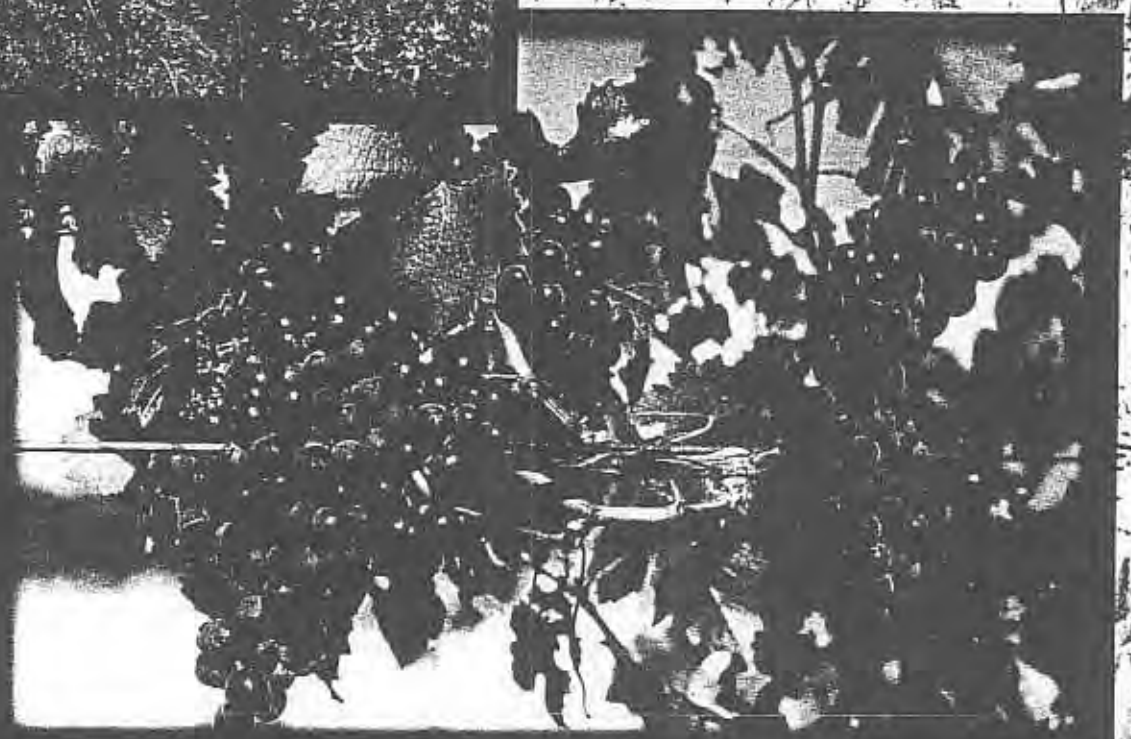
Cover Crops



A guide to species selection and sward management

seedco

Grape and Wine Research and Development Corporation

The Quality Seed Company of Australia

COVER CROP SELECTION GUIDE

Seedco and the Grape and Wine Research and Development Corporation (GWRDC) have undertaken a project which is optimising the use of cover crops in Australian vineyards. This large program consisted of over eighty trial sites across three states of South Eastern Australia in the period 1994-98. The major focus has been on optimising cover crop selection and management processes, to achieve:-

- reduced soil erosion
- maintenance of beneficial soil and cover crop organisms
- improved trafficability
- improved soil structure
- sustainability of the vineyard system
- suppression of volunteer weed growth

Some of the challenges to widespread adoption of cover crops have included:-

- achieving appropriate seed bed preparation and conditions without creating an unacceptable risk of erosion.
- managing potential competition for water and nutrients between cover crops and vines.
- avoiding the risk of harboring pests and diseases.

The decision to grow a cover crop carries with it a level of economic risk. This risk can be minimised by carefully planning cover crop establishment and management, identifying desired benefits, and defining short and long term objectives.

The aim of seeding a cover crop is to employ mid row management which achieves a desired benefit for the vineyard system whilst remaining compatible with existing management objectives and infrastructure. Correct cover crop selection and sward management is crucial in maximising benefits and minimising demand on resources, whilst at the same time ensuring long term sustainability and productivity.

COVER CROP CHARACTERISTICS

The following chart summarises growth characteristics and pest hosting abilities for the main cover crop types

COVER CROP OPTION	CROP TYPE	SEASONAL GROWTH RATING				TOTAL BIOMASS RATING	SPRING SWARD HEIGHT	ROOT KNOT NEMATODE HOST STATUS	LBAM HOST STATUS
		Aut	Win	Spr	Sum				
GREEN MANURE	OATS	2	2	4	0	HIGH	TALL	○	
	OTHER CEREALS	2	2	4	0	HIGH	TALL	○ - ◉	
	FABA BEANS	2	3	4	0	HIGH	TALL	●	
	FIELD PEAS	2	2	3	0	MODERATE	MEDIUM	●	
	VETCH	1	1.5	3	0	MODERATE	MEDIUM	●	
	FORAGE BLENDS	2	3	4	0	HIGH	TALL		
ANNUAL REGENERATING SWARDS	MEDICS	1	1	2	0	LOW - MODERATE	LOW- MEDIUM	●	
	SUBCLOVER	1	1	2.5	0	LOW	LOW	●	
	RYEGRASS	2	2	3.5	0.5	MODERATE	MEDIUM - TALL	○	
PERENNIAL SWARDS	RYEGRASS	1.5	2	3	0-2	MODERATE	LOW	○	
	FESCUE	1.5	1	2.5	2.5	MODERATE	MEDIUM	○	
	COCKSFOOT	1	1	2.5	2.5	MODERATE	MEDIUM	○	
	LUCERNE	1.5	1	3	3.5	MODERATE	MEDIUM	●	
	WHITE CLOVER	1.5	2	2.5	2.5	MODERATE	LOW - MEDIUM	●	
	CHICORY	1	0.5	2	4	HIGH	TALL	Not Determined	Not Determined
BRASSICA CROPS	RAPE	1.5	1.5	2.5	0	MODERATE	MEDIUM	◉	
	MUSTARD	2	2	3	0	HIGH	TALL	◉	
	FODDER RADISH	2	2.5	4	0	HIGH	TALL	○	

SEASONAL GROWTH RATING 1 LOW - 5 HIGH
Aut - AUTUMN, Win - WINTER, Spr - SPRING, Sum - SUMMER
LBAM (Light Brown Apple Moth) - *Epiphyas postvittana*
Root Knot Nematode - *Meloidogyne javanica*

○ NON HOST
◉ MODERATE HOST
● FAVOURED HOST
● HIGHLY FAVOURED HOST

NON HOST
MODERATE HOST
PREFERRED HOST

VINECO PRODUCT
TECHNICAL INFORM

VINECO

REBOUND 1™

An annual regenerating sward consisting of summer dormant **perennial ryegrass and subterranean clover,** providing year round weed suppression and trafficability. Adapted to acidic soils.

Inoculate with **type C rhizobium.** Seed in **April/May** after weeds have been controlled and a suitable **seed bed** has been prepared. Attention to seed bed preparation is critical to provide a smooth, even and firm surface, so that seed can be accurately placed at the desired **depth of 1-1.5 cm.** Limit the amount of weed competition by reducing the seed bank in preceding years, and **controlling emerged weeds** after irrigation/rainfall in autumn.

The suggested seeding rate is **35 kg per sown hectare.** Fertiliser should be applied at seeding. Apply **DAP** at the rate of **120 kg/ha** in the first year. Top dress annually with Super or DAP (100 kg/ha). **Top dressing** will promote persistence and longevity of the plant population.

The sward should normally be mowed in late August to minimise the **risk of frost** damage. Continue to mow the sward as necessary through summer. This has the effect of limiting summer weed growth and promoting prostrate grass growth. There may be a need to control **Red Legged Earth Mite** in autumn to protect emerging seedlings.

REBOUND 2™

An annual regenerating sward consisting of **summer dormant perennial ryegrass and annual medic,** providing year round weed suppression and trafficability. Adapted to alkaline soils.

Inoculate with **type AM rhizobium.** (Seeding time and seed bed preparation as for **Rebound 1™.**)

The suggested seeding rate is **30 kg per sown hectare.** Fertiliser should be applied at seeding. Apply **DAP** at the rate of **120 kg/ha** in the first year. Top dress annually with Super or DAP (100 kg/ha). **Top dressing** will promote persistence and longevity of the plant population.

The sward should normally be mowed in late August/early September to minimise the **risk of frost** damage. It is also suggested that the sward be **mowed for the first time in July** to promote prostrate growth of the medic plants so that subsequent spring mowings do not remove the majority of flowers from the medic, reducing its regenerative ability. Continue to mow the sward as necessary through summer, limiting summer weed growth and promoting prostrate grass growth. In medium rainfall areas(<600mm), it may be necessary to allow the ryegrass to set seed in December, ensuring autumn regeneration. **Red Legged Earth Mite** populations should be controlled in autumn to protect emerging seedlings.

NEMFIX™

An annual resown cover crop which comprises a specific cultivar of **Mustard** selected for its glucosilinate profile/concentration and its potential **biofumigant** benefit.

Nemfix™ is well suited to **sandy, light soils.** It should be established in **March** where irrigation is available. Seed at **8-10 kg** per sown hectare. Fertilise with **150 kg/ha DAP** at seeding. **Topdress with 30-40 units of N in June.**

The sward should be **incorporated in late July/early August** for optimal biofumigant effect. Do not allow the sward to grow beyond **5-10% flowering,** as this is when herbage production is at a maximum. Volunteer growth in the vineyard can be avoided by **not allowing Nemfix™ to set seed.**

Rotate this product with **Coolabah or Swan oats** if root knot nematode suppression is desired. **Nemfix™** can be a useful green manure crop used in rotation with legumes or **Biomax™** where nematodes are not a problem.

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VINECO PRODUCT R[illegible]
TECHNICAL INFO[illegible]

VINECO

BIOMAX™

A green manure cover crop alternative to monocultures of beans or cereals. Contains a **blend** of oats, beans, peas and vetch (soft seeded, non invasive types).

Research has shown that in many cases, the use of a blend of species produces more herbage than a monoculture. This improved productivity varies depending on the presence and nature of any growth limiting factors. Two years of field trials across S-E Australia in 1996/97 demonstrated an increase in dry matter yield of up to 70% by **Biomax™** over monocultures.

The legumes in Biomax all require the same **E type rhizobium.** The seeds are all of sufficient size that settling out of a particular species does not usually occur. Simple hand mixing in the seeder box will remedy any settling which may have occurred during transport.

The suggested **seeding rates** are **100-140 kg** per sown hectare. Use the **100 kg/ha** rate only if seeding in March and applying irrigation to germinate the seed. If seeding in April, use a minimum seeding rate of **120 kg/ha.** A seeding rate of **130-140 kg/ha** should be used if seeding later than mid May to ensure good biomass production in late August/early September (when green manure crops are normally terminated). Seeding depth is the same as that normally used for oats (2-3 cm).

A suitable **fertiliser** is **DAP,** or 18:20:0 (N:P:K). This should be applied at a minimum rate of **120 kg** per sown hectare at the time of seeding. Monitor sward vigour in June, and top dress with Super/DAP if nutrient deficiency symptoms are evident.

Cost effectiveness: Biomax™ sown at 120 kg per sown hectare is approximately equivalent in cost to faba beans costing $0.50/kg sown at 150 kg/ha.

WEEDCHECK™

Fodder radish is the only species included in this product. Weedcheck is so named because of the **strong winter weed suppression** it can achieve. This weed suppression is believed to be a combination of high seedling vigour (which smothers other plants), and a chemical release from the root system (inhibiting other plant germination).

The radish cultivar used in **Weedcheck™** has also been selected because it is a non host for root knot nematodes (Meloidogyne spp) and contains a high concentration of glucosilinates, which can provide a **biofumigation** effect in the soil. **Weedcheck™** also produces a high biomass, and so an optimal biofumigant effect is possible with this product.

These plants have a large **taproot** which is capable of disrupting **hardpans.** Some badly compacted hard pans may need to be deep tilled prior to seeding **Weedcheck™** , allowing the taproot to grow through compressed layers of soil.

Mowing alone will not normally be sufficient to terminate the growth of this species in spring. **Tillage** will terminate its growth, as can an application of **Amitrole®** to the sward after mowing. Roundup® and Sprayseed® have not been totally effective in controlling regrowth after mowing. Optimum biofumigant effect is acheived by terminating growth at 5-10% flower. Volunteer growth in the vineyard can be avoided by **not allowing Weedcheck™ to set seed.** Rotate with cereals, legumes or **Biomax™.**

A seeding rate of 20 kg per sown hectare is suggested for maximum weed suppression. A rate of **12 kg** per sown hectare is normally suggested where a large tap root is desired. Fertilise with **150 kg of DAP** per sown hectare at seeding. **Topdress** in June with **30-40 units of N** per sown hectare.

Seeding should be conducted in **April/early May.** Sow at a maximum **depth of 2 cm.** Rolling with a light roller after sowing can assist in the seed-soil contact and promote good establishment. Weedcheck™ is a non preferred host for **light brown apple moth.**

DEFINITIONS

Cover Crop

A population of plants established in the mid row area of a vine or tree crop. This may be a green manure, a permanent sward, or an annual regenerating sward.

Green Manure

Refers to an annual cover crop, sown each autumn, and grown for maximum biomass production in early spring to raise soil organic matter. This plant matter can be desiccated or mowed, and/or incorporated at the appropriate time, usually prior to budburst in late winter or early spring.

Sward (alternatively Sod)

Refers to ground cover, whether grass, legume or other plant species. Swards can be annual or perennial.

Annual Regenerating Sward

A sward consisting of plant species which sets seed in spring prior to senescence, and regenerates from such seed in the following autumn. Examples include annual grasses, medics, and sub clovers.

Perennial Sward

A sward which may consist of perennial grasses and/or legumes. Examples include ryegrass, fescue, cocksfoot, lucerne, and white clover. These swards persist over summer and can provide year round green growth.

Volunteer Sward

A sward consisting of naturally occurring species rather than selected, sown species. The suitability of a volunteer sward will be determined by its botanical composition and growth habit, and any costs associated with its maintenance & management.

Biofumigant Sward

Refers to a sward consisting of Brassica species (eg. Fodder Radish, Fodder Rape and Oil Seed Mustard). Plants of these species contain chemicals called glucosilinates which breakdown into isothiocyanates, some of which have an ability to suppress nematodes and other soil borne pests / pathogens.

Beneficial/Insectary Sward

A botanically diverse, perennial sward used to provide a continuous flower bloom over the spring and summer period. It provides a haven for a range of insect species, and provides a source of nourishment for beneficial species, such as *Lacewings*, *Trichogramma* wasps and predatory mites.

Seeding Rate

Is the weight of seed distributed over a prescribed area expressed as kg/ha. Within a vineyard, the area sown to a cover crop can be *approximately* half the total area (depending on row spacing). For example, 20kg of seed would be required to sow a cover crop in 1 ha of vineyard at a required seeding rate of 40 kg/ha if row spacing equalled 3.0 metres and a seeder of 1.5 metre width was used.

Biomass

The total herbage production at any given time, measured in kg/ha, either fresh weight or dry weight. For example, the objective of growing a green manure crop is to return maximum organic matter to the soil, hence a sward with a high biomass in spring is desired.

CAUTION

Cover crops provide many potential benefits. However there is potential for some cover crops to host pests and diseases such as Light Brown Apple Moth or phytoplasmas which are associated with Grapevine Yellows diseases (eg. AGY).

Continuing research will progressively improve the selection of cover crops, and as such these options are provided in the light of current experience and maybe subject to revision over time.

Any decision on cover crop selection should be based on local and personal experience as well as the information provided here, and should be made in the light of results emerging from ongoing research.

DISCLAIMER

VinEco Cover Crops

better seeds – better choices

VINECO COVER CROPS

BIOMAX

A proven forage blend, providing a highly productive and adaptable sward of select varieties. By including a diversity in species, this blend incorporates a tolerance to disease incidence and soil type variation, meaning a more consistent and reliable result. Best results are achieved with early seeding in autumn and adequate fertiliser application. **Suggested seeding rate of 120 - 140 kg/ha.**

BT ASSIST (BENEFICIAL/INSECTARY BLEND)

A perennial blend designed with integrated pest management in mind. A botanically diverse sward consisting of a number of species, which provide an extended period of bloom and range of colour. This sward is intended to encourage a wide spectrum of insect species, and provides a source of nourishment to beneficial predators. Best adapted to irrigated mid rows or high rainfall districts. Establish in autumn.
Suggested seeding rate of 20 kg/ha in every sixth mid row.

WEEDCHECK

For the suppression of winter weeds. This product inhibits the emergence and establishment of most winter weed species. A deep tap root assists in the breaking up of hard pans, improving water infiltration and soil aeration. Also incorporating a biofumigant effect, which can suppress soil borne pests such as root knot nematode.
Suggested seeding rate of 20 kg/ha.

NEMFIX

For suppressing populations of soil borne nematodes. A winter active variety which establishes quickly with irrigation in early autumn. This product provides a high biomass, and can be used in nurseries and vineyards alike, **Suggested seeding rate of 6 - 10 kg/ha.** This sward should be incorporated at least six weeks prior to planting vines in nurseries.

REBOUND 1 & 2

Two annual regenerating swards with different adaptations. Rebound 1 is a blend of highly winter/spring active sub clovers with a range of adaptations and tolerances to varying soil types and conditions, together with summer dormant perennial ryegrass. This blend is best suited to higher rainfall districts (450mm<), with soil ph ranging from 5-7.5. A persistent, mulch residue over summer inhibits the development of weeds, which compliments the winter weed suppression achieved by the dense cover crop canopy. **Suggested seeding rate of 35 kg/ha.**

Rebound 2 is a highly productive annual medic mixed with a productive, summer dormant ryegrass, providing good winter growth and summer dormancy, and proven autumn regenerative abilities. This results in persistent ground cover year after year. **Suggested seeding rate 30 kg/ha.**

PERMAGREEN

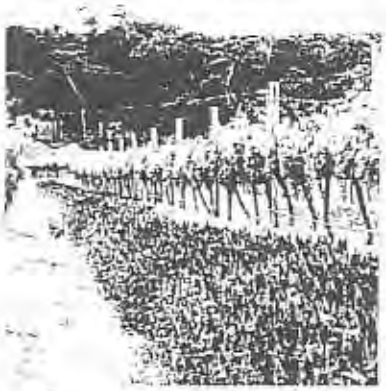
Perennial swards consisting of turf type grasses. Generally for use in higher rainfall districts or where vine vigour suppression is desired. These swards provide year round weed suppression and trafficability. **Suggested seeding rate of 35 kg/ha.** Higher rates should be used when seed is broadcast over the midrow as opposed to drilling seed.

seedco
The Quality Seed Company of Australia

78 Burbridge Road, Hilton, South Australia 5033 • Telephone: (08) 8234 9333 Facsimile: (08) 8234 6133 Email: seedco@seedco.com.au

GUIDE TO TYPES OF COVER CROPS

Medics are annual legumes which set seed in October and regenerate in autumn



Crimson clover is an annual legume with aesthetic appeal

Perrenial ryegrass, cocksfoot and fescues are the most common perennial sward species

An example of a botanically diverse perennial 'Beneficial' sward

Annual Regenerating Sward

Benefits
Improves soil structure.
No annual reseeding or tillage of midrow required
Improves trafficability and erosion control.
Limited competition with vines during the growing season.

Management
Prepare a suitable seedbed in the year of establishment
Control any weeds prior to seeding.
Swards can be desiccated in late spring after seed set to limit moisture competition with vines.
Mow in early spring to reduce frost risk.

Maintenance
Top dress swards with suitable fertiliser annually
Monitor pasture insect pests at seedling emergence and control if necessary.

Application
Suggested for use in irrigated vineyards in areas receiving at least 450mm annual rainfall.
Continuous traffic in new plantings may inhibit the performance of these swards.

Types
Perennial grasses with summer dormancy.
Annual pasture legumes and annual grasses.
Some native grasses have a limited application.

Perennial Sward

Benefits
Improves soil structure.
No annual reseeding or tillage of mid row required.
Provides year round trafficability and erosion control.
Provides summer and winter weed suppression.
Potential to suppress excessive vine vigour

Management
Prepare a suitable seedbed in year of establishment.
Control any weeds prior to seeding.
Mow in spring to reduce frost risk.
In drought years, swards can be dessicated to reduce moisture competition with vines.

Maintenance
Annually top dress with suitable fertilisers.
Monitor pasture insect pests at seedling emergence and control if necessary

Application
Suggested for use in irrigated vineyards, or in regions receiving at least 700mm annual rainfall.
Perennial grasses vary in growth habit and degree of summer dormancy. Select species with appropriate levels of activity for the particular vineyard
Continuous traffic in new plantings may inhibit the performance of these swards.

Types
Perennial grasses, lucerne, chicory and Beneficial or Insectary swards

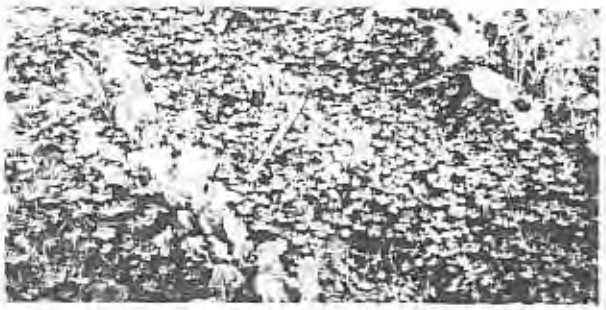
POINTERS FOR RELIABLE COVER CROP ESTABLISHMENT

1. Seed Bed Preparation

A well prepared seed bed is required to optimise seedling establishment

Optimum seed bed conditions will vary for different cover crop species. When establishing small seeded pasture varieties such as ryegrass and subclover, it is recommended that a flat, uniform and firm soil surface exist such that seed can be placed accurately and consistently at the desired depth. The soil should be of a tilth such that seed-soil contact is maximised, thus promoting good plant emergence and establishment.

- Keep tillage to a minimum. Tillage equipment such as scarifiers and discs are preferred to rotary hoes because of their potential negative impact on soil structure.



Rape suffering from nutrient deficiency and competition from volunteer weeds.

- Control weeds prior to seeding permanent and annual regenerating swards.
- Direct drilling is an option for annually re seeded cover crops if weed and trash burdens are low, and the soil type is such that seed can be sown at the desired depth with adequate soil coverage.
- Broadcast seed should be spread on a loose soil surface and incorporated lightly. Use a higher seeding rate when broadcasting than when drilling seed to compensate for seed losses due to uneven distribution and inadequate soil coverage of seeds.

2. Legume Seed Inoculation

Legumes require inoculation with rhizobium to effectively fix nitrogen.

- Inoculate seed with the appropriate strain of rhizobium in the first year of establishment of a sward containing a legume component.

3. Fertiliser

- Apply appropriate fertilisers at the recommended rates at optimum times to ensure good sward vigour.

4. Seeding Depth

Desired depth of seed burial is related to seed size. Small seeds (clovers, medics, and grasses) must not be sown deeper than 15mm (1/2 inch) while larger seeds(cereals, beans, peas) should be sown at 20-30mm (1-1&1/2 inches). Although small seeded, brassicas have good seedling vigour. Seed should be sown at approximately 20mm depth, and the surface rolled post sowing to allow for fast emergence and strong establishment.

- Poor emergence will result when seed is buried too deeply.
- A loss of seedlings may occur if seed is sown too shallow or left on soil surface, and soil moisture is limited.

5. Control of Insect Pests

Some cover crop species, particularly legumes such as vetch, medics and sub clovers are very susceptible to damage by insect pests such as Red Legged Earth Mite and Lucerne Flea.

- Monitor for insect damage at cover crop emergence and control using appropriate insecticides at optimum times.

6. Seeding Time

- Establish green manure crops as early as practical in autumn. Do not dry sow until the end of April.
- Where irrigation of the mid row is possible, green manure crops benefit from earlier establishment in March.
- Perennial and annual regenerating swards are best established after the opening rains.

7. Seed Quality

Always use seed of high quality. Seed not machine cleaned may not always prove the best option, as it can be the source of undesirable weeds. Where a particular cultivar is required, always purchase certified seed as a guarantee of genetic purity.

8. Oversowing

Swards consisting of pasture type species are generally slow to establish. A tilled mid row on a slope can be at risk of erosion and run off, and in some circumstances a vigorous companion crop such as ryecorn may be included in the seed mix to protect the soil surface without suppressing the establishing pasture species.

COVER CROP SELECTION

Once the objective of growing a cover crop has been determined, the following factors need to be considered to allow the selection of the most appropriate species:

Rainfall/Irrigation

Water requirements of the various cover crops are reflected in their relative seasonal growth, as outlined in the chart on the opposite page. Factors which influence crop selection include:

- Total annual rainfall and its seasonal distribution
- The ability to irrigate the mid row area
- A capacity to provide the vines water requirements for the entire growing season
- A capacity to apply extra irrigation water at times when vines and cover crops compete for available moisture

Soil Type and Vineyard Topography

Cover crop species will respond differently to various soil types and conditions. The following factors can influence cover crop establishment, growth and persistence:

- Soil pH
- Soil salinity and sodicity
- Water logging potential
- Soil fertility and organic matter content.
- The potential for surface run off and erosion.
- Soil water storage

Light Brown Apple Moth (LBAM) Pressure

Some cover crops provide a suitable habitat for LBAM. Such crop species should not be used where the pressure from this pest is high (refer to chart on opposite page).

Nematode Pressure

Different cover crops can suppress or encourage nematode populations. (refer to chart on opposite page).

Frost Risk

- Evidence suggests the best protection against frost damage is provided by a bare, compact and damp soil surface. This is best achieved by utilising a green manure cover crop which is tilled and rolled prior to bud burst.
- Sward height and spring vigour can influence the risk of frost if the mid row is mowed and not tilled or sprayed out prior to bud burst.

Weed Pressure

Identify and monitor weeds in spring to formulate weed control and cover crop strategies for the following year(s)

- Consider using cover crops of high winter vigour to compete with winter weeds
- As a precaution, do not establish cover crops with low winter vigour if a high weed pressure exists

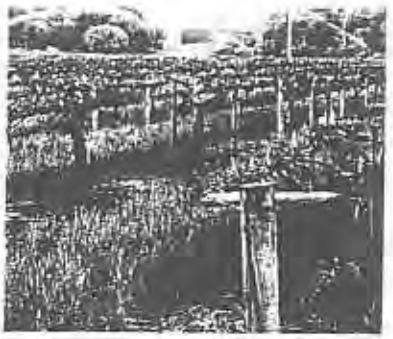
Vineyard Resources

- Select a cover crop which can be established and managed effectively utilising available machinery and resources.

Insect Pest Tolerance

Some cover crop species are susceptible to damage caused by insect pests.

- In high pest pressure situations, select resistant or tolerant species



Irrigation can be used to establish cover crops in autumn and sustain growth in dry periods

Weed control prior to seeding cover crops is essential to avoid smothering the sown species

A sound soil structure is the result of good mid row management

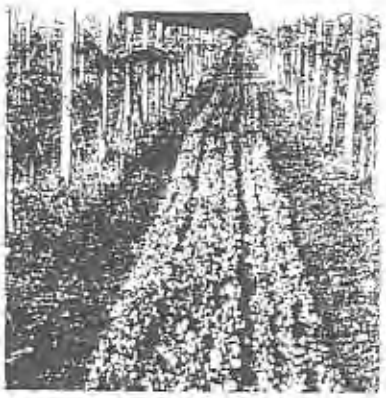
Red legged earth mite can destroy emerging seedlings if not controlled.

GUIDE TO TYPES OF COVER CROPS

Coolabah and Swan Oats are non hosts for root knot nematodes

A forage blend consisting of cereals and fodder legumes

Oil seed mustard is a green manure crop with a potential biofumigant benefit.



Fodder radish has the ability to suppress winter weeds and disrupt hardpans.

Green Manure

Benefits

Adds organic matter and improves soil structure.
Minimal competition with vines for soil moisture or nutrients.
Provides maximum frost protection. Frost risk can be reduced when these annual crops are tilled prior to budburst.
Vigorous species compete well with winter weeds.

Management

Early establishment promotes good spring growth
Direct drilling is an option in friable soils
Ensure adequate fertiliser is applied. Some cover crops may require top dressing in winter
Mow, spray out or cultivate prior to bud burst
Keep tillage to a minimum to preserve soil structure
Rotate crops annually.

Application

Suitable for new plantings and regularly cultivated soils. If left as a standing stubble, can provide wind and sand blast protection, although care must be exercised in frost prone areas.
Not recommended for high rainfall areas or in undulating vineyards because of erosion potential and trafficability problems associated with regular tillage.

Types

Cereals, fodder legumes, brassicas and forage blends (cereals plus legumes).

Brassica Crops

Benefits

Potential to suppress nematode and soil borne pathogen populations.
Provides good bulk for adding soil organic matter.
Minimal competition with vines over summer.

Management

Seed in early autumn, irrigate to establish where possible.
Apply nitrogen at seeding, topdress in winter as required.
Do not sow deeper than 25mm (1 inch).
Rotate annually with other green manure options.
Terminate growth prior to budburst, do not permit seed set. Some brassicas will regenerate after mowing, and may require the application of a herbicide such as Amitrole (in established vines only) or cultivation to prevent the setting of seed.
For biofumigation incorporate cover crop when 10% of its flowers have emerged.

Application

Light soil types where nematodes are a problem
Brassicas do not tolerate waterlogged or heavy clay soils
Brassicas have good tap roots for penetrating hard pans, and can out compete most winter weeds.

Types

Fodder Rape, Fodder Radish, and Oil Seed Mustard

1994 COVER CROP QUESTIONNAIRE

Dominic Scicchitano

INTRODUCTION

The use of cover crops is recognised as good vineyard management practice for many centuries. The benefits and use date back to 1100 BC when faba beans were grown and then cultivated back into the soil. Cover crops in the legume family add nitrogen to the soil, whilst both legumes and non-leguminous cover crops can add organic matter, improve structure and texture, reduce soil compaction, and retard the leaching or run-off of nitrate and other plant nutrients. Cover crops have also been used to suppress plant pathogens, nematodes, and weeds, and to harbour beneficial insects.

The history of cover crops is very long but modern management demands have put pressure on its place in viticulture. The choice of cover crops, green manure crops and permanent ground cover (sod culture) are extensive, but each one needs to be adapted to each site and growers' needs.

AIM

The aim of the questionnaire was to provide guidelines that would help better understand site and growers' needs with respect to inter row/plant selection and management as well as to provide a benchmark to determine the success of the cover cropping extension program.

The questionnaire also gave insight into questions such as
- What is the average size of Australian vineyards ?
- What is the level of irrigation in Australian vineyards ?
- What is the level of cover cropping in Australian vineyards ?
- If cover crops are planted, then what are the main species used ?
- Are the cover crops ploughed, slashed or mulched into the ground, or left to regenerate next autumn?

The questionnaire was posted to 730 wine grape growing vineyards, Australia wide. The listing was obtained from the "Australian and New Zealand Wine Industry Directory" 11th Annual Edition. A further 10 questionnaires each, were posted to 27 different wine growing organisations and grower groups, totalling 1000 questionnaires. Each recipient was given 6 weeks to complete and return their replies. Two hundred and thirty five (235) responses to the questionnaire were received (23.5%) (A future project may be to target the table grape growers of Australia)

RESULTS

The completed questionnaires were collated and statistically analysed using Two way and multi-way frequency tables and a measures of association and the log- linear model.

ASSUMPTION- In order to use the data, it is assumed that the responses received from this questionnaire represent a random sample of all Australian Vineyards.

Question. 1 *What is the area of your property planted to vineyards ?*

ha	NSW	VIC	QLD	SA	WA	TAS	TOTAL
5-20	57.1	65.2	100.0	41.0	74.2	88.9	60.0
20-50	11.9	20.2	0.0	18.0	16.1	11.1	17.0
50-75	4.8	3.4	0.0	8.2	3.2	0.0	4.7
75-100	7.1	3.4	0.0	1.6	0.0	0.0	3.0
100-200	9.5	3.4	0.0	16.4	6.5	0.0	8.1
200+	9.5	4.5	0.0	14.8	0.0	0.0	7.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 1: Proportion of vineyards of different sizes by state. Figures expressed as a percentage

The results show that the majority of Australian vineyards (60%) fall into the 5 - 20 ha range and 15.3% fall into the 100+ ha range. The statistical analysis shows that there is no difference between states, however, it can be assumed from the results that all of the vineyards in Queensland and Tasmania are owner / operated, whilst in South Australia and New South Wales, the number of corporate operated vineyards (ie those that fall into the 100 + ha range) is more significant.

Question. 2 *Does your vineyard have irrigation ?*

	NSW	VIC	QLD	SA	WA	TAS	TOTAL
Yes - dripper	73.8	62.9	100.0	82.0	87.1	100.0	74.8
Yes - overhead	4.8	19.1	0.0	9.8	0.0	00	10.7
Yes - flood	9.5	4.5	0.0	0.0	0.0	0.0	3.4
No	11.9	13.5	0.0	8.2	12.9	0.0	11.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 2: Type of irrigation used in vineyards, by state, expressed as a percentage

In total, 88.9% of Australian vineyards are irrigated and 11.1% are not. Of the vineyards that use irrigation, the main type is dripper (84%), then sprinklers (12%), and flood (4%). New South Wales (Riverina and Murrumbidgee Irrigation Area) and Victoria (Sunraysia) are the only states where flood irrigation is still used. In the drier grape growing states of South Australia and Western Australia, dripper irrigation is the predominant form of irrigation.

Question. 3 *Do you plant cover crops ?*

	NSW	VIC	QLD	SA	WA	TAS	TOTAL
Yes	73.8	66.3	66.7	83.6	80.6	88.9	74.9
No	26.2	33.7	33.3	16.4	19.4	11.1	25.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 3: Adoption of cover cropping, by state, expressed as a percentage.

The results show that 75% of Australian vineyards plant cover crops as a regular management practice, and 25% do not. There is no statistical difference between the states as to the level of cover cropping.

Question. 4 *What species of plants do you sow for use as a cover crop ?*

a) Cereals (wheat, barley etc)
b) Legumes (medics, sub clovers, clovers)
c) Pasture grasses
d) Faba beans or Peas
e) Combinations of the above

The results showed that of the 75% of vineyards that plant cover crops .....

- 17.0% plant a combination of legumes (ie medics, sub clovers or clovers) and pasture grasses
- 16.5% plant cereals only
- 12.0% plant pasture grasses only
- 12.0% plant a combination of cereals and legumes (medics, sub clovers and clovers)
- 11.0% plant cereals and beans or peas
- 8.0% plant legumes (medics, sub clovers and clovers) only
- 6.3% plant a combination of cereals, legumes (medics, sub clovers and clovers) and beans or peas

- 5.1% plant a combination of cereals, legumes (medics, sub clovers and clovers) and pasture grasses
- 4.5% plant beans and peas only
- 1.7% plant other species to those listed above

There is no statistical difference between the states ie one state does not have a preference for one particular species over another

Question. 5 *Is your cover crop*

a) ploughed into the ground at bud burst ?
b) slashed and used as a mulch for weed control ?
c) sprayed with a herbicide before bud burst ?
d) left to seed for regeneration next autumn ?

The results show that .....

- 44.0% slash and use the cover crop as a weed mulch
- 16.6% slash and then leave the cover crop to reseed next autumn
- 9.1% either slash or plough the cover crop
- 8.6% plough the cover crop into the ground
- 4.6% leave the crop to reseed for next autumn
- 0.6% spray with a herbicide

There is no statistical difference between the states ie one state does not have a preference for one management practice over another

Question. 6 *If you do not plant cover crops, do you*

a) cultivate the inter-row for weed control ?
b) control the weeds in the inter-row with herbicides ?
c) leave the weeds to grow during winter then slash before bud burst ?
d) combination of cultivation and herbicide ?

The results show that ...

- 39.0% leave the weeds to grow during winter then slash before bud burst
- 22.0% use a combination of cultivation and herbicide
- 12.0% cultivate the inter-row for weed control
- 10.2% either control the weeds in the inter-row with herbicides or leave the weeds to grow during winter then slash before bud burst

There is no statistical difference between the states ie one state does not have a preference for one particular practice over another

DISCUSSION

The results from the questionnaire (60% of Australian vineyards fall into the 5 - 20 ha range) suggest that the majority of vineyards are owner/operated, 15.3% are 100 ha or more, suggesting that these vineyards maybe corporate owned and operated. Statistically there is no difference between states with respect to vineyard size.

The high level of irrigation is not surprising, with dripper irrigation being the most dominant, as most vineyards are grown where water is a limited resource and so efficient water use is essential. It is interesting to note that most vineyards slash or cultivate the cover crop at or before bud burst. With frost protection taken into consideration, this result maybe a consequence of the limited water supply, and the need to reduce the competition between the vine and the cover crop over summer. The cover cropping research project needs to investigate varieties or mixtures that are water efficient and will not compete with the vines for moisture, possibly the early seeding medics. The project also needs to emphasise the benefits of the short season perennials.

The results show that the majority (44%) of cover crops are slashed and used as a weed mulch and 16.6% slash the cover crop for weed mulch then leave it to reseed. This indicates that most cover crops are re - sown each autumn, although the message of reseeding perennials has reached 20% of the growers. The use of herbicides to control cover crops is low, though the total overall vineyard use of herbicides is still considerable especially for vine row weed control. Approximately 17% of vineyards plough the cover crop into the ground and question 6 shows that of the 25% of vineyards that don't use cover crops, 34% of these growers cultivate the inter-row. These figures are significant

and the project needs to point out the negative effects on soil structure as a result of cultivation. The benefits of slashing need to be emphasised.

The results from the questionnaire indicate that even though most growers (75%) are aware of the benefits of cover cropping, their selection of the correct species may still be based upon very out dated information eg beans and cereals for green manures and pasture grasses for permanent sods. The focus of the project needs to show the growers that there are many species from which to choose from that may have a better fit for their specific situation. For example, an annual clover such as balansa may provide more bulk and nitrogen fixation than the more widely used faba beans or peas.

The project also needs to emphasise the use of self seeding perennials that are sown once every 3 or 4 years and will not compete with the vines for summer moisture.

COVER CROPPING TECHNOLOGY:

IN VINEYARDS

A PRELIMINARY LITERATURE REVIEW

Prepared by

D.M. SCICCHITANO

PROJECT MANAGER - SEEDCO / GWRDC

CONTENTS

1 EXECUTIVE SUMMARY

Recent requirements imposed by government farm policies, shifts in the economics of farming practices, and the public's concern in protecting the environment and conserving our natural resources have created a resurgence of interest in one of the oldest agricultural practices known. The use of cover crops has been recognised as a good management practice since ancient times. The benefits and use date back to as early as 1100 B.C. Bean crops were being used as green manures to improve the yields of the subsequent economic crops.

It was not until more work had been conducted that it was found that cover crops improved and helped sustain the soil environment. Constant cropping and cultivations has resulted in the slow decline in soil structure and fertility. Until recently it was accepted that the declining / degrading soil environment (fertility and structure) could be improved and maintained with the use of synthetic fertilisers and pesticides. With the increasing costs and public awareness of some of the undesirable effects of these synthetic inputs, the attention has shifted from synthetic inputs to the use of more sustainable practices.

Cover crop use has resulted in an amelioration in soil structure, water infiltration and soil fertility. It has also assisted in the overall management of the vineyard, improving the trafficability on wet and hilly sites. Cover crops will also play a role in the control of vineyard pests and weeds.

The type of cover cropping system selected will also depend largely on the benefits required and also on the soil environment into which they will be sown. Strictly speaking, cover crops are grown to protect the soil from erosion and loss of plant nutrients while green manures are crops that are grown with the purpose of improving soil productivity.

By drawing on a range of work that has been conducted, we can build a reasonable picture of the important dimensions of cover cropping technology in vineyards.

II INTRODUCTION

The nineties has been declared the "Decade of Landcare". The objective of such a campaign is that the attention of all people involved in agriculture and horticulture becomes focussed on soil and land management. Productivity in Australian horticulture is often subsidised with high cost chemical inputs such as pesticides and fertilisers, some of which cause undesirable environmental and public health hazards. The agricultural community as a whole needs to use the available resources without causing degradation either in the short or long term. Our (most precious) resources are soil and water, and too often insufficient thought is given to the options available for soil management. Australian horticulture is very productive, but the environmental cost of such productivity is threatening the very sustainability of horticulture. The search for self-sustaining, low-input, diversified and energy-efficient agricultural systems is now of major concern to researchers, farmers, policy makers and the public in Australia.

Davidson (1990) points out that the components of a good vineyard soil management system include :-

a) minimal or no soil cultivation;
b) the reduction of weed populations that deplete the soil of nutrients and water, create management problems and compete with the economic crop;
c) the addition of humus / organic matter to the soil;
d) good irrigation management;
e) maintenance and / or improvement of drainage;
f) stabilising the subsoil and avoiding the developments of hardpans;
g) the reduction in the rate of soil acidification;
h) maintenance of surface soil as aggregates, ie good soil structure;
i) the reduction of frost risk; and
j) reduction of salinity build up.

Whilst the application of these principles to most soils may be relatively straight forward, there are some soils which require more thought. The use of cover crops contributes a key management practice towards sustainable vineyards operations. Cover crops are defined as crops grown specifically for covering the ground to protect the soil from erosion and loss of plant nutrients through leaching and run-off (Parker 1915, Pieters and McKee 1938)

History:

MacRae and Mehuys (1985) stated that the earliest references to green manuring date from the Han Dynasty of China, prior to 1134 B.C. Lupines and faba beans (*Vicia faba*) were used by the Greeks as green manure crops before the third century B.C., and the practice has continued in Southern Europe. Semple (1928), in a review of ancient agricultural practices, indicated that several writers have specifically discussed the use of legumes for soil improvement. Theophrastus (373-287 B.C.) wrote of bean crops being used as green manures by farmers of Macedonia and Thessaly.

Considering this history, it would certainly be difficult to claim that cover crops are a new idea. This paper is a review of the work that has been completed on the use of cover crops, legume and grass species, in vineyard systems. Consideration is given to what has been learned (and to some extent relearned) and what is not known about the agronomic advantages and disadvantages of legume and grass cover crops, their effects on the physical and chemical behaviour of soils, and nutrient recycling in these soils.

Cover crops can be used in a number of ways to help improve the overall management of vineyards. Cover crops can be used to -

a) improve the soil chemical properties, reducing the leaching of fertilisers (nitrates) as well as supplying nitrogen to the economic crop, Freeman (1988);

b) improve the soil physical properties primarily due to the production of biomass which serves as the source of soil organic matter and substrate for soil biological activity, Bruce et al (1991); prevent soil erosion and water run-off on sloping sites, Glen (1990); improve the soil organic matter level, McCarthy et al (1992a);

c) reduce reflected light, air temperature and dust and increase the humidity, thereby providing a better climate for biological control of pests, (McCarthy et al 1992a; Beckingham 1988);

d) improve water infiltration thereby improving soil water drainage and assist the drying out and stabilising of the soil in wet areas, (McCarthy et al 1992a; Beckingham 1988; Lavin and Kogan 1989);

e) improve soil aggregate stability, Burns and Davies (1986),

f) ameliorate compacted soils, (Hulugalle et al 1986; Jordan et al 1956),

g) reduce nematode infestations, (Resck et al 1982; Reddy et al 1986; Mojtahedi et al 1991),

h) improve vineyard trafficability in areas prone to waterlogging, Beckingham (1988);

i) provide wind protection in young vineyards; and

j) harbour beneficial insects that are used to control insect pests, McCarthy et al (1992a).

The use of a cover crop has several potential disadvantages.

a) cover crop vegetation can compete with the economic crop for water and nutrients Beckingham (1988); transpiration losses of soil water by the cover crop can negatively affect cash crop yields, Reeves (1994). Ochaba (1989) and Lyannoi et al (1990) found over a five year period that incorporated cover crops and permanent swards competed with the vines for water and nitrogen and reduced grape yields by about 6% compared to clean cultivation and 14% compared to mulching;

b) if the cover crop vegetation is allowed to grow after bud burst they may increase the frost risk, (McCarthy et al 1992a; Beckingham 1988);

c) it costs money to plant the green manure crop and to terminate the crop before planting the cash crop (or in the case of vine(s) bud burst), (McCarthy et al 1992a; Klonsky and Elmore 1989). The particular economic situation is dependant on the cash crop grown, cover crop chosen; time and method of establishment; method of termination; and the cash value applied to the environment, soil productivity and soil protection benefits derived from the cover crop, Reeves (1994); and

d) the cover crop may act as a host for nematodes, Flaherty et al (1981)

Finch and Sharp (1981) stated: " The drawbacks of cover crop systems can be reduced or eliminated with careful management and control practices. Limitations are small compared to the alternatives. Erosion, compaction and poor water infiltration can, in time, reduce production to the point where it is not profitable to continue using the land for vines or orchards" Evidence that careful management of cover crops will provide better long term results comes from Lyannoi et al (1990) who despite making earlier claims that the cover crops can compete with the economic crop if not properly managed, found that correctly incorporated rye, is recommended for high yields, good grape quality and for enrichment of the soil organic matter.

Cover crops have a role to play

A good cover crop is one that maintains or ameliorates soil conditions, while it satisfies the soil site and management requirements. Reeves (1994) points out that in residue management systems, a cover crop must meet certain requirements: i) it should be easy to establish, ii) it should have a rapid growth rate so as to provide ground coverage quickly, iii) it should produce a sufficient quantity of dry matter for maintenance of residues; iv) it should be disease resistant and not act as a host for diseases of the cash crop; v) it should be easy to kill, and vi) it must be economically viable. There are a number of factors which influence the selection of particular species and cultivars for use in a cover crop mix. This selection is often guided by -

a) The environment - governed by yearly rainfall
- soil type and fertility

b) the purpose for planting (ie. for soil binding, erosion control etc.);

c) the succeeding cash crop; and

d) characteristics of the cover crop itself.

(see section 7 "Pasture species - suitability for use" for a comprehensive listing of cover crop species and their influences)

Different cover cropping systems currently used are as follows -

a) **"Killed sod system"** - ie one which involves the establishment of a grass sward which is then killed prior to planting the economic crop. This leaves a dead mulch which can persist for about 2 years. Zaffignani (1990) found that due to crop competition, ground covers (ie. cover crops) are not generally recommended in vines less than 4 years old, therefore the killed sod system maybe the best alternative, if cover cropping in new vineyards or orchards is to be used. Glenn and Welker (1991) illustrated that peach trees grown using the "killed sod System" were vigorous with an extensive root system which resulted in a large canopy volume and high early yields.

b) **"Green manure crops"** - This is the most common cover crop use in Australia. It is a system where annual legumes and grass pasture species are sown in autumn, then incorporated by cultivation in spring, just prior to bud burst in frost prone areas. If frost is not a problem and there is adequate soil moisture, then mowing or cultivation can be delayed to allow for more bulk (biomass) to be grown. The dead root system of the green manure results in an increase in soil organic matter. Sabirov and Yusupkhodzhaev (1990) showed that depending on the sowing method, green manure crops (peas and rape) that were ploughed into the soil at a depth of 25-30 cm, 50-60 days after sowing increased the soil humus content by between 3-18%.

McCarthy et al (1992a) summarised that increases in soil organic matter :-

i) result in stable soil structures;
ii) provide fabric to sandy soils;
iii) add to the water holding capacity of the soil;
iv) provide a reservoir of nutrient elements;
v) lowers soil bulk density; and
vi) provides a substrate for micro-organisms and soil fauna,

factors that have been identified as contributing to improving the soil climate for sustained vine(s) growing.

c) **"Permanent Sod Culture."** - The principle behind this method of cover cropping is to select pasture species that will be sown in autumn and will be able to persist (with mowing) for the next 2 or 3 years without having to be resown.

There are a number of different roles that the permanent sod can satisfy, depending on the vineyards requirements, for example should the topography of the vineyard be hilly (or undulating) then there is a need to prevent soil erosion and water run-off, as well as to improve
trafficability, and so the pasture species selected will show specific characteristics to satisfy these needs. The role of the permanent sod maybe to reduce the need for summer weed cultivations and improve water infiltration and so again a different pasture mix will be selected.

There is an abundance of work, (McCarthy et al 1992a; Beckingham 1988; Hulugalle et al 1986; Lavin and Kogan 1989), that demonstrates that the establishment of cover crops will help improve crop yields and ameliorate soil problems. The format of this review will be to study each variable that influences vineyard management (and sustainability) and incorporate into the discussion, where cover crops (or permanent sods) can be used to improve the situation.

Therefore the topics for discussion are

III. **THE RELATIONSHIP OF COVER CROPS TO :-**

1. Soils 1.1 Structure/texture (erosion/trafficability).
    - 1.2 Fertility/ organic matter,
        - 1.2.1 Soil biological factors
        - 1.2.2 Organic matter
    - 1.3 Salinity,
    - 1.4 pH,
    - 1.5 Temperatures
        - 1.5.1 Frosts
        - 1.5.2 Heat / vine canopy relationships
    - 1.6 Effects of cover crops
2. Vineyard pests and Diseases
3. Weed control
4. Irrigation management and cover crops
5. Crop and soil nutrient requirements and relationships
6. Pasture species - suitability for use

1 SOILS.

Soil is a fundamental resource in a vineyard system. It plays a most important role in the final vineyard profitability and productivity through its influence on the root systems of the vines. Soil degradation in the form of increasing soil salinity, soil erosion, reduced topsoil depth (or non-existent topsoil), compaction and the loss of organic matter, leading to surface crusting, reduced water infiltration and restriction of the root development of vines highlights the need for a change from the traditional cultivation practice.

"Effective production of the wine grapes requires the soil to be well drained with no impervious layers, as this would lead to water logging and anaerobic situations, soils with a pH of between 5.5 and 8 with at least 30cm of topsoil to allow vigorous root growth and a good source of quality water." (Davidson 1993a, Cass et al 1993). Unfortunately, in many of Australia's grape growing regions not all of these (ideal) conditions exist, and so the vineyard manager is faced with yield reducing factors at the start. With good vineyard management, the manager can deal with many negative factors and still produce top quality yields.

1.1. Soil Structure/Texture (erosion/trafficability)

Soil porosity is one of the major factors controlling the distribution and growth of grapevine roots. Richards (1983) quotes evidence that soil porosity controls the growth and distribution of vine roots and that poor soil structure limits vertical root development. Richards added that in a well structured soil, vine roots will penetrate 2m deep and have horizontal (lateral) growth of 3m.

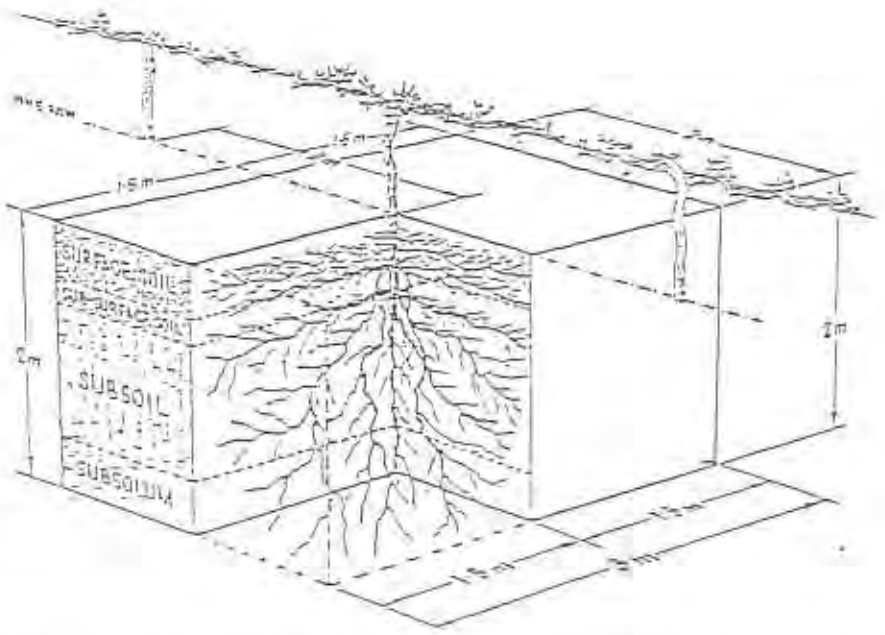


Figure 1. Diagrammatic representation of one quarter of the room of a grapevine in a non-irrigated vineyard soil, showing also the volume of soil available to the roots to a depth of 2 m, together with the named layers of the soil encountered by the roots. (Drawn by R.M. Schuster, CSIRO, Division of Soils)

Cass et al (1993) noted that vital processes such as -

- gas exchange to aid root respiration;
- water infiltration to replace depleted plant available water and allow continued availability of water;
- storage of plant available water; and
- drainage of excess water from the root zone,

are all dependant on soil porosity. If the root system of the vine has bee0n restricted in its growth by a relatively impenetrable or impervious subsoil layer, or by regular water logging and anaerobic conditions in the topsoil, the vine will not thrive and will not be able to lay down the reserves in its permanent parts. Accumulation of carbohydrate reserves ensures a longer and more productive vine life.

Coarse textured soils, such as sands and sandy loams, favour root growth as the roots can easily / readily grow between the larger sized particles. The soils are mainly made up of macropores (75-500um), which more readily store air but they don't store water effectively. Davidson (1993b). Macropores are responsible for the infiltration of water into the soil and also for the drainage of excess water from the root zone. They aid in soil friability. Cass et al (1993).

Finely textured or dense soils, such as clays, may restrict root growth, as the pores are narrower (micropores (0.5 - 30um)). These soils store more water in the micropores, but may not store any air. Davidson (1993b).

The fundamental aim is to have a soil environment that has a balance of micro- and macro - pores. Many years of soil traffic (mechanical and livestock) on soils can lead to soil compaction (destruction of macropores). Wheat yield reductions of 50-70% have been attributed to compaction in the earthy sands of Western Australia. (Henderson 1985, Jarvis 1986). Reeves et al (1984) found that "the weight of individual sub clover plants declined with increasing soil compaction" Soil compaction, which restricts root growth, is greatest below the wheel tracks and is determined by soil conditions, eg moisture and the weight of the machine per unit area in contact with the soil. As the wheel lines tend to be near the vine line, the resulting compaction can remove a high proportion of the total soil volume from root access, this can be overcome by shifting topsoil from the alley to the vine row ("mounding"). Cockcroft (1978)

All pore sizes can be re - created by tillage. Deep-ripping (or subsoiling) can temporarily ameliorate soil compaction problems, but in order to maintain yields it must be repeated every few years to overcome re - compaction and natural settling. Jarvis (1986). This practice is not possible in vineyards, and so cultivation is only a short term solution, in fact it can compound the problem. If the destructive elements are still present after tillage, then the pores will simply collapse again. For example when soil is tilled, bulk density decreases, porosity increases and many macropores will be present. In this condition, failure to protect the soil with a stubble or mulch, will result in the collapse of the tillage induced structure during the next rainstorm or irrigation ie. the use of a stubble or mulch can protect the improved soil structure obtained from deep ripping. Oades (1978) and Tisdall and Oades (1982) state that fibrous deep rooted cover crops are used to stabilise pores and at the same time create new pores. It is therefore recommended that cultivation should only be performed when a) sowing a cover crop and b) when cultivating the cover crop into the ground so that the ground cover provides the stabilising effect.
Suitable species for green manure cover crops include faba beans, lupins, peas, clovers, medics, cereals and grasses.

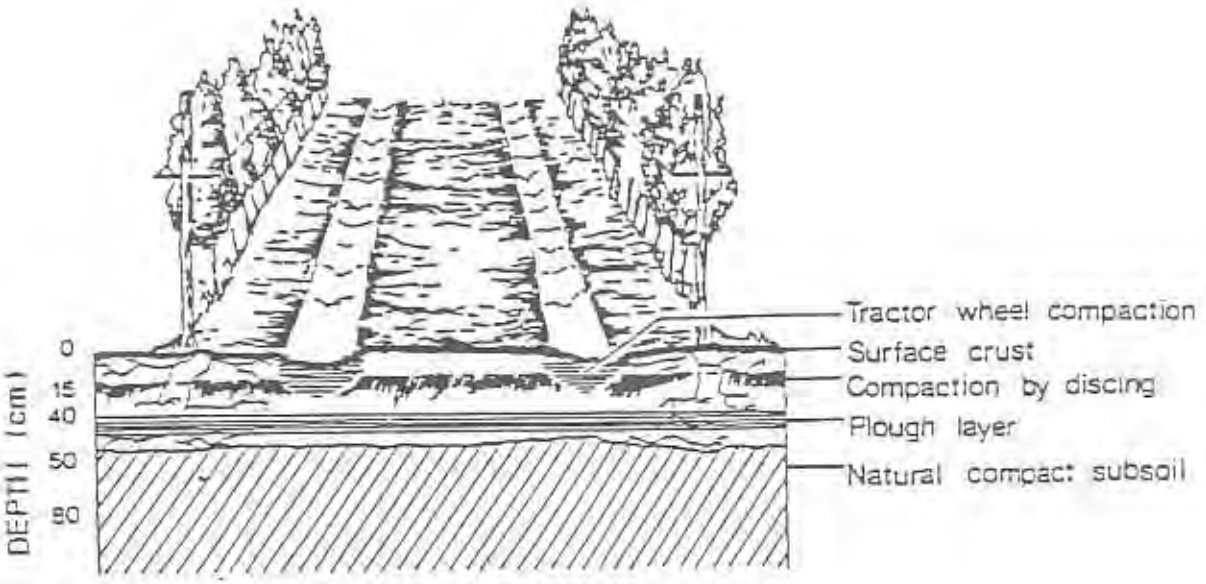


Figure 2 - Diagrammatic presentation of different types of soil compaction commonly found in vineyards.

Glinski and Lipiec (1990) state that cover crops affect soil bulk density and soil strength. Since roots occupy the soil space previously occupied by soil pores, they must displace soil particles, increasing the bulk density of the soil adjacent to the root. However, as roots die and decompose they leave macropores in the soil. Root fabric increases the bearing capacity of soils in no - tillage and can thus reduce the compactive effects of equipment traffic.

Lupins are less sensitive to compacted soils than most other agricultural species. Henderson (1989) suggested that lupins could partially ameliorate compacted soil layers by creating biopores via old tap root channels. A cover crop species that has a deep taproot system will assist in breaking up the subsoil hardpans.

Faba beans (*Vicia faba*) are used extensively as green manure crops. Madson (1951) stated that because of its large taproot and stemmy growth, faba beans act as good cover crops for opening up heavy soils.

A cover crop of Annual ryegrass (*Lolium rigidum*) can increase water infiltration. This species has a heavy, extensive, fibrous root system that holds the soil well and opens it to increased infiltration, and because the vigorous seedlings provide rapid ground cover, the species competes well against most weeds. Guiraud et al (1990). Guiraud also found that the annual ryegrass reduced the total amount of nitrate nitrogen leached down the soil profile. This work was supported by the findings of Bugg et al (1993). Theiss (1990) found that perennial ryegrass (*Lolium perenne*) doesn't appear as efficient at nitrogen uptake as are annual ryegrass and cocksfoot (*Dactylis glomerata*).

Taylor (1985) stated that the heavy root systems of Clover (*Trifolium spp.*) :-

i) make the soil mellow and supportive of root growth of succeeding plants;
ii) enhance soil microbial life;
iii) increase the soil water holding capacity;
iv) reduce wind and water erosion of light soils and the baking of heavy soils; and
v) increase soil permeability

Medics (*Medicago spp*) are a low growing winter annual, that die off early and reseed leaving a small amount of mulch for water conservation and improved weed control.

The taproot system of medics are generally deeper than those of sub clovers (*Trifolium spp*), Bugg et al (1993). Bugg et al (1993) recommends Barrel Medic (*Medicago truncatula*) as being suitable for use in dry land vineyards or crops with limited summer water (for example under drip and low volume irrigated crops).

Cass et al (1993) has put forward other methods, besides cover crops, to create and maintain good soil structure. These include -

i) hilling of topsoil into beds if the topsoil is limiting. This is not seen as the best method available as you are still left with the inter-vine rows that have poor soil structure;

ii) deep and shallow tillage which is useful only if used in conjunction with a green manure;

iii) increasing the earthworm population. Earthworms create biopores (>500um) and improve soil aeration, water infiltration and water drainage. Earthworms are encouraged by a high level of soil moisture and a supply of organic matter, in the form of a surface mulch, on which to feed. It is important not to allow earthworm numbers to increase to an extent that the soil structure maybe damaged by excess wetness as well as remoulding of soil aggregates. Cass et al (1993); and

iv) controlling irrigation. Excessive soil moisture is deleterious to soil structure because it weakens soil aggregates, causing them to collapse under their own weight. Collapse reduces macro - porosity and increases anaerobic conditions. If cover crops are incorporated into wet soils, under anaerobic conditions, micro-organisms produce ethylene which inhibits vine root tip activity, Perret and Koblet (1984).

The use of green manures is the most common use of cover crops in Australia. It should also be noted that continued cultivation of bare soil or a green manure has certain disadvantages viz. -

i) it prevents continuous build up of (dead and decaying) organic matter, McCarthy et al (1992a);

ii) root growth of the vine is restricted, (most vine roots occur in the top 1m with fine vertical roots, comprising the majority of the root system, being concentrated in the top 10-60cm of soil) McCarthy et al (1992a). The frequency and depth of the cultivation affects the root distribution and results in root growth in the surface layers being suppressed. McCarthy et al(1992a).

iii) reduces earthworm populations,

iv) high bulk densities can develop at the interface between surface-cultivated soil and the underlying undisturbed soil in the form of a plough sole, hard pan or tillage pan, (figure 2) Van Huyssteen and Werner (1989b), and for these reasons green manuring should be viewed as a management tool in the overall scenario of sustainable cover cropping.

Cover crops reduce erosion by improving soil structure and increasing water infiltration, protecting the soil surface and dissipating raindrop energy, reducing the velocity of water that moves over the soil surface and by anchorage of the roots, Smith et al (1987).

1.2. Soil Fertility and Organic Matter

Soil fertility embraces all factors that contribute to the long term sustainable productivity of the soil. Vineyard soil management should aim to maintain or improve soil fertility, in such a manner that is compatible with other vineyard operations. Favourable soil conditions encourage healthy roots and hence healthy vines.

1.2.1 Soil Biological factors.

Soil organisms represent a large biomass and therefore a significant sink of mineral nutrients, McCarthy et al (1992a). The biomass influences the rate of availability of nutrients to the roots, eg dressings of straw lead to a temporary nitrogen deficiency because of the increase in numbers of straw degrading organisms, McCarthy et al (1992a). Earthworms benefit the soils by tunnelling and cycling of nutrients and soil particles through the profile, thereby improving air and water movement and ultimately root penetration.

Some flora and fauna are pathogenic to grapevine roots, (McCarthy et al 1992a), for example the fungi Rhizoctonia, Pythium and Phytophthora and the pests Phylloxera and

nematodes (*Meloidogyne spp.*) The roots of other plants can affect grapevine roots either indirectly by altering or competing for soil resources (ie. water, mineral nutrients and soil atmosphere) or directly by providing negative and positive growth signals (ie. allelopathic and companion plants). McCarthy et al (1992a)

1 2 2 Organic Matter

Soil organic matter refers to the organic fraction of the soil; it includes plant and animal residues at various stages of decomposition, cells (living and dead) and tissues of microbes, and substances synthesised by the soil population. MacRae and Mehuys (1993). A fertile soil is one which is high in organic matter. Some of the benefits of organic matter are that it :-

- contributes fabric to the soil (fibres and colloids);
- stabilises soil aggregates;
- contributes cellulosic components add to the soils cation exchange capacity;
- adds to the matric water storage capacity;
- plays a role in ligand binding of metals;
- provides a reservoir of nutrient elements, especially N, P, and S;
- provides a substrate for micro-organisms and soil fauna;
- helps reduce the rate of heat flow through the soil; and
- lowers the soil bulk density.

Green manure will maintain or increase organic matter levels of the soil or maintain or increase soil nitrogen levels but not both at the same time. (Allison 1973, Warman 1980) The breakdown of the green manure crop is influenced by many factors such as the chemical nature of the added material, soil and climatic factors as they affect microbial activity and cultural practices. There has been great debate amongst researchers as to whether the green manure is more effective as a nitrogen source of organic matter (this is irrespective of whether the green manure crop is leguminous or non leguminous). MacRae and Mehuys concluded that there is agreement on what the majors factors influencing green manure breakdown are, but not necessarily on which factors exert the most influence, of what magnitude the effects will be, and how they interact. The major points to be extracted from MacRae and Mehuys' findings is that green manuring will at least maintain if not increase soil organic matter levels.

An application of organic matter to unstable soils can reduce the effect of slaking. Slaking occurs when dry unstable aggregates are unable to withstand the forces associated with the rapid intake of water, Emerson (1977), entrapped air is rapidly forced from the aggregate causing it to explode and collapse ('slake") into small aggregates. Dispersing or slacking soils may reduce water infiltration, drainage and aeration and can cause the surface to set hard. Soils most prone to dispersion have high clay contents (>30%) and high exchangeable sodium percentage (>5%), Beckingham (1988). As the micro-organisms degrade the organic matter, they produce binding substances to stabilise soil aggregates, Tisdall et al (1978).

The maintenance of good soil porosity, water infiltration and soil aeration is dependant on the soil aggregates being stable when wetted. Cover crops maybe used to stabilise aggregates against slaking by adding organic matter to the soil, McCarthy et al (1992a). Ryegrass plants grown for 30 weeks and then sprayed resulted in 34% of the soil being water stable aggregates (ie >25mm in diameter) 22 weeks after herbicide treatment, Tisdall and Oades (1979).

The incorporation of organic matter into the soil can, under some circumstances, have inhibitory effects on grapevine root growth; organic matter and anaerobic conditions may lead to increased ethylene levels, which inhibit root tip activity, McCarthy et al (1992a).

1.3 Soil Salinity

Good soil drainage of vineyards is important because :-

- it removes unwanted surface water, allowing easier access and management to / of the vines;
- it lowers the water table, avoiding crop damage from waterlogging at the root zone, and
- it helps keep the salinity level in the soil profile below a level which causes damage to the grapevines.

Soil Salinity affects all plants in 2 ways :-

a) salt reduces the plants' ability to extract water from the soil. High concentration of soluble salts creates a high osmotic potential, and plants have difficulty in obtaining water and nutrients from the soil solution, and

b) some salts are directly toxic to some plants.

Soil salinity is measured as the electrical conductivity of a soil suspension. Some of the soluble salts that occur in soils include Sodium chloride (NaCl), hydrogen carbonate (HCO3) and sulphate (SO4=) ions. These are referred to as Total Soluble Solids (T.S.S) and the levels of these salts in the soil, determines whether the soil is saline or not. Non-saline soils have <0.05% T.S.S in the surface soils and < 0.1% in the subsoil. Saline soils have >0.15% T.S.S in the surface soils and > 0.3% in the subsoil. A model put forward by McCarthy et al (1992a) estimates that if subsoils have 0.3% T.S.S, then they have the equivalent of 40t of salts / ha in each metre depth.

Salt affected vines show reduced growth of canes and leaves, reduced berry size, bunch numbers and fruiting, Nagarajah (1992).

Vine response to salinity depends on :-

a) soil texture, salt in clayey soils is less harmful to plants than salt in sandy soils,

b) the type of salt present, Sodium and chloride ions are toxic to vines, Nagarajah (1992); and

c) the vineyard management and environment factors.

Sodium (Na+) affects the productivity of vines by:-

i) degrading soil structure. High levels of Na+ will cause soil clay particles to disperse and block the passage of water through the soil pores, reducing the soil friability and permeability. Soils with high sodium levels are referred to as Sodic soils. These soils can be improved by the addition of gypsum (CaSO4). The Ca++ ions from the gypsum replace the exchangeable Na+ ions on the clay particles. These Na+ ions released into the soil solution must be leached down the profile, away from the root zone, otherwise salinity damage may occur. If the exchangeable sodium content of the soil is >6%, then the soil is sodic. Sodic to strongly sodic soils are not usually used for grape growing, Northcote (1992).

ii) by increasing the soil pH above 8.5 and inducing iron (Fe) and zinc(Zn) deficiencies. Iron deficiency takes the form of chlorosis, "Lime induced chlorosis". The high pH renders the iron unavailable to the grapevine (NB. vines on their own rootstock's are much less sensitive to lime induced chlorosis, Northcote (1992)). Zinc deficiency leads to reduced grape yields.

iii) retarding the uptake of potassium (K+) from the soil, Nagarajah (1992). Potassium can have an adverse effect on the quality in dry red wines - the higher the level of potassium, the lower the quality of reds, Northcote (1992)

Nagarajah (1992) lists steps that can be taken to minimise salt toxicity in vineyards :-

i) better irrigation management to prevent waterlogging;

ii) improved drainage to lower the water table below the root zone;

iii) the application of gypsum; and

iv) use of cover crops - growing green manure crops will help build up soil structure by the addition of organic matter thereby, improving infiltration rates and facilitating the leaching of salts from the root zone.

1.4 Soil pH

Soils can be quite variable in pH, both vertically and horizontally in the soil profile. Soils are usually more acidic near the surface and less acidic, even alkaline at depth, where clayey materials are better able to withstand acidification, or there maybe CaCO3 which neutralises it. This pH variation can be quite important because a young plant may have its roots in a poor acidic environment, but eventually thrive when roots reach less acidic or alkaline subsoil layers. Merry (1990).

Soil acidification can result from :-

i) leaching down the soil profile of cations (Ca++, Mg++, K+, Na+) which are replaced with acidic elements such as Aluminium (Al+++) and Hydrogen (H+) Merry (1990),

ii) an increase in soil fertility is often accompanied by an increase in soil organic matter, which is acidic, Merry (1990);

iii) nitrogen fixation by legumes increases nitrate concentrations, and

iv) microbial conversion of ammonium (NH4+) to nitrate (NO3-) in soils is a process that acidifies soils

1.4.1 What does soil acidity do?

The aluminium (Al^{+++}) and manganese (Mn^{+}) elements that replace the leached cations not only make the soil acidic, but are also toxic to grapevines. Aluminium toxicity stunts the growth of roots, affecting the water and nutrient uptake of the vine, Robinson (1989).

Aluminium is not mobile within the plant and so symptoms are only visible in vine roots. Manganese is more mobile in the plant and toxicity is visible in the leaves, Merry (1990). The replaced cations become more available to the plants. Careful irrigation management is required to prevent the increased leaching of these nutrients from the root zone, Merry (1990).

The most acidifying management practice used in most Australian vineyards will be the use of "acidifying" fertilisers, ie those that contain ammonium, urea or elemental sulfur, including fungicides.

Urea is first broken down into ammonium-nitrogen and then to nitrate-nitrogen. This nitrate-nitrogen is the form which is taken up by the roots. Nitrate - nitrogen is acidic and every molecule of urea which is broken down this way contributes to the acidity of the soil, unless it can be neutralised. At the end of the vine growing season, soil nitrate-nitrogen levels have increased, and with the onset of winter rainfall, leaching of the nitrate-nitrogen begins, and soil acidification becomes deeper in the profile. Reversing soil acidification becomes an expensive proposition and it is possible that in the long term, some soil changes maybe irreversible, Robinson (1989).

The build up and eventual leaching of nitrate-nitrogen at winter can be prevented by the sowing of cover crops. The cover crops will dry up the soil by transpiration and prevent the leaching of nitrate - nitrogen, hence increasing the organic nitrogen reserve for the next vine season, reducing the need for expensive acidifying urea fertilisers. They also prevent the build up of nitrate - nitrogen levels to a level that will increase the soil pH. The choice of cover crops is important. Robinson (1989) found that "perennial crops are very effective in conserving nitrate-nitrogen during winter, but they don't release it after bud burst". It is important to select a species that will utilise the nitrate - nitrogen, but also release it when the economic crop requires it. Section 5 further describes the nitrogen relationship between the cover crop and the vine(s).

Merry (1990) points out that it is important to select the correct legume cover crop species that can withstand the current soil pH because -

i) acidic soils tie up molybdenum needed for successful nitrogen fixation;

ii) rhizobia are sensitive to acidity;

iii) acidity causes the increased leaching of Calcium (Ca^{++}) and Boron (B) ions and these are necessary for legumes to set seed; and

iv) acidic conditions decrease the rate of organic matter decomposition, and hence of nutrient turn over.

Continuing acidification usually means that the soil layers that are affected become deeper, resulting in soil acidification becoming more expensive to rectify, and it is possible that, in the long term, some soil conditions may be irreversible.

1.5 Soil Temperatures - Frost / Heat

1.5.1 Frosts -

A major concern for grape growers in all parts of the world is frost damage. Frost damage / injury is a result of the freezing of plant cells, with ice forming either within or outside the cell. During the course of freezing the ice expands, rupturing cell walls and disturbing the normal function of intracellular membranes. Internal freezing of cells kills them immediately, although if freezing is confined to the extracellular regions, damage is less likely to be serious, Westwood (1978).

In Australia, the frost susceptible period is from early bud burst (early - mid Sept.) through to early November. Autumn frosts prior to harvest can result in fruit breakdown and severe effects on fruit maturity because premature leaf drop interferes with the ripening process, McCarthy et al (1992a). Levitt (1980) noted that the degree of frost damage/injury depends upon -

i) the minimum temperatures reached;

ii) how fast the day and night temperature falls; and

iii) the amount of time the temperature is below the critical damage period.

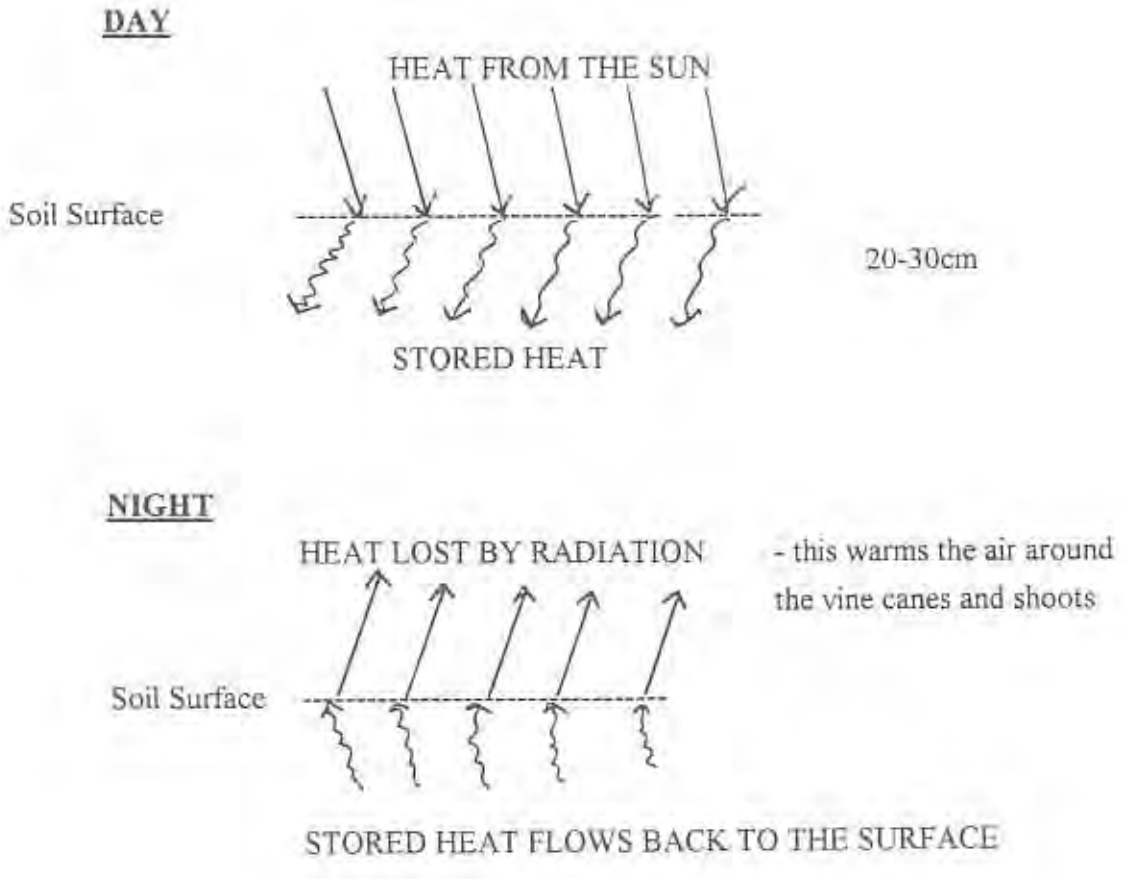
There are 2 types of frosts :-

i) Advective - not common in Australia; and

ii) Radiation Type - this type of frost occurs on clear nights when the night time temperatures at vine level briefly dip below a critical damage temperature. An air temperature of -3.5*C or less will damage buds at the woolly bud stage,-1*c or less will damage buds at early bud burst, -0.5*C will damage shoots up to 15cm long, and 0*C will damage shoots longer than 15cm long, McCarthy et al (1992a)

When long wave radiation from the ground to the sky is not impeded by cloud cover or a high concentration of water vapour in the atmosphere, a cooling of the air near the soil surface results. See figure 3.

Figure 3



Most cultural practices for frost control aim at increasing the amount of heat that reaches the soil surface during the day, (heat stored in the heat bank).
Note:- Sprinklers can be used at night to increase the humidity which reduces re-radiated heat loss and therefore keeps the minimum temperature higher, McCarthy et al (1992a).

The best soil condition for frost control is a bare cultivated compacted wet soil, McCarthy et al (1992a). This environment stores more heat by day and then reconducts heat to its radiating surface at night. Both moisture and compaction improve the thermal storage capacity and conductivity of the soil. Bare, loose dry soil has low heat storage capacity and the air pockets in the soil insulate against heat input by day and output by night.

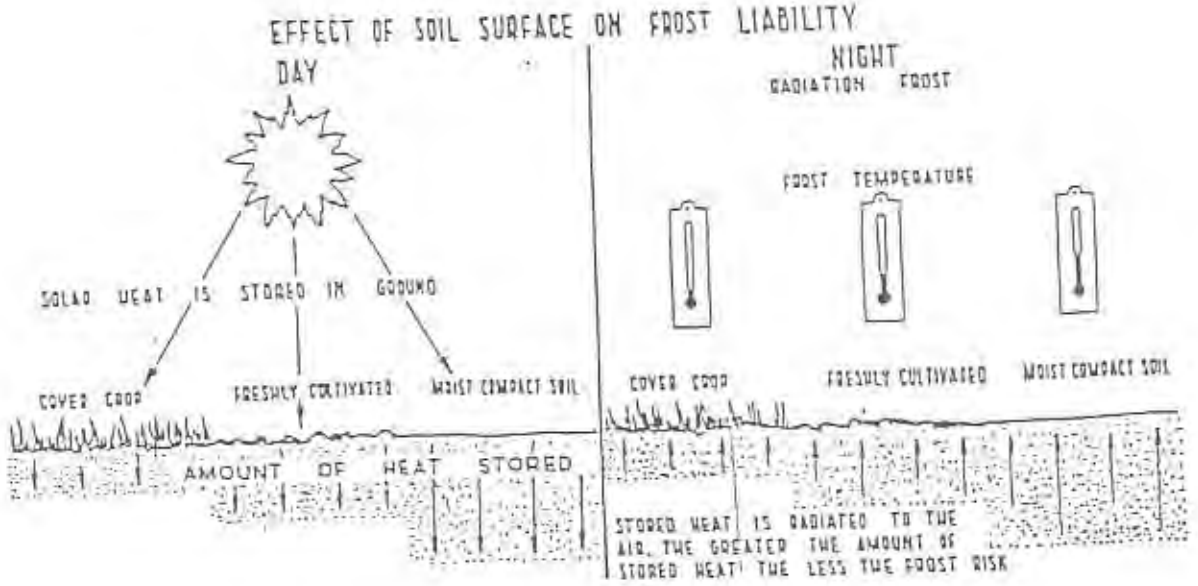


Figure 4 Effects of soil surface on frost liability

Cover crops can increase the frost risk to a vine by -

i) shading the soil and therefore reducing the amount of heat reaching the soil surface;
ii) the coldest air is at the ground level and therefore tall cover crops will raise the cold air closer to the vine canopy, and
iii) cover crops dry the soil and dry soils don't hold as much heat as wet soils.

If the vineyards are in frost prone areas, and cover cropping is still desired then there are a few alternatives possible viz -

i) cultivate or slash the cover crop 3 weeks before bud burst, and again during the vine shoot development stage.

ii) use a low succulent pasture species since:-

- the heat radiating surface is closer to the ground:
- the green and succulent cover crop will store and subsequently release heat, and
- should heavy dew formation occur within the cover crop, there would be some release of latent heat.

1.5.2 Heat

Woodham and Alexander (1966) stated that vine roots grow best at temperatures between 15 - 30*C They reported no growth of potted vines when roots were maintained at 11*C; vines with roots at 20*C stop growth at flowering, while vines with roots kept at 30*C made the best growth and set the most fruit.

Unshaded topsoil can become too hot for root growth. Soil temperatures exceeding 30*C will kill vine roots, Beckingham (1988). It is not uncommon for the surface of dark coloured clay soils or dry sands to reach temperatures of 60 -70 *C and it is by controlling excessive soil temperatures where cover crops play a part. When the soil is covered with a cover crop it will shade the soil surface from the heat, reducing the soil temperatures. (111) found that green manuring decreased the soil temperature, which reduced evapotranspiration and increased soil moisture.

Clearly the use of cover crops plays an important role in influencing the soil climate for vineyards. The types of cover crops , timing and pasture species selected all contribute to the amelioration and sustainability of soil structures and functions suitable for vine growth.

1.6 The Effects of cover crops

One could argue that by leaving the vineyard floor bare you would have simpler management, less interference with irrigation and other equipment as well as less crop competition for nutrients and water. In reality, what you have is greater evaporative water loss from the surface due to higher soil temperatures, lower water infiltration rates due to poorly structured soils with little or no organic matter content, higher soil bulk densities ie

smaller soil pores producing soils that are prone to wind and water erosion and soils that have lowered organic matter contents and fewer earthworm populations.

Depending on the cover cropping system selected, ie a permanent sod or a green manure, all of the above negative effects can be reversed.

Permanent Sod Cultures and green manures can:-

i) improve soil structure and soil water infiltration, as well as vineyard trafficability;
ii) on sloping sites, will prevent soil erosion;
iii) harbour beneficial insects and so reduce insect pests in vineyards;
iv) help develop favourable root environments;
v) help control weeds;
vi) reduce soil water evaporation and improve soil structure through the activity of soil micro-organisms;
vii) reduce soil surface temperatures and help keep them constant; and
viii) increase earthworm activity.

2. VINEYARD PESTS AND DISEASES.

The vineyard is a macro-environment for a number of horticultural pests and diseases viz. Light brown apple moth, Vine moth, Downy and Powdery mildews, soil nematodes and so on. The most damaging pest from the vineyard soil perspective is the nematode.

Nematodes are active, microscopic worm-like organisms that are generally less than a millimetre in length and can be found in the soil in large numbers, Edwards (1987a). Only some species cause economic damage to vines, and then only when numbers are high enough. Most feed on the decaying organic matter, and therefore don't create too many problems. However, some feed on the roots of plants and can interfere with plant growth and so decrease yield. They feed by sucking / puncturing the plant cells and sucking out the contents. If they cause too much cell damage they restrict the movement of water and nutrients within the plant retarding root and shoot development.

The root system becomes stunted, and the leaves may become yellow and wilt readily during hot dry weather, Edwards (1987a) The foliage symptoms caused by root damage from nematodes are similar to those caused by root rots, drought or poor nutrition.

Penetration of roots by nematodes also makes them more susceptible to attack by root rotting fungi that are widespread in soil. Infested roots may have galls , thickened root tips, small dark patches (lesions), poor feeder root development, or a proliferation of shortened roots. Nematodes are more severe on vines in sandy soils. Nematode damage can be made worse by drought, shallow soils overlying clay or lime layers, compacted soils and highly acidic or alkaline soils.

Growing conditions can also influence the degree of nematode damage. For example, highly stressed, non-irrigated vines are more readily damaged by nematodes.

Tests to monitor populations before and after planting are important and will assist in their diagnosis and control. If the vineyard soil is nematode infested, chemical control is required prior to planting. The vines planted should be those that have been grafted onto nematode resistant rootstock's. If nematodes invade an existing vineyard with ungrafted vines, control becomes more difficult. Chemical control is no longer viable, and the next best alternative is to use cover crops.

Root-knot nematode, *Meloidogyne Spp.*, are the most economically important nematodes of grapevines in Australia where they are widespread and can greatly reduce vine vigour and yield. They cause small bead-like galls or knots on roots. *Meloidogyne javanica* predominates in the hotter regions along the River Murray, such as the Riverland and Sunraysia. Root knot nematode have a wide host range, including fruit and nut crops, vegetables, field crops, weeds, cover crops and ornamentals.

Rapeseed (*Brassica napus* L. and *Brassica campestris* L.) is grown in many countries for producing edible canola oil, industrial oils and proteins. However, because of the undesirable Erucic acid that is present in the oil, and the presence of glucosinolates in the oil free meal, this crop has been slow in gaining popularity. (Erucic acid is a long chain fatty acid that is undesirable in rapeseed oil because it is not digested readily). The glucosinolates are sulfur containing compounds that are found in all parts of the plant, Mojtahedi et al (1991)). It is the glucosinolate compounds that we are interested in

The glucosinolates alone, are not harmful. However, in broken down tissue, they are hydrolysed by enzymatic action of plant myrosinase to bitter tasting, toxic and gastro genic compounds. These breakdown products include various forms of fungicidal and bactericidal isothiocyanates. Isothiocyanates include methly-isothiocyanate, a breakdown product of metham-sodium, a commercial nematicide (Mojtahedi et al 1991, McLeod 1993).

The rapeseed plant if not incorporated into the soil will not have any effect on the nematodes. Incorporation as a green manure into the soil, will show nematicidal effects because of the glucosinolate compounds. Davis et al (1989)

The concentration of glucosinolates in leaves and shoots of rapeseed decrease as the plant matures, Uppstrom (1983). If the breakdown products of glucosinolates are responsible for nematicidal activities in rapeseed shoots, then the age of the plant at incorporation may significantly influence the suppression of nematode populations. Johnson et al (1992) found that the incorporation of 30 - 60 Mt / ha of green biomass of rapeseed into the soil 6 months after planting did not affect the population densities of *Meloidogyne incognita and Meloidogyne javanica*. Results from work conducted by Mojtahedi et al (1991) showed that growing rapeseed (cv Jupiter) in infested soils for 2 months and incorporating the crop resulted in the lowest final *Meloidogyne* population.

Rapeseed as a green manure could play an important, if not the only, role in reducing the impact of Root-Knot nematodes in established vineyards. Current trial work comparing legumes, brassicas and cereals as hosts to *Meloidogyne spp.* is showing that the legumes as a group increase infestation the most, followed by the brassicas and the cereals. Humus (*Brassica napus* cv winter rape) has glucosinolate levels 4 times as high as most modern canola varieties and so nematode control is promising.

Kouame et al (1989), after screening 134 sub-clover lines, found that all had intermediate to high susceptibility to Root-Knot nematodes (*Meloidogyne spp*). If the decision is made not to use green manures, as opposed to permanent cover crops, then it is necessary to be aware that perennial legume and grass species are preferred over annual species because large numbers of nematodes migrate from the roots into the soil after annuals mature and die-off, Marks and Townhend (1973).

Ball & Gray (1980) found that varieties of hybrid vetch (*Vicia sativa*) such as Canaba White, Nova II, Vanguard and Vantage, were resistant to the nematodes *Meloidogyne javanica and Meloidogyne incognita* but susceptible to *Meloidogyne arneria and Meloidogyne hapla*

Weeds species such as Fat hen *(Chenopodium album* L*)* and Blackberry nightshade *(Solanum nigrum* L*.)* are very good hosts for Root - knot nematode (*Meloidogyne* spp) (Edwards 1987a; Edwards 1987b; Buchanan 1979).

Heliothis (*Helicoverpa punctigera* and *Helicoverpa armigera*) is a member of the Lepidoptera family of insects. It is a pest of vegetables (tomatoes and brassicas) and control is achieved by either chemical or biological methods. Light Brown Apple moth (*E. postvinna*) and Vine Moth are also members of this family of insects. Light Brown Apple moth feeds on a wide range of horticultural crops and weeds. It is more abundant in cooler regions and is favoured by conditions that cause lush growth of its host plants, and by cooler summer months. Although the caterpillars mainly feed on foliage, most economic damage is caused by the spring and summer generations when they migrate from foliage and feed on the bunches. They can cause extensive loss of flowers or newly set berries. Preliminary results from work completed by Trigg, unpublished data (1994), shows that Coriander (*Coriandrium sativum*) may play some role in the control of Heliothis (*H. punctigera* and *H. armigera*). This needs to be further investigated to discover the corianders effects on Light Brown Apple moth and Vine moth.

It is worth noting that the satisfactory control of Phylloxera can only be achieved by the use of resistant rootstock.

3 WEED CONTROL & COVER CROPS

With the increasing public pressure to reduce the use of pesticides for food production, fruit and grape growers are interested in developing alternative strategies for reducing weed competition in orchards and vineyards. One possibility would be to establish low-growing non competitive ground cover species. Such species would need to be dense enough to prevent weed seeds from germinating, yet not compete with the economic crop for nutrients or water. An added advantage of the ground cover species would be if mowing was not required.

The common alternative to chemical weed control in vineyards has been the use of cultivation. Depending on summer rainfall this can occur between 5-8 times a season, with no real impact on soil structure. Cover crops can be utilised in a number of ways to help suppress and in some cases completely control weeds.

Research into possible ground cover species has concentrated mainly on small grass species and also various legumes such as clovers. There is a wide range of species which could potentially act as ground covers in vineyards which show varying degrees of competitiveness both with the vine and with weeds.

A permanent sod may be established with the idea that the competition from the permanent pasture species will prevent germination of weed seeds. When first establishing the permanent sod it is important to select grass and legume species that have vigorous seedling growth and that provide rapid ground cover. Plants that have slow seedling vigour and erect growth habits will be poor competitors against weeds. Chemical weed control is usually required in the establishment phase, Finch and Sharp (1981). If a pasture species chosen for use in a permanent sod has slow seedling vigour, then it is suggested that the seeding rate be increased.

For example perennial ryegrass has slower seedling establishment and lower seedling vigour than does annual ryegrass. However, once established its spreads by tillering and will compete and smother weeds effectively.

Purple vetch, with its viny habit, will grow up most grasses, weeds or other plants in the mix and so is regarded as a good smotherer of weeds, Peaceful Valley Farm Supply (1988)

Medics produce hard seed, which remain hard over summer through to next autumn or beyond. This means that germination in the second year may be thin and so weed competition may not be as good. It is suggested that harrowing may encourage greater germination of medics (and weeds) and so improve the medics ability to compete against weeds.

There is a trend towards growing cover crops that, when cut, the clippings are thrown in long strands onto the vine row. This method is becoming popular when using permanent sods. It is important to choose legume and grass species that will give large amounts of bulk. Van Zyl and Van Huyssteen (1983) indicated that a "mulch (as dry matter) of 5t/ha of Wimmera rye or 8t/ha of vetch is necessary to provide an adequate weed suppression and soil shading role. The green weight of the cover crop would need to be significantly greater"

The allelopathic nature (ie the sometimes inhibitory or harmful effects of a living plant on other nearby plants) of certain cover crop species has been investigated. Schenk and Werner (1991) stated that various legumes in the tribe *Vicieae* (peas, lentils and vetches) contain Beta-(3-isoxazolinonyl) alanine, which is released into the soil as a root exudate and shows allelopathic tendencies. This chemical can cause reduced growth in seedlings of various grasses and lettuce.

Cereal rye produces several compounds that show allelopathic effects. The most active compounds are 2 hydroxamic acids and their breakdown products. Perez and Ormeno-Nunez (1991) reported that hydroxamic acids can inhibit root growth of wild oat (*Avena fatua* L.)

Duke (1981) stated that white and blue lupins are tolerant of weeds, whereas yellow lupin is deemed susceptible. The alkaloids of white lupins are said to act as a natural herbicide when the crop residue decomposes in the soil

4. IRRIGATION MANAGEMENT AND COVER CROPS.

Water is held in the soil as films around soil particles and temporarily in pores. When all the pores are filled with water and the air has been displaced, the soil is said to be saturated. The flow of water from the soil into plant roots is along a gradient of increasing water tension.

The development of root systems is reduced in water logged soils, not only because there is less oxygen to diffuse to the root zone, but also because there can be a build up of carbon dioxide and ethylene, both of which are inhibitory to root growth and function. If cover crops are incorporated into wet soils, creating anaerobic conditions, micro-organisms produce ethylene which inhibits root tip activity, Perret and Koblet (1984).

"Waterlogged (or wet) soils are slower to change temperature" Davidson (1990), therefore soils that become waterlogged and cold in winter, will stay that way long into spring and so new root growth is retarded. Temporary waterlogging can be reduced with the use of cover crops which are used to "de - water" the soil

There are four critical periods in the growing season of the grapevine where water quality and availability are critical.

i) bud burst to flowering - in Australia, excessive soil water, leading to waterlogging and oxygen deficiency, is the major problem, Hale (1959). Cover crops play a major role in assisting in the utilisation and drainage of this excess water, McCarthy et al (1992a).

ii) flowering to veraison - flowering and setting are sensitive stages because abscission and cell division processes are involved and water stress at this time leads to poor setting and smaller berries, (Alexander 1965, Hardie and Considine 1976). It is also the time when water consumption in vineyards rises steeply. It is critical at this stage, in limited water supply areas, that the cover crop is not competing with the grapevine for water

iii) Veraison to harvest - during fruit ripening, the vine can withstand a considerable amount of water stress; foliage will wilt and older leaves will senesce and drop, but berry sugaring proceeds.

iv) Post harvest and dormancy - dry soils after harvest inhibit the 2nd flush of root growth and cause early leaf fall, thus limiting the build up of carbohydrate and nitrogen reserves in the wood of the vines essential for bud and shoot growth during winter and spring.
It is during this period that autumn sowing of cover crops is taking place, so it is critical to be aware that excessive cultivation to prepare the seed bed, may lead to drying out of the soil and that the cultivation may also damage the newly formed secondary roots.

With most irrigation systems the basic aim is to distribute water uniformly over the whole vineyard area, in order to wet all the soil in the root zone. In Australia, there are 3 types of irrigation systems used.

a) furrow irrigation
b) overhead irrigation
c) low level irrigation - micro sprays
- dripper

The type of system used is dependant on a number of factors viz water availability, vineyard topography, water quality and soil type.

When selecting a cover cropping system, irrigation technique and how the cover crop affects the irrigation must be taken into consideration. For instance, in a furrow irrigation system, cover crops sown to improve the water infiltration rate and provide stability for traffic, should not slow the rate at which the water flows down the rows.

There is no doubt that the use of cover crops will improve the water infiltration rate into the soil. In Lavin and Kogan (1989), the results show that "After 6 years, soil water infiltration was almost 3 times greater under permanent weed cover than with chemical weed control. Poorest infiltration occurred with mechanical control".

Likewise in Glen (1990) "A dead mulch created by killing grass in tree rows before planting, persisted approximately 2 years. It trapped 76% of rainfall from 14 thunder storms, compared to 80% by a mowed living mulch, 57% by a cultivated system and 51% by a herbicide strip system"

And McCarthy et al (1992a) found that "Plots under sward retained as much or more soil moisture during the growing period than those under clean cultivation due to i) reduced water run-off and ii) lower ground temperatures leading to less evaporation".

5 SOIL NUTRIENTS.

The use of cover crops to increase infiltration and reduce erosion also reduces nutrient losses in surface water run-off. Nitrogen (N) and phosphorus (P) are the two nutrients most associated with degradation of water quality arising from agriculture, Logan (1990) Loss of P to the environment is associated with surface run - off while loss of N is primarily through leaching losses of nitrate N to ground water, Reeves (1994). Sharpley and Smith (1991), recently reviewed the effect of cover crops on surface water quality and noted that the use of a cover crop in various cropping systems consistently decreased N and P transported in the run-off. Meisinger et al (1991) found in a literature review that cover crops reduce N leaching primarily by uptake of N for production of biomass; however, reducing leachate by consumption of soil water for growth is also an important mechanism for reducing N leaching. Synchronisation of cover crop growth and consequent soil water and N demand with the peak leaching season, is another important factor in the cover crops ability to reduce N leaching.

The effective use of cover crops / sod systems depends on understanding the competitive and nutrient interactions, between sod plants and the economic crop (Haynes 1980; Zimdahl 1980; Morlat et al 1984; Skroch and Shribbs 1986). Cover crops can be used to compete with the vines to reduce vine vigour and encourage more reproductive (fruit) growth as well as to contribute towards the overall soil fertility. Great care is needed to achieve the right balance between the vines and the sod. Although the residue from cover crops can increase infiltration and reduce evaporation losses, transpiration losses of soil water by the cover crop can have a negative effect on the vine, Reeves (1994). McCarthy et al (1992a) also state that the biggest disadvantage of using sod cultures is their competition for water and mineral nutrients, the relative significance of each dependant on the local soil and environmental conditions. Possible methods of reducing nutrient competition between sod and the economic crop is to suppress the sod with chemicals and the provision of additional nutrients (mowing does not significantly decrease sod competition with the vines), Skroch and Shribbs (1986). Results show that sod and grapes compete for nitrogen and other nutrients when they are limiting. Perennial ryegrass sod led to reduced foliar concentration of N, S, Ca, B and Mn in "Chardonnay" wine grapes, Tan and Crabtree(1990). In alkaline soils, there is a reduced availability of N, Ca, Mg, Mn, Fe, Cu, and Zn.

In acidic soils the availability of Al and Mn is increased and these 2 elements and sometimes Cu may become toxic, McCarthy et al (1992a). Smart et al (1991) stated that Al toxicity causes severe stunting of roots which are short, stubby relatively unbranched and darked coloured.

Many of the advantages and disadvantages of cover crops are common to both grasses and legumes. Where differences in the effects from the two types of covers occur, they are largely related to fixation of N by legumes and resultant differences in N content of residues between the two groups of cover crops. The Carbon : Nitrogen ratio of cover crop residues is an indicator to the cover crop's affects on soil N, Reeves (1994).

The N contribution from grass cover crops is negative, (Brown et al 1985; Wagger 1989, Reeves and Touchton 1991, Torbet and Reeves 1991) due to the wide C:N ratio of the residue. The C:N ratio of grass residues is mostly dependant on total dry matter produced and time of termination. Early termination of the cover results in a narrower C:N ratio in the residue, with the total amount of residue produced reduced, Reeves (1994). The narrower C:N ratio results in the rapid decomposition of the residue, reducing ground coverage. For these reasons it is critical that the grass green manure crop is not terminated, ie. cultivated, too early. In practice, however, grass green manures are usually killed at a stage of development that results in a wide C:N ratio, resulting in an initial, if not persistent, immobilisation of N during the cropping season, (Aulakh et al 1991; Doran and Smith 1991, Somda et al 1991, Torbet and Reeves 1991). The use of starter fertiliser to supply 25 to 30 kg N / ha has been shown to be a good management practice, (Reeves et al 1986; Touchton et al 1986, Reeves et al 1990).

The N content of legume cover crop residues varies with species, residual soil N, adaptability to specific soil climatic conditions, and time of termination of growth. Management factors strongly influence the N content of legume cover crops and the contribution of N available to the following cash crop. Practices that promote early establishment, ie., early planting, inter seeding, or natural reseeding, result in greater dry matter and consequent N production, (Brown et al 1985; Oyer and Touchton 1990). Incorporation of legume cover crop residues results in more rapid mineralisation than when residues are left on the soil surface, Wilson and Hargrove (1986); consequently, the legume - residue N may not be available to the succeeding crop during the early part of the growing season.

Richards (1983) stated that root branching in grapevines is highly dependant on the available N and P levels of the soil. A leguminous cover crop left on the surface, typically contributes only half as much nitrogen as one that is disced / cultivated into the soil. If the cover crops are allowed to mature fully, as much as 60% of the nitrogen maybe tied up in seed, and be unavailable to the economic crop. Peret et al (1989) recommends that "hoeing or mulching of the green manure crop should be performed 3 weeks before the main period of vine shoot growth". This is particularly true if the cover crop selected is determinate (ie vegetative growth stops and reproduction begins at a discrete stage).

For the rest of the season the cover crop should be left to conserve the soil nitrate, which would otherwise be leached away. This means that green manure cover crops are resown at the beginning of each autumn. In situations where self seeding and nitrogen contributions are necessary attributes of the sod species, then the use of indeterminate legumes eg medics and sub clovers (legumes that continue to grow after reproduction) is recommended. A substantial amount of nitrogen will reside in vegetative parts of the plant, even after seed has matured. These legumes are useful in situations where a summer sward is required, ie to prevent soil erosion, water run-off and improve water infiltration. There is no question that cover and economic crops can compete for the available soil nutrients and water. However, the flexibility of the cover cropping system can minimise this competition. Such relationships need to be assessed and the type of cover crop required selected accordingly. For example in areas where water is limiting then the use of a green manure (that is cultivated into the soil prior to vine bud burst) is recommended or if water is not limiting but nitrogen is and the pH is alkaline then the use of an indeterminate legume that will contribute large amounts of nitrogen is recommended.

6 RESEARCH AND TECHNOLOGY TRANSFER NEEDS

The benefits of crop rotation and cover crops are well established if not well practised in modern highly capitalised and mechanised agricultural production systems. The main focus that research on cover crops should address is the economics of the practice. Unless a practise is economically viable, there is no incentive for growers to adopt it. Specifically, research efforts should:

i) Define the role of cover crops in integrated pest management (IPM) schemes. The short-and long-term agro ecological interactions, especially in regard to weeds, plant pathogens, and insects, between cover crops and the economic crop need to be better understood;

ii) Develop an economic risk analyses for cover crops;

iii) Develop cropping systems that are more economically conducive to the integration of rotations and cover crops. Research areas should include reseeding cover crop systems; breeding and screening of cover crop germplasm to develop improved cover crops, eg., improved cold tolerance of legume covers, maximisation of early biomass (and in the case of legumes, N) production, and early seeding; and developing management practices and alternative rotations that improve compatibility of cover crops and crop rotation in production systems. The latter should include development of dual use cover crops and rotations, eg., crops that serve as cash crops as well as cover crops.

7 PASTURE SPECIES - SUITABILITY FOR USE

There are a number of factors which influence the selection of particular species and cultivars for use in a cover crop mix. The selection is often guided by

i) The vineyard environment - soil type
- soil pH
- soil salinity

ii) The purpose for using cover cropping such as improving water infiltration or to lower the water table from the root zone.

iii) the growth period and habit of the cover crop species.

The following tables summarise the important variables of cover cropping and the potential variety of legume and grass species available for evaluation.

COVER CROP TECHNOLOGY

1996

FIELD DAY REPORT

RICHARD PORTER

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INTRODUCTION

The Cover Crop Technology(CCT) project commenced in 1994, with funding from the Grape and Wine Research and Development Corporation(GWRDC). This project has the charter of identifying suitable cover crops for a variety of end uses across the spectrum of grape growing regions in South Eastern Australia. Additionally, an extension kit is to be developed by the principle researcher for use by grape growers, which will address criteria relating to selection and management of cover crops.

The 1994 season produced poor results as a result of dry conditions, and only one trial site was successfully established at Padthaway. During the following season, four major trial sites were established at Mildura, Griffith, Barossa Valley and the Coonawarra. These sites in the first two years were designed to evaluate a broad range of plant types with potential applications as cover crops. Over 95 species/cultivars were evaluated in these two seasons, with observations made of establishment density and vigour, percentage ground cover, sward height and vigour, biomass production, and persistence/regeneration in the second year.

Following the analysis of these results, together with observations made at a series of secondary sites established in 1995, decisions were made as to which cultivars were suitable of further investigation in 1996. Blends of cultivars were developed also to create swards of diverse botanical composition, a feature which was identified as a desirable characteristic as a result of observed variations in growth habit, disease resistance and specific adaptations in the field.

A large trial program was implemented in the Autumn of 1996. In total 24 trial sites were established during April/May, utilising a small plot coneseeder hired from the Waite Research Institute. Cultivars sown at each site varied depending on regional adaptations, with the main types of cover crop represented at each site.(ie. Permanent Sod(PS), Annual Regenerating Sod(ARS), Green Manure(GM), Bio fumigant(BF), and Mow and Throw(MT)).

Following establishment, the trials were monitored throughout the growing season, with assessments made of seeding rates, fertiliser requirements, establishment vigour, species ratios in blends, susceptibility to Red Legged Earth Mite(RLEM), disease resistance, ground cover, sward vigour, weed suppression, time of maturity, sward height and biomass production.

As part of the extension of this technology, it was decided to conduct an extensive field day program, enabling interaction and discussion with growers on site at suitable times and trial locations. A list of field day sites and dates appears in this report.

The organisation and format of the field days varied from site to site, depending on the size of the growing region, the potential number of growers attending, the cultural composition of the region and the overall presentation of the trial. In some instances, local retail outlets were identified as co-operators to assist with promotion and extension activities, and in some cases sponsorship.

The following is a report on observations made, and relative comments received from growers, at the field days which may impact on future directions of this project.

1996 TRIAL LOCATIONS

STATE	REGION	GROWER	SOWING DATE
SA	WAIKERIE	SOUTHCORP	APRIL 11
SA	WAIKERIE	OXFORD LANDING ESTATE	APRIL 11
SA	KINGSTON O.M.	BRL HARDY	APRIL 12
SA	RENMARK	M. RICHARDS	APRIL 10

SA	LOXTON	J.SCHNEIDER	APRIL 10
VIC	MILDURA	A. CHISARI	APRIL 13
VIC	MILDURA	G. MILIC	APRIL 13
NSW	GRIFFITH	McWILLIAMS WINES	APRIL 15
NSW	YENDA	P. DICKIE	APRIL 15
VIC	RUTHERGLEN	PFEIFFERS WINERY	APRIL 16
VIC	NAGAMBIE	MITCHELTON	APRIL 17
VIC	GREAT WESTERN	SOUTHCORP	APRIL 18
SA	COONAWARRA	HOLLICKS	APRIL 19
SA	LANGHORNE CREEK	ORLANDO WYNDHAM	APRIL 19
SA	CLARE	SOUTHCORP	APRIL 22
SA	AUBURN	N. ZWIERSEN	APRIL 22
SA	WOODSIDE	NEW ERA VINEYARD	APRIL 24
SA	EDEN VALLEY	MILDARA BLASS	APRIL 26
SA	ANGASTON	YALUMBA	APRIL 26
SA	NURIOOTPA	W. ROHRLACH	APRIL 26
SA**	COONAWARRA	LECONFIELD	MAY 9
SA	PADTHAWAY	BRL HARDY	MAY 9
SA	COONAWARRA	SOUTHCORP	MAY 9
SA	PADTHAWAY	ORLANDO WYNDHAM	AUGUST 8
SA*	ROBE	CAPE JAFFA WINES	JULY 15
SA**	COONAWARRA	SOUTHCORP	AUGUST 18
SA	McLAREN VALE	SOUTHCORP	APRIL 23

* Denotes Bio fumigation trial

** Denotes Beneficial Blend trial

1996 FIELD DAY PROGRAM

LOCATION OF SITE	DATE AND TIME OF FIELD DAY
RENMARK	19 AUGUST 11.00 AM
LOXTON	19 AUGUST 3.00 PM
WOODSIDE*	26 AUGUST 1.30 PM
EDEN VALLEY*	26 AUGUST 3.30 PM
WAIKERIE	28 AUGUST 8.30 AM
MILDURA*	30 AUGUST 3.30 PM
WOODSIDE	1 SEPTEMBER 11.30 AM
LANGHORNE CREEK	2 SEPTEMBER 10.00 AM
McLAREN VALE	2 SEPTEMBER 3.00 PM

CLARE	3 SEPTEMBER 10.30 AM
AUBURN	3 SEPTEMBER 12.00 PM
GRIFFITH	10 SEPTEMBER 4.00 PM
RUTHERGLEN	11 SEPTEMBER 4.30 PM
MITCHELTON	12 SEPTEMBER 11.00 AM
PADTHAWAY	30 SEPTEMBER 3.00 PM
COONAWARRA	10 OCTOBER 3.00 PM
EDEN VALLEY	14 OCTOBER 5.00 PM

FIELD DAY OBSERVATIONS AND COMMENTS

1. RENMARK

Attendance; 12 growers plus Industry reps.

Observations:

- Lower rate of Ebony in mustard/oats/medic blend to great effect. Previous observations have indicated that the rate of 60/12/5 to be excessive. In this instance a ratio of approx. 60/6/5 was used. Suggest future rates of 5 kg/ha for monoculture and 3 kg/ha in combination with oats or triticale. This blend performs best in the Riverland, and must be sown early (March/April), with O/H irrigation preferred.
- Rangi Rape should be sown at a rate of 3-4 kg/ha only. All brassica crops require N and P, as well as extra S to achieve maximum Bio fumigation benefit.
- Paraggio the best performed medic in this trial.

Comments from Growers

- Medic decline or reduced loss sward density and vigour over approx. four years is a common observation by growers in this area. Could possibly be attributed to a reluctance on behalf of vignerons to apply P annually, or insecticide at establishment.
- More permanent sod being sown in the Riverland of SA, less green manure due to awareness of soil structure degradation implications. No water restrictions apply as yet. Haifa white clover and Blockaid/Blockout type mixture most prevalent.
- A prostrate white clover preferred to reduce the need to mow. Some preference for non-legume cover crop because of Light Brown Apple Moth(LBAM) hosting ability, and the perception that "clovers require more water"
- Undervine mulch poses problems regarding access with mechanical grape harvesters, bushfire danger, proliferation of earwigs, N deficit caused by placing straw/mulch under the vine row. Some of these observations may only be region specific.
- Faba beans the most prominent GM. There appears no regard for rotating annual swards such as beans or oats in some instances. Little awareness of BF.
- High level of inquiry regarding Jindera. Prostrate lucerne used to smother summer weeds such as caltrop. Some concerns regarding blocking of irrigation drains(sub surface) by the roots of this plant. Using a spring sowing rate of only 400 g per hectare, and establishing it in only two sowing rows thus allowing plant growth to cover the remaining area has been a recommended practice. The retail price in excess of $20.00/kg contributes to the low sowing rate.
- All growers impressed with the basic concept of botanical diversity within swards to accommodate variations across a vineyard

1. RENMARK cont.

- Clare subclover received some favourable comments. Doubts remain about it's ability to regenerate in year two. Desirable characteristic is non aerial seeder, as frost potential means all cover crops must be closely mowed during early spring.
- Hayfever/allergies a reason why some growers prefer non ryegrass perennial sods. Site to be continuously monitored for regeneration after mowing and persistence. IAMA staff to monitor root knot nematode numbers from white clover, Rangi rape and mustard treatments.

This site was established with the co-operation of RFC IAMA staff from the Renmark and Loxton stores. Kerry DeGaris was the contact person who was very active in promoting the site and field walk. Little assistance received from the local newspaper who "lost" an editorial and photograph supplied to them, and did not print it until the day of the field walk.

Promotion of this field day was via press release/editorial and photograph in the local paper. Additionally, our printed flyers were provided to RFC stores for distribution to growers.

2. LOXTON

Attendance: 10 growers plus Industry reps.(PISA and IAMA)

Observations

- Santiago and Paraggio medics much more productive than other medics sown at the site. Opportunity for Carpet in this area/region.
- Oats not included in 3-way mix with Ebony and medic, growth no where near as advanced for the brassica crops at this site, the difference being a lack of water applied at seeding. Rates for both brassica crops again excessive. Medic seeding rates of approx. 20 kg/ha appear justifiable economically, and appropriate agronomically. Early seeding followed by irrigation where possible, is paramount in this region.

Comments from Growers

- Medic decline again noted. Even after four years of annual reseeding, the productivity of the sward was noted to be declining. Attention will need to be given to mowing regimes to ensure sufficient seed set, annual super applications in Autumn, and attention to insect pest control. Additionally, rotation of annually resown crops will need to be addressed in the extension kit for growers.

2. LOXTON cont.

- Growers at this site again noted the decline in use of GM. Questions were posed regarding vigour control using summer active inter row crops which compete with the grape vine for water and nutrients in January and February (for example Chicory from NZ.). Jindera lucerne again mentioned, as well as sprayed weed mats(eg. Carpet?).
- Winter weed competition is a noted point of interest. Applications here for Adagio and Triticale.

No acknowledgment given to Seedco by IAMA rep. in a a short presentation, which was a little disappointing given the opportunity provided by us. However, both RFC stores appear to control a significant market share of grape growers.

Of special note is the recent development of an arrangement between IAMA and Southcorp, who have nominated IAMA as a preferred supplier of viticultural requirements. This agreement not only extends to Southcorp directly, but also contract growers supplying fruit to this major player in the wine industry. Entitlements include a discount on retail purchases and access to relevant technical information and extension services.

Promotion of this field day was via press release/editorial and photograph in the local newspaper. Additionally our printed flyers were provide to RFC stores for distribution to growers.

3. WOODSIDE/EDEN VALLEY Industry Information day

Attendance: 15

Including: JS.RP
Peter Hayes (GWRDC)
Hugh Armstrong (GWRDC and CRC)
Jodie Armstrong, Claire Harvey (Di Davidson consulting)
Barry Langbein
Phil Nicholas, Michael McCarthy (PISA)
Pat Wark, Gil Rogers (Growers)

Observations

- Need to be able to justify seeding rates, particularly with small seeded legumes. White clover rates at sites such as Eden Valley can vary up to 20 kg/ha., while generally should be in the order of 6-8 kg/ha for monocultures, and 2-4 kg/ha for blends with perennial grasses. Sub clover and medics are easily justified at 20 kg/ha for reasons relating to early ground cover, weed competition, and tolerance of management

3. WOODSIDE/EDEN VALLEY cont.

shortcomings such as lack of attention to RLEM control and seeding depth. The financial burden carried by increasing the seeding rate from 12 kg/ha to 20 kg/ha is of the order of $30/ha, which is not a deterrent given the associated benefit.

Justification of high seeding rates relative to broadacre situations will need to be included in the extension kit for grape growers.

- Question as to why grow a cover crop? Need to identify and nominate the expected benefits associated with the different options available to growers, hence defining objectives/aims/reasons for utilising a cover crop in the first place.

- As a result of the undulating nature of the Adelaide Hills, the potential for erosion is quite high, and the use of perennial cover crops is most often employed. Water use by the mid-row sward is an issue, as can be frost at budburst. Essentially ground cover from the break of season, allowing access and traffic ability during winter and early spring whilst protecting the topsoil is the primary objective.

- Management is a major issue, as once a cover crop is established, information needs to be provided as to how to maximise the potential benefit(s).

4. WAIKERIE

Attendance: 15

Observations:

- Adagio fodder radish had provided massive growth. Green Manure blends were very productive and visually outstanding. Ebony/oats/medic blend requires refining, with medic redundant, and a rate of 60:3-4 Oats/Ebony preferred.

- Irrigation was applied shortly after seeding at this site, with the benefits most obvious at this time of the season, as displayed by the excellent production of Vicia spp., cereals, peas and brassica crops.

- Paraggio, Mogul, Kelson, Santiago and Harbinger AR medics all productive. Carpet seed was unfortunately not available for this trial.

- Perennial blends of turf type perennial grasses plus Palestine/O'Connors(5-10%), and Ellet/Demeter plus Waverley/Tamar(20%) would be suitable to this area where O/H irrigation is available. Jindera prostate lucerne again was mentioned, however the Autumn sown plots this year were relatively unsuccessful. A trial on the nearby Yalumba Oxford Landing Estate was established to specifically address the problem of summer weeds. In this instance the trial plots of Jindera appear to have established well. Oxford Landing themselves establish Trifecta lucerne under a companion crop of cereal rye, with good success. Lucernes are not utilised in entire vineyards, but where there may exist drainage problems, or high densities of summer weeds such as caltrop.

Comments of Growers:

- Green Manure blend including Coolabah, Beans, Peas, Vetch and medic received favourable comment, with people impressed with the diversity and bulk in comparison with pure beans. Suggest using Kelson and Clare as understorey in future blends.

Waikerie Producers is the local IAMA outlet. We received assistance from the staff of this shop in the form of distribution of flyers via direct mail to customers, and co-ordination of placement of newspaper editorial. Store manager Mark Hudson is quite motivated, however the remainder of staff are not of the same ilk! An alternative distributor should be identified in this region, although the scale of Southcorp holdings in the district should not be ignored. Major developments are occurring at Kingston on Murray, Qualco and Waikerie, with major companies including Southcorp, BRL Hardy, S.Smith&Sons, and Australian Vintage. We have established links with all of these companies this year, with a view to potentially offering recommendations and technical support to seed supply in 1997.

5. MILDURA

Attendance: 12

The majority of people attending were Industry related, either from Dareton Research Station, IAMA, or the Australian Dry Fruits Association. Several growers were also present.

Observations:

- Medics consistently performed well. Local researchers commented that Paraggio had been the best medic for the region, a conclusion drawn from ten years of research.

Mogul was now regarded as equivalent to this variety. Mowing height need be to only 4 inches in this area to protect against frost. Most locals regard budburst as the time to incorporate green manures and mow ARS or PS. Spineless burr medics (eg Santiago) preferred because of labourers in the vineyard. Water use by cover crops was a major concern for Riverland growers.

5. MILDURA cont.

- N,P,K deficiency was apparent, which was probably due to leaching by flood irrigation and high winter rainfall. The majority of the soil appeared to be sodic in nature, and in this instance it was medics, faba beans and vetch which performed best.

- Green Manure blends again received favourable comment. Unlike the South Australian Riverland districts, permanent sod is not replacing Green Manures, with reported poor persistence and excessive vigour of perennials reported.

- Rangi Rape should be sown at 4-5 kg/ha, with N applied if flood irrigation utilised. Water restrictions now apply in this region which limit the options available to growers, as only two applications of water are scheduled from the end of March. This year a water was applied pre seeding (ie early April), and a follow up irrigation was required in early May as no rainfall had been received. This regime will impact upon seeding strategies as well, since the optimum seeding time has traditionally been late March. Some growers dry sow Green Manure crops prior to the penultimate watering in March, and by doing so achieve significantly greater biomass production and earlier maturity of swards. This strategy however is susceptible to late breaks of season.

- Fenugreek performed reasonably well at the second site, at least equivalent to Kelson. The seed for this particular species was not inoculated prior to seeding, and yet good nodulation was observed, presumably they were colonised by existing background medic inoculum resident in the soil. Perhaps a niche worth exploring could be the use of Fenugreek to inhibit the migration of snails in the vineyard, similar to it's utilisation as a barrier crop to prevent rodent infestation of cereal crops. This sort of application would impact particularly upon dry fruit blocks in the area where snails are becoming more of a problem.

- LBAM hosting ability was again a concern of growers, and data gathered by La Trobe University staff will be of significant importance.

- The proposed cover crop program for 1997, incorporating involvement of a local grower group at establishment time, received positive feedback. Steve Kelly of AFDA was very keen to be involved, and will be useful in identifying suitable groups and providing advice, having run similarly promoted programs in recent years.

- Ebony and Adagio performed equally well. Both require N and early establishment to maximise productivity.

5. MILDURA cont.

- Carpet seed was requested by Dareton researchers Davidson and Sanderson for 1997. They wish also to be collaborators in the program next year. They expressed a need to cover a greater region along the Murray irrigation region, and there may be the requirement to send seed to growers to establish their own trials.

Irymple Co-op (IAMA) was used as the contact re-saler in this region. Peter Hahn is the field officer, and provided very good feedback, both when assisting to identify grower/co-operators and when promoting the field day. Unfortunately numbers were down due to a lack of pro-active flyer distribution. The need was identified for bilingual brochures/kits in this region, with the two prominent languages being Italian and Turkish. Often these people were incapable of understanding written English though they could speak it with some fluency. Adoption of some cover crop techniques will be slow because of traditional practices which pre-date migration to Australia for some people.

6. WOODSIDE

Attendance: 45

Observations:

- As for the Industry day, much of the emphasis was on erosion control and prevention. Adelaide Hills mixes abound, but often include Phalaris and other undesirable species. A fast establishing, non clump forming, relatively low growing, winter active/summer dormant blend was desired. Direct drilling was the preferred establishment option, which minimises erosion risks.

- Water usage of a perennial crop over summer was a primary concern for local growers. Not all Hills vineyards are irrigated, and limited moisture reserves and the deletion there-of remains the single greatest inhibiting factor with respect to wider adoption of cover cropping.

- Sub clovers, white clovers, fescues and ryegrasses will need to be explored further in the future. Barry Langbein's experience will prove valuable to some degree in formulating mixtures, however the ungrazed vineyard regime is quite different to a grazed Adelaide Hills pasture, particularly with regard to grower requirements and diversity, and the persistence of species. Clare/Nuba/Gosse/Ellet type mixture should be successful.

6. WOODSIDE cont.

This field day was promoted through the Adelaide Hills Grape growers Association, with sponsorship from Mt. Torrens CRT(Farmer Johns), Lenswood Co-op(IAMA), Tom Ayers Vineyard Contracting, Shearers(via N. Giles at Strathalbyn), Chris Grow Engineering, Pivot fertilisers, and Enviromist. A BBQ lunch was provided to growers, with presentations from Barry Bull of Pivot fertilisers, and Dr. Judy Eastham of CRC Soil and Land Management, who spoke on Irrigation scheduling using sap flow monitors. This is a particularly pro-active group of growers, with a diversity of backgrounds and levels of experience, ranging from Tim Knappstein to city working hobby farmers. Farmer Johns is the best option for a retail outlet in the Adelaide Hills region.

7. LANGHORNE CREEK

Attendance: 25

Observations:

- Fodder Radish had established well, providing early ground cover and excellent weed suppression. RLEM in this area can provide a significant and often devastating effect on Trifolium spp. Traditionally this has been medic country.

- High background weed content present(soursob, ryegrass, medic). The site was very rough when sown, with couch debris on the surface, and a very undulating and inconsistent seed bed. The drill used was not suitable for the preparation of the soil, and as a result there was a relatively poor establishment of small seeded species such as sub clover, medic and perennial clovers and grasses. The soil is generally red sand over clay, and alkaline. The vineyards are generally drip irrigated in this region, with flooding of the Bremer River a frequent occurrence in Winter/Spring(as was the case this year). Growers require a cover crop which is able to tolerate the water logged conditions at this time, and retain the soil. Cereal rye and Triticale are two crops which have proven successful in recent years.

- Wind protection of new vines is paramount. The sand blasting effect of high winds and bare soil surfaces combined, can cause significant damage to recently planted vines, not only in Langhorne Creek, but in Riverland districts, or where ever sandy soil prevail. A common blend is 60 kg/ha of cereal rye, plus 8-10 kg/ha of annual medic.

- This trial demonstrates the necessity of matching seeding equipment to seed bed preparation. Coulter tines would have handled the excess trash well, unlike the Baker boots on the machine we used.

Comments by Growers:

- Seeding time needs to be defined. Trade if between early seeding and possibility of delayed opening rains or a false break. Also to be considered is the end of vintage and re-allocation of vineyard resources.

- Some inquiry from growers regarding the growing of a prostrate, perennial for the purpose of reducing temperatures in the vineyard over the summer period. Turf type fescues would probably provide the best tolerance of the dry conditions in non-irrigated or dripper fed vineyards.

- Nitro and Prolific look good, with the bloom appealing to growers, however the aerial seeding nature may inhibit mowing regimes. Under vine mulch would be washed away with flood waters in years such as 1996, and is not a common strategy in this region.

This field day was sponsored by N. Giles, Pivot Fertilisers, Vivco (Strathalbyn), and Tom Ayers Rural Contracting. Dr Judy Eastham provided a presentation on vine row mounding and irrigation scheduling using sap flow monitors. Vivco are a competent retailer in this region, but probably not he only option to consider for future marketing of Seedco blends. Orlando Wyndham, the co-operator used this year received contradictory advice from Lange Seeds last year, and took their 16MT seed order to Adelaide Seed Co. instead. In 1997 the management have again requested my recommendations for this 400 Ha development, and if appropriate we should service them direct. Other smaller growers will continue to be referred to Lange Seeds for seed purchases.

8. McLAREN VALE

Attendance: 22

Observations:

- Green Manure blends again a stand out, along with the sub clover/ryegrass mix. All entries at this site performed well. Adagio offered weed suppression, Triticale was adequately early in maturity to provide a persistent straw mulch if mowed at bud burst, and was matched by Blanchefleur.

- Clare/Nuba/Gosse and Ellet will be a suitable blend for this region. RLEM control is important, as is direct drilling because of the topography in some instances. Triticale plus 3 vetches was consistently good across the trial, as well as in an undeveloped part of the Seaview vineyard where vine planting will take place next year.

- A majority of the vineyards in this area employ Faba beans or oats, often in alternate rows. Little area is sown to ARS, and practically no perennial sod is used, possibly because a majority of vineyard is effectively dry land.

Comments by Growers:

- Early seeding is a priority in this area, as cool weather in May reduces sward production at bud burst significantly. GM cover crops are incorporated at this time in most situations due to frost risk and concerns regarding water usage.

- A large number of vineyards in the region are small scale, and a lot of growers are ethnic, and extension kits for the region need to be simple and user friendly. Another outlet for an Italian version.

This field day conflicted with a visit to a nearby vineyard by Philip Myburgh from South Africa, and numbers were reduced accordingly. Promotion of the day was via Craker Holdings, who distributed 400 flyers on our behalf, as well as sponsoring the afternoon by providing drinks. Crakers displayed a Shearer vineyard seeder, Howard mowers and Case tractors on site. Dr Judy Eastham again presented on sap flow monitoring for irrigation scheduling. Southcorp are desiring further involvement in this work.

9. CLARE

Attendance: 45

Observations:

- Ebony performed reasonably in most plots. Local seeding rate is 8 kg/ha. Perennial swards performed well, local rates should be 3-4 kg/ha white clover plus 20 kg/ha rye. Demeter or turf type fescues may be best option for the dry land vineyards which dominate this region.

- Clare/Nuba/Gosse plus Ellet was again good. Need for RLEM control i Autumn. triticale and vetch productive, no need to consider this sa a blend as a three way mix is easily achieved by growers self mixing, however the rate of Trit. needs to be increased next year, leaving the rate of vetch constant(eg. 80-100 kg/ha triticale plus 20-25 kg/ha of vetch)

9. CLARE cont.

- A Multicut sward for side throw would be utilised in this area, at the moment triticale is the best option. Need to investigate Laser/Elite II/ KRC-6/Dargo blend further, including persistence of residue, time of first mowing, fertiliser requirements, and the number of cuts and biomass production achieved. Present indications are that 15-20 kg/ha of rye plus a a total of 12-15 kg/ha of trifoliums will be optimum.

- Higher total rates of GM blends/cultivars should always be compensated with by increased fertiliser applications. The rate of vetch should not be so great as to cause lodging in the sward, with 30 kg/ha the maximum in a blend, and 35-40 a maximum if grown monoculture.

- Triticale has out yielded oats in the trial at Clare, and a rate of 175-200 kg/ha is most often used. Weed suppression is another feature of Trit., as with Adagio which provided good bulk. Concern expressed over the allopathic effect of this brassica on vine vigour, as well as the regenerative ability of the radish post mowing.

Comments by Growers

- Broadleaf weed control in cover crops has limited options. Need for a Jaguar type chemical to be registered for use. An alternative is to develop a strategy to control winter weeds in alternate years with Adagio and triticale until an ARS can be successfully established.

- An annual regenerating sod will be the optimum situation in this area, as perennial are limited by water availability. Minimum tillage is used in Clare, not zero tillage which has been attempted with poor results after ten years.

- A keen interest was shown in: the fodder blend incorporating oats/beans/peas/vetch/Kelson/Clare.; Adagio; Clare/Nuba/Grass; Fescues; Mow and Throw. GM's are not always incorporated, often mower mulched. A need to address seeding rate/fertiliser rate interaction, weed control, LBAM hosting ability, BF effect on vine vigour

Vivco at Clare were most pro-active in the area of field walk promotion and publicity, as well as creating continued trial awareness with their grower customers. A reflection on the staff at this retail outlet was the enthusiasm and number of those attending. Elders rep was present on the day, but his knowledge of this work and poor rapport with growers was obvious. IAMA is an obvious choice for a retailer of Seedco blends in the Clare Valley.

10. AUBURN

Attendance: 37

Observations:

- Similar to the Clare site. Ebony and Triticale would work in this area if sown early, using rates in the vicinity of 100/4 or 100/3. Rangi rape should be sown at 4-5 kg/ha maximum.

Comments of Growers:

- Question regarding water way conservation of soil. Species need to be tolerant of water logging while providing good trafficability and access during winter. Phalaris is an obvious choice, but growers are negative about using this grass in vineyards. An aspect for further investigation in the future.

- Need to describe ground preparation and seeder calibration etc. when formulating extension kit.

- There would be a significant demand for the forage blend if actively promoted in this area. IAMA staff considered the Sub clover/ ryegrass mix an important and impressive development.

Caroline Reichstein co-ordinated efforts regarding this field day very well. She was responsible for distribution of flyers to clients, and assisting with publicity in the local newspapers. A BBQ was held for those attending, with sponsorship from WSB distributors, who demonstrated a Ben Wye mower, and a new range of AGCO tractors. An excellent example of how to run and promote project awareness.

11. GRIFFITH (YENDA)

Attendance: 28

Observations:

- Part of the vineyard was subject to soil sodicity, in which case Kelson medic was a good performer.

- The ratio of cultivars in the Clare/Nuba /Ellet blend was again ideal for the first year.

- The N rich mix of beans/peas/vetch has a good ratio of species, however the overall rate could be increased significantly(50%), to achieve a better result. This is an observation made at several sites. Balansa has a good reputation in this district and is well suited to the soil types here. Flood irrigation has led to soil sodicity and compacted inter rows which inhibit emergence, especially of small seeded cultivars.

- Lupins are grown with success in the area, but need to use a rate of 150 kg/ha.

Comments by Growers

- The green manure blend of Oats/beans etc again received much good comment. The concept of botanical diversity is easily understood and logical to most growers, and was demonstrated at this site where some cultivars were poorly adapted to specific parts of the vineyard leading to gaps in rows where monocultures existed.

- Adagio again received favourable comment. The seeding rate used this year was 20 kg/ha at all sites, and this would appear appropriate.

- A significant portion of growers are Italian, and there is a reliance on existing traditions of twin furrow irrigation and continuous discing of the land using antiquated equipment with poor depth control. GM's are often unnecessarily worked until any incorporated biomass is broken down resulting in no net benefit.

- Haifa white clover has been grown successfully in a number of vineyards throughout the region over a number of years. A potential exists to develop minimum mow perennial sods for this area, eg Palestine clover plus turf type grasses. The small seeded varieties failed this year because the flood irrigation post seeding caused the surface to seal over, and should be a consideration when making recommendations.

Peter Reynolds from Yenda Producers provided good assistance during the year, but unfortunately left in August to take up a position with SPS. Y.P. used the filed day sa an opportunity to introduce his replacement Barry Sidlow, and in return provided refreshments at the conclusion of the day. Promotion of the day was via direct mail of flyers to 450 growers(ex Orlando and Y.P.). A segment on local FM radio was also conducted which provided a last minute opportunity for promotion on the day of the field walk.

12. RUTHERGLEN

Attendance: 7

- Acid, sandy river soils. Phylloxera district, with severe nutgrass problem. Peas are often used as a cover crop in this area. RLEM is a problem in Autumn. LBAM concerns exist, rabbits had destroyed a number of plots.

- Lupins should be grown at 150-175 kg/ha, Fenugreek is not an option where water logging occurs. Adagio again impressive for out competing winter weeds. Junee provided a good dense sward most often.

- Derby Supreme appears a a very prostrate, dark green rye. In combination with strawberry clover, a short perennial sod with potential to smother weeds and give a carpet effect would be achievable.

Comments by Growers

- Accent on non legumes. Concerns regarding water use over summer.

- Group considerably reticent.

Promotion of this day was via direct mail to about twenty vignerons in the region, and so turn out was predicted. Consider an alternative vineyard for next years work, away from the nutgrass problem, and having used Pfeiffers for the past two years. Requirement to make recommendations for this grower.

13. MITCHELTON

Attendance: 25

Observations:

- RLEM population early in the season reduced the plant densities in a number of plots significantly-a good example of requirement for insecticide control in Autumn. A very wet winter has demonstrated the relative tolerance of different species to waterlogging. Fenugreek was again poor, Cereal rye was very tolerant of the conditions, small trifoliates such as Persians and balansa were devastated by RLEM. Carpet should perform well in this region

- The Coolabah/Kelson blend proved effective. Ebony should be sown at a lower rate of 5-6 kg/ha. Clare/Nuba/Gosse/Ellet will be very successful and acceptable. Santiago very impressive.

Comments by Growers:

- 70 kg/ha of Cereal Rye is the locally used norm.

- LBAM is a concern, and as a result the work of La Trobe University staff becomes not just relevant but very important.

- Considerable interest in totally integrated vineyard management, for example utilising beneficial blends and hedgerows complementary to IPM programs to achieve a higher level of pest control from a reduced reliance on synthetic pesticides and increased efficacy of biological controls. The use of a hedge row would be to incorporate a border catch crop to harbour beneficials and give an alternative source for target pests, as was seen in California. This is another area for future investigations. Investigate also the use of V. Ervilia to combat rabbits, Fenugreek for snails and non hosts of LBAM.

This filed day incorporated a lunch at the Mitchelton winery, which helped us to achieve a near 100% turnout of growers, since invitations were via direct mail of flyers to Goulbourn Valley Wine makers Assoc. This group were very interested in alternative management, and next years program should prove most popular.

14 PADTHAWAY

Attendance: 7

Observations:

- Triticale rate should be increased in the vetch based GM blend, eg 100/25 ratio. Ellet should be the selected ryegrass in the sub mixes, as vigour is best in the first year, and persistence appears greater in second year.

- Santiago, Paraggio appear to have performed well, and this would indicate that carpet again would provide a good result. Adagio and other GM blends appear to have performed best, and this would be a result of the ability of the seeder to accurately place the seed. The seed bed itself was densely covered in couch residue prior to seeding, and the baker boots were not suited to the direct drilling attempt.

14 PADTHAWAY cont.

Comments by Growers:

- Frost risk is a concern in this region. As a result all swards must be mowed flat at budburst, and ARS should be prostrate, for example Denmark displays a very flat and low growth habit whilst providing good ground cover. Minimum mowing is desired, though there exists some interest in under vine side throw mulching.

- Sunflowers may provide an alternative food source for birds if used as a perimeter crop. Snails are an increasing problem and concern, though an application of copper reportably "knocks them out of the vines" Hard pans are a major problem in this area with considerable interest in the ability of Adagio to combat this, along with Safflower, as previous methods have been unsuccessful. A doubt exists over the persistence ability of perennial ryegrasses.

- Irrigation in the area is predominantly dripper, with some O/H, with very little GM conducted in the area. Triticale a better option than oats generally. Aerial seeding plants are difficult to manage at budburst because of mowing requirement. Nematodes not an issue there.

- Next years proposed program received positive feedback, although this appears to be a hard to motivate group of growers. The majority of vineyards are under the control of large corporate structures, with this project having already targeted Southcorp, BRL Hardy, and Orlando Wyndham. Brown's have also been approached and are keen to utilise our services next year.

- Growers request that the following issues be addressed: hard pans; frost control, water use by annuals and their persistence/regeneration; overall cover crop management(when to mow etc.); use of hedgerows to combat birds, snails; and again the need to sow a waterlogging tolerant headland or waterway(non phalaris).

The field day at this site was conducted with no sponsorship, and without an IAMA presence, although an invitation was extended to D. Brown. As mentioned, most of the vineyard is under the control of one of half a dozen major corporate structures, and each could be approached one on one directly by us, negating the need to use the only retail outlet in Padthaway(IAMA). Promotion of the day was via direct mail, and the poor attendance was solely attributed to gale force winds and driving rain all day, as there have been a number of apologies for non attendance received. The

spring sown trial at Orlando's is progressing very well, and includes ten treatments sown by conventional machinery to investigate the potential settling-out nature of some of the developed blends.

15 COONAWARRA

Attendance: 15

Observations:

- Effectively all plots established well. From observations in the 1995 trial adjacent to this years main trial, it appears sub clovers and white clovers are persisting very well, while medics are not apparent. Ellet is the superior rye, with Victorian disappointing in the second year. Tribute fescue looks good, while Demeter is too tall and stalky.

- Need to stress the importance of a dense perennial grass mat to provide a dense lawn like sward, as a low rate will result in clumping. All phalaris is persisting well but is deemed undesirable by most growers. Of the white clovers, Waverley has persisted best, closely followed by Tamar, then Kopu, while the rest are near to non existent.

- Need to gain some experience with Chicory for vigour control over summer.

Comments by Growers:

- Adagio most impressive(note 50 kg required by B. Lynn). Carpet and the GM blends, sub clover blend and Ebony all performed this season.

- Require a low growing annual because of frost concerns. Some commented that by mowing the radish or mustard, 90% bare ground would result which would be most beneficial for negating frost. Weed suppression important, as is summer dormancy and early maturity, since competition for available water is a concern. Denmark exhibits a suitable growth habit, but gives poor ground cover early in the season, and persistence may be a problem.

- Seeding date in the Coonawarra is compromised because of a lack of resource availability due to late vintages in this cooler region. As a result the sowing of cover crops does not usually occur until early May, by which time growth of the crop is restricted by the onset of cooler weather.

This field day was promoted via a direct mailing to approximately 60 South East Grape growers Association members. As with each of the days promoted in this manner, the cover crop brochure was included in the invitation, along with a Shearer pamphlet and the general Seedco leaflet. Additional field walks are scheduled for this trial area during Vititec at the end of October.

16 EDEN VALLEY

Attendance: 27

Observations:

- Green Manure blends still looking good despite recent frosts to the top wire in the vineyard. Most pasture spp. suffering due to the very wet conditions all winter. The best performed species are Mustard, radish, Triticale, Gosse, and Santiago.

- It is important to note the necessity to apply additional fertiliser where leaching has, or is likely to, occur. This is especially true for brassica crops.

- The proposed program for next year was well received by the group, and it was suggested that I approach the Barossa landcare group for involvement. Most of the growers present were from the Barossa, not Eden Valley.

Comments by Growers:

- Ideally looking for an annual, regenerating sod, with a preference for early flowering(ie. August), such that seed set occurs in early September at latest. The sward should ideally senesce at bud burst, or be able to be desiccated. Early ground cover in Autumn is important, giving 100% cover in winter, but with no summer activity.

- Water usage by cover crops again is a major concern

- Clare/Nuba/Ellet mix received a lot of positive comment. Santiago was very productive, and Carpet would have a lot of applications in the Barossa.

- Triticale, Oats, and Beans are the more traditional GM's, question as to whether 12MT/ha biomass is achievable to enable a good undervine mulch by use of side throw mowing.

Bill Hannaford is the new agronomist at Farmer Johns(CRT), Nuriootpa, and he appears to be a very knowledgable and pro-active worker. I feel both Farmer Johns outlets(also at Mt. Torrens) would provide excellent opportunities to gain market share in the Adelaide Hills and Barossa regions. Dermody's is the IAMA outlet in Nuriootpa, but they do not have the same drive or professionalism.

CONCLUSIONS

Approximately 350 people attended the 16 field walks conducted this year. This number was made up mostly of growers, but a number of researchers and industry representatives also attended the days, providing feedback on a range of different issues from a diversity of perspectives. The inclusion of social interaction by way of a BBQ or even drinks at the conclusion of the formal proceedings is a sure way of maximising the number of people attending, and is a way of avoiding "preaching to the converted". In some instances, such as the Adelaide Hills, a lot of the growers are only part-time, and so week-end settings are most appropriate.

One of the major concerns expressed by vignerons regarded water usage of the cover crop after budburst. Relevant to this query is the optimum time for mowing or mulching of ground cover, not only to conserve soil moisture and limit competition, but also to provide the most persistent straw residue.

The ability of a cover crop to host LBAM is also of prime importance and is an issue foremost in peoples minds. The feedback we are due to receive from La Trobe University will be of major importance.

Of the blends developed for trials this year, the two most widely accepted were:
1. Clare/Nuba/Ellet blend at the rates of 8/8/15 kg/ha respectively
2. Coolabah/Red Bean/Glenroy/Popany/Languedoc/Paraggio/Argeles blend at the rates of 35/20/20/8/8/5/5 kg/ha respectively.

These two blends have the potential for further refinement and marketing as a pre blended vineyard mix.

Other blends which have potential wide use applications are as follows:
1. Coolabah/Ebony
2. Triticale/Vetch
3. Ellet/Demeter/Waverley
4. Palestine or O'Connors/Derby Supreme
5. Dargo/Elite II/Laser/KRC-6

The rates and ratio's of some of these blends require adjustment from those used this year, while others require significantly more investigation to determine rates for optimising their end use performance.

Data drawn from McLeod and Kirkegaard will provide the basis for much of the future recommendations relating to Bio fumigation. Adagio has performed well in the area of weed suppression which should see it utilised significantly in 1997 regardless of its ability to suppress nematodes. Rangi rape requires a low seeding rate to be effective, and as for all brassica crops, has a requirement for extra N and P, especially on leached soil. Ebony Mustard also requires a lower seeding rate than that used this year, and as a brassica crop has the same fertiliser requirements as rape.

There is considerable interest in "alternative " vineyard management, with respect to the use of hedge rows and beneficial blends to assist in controlling common pests. This area of application of cover cropping is open for much further investigation, and submissions have been made to GWRDC by staff at UNE, Armidale, for this purpose. The ratios of flowering species and the choice of cultivars is open for review, with a reduction in cost paramount.

Soil erosion control, improved traffic ability, aesthetics, increased accessibility over winter, breaking of hardpans, and improved soil structure are the main reasons growers currently use cover crops. Integrated vineyard management utilising the cover crop as a tool to impact on other aspects of vineyard operation will be the reasons growers change their current mid-row management practices.

Management of a cover crop is deemed as important as cultivar selection, and a large component of the proposed extension kit will need to address this issue. Topics to be covered will range from seeding depth, seeder calibration, fertiliser applications, seed bed preparation, pasture pest control, sward utilisation via mowing and/or incorporation, and sward management to maximise persistence or regeneration over several years. An important consideration when making recommendations is the existing soil conditions, and the computability with the available seeding equipment. An assessment of the likely impact upon cover crop emergence should be made, with seeding rate adjustments if required to ensure adequate establishment.

Cereal Rye and Triticale are preferred to oats in waterlogged and dry conditions. Where sand blasting of young vines occurs, the best cover crop is either Triticale or cereal rye, which is left to stand over the summer. On occasions, this cover crop can be undersown with a pasture legume, such as medic or sub clover.

Kelson medic may be the best option for sodic soils. Other cultivars to perform well in sodic conditions are Paraggio, Santiago, Blanchefleur, Faba Beans, and Popany. Fenugreek performed particularly poorly on both sodic and waterlogged soils. Some growers requested a blend which is suitable for use on headlands and water ways, which must be basically perennial, prostrate and tolerant of water logged conditions, noting that Phalaris is not a preferred cultivar.

RECOMMENDATIONS

1997 TRIAL PROGRAM

The proposed program for next season was aired at most field days recently, and the idea seemed to meet with good acceptance. There will be the need to identify a suitable grower group in each region in January/February, and locate an appropriate site at this time also. Negotiations need to be conducted with John Shearers regarding the provision of a seeder for promotional use when establishing these trials, the idea being to transport the seeder from site to site, with the co-operator providing the tractor. I feel it necessary

to target at least the same number of trial sites this next year, as the extension of seeding methods, rate selection, cultivar selection and sward management is best conducted hands on. I would anticipate a reduced workload per site next year, with assessments made of establishment densities and vigour, and spring biomass availability and growth habit the most important parameters for me to monitor. Monitoring of regeneration in 1996 trials will be a significant task for the early part of the season also. The format of the trials will be such that several rows of each of 10-15 treatments will be seeded to demonstrate a range of most appropriate blends and monocultures in the specific region/vineyard. By having the grower group present on the day of seeding, it is anticipated that seeder calibration, seeding depth, and seedbed preparation can be demonstrated. This method is hoped to confer "ownership" of the trial upon the group such that they monitor the progress independently, with a field day in spring much the same as this year to discuss the relative merits of cover crops and any observations made.

New areas for research considered next year will include the assessment of vigour reducing species such as Chicory. Spring seeding and establishment/management requirements of these species will be aspects investigated, as they will be also for prostrate lucerne. There exists a need for the investigation into the trait of lucerne in blocking sub surface irrigation drains, ie. is it fact or theory only?

Some of the areas of investigation which have been initiated this year and which will require further work include:
1) Bio Fumigation, in particular the use of Adagio and Ebony. Seedco will need to consider tonnages required for 1998, which will be largely determined by the experience of those growers utilising these crops in 1997. There exists a need to identify the ability of the radish to regenerate after mowing in spring, and by way of doing this define the optimum time for mowing. Experience may show incorporation is required to cease the regenerative ability of this plant, and the observations of McLeod and Kirkegaard will also impact upon this. Brassica seeding rates for 1997 will be in the order of 20 kg/ha for radish, 5-6 kg/ha for Ebony, and 4 kg/ha for Rangi Rape. Early seeding of these crops is important, with O/H irrigation in Riverland districts desirable. Blends incorporating mustard will be of the order of 100:4 kg/ha for Triticale/Ebony, and 60:3 kg/ha for Coolabah/Ebony, with the Riverland districts most appropriate for these mixes. The effectiveness of a spring seeding of Adagio is to be considered also.

2) Green Manure blends are reasonably well defined now. For maximum biomass production, the Coolabah/Red Bean/Glenroy/Popany/Blanchefleur/Medic/Sub mix will be recommended. Changes to this blend will be the substitution of a Seedco proprietary vetch for Blanchefleur, and the inclusion of Kelson and Clare as the medic and sub. Ratios and the suggested seeding rate will remain constant. Coolabah/Kelson has applications, with the ratio of 60/20-25 appropriate. Another alternative is the use of Triticale plus vetch, with the suggested ratio 100:25-30 kg/ha successful. An N-rich mix, consisting of Red Beans, Glenroy peas, and Popany, Topcut and a V.Sativa in the ratio 60:60:8:6:8 may be requested by some growers. The total rate of this last blend may need

to be lifted up another 20-30%. The benefits of leaving a mulch on the inter-row surface as opposed to incorporation need definition also.

3). Annual Regenerating sod. the most appropriate and consistent being the blend of Clare/Nuba/Gosse/Ellet in the ratio 6/6/6/15 kg/ha. This blend should achieve good acceptance in the market, although as yet we have no data on the regenerative abilities of the sward, or the dynamics over several seasons, an area needing attention next year. An overall seeding rate of 18-22 kg/ha for annual medics or sub clovers will be recommended next year. The best medics in 1996 have been Santiago, Paraggio and Mogul. Carpet has excelled in the few trials in which it was sown, and will be suggested for use in most areas next season, depending on availability. From my observations at Coonawarra and Eden Valley, it would appear that this cultivar is 7-10 days earlier in maturity than Paraggio, which is a significant benefit from a vineyard perspective, as is the slightly more prostrate growth habit and denser vine mass. Sanderson and Davidson, researchers at Dareton have requested Carpet seed for their trials in 1997.

4). Mow and Throw. This is an area for much further investigation. From Seedco's perspective, there is the need to define the most effective sward in terms of botanical composition, mowing regimes, straw persistence and biomass production. At this stage Triticale would be the recommended sward for M&T, with a sowing rate of 175-200 kg/ha, and high rates of N and P. Growers have noted side effects of undervine mulch, such as the proliferation of earwigs, N deficit caused by soil micro-organisms, increased frost damage, and causing an impediment to mechanical harvesters.

5). Perennial sods Several discrete sods can be differentiated, depending on the growth habit desired by growers. The first is a prostrate, year round ground cover, consisting of turf type cultivars. The recommended blend for 1997 in this instance will consist of 10% strawberry clover, 20% Denmark sub clover, and 70 % Tribute fescue. The role of Derby Supreme ryegrass will continue to be defined in the 1997 trial program. A second type of PS is the Waverley/Ellet blend, which may incorporate a component of Demeter as well. The ratio of cultivars in this instance would be of the order 20:60:20. There has been significant inquiry regarding an obligate dormant perennial grass, and as such any Berber cocksfoot available for trials next year should be obtained. Additionally I intend investigating the role of desiccants such as Sprayseed to control the vigour of perennial species over the critical months of summer(single, low rate, strategically timed applications). The persistence of all perennial species under dry land conditions is to be monitored carefully this season.

A future initiatives for Seedco may include the development of a prostrate, persistent white clover for the MIA and Riverland regions. Early maturing crimson clover would have great appeal to most vignerons where frost risk is minimal. A prostrate lucerne will have some uptake, but quantities would be small, and Jindera is already established in the market. A better option may be to advocate the use of Trifecta for vigour control, and alternative methods for summer weed suppression including a dead mulch or strawberry clover/turf grass blends etc. Water restrictions which are already in effect in Mildura are

going to impact upon cover cropping in this region, and future restrictions may eventuate in other districts. Awareness of these changes will be vital to keep abreast of dynamics in this field.

Aesthetics in a vineyard will emerge as a consideration in some cases as the tourism aspect becomes more integral to the wine trade. A blend incorporating Nitro, plus a Crimson, Red and Balansa clover would provide a range of colour at bloom. This area leads on to the development of Beneficial blend s for utilisation in conjunction with IPM programs. Such beneficial blends should also include white clover, alyssum, gypsophila, phacelia, Californian Poppy, Blanchefleur, and birdsfoot trefoil. As mentioned previously in this report, other researchers have put forward proposals to continue tis work in Australia next year in collaboration with us. Aligned with this work is the requirement to continually monitor the LBAM hosting ability of all cover crops. I would also like to investigate the use of Fenugreek as a barrier crop, particularly with reference to snails.

Growers have indicated the need for broadleaf weed control in vineyard mid rows. Apart from investigating Adagio's role in this cause, a push for registration of Jaguar selective herbicide would benefit the industry considerably, and would ease the burden on some clover based swards

Such initiatives form part of the future evolution of totally integrated vineyard management, which considers cover crops not as an entity worth only minor consideration, but rather as a tool which is basic to soil management, pest control, irrigation management, weed control, canopy design and fruit quality. Identification of vineyard needs and goals, suitable cover crop selection, and employment of optimum management practices form the charter for this project in 1997

Marketing of Seedco blends and Adagio should be targeted through pro active, motivated retailers which should be identified region by region. To date several suitable outlets have been encountered, notably:

IAMA outlets at

- Clare(VIVCO)
- Irymple(Irymple Co-op)
- Mildura(Mildura Co-op)
- Penola(VIVCO)
- Yenda(Yenda Producers)

CRT outlets at

- Shepparton(I.K. Caldwell)
- Mt Torrens(Farmer Johns)
- Nuriootpa(Farmer Johns)

A separate report addressing marketing issues will be presented in November.