final report

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Exploring hidden economic losses in sub-clover pastures

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Executive Summary

The project aimed to quantify the level and effects of sub clover root disease in pastures across the south-east region of South Australia. It aimed to understand the production and economic impact of root disease and, through the evaluation of chemical and cultural control methods, establish cost-effective solutions to manage these diseases.

The main soil-borne pathogens that effect sub-clover include *Pythium sp., Phytophthora sp., Aphanomyces sp.* and *Rhizoctonia.* These pathogens usually exist as a disease complex that can affect establishment and persistence, reduce germination, destroy roots, reduce plant size and cause failure of nodulation and persistence of pastures.

Over the three year project, various cultural and chemical practices were investigated to quantify their impact on controlling root disease in sub-clover pastures. A number of sub-clover varieties were also assessed to see if there were differences in varietal resistance to root disease between commonly grown varieties (both older, well established varieties and newer varieties) across the south-east region of SA.

At the end of the three years of trial work, there were no significant production benefits found from the application of a range of fungicides applied as either seed treatments or as post-emergent spray applications. The continued use of Apron® as a seed treatment is thought to still be important (germination increases of 5-10% – although not significant) as an insurance policy in case the site being sown has high levels of disease.

There were significant differences in varietal performance over two seasons (2015 & 2016), with some of the newer varieties (purported to have higher disease tolerance) performing well. However, Trikkala (an older variety that has performed well in the region) consistently outperformed the ten other varieties tested, especially Woogenellup (a variety known for its susceptibility to various disease pathogens). Trikkala has been grown across the south-east of SA for many years, and the seed is bred locally; it is thought that a local biotype with good field tolerance to root disease pathogens may have adapted over time.

Whilst root diseases are clearly present across the south-east of South Australia, the lack of disease response over the life of the project suggests that current "best management practices" that are used when new pastures are being established (i.e. knockdown herbicide in advance of sowing, cultivation for an even seed bed and good seed soil contact, the use of Apron® seed dressing, and sowing newer varieties or varieties that have long been utilised in the region) appear to be ensuring that producers are minimising the risk that root disease may have on sub-clover establishment and survival.

Table of Contents

1 Background

1.1 Mackillop Farm Management Group

The MacKillop Farm Management Group (MFMG) is the largest, most coordinated producer group in the south east (SE) of South Australia (SA). It has a membership of approximately 130 farm businesses and 20 sponsor businesses which cover approximately 70 agribusiness representatives. It has strong links with local government organisations including the South East Natural Resources Management Board and Primary Industry and Resources South Australia (PIRSA) through the South Australian Research and Development Institute (SARDI) & Rural Solutions SA.

The MFMG has a sub-group – previously known as the South-East Prime Livestock Achievers (SEPLA), which concentrates on Livestock Production, Nutrition and Pasture Management for the wider group. This project initially had 10 core producers involved; the majority being members of SEPLA, MFMG, and interested members of various Ag Bureau's. Over the life of the project, this increased to 12 core producers with some of those becoming involved when initial sampling suggested that they had high levels of root disease present in their pastures.

Producers involved run mixed farming operations; having both cropping and livestock production (sheep, beef cattle and a mixture of the two) as key components of their business. The core group of producers run approximately 55,000 head of stock (cattle or sheep) and manage 14,500 ha, located from Mount Gambier in the south through to Field in the north of the region. The majority were located in the areas to the south of Padthaway, east to the SA/Victorian border and west to the coast in higher rainfall environments where sub-clover pastures (often in a mix with grass species) are the dominant pasture type.

The producer group actively undertake livestock and pasture-relevant projects which has included the MLA Producer Demonstration Site (PDS) "Success with perennial pasture stands" (2010-2013) and the Producer Initiated Research and Development Project (PIRD) "Optimising Red Meat Productivity" (2008-2011). They also managed two EverGraze Supporting Sites.

1.2 Issues faced by group members

There is a large variation in the rate of successful pasture establishment across the south-east region of SA. In some cases the reasons can be identified (weed control, pest issues or other uncontrollable events such as waterlogging or excessive dry spells) but often the variations in establishment are unexplained.

Producers considered root disease to be an "unknown" factor which could be affecting successful establishment and the persistence of sub-clover across the region. It was not felt that root diseases, nor the degree of the problem were well understood – either the pathogens that are present in the soil, or those that are potentially harmful to clover establishment and persistence. Producers "gut-feel" was that establishing a pasture after canola seems to work well which may be an indicator and a consequence of lower root disease.

1.3 Producer management practices

At the start of the project producer's management practices in potential soil borne disease identification and practices to minimise them were limited. There was in general, a low understanding of root disease in sub-clover pastures, but there was concern around establishment and persistence of pastures. It was thought that one contributing factor may have been root disease and if this was quantified and economic solutions could be identified, that this would then impact on the producer's ability to produce red meat. Several participants did not know what root diseases were and the majority did not have the ability to identify root disease. Some producers felt that they currently managed root disease through break crops and other management practices used in the renovation process. However others felt that they did not address root disease at all and were not sure of the impact of root disease on their business.

The majority of producers across the region have a large amount of Trikkala sub-clover in their pastures, with some newer varieties being introduced more recently. Trikkala is grown locally, seed is readily accessible and it is seen as a variety that is well adapted to the south-east region. In some cases, seed is purchased bare (often the case with Trikkala), but the newer varieties are generally inoculated and treated with Metalaxyl (Apron®) and an insecticide.

Management practices prior to establishing a new pasture are extremely variable across the region; the pre-seeding treatments (time of fallow, previous paddock history), varietal selection and seeding systems vary greatly, however there is a very low number of disc seeders with the majority of growers using either a cultivation pre-seeding or a tyned implement. No fungicides were used as pre or post-emergent spray applications on existing pastures.

1.4 Group's motivation

The majority of producers understood the potential issues of root disease in their cropping programs and wanted to see if similar issues existed in their pastures. Work that had been done by CSIRO in the south-east region had identified a large number of pathogens in the soil. Although this work looked at broadacre crops, producers have questioned if any of these pathogens are affecting other areas of their business (and in particular pasture production).

Producers have a strong focus on filling the winter feed gap and making sure there is good sub-clover establishment and regeneration at this time, especially when they have spent significant dollars on pasture renovation. Producers want to understand if root diseases are actually having an impact on their pastures and if so what are the required management strategies. Maintaining a pasture with persistent and good sub-clover content is not only essential in its own right for productive pastures, but it is also thought this will help the persistence of other desirable grasses for greater overall production and feed quality.

2 Projective Objectives

This project forms part of MLA's Producer Research Site program that is part of the southern Feedbase Investment Plan. In particular, this project supports the MLA-funded project B.PSP.0005 – Managing Soil borne Root Disease in Sub-clover pastures.

The PRS project objectives were to have:

1. Quantified the level and type of sub-clover root diseases in pastures
2. Evaluated the impact of fungicides and effects of alternative management treatments on sub-clover establishment
3. Evaluated seed treatments (including their cost-effectiveness) and their role in root disease suppression for establishing sub-clover pastures

4. Evaluated chemical control methods (including their cost-effectiveness) to suppress disease in existing sub-clover pastures

3 Methodology

To conduct the research, trial protocols were developed in consultation with BIGG (the Barossa Improved Grazing Group) and Professor Martin Barbetti's research group from the University of Western Australia (UWA) to ensure both statistical rigour and for transference of information. In all trials except the Farmer Paddock Sites in 2014, Woogenellup (a variety with known high susceptibility to most root disease and commonly used as an experimental standard for root disease assessment across Australia) was utilised, so that all of the data collected could be compared to a wider dataset.

GPS locations and site characteristics were recorded for all trial sites and soil samples were collected for analysis of soil chemistry at each site. This and other metadata has been collated into the data file.

3.1 Research Sites

Research sites were located across the south-east region; a long-term site was established at Furner. The other site location changed annually based on results from the previous year, the disease burden found at the site (as determined by the South Australian Research and Development Corporation's (SARDI) Predicta-B test) and the opportunity for extension activities. All sites were existing long-term sub-clover pasture paddocks that hadn't been cultivated for at least 5 years. Table 1 shows the main research sites and outlines the trial activities conducted at each of the sites.

All sites were fenced to exclude stock for the duration of each growing season to facilitate germination, survival and growth assessments as well as isolate stock from areas where unregistered products were being trialled.

Furner (2014-2016) site was located on Legges Lane at Furner (140.0940; -37.1188). It was located on a sandy loam flat at the eastern side of an interdunal plain. The soil was slightly acidic over an alkaline clay at depth. The background sub-clover population in the adjacent paddocks was *Trifolium subterraneum* subsp. *yanninicum* (most likely Trikkala and possibly Yarloop (K. Foster, *pers. com.*)).

Woolumbool (2014) site was located on Little Gums Road, Woolumbool (140.643; -36.775). It was located on a neutral brown sandy loam over an alkaline clay soil. The site was on the edge of a flat and became inundated with water during the season with some areas having to be resown. The background sub-clover population in the adjacent paddocks was *Trifolium subterraneum* subsp. *yanninicum* (Trikkala and Yarloop with some of the older *Trifolium subterraneum* subsp. *subterraneum* variety Dwalganup also present (K. Foster, *pers. com.*)).

Avenue Range (2015) site was located at "The Washpool", Washpool Road, Avenue Range (140.2565; -36.9114). This site replaced the Woolumbool site from 2014 to avoid the waterlogging risk that had been experienced in the previous season. The site was located on highly fertile black soil with high free lime all over a shallow layer of calcrete. The background sub-clover population in the adjacent paddocks was *Trifolium subterraneum* subsp. *yanninicum* (Trikkala) (K. Foster, *pers. com.*).

Binnum (2016) site was located on the Border Track, Binnum, Victoria, immediately adjacent to the SA border (140.9613; -36.7172). The site was chosen due to the high initial disease levels as determined by the Predicta-B test and its close proximity to the UWA Victorian research site. The site was a duplex soil with a neutral sandy loam over an acidic clay subsoil. The background sub-clover population in the adjacent paddocks was predominantly Trikkala and Mount Barker.

Table 1. Trial activities conducted at each site

		Trial Activities Conducted at Sites				
Site Location	**Year**	**Level of root disease**	**Cultural methods**	**Chemical control**	**Fungicides & seed treatments**	**Varietal differences**
Furner	2014-2016	✓	✓	✓	✓	✓
Woolumbool	2014	✓	✓	✓	✓	
Avenue Range	2015	✓			✓	✓
Binnum	2016	✓			✓	✓

3.2 Quantifying the level of root disease

Eight farmer paddock sites were identified and established in 2014 (Table 2). The reduction in germination, establishment, growth and nodulation of sub-clover due to root disease was assessed at these sites as an indicator of the level of root disease present across the region. An untreated and a treated (with Apron®; Metalaxyl as active ingredient) strip of *Trifolium subterraneum* subsp. *yanninicum* (Trikkala), 1m long with 100 seeds as per the main experimental sites, was sown adjacent to each other.

Table 2. 2014 Producer paddock sites and locations

Producer Name	**Property / Trading Name**	**Location**
Martin Flower	Boorala	Frances
Jen Lillecrapp	Aberdare	Wrattonbully/Joanna
David Farley	Jalsted	Kybybolite
N & J Edwards	The Washpool	Avenue Range
Duan Williams	Gran Gran Proprietors	Mt Burr
Rowan Giles	Crower	Crower
David Rasheed	Boolapucke	Keilira
Lucindale Area School		Lucindale

Treatments were:

- *Trifolium subterraneum* subsp. *yanninicum* (Trikkala) sub-clover seed plus (+) Apron® Seed Dressing

- *Trifolium subterraneum* subsp. *yanninicum* (Trikkala) sub-clover seed minus (-) Apron® Seed Dressing

Monitoring included:
- *The strips were assessed for germination, survival and growth of seedlings at 3, 9, and 12 weeks post sowing.*
- *Nodulation assessments were conducted at 12 weeks post-sowing using the GRDC "Assessment of nodulation" score sheet.i*
- *Photographs of plant shoots and roots were taken of each treatment at around week 12 and compared with the reference group.*
- *Soil samples were also collected for Predicta B testing for pasture pathogens at some of the sites.*

3.3 Effect of cultural methods on root disease in sub-clover establishment

Aim: To evaluate the timing of herbicide "knockdown" application and the subsequent "brown-out" period prior to establishing sub-clover pastures in 2014.

A randomised block trial design was used. There were four sowing times (0, 1, 2 and 4 weeks) following the application of a knock-down herbicide (Glyphosate at 1.5L/ha) and two sub-clover varieties (*Trifolium subterraneum* subsp. *subterraneum* (Woogenellup) - an experimental standard for root disease assessment across Australia; and *Trifolium subterraneum* subsp. *yanninicum* (Trikkala) - a commonly sown variety across the region; both using untreated seed). Each treatment was replicated 6 times under advisement from the researcher Martin Barbetti. Reference strips of Trikkala seed treated with Metalaxyl for the control of root disease (i.e. Apron® treated) were also sown.

Treatments were:
- Roundup CT @ 1.5L/ha + 0 days
- Roundup CT @ 1.5L/ha + 7 days
- Roundup CT @ 1.5L/ha + 14 days
- Roundup CT @ 1.5L/ha + 28 days
- Varieties (x2); Trikkala and Woogenellup

Each 'treatment' strip consisted of a 1m line sown with 100 seeds of the selected sub-clover variety. Prior to sowing, the surface was scraped with a shovel to remove residual seeds. A star dropper was used to create a 1m long furrow approximately 5mm deep into which the 100 seeds were sown by spreading as evenly as possible along the length of the furrow. The seeds were then loosely covered by soil.

Monitoring included:
- Each treatment strip was assessed for germination, survival and growth of seedlings at approximately 3, 9 and 12 weeks post-sowing.
- Nodulation assessments were made at 12 weeks post-sowing
- Photographs of plant shoots and roots were taken of each treatment at around week 12 and compared to the reference group.

3.4 Use of chemical control to suppress root disease

Aim: To evaluate the potential for improving existing stands of sub-clover using chemical control treatments in 2014.

A randomised block trial design was used to assess two chemical control treatments with the best potential to suppress root disease (phosphorus acid and Metalaxyl). These chemicals were applied to an existing stand of established sub-clover at each of the two main trial sites at two rates using a 5L pressurised hand sprayer. There were four replicates of each application, with test strips 1m wide by 10m long (0.001ha).

The effectiveness of the treatments was assessed by comparing herbage yield in paired areas for treatments, with plant density assessed at 3 weeks and biomass cuts and pasture composition at 6 and 16 weeks post chemical application.

Treatments were:

- Metalaxyl-M (Apron® XL 350 ES Fungicide Seed Treatment with 350 g/L Metalaxyl-M) applied at 10 g/ha
- Metalaxyl-M applied at 100 g/ha
- Phosphorous (Phosphonic) acid (Sprayphos® 620 systemic fungicide with 620 g/L phosphorous (Phosphonic) acid present as mono and di potassium phosphonate) applied at 100 g/ha
- Phosphorous (Phosphonic) acid applied at 1,000 g/ha

Monitoring included:

- Plant density assessments at 3 weeks
- Biomass cuts and pasture composition assessments at 6 and 16 weeks post-chemical application

3.5 Impact of fungicides and seed treatments

Aim: To evaluate the impact of fungicides and other seed treatments on the establishment of sub-clover in 2015-2016.

The sites were sprayed with a knock-down herbicide (Roundup UltraMax® at 1.5L/ha (active constituent glyphosate at 570 g/L) spiked with 20ml/ha Hammer® 400 EC (400 g/L carfentrazone-ethyl as active) approximately 2 weeks after the main season break (i.e. following germination of most weeds and pasture).

A complete fertiliser application (Brunnings Complete 'D': 7.5% N, 3.9% P, 8.9% K, 17.2% S and 8.4% Ca) was also applied to negate any macro-nutrient deficiencies and ensure that root disease is the only factor affecting the sown seed. Two weeks after spraying (to allow for brown-out and root release) replicated strips of untreated and treated *Trifolium subterraneum* subsp. *subterraneum* (Woogenellup) were sown. Insecticide to control red-legged earth mite was sprayed post-sowing (Talstar® 250 EC at 40 ml/ha; active constituent 250 g/L Bifenthrin).

Six treatments (four seed dressing treatments, a nil control and one in-furrow treatment) were replicated six times in a randomised block design under advisement by the UWA team. (Nil vs 4 seed treatments + 1 in-furrow treatment = 6 x 6 reps = 36 strips). All seed treatments were applied to 100 seed batches in test tubes with appropriately diluted products. In addition, in 2015 all seed was inoculated with Group C inoculant using the slurry method, also in 100 seed batches in test tubes. In 2016 seed was inoculated using 0.25g of Alosca Technologies Group C Alosca® granulated inoculant applied along with each strip of seed.

Treatments were:

- Nil control
- Apron® XL 350 ES seed treatment (Metalaxyl-M as active constituent) as per label rate of 1ml per 1kg seed
- Thiram 600 flowable fungicide (600 g/L Thiram as active constituent) as per label rate for lupins of 2ml plus 3ml of water per 1kg seed
- Rovral® Liquid Seed Dressing Fungicide (250 g/L Iprodione as active constituent) as per label rate for lupins of 4ml plus 2ml of water per 1kg seed, (5)
- Dividend Extreme® Fungicide Seed Treatment (92 g/L Difenoconazole and 23 g/L Metalaxyl-M as active constituents) as per label rate for wheat/barley seed of 2.6ml plus 2.4ml of water per 1kg of seed
- Phosphorous (Phosphonic) acid as an in-furrow/post-sowing application (Sprayphos® 620 systemic fungicide with 620 g/L phosphorous (Phosphonic) acid present as mono and di potassium phosphonate) as per label rate of 300.7 g/ha of active constituent
- Rancona® Dimension Seed Treatment (25 g/L Ipconazole and 20 g/L Metalaxyl-M) as per label rate for wheat/barley seed for Rhizoctonia and Crown Rot suppression of 3.2ml per 1kg of seed

Each 'treatment' strip consisted of a 1m line sown with 100 Woogenellup seeds. Prior to sowing the surface was scraped with a shovel to remove residual seeds. A star dropper was used to create a 1m long furrow approximately 5mm deep into which the 100 seeds were sown by spreading as evenly as possible along the length of the furrow. The seeds were then loosely covered by soil.

Monitoring included:

- Each treatment strip was assessed for germination, survival and growth of seedlings at approximately 3, 9 and 12 weeks post-sowing.
- Nodulation scores assessed at 12 weeks post-sowing
- Photographs taken of plant shoots and roots for comparison between treatments

3.6 Sub-clover varietal differences in root disease susceptibility

Aim: To evaluate the role of newer varieties on the establishment of sub-clover in 2015-2016.

Indications from our 2014 trials were that there were varietal differences in root disease susceptibility, however those trials were limited to the use of Trikkala and Woogenellup varieties – both relatively old varieties of sub-clover. Given that there are many newer varieties on the market, as well as the likelihood that local producers would use more appropriate varieties to address root disease in new stands of pasture, the comparison of a range of newer varieties was deemed appropriate.

The sites were sprayed with a knock-down herbicide (Roundup CT® at 1.5L/ha (active constituent glyphosate at 450 g/L) spiked with 20 ml/ha Hammer® 400 EC (400 g/L carfentrazone-ethyl as active)) approximately 2 weeks after the main season break (i.e. following germination of most weeds and pasture). A complete fertiliser application (Brunnings Complete ‘D’: 7.5% N, 3.9% P,8.9% K, 17.2% S and 8.4% Ca) was also applied to negate any macro-nutrient deficiencies and ensure that root disease is the only factor affecting the sown seed.

Two weeks after spraying (to allow for brown-out and root release) replicated strips of untreated and treated (with Metalaxyl) *Trifolium subterraneum* subsp. *brachycalycinum*, *Trifolium subterraneum* subsp. *subterraneum* and *Trifolium subterraneum* subsp. *yanninicum* varieties (10 in 2015; 5 in 2016) were sown. Insecticide to control red-legged earth mite was sprayed post-sowing (Talstar® 250 EC at 40 ml/ha; active constituent 250 g/L Bifenthrin).

In 2015 all seed was inoculated with Group C inoculant using the slurry method in 100 seed batches in test tubes. In 2016 seed was inoculated using 0.25g of Alosca Technologies Group C Alosca® granulated inoculant applied along with each strip of 100 seeds. Each treatment was replicated 6 times as per normal practice by Martin Barbetti and his group in a randomised block design.

Treatments include +/- Apron® seed dressing in each of the following varieties:

- Trikkala
- Monti
- Goulburn
- Leura
- Mt. Barker
- Dalkeith
- Campeda
- Antas
- Mintaro
- Woogenellup

Each ‘treatment’ strip consisted of a 1m line sown with 100 seeds. Prior to sowing the surface was scraped with a shovel to remove residual seeds. A star dropper was used to create a 1m long furrow approximately 5mm deep into which the 100 seeds were sown by spreading as evenly as possible along the length of the furrow. The seeds were then loosely covered by soil.

Monitoring included:

- Each treatment strip was assessed for germination, survival and growth of seedlings at approximately 3, 9 and 12 weeks post-sowing
- Nodulation scores assessed at 12 weeks post-sowing
- Photographs taken of plant shoots and roots for comparison between treatments.

3.7 Statistical analysis

All data was statistically analysed using either GenStat statistical program by the (UWA – 2014 data) or Statistical Analysis Systems (SAS), using analysis of variance using general linear modelling (GLM) (SAS Institute Inc. – 2015 & 2016 data).

3.8 Economic analysis

All costs were taken from the 2017 Farm Gross Margin and Enterprise Planning Guide[ii] (where available). If not available, then estimated costs were obtained from local resellers in Naracoorte, South Australia.

3.9 Extension and Communication

The Mackillop group had their first project meeting on 22nd January 2014 to discuss the project topic and to seek agreement with WA researchers (Martin Barbetti) on participatory R&D activities, what research questions were to be investigated, and plan how the project might proceed.

Annual review meetings with the researchers and producers, focussing on the progress of the project, were held on 29th January 2015 and 1st February 2016 in conjunction with the Barossa Improved Grazing Group (BIGG) in Adelaide. A combined final meeting was held to discuss project outcomes on 9th November 2016 where final results were presented.

Project updates were extended to the wider MFMG community annually through an inclusion in its annual trial results book. The project was also discussed and preliminary results extended at field days that were held throughout the life of the project. Annual project meetings and/or phone discussions were held with the core group to update them on the project progress. The Grasslands Society of South Australia (GSSA) and the local Furner Ag Bureau were also kept informed with presentations at some of their meetings and discussion at GSSA field days.

4 Results

4.1 Measured trial results

4.1.1 Quantifying the level of root disease

The reduction in germination, establishment and growth of untreated compared to Apron® treated Trikkala sub-clover at farmer paddock sites was used as an indicator of the level of root disease across the region. The combined results from all 8 farmer paddock sites are shown below in Fig. 1 while Table 3 shows the results site by site (Note: these were only survey sites and the data was not statistically analysed). The average reduction in germination and establishment across the region (Fig. 1) was approximately 6% (Day 22 data) whereas 12 and 15% reductions were evident at days 59 and 85 respectively. The individual site data in Table 2 shows that four sites had consistently reduced germination and growth (Avenue Range, Kybybolite, Mt Burr and Joanna) in the untreated Trikkala, with a fifth site (Lucindale) also showing a large reduction at day 22. These results indicate that there is root disease present across the region (5 out of 8 farms) and it is impacting on seedling emergence at these farms by approximately 10% (range 2% to 20%).

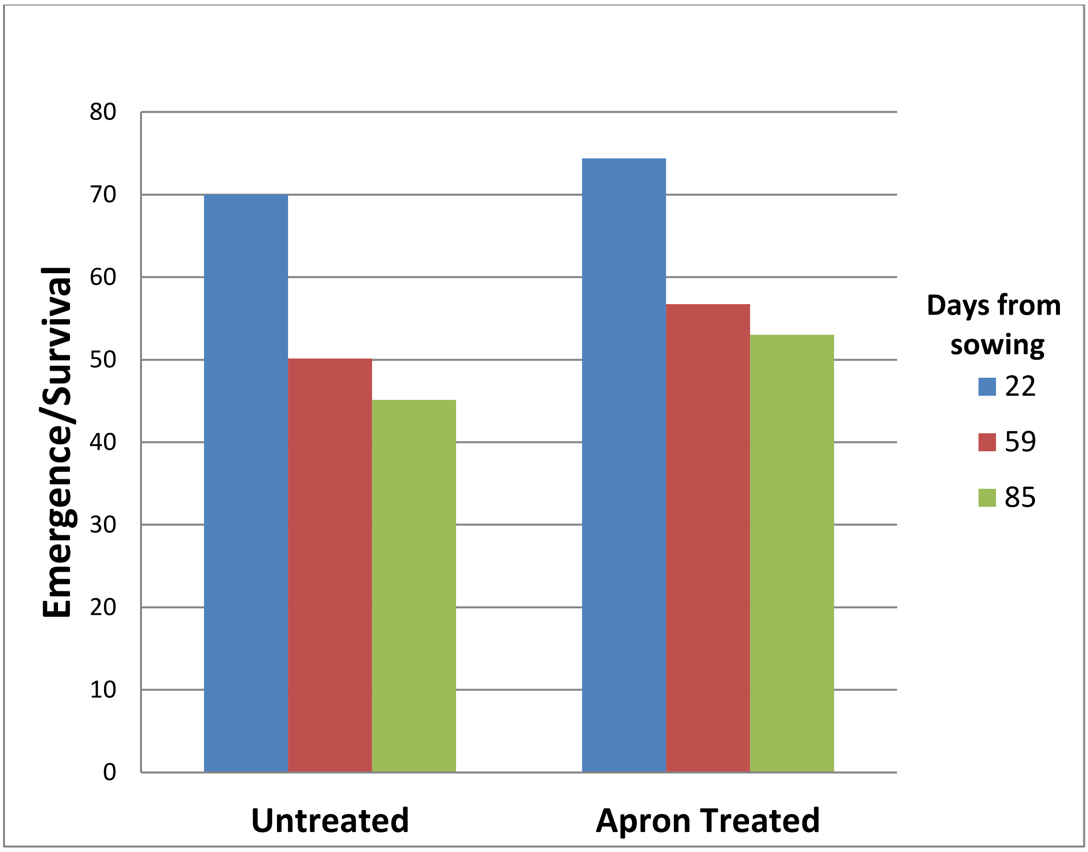


Figure 1. Combined responses of germination and survival of Trikkala sub-clover with Apron® seed dresssing at survey sites.

Table 3. Individual site responses by Trikkala with and without Apron® seed dressing

Site	Root disease assessment at approx. 3 weeks post-sowing			Root disease assessment at approx. 9 weeks			Root disease assessment at approx. 12 weeks		
	Days	Untreated	Treated	Days	Untreated	Treated	Days	Untreated	Treated
Avenue Range	24	68	81	62	58	67	85	61	75
Crower	22	74	75	59	58	55	85	56	60
Frances	23	73	58	60	59	53	86	10	26
Keilira	21	77	75	58	65	61	84	63	52
Kybybolite	23	57	69	60	37	65	86	35	42
Lucindale	22	53	71	57	14	28	86	6	6
Mt Burr	20	77	80	57	54	68	85	78	88
Joanna	23	81	86	60	56	57	86	52	75
Average	22.3	70	74.4	59.1	50.1	56.8	85.4	45.1	53

Starting in 2015 soil samples were collected at the core research sites (Avenue Range, Binnum, Furner and Woolumbool) during summer/autumn (e.g. February/March) and submitted for Predicta

B assessment to aid in site selection for those years. Samples were also collected and analysed during spring 2015 and 2016 to aid interpretation of trial results. Results from these samples are presented in Fig. 2 and indicate that *Aphanomyces trifolii*, *Didymella pinodes/Phoma medicaginis* var. *pinedolla*, *Rhizoctonia* (Eradu) and *Pythium clade f* were the main pathogens present. The Furner and Binnum sites consistently had the highest pathogen levels and Avenue Range and Woolumbool only had significant levels of *Didymella pinodes/Phoma medicaginis* var. *pinedolla.* Only those pathogens that were detected by the Predicta B test in the submitted samples are presented. Other pathogens that are part of the test but that returned zero values were *Rhizoctonia solani* AG2.2, *Rhizoctonia solani* AG8, *Phoma koolunga* and the nematodes *Pratylenchus penetrans*, *Pratylenchus thornei*, *Pratylenchus quasitereoides* and *Pratylenchus teres*.

As the Predicta B test is still under development for pasture pathogens, the potential impacts on production of the pathogens identified at the levels shown are largely unknown. The tests were used mainly as a guide to indicate the presence or absence of pathogens.

What has however been observed is the changes in pathogen levels and pathogen complexes under varying environmental conditions with *Rhizoctonia* levels being higher in drier environments and the remaining diseases being more prevalent under higher rainfall conditions.

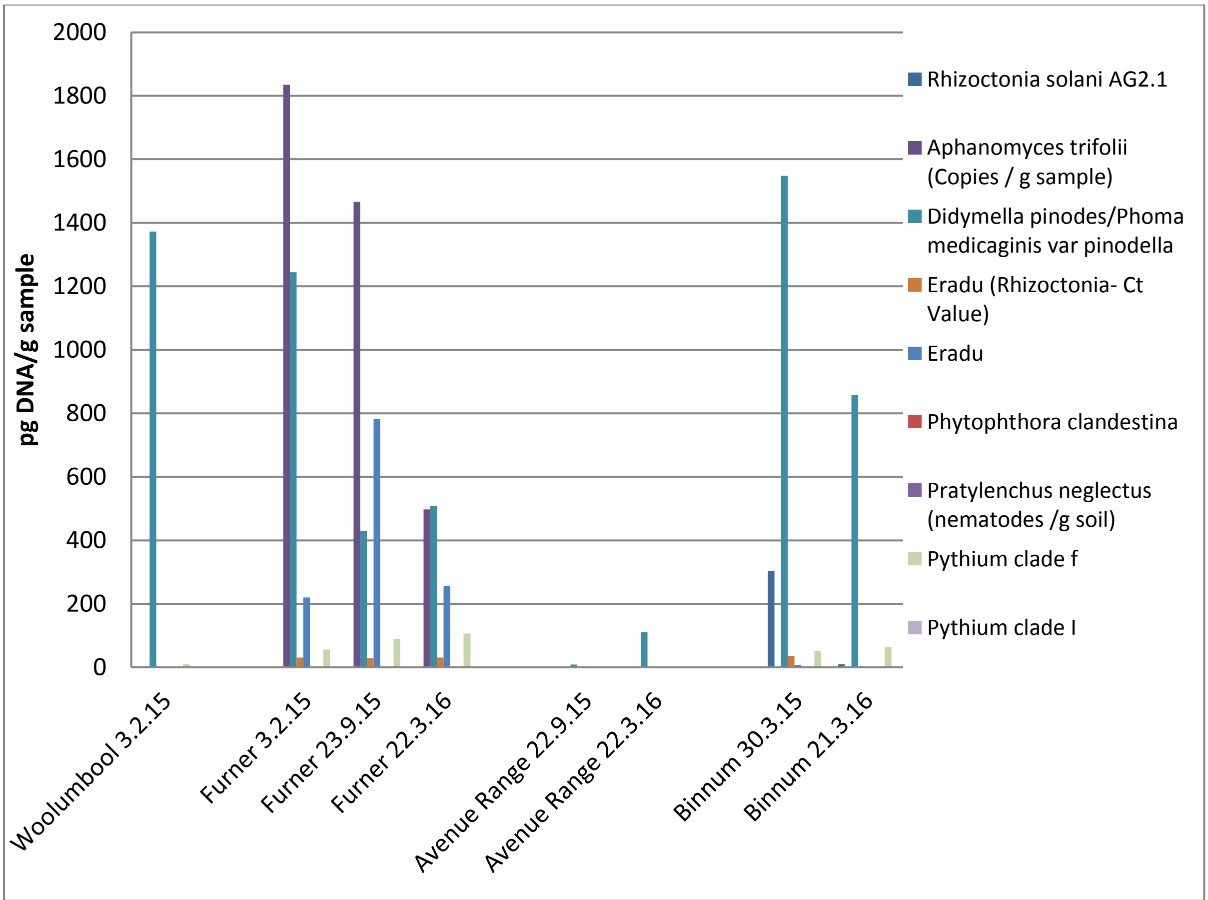
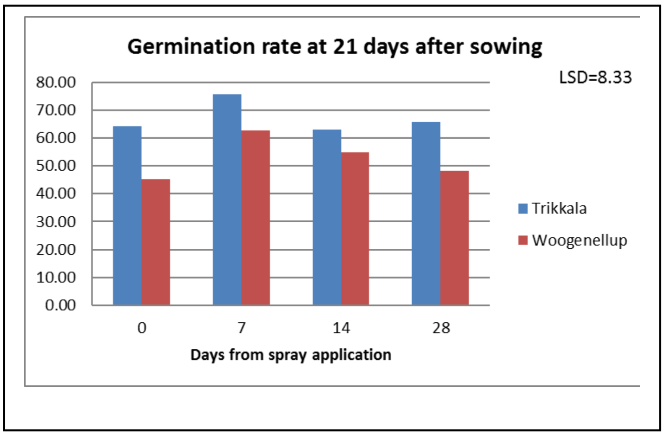


Figure 2. Predicta B-determined soil pathogen levels at the main research sites (Avenue Range, Binnum, Furner and Woolumbool) in 2015 and 2016.

4.1.2 Effect of cultural methods on root disease in sub-clover establishment

At the Furner site, waiting seven days after the knockdown application of glyphosate increased germination significantly across both Trikkala and Woogenellup sub-clover cultivars (as assessed at 21 days after sowing), however this initial difference between sowing straight away and waiting 7 days was not significant when assessed 60 days post-sowing. (Figs. 3 and 4).

Figs 3 and 4 also show that where the sub-clover was sown either immediately post-knockdown or 7 days after the knockdown application, there was a significant difference in the germination between varieties. This was observed initially at 21 days and continued to remain significantly different right through to the final assessments (taken at 86 days post-sowing).



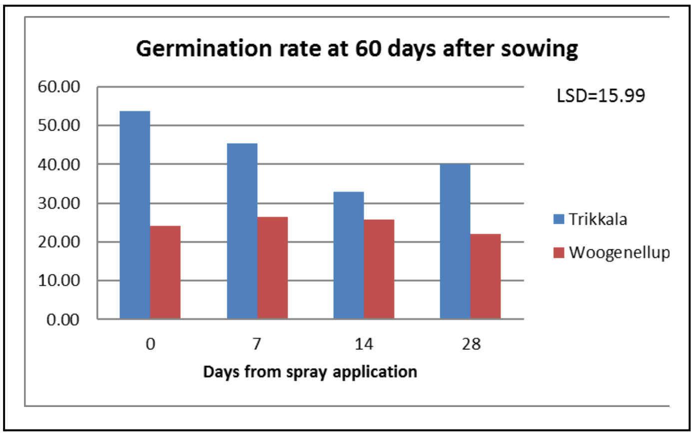


Figure 3. Varietal differences in germination rates and establishment in single rows at 21days.

Figure 4. Varietal differences in germination rates and establishment in single rows at 60 days.

The site at Woolumbool became inundated with water due to significant and ongoing rainfall within one week of sowing and results were highly variable (range 0-55 counts/100 seeds sown) and not suitable for accurate assessment.

4.1.3 Use of chemical control to suppress root diseases

There was no significant difference found between foliar treatments Sprayphos® 620 (phosphorous acid as active ingredient) and Apron® (Metalaxyl-M as active ingredient) by taking biomass cuts at both 42 and 112 days after application at either the Furner (Fig. 5) or Woolumbool (Fig. 6) sites.

The site at Woolumbool produced an average of 3020 kg DM/ha after 112 days, while the site at Furner produced an average of 4009 kg DM/ha.

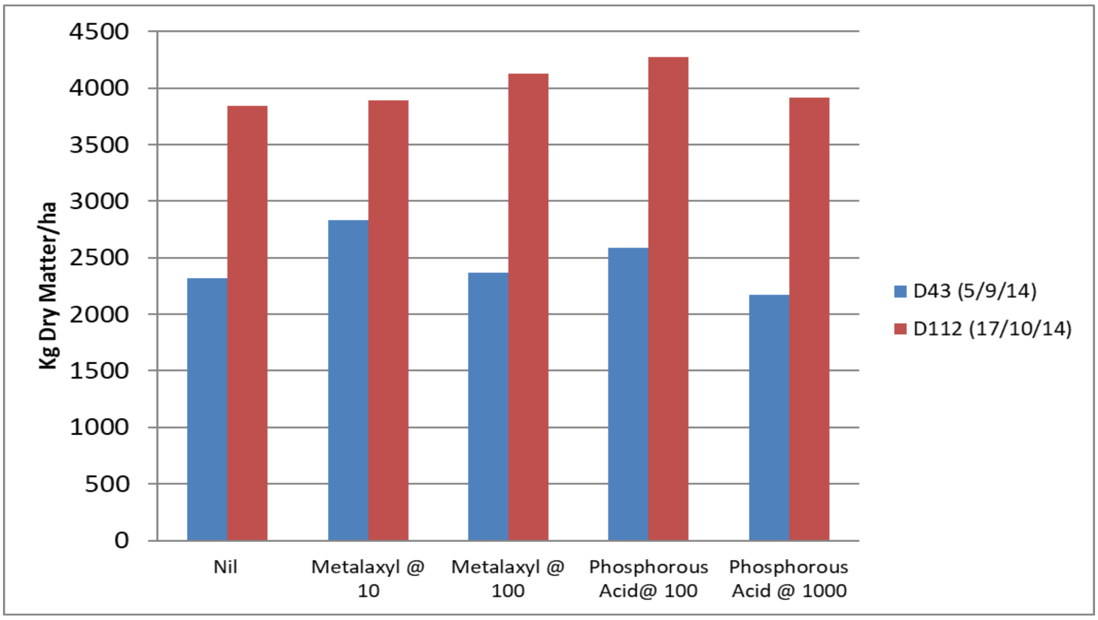


Figure 5. Biomass production at Furner site 43 and 112 days post-application

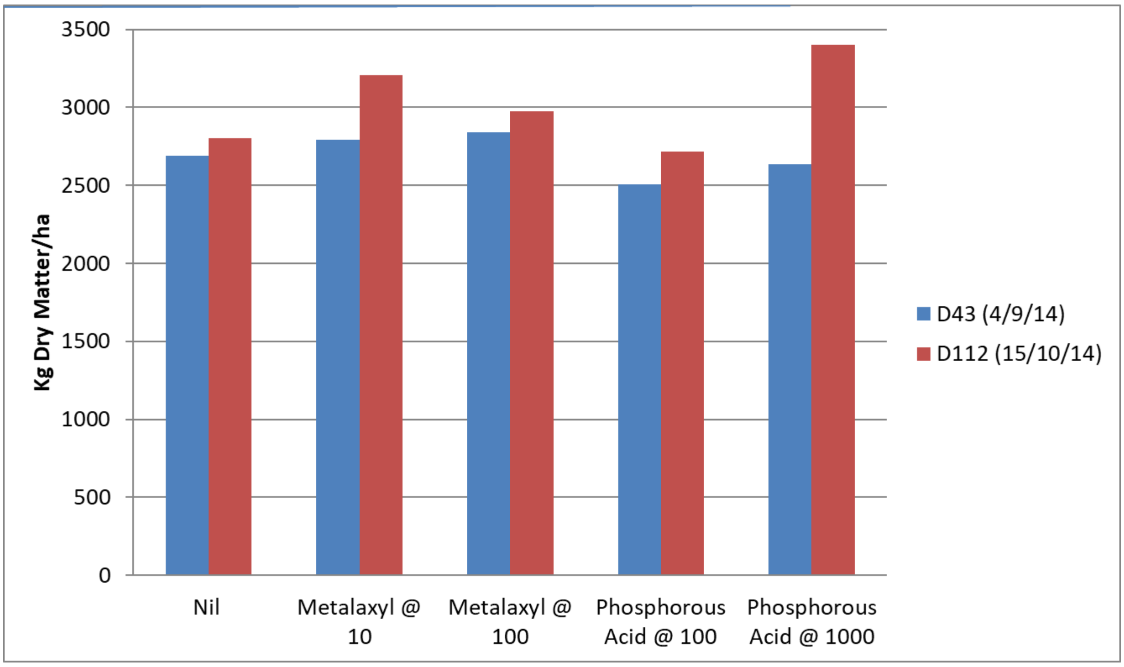


Figure 6. Biomass production at the Woolumbool site 43 and 112 days post-application

4.1.4 Impact of fungicides and seed treatments

In 2015 and 2016, two on-farm trial sites were established to evaluate the impact of fungicides and other seed treatments on the establishment of sub-clover. The products were refined each year based on consultation with the producer group, local agronomists and feedback from Prof. Martin Barbetti and Dr Kevin Foster (UWA).

The impact of fungicide and seed treatment results were collated across sites within each year and a combined GLM procedure analysis conducted (SAS Institute Inc.). In 2015, there was initially (after 21days) a significant negative impact on germination caused by using Rovral® Seed Dressing (Iprodione as active) when compared to the untreated control and Dividend M (Difenoconazole and

Metalaxyl-M as actives) and Thiram (Thiram as active) as seed dressings but not Apron® (Metalaxyl-M as active) or the in-furrow Sprayphos® 620 (phosphorous acid as active), however by 64 days (and again at 96 days), this impact was no longer significant (Fig. 7).

In 2016 (Fig. 8), no significant differences were observed across either of the sites using Apron®, Sprayphos 620® and Rancona Dimension® (Ipconazole and Metalaxyl as actives).

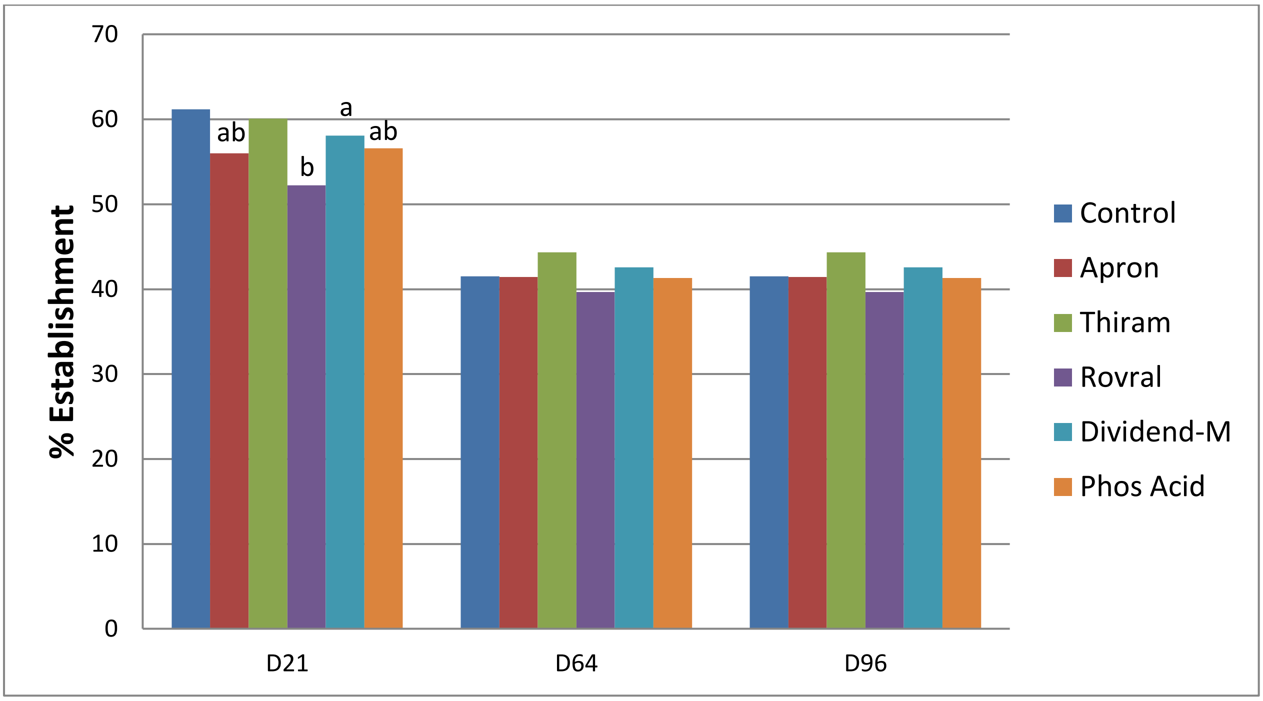


Figure 7. Affect of seed and in-furrow treatments on sub-clover germination and establishment in 2015. (Means followed by the same letter do not significantly differ p=0.05)

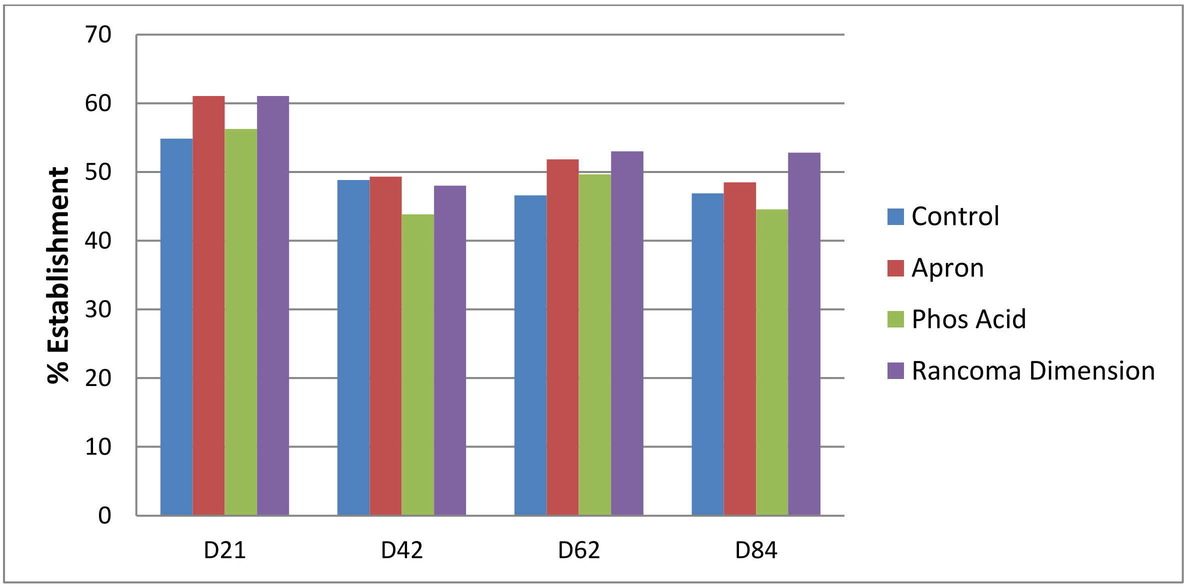


Figure 8. Effect of seed and in-furrow treatments on sub-clover germination and establishment in 2016.

In both 2015 and 2016 there were significant differences at most assessment times between the 2 sites used – Avenue Range (Washpool) being higher than Furner (Bateman) in 2015 at Days 21, 64 and 96 and Binnum (Sambell) higher than Furner (Batemen) in 2016 at Days 62 and 84 but not at Day 21 (Figs 9 & 10). Note that the Day 42 assessments (2016) were only from the Binnum site.

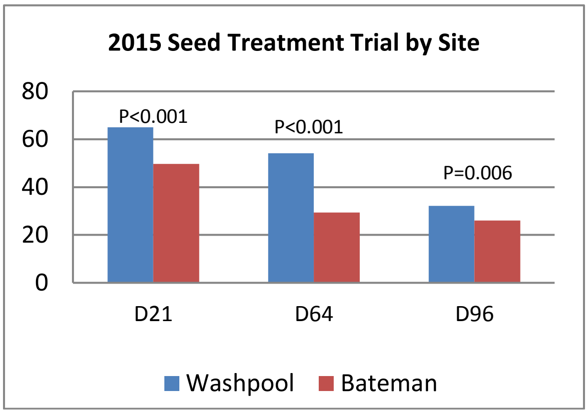


Figure 9. Site differences in the seed treatment trial in 2015

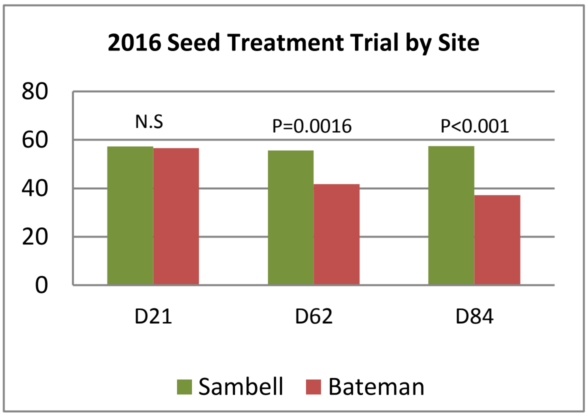


Figure 10. Site differences in the seed treatment trial in 2016.

4.1.5 Sub-clover varietal differences in root disease susceptibility

Two on-farm sites were established in both 2015 and 2016 to evaluate the role of newer varieties and their effectiveness (or otherwise) in resisting root disease. Varieties were chosen through consultation with producers and local agronomists and Woogenellup (a known susceptible variety) was included as an experimental standard. Varieties were sown with and without Apron® seed dressing.

In 2015, ten varieties were sown at both Avenue Range (Washpool site) and Furner (Bateman site). In 2016, this was reduced to five key varieties that were sown at Furner and Binnum (Sambell site). For unknown reasons germination was very poor at Binnum in 2016 (maximum 12% germination) resulting in no valid results from this site. Across the rest of the sites and years, germination, establishment and persistence of the locally grown and adapted variety Trikkala was consistently superior to the other varieties, with Dalkeith, Antas and Mintaro also performing well and Leura, Goulburn and Woogenellup all performing poorly. Furthermore, the majority of varieties were significantly better (in terms of germination and persistence) than Woogenellup across both seasons. This is represented in the 2015 Avenue Range data (Fig. 11), Furner data (Fig. 12) and Binnum data (Fig. 13) where the significant differences shown are for the Day 96 assessments, although similar differences were also present at days 21 and 64.

In 2015 the Avenue Range site had a higher average germination and persistence than the Furner site at Days 21 (75 vs 71%) and 64 (61 vs 48%), whereas the reverse was the case at Day 96 (39 vs 43%).

There was no significant response to the addition of Apron® seed dressing on the germination and establishment of any of the varieties trialled (supporting what has been seen at the same sites in the fungicide and seed treatment trials). Also consistent with the other trials in this project there was about a 5% increase in germination and persistence for the Apron treated seeds over the untreated seeds.

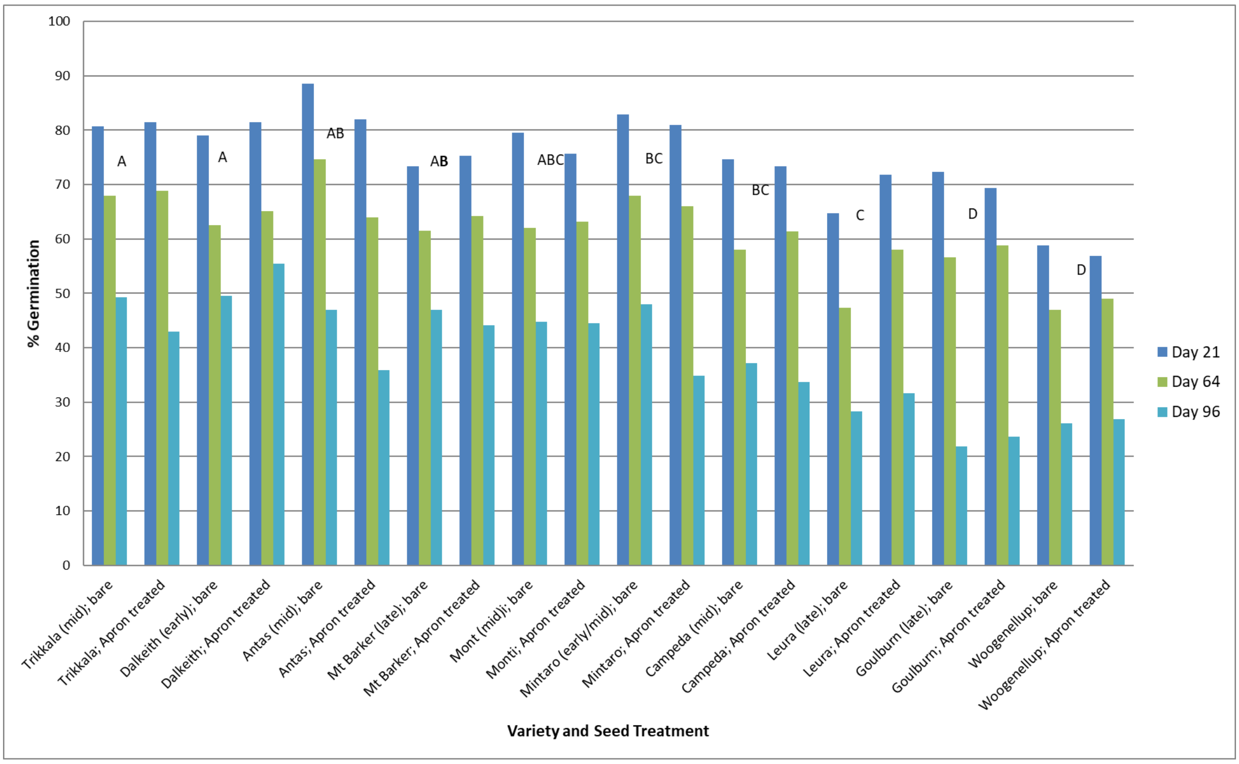


Figure 11. Sub-clover germination and persistence of 10 varieties at three assessment times following sowing at Avenue Range. (Varieties with different letters are significantly different from each other at the Day 96 assessment at a confidence level of 95%)

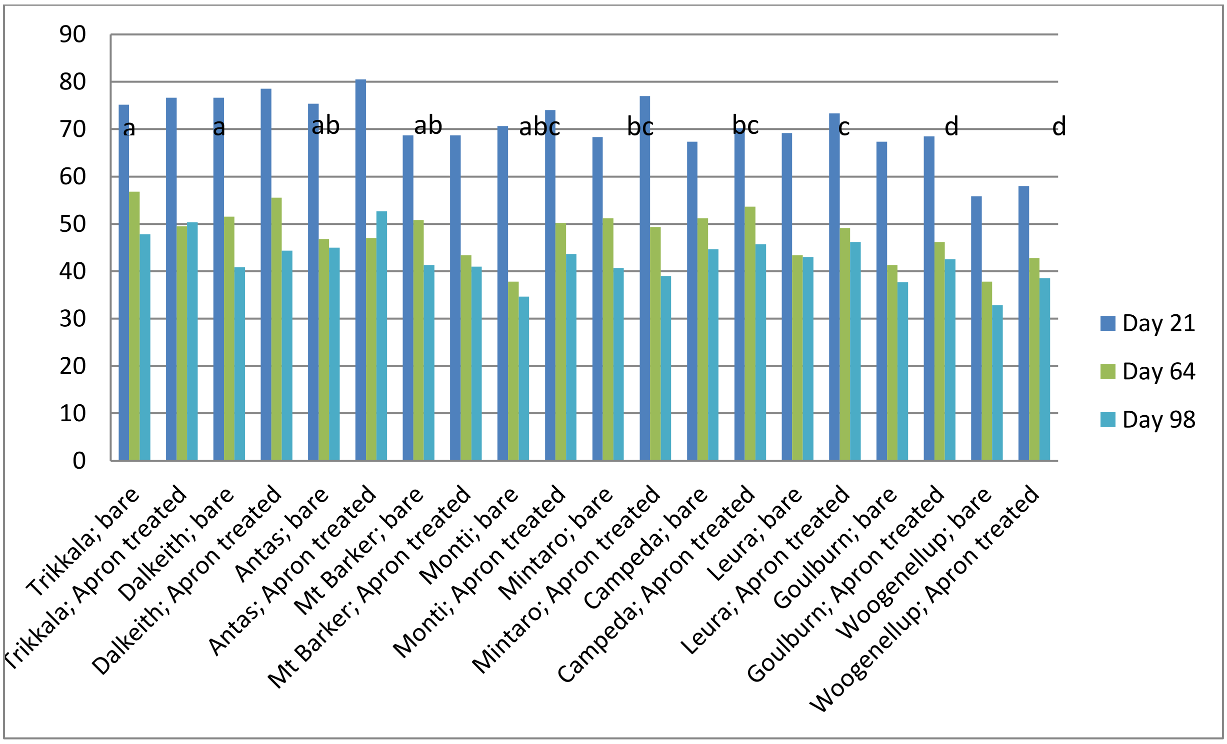


Figure 12. Sub-clover germination and persistence of 10 varieties at three assessment times following sowing

at Furner. (Varieties with different letters are significantly different from each other at the Day 96 assessment at a confidence level of 95%)

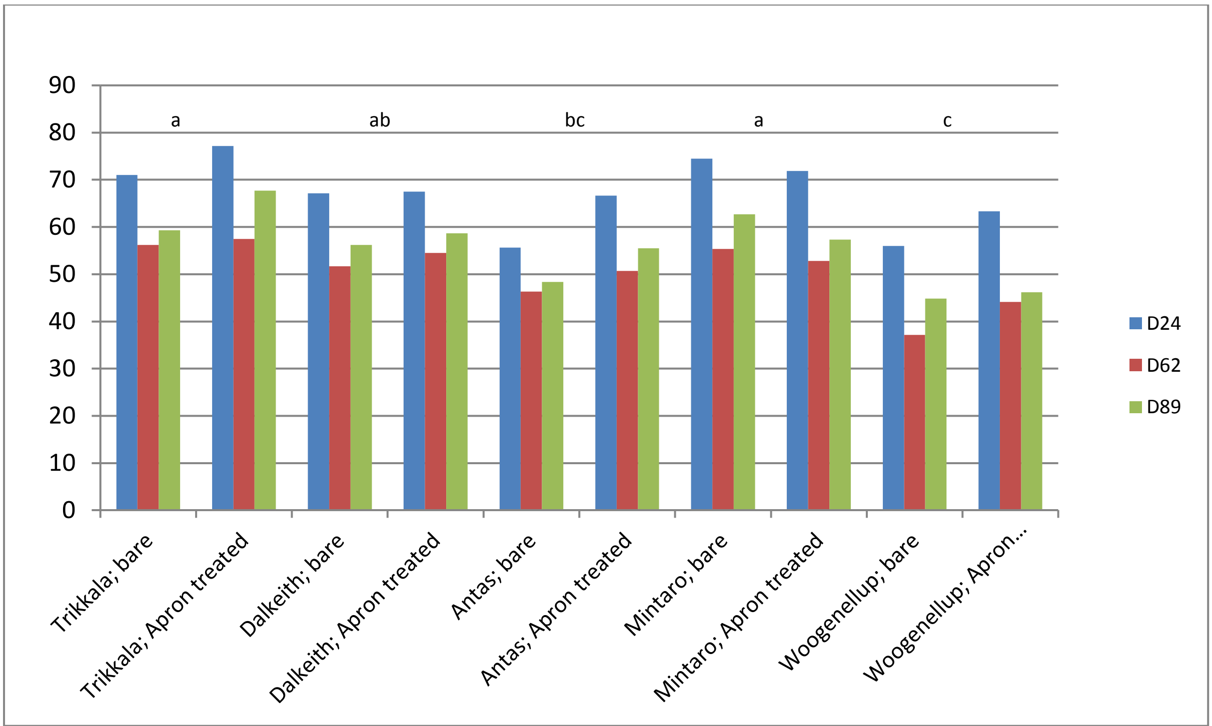


Figure 13. Sub clover germination and persistence of 5 varieties at three assessment times following sowing in 2016 at Furner only. (Varieties with different letters are significantly different from each other at the Day 96 assessment at a confidence level of 95%)

4.2 Extension and communication

A summary of the communication activities that were conducted over a four year period are shown in Table 4.

Table 4. Extension activities and communications delivered.

Date	Activity	Number of people
January 2014	Initial project meeting with producers at Lucindale	10 attendees
February 2014	Article in Stock Journal creating awareness around project	11000 circulation
October 2014	Field Day at Furner site	38 attendees
January 2015	Annual collaborative meeting (Adelaide) with producers, Rural Directions, BIGG and UWA	
February 2015	Project discussions at MFMG meeting – Lucindale	11 attendees
February 2015	Project update at Furner Ag Bureau	13 attendees
April 2015	Approved project report (2014 results) published in MFMG annual trial results book	240 published
November 2015	Grasslands Society of Southern Australia Field site visit (Avenue Range)	27 attendees
November 2015	Article in Stock Journal with an update on project (combined with the BIGG)	11,000 circulation

February 2016	Annual review meeting (Adelaide) with producers, Rural Directions, BIGG and UWA	
February/March 2016	Information presented at MFMG Trial Results Update meetings at Furner, Naracoorte and Padthaway	28 producers (45 attendees)
April 2016	Project update at MFMG meeting – Naracoorte	11 attendees
April 2016	Approved project report (2015 results) published in MFMG annual trial results book	250 published
September 2016	Field Day at Binnum “Productive pastures for sheep” visit to trial sites. Run in conjunction with other projects	46 attendees (38 producers)
November 2016	Final collaborative project meeting held in Adelaide	
March 2017	Key results presentation at the Grasslands Society of Southern Australia Pasture Update at Lochaber	30 attendees
April 2017	Approved project report (2016 and final results) published in MFMG annual trial results book	250 published

5 Discussion

5.1 Outcomes in achieving objectives

The group’s research aimed to quantify the level and effects of sub-clover root disease in pastures across the south-east region of South Australia. It was trying to understand the production and economic impact of root diseases in sub-clover and, through the evaluation of chemical and cultural control methods, establish cost-effective solutions to manage these diseases.

The key question was investigated through 4 objectives which are shown in Table 5.

Table 5. Project objective and outcomes.

Project objective By May 2017 the MFMG will have;	Outcome
1. Quantified the level and type of sub-clover root disease in pastures	Partial Achievement Throughout the life of the project, various pathogens were observed. This depended largely on seasonal conditions with the pathogen complexes varying under different climatic conditions. The pathogens did not, however appear to be impacting on production of locally grown cultivars.
2. Evaluated the impact of fungicides and effects of cultural methods on sub-clover establishment	Achieved Initially the effects of cultural methods were investigated, however there was no response observed so the focus of the research changed. The impact of fungicides was investigated with varying results.
3. Evaluated seed treatments (including	Achieved

their cost-effectiveness) and their role in root disease suppression for establishing sub-clover pastures	A range of seed treatments were evaluated and results received were not consistent or significant, however the current practice of treating seed with Apron® seed dressing (Metalaxyl-M as the active ingredient) should continue to minimise the risk of root disease when sowing new pastures.
4. Evaluated chemical control methods (including their cost-effectiveness) to suppress disease in existing sub-clover pastures	Achieved There was no improvement in biomass production through the use of chemicals and fungicides when applied to existing sub-clover pastures – foliar application of phosphorous acid or Metalaxyl-M to existing stands of sub-clover was ineffective in increasing the growth of these stands..

5.1.1 Quantifying the level of root disease

Results from the eight paddock sites spread across the region (from Keilira in the Upper South East through to Mt Burr in the lower South East, approximately 150km south, and from Keilira, Avenue Range and Crower in the west across to Frances and Wrattonbully in the east near the SA/Victorian border) gave a strong indication that root disease was present across region. This conclusion was based on consistent increases in germination and survival of *Trifolium subterraneum* subsp. *yanninicum* (Trikkala) treated with Apron® (Metalaxyl-M as active ingredient) across the sites (6-17%). No clear trends in germination rates (statistical analysis was not possible due to the non-replicated nature of the sites) were evident in terms of geography (i.e. north to south/east to west/lower to higher expected rainfall) or soil type at the sites other than the Lucindale site. There Trikkala declined rapidly in survival, possibly due to the very sandy nature of the site (versus clay or loams at the other 7 sites) and the very early 'finish' to the season in 2014.

Predicta B soil test results taken only at the 4 core research sites across 2015 and 2016 indicated that there was a large degree of variation in the root diseases and root disease complexes present at the sites, with the Furner site consistently having both the greatest number of diseases present and at the largest levels. *Aphanomyces*, *Ascochyta*, *Rhizoctonia* and *Pythium* were all present at high levels at Furner; *Rhizoctonia*, *Ascochyta* and *Pythium* were all detected at high levels at Binnum, with very low levels of *Phytophthora* and *Pratylenchus* also detected; furthermore, Binnum was the only site at which *Rhizoctonia* was detected (possibly due to its lower rainfall environment when compared to other sites; particularly in the season that sampling occurred). At the Woolumbool site *Ascochyta* and low levels of *Pythium* were detected and although *Ascochyta* was present at all 4 sites it was the only disease detected at the Avenue Range site. A coherent conclusion is difficult to draw from these results, since despite the Predicta B results indicating there was much more disease at the Furner (and to a lesser extent Binnum) site, there was no clear correlation of this with any consistent and large reduction in germination, persistence and growth at this site over the others. The Predicta B tests provided an indication of the potential disease complexes present and is likely to have potential use in the future for producers as more information becomes understood around the critical levels where disease impacts on production.

Despite the lack of a clear conclusion from the Predicta B testing, the other indicators of disease (i.e. trend for Apron treatment having a small effect on Trikkala germination, etc.) from this project show that root diseases are present at some levels across the region and should be a consideration when establishing new pastures.

Local seed sheds in the south-east charge approximately $1.50/kg to inoculate seed and apply Apron Seed Dressing. At a sowing rate of 6kg/ha, this increases the total cost by $9/ha. When coating seed locally, the number of seeds being sown at a similar rate decreases (91% seed; 9% coating). This rate increases with seed supplier coating where the weight of the seed coat can increase to as high as 40%.

The 6-17% increase in germination found across these sites with Trikkala (at $5.75/kg bare) treated with Apron would compensate for the reduction in seed numbers being sown, resulting in similar plant establishment to bare seed (at the 6% level). Where the higher increases (17%) were observed, a slight reduction in seed rate to 5.5kg treated seed/ha may be viable saving the farmer up to $8/ha after coating costs.

5.1.2 Effects of cultural methods on establishment

The results from Trial 1 (brownout trial) showed that under current farmer practice, there was no benefit of waiting longer than 7 days after a knockdown herbicide application to establish sub-clover pastures. Waiting longer (14 and 28 days) actually had a negative impact on germination at the Furner site.

It is thought that other factors related to time of sowing such as soil temperature, water inundation and frost events at the time of sowing may have adversely impacted on the germination (33mm of rain fell at the Woolumbool site in the 2 weeks following knockdown and resulted in significant inundation of the 1m furrows into which the seed was sown). The practicality of waiting for approximately 7 days post-spraying is that this allows for root release by the sprayed plants, making sowing easier. This may consequently also result in greater soil disturbance during sowing – a factor indicated by Prof. Barbetti that aids the reduction of soil pathogens. The use of cultivation is an important factor to consider locally when renovating pastures.

5.1.3 Foliar chemical control options

This trial of 2 post-emergent treatments (Metalaxyl-M and phosphorous acid applied as ground/foliar sprays) to try to manage disease in existing sub-clover pastures was not effective, with no significant differences found in biomass produced between the treatments and the untreated controls.

Reasons for the lack of effect were unknown at the time, but there were suggestions that it may have related to time of application, the chemicals used, season and/or the type and level of diseases present (remembering that affects in sub-clover are usually due to a complex of pathogens). The two products tested were selected on the advice of Martin Barbetti and his team as the most promising of those currently being tested in their trials. Phosphorous acid is a registered product for foliar application in sub-clover to treat root rot from *Phytophthora,* whereas Metalaxyl-M is registered as a seed treatment (but not as a foliar application) for control of *Pythium* and *Phytophthora*. Furthermore, subsequent Predicta B results for the Woolumbool site (note that the samples were collected the following February) indicated only *Ascochyta* was at a high level at the Woolumbool site, but *Aphanomyces*, *Ascochyta*, *Rhizoctonia* and *Pythium* were all present at Furner so there was some prospect of an affect being observed. Due to the complexity of the issues involved it was decided not to pursue this issue with further trials.

As the project progressed, it was suggested that a local biotype of Trikkala with good field tolerance to root disease pathogens may have evolved over time. These initial foliar chemical control trials were all conducted on existing Trikkala stands and this adaptability may have contributed to the lack of response.

Of the two foliar sprays, Phosphorous acid showed the most promise, but at a product cost of $3.40/ha (Sprayphos 620 @ 485ml/ha) plus approximately $10/ha for application, producers are advised to consider a test-strip prior to broad scale application to assess the responsiveness of their individual paddocks.

5.1.4 Fungicide and seed treatments

Trials testing the effects of seed treatments (Apron®, Thiram 600, Rovral®, Dividend Extreme® and Rancona® Dimension were all tested) and the in-furrow/at sowing use of Phosphorous acid were undertaken in all three years of the project (Apron® only in 2014; more extensive testing in 2015 and 2016). Despite the range of seasons encountered (relatively dry with early 'finishes' in 2014 and 2015; very wet with an excellent spring in 2016) there were only relatively small and largely non-significant effects of any of the seed treatments or the in-furrow treatment across all sites and all years. The most extensively tested treatment was Apron® (Metalaxyl-M as the active ingredient) as a seed treatment. Although there were relatively consistent increases of 5-15% in germination and survival of the various sub-clover varieties tested, none of these were significant effects. On this basis it is felt that this seed treatment, whilst not a guaranteed or clear performance improver across the region is probably an excellent insurance policy to reduce or control possible effects of potential root disease across the region. This is especially the case since the actual level and causes (i.e. diseases present) of root disease in any given paddock is usually unknown. Apron® is registered for the control of Pythium and Phytophthora in sub-clover (as well as cotton, peas, lucerne, carrots, beetroot, maize, sweetcorn and radish) and is already routinely used by most seed resellers when packaging sub-clover seed for sale.

Significant differences between sites were evident at most assessment times in these trials – Avenue Range being higher than Furner in 2015 at Days 21, 64 and 96 and Binnum higher than Furner in 2016 at Days 62 and 84 but not at Day 21. Given the high level of disease indicated by the Predicta B testing at these sites this may be the best indicator of differences being evident (possibly) as a consequence of the level and complex of diseases present. Furner was consistently high for *Aphanomyces* and *Ascochyta* and *Rhizoctonia* and *Pythium* were also present at this site, whereas only low levels of *Ascochyta* were present at Avenue Range. *Ascochyta* was present at similar levels at both Furner and Binnum, but *Rhizoctonia*, *Pythium*, *Phytophthora* and *Pratylenchus* were all generally low and lower at Binnum than Furner.

Other reasons for these site differences could include the relative geographical spread of the sites, with the Furner site being 70-100 km further south than either the Avenue Range or Binnum sites making it generally both colder and wetter. Soil type and site nutrition may also have had an effect, although an attempt was made to control site nutrition using a broad spectrum 'complete' fertiliser at all sites in 2015 and 2016.

Locally packed sub-clover seed is often inoculated prior to leaving the shed. The additional cost to apply Apron as a seed dressing in this process is $0.60/kg, an additional cost of 8% (or $4.20/ha based on a seeding rate of 7kg/ha).

5.1.5 Varietal response

In contrast to the other trials, there were significant germination and survival differences between some varieties tested, especially when compared to the highly susceptible variety, Woogenellup. Trikkala, Dalkeith and Antas all consistently showed significantly higher germination, establishment and persistence levels when compared to Goulburn, Leura and Woogenellup in 2015 (out of the 10 varieties tested). In 2016, Trikkala, Mintaro and Dalkeith again all had significantly higher levels of germination, establishment and persistence compared to Woogenellup (only 5 varieties tested), with Antas not performing quite as well as in 2015.

These significant differences in varietal performance across two seasons (2015 & 2016) are important for local producers as some of the newer varieties, purported to have higher disease tolerance than older varieties, performed well. However, Trikkala (an older, mid-maturity *yanninicum* variety that has performed well in the region), Dalkeith (an early/mid-maturity *subterraneum* variety) and Antas (a late-maturity *brachycalycinum* variety) consistently outperformed the other varieties tested, especially Woogenellup (a superseded variety known for its susceptibility to various disease pathogens), Leura and Goulburn.

Trikkala has been grown across the south-east region for years and the seed is bred locally. It is thought that a local biotype with good field tolerance to root disease pathogens may have developed over time. Results from this work indicate that this variety is extremely well adapted and is hard to go past when renovating pastures in the South East of South Australia. It appears to have all the important attributes local graziers look for in their clover pastures – good germination, persistence and growth, thereby having plenty of nitrogen-fixing ability for the overall health and productivity of mixed pasture swards.

These variety trial results also indicate that updated testing of disease tolerance of many newer varieties would be a very useful service for local (and probably all other) livestock producers as it is apparent that most disease classifications are based on old data, with many newer varieties not having been independently tested. This project and local independent demonstrations of relevant varieties (new and older, still productive ones) would be of enormous value to producers when trying to select varieties for their new pastures (this applies to all pasture species, not just sub-clovers).

Table 6 shows the cost of some of the seed varieties that performed well at the producer research sites, their recommended rates and costs (based on 2017 seed costs) for both untreated and treated seed.

Table 6. Cost of selected, good performing varieties

Seed Treatment	Seed rate	Seed cost	Seed Cost

		(kg/ha)	($/kg)	($/ha)
Trikkala	Bare	6	$ 5.75	$ 34.50
Trikkala	Inoculated	6.5	$ 6.75	$ 43.88
Trikkala	Inoculated + Apron	6.5	$ 7.35	$ 47.78
Dalkeith	Bare	6	$ 5.00	$ 30.00
Dalkeith	Inoculated	6.5	$ 6.00	$ 39.00
Dalkeith	Inoculated + Apron	6.5	$ 6.60	$ 42.90
Antas	Bare	7	$ 7.60	$ 53.20
Antas*	Inoculated + Apron	9	$ 7.60	$ 68.40

*Antas coated seed is direct from the seed marketer and isn't coated locally; the additional seeding rates allow for the amount of coating on the seed. Antas is also a larger seed, so the base seeding rate is often increased compared with other sub clover varieties to allow for the increased seed size.

5.2 Promotion of research results and its effectiveness

5.2.1 Engagement of producers

There were approximately 10 repeat producers engaged throughout the project. The preliminary results of the project were promoted through annual extension documents to a wider audience and at field days that were held throughout the life of the project. The lack of results at local research sites made delivery to a wider audience more difficult. Even though there were noticeable trends, apart from varietal differences, no significant results were achieved.

5.2.2 Participant knowledge

At the start of the project, soil diseases within pastures were an "unknown factor". Its existence was suspected but not proven or quantified.

By the end of the project producers improved their knowledge around root diseases, the complexes that exist and the impact of varying environmental conditions on the diseases that were likely to be present in any one season.

Their skill level in managing disease inadvertently by conducting what is considered 'good farmer practice' was high initially and all results achieved showed that the participants maintained that skill level, but did not grow it further.

5.2.3 Participants attitude

Producers now understand that even though root disease is present in varying levels across the region, that as long as they maintain or adopt best practice methods when establishing pastures, and utilise varieties with proven field tolerance, then they shouldn't experience any major issues with regards to root disease impacting on establishment.

5.2.4 Producer Practice Change

Producers will continue to maintain 'good farmer practice' when renovating pastures and ensure that appropriate seed is treated with Apron® Seed Dressing and that adequate soil disturbance occurs to ensure good germination and establishment levels. The use of Predicta B soil sample testing (once commercialised) may be taken up by some producers if renovating pastures in paddocks thought to be high in root disease, or in those paddocks that have had very poor pasture performance.

5.2.5 Enablers to change

Most grazing systems across the region are currently reliant on sub-clover to provide nitrogen. Producers want sub-clover to continue providing this nitrogen rather than having to revert to N fertiliser in pastures. If they are investing in new pastures, they want the process to be successful and the sub clover stand to persist into the future.

The project utilised the Predicta B soil sample testing service which is still under development phase for pastures. Utilising this has increased producer knowledge around the service.

5.2.6 Barriers to change

A gap exists in the knowledge of disease tolerance of different varieties; there is no screening process that independently assesses this. This will impact on the adoption of newer varieties that may have other benefits within the production system.

Other barriers that provide a challenge to producers are:

- Cost, commercialisation and reliability (time taken to process) of the Predicta-B service, and interpretation of the Predicta-B results.
- Seasonal variability has an influence on the pathogen complexes present; all diseases may be present, but their expression may vary based on seasonal conditions;
- The lack of consistency in expression of the disease.

5.3 Effectiveness of the participatory research process

The research topic remained the same throughout the project, however the focus of work varied based on feedback from researchers from UWA and from the parallel project undertaken by the BIGG. The constant was the use of Woogenellup as a known, susceptible variety. The selection of appropriate sub-clover varieties to test in 2015 and 2016 was undertaken in consultation with local agronomists and seed resellers to reflect commonly used varieties across the region.

Initially, cultural practices and their impact on clover establishment and germination were looked at, but as these were not as high as anticipated after the initial year and after consultation with UWA researchers, trial protocols and treatments being assessed were modified to try to maximise the affects and impact of the root disease (e.g. use of insecticide at sowing, blanket application of fertiliser at sites, inoculation of seed prior to or at sowing).

Changes largely came from researcher advice (use of different seed treatments, post-emergent applications) which paddocks/properties to try based on advice provided from Kevin Foster based on AWI sampling results (surveys conducted in same paddocks that were being utilised for MLA project); inoculation of seeds prior to sowing (including use of Alosca in 2016); use of fertiliser & insecticide.

The involvement of researchers was useful in reviewing the research process at annual review meetings, however the lack of results locally conflicted with their views on the importance of root disease and its impact across the south east region of SA. There was also little engagement at the UWA research sites until the final year (even though the group had assisted them in locating these sites initially).

The group added value to the research topic by providing sites and paddocks for use, fencing the areas required and in the third year, co-locating with the UWA site and incorporating the final year field day into a wider industry event.

Producers felt that in most cases, they are essentially managing root disease through the use of good management practices and locally adapted varieties, however when newer varieties are marketed as 'replacement' varieties, producers are looking for the confidence to plant these varieties knowing that they have similar field tolerance to root diseases as Trikkala. Disease tolerance screening of newer varieties was an area that was identified for potential future research to aid producers in making more informed decisions.

A quote from one of the producers. "Having some of the work on our property, especially the variety testing, was very valuable in being able to see how a range of varieties performed on our paddocks. This has emphasised the continued use of Trikkala in our ongoing pasture renovation program. The low disease profile on our property has also reaffirmed our continued use of cultivation and Apron seed treatments as useful additions to our pasture renovation program."

6 Conclusions/Key Messages/Recommendations

At the end of the three years of trial work, there were no significant production benefits found from the application of a range of fungicides as seed treatments or as post-emergent spray applications. The continued use of Apron® as a seed treatment is thought to still be important (germination increases of 5-10% – although not significant) as an insurance policy in case the site being sown has high levels of root disease, given that an assessment for disease levels is not yet available.

There were significant differences in varietal performance over two seasons (2015 and 2016), with some of the newer varieties (purported to have higher disease tolerance) performing well. However, Trikkala (an older variety that has performed well in the region) consistently outperformed the nine other varieties tested, especially Woogenellup (a variety known for its susceptibility to various disease pathogens). Trikkala has been grown across the south-east region for many years and the seed is bred locally. It is thought that a local biotype with good field tolerance to root disease pathogens may have adapted over time.

Whilst root diseases that can affect sub-clover are clearly present in the South East of South Australia, the lack of disease response over the life of the project suggests that current "best management practices" that are used when new pastures are being established (i.e. knockdown herbicide in advance of sowing, cultivation for an even seed bed as this also helps reduce disease pathogens, the use of Apron® seed dressing and sowing newer varieties or varieties that have long been utilised in the region) appear to be ensuring that producers are minimising the potential risk that root disease may have on sub-clover establishment and survival.

The range of root diseases present across the trial sites and their levels (as determined by the Predicta B test) and the very loose relationship between these and differences in germination, survival and persistence at the various sites indicate that this test could become a useful tool in the hands of trained agronomists providing further validation of a relationship between the extent and level of disease and possible responses could be established.

7 Bibliography

GRDC (2013) Inoculating Legumes: The Back Pocket Guide, GRDC Publication

Rural Solutions SA (2017) Farm Gross Margin and Enterprise Planning Guide. Available on-line at http://www.pir.sa.gov.au/consultancy/farm_gross_margins_and_enterprise_planning_guide (verified 24th August 2017)

8 Acknowledgements / Additional contributions

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Krysteen McElroy and Charlie Crozier, MacKillop Farm Management Group

Brett Nietschke, Barossa Improved Grazing Group

R Bateman, Furner

Sambell Family, Binnum

Graham Clothier, Woolumbool

Jamie Tidy and Joshua Rasheed, Naracoorte Seeds

Kirk Brehaut, Heritage Seeds

Adam Hancock, Elders Naracoorte