Monitoring alternative fertilisers demonstration

Moorooduc Plains 2017

Australian Government
National Landcare Program
Bass Coast Landcare Network
Mornington Peninsula Shire
wpcln Western Port Catchment Landcare Network Central Region
South Gippsland Landcare Network
Demonstrating Sustainable Farm Practices

Monitoring alternative fertilisers on the Moorooduc Plains

Introduction

The aim of this demonstration was to provide some information to assist the decision making process in the selection of fertiliser for pasture production for beef grazing properties on the Moorooduc Plains. Information gathered on pasture response, soil health and input cost of a range of available fertilisers was designed to assist in making appropriate management decisions.

The trial site is situated on a 34ha grazing property with access to an additional 40ha, adjoining the Moorooduc Highway. Their overarching aim has been to produce high performance Poll Herefords that are fertile and easy calving with high carcass merit. The farmers use Breedplan to benchmark their cattle and as a breeding selection tool and are ruthless in culling inferior stock.

Geoff Coghill (farmer owner) in the demonstration paddock with some of his Poll Hereford breeding cattle

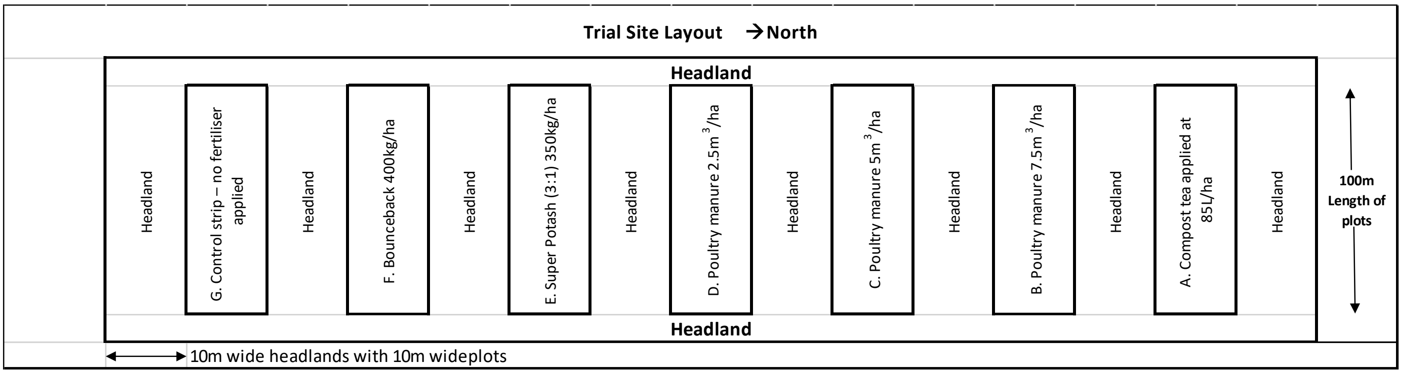
The soils on the farm are Sodosols which are described as grey to brown sandy loams. They have developed on Tertiary sediments and are weakly structured with moderate organic matter content.

It is recognised that soil acidity in Sodosol soils are common and soil pH levels require regular monitoring and application of liming materials.

Sodosol soils are generally most suitable for cropping and grazing enterprises. The depth of the A-horizon is usually >200mm.

Trial Design

The demonstration site was located in a gently sloping westerly facing paddock. There were 6 different fertilisers trialled against a control and the test strips were 10m wide and 100m long separated by 10m wide control strips and headlands at each end of the paddock. The demonstration ran from over 3 years.



Poultry manure has been widely used as an alternative fertiliser on grazing pastures for many years improving both the pasture composition and the feed quality (RIRDC, 2014). Poultry manure was used in this trial at 3 different rates and the effect it had on pasture growth and soil physical, chemical and biological properties were monitored. The applications of Poultry Manure were compared with applications of compost tea, Bounceback (pelletised poultry manure), and 3:1 (Super Potash) fertiliser. The application of compost tea was based on the potential stimulation of biological soil populations and their effect on plant physiology and productivity (Calvo et al, 2014).

The trial site had the following inputs applied on an annual basis:

A. Compost tea @ 85L/ha – cost $73/ha)
B. Poultry manure @ 7.5m^3/ha cost $142/ha
C. Poultry manure @ 5m^3/ha cost $95/ha
D. Poultry manure @ 2.5m^3/ha cost $48/ha
E. Super Potash (3:1) @ 350kg/ha - cost $157/ha
F. Bounceback @ 400kg/ha – cost $177/ha
G. Control strip – no fertiliser applied

Spreading poultry manure (right)

The SoilKee aerating and sowing (left)

During the trial, broad leaf weeds were managed with a conventional spray program. The Soilkee soil aerator which has been successfully trialled across Gippsland catchments was also used across the demonstration site in the second year to improve the aeration of the soil and to add additional winter active species including peas and oats.

Analysis of Results

Testing Protocols

Testing and monitoring criteria was based on assessment of the soil's physical, chemical and biological characteristics along with data on pasture yield.

Physical observations

The initial soil assessment indicated a soil with poor physical characteristics. The most prominent soil constraints were identified as a lack of soil structure, soil compaction, few water stable aggregates, minimal water infiltration and restricted pasture root growth.

The soil supported a varied rye grass pasture with flat weed and dock distributed through it. At the conclusion of the trial there was no discernible change in the soils physical characteristics.

Soil sod illustrating lack of root penetration in compacted soil

Shallow pit filled with water with the slow infiltration illustrating compaction. Some of the pasture species are also shown demonstrating species that have shallow rooting systems

Soil biological profile

The microbiological analysis indicated a soil with low microbial status. There were low total bacteria and insufficient protozoa that are responsible for cycling nitrogen. Nematode and mycorrhiza numbers were also too low to contribute to nutrient pools. This data supported the physical observations of soil compaction at 80mm depth that indicated an environment not conducive to an active microbial population (Horman et al, 2009).

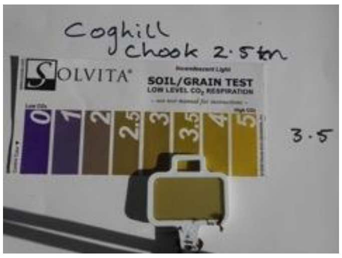
The Solvita Soil Health tests conducted also supported these results.

Solvita soil health test (CO_2 respiration)

The Solvita soil test is a technology and method that allows the soil CO_2 respiration of microorganisms to be measured in the field. As biological activity increases and organic matter cycles, CO_2 is released. The rate of release is regarded as an indicator of soil health.

A soil sample from the benchmark soil assessment was placed in a sample jar. An indicator probe was inserted into the soil and the lid secured and kept at room temperature for 24 hours. The colour of the probe was compared with a supplied colour key which indicated the level of CO_2 released and hence the degree of biological activity. A bright yellow colour indicates a high level of biological activity.

The control soil sample taken from the trial area indicated a 4.5 (scale 1-5), which is regarded as high biological activity). The Solvita soil test supported biological analysis and field observations of compaction and minimal water infiltration.



Solvita Soil respiration test results for the different treatments

Solvita tests were taken across all the treatments at the end of the trial and are displayed above. The treatment comprising Poultry manure applied at 7.5m^3/ha was the only treatment that displayed maximum biological activity. The 3:1 fertiliser and the Control strip also displayed high results. It is noted that cattle grazing across the site depositing dung and urine would also have a positive influence on the stimulation of biological activity.

Soils Chemistry changes

Soil Analysis and Solvita changes between treatments and compared to the Benchmark								
Nutrient	**Benchmark**	**A. Compost tea**	**B. Poultry Manure 7.5m^3**	**C. Poultry Manure 5m^3**	**D. Poultry Manure 2.5m^5**	**E. Super Potash 3:1**	**F. Bounce back**	**G. Control**
	2014	**2017**	**2017**	**2017**	**2017**	**2017**	**2017**	**2017**
pH 1:5 Water	5.88	6.12	5.96	5.82	5.81	5.81	5.94	5.86
Olsen P mg/kg	20	14	26	23	18	30	14	21
Colwell P mg/kg	36	49	64	45	34	65	42	31
Nitrate N mg/kg	14	7.8	9.8	5	3.9	5.5	12	12
Carbon %	3.42	4.13	3.53	3.65	3.85	3.99	3.5	4.13
Effective CEC cmol+/Kg	5.36	6.31	6.02	5.27	5.65	5.81	5.54	5.87
Ca/Mg ratio	3.9	3.6	3.6	3.7	3.4	3.7	3.4	3.3
Ca CEC %	67.50%	68%	67.40%	66.50%	62.20%	61.90%	63.10%	60.10%
Mg CEC %	17.30%	18.80%	18.60%	18.10%	18.30%	16.60%	18.80%	18%
K CEC %	6.00%	5.40%	6.30%	6.90%	6.80%	6.90%	6.80%	8.20%
Na ESP %	6.40%	3.80%	3.30%	4.00%	6.70%	7.50%	6.40%	6.80%
Ca/Mg ratio	3.9	3.6	3.6	3.7	3.4	3.7	3.4	3.3
Solvita	3	3	5	3.5	3.5	4.5	3	4.5

Soil pH did not vary over the length of the trial on the various test strips.

Olsen P as the most available P increased from 21mg/kg in the control to 30 mg/kg in the 3:1 strip and 26mg/kg in the 7.5t/ha of poultry manure.

Colwell P which measures the potentially available P, increased in the control from 31mg/kg to 65mg/kg in 3:1 strip, 64mg/kg in the 7.5t/ha strip, 49mg/kg in the compost tea strip and 45mg/kg in the 5t/ha poultry manure strip.

There was no observable changes in the organic carbon or Effective Cation Exchange across all the strips.

The % CEC of Calcium in the control of 60.1% is lower than the other strips.

The control ESP % of Sodium was 6.8%. This increased to 7.5% in the 3:1 strip, but decreased in all the other strips.

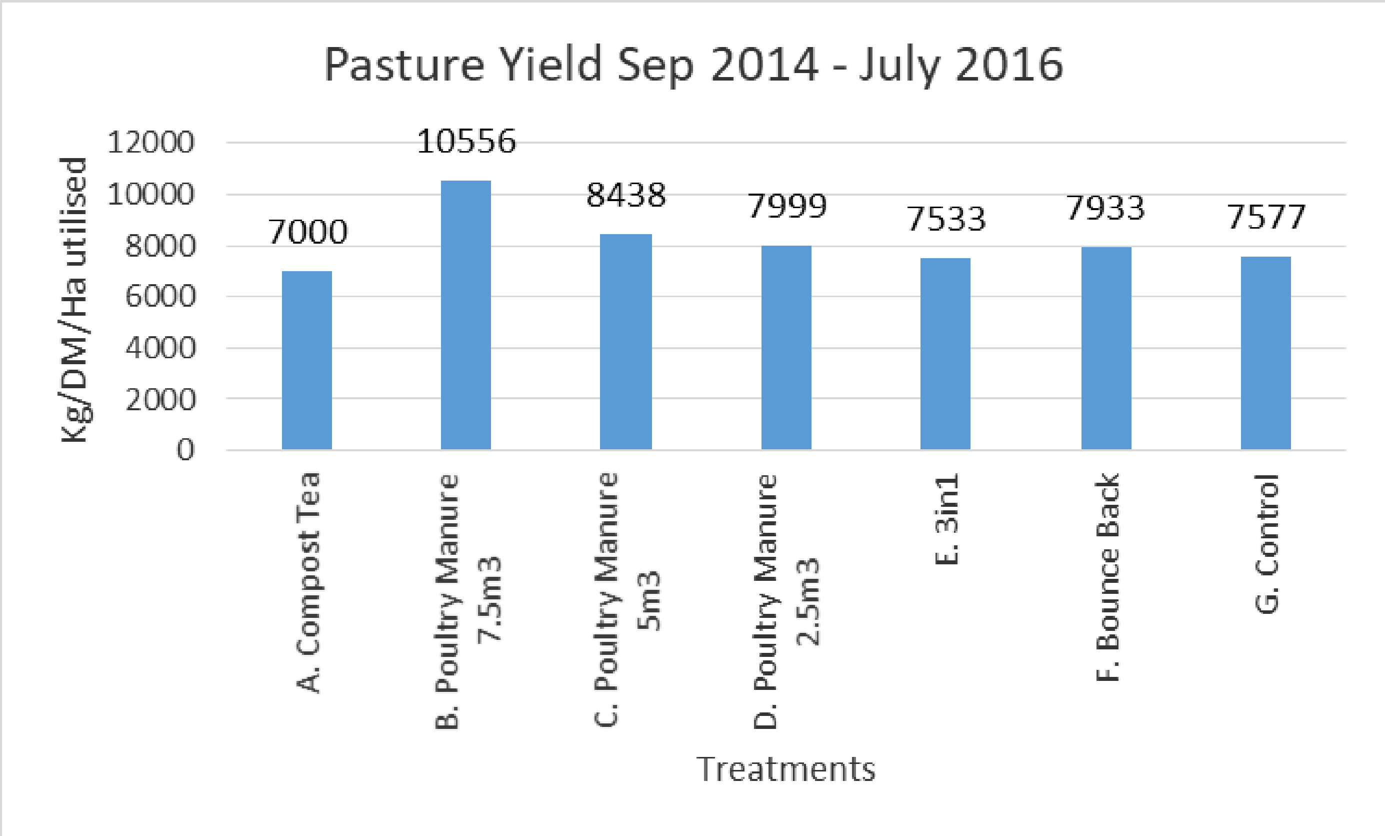
Soilkee soil aeration

The Soilkee aerator was used across all the test strips in the second year of the trial. An attached seed box sowed field peas, oats and pasture grasses. Germination was successful and very good growth was achieved. There was an observable increase in pasture growth in the areas that the SoilKee was used when compared with the areas that the SoilKee wasn't used. However, there was no noticeable difference in pasture growth across the various treatments.

Winter active species (left side) where SoilKee was used

Pasture yield

Pasture yield was measured over the first 2 years of the demonstration with an electronic 'GM Pro' Pasture Meter. The pasture was measured prior to the cattle entering the paddock for grazing. The rotation length varied from between 30 days in Spring up to 90 days through Summer. As at July 2016 there was an increase in the pasture yield in the 7.5m^3, 5m^3 and 2.5m^3 poultry manure strips followed by the Bounceback strip with the 3:1 fertiliser performing the same as the control strip. The compost tea strip produced the least amount of pasture.



Pasture yield in Treatment B. 7.5m^3/ha of poultry manure measured 25% higher than the next most productive treatment (which was treatment C. poultry manure 5m^3/ha). The poultry manure applied at 2.5m^3/ha and the Bounceback were the next most successful inputs. The 3:1 fertiliser provided similar production yields to the Control strip. The compost tea treatment grew the least amount of grass, but it should be noted that the low rates of application and the low nutrient content of the tea will not add to the nutrient pool being externally added. Its primary purpose was to stimulate biological activity, potentially mobilising plant nutrients. A range of variables such as soil temperature, moisture affecting nutrient cycling could explain why the pasture yield was lower in the compost tea when compared to the control.

Summary

The initial visual soil physical observations and the soil biological analysis did not change greatly over the length of the trial. Soil compaction over all strips still appeared to be a major constraint to pasture production. Compaction, along with a moderately acid soil are possibly key factors why soil biology is not functioning as it should with fungi dominating over bacteria in the pasture soils.

The 3:1 fertiliser raised the phosphorus (Olsen P and Colwell P) levels, but also resulted in a raised ESP sodium level. The poultry manure applied at 7t/ha raised the pH, the Olsen P and Colwell P levels. It also reduced the ESP Sodium to below levels of the soil being identified as sodic. The application of poultry manure at 5t/ha was the next best in performance indicating increased Olsen P and Colwell P and slightly lowering the ESP sodium level. Bounceback fertiliser did slightly raise the pH and lower the aluminium level. A slight increase is seen in the ammonium nitrogen in the Bounceback strip, which indicated a stimulation of the nitrogen cycle, along with an increase in Colwell P and potassium levels.

The 2.5t/ha of poultry manure was the least effective in raising nutrient levels. The compost tea did however appear to raise the pH, Colwell P, and lower the ESP Sodium percentage. It is not clear of the mechanism behind this observed effect.

The trial utilising the compost tea demonstrated the importance of understanding how to prepare this biological material and analyse it prior to application. There are many variables associated with its production and great care has to be exercised to ensure that the product that is applied actually demonstrates active microbial populations.

Visual soil observations of this sandy loam soil indicated severe compaction from 80mm. The use of the Soilkee that aerated to a depth of 100mm in the short term was not sufficient to shatter this horizon and provide root access. Previous trials have demonstrated that the use of this machine does encourage deeper root access over longer trial periods. It is therefore possible that results from this aeration may not be evident until well after the completion of the trial. The use of deep-rooted pasture species such as tillage radish, chicory and Lucerne may be advantageous in the future to help reduce compaction through the deep penetration of roots.

As compaction was seen as a major restraint to increased production, the levels of ESP sodium may negatively impact soil structure causing the collapse of soil pores. Interestingly the conventional 3:1 fertiliser led to an increase in the ESP sodium thereby possibly increasing soil compaction.

Kg nutrient applied per Ha annually (DM basis)							
Nutrient	**A. Compost tea 85ltr/ha**	**B. Poultry Manure 7.5m³**	**C. Poultry Manure 5m³**	**D. Poultry Manure 2.5m⁵**	**E. Super Potash 3:1 350kg/ha**	**F. Bounce back 400kg/ha**	**G. Control**
Nitrogen	0	80	54	27	0	12	0
Phosphorus	0	31.6	21	10.5	23.8	8	0
Potassium	0	47.9	32	16	43.8	6.8	0
Calcium	0	46.4	31	15.5	52.5	28	0
Sulphur	0	21	14	7	27.7	8	0
Cost per/ha	**$73**	**$142**	**$95**	**$48**	**$157**	**$177**	**$0**
Pasture utilised t/DM/ha	**7000**	**10556**	**8438**	**7999**	**7533**	**7933**	**7577**

Key learnings from demonstration

- Soil compaction levels were an impediment to increased pasture production
- Poultry manure at the rate of $7.5m^3$/ha raised the pH, Olsen and Colwell P levels and reduced the sodium ESP levels
- Poultry manure at the rate of $7.5m^3$/ha had the highest pasture yield
- The compost tea strip had a lower pasture yield than the control
- The 3:1 strip had a similar pasture yield to the control

References

Calvo, P., Nelson, L. & Kloepper, J.W. Agricultural uses of plant biostimulants, Plant Soil (2014) 383: 3. doi:10.1007/s11104-014-2131-8

Horman, J.>, Joao Carlos de Moraes Sa, Randall Reeder, 2009, The Biology of Soil Compaction, Ohio State University, Agriculture & Natural Resources Downloaded from Internet : http://ohioline.osu.edu/factsheet/SAG-10

RIRDC, 2014 Chicken litter: alternative fertiliser for pastures and ways to increase soil organic carbon, Publication N0. 14/067, September

This project is supported by Western Port Catchment Landcare Network through funding from the Australian Government's National Landcare Program