Bioprime: Impact on wheat production

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Purpose:	The trial purpose was to compare seed dressing and foliar application of Bioprime using granular and liquid fertilisers
Location:	North West Rd, Moora
Soil Type:	Tenosol, Yellow sand/sandy loam
Soil Test Results:	Refer below
Rotation:	Wheat/Lupins
Growing Season Rainfall (April- October 2015):	324 mm (Moora)

BACKGROUND SUMMARY

Bioprime is a patented ferment of molasses (patent number: WO2014082130 A1) that is applied as a seed coating, or foliar and soil spray. It contains many diverse carbon compounds that elicit different functions in the soil. Firstly, certain Bioprime constituents such as 2,3-Butanediol and acetoin have been shown to improve plant growth directly (Ruy et al., 2003). Secondly, the labile carbon compounds of Bioprime will stimulate the microbial activity in the soil as a whole – a process known as the soil priming effect. Finally, the furanones in Bioprime directly influence certain members of the soil microbial community (Bais et al., 2006) that potentially colonise plant roots. Bioprime suppresses non-beneficial bacteria, and promotes the growth of plant-beneficial bacteria and fungi. Bioprime causes an overall increase in the biodiversity of microbes associated with roots. The actions of Bioprime are hormonal in nature, so application rates are very small, thereby making it a cost-effective soil management tool.

The 2016 Bioprime trial at the WMG site was conducted to investigate the interactions of Bioprime application with in-furrow liquid fertiliser compared to conventional granular fertiliser, and their effects on plant growth and grain yield. Bioprime was added as a seed dressing (2 L/t seed), and/or as a post emergence spray (4 L/ha). This is the fifth of Bioprime field trials (three previous years with Liebe Group at Buntine and at Forrestdale with different crops). West Midlands Group (WMG) trial design in 2016 was replicated exactly at the Liebe Group and to some extent at Forrestdale in 2016.

In addition to agronomic outcomes, the trial has also been sampled for molecular biological analysis of wheat rhizosphere and phyllosphere microbial communities. This is to investigate the links between root and plant colonisation by beneficial bacteria and fungi with Bioprime application and growth improvements. These data are currently being analysed at Bioscience.

TRIAL DESIGN

Fully factorial randomised block design, 9 treatments, 8 replicates of each.

Plot size: 12 m x 2.4 m x 6 rows

Machinery use: Living Farm, small plot seeder & harvester.

Repetitions: 8 Replicated randomised Blocks

Crop type and varieties used: Wheat (Mace)

Seeding rates and dates: 75 kg/ha, 15/06/2016

Fertilizer rates and dates: 100 kg/ha Gusto Gold, 50 kg/ha Urea, post 50 L/ha UAN

Herbicide rates and dates: pre: 1.5L/ha Glyphosate, 2L/ha Trifluralin, 118g/ha Sakura, 400g/ha Diuron. Post emergent 1L/ha Velocity.

Other applications/ treatment rates and dates: Pre-emergent insecticides 1L/ha Chlorpyrifos, 300 ml/ha Bifenthrin.

TRIAL LAYOUT

Treatment List

Factor Treatment	Fertiliser Granular/Liquid	Seed Treatment	Bioprime 4L	Bioprime Tillering
1	Granular	N/A	0	
2	Granular	N/A	4	
3	Granular	Bioprime	0	
4	Granular	Bioprime	4	
5	Liquid	N/A	0	
6	Liquid	N/A	4	
7	Liquid	Bioprime	0	
8	Liquid	Bioprime	4	
9	Liquid	Bioprime	4	4

Trial Layout

West	9	1	6	7	4	3	5	8	2	5	2	3	1	7	4	6	8	9	East
	6	8	1	2	4	7	9	3	5	5	7	1	8	9	2	3	6	4	
	2	1	5	9	4	7	6	8	3	9	4	1	6	3	2	7	8	5	
	8	9	4	6	5	2	1	7	3	5	8	9	1	4	3	6	7	2	

RESULTS/STATISTICS

The fully factorial trial design analysis showed the greatest significant difference was across field variability, with high variance between replicate blocks. This was also found for the Liebe Group trial. The next most significant difference was with granular versus liquid fertilisers, where granular fertiliser produced 4% higher yield overall ($p > 0.05$), even though NPK application rates were identical. This was also found for the Liebe Group trial.

Across field variability is reflected in the pre-sowing soil analysis of the three trial sites. (Table 1 – the range of data reflect soils collected from the north and the south of the WMG trial area). Compared to other sites, the WMG site was more acidic, and had lower levels of

P and exchangeable cations, whereas it had higher soil carbon than the Liebe site at Buntine.

Yield data from the entire dataset (3 sites) is presented in Table 2.

Table 1: Soil parameters (0-15cm) for 2016 Bioprime wheat field trials at the Liebe Group, WMG and Forrestdale. All were sandy Tenosols with less than 3% clay content

Analytes	Unit	Forrestdale	Liebe	WMG
Electrical Conductivity	mS/cm	0.04 – 0.06	0.1	0.05 – 0.08
pH - $CaCl_2$	-	5.9	5.5	4.5 – 4.6
pH - H_2O	-	6.2 – 6.3	6.1 – 6.3	5.4 – 5.5
Ammonium-N	mg/kg	10.5 – 18.8	<0.01 – 1.13	2.09 – 3.25
Nitrate-N	mg/kg	0.74 – 1.40	16 – 17	6.0 – 21.5
Phosphate-P	mg/kg	17.2 – 28.1	9.0 – 11.8	7.60 – 7.96
Exchangeable Calcium	mg/kg	589 – 1040	755 – 896	285 – 348
Exchangeable Magnesium	mg/kg	144 – 216	46.6 – 73.1	34.5 – 38.9
Exchangeable Sodium	mg/kg	32.5 – 35.3	49.3 – 57.0	36.6 – 57.0
Exchangeable Potassium	mg/kg	9.99 – 18.6	48.7 – 81.3	30.7 – 36.9
Carbon	%	1.02 – 1.42	0.50 – 0.66	0.70 – 0.75
Sulphur	%	0.009 – 0.010	0.002 – 0.01	0.007 – 0.009

Table 2: Yield results for 2016 Bioprime wheat field trials at the Liebe Group, West Midlands Group (WMG) and Forrestdale. Standard error is given in parentheses. For each site highest yields are bold and underlined.

Treatment No.	1 (control)	2	3	4	5 (control)	6	7	8
Fertiliser	Granular	Granular	Granular	Granular	Liquid	Liquid	Liquid	Liquid
Seed treatment	None	None	Bioprime	Bioprime	None	None	Bioprime	Bioprime
Foliar treatment	None	Bioprime	None	Bioprime	None	Bioprime	None	Bioprime
Grain yield	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)
Liebe Group	3.45 (±0.04)	**3.63** (±0.18)	3.34 (±0.05)	3.39 (±0.10)	3.27 (±0.07)	3.28 (±0.09)	3.39 (±0.08)	3.28 (±0.06)
WMG	2.20 (±0.09)	2.23 (±0.06)	**2.33** (±0.09)	2.29 (±0.07)	2.11 (±0.05)	2.28 (±0.08)	2.11 (±0.09)	2.13 (±0.07)
Forrestdale	1.88 (±0.15)	**2.34** (±0.19)	n.d.	2.08 (±0.13)	n.d.	n.d.	n.d.	n.d.
Average yield response%	100%	**110%**	101%	104%	100%	104%	102%	101%

n.d. = no data.

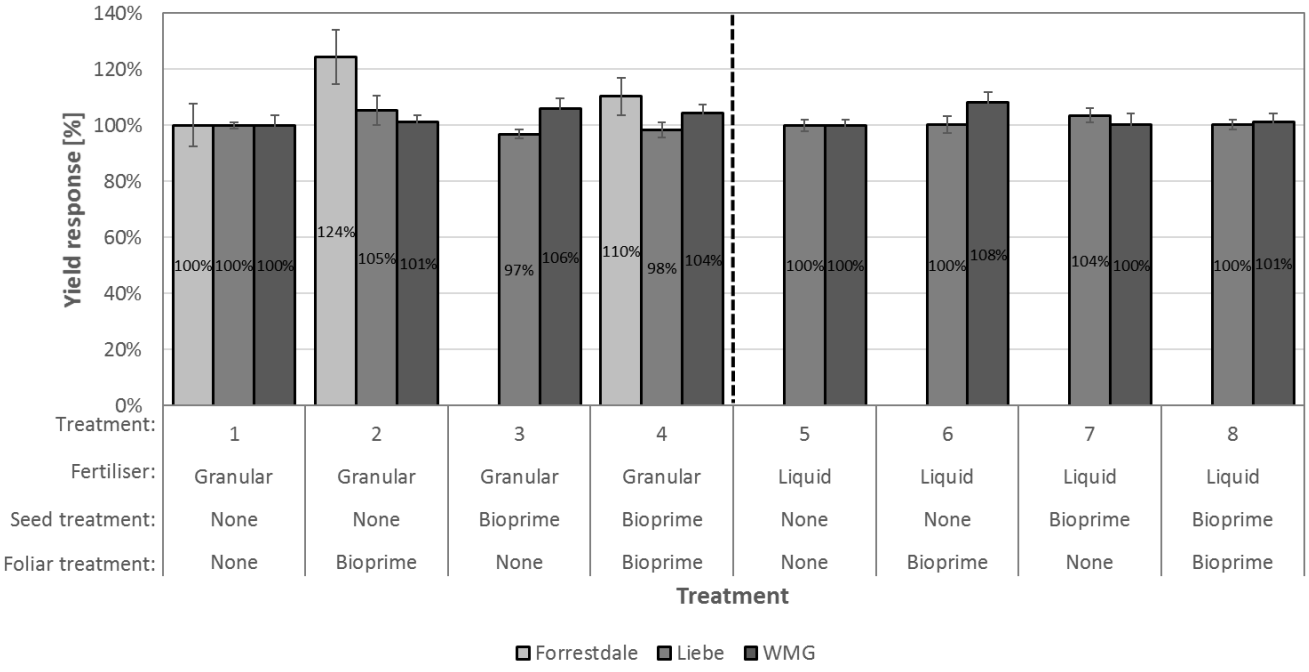

Figure 1: Comparison of yield response across three trial site for 2016, using data from all trial plots

Because significant across field variance largely obscured the trend of results, and because many replicates were used, data was transformed by removing outliers, being the smallest and largest yield plots for each treatment. This produced a clearer, and more statistically significant picture of trial outcomes at WMG.

Table 3 shows:

- With granular fertilisers, both the seed treatment and foliar applications produced small, but statistically insignificant yield increases. Using both treatments produced a 7% yield increase ($p < 0.05$)
- With liquid fertilisers, the foliar application of Bioprime produced a 10% yield increase ($p=0.01$), whereas Seed Treatment did not increase yield, but rather reduced the impact of the foliar treatment with Bioprime.
- A double application of foliar Bioprime (at 2 leaf and tillering) did not improve yield compared to a single, early application.

Table 3. Yield of Bioprime treated plots with highest and lowest scores removed from each block

Treatment									
Bioprime (4L) Spray	0	4	0	4	0	4	0	4	4+4
Seed Treated	None	None	BP	BP	None	None	BP	BP	BP
Fertiliser	Granular	Granular	Granular	Granular	Liquid	Liquid	Liquid	Liquid	Liquid
Treatment #	1	2	3	4	5	6	7	8	9
	2.40	2.26	2.64	2.36	2.12	2.14	2.39	2.29	2.14
	2.16	2.22	2.41	2.36	2.15	2.46	2.03	2.22	2.11
	2.10	2.22	2.11	2.36	2.21	2.34	2.16	2.20	2.29
	2.32	2.06	2.16	2.28	2.06	2.14	2.08	1.97	2.18
	1.99	2.42	2.39	2.44	2.14	2.46	2.15	1.93	2.20
	2.18	2.13	2.14	2.28	1.97	2.33	2.08	2.07	2.16
Mean	2.19	2.22	2.31	2.35	2.11	2.31	2.15	2.11	2.18
Median	2.17	2.22	2.27	2.36	2.13	2.34	2.12	2.13	2.17
StDev	0.147	0.124	0.208	0.060	0.084	0.142	0.129	0.145	0.063
Var	0.022	0.015	0.043	0.004	0.007	0.020	0.017	0.021	0.004
StError	0.05	0.04	0.07	0.02	0.03	0.05	0.05	0.05	0.02
% diff		**101.288**	**105.352**	**107.136**		**109.737**	**101.958**	**100.206**	**103.503**
Average				104.592					103.851
t-Test p value		0.72681	0.28522	0.03637		0.01243	0.52562	0.95071	0.11491

FINANCIAL ANALYSIS OF RESULTS

Using granular fertiliser, application of Seed Treatment (@ $1.80/ha) and 4 L/ha of foliar Bioprime (@ $8/ha) produced 160 kg/ha additional grain, or (assuming $250/tonne for wheat) a $40 return for $9.80 spent. Using liquid fertiliser, application of 4 L/ha of foliar Bioprime (@ $8/ha) produced 200 kg/ha additional grain, or (assuming $250/tonne for wheat) a $50 return for $8 spent.

OBSERVATION/ DISCUSSION/ MEASUREMENTS

The West Midlands site had an average yielding year for the Moora area. The Liebe Long Term Research Site had a good growing season in terms of rainfall and seasonal distribution. The average yield was about 50% higher than previous wheat trial years. This was similar to Forrestdale which also had good rainfall and seasonal distribution.

On average, all Bioprime treatments combined resulted in a 4% yield increase. Treatment 2 (foliar Bioprime and granular fertiliser) performed best, achieving a 10% yield increase averaged across the three sites). At the WMG site, five Bioprime treatments resulted in positive yield responses whereas this number was lower at the Liebe site (2 treatments). With data corrected for outliers, all Bioprime treatments resulted in a positive yield response. Given

that the Liebe site, relative to the WMG site had a higher soil pH, and higher pre-seeding phosphate and exchangeable cations concentrations (Table 2), an average higher yield was expected and achieved here compared to the WMG (3.36 t/ha and 2.15 t/ha, respectively in unamended control treatments). Thus, the higher soil quality and soil health present at the Liebe site combined with the good 2016 season in terms of rainfall likely narrowed the yield gap.

As such any management options aiming to close the gap between actual and potential yield, would have had less scope to achieve this at the Liebe site in 2016. In contrast, the lower soil fertility at the WMG allowed Bioprime to more consistently improve crop production. The 2016 data suggest the opportunity to improve yield on a poor soil in a poor year is greater than on good soil in a good year.

Ongoing research will continue to further develop Bioprime technology as a tool to improve soil biology and maintain plant health and yield. There is a substantial database of microbiological and yield results which continues to expand with the expectation of understanding the links between root and plant colonization by beneficial bacteria and fungi with Bioprime application and growth improvements.

References

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