## Northland's diversified forages

Annual and perennial clover results from plot-scale trials 2016-2020

## Project overview

**Objective:** 'Identify and use pasture species that give advantages in absolute yield and/or timing of growth, plus feed quality.'

A **diversified pasture** is "fit for purpose" for a specific environment / farm system. Using a range of pasture species adds *resilience* to pasture systems – diversity of species reduces risk and increases yield.

## Introduction

Various legumes were evaluated in plot trials 2016-2020 to assess field germination, growth patterns, total growth, flowering dates, feed quality and any insect and/or soil-borne pathogen problems.

- The annual legumes investigated were arrowleaf clover, crimson clover, balansa clover, berseem clover, subterranean clover, Faba bean, Persian clover, sweet white clover, burr medic, yellow serradella.
- The perennial legumes investigated were AberLasting clover, white clover, Lotus corniculatus, Lotus pedunculatus, lucerne, red clover, strawberry clover.

The biennial legumes sulla and alsike clover were also investigated.



### Summary

- Clovers have seasonal growth profiles. Annual clover growth is maximal October-November, coincident with the time of consistent rainfall. White clover or red clover growth is maximal during the summer period, but growth can be severely compromised since rainfall is less reliable.
- Under good growing conditions, addition of red clover can provide a strong surge of high-quality (protein) feed.

#### For red clover:

- (1) consistent rainfall is required to achieve most, or all, of the potential for very high growth January–March
- (2) daily growth rates of above 100 kg DM/ha/day for a 2-month period occurred at NARF (Northland Agricultural Research Farm) under very good growth conditions.
- The most consistently successful annual clovers in terms of growth are Persian clover, berseem clover, and to a less extent balansa clover.
- Feed quality analysis indicates that Persian clover and berseem clover produce highquality feed, especially in terms of protein levels.
- When sowing clover seed, the presence of trash (dead pasture) negatively affects subsequent germination. A major problem for white clover, it is a huge problem for annual clovers.
- Another major problem for annual clovers in the establishment phase (from germination in May to September) is the presence of soil-borne pathogens. In the worst cases, the presence of soil-borne pathogens can kill 80-90% of annual clover seedlings.





# Results

### Seed quality - Germination results

There were issues 2016-17 with very low germination in subterranean clover (cv. Woogenellup), sweet white clover and crimson clover (cv. AU Sunrise) seed lines. Other seed lines had lower-than-ideal ("medium") germination levels - these germination seed lines were subterranean clover (cv. Coolamon), uncertified berseem, and *Lotus corniculatus* (cv. Goldie).

#### cv. refers to cultivar.

Seed lines with acceptable germination (i.e. > 95%, including hard seed, germination) were Persian clover (cv. Lusa), AberLasting clover (hybrid), white clover (cv. Kakariki) and white clover (cv. Mainstay), strawberry clover, *Lotus pedunculatus* (cv. Trojan).

Hard seed is seed that subsequently germinates after the seed germination lab tests were completed.

Sweet white clover and crimson clover seeds had the lowest germination - they were probably very old seed, even though they had been stored under very good conditions.

#### Legume seed germination results Bio-Protection Research Centre, Lincoln University

Seed used April and May 2016; seed viability determined June 2016.

Efficacy of seeds suggests farmers need to know germination levels before sowing – either relying on recent industry germination results or undertaking their own tests.

Seed line	Lab germination /	Viable / Useful
Annual legumes	Hard seed (%)	seed (%)
Arrowleaf clover (cv. Arrotas)	23 / 71	94
Crimson clover (cv. AU Sunrise), coated	2/0	2
Balansa clover	58 /20	78
Berseem clover, uncertified	58/0	58
Subterranean clover (cv. Coolamon), coated	69 / 1	70
Faba bean	88 / 0	88
Persian clover (cv. Lusa)	88 / 2	90
Sweet white clover	2 / 1	3
Burr medic (cv. Spineless)	72 / 10	82
Subterranean clover (cv. Woogenellup)	35/0	35
Yellow serradella	3 / 97	100
Perennial legumes		
AberLasting clover (hybrid)	88 / 5	93
White clover (cv. Kakariki)	91/3	94
Lotus corniculatus (cv. Goldie)	68 / 0	68
Lotus pedunculatus (cv. Trojan)	91/0	91
Lucerne, coated	80/3	83
White clover (cv. Mainstay)	88 / 7	95
Red clover (cv. Relish), coated	86 / 3	89
Strawberry clover	60 / 38	98



78/5



# Annual clovers

### Growth of annual clovers

Early growth of annual clovers in 2016 from sowing in April/May to late-July/early-August was slow. The potential growth of annual clovers September to November is higher than for white clover and red clover.

<b>Clover growth – Awanui, 2016</b> (from sowing in April to 27 October)			
Species	kg DM/ha/day		
Berseem clover	61		
Balansa clover	48		
Persian clover	58	Ν	
Red clovers	23		
White clovers	27		
Lotus pedunculatus	22		
<b>Control</b> – ryegrass + white clover 23			
	A CONTRACTOR OF A	72.5	

Over the four-year trial period, Persian clover was the most consistent, highyielding annual clover. Monocultures at Te Kopuru showed Persian clover had the highest yield (9,415 kg DM/ha) of annual clovers across the three years' monitoring from sowing in mid-May to early December.

Data is for sown species only, since monocultures were used. The only certified Berseem clover seed involved the cultivar 'Elite II'.

	Annual	Annual legum	ne growth (Yield – kg	g DM/ha/year)	
	legume, sown in monoculture	<b>2017</b> (Sowing date 10 May)	<b>2018</b> (Sowing date 10 May)	<b>2019</b> (Sowing date 17 May)	
	Balansa clover	7,850	6,963	5,254	
	Persian clover	9,630	8,232	10,384	
The second	Berseem clover	2,817		5,841	
3	Berseem (cv. Elite II)		8,080		
	Crimson clover	3,433	4,622		
	Burr medic (cv. Spineless)	6,177	3,833		

The following graph shows:

- balansa clover died out quickly due to flowering early
- Persian clover showed good sustained growth.

#### Te Kopuru 2018 100 Balansa 90 Berseem 80 Persian 70 kg DM/ha/day 60 50 40 30 20 10 0

April to Mid-September to mid-September mid-October

Mid-October to mid-November

Mid-November to mid-December

Annual average legume monoculture sowing 2019 at Awanui and Te Kopuru showed:

- Persian clover grew the highest yield and had the lowest weed growth
- subterranean clover failed at Awanui and had low yield at Te Kopuru it had the highest weed growth.

Annual clovers	<b>Total growth</b> (kg DM/ha/year)	Growth of sown species (% of total growth)	Growth of weeds (% of total growth)	
Balansa clover	7,296	44	34	1
Subterranean clover (average two cultivars)	5,547	21	37	3
Berseem clover	7,104	57	16	
Persian clover (average four cultivars)	9,558	89	9	

### Daily growth annual clovers,

## Success or failure of annual clovers on peat soils

Six annual clovers were sown as monocultures on peat soil at Ruakaka. Growth data from May sowing to 26 November was measured. On this soil type Persian clover and Berseem clover produced 'successful overall pasture growth' -

i.e. > 6,000 kg DM/ha/year.

Species	<b>Growth of</b> sown species (kg DM/ha/year)	Comment
Persian clover	7,167	Successful
Berseem clover	7,366	Successful
Balansa clover	3,390	Partial success
Arrowleaf clover	0	Failed
Crimson clover	0	Failed
Burr medic	1,560	Partial failure

## Summary - Annual clovers as monoculture sowings

- High yields were obtained from Persian clover (cv. Resal) and Berseem clover (cv. Elite II); this was especially apparent at NARF (Northland Agricultural Research Farm) with yields of 12,656 kg DM/ha/year and 12,931 kg DM/ha/year respectively from April/May up to their final harvest December/January.
- Total average growth from the annual species in Northland from sites at Te Kopuru, Dargaville and Awanui follow.

Balansa - 6,249 kg DM/ha Persian - 9,725 kg DM/ha Berseem - 9,816 kg DM/ha

- Balansa, Persian and berseem annual clovers showed relatively slow to medium daily growth from sowing through to mid-late July, averaging 21 kg DM/ha/day across the three Northland sites.
- August growth at NARF improved from July (21 kg DM/ha/day) to 47 kg DM/ha/day, with berseem having 23% higher growth compared to both balansa and Persian.
- Persian clover (cv. Resal) grew 88 kg DM/ha/day as an average across all three Northland sites October-November, with growth rates very similar between the three sites.
- The variation between sites' growth for Persian clover (cv. Resal) November-December was huge - from a low of 28 kg DM/ha/day at Ruakaka to a high of 94 kg DM/ha/

day at NARF. It is assumed these results are due to later growth of the Persian clover at NARF (mid-late December) compared to the other two sites.

 At NARF, balansa clover flowered in October and ceased growth by late-October; berseem and Persian, in comparison, ceased growth late-December to early-January.

## Summary of annual clover performance

Berseem clover and Pe<mark>rsian</mark> clover were "successful" in growth at all sites.

Species th<mark>at "</mark>failed" (e.<mark>g. yie</mark>ld < 6 tonne of dry matter for the growing season) were:

- balansa at Ruakaka
- arrowleaf, crimson clover and burr medic (cv. Spineless) at Ruakaka and Te Kopuru.

## Perennial clovers

Perennial clover evaluation was undertaken at three sites (Te Kopuru, Awanui and Kerikeri) 2016/17.

Monitoring of another site at Te Kopuru was undertaken in 2017/18.

### Te Kopuru 2017/18

The perennial clover yield data was based on:

• sowing date - 10 May 2017 • final harvest date - 8 May 2018.

Species	<b>Growth for</b> <b>the year</b> (kg DM/ha/year)	% of sown or target species plant material present at final harvest
White clover (cv. Mainstay)	13,277	90
White clover (cv. Quest)	12,302	98
White clover (cv. Kakariki)	12,775	71
Red clover (cv. Ceibo)	13,720	83
Red clover (cv. Relish)	15,207	95
AberLasting clover	10,736	Inconclusive
Lotus pedunculatus (cv. Trojan)	13,436	29
Lotus pedunculatus (cv. Tannet)	11,112	5
Alsike clover (cv. Hytas)	13,262	Inconclusive
Control - Ryegrass plus White clover	15,906	98
Control - Tall fescue plus White clover	16,956	98
Control - Cocksfoot plus White clover	16,070	95

#### Results

The results could be attributable in part to the summer having good rainfall; results would be expected to be quite different in a drier summer.

Impressive yearly growth rates for white clover, red clover and the control perennial grasses and white clover mixes. The average yearly growth was:

white	e cl	over
2,785	kg	DM/h

red	clover
14,463	kg DM/ha

perennial grasses + white clover 16,311 kg DM/ha.

Production was very similar between perennial ryegrass, tall fescue and cocksfoot, with just over a tonne (1,050 kg DM/ha - 7% difference) separating the highest and lowest production.

The white clover and red clover swards remained relatively pure throughout the whole period - averaging 87% "pure" at 12 months. At the 12-month stage, one red clover sward and two white clover swards were 95% or above for purity.

## NARF2018/19

For annual and perennial clovers sown in mixes, the addition of a high-performing annual clover improved pasture growth August-December.

Pasture	<b>Growth August 2018</b> (kg DM/ha/year)	
Perennial grasses, white clover and red clover (no annual clover)	27	に見
Perennial grasses, white clover and red clover <i>plus</i> annual clover	48	
Annual clover only	47	

Persian clover and Berseem clover generated much higher growth in pasture mixes compared to pasture mixes without annual clovers; these annual clovers made up 84% of plant material present at harvest.

As shown by the following table for NARF 2018/19, with good growth conditions the addition of red clover can provide a surge in growth of high-quality feed, especially with respect to protein.

Period	<b>Red clover</b> (% dry weight)	<b>Growth of sown species</b> (kg DM/ha/year)	
November-December	71	108	10.14
December-January	96	111	
January-February	96	42	

The results, attributable to good rainfall, if nothing else highlight the potential of irrigation ...



July-September berseem 'treatment' (i.e. average of ryegrass, tall fescue, cocksfoot that had berseem as the annual clover) **+2,169 kg DM/ha** compared to other treatments with no annual clovers

October-January 'treatments' with no annual clovers present had **+1,772 kg DM/ha** compared to those treatments with berseem annual clover present

Red clover contributed almost all the pasture grown during the superb growth conditions reflected in the startling December results.

Consistent rainfall post-Christmas is required to achieve most or all of the potential for very high growth January-March.

### Problems associated with annual clovers

There have been two major reasons for failures with annual clovers, in both plot-scale monitoring and whole-paddock sowings.

• Low germination.

Poor germination occurred when existing pastures were not sprayed out; or, if sprayed out, dead plant material was not removed well.

Mulching of non-sprayed kikuyu-dominant pastures, even using high sowing rates of annual clovers, did not ensure good germination.

• Soil-borne pathogen attacks.

Soil-borne pathogen attacks (fungi and oomycetes) on establishing legume plants were serious, killing 80-90% of seedlings in some instances.

Entomological surveys indicated there were no insect problems involved in annual clover deaths (i.e. there were no "above ground" insect problems); but, with soil-borne pathogens present, there were major "below ground" problems.

### Pathogens

A number of plant samples were analysed in the lab. A range of pathogens were cultured from plant roots and crowns. All clover samples showed symptoms of root browning, and rotting; leaves had the associated reddening. Important pathogens were *Rhizoctonia solani, Phytopythium* and a *Pythium* species - these are important soil-borne pathogens that favour wet or fluctuating wet and dry soil conditions.

The annual clovers berseem, and especially Persian, are less susceptible to soil pathogen attack than balansa clover or subterranean clover. White clover and red clover are less susceptible than any of the annual clovers.

### Effects on yield of mixes involving or not involving annual clover species

Effects on mix yields either involving or not involving annual clover species were conducted at NARF 2018/19.

Red clover yields were lower where Persian clover or berseem clover were present. Red clover yields were highest where balansa clover was present or there was no annual clover present.

- Very little difference in the 12-month yield between mixes.
- Very high production from all clovers except white clover.

	Mixes with Persian or berseem clover (kg DM/ha/year)	Mixes with balansa clover or no annual clover (kg DM/ha/year)
Total yield	19,679	21,457
Annual clover yield	10,228	
Balansa yield		3,401
Red clover yield	6,985	12,692
White clover yield	844	2,294
Grass yield	1,622	3,070
"Combined" clover yield	18,057	18,387

# Feed quality

Lab analysis involved measuring metabolisable energy and protein content. Clovers vary in feed quality.

- In October, there was little difference between annual clovers and red clover or white clover.
- But, during November and into December, Persian clover appears to be a higher dual (i.e. metabolisable energy and protein content) feed compared to berseem; white clover was highest for energy.

Energy is measured in 'Megajoules of metabolisable energy per kilogram of dry matter' or MJ ME/kg DM.

Energy (MJ ME/kg DM)			
	October	November	December
Arrowleaf	10.7	10.3	
Balansa	9.5-11.5	9.5	
Berseem	11.0	10.6	10.4
Persian	11.2-12.0	10.8-11.7	10.6
White clover	10.8-11.8	11.7	11.4
Red clover	11.2		10.0

Legume protein levels are generally high well into December, considerably higher than any of the grasses.

	Protein content December (%)
White clover	25.8
Lucerne	36.0
Berseem clover	20.5
Persian clover	20.2
Perennial ryegrass	12.5
Tall fescue	13.4
Cocksfoot	15.9

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