

BioAg Mackenzie Trial Establishment 2021



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Executive Summary

New Zealand field trials evaluating BioAg fertilisers commenced in December 2016 in lowland Southland and in Canterbury. These trials have been extended to the South Island high country in 2018.

Unfertilised high country basin floor soils are free-draining, low in fertility with toxic subsoil aluminum levels. With irrigation and soil amendment they are highly productive, but the effects of biological fertilisers is unknown.

A dryland trial site, near Twizel, that has never been fertilised and is representative of Mackenzie basin floor soils, has been precision soil mapped, soil tested, and rabbit fenced. An adjacent irrigated developed high fertility trial site on the same soil allows parallel assessment of BioAg fertilisers.

Initial application was delayed until the 2021 – 2022 growing season to allow good lucerne establishment.

BioAg base biologically activated phosphate was applied at the dryland site on the 5th May 2021. BioAg Soil and Seed was applied in adjacent irrigated and dryland sites in spring, on the 18th November 2021. BAP was also applied on the irrigated site.

The trial will be drilled with lucerne by late November.

This trial will allow assessment of pasture production responses during the 2021 – 22 growing season.

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1. Introduction

New Zealand field trials evaluating BioAg fertilisers started in December 2016 at lowland sites in Southland and Canterbury¹. Extension to native low-fertility South Island high country soils has now commenced at Glenbrook / Westside Station, near Twizel, in the Mackenzie basin.

Trial Site and Preparation

The site is at 468 m altitude on unfertilised Mackenzie soils on fluvio-glacial outwash with former stream channels and ridges. Dryland resident vegetation is low-fertility grasses browntop and sweet vernal with the flatweed *Hieracium pilosella*, annual hare's foot clover and a scattering of native fescue tussock (Figure 3, Frontispiece). Irrigated vegetation is ryegrass and white clover. To evaluate the fertiliser effect on improved pasture species, lucerne (*Medicago sativa*) was direct drilled to act as an indicator test plant in spring 2018 (Figure 1) and the site was fenced to exclude grazing (Figure 2). The adjacent fertilised irrigated site is white clover - ryegrass pasture (Figure 3).



Figure 1. Trial lucerne drilling in spring 2018.



Figure 2. Trial site netting fence and 10 cm apron to exclude rabbit, hare and stock grazing.

¹ Espie, P.R. 2019. BioAg New Zealand fertiliser trials 2016 - 2018. AgScience Contaract Report, December 2019, 47 pp,

Soil depth to gravel in Mackenzie soils closely corresponds to vegetation patterns, showing the strong influence that soil phases have, primarily through soil moisture and nutrient supply (Figure 3 left). To assess how soil variability may interact with fertiliser responses, soil phases on the trial site were precision soil mapped. Electrical capacitance varied from 0.06 dS/m on shallow soil phases to 0.49 dS/m on deep phases, closely corresponding to vegetation patterns (Figures 3, 4).



Figure 3. Left. Site vegetation cover and location of the dryland trial) and irrigated sites. Right. Soil phase mapping. Red = shallow soil phase to medium (orange and yellow) to deep phases (green).



Figure 4. Mackenzie Soil Phases. Left: shallow phase, depth to gravel 20 cm; Right: deep phase, depth to gravel 50 cm.

Soil Phase Chemistry

Soil acidity decreased from pH 5.6 in the upper surface to pH 5.5 in the lower topsoil and upper subsoil before increasing to pH 5.8 in the lower subsoil (Figure 5). There was little difference between soil phases, excluding a possible anomalous value on the deep soil phase at 25cm.

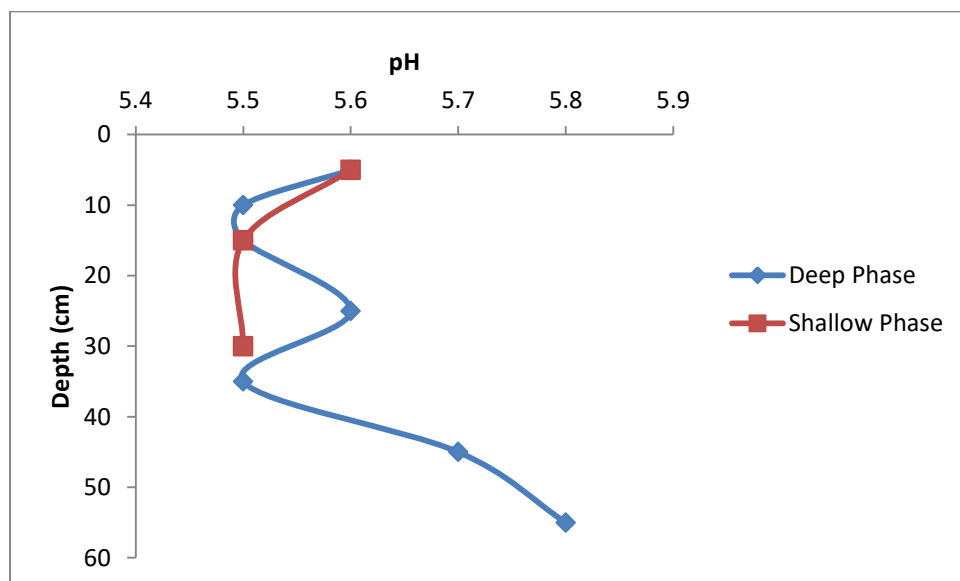


Figure 5. Change in soil acidity with depth.

Soil aluminium levels exceeded the levels toxic to legumes in both soil phases and increased down the profile to peak at 10 – 20 cm in both phases (Figure 6). The higher levels in the deep soil phase are due to their higher moisture holding capacity and hence greater weathering with more aluminium released from clay minerals.

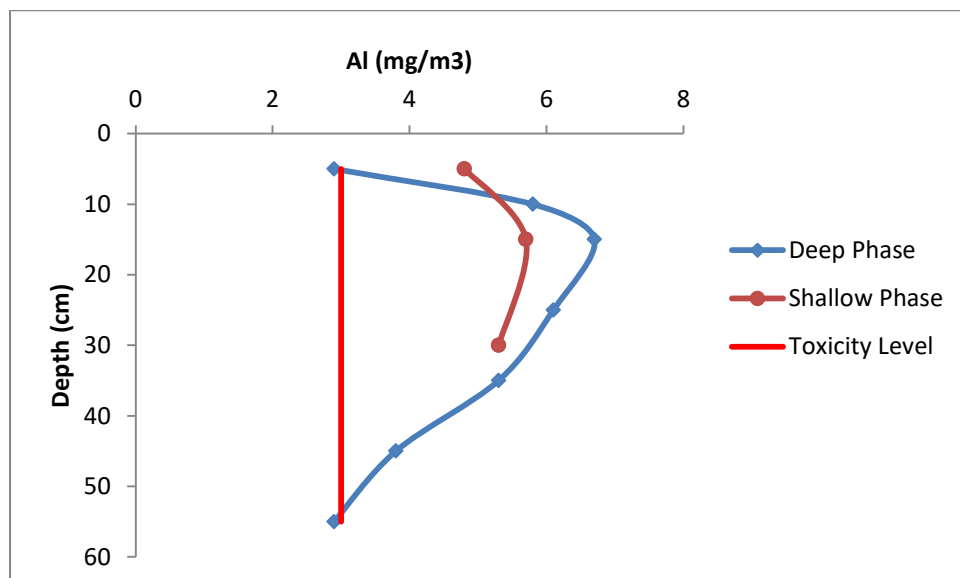


Figure 6. Change in soil aluminum with depth.

Soil carbon levels were slightly higher in the deep soil phase, consistent with more moisture and biological growth. As usual, they decreased with depth in both phases (Figure 7).

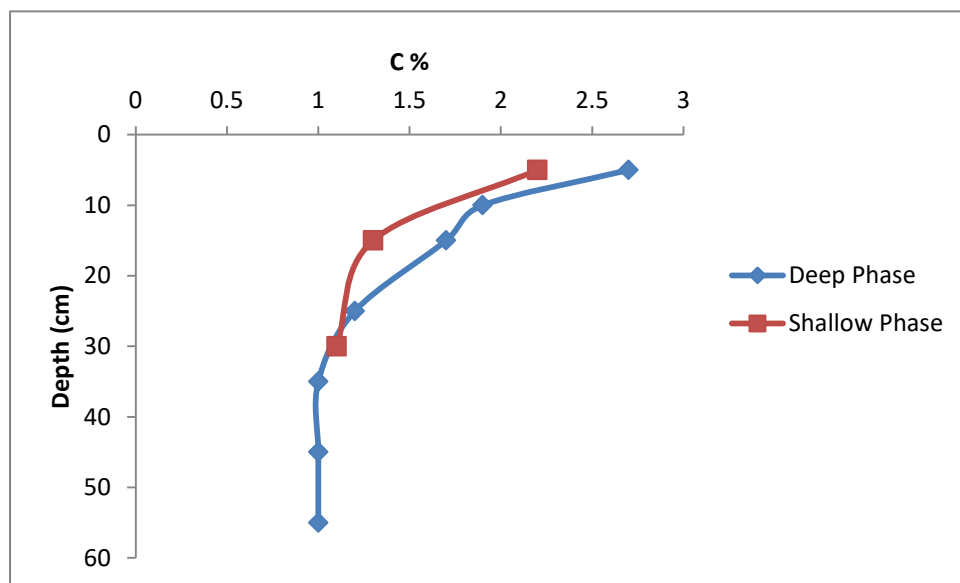


Figure 7. Change in soil carbon with depth.

Total nitrogen levels followed a similar depth trend to carbon in both phases (Figure 8)

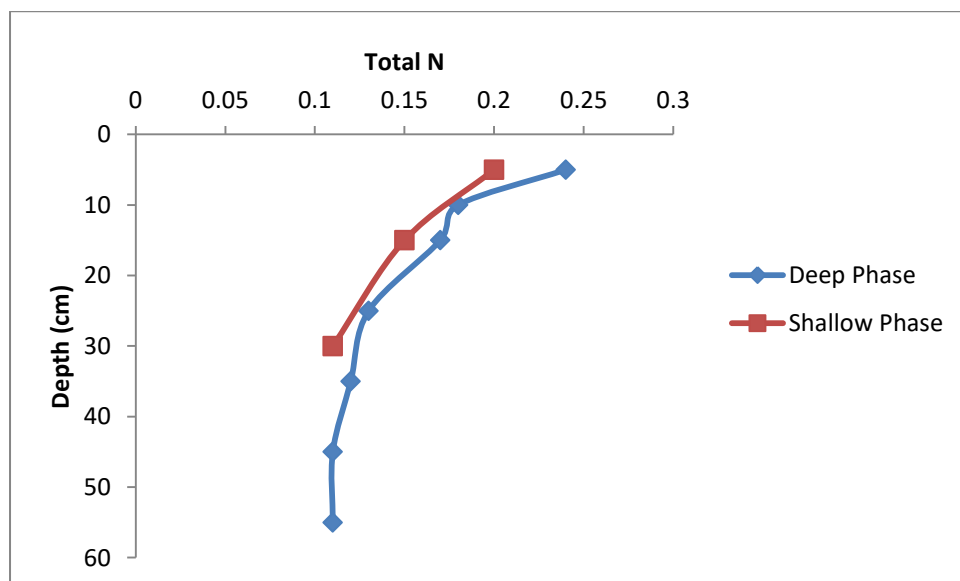


Figure 8. Change in total nitrogen with depth.

The carbon to nitrogen ratios decreased in both soil phases with a rise at 30 cm in the shallow phase due to its low N at this depth, possibly related to the major change in soil texture here to gravel (Figure 9).

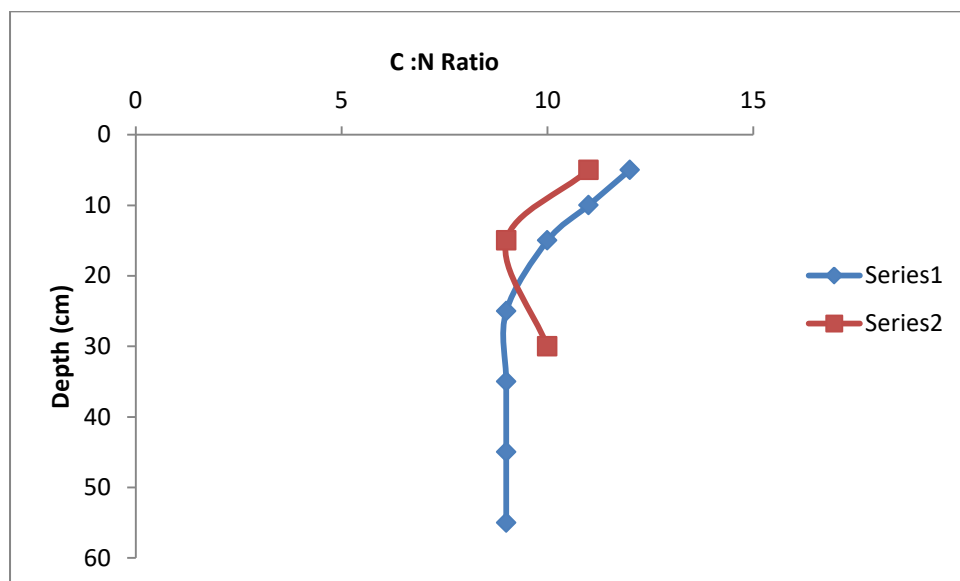


Figure 9. Change in the carbon to nitrogen ratio with depth.

Soil phosphorous levels were similarly higher in the uppermost deep soil phase and then decreased with depth in both profiles (Figure 10). The increase in P in the shallow soil phase at 30 cm may also be related to the major change in texture to gravel (Figure 3).

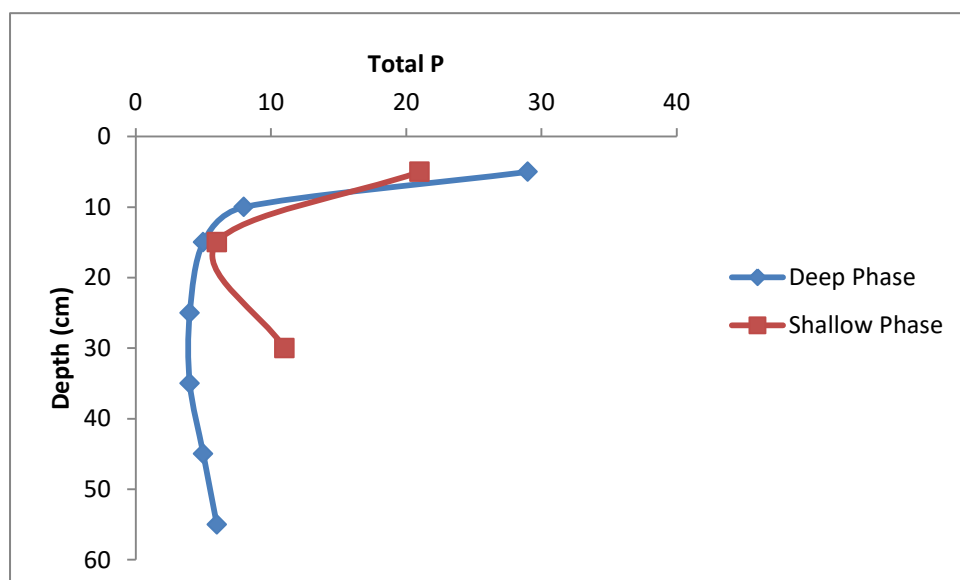


Figure 10. Change in soil total phosphorous with depth.

The metal cations potassium (K), calcium (Ca) and magnesium (Mg) also followed similar phase and depth trends down the profile: with Mg levels notably lower in the shallow phase (Figure 11).

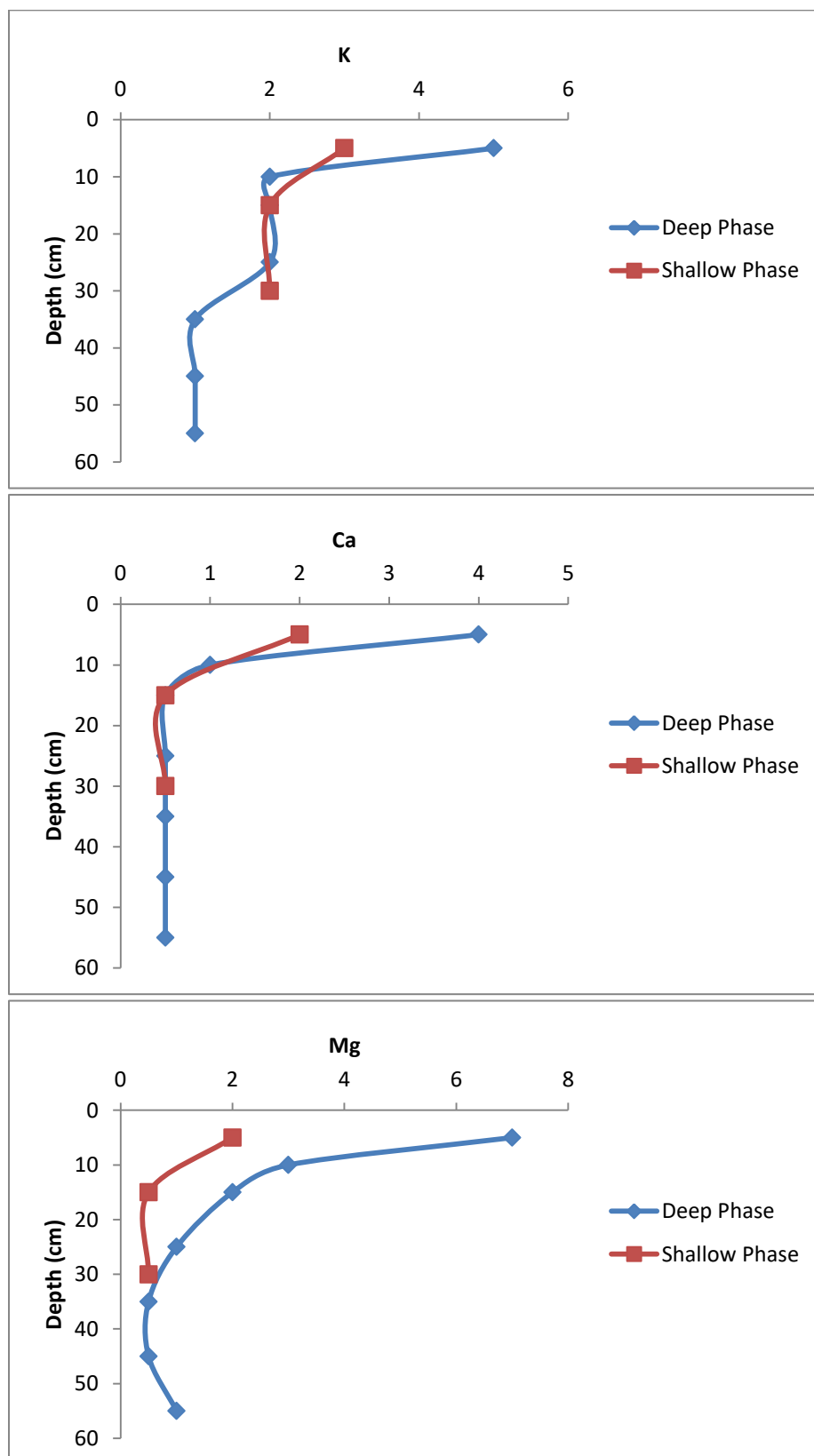


Figure 11. Change in soil cations with depth (MAF Quick Test units).

Topsoil chemistry differences between the irrigated and dryland sites are shown in (Table 1).

The dryland unfertilised site is more acidic, with notably lower potassium, calcium, sulphur and micronutrient manganese, zinc, cobalt and boron levels.

Table 1. Irrigated and Dryland topsoil chemistry.

Management	Irrigated	Dryland
Pasture	Improved	Native
pH	5.9	5.6
Potassium	0.4	0.24
Calcium	4.1	2.1
Magnesium	0.4	0.38
Sodium	0.05	0.05
CEC	9.3	12
BS%	50.5	29
Phosphorus (Olsen)	21.0	18
Sulphur (SO ₄)	8.8	2
Carbon	2.6	2.8
Organic matter	4.5	4.8
Iron	133.8	129
Managanese	18.5	9
Zinc	0.8	0.5
Copper	0.9	0.9
Boron	0.5	0.3
Cobalt	0.3	0.02
Cation % of BS		
Potassium	3.8	2.6
Calcium	42.0	23
Magnesium	4.5	4.1
Sodium	0.3	0.1
MAF Units		
Potassium	8.0	5
Calcium	5.5	3
Magnesium	10.5	8
Sodium	<2	<2

Experimental Design and Establishment

The trial will examine the interaction between BioAg Biologically Active Phosphate (BAP) and Soil and Seed (S&S) fertilisers and responses on dryland and irrigated pastures.

BAP is a highly reactive Algerian phosphate rock which has been inoculated with microbial stimulants that increases plant nutrient availability. BAP contains 13% total phosphorous with citric solubility of 37% and formic solubility of 64%. Soil and seed is a liquid biological culture containing micro-organisms which increase the functional availability of nutrients and minerals.

For the low fertility dryland site 250 kg of BAP was mixed with 500 kg lime and 50 kg of elemental sulphur and applied at a rate of 800 kg/ha in winter to match commercial soil recommendations. It was hand applied in winter together with a single rate of Actibor, supplying boron, at 1.5 kg/ha to allow time for incorporation before spring application of Soil and Seed (Figure 12). Soil and Seed was spray applied at four rates (0, 4, 8 and 12 l/ha) in a factorial design on the 18th November 2021 (Table 2).

The irrigated site as had been previously limed and fertilised with high P levels, so a BAP was applied in spring with Soil and Seed, at the same rates as previously, on the 18th November 2021 (Figures 12, 13).

Dryland BAP and Soil and Seed were applied in a randomised block design with Actinobor in four blocks, totalling 36 dryland plots. On the irrigated site a single application of BAP was applied with four rates of soil and seed in five blocks, totalling 20 plots. There was a 1 m buffer strip between dryland plots and a 2 m buffer strip between irrigated plots.

Table 2. Fertiliser application rates.

Fertiliser	Rates
Soil and Seed	0, 4, 8, 12 l/ha
Biologically Active Phosphorus Mix	800 kg/ha + 0, 4, 8, 12 l/ha S&S
Actibor	1.5 kg/ha



Figure 12. Glenbrook dryland fertiliser application plot 2 x 5 m, May 2021.



Figure 13. Glenbrook irrigated site, November 2021.



Figure 14. Soil and Seed irrigated site application, 2 x 10 m plots, November 2021.

Comment

The trial of high country BioAg fertilisers for low-fertility dryland and high-fertility irrigated pastures has been successfully established.

Drilling the dryland indicator test species lucerne is scheduled for late-November and will provide an additional indicator of fertiliser effect.

Pasture fertiliser response will be measured by mowing and by assessing lucerne establishment and growth later this season.

Acknowledgements

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