

Mitta Valley Landcare Group Soils Project 2015-2019

Report On The First Years Activities

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Introduction:

The Mitta Valley Landcare Group's strategic plan included the formation of a soils group in 2015, one of the aims of the soil group was to investigate the belief amongst the group that more and more inputs (N,P,K) were needed to gain the same rate of pasture growth, and that we should investigate the biological aspects of our soils to see if the soil condition and nutrient exchange could be improved while lessening the reliance on artificial chemical fertilisers. It is planned that this trial will continue for four years to monitor the results over a reasonable period.

The Mitta Valley contains many different soil types, from sandy granite through heavy clay/shale areas to river flat country, which gave us a wide variation of soils to work with. Initially, 10 farmers agreed to set up trial sites on their properties so consistent monitoring of their soils could be performed. The number of trial farms has now increased to 14. All trial sites are on farms producing beef cattle.

The initial idea was to trial several different ways of stimulating the biological activity in the soil. Companies within 500 kilometre radius of the Mitta Valley were contacted (for logistical reasons) to see what products they produced, but there was a surprising lack of choice and even more surprising lack of interest show with several of the companies contacted. It was an easy task to chose Bioactive Soil Solutions, as they were not only interested in what we hoped to achieve but came to the Mitta Valley to discuss their products, application rates and to assist us with setting up the trial sites. Bioactive Soil Solutions have also visited the Mitta Valley five times during the first year of the trial period to help monitor the trial sites. Bioactive Soil Solutions also guaranteed the five main bacterial strains in their product (detailed at Annex A) and explained the blend of soil conditioners and biological nutrients contained in their products. Bioactive Soil Solutions Biological Pasture Blend was also easy to apply as it could be sprayed with conventional boom or fan spraying equipment calibrated to apply 20 litres of pasture blend biology, 20 litres of nutrient blend to 460 litres of water to cover 5 acres.

Methods:

To monitor the trial sites and provide measurable and quantifiable results between the trial site and its control areas effectively the Mitta Valley Landcare Group funded the following test equipment:

Digital microscope (N130B Digital Biological Binocular Microscope)

Hand Held Refractometer (Brix Meter)

Digital pH tester (Oakton pH testr 20 Accuracy to 0.01 pH)

At the start of the project each landholder defined the area of their trial sites which varied from five acres to 100 acres and the control area adjacent to the trial site so the soils would be very similar to

allow an effective comparison between the area treated with Bioactive Soil Solutions Pasture Blend and the non treated control area.

Initial soil and tissue samples were taken from each trial site and their control area to gain a base line of data before the addition of the soil biology. After this, samples from each trial site and control were conducted at regular intervals to monitor changes.

The soil samples were taken using a 0 to 100mm soil probe and examined under the microscope to determine the amount of microbial activity and the species of microbes present in the sample using the techniques recommended by Dr Elaine Ingham. Dr Ingham's methods are detailed on the internet at <https://www.youtube.com/watch?v=H8CCIDH7jW0>. Through the use of a digital microscope using 400x magnification, still images and video footage of each sample could be taken to compare results over time and see the effects of different seasonal conditions.

Tissue samples were taken from each trial site and the corresponding control site. These tissue samples were taken from the predominant pasture species at each site and varied from perennial rye grass to native grasses. Each sample was obtained by bruising the grass sample in a mortar and pestle to make it easier to extract the grass juices using a garlic crusher. The garlic crusher extracted enough plant juices to provide a sample to be used in the refractometer. The refractometer was used to indicate the available nutrient and sugars in the sample to give an indication of the nutrient density of the sample. All samples were taken between 10am and mid day as the nutrient density can change throughout the day and the results were recorded for each sample.

During the trial period, professional soil tests were carried out and gave an indication that the soil pH was changing in the treated trial sites. The Mitta Valley Landcare Group purchased an accurate pH meter so the pH of the soil could be monitored during the trial period. The soil samples taken from the trial site and the control site were prepared by mixing each soil sample thoroughly and placing 20g of soil and 20cc of demineralised water in a sample jar and agitating it for 30 minutes to obtain the sample. The pH meter was calibrated before each batch of tests using pH 7 and pH 4 buffer solution to ensure accuracy of the test results.

A comprehensive biological and mineral soil analysis of each trial site was carried out using SWEP Laboratories in Melbourne. This was to obtain a benchmark for further analysis to be carried out in subsequent years and to understand the current nutrient and biological balance in the soil. The test results gave a very good indication if there were any serious deficiencies in the soil and if there were any areas which needed amelioration before further samples were taken from the trial sites.

A photographic record of the soil and root condition was also taken at each trial location by digging a 300mm by 300mm by 300mm soil sod to monitor any changes to the soil structure, colour and friability during the trial period. Also at this time, the dugout sod was examined to check the root condition and development as well as any signs of nodulation on the clover roots. An earth worm count was also performed and an examination to see if there were any signs of fungi activity through observing white filaments within the root zone of the pasture.

Data obtained:

From the initial soil samples taken from the trial and control sites the microscope revealed that there was a varying level of microbial activity in the soil. The greatest activity level was found in

river flat country where the higher year round moisture level was maintained. The soils from these areas usually contained the most top soil and a greater carbon content of the soils tested. The least activity was found in heavy clay/shale soils which rapidly dry out in the warmer months and retain very little moisture. It is very difficult to see the microbial activity in still images from the microscope so YouTube videos of the results of the initial images in June 15 and the subsequent images from July 15 and March 16 can be found at <https://www.youtube.com/watch?v=62erwPpnuqA> or searching YouTube for Mitta Valley Landcare Group Soils Project.

Tissue Samples - Refractometer Results:

The results from the refractometer (Brix test) have been averaged across trial and control sites to produce a clearer graph of the results. After the Bioactive Soil Solutions Pasture Blend was added in June 15 it can be seen that the average Brix reading between the treated areas and the control areas was about two points better in the treated areas. See Figure 1 below.

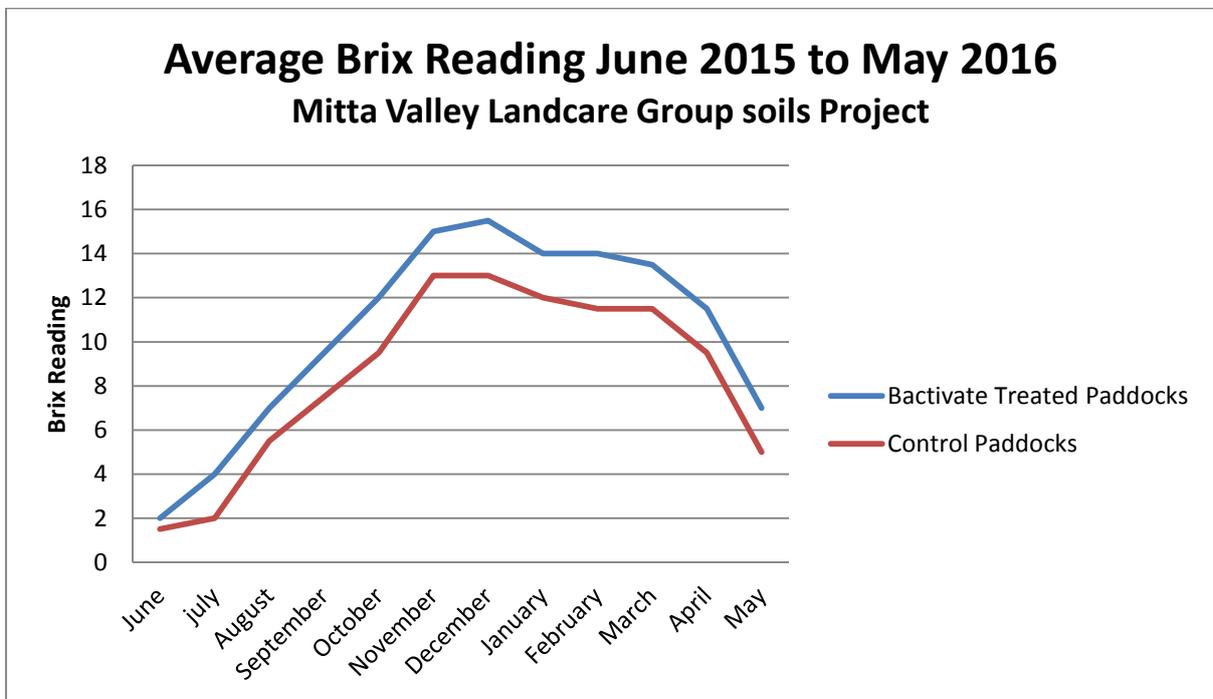


Figure 1

pH test Results:

pH testing was not added to the trial tests until April 16 as it only became apparent that there may be a change to the pH levels from the professional soil tests carried out. From the initial testing carried out the following results were obtained, at Figure 2:

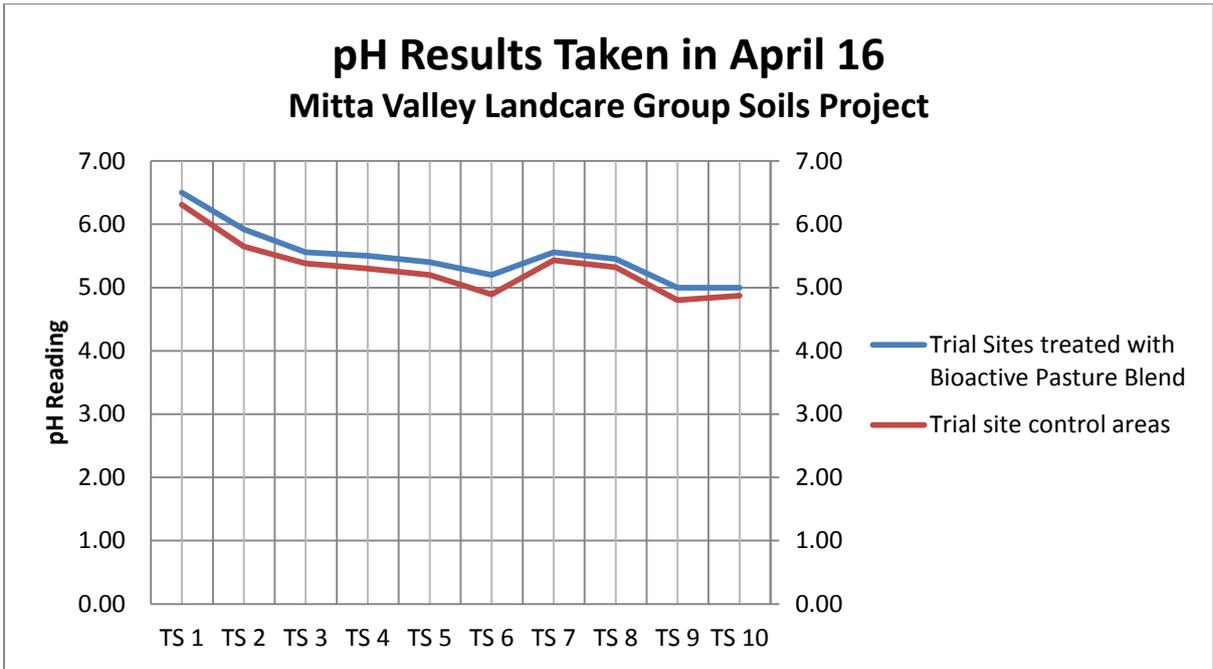


Figure 2

Photographic Results:

Below are several photographs showing the difference between the trial site treated with Bioactive Pasture Blend and the control paddocks.

The photographs taken at Figures 3 and 4 were from Trial site 1, which has had one side of the paddock treated three times with Bioactive Pasture Blend (June 15, October 15 and February 16). The samples on the right hand side of the photograph have been treated and on the left is the control. The Bioactive treated part of the paddock on the right of the photograph has been transformed from hard clay/shale to friable top soil. The root structure in the treated sample is far more dense and actively growing young white shoots are evident. No worms were found in the untreated sample and five worms in the treated sample.



Figure 3



Figure 4

Ten samples from each side of the paddock were taken with similar results throughout.

The photograph below at Figure 5 shows the soil samples taken from trial site 3 which is from paddocks consisting of granite based soils. The sample on the left is the control and the sample on the right has had two applications of Bioactive Pasture Blend in July 15 and March 16.



Figure 5

The soil in the Bioactive treated paddock has far better structure while the control sample is still consisted of mainly a coarse grit with little root penetration into the grit layer.

The photograph below at Figure 6 was taken from trial site 6, which is heavy clay/loam based soils from the river flat country. The control paddock sample on the left had the consistency of a hard cheese, was compacted, only two worms were found in the sample. The sample of the right has had Bioactive Pasture Blend added in June 15 and October 15. This sample had a far more friable texture, broke up easily and contained 10 worms.



Figure 6

The photograph at Figure 7, below, shows the difference between the root structure and nodulation of a clover plant in the untreated paddock on the left and the treated paddock on the right. The roots on the right hand clover plant are far more robust, have more root mass, greater length and greater nodulation. This difference has been seen throughout the trial sites.



Figure 7

Discussion:

At the start of the Mitta Valley Landcare Group Soils Project our aims were to increase grass growth, biological activity, and to produce healthier pasture and livestock. Our investigation into the introduction of soil biology to our trial sites proved to have greater effects than we had expected.

Grass Growth: There was a noticeable difference in the growth of the grass in the treated paddocks, and this growth was usually a darker green. The extra growth was most noticeable after cutting hay as the paddocks were all cut to the same length and at the same time. The treated paddocks reached the three leaf stage of growth about 8 days sooner than the untreated paddocks. The treated paddocks also produced growth further into the summer period, this was probably due to the better soil structure and greater depth of top soil retaining more moisture. It was also noted that the paddocks treated with Bioactive Pasture Blend produced two more round bails per Ha than the untreated paddocks.

Biological Activity: The increase in the biological activity in the soil was expected as we were adding five live strains of bacteria and a complex mixture of bacteria growth promoters and a carbonised molasses. This mixture is designed to promote not only the bacterial strains added to the soil but to feed and promote the growth of the existing micro organisms in the soil.

It was initially thought that the long, hot and dry summers we experience in the Mitta Valley would kill off the bacteria as the moisture level, particularly in the hill and valley paddocks, becomes so low that the soil is just dust for several months of the year. To our surprise the biological levels in the soil were maintained and the activity levels when viewed through the microscope were consistent with the samples taken when the soil still had some moisture in it. It is not known if the biology is still active in the soil at this time or if the biology bursts into life once the soil sample is mixed with demineralised water to prepare the slide for the microscope. From information researched on the internet it is likely that there is a combination of both. The biology around and directly in contact with the root material is probably still active and the rest of the bacteria is either dormant or in a spore form ready to activate once the moisture levels increase. With the limitation of our laboratory equipment testing this further is not possible.

Effects of Fertiliser Application: The effects of fertiliser application on the biological activity in the soil was a consideration during our trial period. From the samples taken for the trial sites where some paddocks had been fertilised with single super phosphate (SSP) and others had not there did not seem to be any degradation to the biological levels in the samples taken from fertilised paddocks. What was noticed that the same paddock response was achieved with a lesser rate of fertiliser application. The usual rate of application of (SSP) in Autumn is 200kg/Ha where on two of the trial paddocks the rate of SSP application was cut down to 80kg/Ha without any visual difference to the pasture growth. A similar trial was conducted using urea normally used to boost pasture growth in the Autumn to provide a feed wedge for the winter period. Two trial paddocks were treated with 80kg/Ha of urea and again there was no negative effects to the biological activity found in the samples taken. Trials were not conducted with higher rates of SSP and urea this year but in following years this trial will examine the effects of greater application rates.

Brix Readings: From the Brix readings taken for all the trial sites and the control paddocks it was evident that the Brix readings increased by an average of two points on the scale. This indicated that the nutrient density had increased in the treated paddocks. The increase in Brix reading indicated that healthier and more nutrient pastures were being produced and therefore more nutrient available to the livestock eating the grass.

Changes to the pH of the soil: Through professional soil tests carried out during the trial period it was suspected that the pH in the trial paddocks was increasing. The Mitta Valley Landcare Group purchased an accurate pH meter so measurement of the pH could be assessed. From the data compiled from this testing there was a measurable difference found between the trial sites and the control. An average increase of 0.18 pH was observed throughout the trial sites. This does not seem to be a great increase but as the pH scale is a logarithmic scale this is the equivalent to approximately 1 tonne/ha of lime application to heavier clay soils.

Soil Structure: Probably the most dramatic changes experienced during the first year of the trials is the changes to the soil structure in the treated paddocks. All soil types in the treated paddocks examined over the trial period showed a significant increase to the depth of top soil. With one application of Bioactive Pasture Blend an average of 15mm of top soil was added to the soil and with three applications over 55mm of top soil. In all cases the soil in the treated paddocks was more friable and had better root structures (density and length). There was also more evidence of fungi activity and a better nodulation rate on clovers. The worm activity in all treated paddocks increased significantly which probably helped break up the hard packed layers of the soil. The water infiltration and retention within the soil has increased, this has been evident from the pasture response after summer rain and the extended growth experienced going into the summer months.

Costs:

At current pricing the Bioactive Pasture Blend cost \$310 + GST to cover 2 Ha. From the trials carried out this year it was apparent that if the fertiliser application (SSP) was cut from 200kg/Ha to 80kg/Ha there was no visual difference to the rate of grass growth. With the current cost of SSP @ \$459 +GST per tonne the savings in SSP application would be \$110.16 + spreading costs per 2 Ha application.

Conclusion:

A great deal has been learnt from the first year of the Mitta Valley Landcare Soils Group trial. From the results obtained it is clear that the following advantages have been found when using Bioactive Pasture Blend on the trial sites:

Increased grass growth - particularly at start of summer months

Increase in biological activity

increase in nutrient density of the grass

positive changes to the soil structure and depth

Better water retention in the soil

Better water infiltration into the soil

Reduced reliance of Artificial chemical fertilisers

The trial period covered one of the worst growing seasons experienced in the Mitta Valley for some time in that it was much dryer than normal and the summer heat started much sooner and continued well into Autumn. This trial is scheduled to continue for another three years to confirm the results found this year and to allow further professional comprehensive soil tests to be carried out to confirm our finding and see the changes to the mineral and biological composition of our soil.

Recommendations:

Continue with the close monitoring of all trial sites for the next three years.

Continue with 2 applications per year of Bioactive Pasture Blend to each trial site.

Quantify the grass growth by measuring the dry matter production between treated and untreated paddocks.

Carry out comprehensive soil and biological testing through SWEP Laboratories annually.

Monitor the effects of broad leaf selective herbicide on biological activity.

Acknowledgements:

Mitta Valley Landcare Group - Funding of experimental equipment and support

Bioactive Soil Solutions Pty Ltd - Support and advice with setting up and monitoring trial sites

Dr E Ingham - On line courses identifying and sampling biological activity in soil

NECMA - Funding of SWEP soil and tissue tests through the Farm Mentor Grant

SWEP Laboratories - Carrying out extra biological soil testing to meet our requirements

Farm Trial Sites - To all the farmers who agreed to trial sites on their properties and for the time, effort and costs associated with this project trial, a very big thank you.

Organisms found in Bioactive Pasture Blend

Organism	Scientifically Supported Function
Bacillus subtilis	<p>Shown to alleviate soil stalinization stress; solubilising soil inorganic phosphate; myco-remediation of soil organic contamination.</p> <p>The bacteria bio-film communities form a mutualistic interaction with plant rhizome system, providing pre-emptive colonisation. It is able to combat the impact of pathogens by releasing, a number of natural enzymes, siderophores and antibiotics.</p>
Bacillus megatherium^{2,3,4}	<p>Highly efficient phosphate solubilising bacteria that secrete organic acids that can mobilise insoluble nutrients like Phosphorus.</p> <p>Active in soil organic matter breakdown and turnover</p>
Bacillus mucilaginosus^{2,3}	<p>Nitrogen fixing and mineral dissolving soil bacterial.</p> <p>Application on one hand allows enriching the root space by the mobile nitrogen, phosphorus and potassium and on the other hand allows reducing excessive spending of mineral fertilizers</p> <p>Potential to dissolve soil minerals (releasing potassium)</p>
Bacillus licheniformis^{2,4}	<p>Nitrogen fixers. Solubilising P.</p> <p>It is able to produce growth promoting metabolites indole acetic acid (IAA).</p>
Bacillus thuringiensis	<p>Combats the effects of pathogens and soil disease</p> <p>Solubilise phosphate.</p> <p>Produces growth promoting metabolites(IAA producing bacteria).</p>

1. Search data were obtained from the Web of knowledge. Typical research papers are shown in the bibliography.
2. The organism can synthesize phytohormones particularly auxins and cytokinins to stimulate plant growth. In such studies plant seeds were subjected to bacterization. Relevant paper: Sokolova et al., 2011; Probanza et al., 1996; Gutierrez Manero et al., 1996; Ortiz-Castro et al., 2008; Prashanth and Mathivanan, 2010.
3. Organisms are considered as 3rd class bio-additives, consists of products of microbiological synthesis. 1st class of bio-additives are easy assimilating substances of biogenic microelements and the basic nutrient elements (N, P, and K). The 2nd class bio-additives are constructed on the basis of plant growth promoter factors and cell stimulators (Vinaro and Dirina, 2007).
4. Study of inoculation of the bacterium in soil showed the plant growth stimulation effect can be explained not only by their N₂-fixation and/or P-solubilisation ability but also by their production of hormone-like secondary metabolites (Cakmakci et al., 2007).