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Three Year Study Shows Biostimulant Enhanced Anhydrous Ammonia Reduces Agriculture Production Costs

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Biostimulant enhanced anhydrous ammonia reduces agriculture production costs

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Abstract:
The use of biostimulants for enhancing efficiency of fertilizers has a chequered history with many field demonstrations leaving economic validation wanting. Success of the innovation using organic biostimulant coated urea for improving production economics, prompted further research to enhance efficiency of anhydrous ammonia in irrigated agriculture in Queensland, Australia where anhydrous ammonia is a common fertilizer used in flood irrigation systems.
Anhydrous ammonia is a toxic gas applied to soil under temperature controlled pressure. This has a deleterious impact to the soil organic matter and biota which facilitate fertiliser use efficiency. The research combined refined organic acids and bio-catalysts with anhydrous ammonia during its application, and explored yield response, production economics and residual soil nitrogen.
The biostimulant efficiency mechanism is to capture, control and store ionic and organic forms of nitrogen to reduce the environmental losses of fertilizer nitrogen and promote a more sustained availability of nitrogen to the rhizosphere.
A three year commercial scale demonstration in irrigated cotton has produced equivalent yields to usual practice even when reducing application rates by 20%. This has reduced the cost of nitrogen per production unit (bales of cotton lint) by >15%.
This improved nitrogen use efficiency not only improves the growers' production economics, but improves global goals by directly impacting the reduction in carbon footprint due to fertilizer use.

Key Words:
biostimulants, anhydrous ammonia, nitrogen use efficiency, enhanced efficiency fertilizer

Background:

Final Report: July 2014
Crop: Irrigated Cotton
Location: “Brookglen”, St George. QLD. Australia.
Researcher: David Hall – Pathway Ag Research Consultants
Benefactor: EcoCatalysts Pty Ltd

Treatments (each year):

Anhydrous Ammonia supplied by Incitec Pivot Ltd – Big N is a registered trademark of Incitec Pivot Ltd
Biostimulants supplied by Advanced Nutrients Pty Ltd – EnhanceMax is a Trade Mark of EcoCatalysts Pty Ltd.

1. BIG N® @ 183kgs/ha (AA(150))
2. BIG N® plus EnhanceMax™ @ 183kgs/ha + 6.7L/ha (AA(150)+EM)
3. BIG N® plus EnhanceMax™ @ 146kgs/ha + 5.5L/ha (AA(120)+EM)

Treatment Legend:

AA(150)	Anhydrous Ammonia @ 150kgsN/ha
AA(150)+EM	Anhydrous Ammonia @ 150kgsN/ha + 3.65% EnhanceMax
AA(120)+EM	Anhydrous Ammonia @ **120kgsN/ha** + 3.65% EnhanceMax
and	
AA(150)	Usual Practice
AA(120)+EM	Enhanced Efficiency Fertiliser (EEF)

Method:

The fertility of the soil at the commencement of this trial should be noted as being typical of the St George Irrigation district, i.e. a grey clay soil with a moderately alkaline surface which increases with depth. There are no significant sub soil constraints although the ESI in the 30 – 60 cm strata is 0.027, this is not considered serious as there is sufficient irrigation water to prevent any ion competition. Potassium, other cation levels and trace elements are non-limiting. The field has a natural fertility gradient north to south.

During September of each year (2010, 2011, 2012) soil tests were taken from Field 134 to at depths of 0–10cm, 10–30cm and 30-60cm. The amount of applied nitrogen was based on usual practice on the farm, with the full amount being 150 kgsN/ha (183kgs/ha of fertiliser) and the 20 % less amount being 120 kgsN/ha (146kgs/ha fertiliser).

Each treatment was applied in four replications to plots approx. 1.0-1.2 ha each, a total of 5 – 5.5 ha per Treatment. Plots were placed in randomised row design to facilitate commercial farming practices.

The fertiliser, with and without amendments, was applied 10cm deep in the band by Cold Flow application method in mid-September all years. The biostimulant was dribbled on top of the fertiliser in the soil before the press wheel closing the slot.

Fig1: Application of biostimulant with anhydrous ammonia

Planting of Sicot 74 BRF variety cotton (*Gossypium hirsutum*) took place the 10-11th November 2010, 3-4th October, 2011 and 13-14th November, 2012. All years considered late due to environmental conditions, especially so in Year 1 and 3. 80kgs MAP was applied to all plots at planting in all years as is usual practice.

According to the assessment of the protocol, soil samples (0 – 10 cm and 10 – 30 cm depth in-crop, additionally 30-60cm post harvest) were to be collected approx. 7, 14, 21 and 28 days post emergence and again post harvest. Analysis required for a minimum of nitrate, ammonium, phosphorus, sulphur conducted under ASPAC/NATA approved methods.

This sampling programme unfortunately didn't occur in Year 1 except for a single test taken 29th November due to rain making it impossible to sample the soil. Environmental conditions hampered some sampling in subsequent years, Year 2 allowed samples to be collected 7, 19, and 28 days after emergence, and Year 3 allowed sampling 7, 14, 26, 38 days after emergence. All years post-harvest sampling occurred in July.

A severe hail event in late December of Year 3 caused some typical bruising of stems, leaf shredding and knocked of squares equally across all treatments. An application of Urea/MAP blend (20kgsN/ha + 4kgsP/ha) across all treatments aided in a successful crop recovery although yields were slightly down as a result.

Fig2: Yr3 hail effected cotton

Fig3: Yr3 recovered cotton after hail

In-crop operations was handling under commercial conditions by the farm owner and management. Tillage, irrigation, weed and pest control and other farm operations is run under a Best Management Practice (BMP) Program and was the same for all treatments operated as one entire field.

The field was picked on 2nd May 2011, 22nd April, 2012 and 30th May, 2013 respectively Years 1-3. Private contractor with yield measurements taken directly from the yield monitoring equipment in the 4 row cotton picker.

Within each trial plot there were 4 passes (16 m width per plot) by the machine which provided data for each pass; this was recorded separately rather than bulking the results as some passes were on the outside and others on the inside. Results were all analysed individually to allow greater rigour and data integrity.

Full raw data sets are available on request.

Results:

If we accept that the highest yield may not always be the most profitable crop, the pursuit of reducing input costs may result in a reduction in overall yield per hectare. This may reduce one input cost but the reduced scale may increase other costs. It is therefore desirable to maintain or increase yield whilst reducing the input costs of fertiliser.
This study is to determine three points: Yield under both usual practice and enhance efficiency, Economic viability as related to costs of fertilizer per unit of production, impact on soil nutrient Reserves.

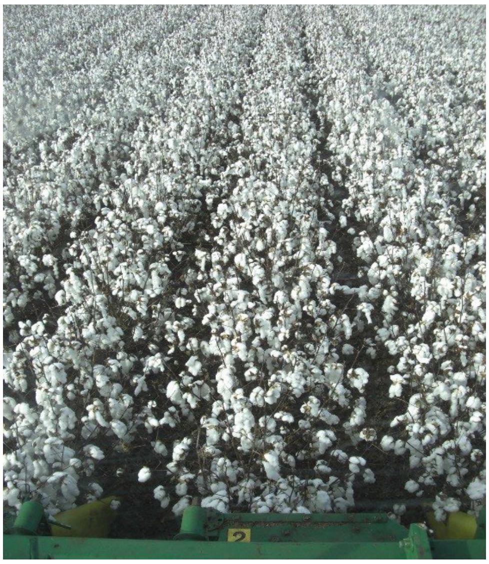
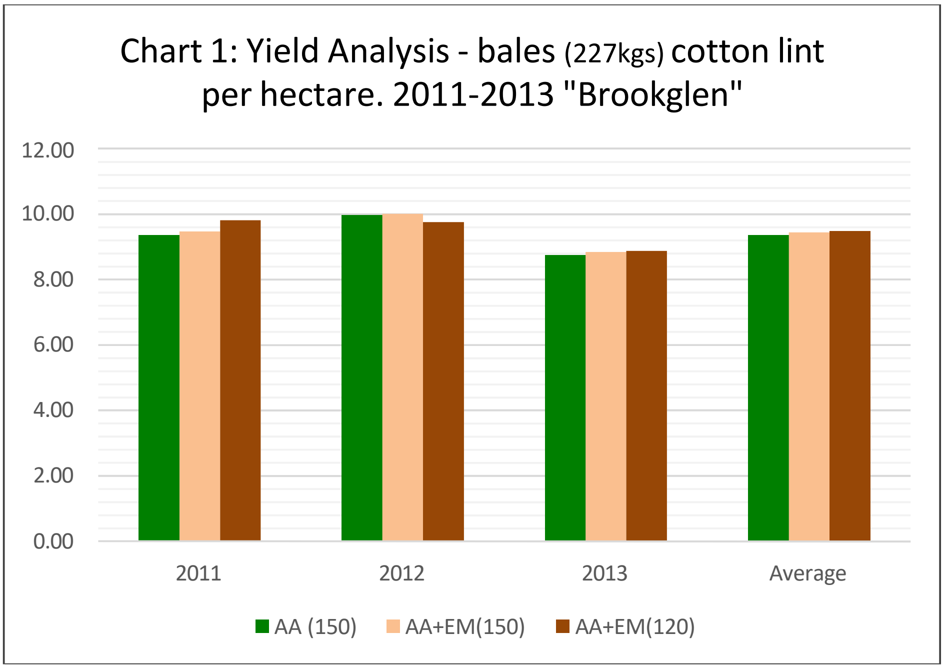


Fig4: Final year cotton harvest

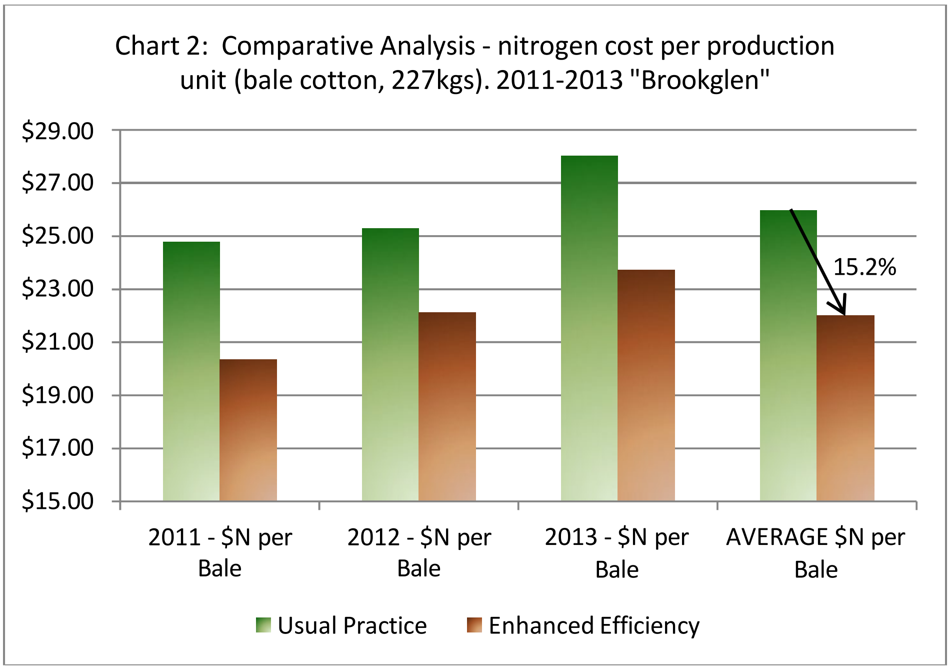
Yield

All three treatments over all three years produced similar results with no significant difference between treatments (Chart 1). Year 3 results are noticeably reduced due to hail impacts.



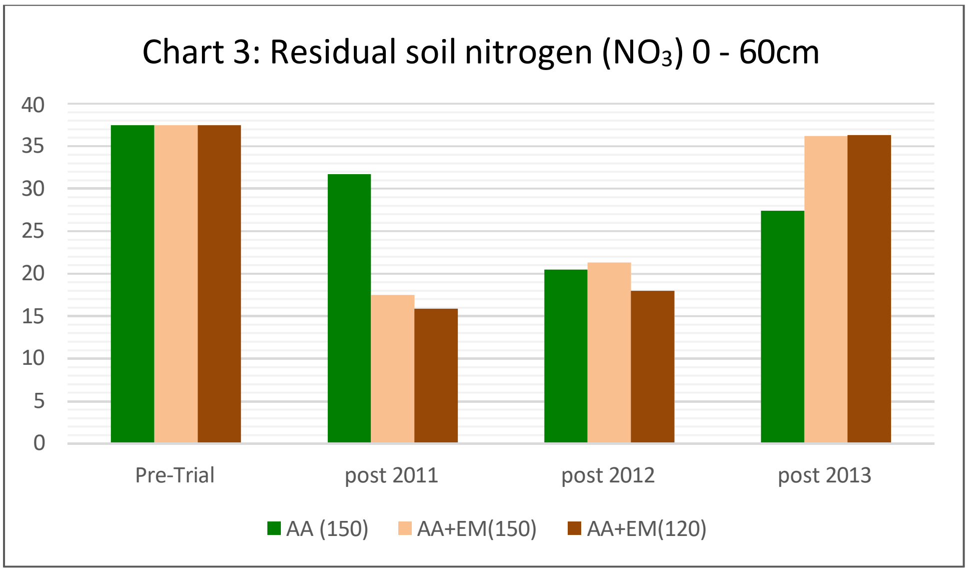
Economics

Nitrogen carried an impost of A$1.33/kgN (av. A$1090 per tonne fertilizer) over the 3 year study period. A simple economic analysis of the nitrogen related production costs discovered the cost of nitrogen per bale (227kgs) of cotton lint, over the 3 year study, averaged A$25.97 when applied as anydrous ammonia (Usual Practice – AA (150)).
The biostimulant enhancement of the fertiliser (Enhanced Efficiency – AA+EM(120)) allowed a reduction in nitrogen applied that reduced the cost of nitrogen per bale of cotton to A$22.01 per bale (Chart 2).



Nitrogen Reserves

Residual soil nitrate content was measured before the study began and then post harvest of every year. Though some differences were observed between treatments, it is clear amongst all treatments that nitrogen is not being "mined", particularly in the treatment using 20% less nitrogen applied (AA+EM(120)). Differences in post 2011 may be a sampling error, increases in post 2013 are possibly due to the hail induced application of additional fertilizer. (Chart 3).



Conclusion:

The focus of this study is on the commercial benefit if any of using biostimulants with conventional fertiliser to improve production economics through increased fertiliser use efficiency.

In the case of using the organic acid based biostimulant, EnhanceMax™, with Anhydrous Ammonia, BigN®, in irrigated cotton production, the answer is affirmative to an increase in economic benefit and a 20% reduction in greenhouse gas emissions from the ammonia production.

The results of the study have yielded a reduction in nitrogen cost per unit of production of 15.2% with no loss of overall yield produced or mining of soil fertility.

Appendix 1

Tables:

Table 1: Yield Analysis

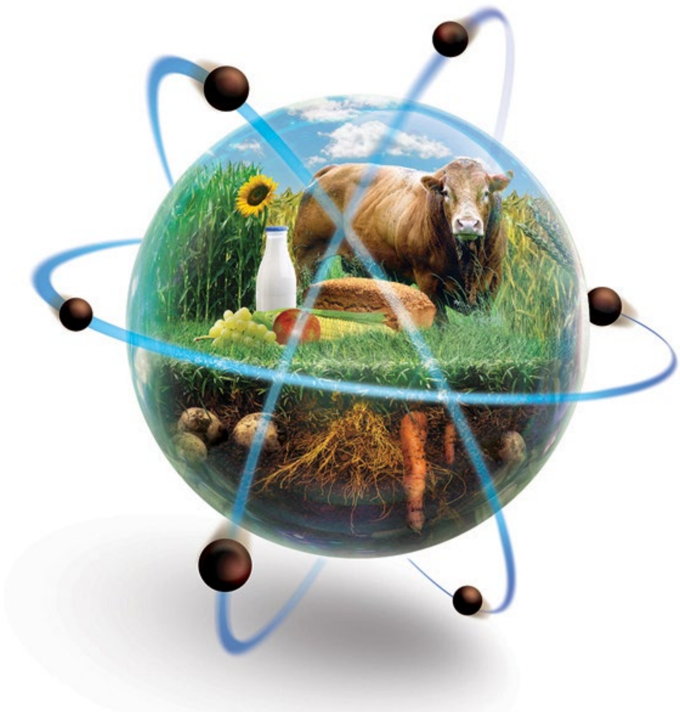
	AA (150)	AA+EM(150)	AA+EM(120)
2011	9.36	9.47	9.82
2012	9.97	10.01	9.75
2013	8.76	8.84	8.87
Average	9.37	9.44	9.48

Table 2: Economic Analysis

	Usual Practice	Enhanced Efficiency	
2011 - $N per Bale	$24.79	$20.36	17.88%
2012 - $N per Bale	$25.28	$22.13	12.47%
2013 - $N per Bale	$28.03	$23.72	15.37%
AVERAGE $N per Bale	$25.97	$22.01	15.24%

Table 3: Residual soil NO_3

	AA (150)	AA+EM(150)	AA+EM(120)
Pre-Trial	37.5	37.5	37.5
post 2011	31.7	17.5	15.9
post 2012	20.5	21.3	18
post 2013	27.4	36.2	36.3



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