

Wairarapa and Hawkes Bay Field Days

Annual clovers in dryland systems



Wednesday 26th Oct - Tokaroa Farm, 1106 Ponatahi Rd, Martinborough

Thursday 27th Oct - Poukawa Research Farm, 1391 SH2, Hastings

Lincoln University 'Sub 4 Spring'

Professor Derrick Moot and Mr Dick Lucas

- ♣ Role of sub clover in dryland systems
- ♣ Suitability of different sub clover cultivars

On-Farm Research Forages for Dryland

Dr Paul Muir

- ♣ Yield and animal performance on plantain
- ♣ Role of annual clovers in plantain
- ♣ Matching plantain cultivar to your system

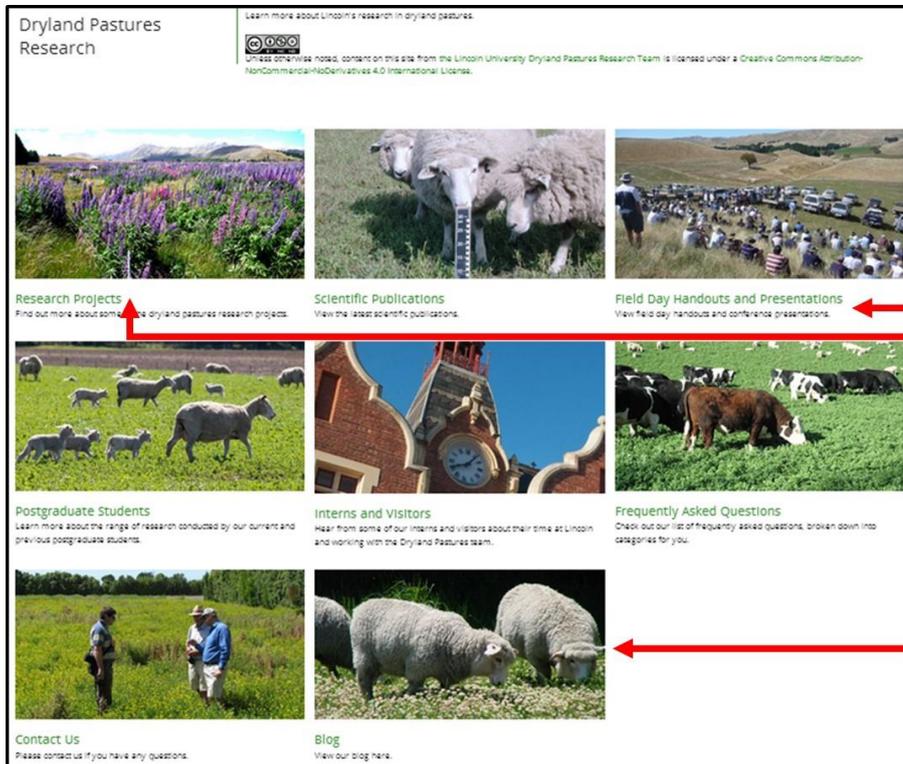
"This work was undertaken as part of Phase II of the Pastoral 21 Programme, funded by the Ministry for Business, Innovation & Employment; DairyNZ; Beef + Lamb NZ; and Fonterra, and Ministry for Primary Industries, Sustainable Farming Fund."



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Website & Social Media

- Website: www.lincoln.ac.nz/dryland



DPR website

Info on:

- Field Day presentations
- Current research projects (inc access to Maxclover Photo Diary)
- FAQs
- Postgraduate study
- Direct link to Blog

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- Blog: <https://blogs.lincoln.ac.nz/dryland/>
- Facebook: [@DrylandPasturesResearch](https://www.facebook.com/DrylandPasturesResearch)
- YouTube: <https://www.youtube.com/DrylandPastures>

Dryland Pastures Research Team

Mission statement

“To provide research results that assist dryland pastoral farmers to develop resilient farm systems that are financially, economically, environmentally and socially sustainable.”

The Problems

- Dryland sheep and beef properties usually start the spring season with full soil moisture recharge but run out in summer.
- The amount of water available is dependent on the soil water holding capacity of the soil, the ability of the pasture species to use the water efficiently, and in season rainfall.
- Nitrogen is always deficient in grass dominant dryland pastures and this reduces water use efficiency of the plants.
- The herbage produced must be high quality to maximize live-weight gain during lactation in the reliable spring growth period.
- Lambs born at ~5 kg must grow at least 300 gm/hd/d to achieve 35 kg liveweight in 100 days (before soil moisture runs out).
- Lambs still on the farm during the dry summer months compete with ewes for priority forage. This may affect the ewes condition going into mating and subsequently lambing performance the following year.

The Solutions:

- High quality forages that maximize water use efficiency (kg DM/mm/ha) and water extraction (Lucerne).
- Pasture species that fix nitrogen and grow early in spring when soil moisture is available (Annual clovers).
- Grazing management systems that maximize spring live-weight (LWG/ha) gain but enable the high quality forages to survive and thrive.
- Persistent grass species that respond to moisture after summer dry periods (Cocksfoot).
- Appropriate research information to allow farmers to develop management systems that maximize the benefits of dryland pasture species (Field days)!

Weather data summary - Wairarapa

Rainfall and evapotranspiration

The months from October 2015 to April 2016 were dry in the Wairarapa as highlighted by Figure 1.

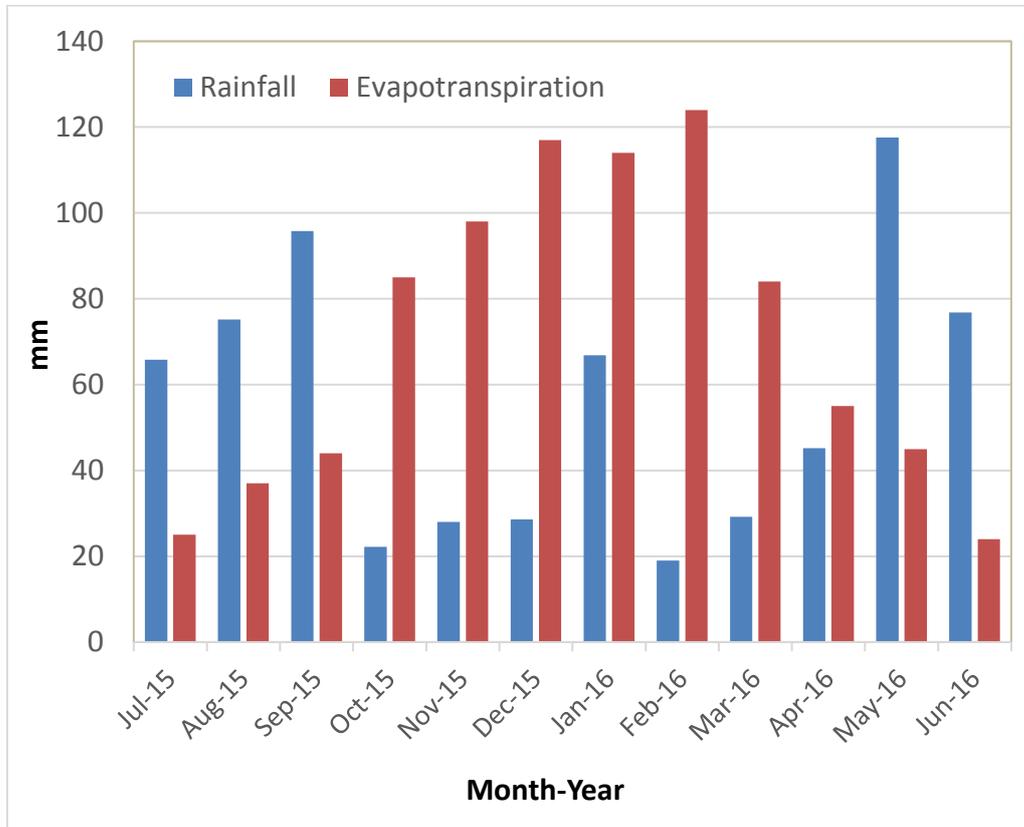


Figure 1: 2015-16 monthly amounts of rainfall and evapotranspiration, Glen Eden Farms Ltd (approx. 0.8 km from Tokaroa farm experimental sites).

The lack of rainfall, and therefore soil moisture, may have had the following effects:

- ♣ reduced dryland pasture growth
- ♣ delayed reestablishment of resident sub clover populations
- ♣ delayed and reduced germination and establishment of sown annual clovers

Sub clover germination is triggered by a significant rainfall event >20mm during the autumn. However there was no significant rainfall recorded here until late May when ongoing rainfall amounted to 88 mm over a 10 day period.

Clover & plantain cultivar plot map

	Plot no. Cultivar name	Plant type
Raceway	1. Narrikup	Sub clover
	2. Napier	
	3. Monti	
	4. Denmark	
	5. Coolamon	
	6. Antas	
	7. Woogenellup	
	8. Denmark	
	9. Antas	
	10. Napier	
	11. Narrikup	
	12. Woogenellup	
	13. Coolamon	
	14. Monti	
Raceway	15. Taipan	Balansa
	16. Bolta	
Raceway	17. Laser	Persian
	18. Lightning	
	19. Lusa	
Raceway	20. Arratas	Arrowleaf
	21. Cefalu	
Raceway	22. PG742	Plantain
	23. Boston	
	24. Tonic	
	25. N16PL3	
	26. Tuatara	
Raceway	27. Relish	Red clover
	28. Tuscan	
	29. TP22	
	30. Sensation	

Figure 2: Layout of the clover and plantain cultivar demo plots, Tokaroa Farm.

Note: Sub clover sown at 10 kg/ha; annual clovers, plantain and red clover were sown at 8 kg/ha.

Sub clover cultivars - Sub 4 Spring

Location: Tokaroa Farm, Martinborough.

Aim: evaluate subterranean clover cultivars that may be suitable for introduction to pastures through direct drilling in this environment.

Methods

- ♣ Sub clover seed sown in 3 x 20 m plots at 10 kg/ha on 21/4/16
- ♣ Two plots of each cultivar: Antas, Coolamon, Denmark, Monti, Napier, Narrikup and Woogenellup (Figure 2).
- ♣ Establishment numbers counted 6.3 weeks after sowing.
- ♣ Ground cover assessed at 16 weeks for sub clover, grass (predominantly a *Poa* species), weeds¹ and bare ground.
- ♣ At 19 weeks, 60% of each plot sprayed with 'Sequence' to control the grass.
- ♣ Herbage cut at 23 weeks – one 0.18 m² quadrat per plot – cage placed on a sub clover replicate prior to grazing same day (29/9/16, approx. 4 weeks ago, Figure 3).



Figure 3: Tokaroa Farm sub clover cultivar plots when the herbage was cut (29/9/16, Photo: Sonya Olykan).

¹ Main weeds = Cranesbill and Mouse-eared chickweed, minor = Sow thistle, nettle, amaranthus.

Results

♣ **Establishment:** Four of the sub clover cultivars – Antas, Coolamon, Narrikup and Napier - established well on this site with counts of 86 to 90 plants/m² (Figure 4).

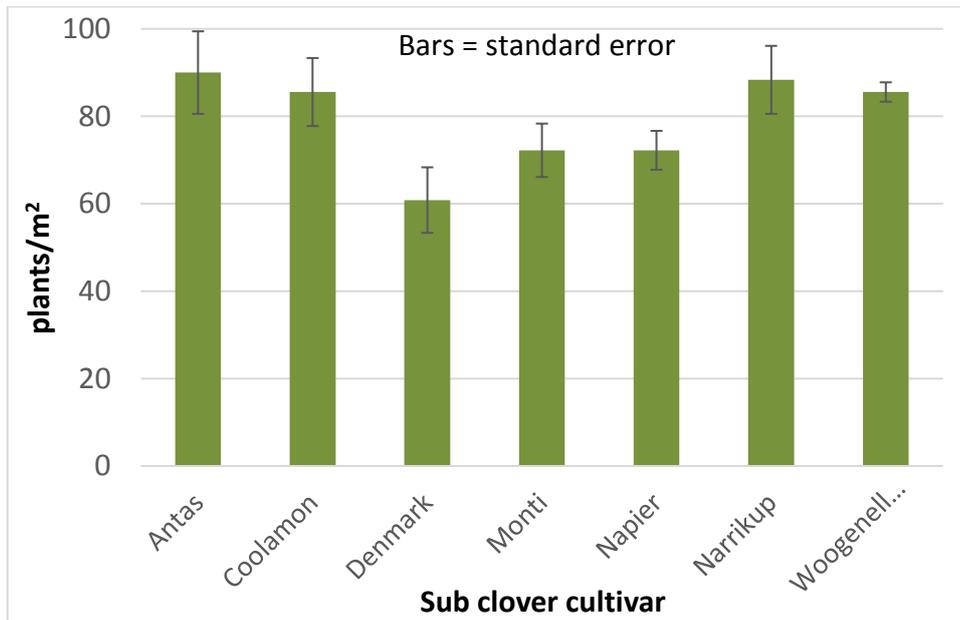


Figure 4: Sub clover cultivar establishment at Tokaroa Farm (4/6/16).

♣ **Ground cover:** By 16 weeks the sub clover cultivar Antas occupied 53% of the area. Cultivars Narrikup and Woogenellup occupied around 40% (Figure 5). The other four cultivars occupied 18 to 23% of the area and were dominated by grass (43 to 48%) with bare ground at 25%. Across the plots the weeds occupied 8 to 13% of the area.

The differences between the cultivars were more pronounced than expected, based on establishment data, suggesting that the Antas, Narrikup and Woogenellup plants were larger and with a larger leaf area were able to spread at this site and compete with the grass.

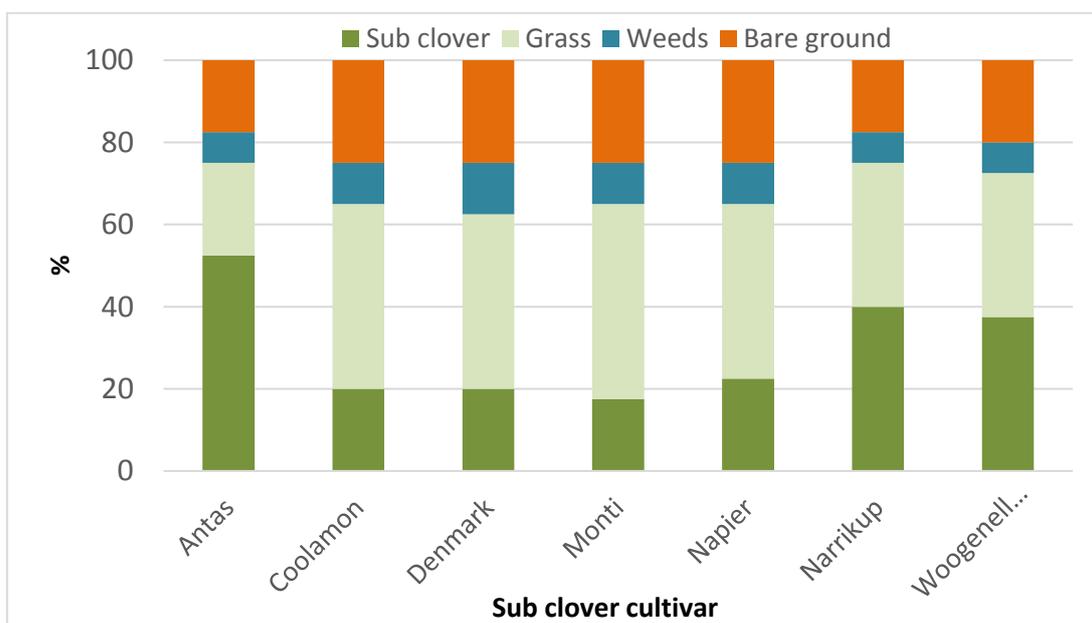


Figure 5: Ground cover % of sub clover cultivar plots, Tokaroa Farm (11/8/16).

♣ Dry matter production:

By 26 weeks Antas had grown the most providing 3300 kg DM/ha (Figure 6). Narrikup and Woogenellup produced 2800 and 2900 kg DM/ha, respectively. The other four cultivars produced 2100 to 2400 kg DM/ha. It is likely that the provision of weed control particularly benefitted these cultivars.

A cage was located on a replicate of each sub clover cultivar and the next day the area was opened up to the ewes and lambs to graze for 12 hours. The area has now been closed for nearly 4 weeks since the DM cut to allow regrowth.

The herbage under the cages represents the total amount of sub clover growth from the time of establishment.

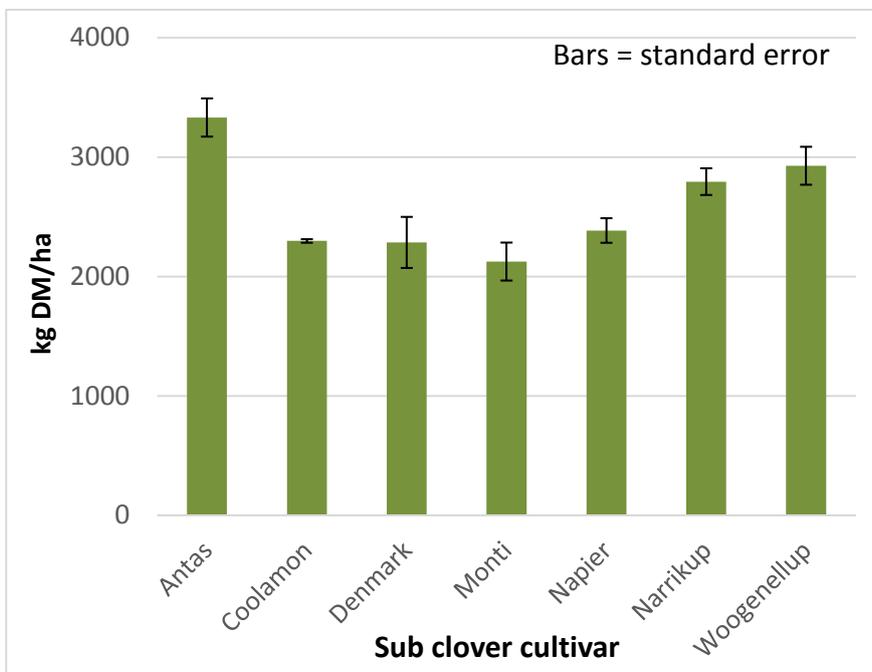


Figure 6: Dry matter production of sub clover cultivars, Tokaroa Farm (29/9/16).



Figure 7: Sub clover cultivar Antas. Height of measuring stick is 30 cm. (29/9/16 Photo: Sonya Olykan).

Conclusions

Three sub clover cultivars, Antas, Narrikup and Woogenellup, have shown promising establishment and dry matter production at Tokaroa Farm.

The sub clovers need to be spelled from grazing to allow flowering and seed set to ensure reestablishment next season.

For this experiment herbicide was needed to reduce the grass competition. Can competing weeds and pasture species be controlled with grazing?

Recommendations

The performance and persistence of the sub clover cultivars be investigated in a legume/plantain pasture.

Exclosure demonstration plots – Sub 4 Spring

Location: Tokaroa Farm, Martinborough.

Aim: To provide a farmer demonstration as to what happens to hill country pasture across a wide range of land classes with significant resident population of sub clover in it when spelled.

Methods – 2015 season

4 closing (spelling) treatments (see Figure 8):

1. Current management (no exclosure, i.e. surrounding paddock)
2. Closed for 3 weeks (Exclosure 2). Herbage samples taken on 20th October 2015.
3. Closed for 6 weeks (Exclosure 3). Herbage samples taken on 7th November 2015
4. Closed for 9 weeks (Exclosure 1). Herbage samples taken on 30th November 2015.



Figure 8: Layout and spelling times for the exclosure plots, 2015 season, Tokaroa Farm (Photo: Malcolm Macfarlane)

Results and discussion

Pasture and sub clover production in the exclosures

The amount of pasture dry matter increased between spelling weeks 3, average of 428 kg DM/ha, and 9 weeks with 2503 kg DM/ha (Figure 9). At 6 weeks there was 576 DM/ha.

After 9 weeks spelling there was a noticeable difference between DM production on the easy and steep slopes in the exclosure: 3193 kg DM/ha v. 1813 kg.

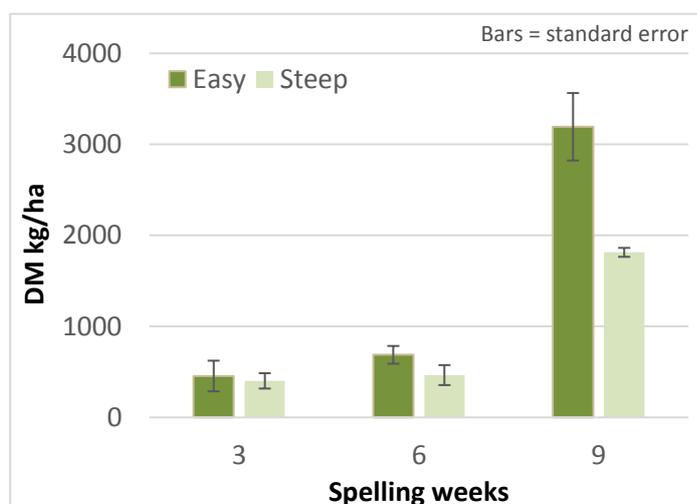


Figure 9: Effect of spelling weeks and slope type on pasture growth in the exclosure plots, Tokaroa Farm.

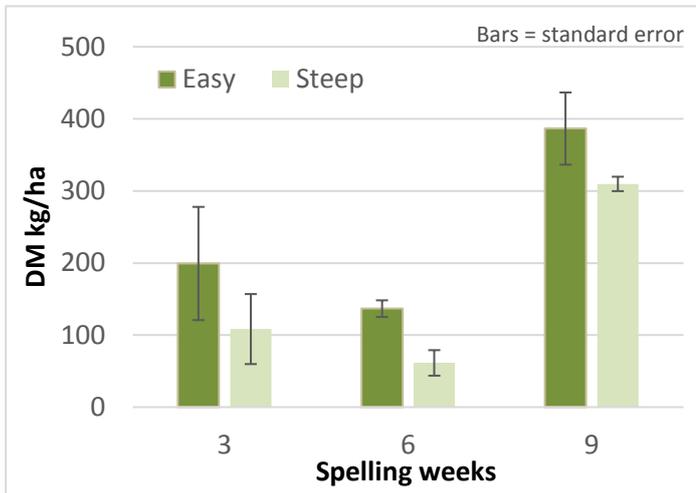


Figure 10 Effect of spelling weeks and slope type on sub clover growth in enclosure plots, Tokaroa Farm.

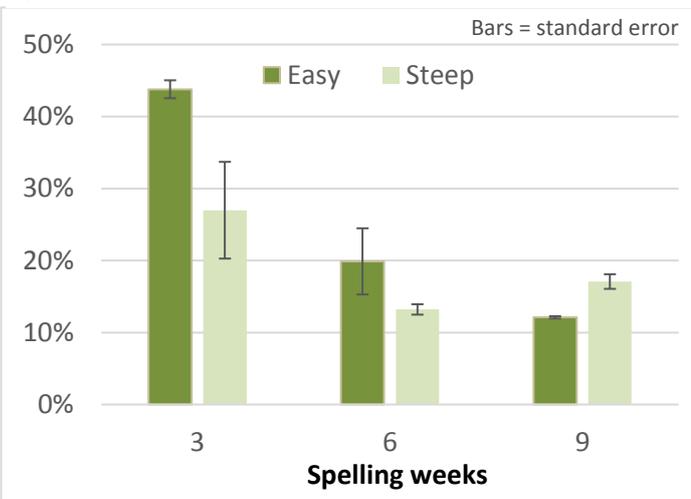


Figure 11 Effect of spelling weeks and slope type on the percent sub clover in the pasture of the enclosure plots, Tokaroa Farm.

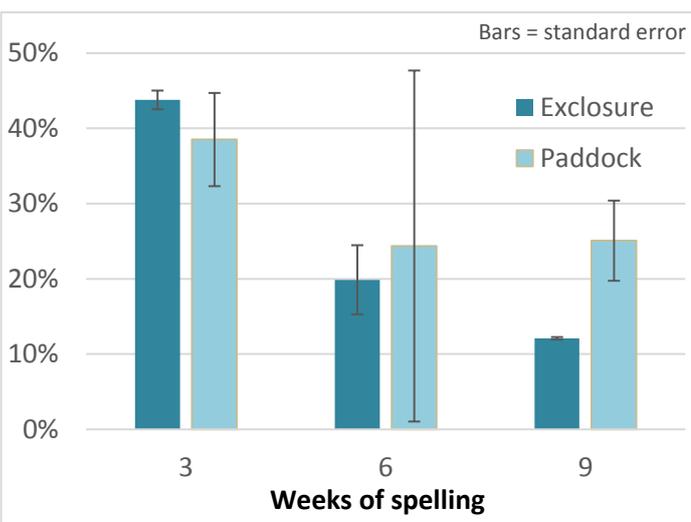


Figure 12 Effect of spelling weeks on the percent sub clover on the easy slopes in the pasture versus enclosure plots, Tokaroa Farm.

² The steep slope sampling sites in the paddock were chosen because they did not contain sub clover.

The results for sub clover DM alone are variable (Figure 10). The increase from weeks 3 to 9 was significant - 154 and 348 kg DM/ha respectively - but less pronounced compared to overall pasture production (Figure 9). Also the difference in sub clover production between the easy and steep slope at week 9 is much less pronounced – 387 compared to 310 kg DM/ha.

As pasture growth increased with spelling weeks the proportion of sub clover declined (Figure 11). This was especially noticeable on the easy slope where sub clover was 44% of the pasture DM weight at week 3 but only 12% by week 9.

There was less sub clover on the steep slopes and this declined from 27% at week 3 to 17% by week 9.

Sub clover in the enclosures compared to paddock, easy slope²

The only significant difference between the enclosure and paddock 'easy' slope sites occurred in week 9 when the proportion of sub clover was higher in the paddock where grazing had reduced the effect of grass competition on sub clover production (Figure 12).

Sub clover reestablishment in the enclosures

The reestablishment of sub clover was measured in early June 2016. The data suggests that 3 weeks of spelling greatly promotes sub clover reestablishment (Figure 13). However the week three enclosure also had the highest sub clover component (Figure 11) and because the treatments were unreplicated it is difficult to know what effect enclosure location has had. In addition there were no time zero measurements to quantify sub clover populations to start with.

Overall the reestablishment counts for sub clover were good given the poor autumn rainfall.

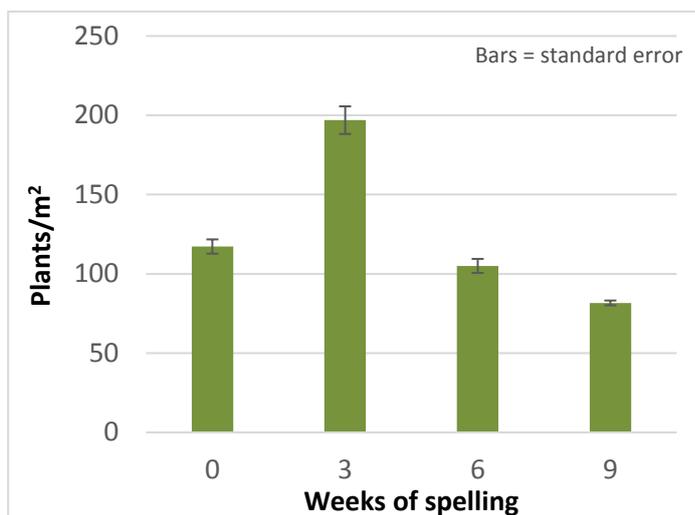


Figure 13 Effect of spelling weeks on the reestablishment counts of sub clover in the enclosure plots, Tokaroa Farm.

Conclusions

Because there was only one replicate of each spelling treatment it is not possible to identify if site factors, associated with the position of the enclosures on the slope, or variation in sub clover populations affected the results.

Another consideration is the low rainfall in October 2015 (see Figure 1) impacting on pasture DM production between spelling weeks 3 and 6.

Recommendations

This experiment has been redesigned for the 2016 season to address the lack of replication and reduce variation issues shown in the data:

- ♣ Each enclosure has been divided in half with one half being spelled for 4 weeks and the other for 8 weeks. This provides a replicate of each spelling treatment at each slope position.
- ♣ The experiment started on 29/9/16 and the 'Day 0' sub clover populations were assessed inside the enclosures and in the control paddock.

Herbicides and sub clover cultivars for hill country

Location: Glenside Farm, Taratahi.

Aim: To provide a farmer demonstration of cultivars and herbicide options for oversowing on hill country.

Methods

Herbicides: 6 treatments applied by helicopter down the slope (no replicates) in spring (S, applied on 31/11/15) and/or autumn (A, applied 19/4/16) aimed to either provide a full pasture kill or suppress the pasture:

- ♣ Control: No spray
- ♣ HiG-S: Roundup at 3 L/ha plus 40 g/ha Hammer in 100 water litres/ha (full kill)
- ♣ HiG-SA: as above plus an autumn application (full kill)
- ♣ HiG A: Roundup at 3 L/ha plus 40 g/ha Hammer in 100 water litres/ha in autumn (full kill)
- ♣ LoG-A: Roundup at 0.7 L/ha in 100 water L/ha in autumn (sward suppression only)
- ♣ Para- A: 0.8 L/ha FLASH® (contains 250 g paraquat/L) with low water rate (60 litres/ha) in autumn (sward suppression only)

Sub clover cultivars –Antas, Coolamon, Denmark, Narrikup and Woogenellup broadcast sown on 24/4/16 with a spinner at 20 kg/ha.



Figure 14: Looking down the slope 2 weeks after application of the HiG-S herbicide and the weed and pasture kill was good. Evidence of spray drift to the east (right). Glenside Farm, Taratahi (*Photo: Malcolm Macfarlane*).

Herbicide treatments differed in their effectiveness

Herbicide treatment significantly affected ($p < 0.001$) pasture ground cover components: % green, % dead and % bare ground.

Most effective treatment was a high rate of glyphosate applied in spring (HiG-S, Figure 15). The proportion of green was 12% compared to 40% in the control.

A high rate of glyphosate in autumn (HiG-A) significantly reduced the green component to 23%.

HiG-S significantly increased the proportion of bare ground from a control level of 13% to 32 and 34% respectively. This had positive benefits for resident sub clover reestablishment (see Figure 17) but provided an opportunity for weed invasion, particularly mouse-eared chickweed.

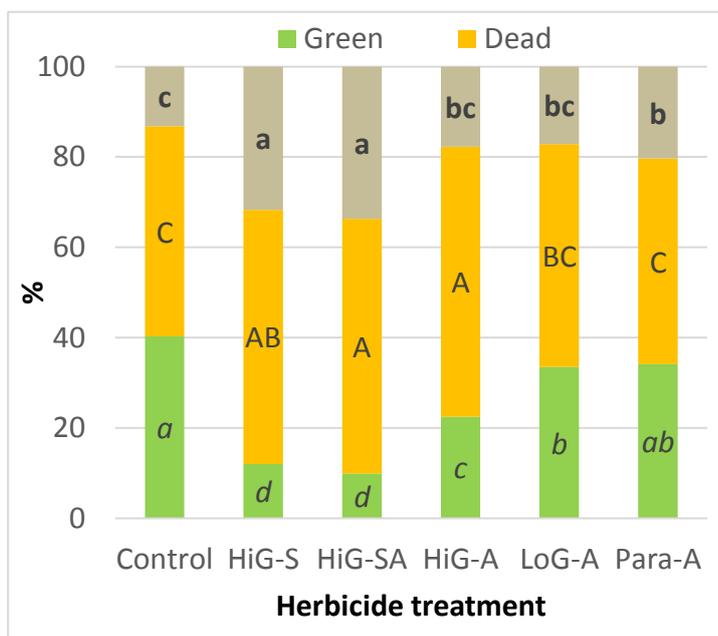


Figure 15: Herbicide effect on % ground cover at Glenside Farm, Taratahi (assessed 9/5/16, Fisher's Protected LSD (5%).

Autumn herbicide improved sown sub clover establishment

Autumn applications of low glyphosate (LoG-A), high glyphosate (HiG-A) or paraquat (Para-A) resulted in the establishment of about 40 sown sub clover plants/m² (Figure 16).

A control area was not counted for sown sub clover establishment.

Sub clover cultivar type had no effect on establishment and there was no interaction between the herbicide and cultivar.

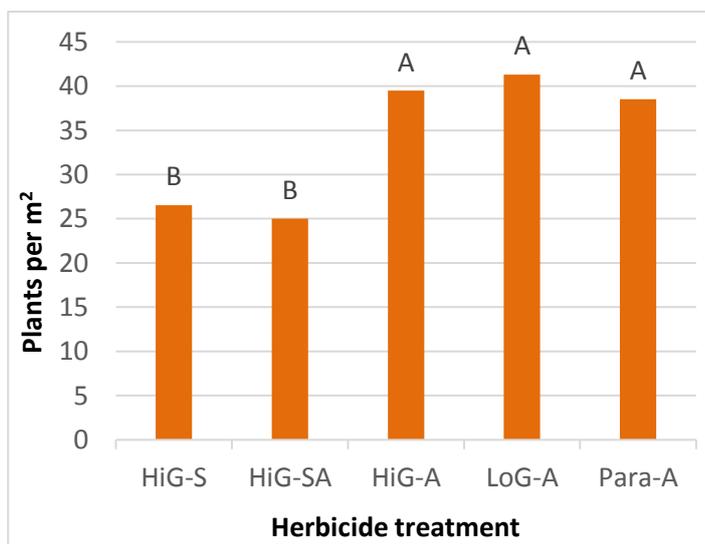


Figure 16: Herbicide treatment affected sown sub clover establishment at Glenside Farm (Fisher's Protected LSD (5%).

Spring herbicide improved resident sub clover establishment

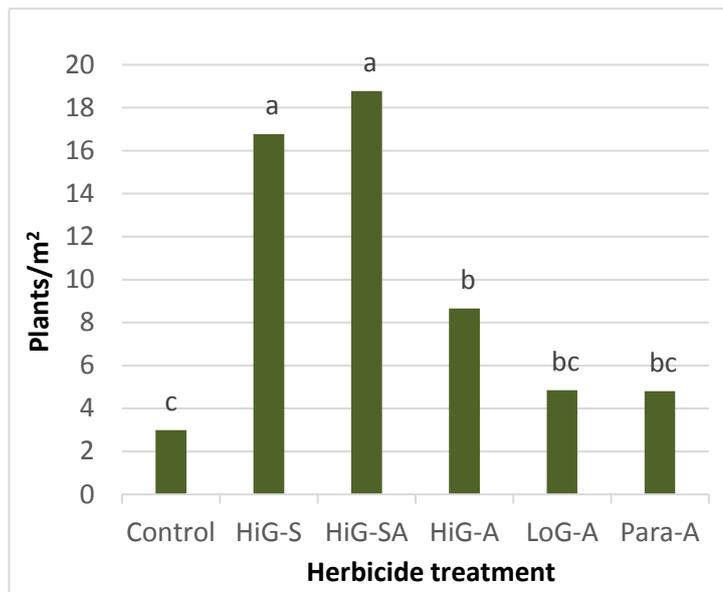


Figure 17: Herbicide treatment affected resident sub clover establishment at Glenside Farm (Fisher's Protected LSD (5%).

In the control there were three established resident sub clover plants/m² (Figure 17). The numbers were highest, at 17 to 19 plants/m², in plots with the spring application of glyphosate at a high rate (HiG-S and HiG-SA).

Resident sub clover establishment happened earlier than that for the sown cultivars (Figure 18). The autumn herbicide application was too late to aid resident sub clover establishment so the effects of the autumn herbicides were no different to the controls (except for applying a high rate of glyphosate).



Figure 18: Photos taken on the same day (8/6/16) at the Glenside Farm experiment. A) Resident sub clover established much earlier in the spring herbicide treatment. B) Close-up of germinated sown sub clover at the cotyledon stage (Photos: Annette Litherland).

Conclusions

Sown sub clover: Results highlight the effectiveness of autumn herbicide applications to suppress the competing pasture (grass) and provide the opportunity for sown sub clover to establish. However ongoing pasture competition needs to be managed with grazing. The sowing rate of 20 kg sub clover seed/ha equates to about 300 seeds/m².

When oversowing seed, germination and survival is usually less than 10%. At Glenside sub clover seedling counts above 30 plants/m² which indicates that the oversowing was a success.

Resident sub clover: There are already viable resident sub clover populations on Glenside Farm (see Figure 19 for examples) and in the dryland hills of the Wairarapa but 'traditional' grazing practices have resulted in the residents becoming small leaved and prostrate to survive. At Glenside the spring application of herbicide promoted resident sub clover populations by eliminating the pasture competition. However it also resulted in a significant weed issue that required further action.

The challenge is to develop a grazing management regime that will improve the proportion of the resident sub clover in existing pastures, particularly on the drier north-facing slopes, or allow the establishment of oversown cultivars proven to be productive in the Wairarapa.

Recommendations

That a case study be undertaken to extend this research to suitable production areas on Glenside Farm and investigate the feasibility of:

- A) using grazing management (e.g. spelling paddocks during flowering and seed set) to promote the reestablishment and of resident sub clover and improve population numbers.
- B) identify ways of introducing persistent and productive sub clover cultivars that will improve the legume content of pasture on an ongoing basis.



Figure 19: Two types of resident sub clover plants taken from Glenside Farm are being grown at Lincoln University for identification purposes (Photos: Sonya Olykan).

Poukawa Research Station – Hawkes Bay

Effects of sowing dates (temperature and photoperiod) on sub clover cultivars

Carmen Teixeira, Derrick Moot

Sub4Spring team – a collaboration between Lincoln University and On-Farm Research at Poukawa

Background

Subterranean clover (sub clover)

- Autumn / winter legume to complement other legumes.
- High quality feed early in spring and self-reseeding legumes with high N contribution.

Early plant growth/development and flowering time are important aspects for cultivar choice (fit for the environment) and management (grazing strategies and re seeding).

Problem/opportunity: new improved sub clover cultivars are available on the New Zealand (NZ) market. All selected for Australia production systems. Cultivars differ immensely in terms of maturity, plant form and yield potential. What can we expect of these cultivars growing in temperate NZ?

The experiment

Six cultivars (early, medium, late; based on Australian data) were selected: ‘Narrikup’, ‘Monti’, ‘Woogenellup’ (considered resident), ‘Antas’, ‘Denmark’ and ‘Leura’. The same experiment is at Field Research Centre, Lincoln University, Canterbury (see Table 3).



Sowing date code	Date
S1	19 February 2016
S2	30 March 2016
S3	30 May 2016
S4	05 July 2016
S5	24 August 2016
S6	11 October 2016
S7	scheduled November 2016
S8	December 2016

Figure 20: Overview and Sowing dates (S) used to quantify phenological development of six subterranean clover cultivars of the sub clover cultivar experiment at Poukawa Research Station Hawkes Bay, New Zealand. Pure stands were irrigated and not grazed until flowering. Targeted plant population: 2200 plants/ m².

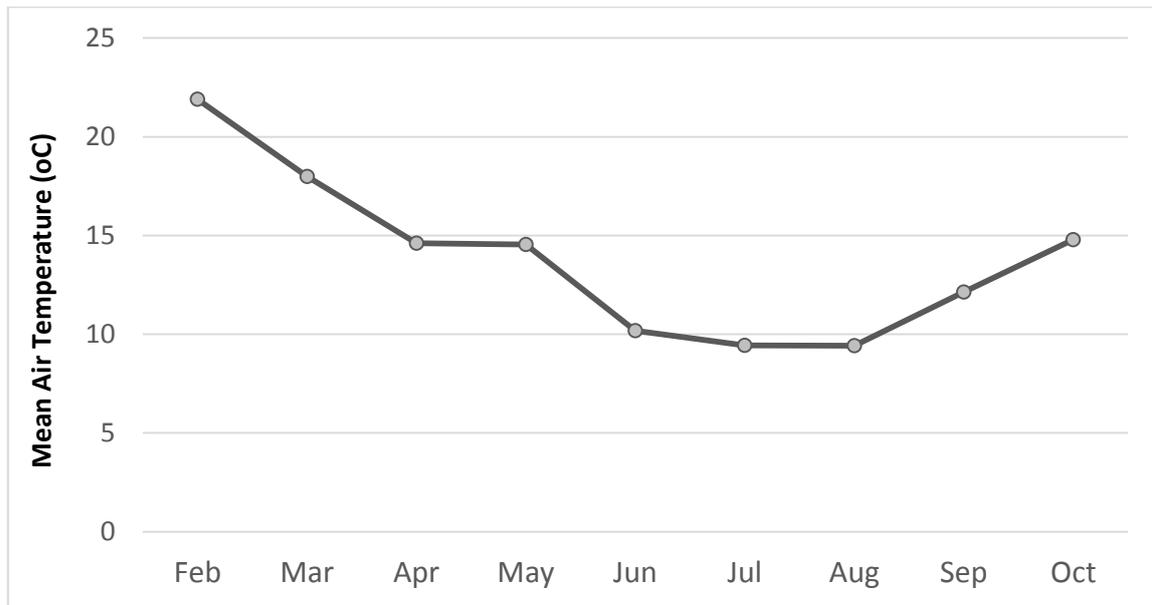


Figure 21: Mean air temperature (°C) from February 2016 to October 2016, Hastings weather station, Hawkes Bay, NIWA, 2016.

Preliminary results

A. Sowing dates and plant development

- from sowing to 5 trifoliate stage

It took about a week for seedlings to emerge when sown in March (Table 1). Emergence was delayed (~ 2 weeks) with the low late autumn and winter temperatures. Overall the subs required 130 degree days (°C/d) for emergence. Emergence was irregular in February (S1) due to uneven irrigation and weed competition (*) and therefore not used for establishment estimations.

Table 1: Average days after sowing (DAS) , mean air temperature (T, °C) and estimated thermal time (TT°Cd) to 50% emergence and to 5 trifoliolate leaf stage for six sub clover cultivars sown in 2016 at Poukawa Research Station, Hawkes Bay.

Code	Date	Emergence			5 Trifoliate stage		
		DAS	T (°C)	TT(°Cd)	DAS	T (°C)	TT(°Cd)
S1	19 February	17	20.0	*	*	*	*
S2	30 March	8	16.0	132	37	9	549
S3	30 May	15	9.5	142	70	6.5	670
S4	05 July	14	9.3	127	58	10	554
S5	24 August	10	12.0	119	NA	NA	NA

*data were not considered for estimation of the thermal time to emergence due to irregular field conditions. NA= data collection ongoing.

Seedlings reached a “safe graze/ spray” stage of 5 trifoliates earlier when sown in March (~ 37 DAS). Late sowings (May/ July) resulted in slow growth and plants needed > 60 DAS to produce 5 trifoliates. So far, the preliminary analysis show an average thermal requirement of 580 °Cd requirement to produce 5 trifoliates (equivalent of an average phyllocron of 77 °Cd/leaf). These values are 30 % higher than previous published data, which suggests a genotype/environment effect. Further data and analysis will reveal more about these “new released” cultivars and strategies to manage them effectively. Details of sub clover development phases are available in the sub clover guide (page 3).

- **from sowing to runners and flowers**

Table 2: Average days after sowing (DAS) , mean air temperature (T, °C) and estimated thermal time (TT°Cd) to reach 50% of runner extension and initial flowering*** for six sub clover cultivars sown in 2016 at Poukawa Research Station, On- farm Research, Hawkes Bay.**

Code	Date	Runner extension **			Flowering ***		
		DAS	T (°C)	TT(°Cd)	DAS	T (°C)	TT(°Cd)
S1	19 February	*	*	*	204	11.6	2600
S2	30 March	80	14.0	1039	162	12.0	1880
S3	30 May	90	11.0	860	NA	NA	NA

** Visible runner with more than 20 mm length. See more about runners and flowers on the sub clover guide (page 7).

*** Flowering is variable among the cultivars: e.g. ‘Monti’ and ‘Narrikup’ being consistently early throughout the observations at Lincoln and Poukawa sites. NA= data collection ongoing.

About the cultivars:

A visual evaluation of the plants at the vegetative phase (45 DAS) is presented in Figure 22. Plots were scored according to a vigour scale (10 equals =excellent = healthy plants, high sub clover coverage, low presence of weeds).

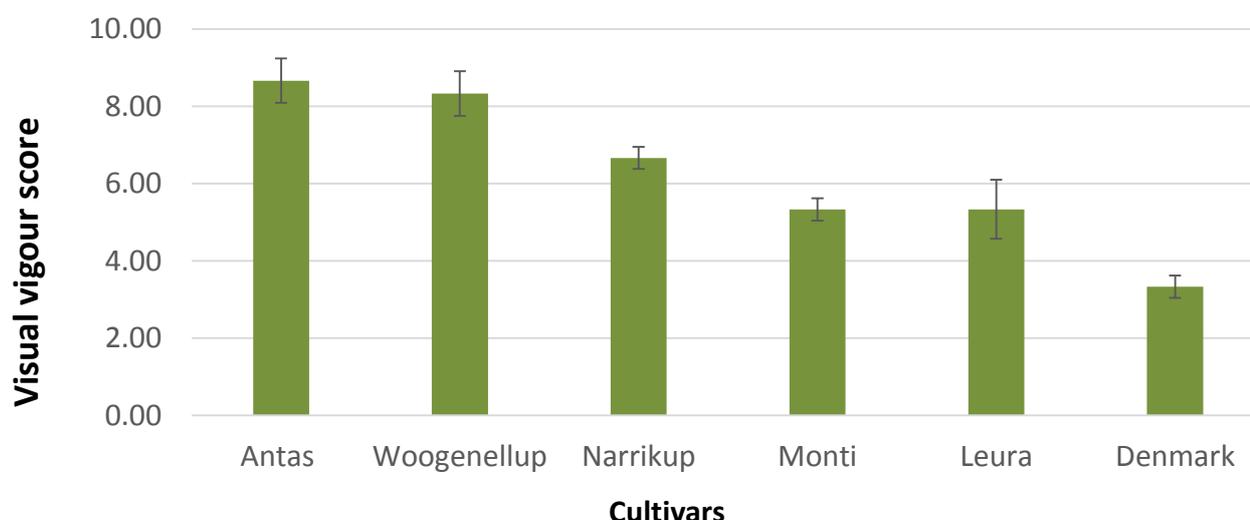


Figure 22: Visual plant vigour scores (10 = excellent; 0= poor) of sub clover cultivars sown on 30 March 2016 and scored 45 DAS, at Poukawa Research Station, Hawkes Bay, New Zealand.

Accumulated Dry matter: from sowing to flowering (preliminary data from Lincoln University experimental site)

Table 3 shows dry matter yields and estimated growth rates taken from selected sowing dates at the Field Research Centre area during 2016 and 2015. The pure stand (~ 2000 plants/m²) small plots were irrigated and cut only once near flowering to evaluate genotype potential and performance of the six sub clover cultivars.

Table 3: Sub clover cultivars, average DM yields (kg /ha) and growth rates recorded at Field Research Centre experimental area, Lincoln University, New Zealand.

Cultivar	Mean kg DM/ha	Estimated growth rates kg DM/day		
		2016 Sown : Mid Feb Cut: Early Sept	2015 Sown: late July Cut : early Dec	2015-2016 Sown: early Nov Cut: Mid Feb
Antas	11089	37	36	204
Narrikup	8120	32	24	156
Monti	8077	34	15	195
Wooгенellup	5373	26	30	85
Leura	4604	18	16	62
Denmark	3370	17	20	38

The plants which grew during November 2015 – February 2016 were near optimum conditions: temperatures ~ 17.5 °C and benefited from exceptional rain in Canterbury during December 2015 and January 2016.

- ‘Antas’ has produced more dry matter (>10000kgDM/ha) in this experiment and our results are consistent with other experimental sites (Ashley Dene, Cave). This sub clover has large seeds, with large leaflets and good early seedling vigour.
- In well managed small plots ‘Monti’ and ‘Narrikup’ produced 8000 kg DM/ha, which represents about 200 kg/ha fixed atmospheric nitrogen.

General practical sub clover tips!

- Consider high sowing rates at establishment (> 10 kg seeds/ ha) to ensure high herbage/ seed yields and ensure future re seeding on your pasture!
- The more biomass produced, the more Nitrogen it is fixed. Rules of thumb (25 kg/ha N per 1t DM).
- Earlier flowering cultivars, e.g. ‘Monti’ and ‘Narrikup’ tend to grow more dry matter early, while late flowering ones (e.g. ‘Leura’ will make most of late rains).

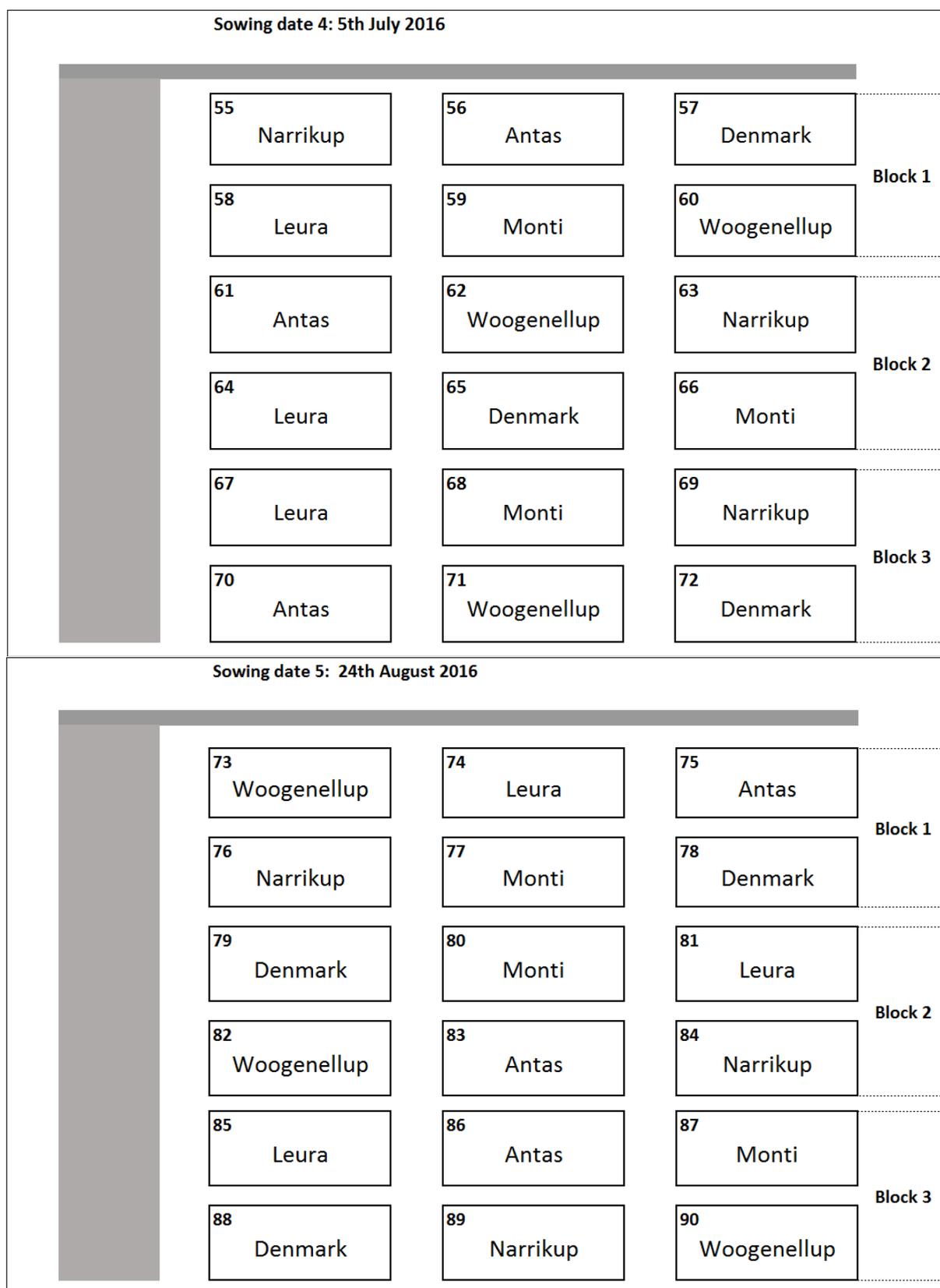


Figure 23: Layout of sub clover cultivar plots for two of the sowing dates - 5/7/16 and 30/8/16.

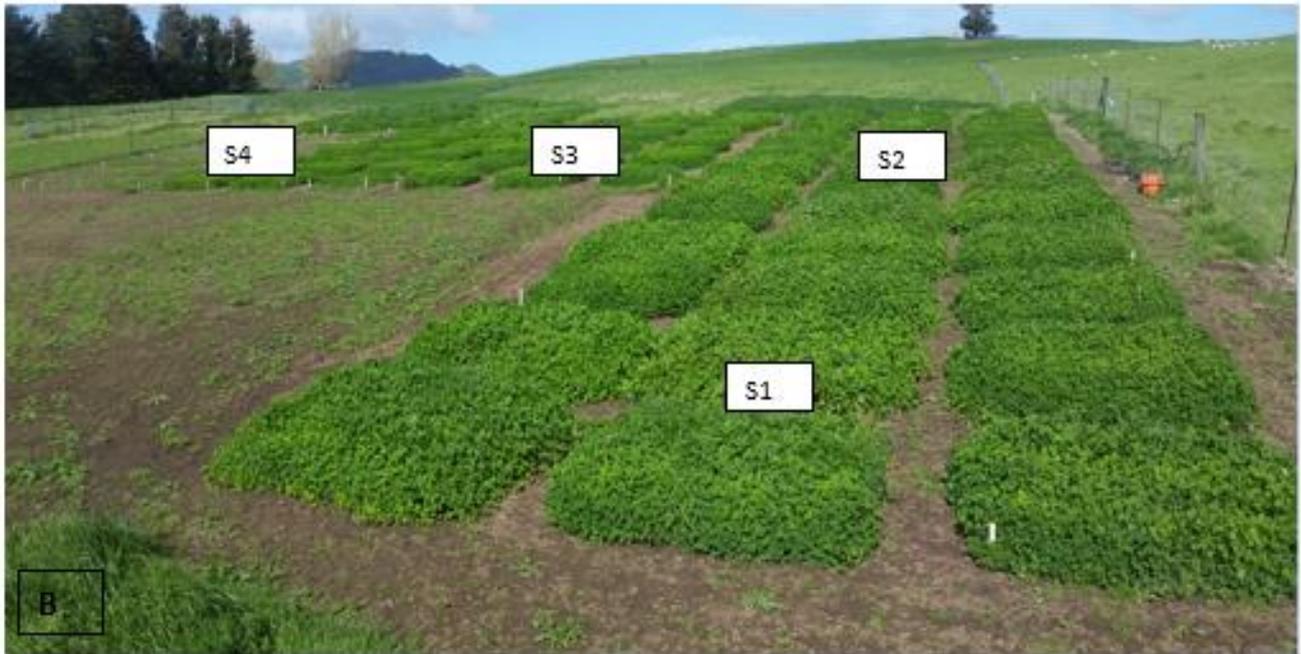


Figure 24: Photos of the Poukawa sub clover experiment. A = overview of the experimental area, B = close up of the sub clover experiment from sowing date 1 (S1) to sowing date 4 (S4) (Photos: Noel Smith).

Ashley Dene Dryland Pastoral Experiments

- Farm purchased in 1909.
- Consists of Home Block = 47.9 ha,
Cemetery Block = 103.9 ha
Main Block = 204.9 ha – now dairy
- Soils on Home and Cemetery Blocks: Lowcliffe moderately deep, Lowcliffe stony, Ashley Dene deep and Lismore stony soils.

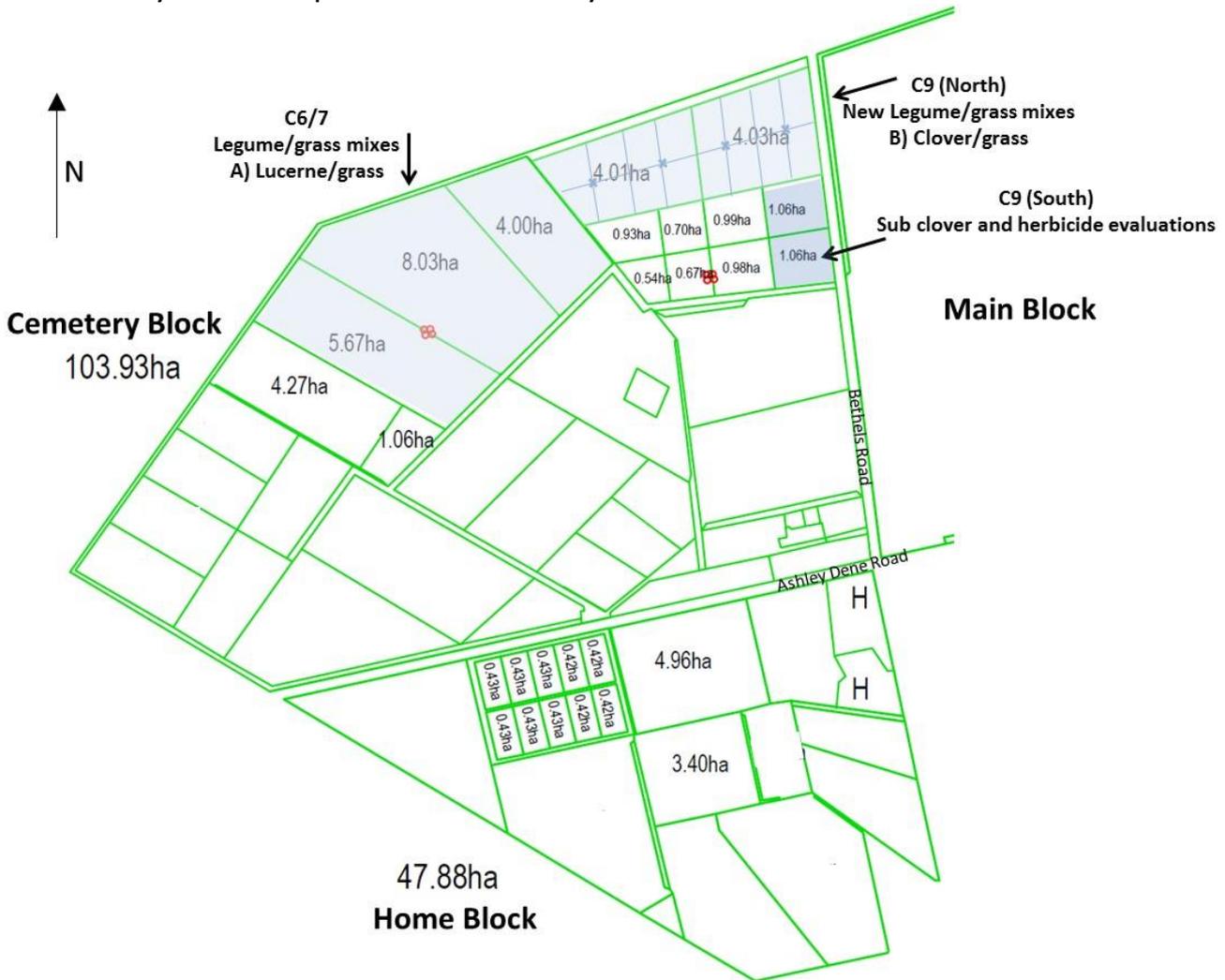


Figure 25 Map of Home and Cemetery Blocks at Ashley Dene Farm, Canterbury. Shaded areas are active experiments monitored for P21.

Pastoral 21

“This work was undertaken as part of Phase II of the Pastoral 21 Programme, funded by the Ministry for Business, Innovation & Employment; DairyNZ; Beef + Lamb NZ; and Fonterra, and Ministry for Primary Industries, Sustainable Farming Fund.”



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Previous Research Results

MaxClover (2002 – 2012)

Pasture composition:

- Lucerne monocultures remained >90% pure due to the winter weed control program.
- In the cocksfoot pastures the originally sown grass and companion clover species disappeared from the pasture at about 3% per year (Figure 26).
- Ryegrass and white clover were lost at a rate of 10% per year in these dryland grazed pastures (Figure 27), probably due to grass grub.

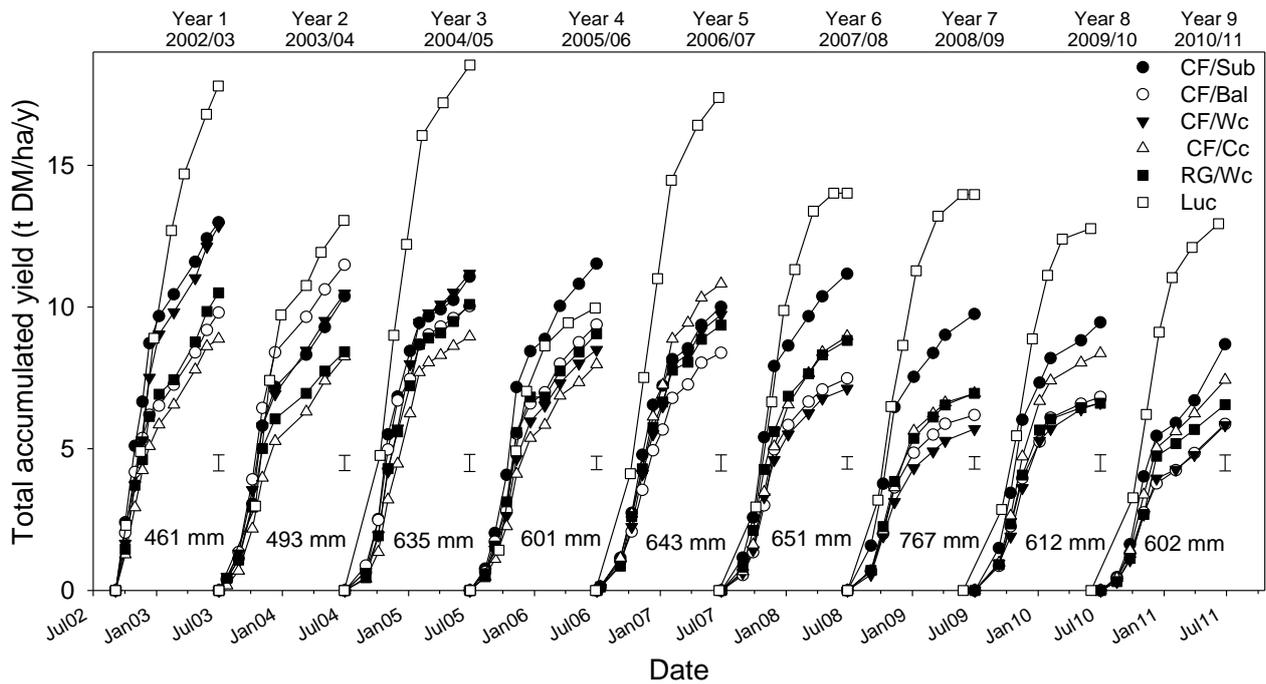


Figure 26 Total annual accumulated DM yields of six dryland grazed pastures at the 'MaxClover' grazing experiment at Lincoln University over nine years.

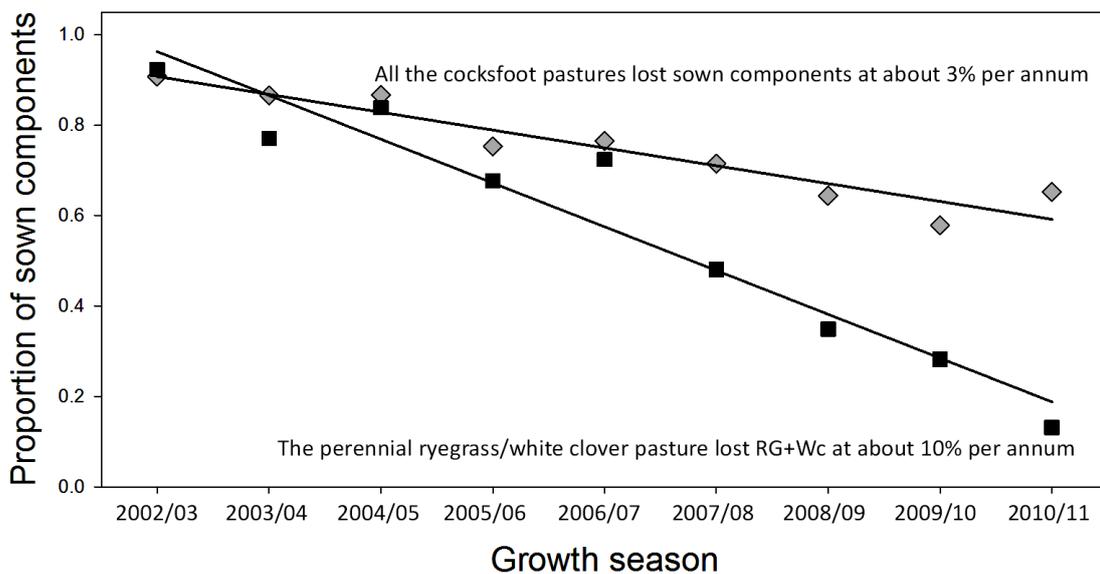


Figure 27 Rate of loss of the originally sown pasture components (grass+companion clover) from the five grass based dryland pastures at the 'MaxClover' grazing experiment at Lincoln University.

Yield of four grasses under summer dry conditions

Shirin Sharifiamina
Email: Shirin.sharifi@lincolnuni.ac.nz

Supervisor: Prof. Derrick Moot

The Problem: Perennial ryegrass persistence is limited under dryland conditions.

Comparative studies of the effects of nitrogen and severe drought on the production of cocksfoot, tall fescue, brome and perennial ryegrass under summer dry conditions are limited.

Treatments:

Species	Cultivar	Sowing rate (Kg/ha)	Nitrogen	Sowing date
Per. Rg	<i>Stellar AR1</i>	20	Full and 0 N	10/10/2014
Cocksfoot	<i>(SFR36-009)</i>	10		
Tall fescue	<i>Finesse Q</i>	25		
Brome	<i>Bareno</i>	35		

Two soil types:

Ladbrooks (Peaty Orthic Gley soil) and **Ashley dene** (Lismore Stony silt loam soil) with high and low water holding capacity.

Measurements:

- Seedling germination, shoot and root biomass
- Botanical composition
- Dry matter production (DM)
- Soil water extraction
- Light interception
- Canopy temperature

Main results

Establishment year (2014/15):

- Oct 2014- June 2015, no significant difference in DM at Ashley Dene (1.7-2.7 t/DM/ha) or Ladbrooks (6.8-8 t/DM/ha).

Second year (2015/16):

- At Ladbrooks, DM production of all grass species in +N (~20 t DM/ha/yr) was approximately double –N (~10 t DM/ha).
- N applied at Ashley Dene, did not increase DM yield of tall fescue, brome and perennial ryegrass.
- For cocksfoot +N yield was ~2.5 t DM/ha greater than perennial ryegrass, brome and tall fescue under severe drought conditions.

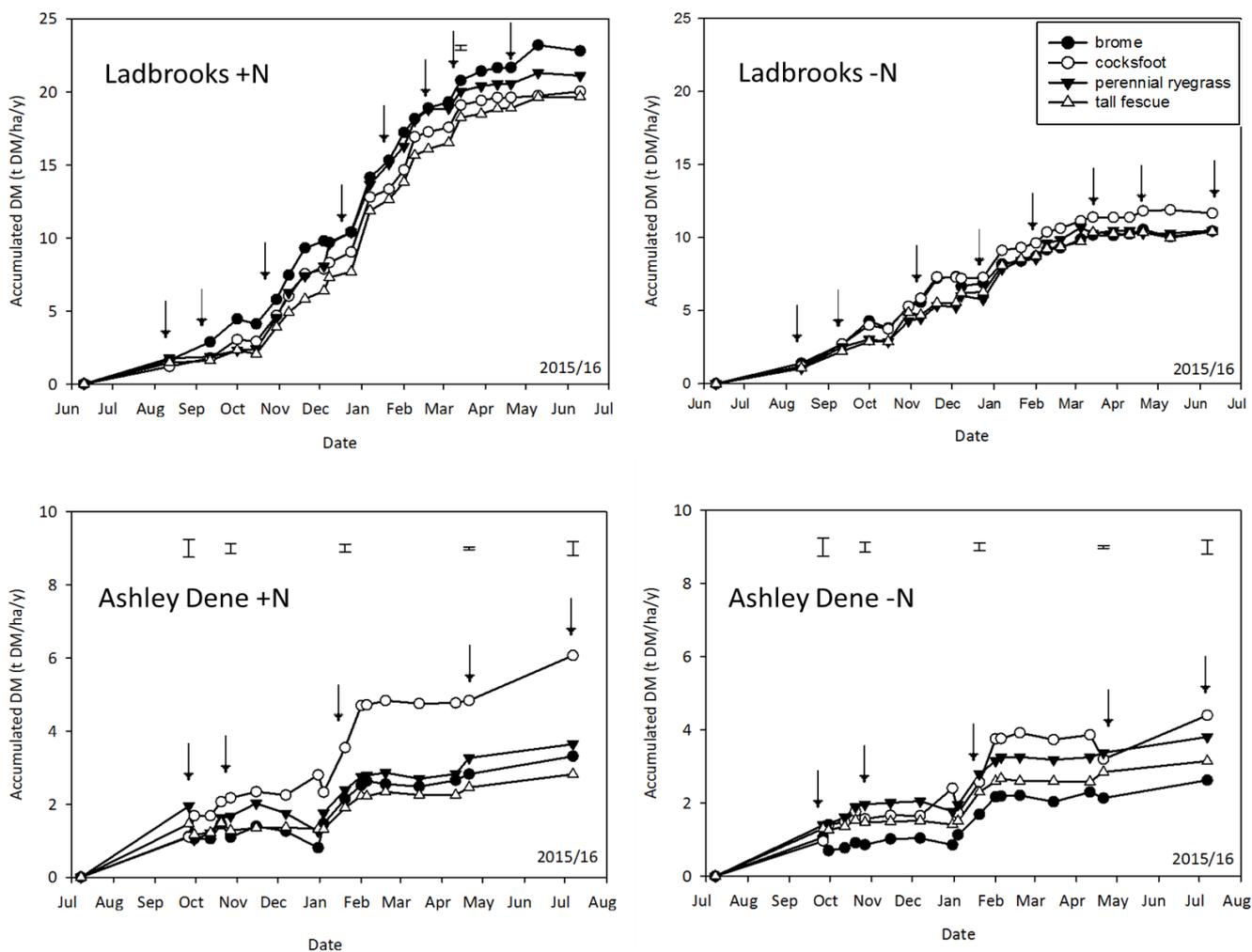


Figure 28: Accumulated DM production of brome, cocksfoot, perennial ryegrass and tall fescue over time, in 2014-16 at Ladbrooks and Ashley Dene, Canterbury, New Zealand. Treatments are +N and –N. The error bar is the highest SEM when species treatments were different ($p \leq 0.05$) on DM production. The arrows indicate a destructive harvest.

Note: nitrogen application in +N treatments occurred after the destructive harvest.

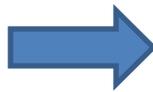
The Solution:

- All species were suitable and have produced the same amount of DM when soil moisture was available on a deep peaty soil at Ladbrooks.
- Under severe moisture stress cocksfoot was the most productive and responded quickest to summer rainfall when it had N available.
- Pasture persistence remains to be quantified over the next two years.

Ovulation rates of ewes following removal from oestrogenic lucerne for different durations

PhD candidate Rachel Fields - Prof Derrick Moot, Ass. Prof Graham Barrell

- Lucerne can contain an oestrogenic compound called coumestrol.
- Coumestrol is produced in response to fungal pathogens. We have found no response to development stage or water stress.
- Coumestrol can lower the fecundity of ewes if they eat lucerne containing high levels during the mating period.
- This results in fewer multiple births and more singles, decreasing lambing rates.

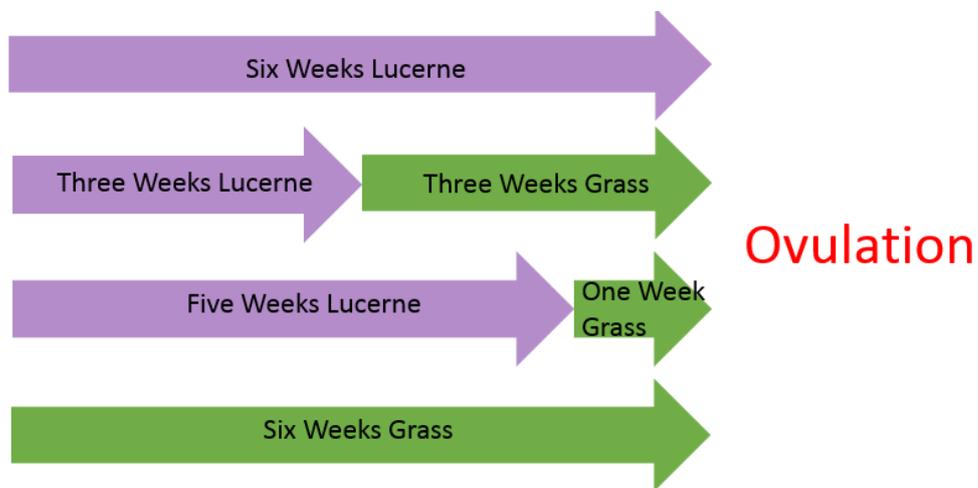


Problem

Suppression of fecundity is temporary and can be mitigated by removing the animals from lucerne. How long before mating should they be removed?

Methods

- **2-tooth Ewes (~18 months)**
- **15 ewes per treatment**
- **Four grazing treatments**
- **Blocked by live weight**
- **Break-fed with back fence**



Measuring Ovulation Rate

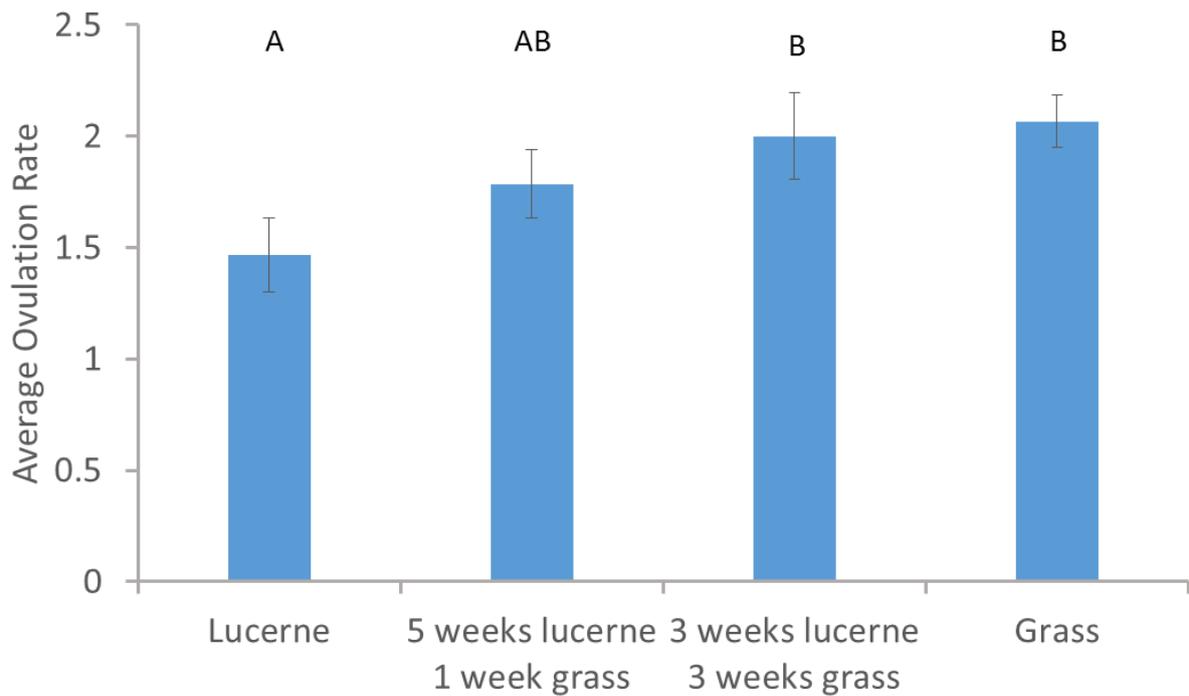
Ovulation occurs while the ewes are in oestrus (heat). During the autumn, on average ewes will ovulate every 17 days. To measure the ovulation rate the ewes must be synchronised.

- Controlled internal drug release (CIDR) devices were used for 12 days.
- Ovulation occurred 24-48 hours after CIDR removal.
- For each egg that is released from the ovary a corpus luteum develops.
- Corpus lutea were counted by laparoscopy (key hole surgery) a week after ovulation.

Ovulation Rate Results

No effect of grazing treatment on live weight:

- 5.3 kg gain over six weeks.
- Average weight of 66.3 ± 0.97 kg at ovulation



*Means that do not share a letter are significantly different (Fisher's LSD).

Removal of ewes from lucerne three weeks prior to ovulation (oestrus) prevented suppressed ovulation rate.

Solution: Applying to farm systems

Ewes can be synchronised with teaser rams so that they ovulate at a similar time, and thus the time on lucerne can be maximised.

- Teaser rams cause ovulation and a silent heat within three or four days. This is followed by a cycle every 17 days through the breeding season until pregnancy.
- Remove ewes from lucerne, put with teaser rams for two weeks, and then swap for entire rams.
- This will give ewes approximately three weeks off lucerne before ovulation.

If teasers are not used:

Remove ewes from the lucerne two weeks before the rams are introduced. This will give over half of the ewes at least three weeks off lucerne before they ovulate.

Disclaimer- *Despite these results, if there is no good alternative to lucerne it is better for the animals to be gaining/maintaining weight on lucerne than losing weight on low quality, dead pasture.*

There is a strong, well-documented, relationship between live weight and ovulation rate.

Cemetery Block – MaxAnnuals

Dr Alistair Black Mr Dick Lucas Prof Derrick Moot

The Problem: Shortage of feed available in early spring for set-stocking and before lucerne is ready to be grazed.

Clover/grass mixes (Year 1)

C9A(N) + C9B(N)

- Established in paddocks C9A(N) and C9B(N) (total area 8.04 ha)
- Four pastures, replicated four times, were established in an RCB between 26 Mar and 16 Apr 2013. Two replicates were sown on each date.
- Paddocks are ~0.5 ha in size, except Paddocks 1 (0.6 ha) and 9 (0.3 ha).
- Soils are stony and have variable depth to gravels, typical of a floodplain. They are classified as Lismore stony soils over most of the site.
- Grazed by hoggets in spring of 2013 and by ewes with lambs in spring 2014.
- On 10 Oct Reps 2 and 4 were closed. Reps 1 and 3 were closed on 18 Oct 2013.

C9N grazing experiment - Cocksfoot v ryegrass x fescue with sub clover and ± balansa clover

4 reps with Reps 1 & 2 [C9A(N)] with a RG/Sub background and Reps 3 & 4 [C9B(N)] with a brassica and lucerne background

- Pastures 1. CF + Sub (CF/Sub)
 2. CF + Sub + Balansa (CF/SB)
 3. RG/Fescue + Sub (RF/Sub)
 4. RG/Fescue + Sub + Balansa (RG/SB)

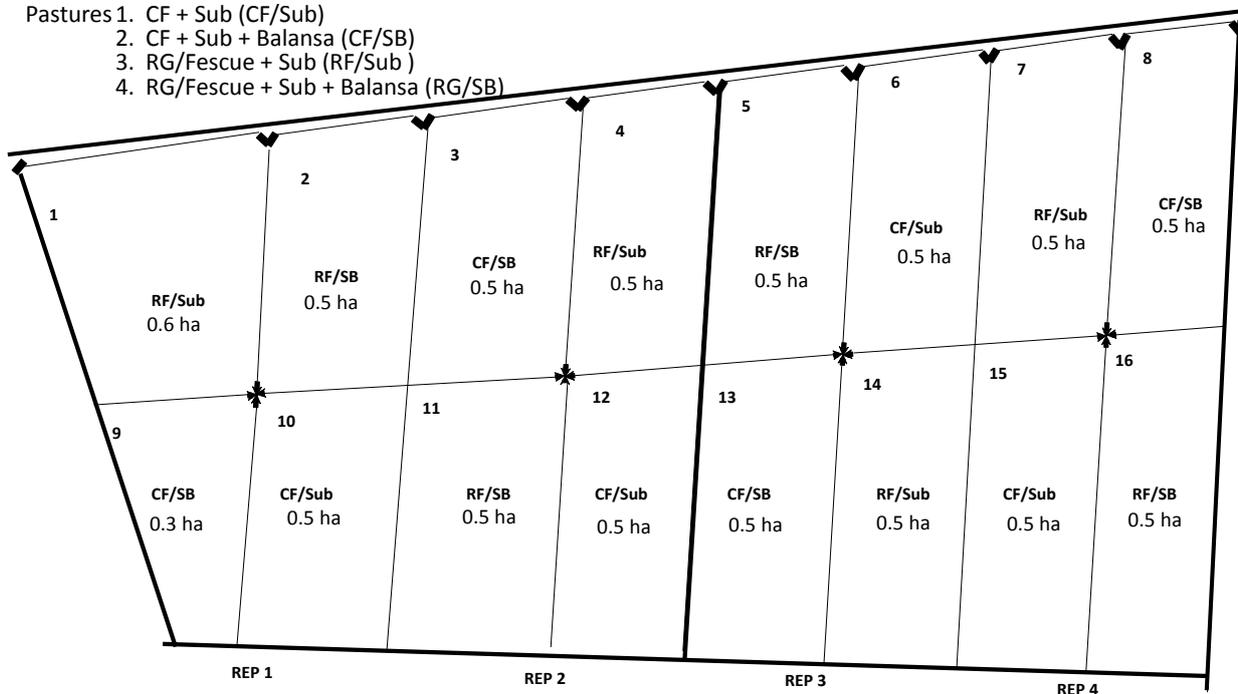


Figure 29: Experimental plan of the MaxAnnuals clover based pastures in C9A&B(N) at Ashley Dene, Canterbury.

Table 4: Sowing rates (kg/ha) of species and cultivars used in the dryland pastures established in C9N(A) and C9N(B) at Ashley Dene, Canterbury in autumn 2013. RGxMF is a perennial ryegrass x meadow fescue hybrid + a novel endophyte and CF is cocksfoot. All pastures were established with basal sub clover, white clover (Wc) and plantain.

Pasture	Sub clover		Wc	Plantain	Balansa	RG x TF	CF
	'Rosabrook'	'Denmark'				hybrid 'Ultra Enhanced'	
CF/Sub	5	5	0.5	0.5	0	0	2
CF/SB	5	5	0.5	0.5	4	0	2
RF*/Sub	5	5	0.5	0.5	0	10	0
RF*/SB	5	5	0.5	0.5	4	10	0

* ~20kg/ha (target) SFR31-033 AR1 perennial ryegrass broadcast on 16 April 2015 due to failure of RF to survive.

The sub clover mixture aims to compare the standard, **late flowering** 'Denmark' with the recently released more erect, **late flowering**, red-legged earth mite tolerant 'Rosabrook'.

Results

The first year was predominantly aimed at generating a seedbank for annual clover re-generation for the next 3-4 years. The first set of LWt production from ewes and lambs grazing in spring occurred in 2014/15 (Yr 2).

2015/16 (Yr 3)

- Grazing for the 2014/15 season was initiated on 20 Aug 2015 for the ryegrass based pastures (spelled over winter as ryegrass had to be oversown in autumn of Yr 2 as originally sown RG had failed to survive drought).
- For the cocksfoot based pastures grazing was initiated on 10 Sept 2015 (21 days later) because there was less feed available. This was a consequence of winter grazing (June/July 2015) to open the canopy for young sub clover seedlings which were being suppressed by vigourous cocksfoot growth.
- Net result was early grazing in ryegrass plots reflected 126 days regrowth (April-August) compared with the cocksfoot where grazing was initiated on 10 Sept on approx. 68 days of regrowth.

2016/17

- Grazing for the initial set stocking period of the spring lactation phase was initiated from 6-13 Sept as stock became available from the commercial flock. Animals assigned to each treatment were mobbed up and began rotationally grazing in late September.

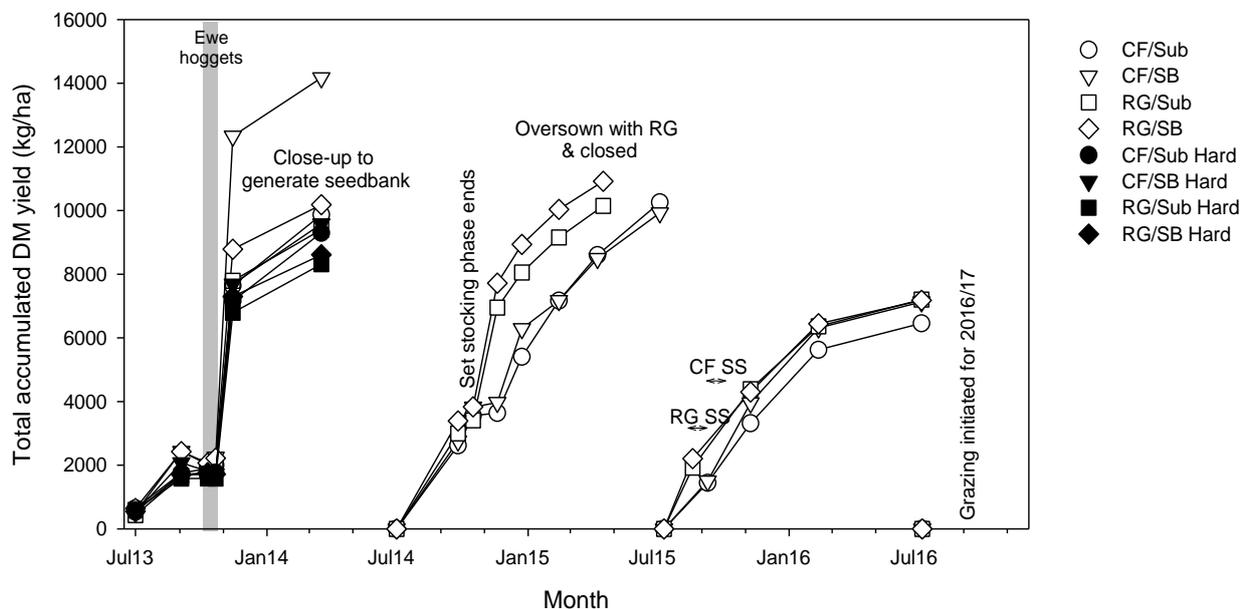


Figure 30: Accumulated DM yield (kg/ha) in 2013/14 (Yr 1), 2014/15 (Yr 2) and 2015/16 (Yr 3) of cocksfoot (CF) or ryegrass/fescue hybrid (RF) pastures established with sub (Sub) or sub and balansa (SB) clovers. White clover and plantain were included in all pasture mixes. For 2014/15 spring data is from cage cuts under set stocking. RF pastures were broadcast with approx. 20 kg/ha of AR1 perennial ryegrass in April 2015 and closed to allow establishment.

Spring 2014/15: Lactation phase summary

Total LWt production during the lactation phase was 545 ± 43.6 kg/ha of which 428 ± 29.9 was from lambs at foot. Stocking rates were similar on all pastures at 11.9 ± 0.3 ewes/ha plus 21.6 ± 1.2 lambs/ha. This resulted in a similar amount of grazing days achieved on all four pastures. Average LWt gains per head were 173 g/hd/day for ewes and 345 g/hd/day for lambs at foot during the 83 day period between 2/9/2014 and weaning on 24/11/2014.

Total stocking rates in all pastures were reduced prior to weaning (22 Oct 2014) as water stress compromised DM production (Figure 31).

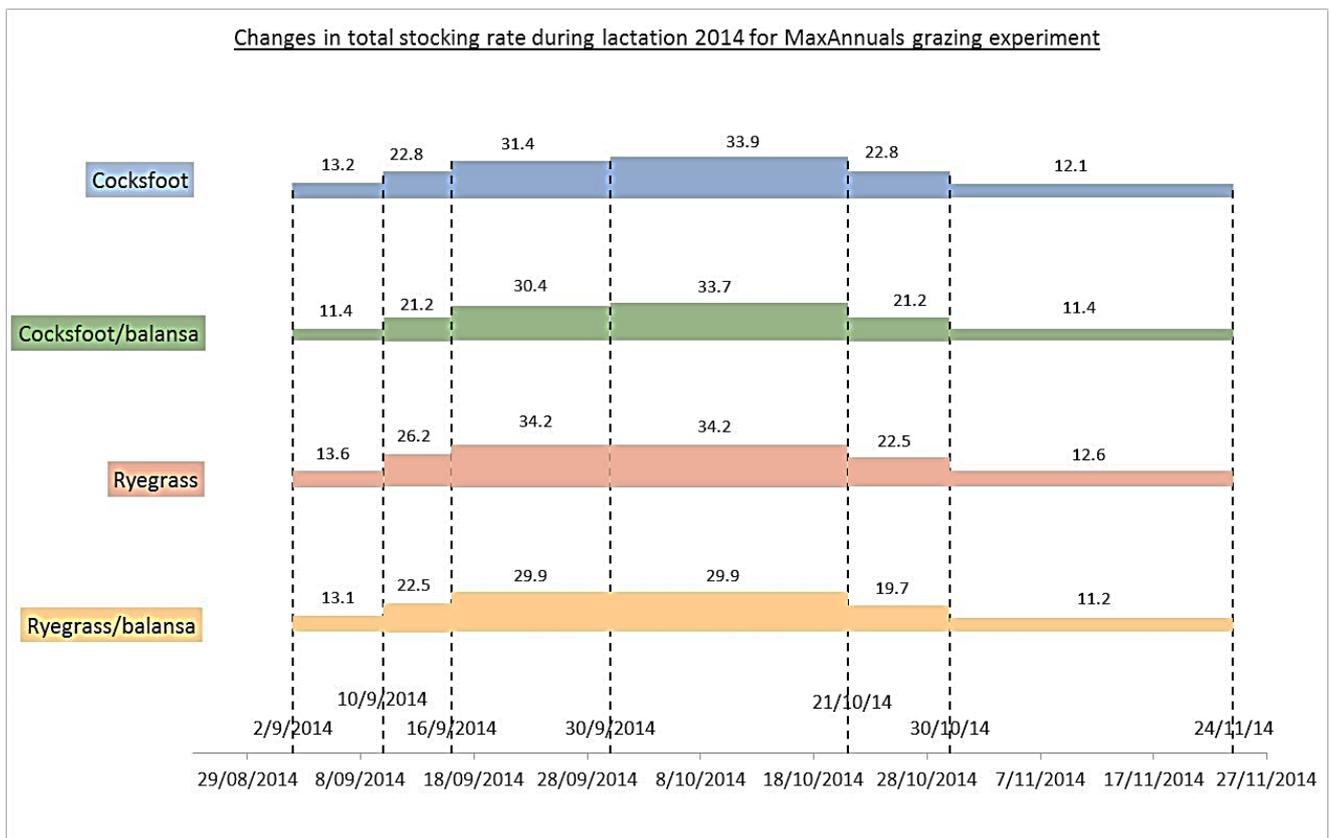


Figure 31: Changes in total stocking rate (ewes plus lambs at foot/ha) during the lactation phase on the grass/clover pastures in 2014/15.

Table 5: Stocking rate, grazing days (GD), mean daily Liveweight (LWt) gain per head, and total LWt produced/ha from ewes with twin lambs at foot set stocked on cocksfoot (CF) or hybrid ryegrass (HRG) pastures established with sub clover with or without balansa clover between 2/9/2014 and weaning on 24/11/2014.

	CF/Sub	CF/Sub/Bal	HRG/Sub	HRG/Sub/Bal
Ewe GD/ha	658	673	690	653
Lamb GD/ha	1202	1277	1299	1200
Ewe LWt gain/hd	121	158	201	212
Lamb LWt gain/hd	340	328	356	354
Ewe LWt/ha	80	109	140	140
Lamb LWt/ha	408	418	464	423
Total Lactation LWt/ha	487	527	603	563

Summer/Autumn 2014/15:

Only maintenance grazing events occurred after weaning (nil LWt gain) until June 2015 when ram hoggets rotationally grazed CF based pastures. An additional 63 kg LWt/ha was produced at this time.

Spring 2015/16: Lactation phase

- Mean daily LWt gain (g/hd/day) from lactating ewes and twin lambs at foot are shown in Table 8. Pastures were then destocked due to a lack of feed.

Table 6: Mean daily LWt gain (g/hd/day) from lactating ewes and twin lambs at foot between 20/8/2015 and 10/11/2015 (82 days)

Pasture	Class	
	Ewe	Lamb
CF/Sub	23	330
CF/SB	30	334
RG/Sub	142	317
RG/SB	115	326

- Weaned lambs were returned to the plots to graze between 6/1/2016 and 7/3/2016. During this time only two mobs grazed rotationally in an 8-paddock rotation. One mob grazed the cocksfoot based pastures (CF/Sub and CF/SB) and a second mob rotationally grazed the ryegrass-based pastures (RG/Sub and RG/SB). This was because there was no annual clover present.
- Weaned lambs gained 199 g/hd/d on cocksfoot-based pastures while those on ryegrass-based pastures grew 247 g/hd/d over the same period.
- There was insufficient feed to support autumn grazing by hoggets due to prolonged water stress conditions but a cleanup graze was performed by ewes from 7/4/2016 to 26/4/2016. This was a maintenance grazing event and LWt was not measured.

Spring 2016/17: Lactation phase

- Replicates 3 and 4 (Bethells Rd end) were stocked at 7 ewes + twin lambs at foot/ha on 6 Sept 2016. Replicates 1 and 2 were stocked at 7.5 ewes + twin lambs at foot per hectare on 13 Sept 2016.
- The delay to the start of grazing was because of late lambing in the commercial flock which limited access to stock rather than a difference in growth of the pastures.

The Solution: Annual clover based pasture systems produced high quality feed that enabled lamb growth rates of 300+ g/hd/d in early spring.

Sub clover is not “Part of the native.” It has to be actively managed.

Mr Dick Lucas and Prof Derrick Moot

The Problem – the sub clover seed bank is empty at Ashley Dene (Figure 32).

We have monitored the seed bank and seedling strike since establishment:

April 2013	10 kg/ha sub clover seed sown.
Nov 2013	Pastures spelled from October created 600 kg seed/ha.
Autumn 2014	Good establishment with March/April rains. 240 kg seed/ha remained dormant in soil.
Spring 2014	Extremely dry spring, ewes with twin lambs selectively grazed sub clover. Lambs weaned early. Little seed produce. Total seed bank 250 kg/ha.
Autumn 2015	Germination April, 100 kg seed/ha remaining in seed bank
Spring 2015	Dry spring, ewes and twin lambs graze clovers close, early weaning. Negligible seed set. Seed bank 110 kg/ha going into summer.
January 2016	Over 100 mm rain 3 January. Big flush of sub clover seedlings but all dead by early March. Seed bank now 40 kg/ha.
March 2016	Second germination after first false strike. All March germinated seedlings dead by early June. Seed bank now 16 kg/ha after second false strike.
June 2016	Third sub clover seed germination, slow growth and development of new seedlings in cold conditions.
September 2016	Only 10 small sub plants/m ² . Seed bank ~5 kg/ha.

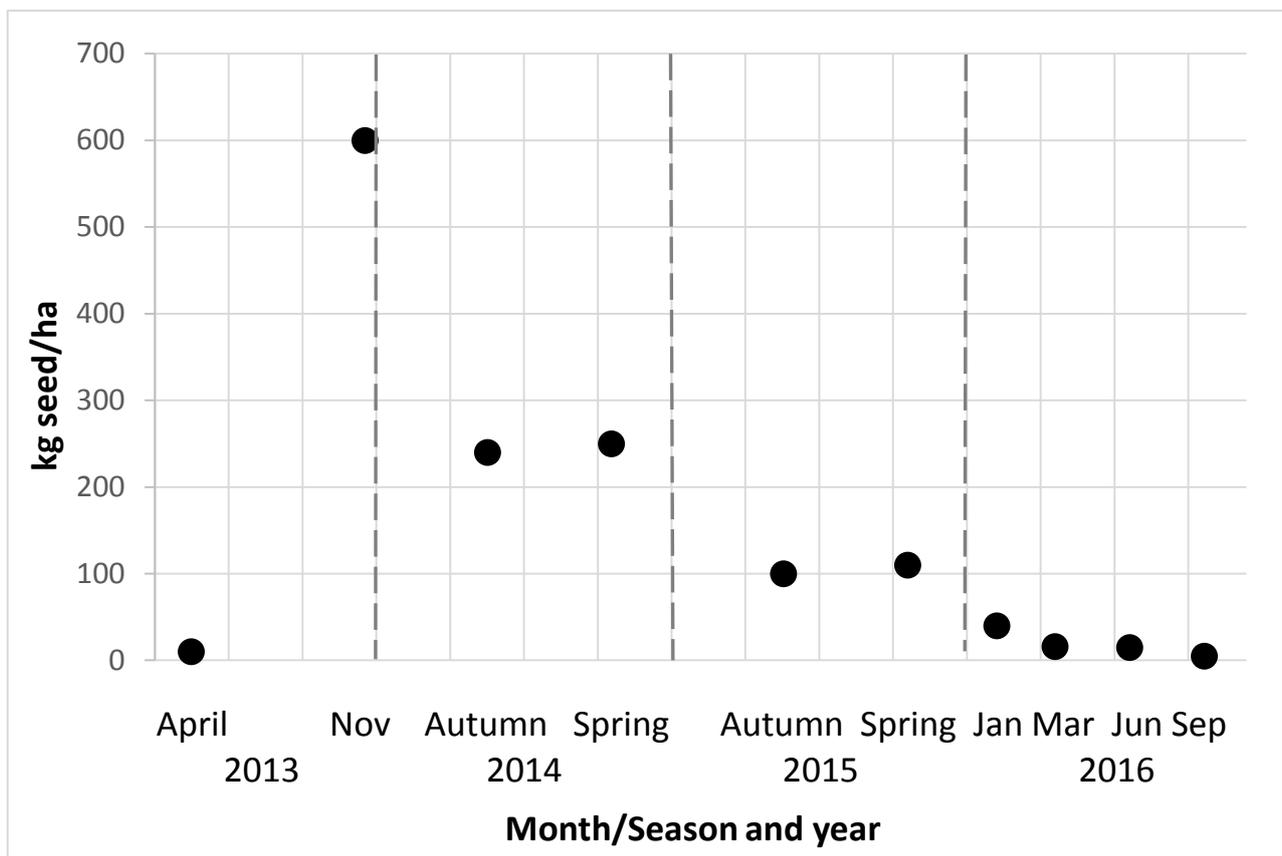


Figure 32: Quantity of subterranean clover seed in the seedbank of the MaxAnnuals pastures over time.

- Low clover in its fourth spring caused by two drier than average years and two false strikes in 2016 summer/autumn.
- Seedbank reduced from 600 kg/ha produced from early closing in the first spring (2013) to ~5 kg dormant/hard seeds in the soil.
- The low (10 sub clover plants/m²) current population is from seeds that germinated in June 2016 after two seasonal false strikes.
- They had a cold start and will struggle to produce seed under the present high grazing pressure.
- The lack of clover in all four pastures will result in lamb live weight gains less than our target of 300+ g/head/day.
- There is insufficient seed to manage the pasture to rebuild the seed bank.
- This very stony silt loam soil has very low soil moisture storage capacity and in a 600 mm rainfall it is equivalent to many sunny faces in hill country.

- The 'Denmark' and 'Rosabrook' sown are late flowering and have not set seed before running out of water in the last two years.
- The clover will have produced at least 200 kg N/ha to be used by the grass making it have a higher water use efficiency and improving grazing preference.

The Solution

- Overdrill 10 kg/ha of seed in pastures in early March 2017.
- Select mid flowering cultivars that start in the second half of September so burrs are physiologically mature by the end of October.
- These cultivars may be more suited to this difficult site.
- These newly sown subs will need lenient grazing in spring 2017 so they can create a new seed bank – it is a new sowing.

Note: On deeper soils on Iversen Field (Lincoln University campus) with greater soil moisture storage but the same rainfall as Ashley Dene the late flowering 'Denmark' sub dominated 'Campeda', a mid-flowering cultivar. But on the same soil as MAXannuals, 'Campeda' dominated 'Leura' (very late flowering). Selection of an appropriate sub for different areas can be guided by our "Sub clover management guide."

Guide for subterranean clover identification and use in New Zealand (First Edition)

Carmen Teixeira, Sonya Olykan, Dick Lucas and Derrick Moot.

Subterranean clover:

- ♣ the best adapted clover for dryland pastures in New Zealand,
- ♣ winter annual clover provides more high quality biomass during late winter and early to mid-spring than the more frequently sown perennial white clover (Figure 33), and
- ♣ particularly advantageous for high demand livestock such as lactating ewes.

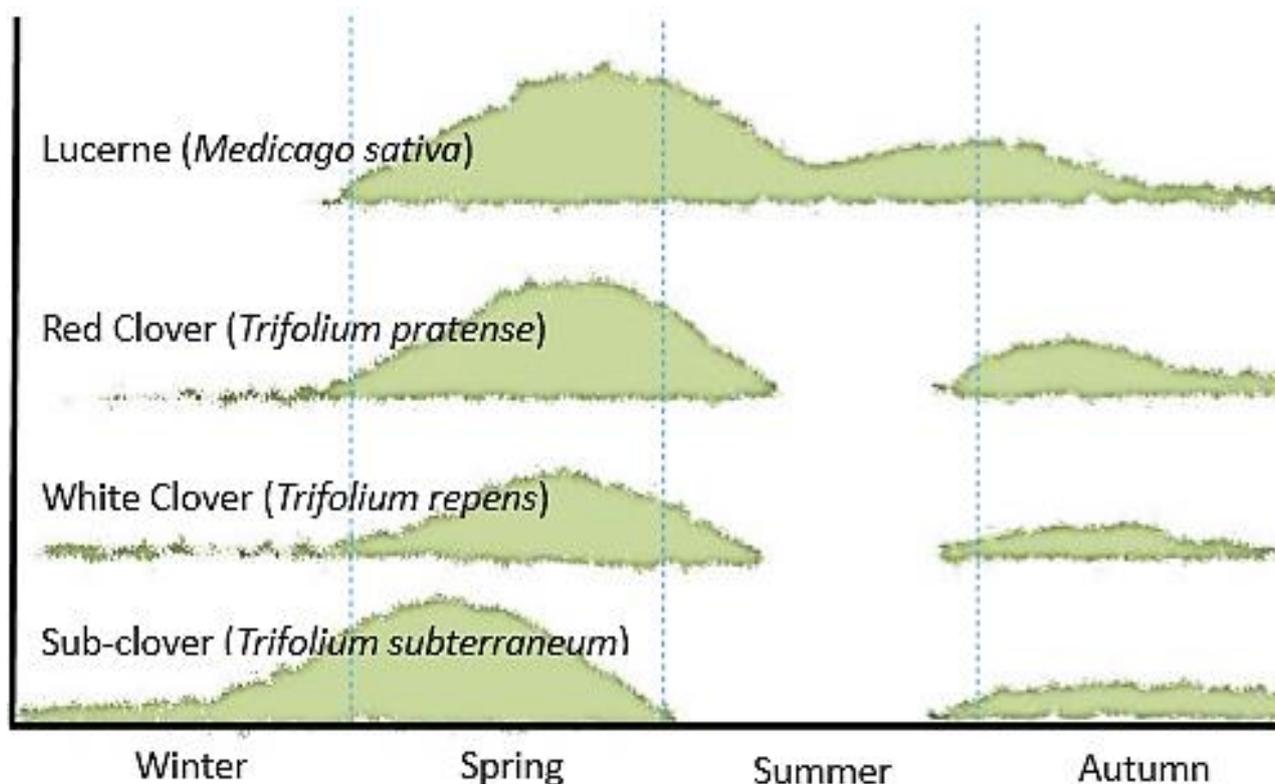


Figure 33: Seasonal biomass production of common pasture legumes under dryland conditions (adapted by Lucas, R. 2016 from Undersander et al. 2002 and Mills et al. 2014)

Features which differ between cultivars are trifoliate leaf markings, hairiness of runners (stems), petioles (leaf stems), and peduncles (flower stems), stipule colour (structure at base of petiole), and flower colour (calyx pigmentation), for example:

Mt Barker

Trifoliate leaf



Stipule



Flower

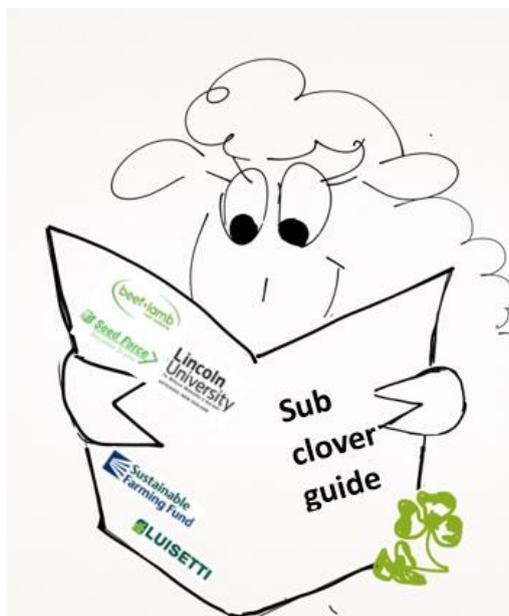


If you would like a copy of the guide:

♣ there are copies available to take away today from the Field Day or

♣ the sub clover guide can be downloaded from:

<http://www.lincoln.ac.nz/Research/Current-Research/Dryland-Pastures-Research/Research-Projects/Sub-4-Spring/>



Herbicide Options for Subterranean Clover

Teresa Lewis; Professor Derrick Moot; Ass. Prof Rainer Hoffmann

Sub clover:

- Annual legume – fixes nitrogen
- Active growth occurs winter – late spring
- Sets seed and dies over summer, avoiding drought stress

Problem: Autumn sowing of sub clover means it is highly susceptible to competition from weeds during establishment each year.

Question: Do we have viable chemical options which can effectively control weeds early in the growing season, and increase the annual yield potential?

- Only one herbicide is recommended for use on sub clover in NZ - Headstart®

This Experiment:

Eight herbicide treatments applied to four commercially available sub clover cultivars, and a white clover control.

Sub clovers: 'Antas', 'Denmark', 'Monti' and 'Narrikup'.

White clover: 'Huia II'

- Drilled 22 March 2016, but emergence delayed by no rainfall!
- Experiment 1 sprayed 14 June 2016, at 1-2 trifoliate leaf stage
- Experiment 2 sprayed 12 July 2016 at 3-4 trifoliate leaf stage

Table 7: Brand name of herbicide, active ingredient, mode of action, and product application rate

Herbicide	Active Ingredient	Mode of Action	Rate / ha
2,4-DB	400 g/L 2,4-DB	Auxin-type action	8 L
Basagran	480 g/L Bentazone	Photosynthesis inhibition	3 L
Headstart	Flumetsulam	ALS inhibition	1.0 L
Jaguar	250 g/L Bromoxynil + 25 g/L Diflufenican	Photosynthesis inhibition	1.0 L
MCPB	385 g/L MCPB	Auxin-type action	7.5 L
Pulsar	200 g/L MCPB + 200 g/L Bentazone	Auxin-type action + Photosynthesis inhibition	6 L
RoundUp	360 g/L Glyphosate	Amino Acid biosynthesis inhibition	1.0 L
Spinneraker	240 g/L Imazethapyr	ALS inhibition	400 ml



Figure 34: Plant growth at application date. Top is Experiment 1, sprayed 14 June 2016; Bottom is Experiment 2, sprayed 12 July 2016.

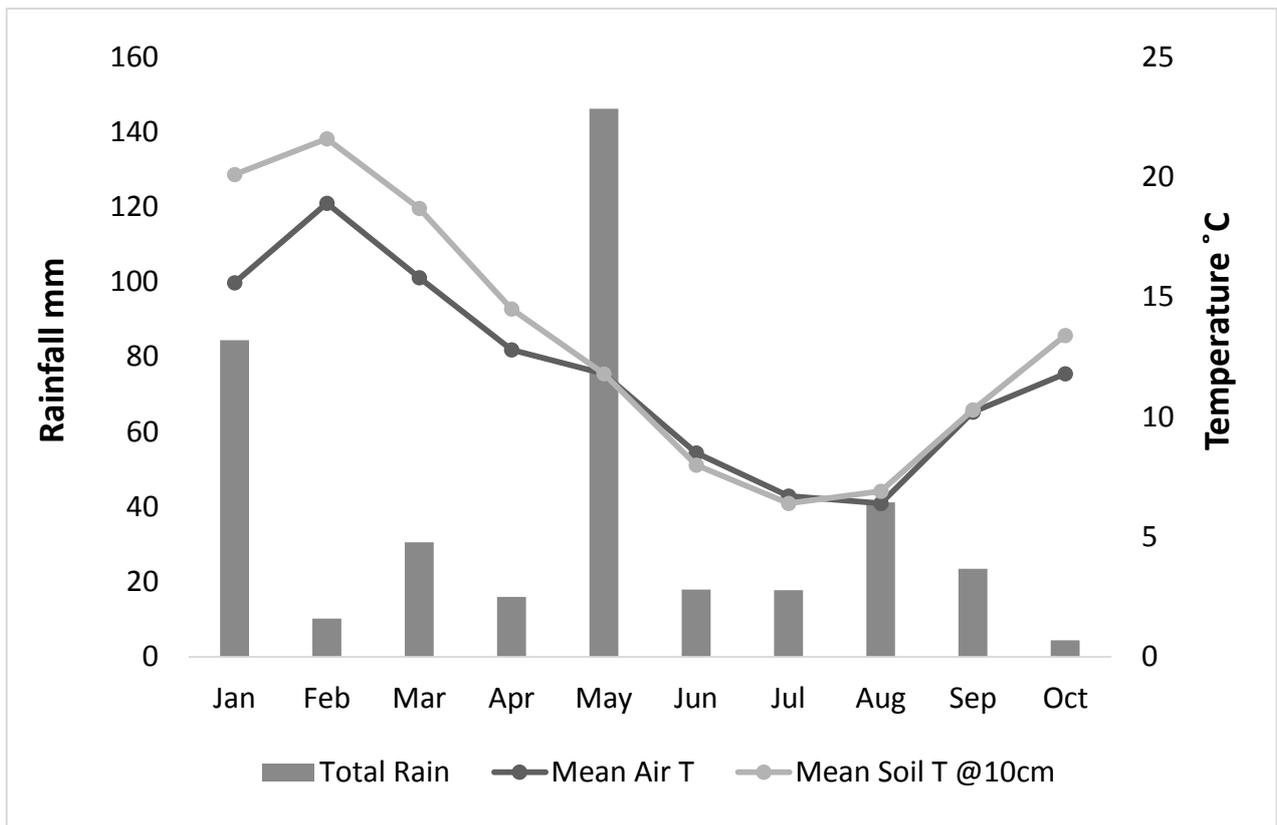


Figure 35: Average weather data for Ashley Dene, Springston from January 2016.

Preliminary results:

Harvest yields from the 1-2 trifoliolate leaf stage spraying

- Herbicides have different effects on cultivars
- ‘Antas’ was highly susceptible in terms of percentage yield decrease, but still had higher yields than ‘Monti’ and ‘Denmark’ in all treatments.
- ‘Narrikup’ was the most tolerant, and maintained high yields.
- ‘Monti’ hasn’t thrived in this dry, well-drained environment, but was tolerant of herbicide.
- ‘Denmark’ was very tolerant, but low yielding. Would be a good companion cultivar.
- EWRS scores can provide a relative estimate of damage, but needs support from harvest yields.
- This spring the sheep preferentially grazed plots with successful weed control, as easier access to clover.

Note yield advantage to Antas and Narrikup over white clover.

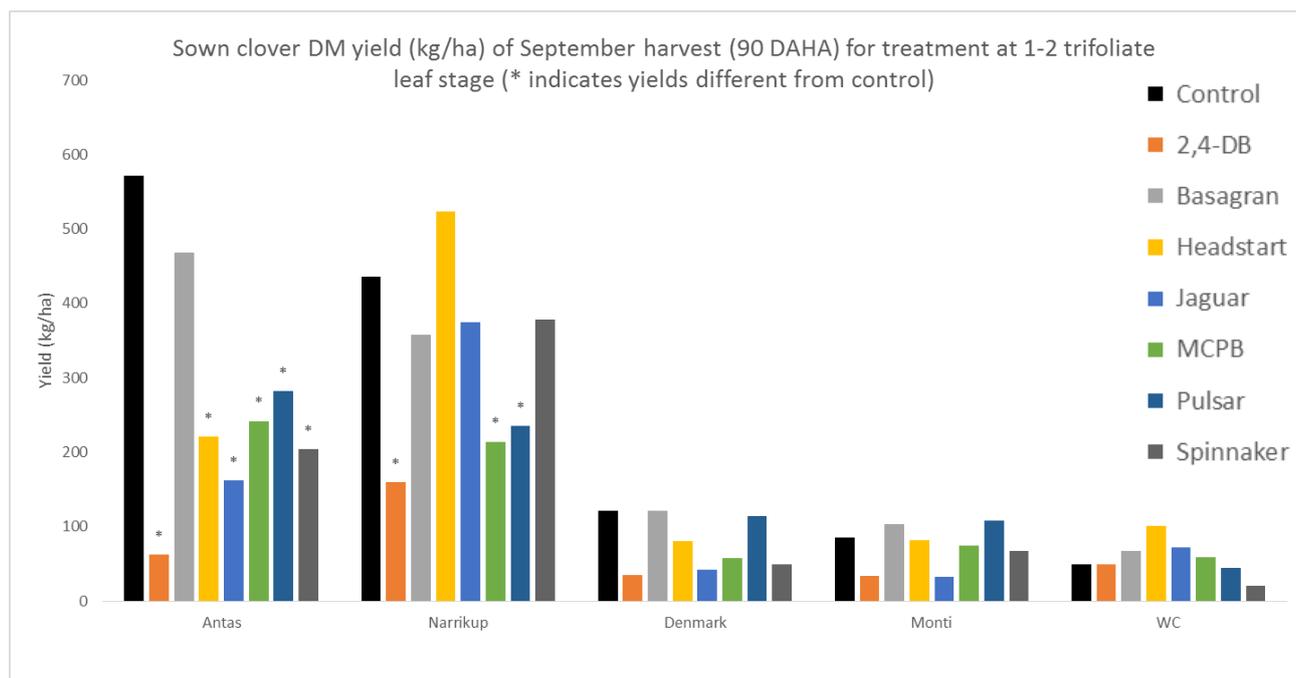


Figure 36: Sub clover DM yields (kg/ha) at 90 DAHA with treatment applied at the 1-2 trifoliolate leaf stage.

Table 8: Sown sub clover yields (kg/ha) from September harvest of 1-2 (90 DAHA, harvested 16/09/16) and 4+ (60 DAHA, harvested 20/09/16) leaf stage treatment applications. (*indicates different from control P<0.001)

Leaf stage	Antas		Denmark		Monti		Narrikup		WC	
	1-2	4+	1-2	4+	1-2	4+	1-2	4+	1-2	4+
Control	570	330	120	160	85	105	435	700	50	15
2,4-DB	60*	200	35	25	30	10	160*	120*	50	15
Basagran	470	330	120	205	105	120	360	575	70	10
Headstart	220*	210	80	50	80	65	525	290*	100	20
Jaguar	160*	70*	40	50	35	50	375	190*	75	15
MCPB	240*	130*	60	40	75	35	215	280*	60	20
Pulsar	280*	170*	115	55	110	35	235*	345*	45	25
RoundUp	0*	0*	0	0	0	0	0	0*	0	0
Spinnaker	205*	170*	50	45	70	50	380	400*	20	45

Solution:

- Basagran® and Headstart® have provided effective weed control with minimal impact on sub clover.
- Time of application hasn't affected clover DM yields relative to controls for Basagran®, Headstart® and Spinnaker® treatments.
- Successful weed control lead to heavier grazing of treated plots.

Student projects on Pastoral 21/SFF

Natalie Stocker	BAGSci (Hons)	completed 2011
Alice Speedy	BAGSci (Hons)	completed 2012
Sarah Bennett	BAGSci (Hons)	completed 2012
Mart-Marie Roux	BAGSci (Hons)	completed 2012
Emma Coutts	BAGSci (Hons)	completed 2013
Richard Sim	PhD	completed 2014
Lisa Box	BAGSci (Hons)	completed 2014
Russell Croy	MAGSci	In progress
Teresa Lewis	MSc	In Progress
Carmen Teixeira	PhD	In Progress

Websites + Social Media

Dryland Pastures website: www.lincoln.ac.nz/dryland

Dryland Pastures blog: <https://blogs.lincoln.ac.nz/dryland/>

Facebook: **@DrylandPasturesResearch**

Mr Roland Stead kindly provided financial assistance to the Lincoln University Dryland Pastures Research Team for the completion of several post graduate programmes that contributed data to this publication.



Ministry for Primary Industries
Manatū Ahu Matua

