Bioprime: Impact on Yield, Soil Carbon Accumulation and Nitrogen Use

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Aim

Trials from over four years are examining different rates and timing of application of Bioprime, a liquid soil amendment which changes soil microbiology. The aim is to relate measured plant growth and yield improvement to changes in microbial populations in the soil around roots, and to show how these changes and different ways of applying nitrogen (N) impact on soil carbon accumulation.

Background

This is the third year of Bioprime trials at the long term site. A review of the last two years led to a revision of the trial design, with fewer treatment types and more replicates.

In the previous two years, rainfall was poor in the first year, but relatively good in the second. Insufficient N caused a significant yield decline in the first year, but there was no decline in the second, possibly due to increased mineralisation of N following deep ripping of the soil in the second year. The decision was made to not test different N rates and application times, but rather to lower all fertiliser to 2/3 standard practice.

In 2014 Bioscience developed a new seed dressing form of Bioprime. The 2014 trials examined the impact of this new product on grain yield, with and without subsequent application of the standard liquid Bioprime.

Trial Details

Property:	Long Term Research Site, west Buntine
Plot size & replication	12m x 1.83m x 9 replications per treatment
Soil type	Sand/sandy loam
Soil pH ($CaCl_{2)}$	0-10cm: 5.1
EC (dS/m):	0.082
Soil carbon (%)	0.64
Sowing date	07/06/2014
Seeding rate	75 kg/ha (Mace)
Fertiliser	07/06/2014: 30 kg/ha Superphosphate, 17kg/ha Potassium sulphate, 30 kg/ha Urea
Paddock rotation	2011: wheat, 2012: wheat, 2013: wheat
Herbicides	05/06/2014: 118 g/ha Sakura, 2.5 L/ha Avadex, 400 mL/ha Diuron, 2 L/ha Spray.Seed
Growing Season Rainfall	185mm

Trial Design

Half the trial used seed treated with Bioprime Seed Treatment at 3 L/tonne of grain, and the other half used untreated seed. Standard Bioprime was applied at 3 rates (3 L/ha and 6 L/ha at the 2 leaf growth stage, and 3 L/ha at both 2 leaf and tillering). Including untreated controls, this meant 8 treatments were tested in 9 replicate blocks.

Living Farm sowed and managed the trial, applying herbicides as they saw fit, undertook scoring throughout the season and harvested plots.

Data Collection

Bioscience visited the site at tillering and undertook visual rating. Plant roots were collected from healthy and unhealthy plants in the four treated and four untreated areas which showed signs of Rhizoctonia and compared to areas free of Rhizoctonia. This complemented trials undertaken elsewhere looking at the impact of Bioprime on Rhizoctonia. Root samples were recovered and the adhering rhizosphere soil was analysed by extracting DNA and undertaking ARISA profiling of microbial diversity.

Throughout the growing season, visual rating by both Living Farm and Bioscience did not show any significant differences between treatments.

2014 Yield Results

Table 1: Average Yield (converted to tonnes per hectare) from 9 replicates of each of 8 treatments. Seed treatment without additional Bioprime produced a 7.5% increased grain yield. Treatment with foliar Bioprime caused a small (3%) but not significant increase in grain yield (treatment 5 compared to treatment 1).

Trt No.	Type	Treatment Name	Yield (t/ha)
1	CHK	Untreated	1.61^{cd}
2	SDTR FERT	Seed Treated No Foliar	1.73^{a}
3	SDTR FERT	No Seed Treatment 3 L/ha Bioprime @ Tillering	1.58^{d}
4	SDTR FERT	Seed Treated 3 L/ha Bioprime @ Tillering	1.69^{abc}
5	SDTR FERT	No Seed Treatment 6 L/ha Bioprime @ Tillering	1.66^{a-d}
6	SDTR FERT	Seed Treated 6 L/ha Bioprime @ Tillering	1.71^{ab}
7	SDTR FERT FERT	No Seed Treatment 3 L/ha Bioprime @ Tillering 3 L/ha Bioprime @ Anthesis	1.64^{a-d}
8	SDTR FERT FERT	Seed Treated 3 L/ha Bioprime @ Tillering 3 L/ha Bioprime @ Anthesis	1.62^{bcd}
		LSD	0.088
		CV	5.64
		F Prob	0.022

The DNA results demonstrated no clear difference in root colonisation between treated and untreated seed, whereas application of liquid Bioprime to soil produced the expected changes in diversity within the different microbial groups tested (See Figure 1). Five of the groups, Dikarya (higher fungi), Firmicutes (formerly called gram positives), gamma Proteobacteria, Bacteroidetes and Archea showed significant increases in species diversity.

It was noteworthy that the Rhizoctonia patches were more evident in plots within the central block. We analysed the rhizosphere DNA from affected and unaffected plants within the same treatment plots. The analysis suggested Rhizoctonia is not correlated with the microbial diversity as measured by ARISA.

Complete data and statistical analysis can be viewed online at: www.biosciencewa.com/agriculture/trial results2014/Liebe.pdf

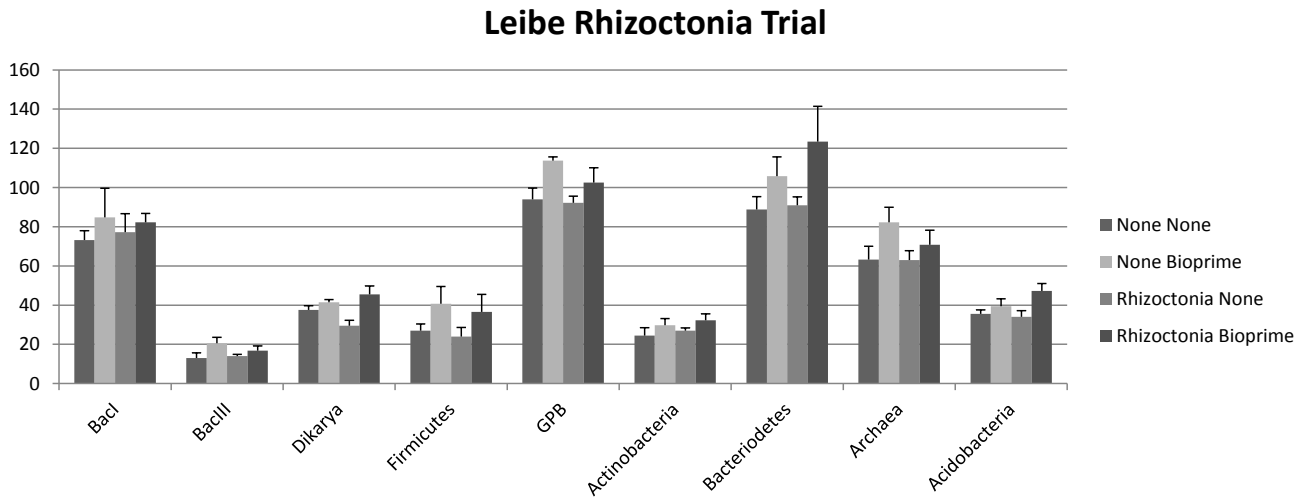

Figure 1: Graph of OTU (Operational Taxonomic Units) of 9 microbial groups from wheat rhizosphere soil. Treatment with Bioprime changed biodiversity in 7 of the 9 groups, but the incidence of Rhizoctonia was not evident from ARISA data.

Discussion

The 2014 growing season had reasonable rainfall at 190mm, compared to 162mm in 2012 and 228mm in 2013. However, there was an unusually hot and dry August which is thought to have reduced tillering and ultimately, grain yield, to an average of 1.66 t/ha (compared to 1.45 t/ha in 2012 and 2.51 t/ha in 2013).

Under these conditions the seed treatment form of Bioprime produced a better yield outcome than the foliar application. Based on $280 per tonne for wheat, and a cost of $24 per tonne to treat seed, the treatment provided a net benefit of $31.80/ha.

The DNA evidence was that seed treatment did not produce a change in rhizosphere microbial diversity as measured using the ARISA assay. Contrasting this, post emergence treatment with Bioprime produced significant changes in 5 of 9 groups tested and smaller, but not significant changes in another 2 groups. This suggests different mechanisms are operating with seed dressing and soil application of Bioprime. There did not seem to be any synergistic interaction between seed treatment and later applications, suggesting the changes in root colonisation did not have an impact of grain yield in 2014.

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