Envirosystems – SlurryBugs and SlurryBooster Slurry Additive Trial - 2011

Confidential Report for Envirosystems Ltd

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Disclaimer:
The Protocol followed by Kingshay for the study was that considered most appropriate to the technical knowledge and practical conditions at that time and was designed to reflect farming practice.

All results and interpretations reported are specific to the product described in the report and also to the conditions which prevailed during the study.

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1 Slurry additive trial

The trial objective was to determine the effects of SlurryBugs slurry additive on the handling characteristics and nutrient value of slurry compared with a negative (no additive) control.

1.1 Materials and methods

1.1.1 Week 0

- Freshly scraped slurry from the lagoon at Bridge Farm, Somerset was used to fill 60lt barrels with 40lt of slurry, 3 barrels for the treated slurry and 3 barrels for control. A slurry sample was taken for quality analysis.
- SlurryBugs and SlurryBooster additive was added to the 3 treatment barrels at the agreed rates i.e.:
    - 88 mg SlurryBugs; 2.2g/m^3
    - 88µl SlurryBooster;2.2ml/m^3

  This was added to de-ionised water and briefly stirred to mix the additive into the slurry
- The same quantity of water was added to the control slurry.
- The containers were then stored at an ambient temperature of approximately 15°C

1.1.2 Weekly treatments

An additional litre of fresh slurry was added to all barrels each week via a funnel to minimise crust disturbance:

- Treated barrels. 1 litre of slurry plus 2.2 mg of SlurryBug additive (55g/m^3) and 2.2 µl SlurryBooster (0.055 ml/m^3). This was diluted with de-ionised water to enable accurate measurement
- Control barrels. 1 litre of slurry plus 10ml of de-ionised water

1.1.3 Four weekly testing. Weeks 4 and 8

- Samples of slurry were extracted from below any slurry crust formation with minimal disturbance to the crust
- Laboratory analysis of these samples was undertaken by NRM Ltd, Bracknell, Berks (nutrient analysis) and Sciantec Ltd, Cawood, Yorks (Bacterial Counts), in accordance with the agreed protocol

1.1.4 Week 12

- Samples of slurry were extracted from below the slurry crust with minimal disturbance of the crust
- Samples were analysed as in 1.1.3 above
- The following measurements were taken for the slurry crust:
    - Shear strength – measured by a 33 mm Shear Vane (Pilcon Engineering, Basingstoke. Hants)
    - Depth
    - Weight

2 Results

Data measured during the trial were subjected to a statistical analysis of variance (ANOVA). Results are presented as:

- Standard Error of the Mean (SEM). The standard deviation of the error in the sample mean relative to the true mean
- Significance probability (p) at the p = 0.05 level (95%) i.e. levels of p <0.05 indicate that the differences between treatments are statistically significant
- Least Significant Difference (LSD). The minimum difference between treatments needed before the difference is statistically significant

The following results relate to any nutrient and bacterial parameters that were determined to be statistically significant from the Control treatment or are of particular interest. Crust parameters are discussed separately. For detailed laboratory results see Appendix 1, Tables 1 - 3.

2.1 Total Nitrogen (N)

Total N% of the SlurryBugs treated slurry increased significantly compared with the untreated control slurry (Figure 1). Total N averaged 17.5% higher for the treated slurry compared with the control treatment over the three test results.

The higher level of N was statistically significant for two of the three 4-weekly tests and peaked at 25% higher N for the treated slurry in the final test. Total N% peaked at the 8 week analysis.

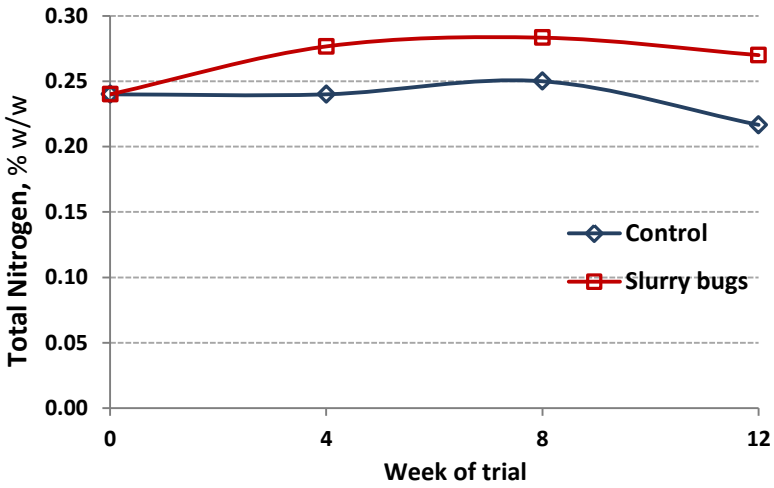

Figure 1. Total Nitrogen percentage of the SlurryBug treated slurry compared with control. Kingshay Slurry Additive Trial 2011

2.2 Ammonium Nitrogen (NH_4)

Total NH_4 of the SlurryBug treated slurry increased significantly compared with the untreated control slurry (Figure 2). Total NH_4 averaged 17% more for the treated slurry compared with the control treatment over the three test results.

The higher level of NH_4 was statistically significant for all of the three 4-weekly tests, peaking at 22% higher NH_4 for the treated slurry after 4 weeks.

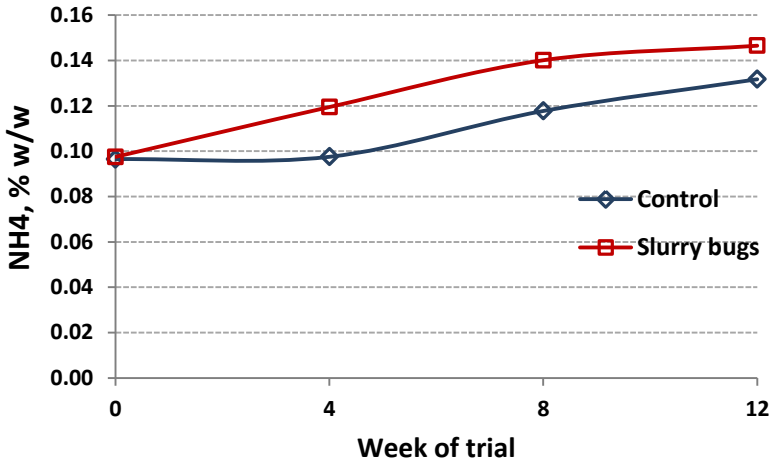

Figure 2. NH_4 in the SlurryBug treated slurry compared with control. Kingshay Slurry Additive Trial 2011

2.3 Organic N v. Mineral N

Increased levels of NH_4 in the SlurryBug treated slurry indicate the likelihood of increased mineralisation of organic N. Figure 3 shows the potential split between organic N and mineral N after the 12 week treatment period, assuming Total N is purely a combination of these two categories of N.

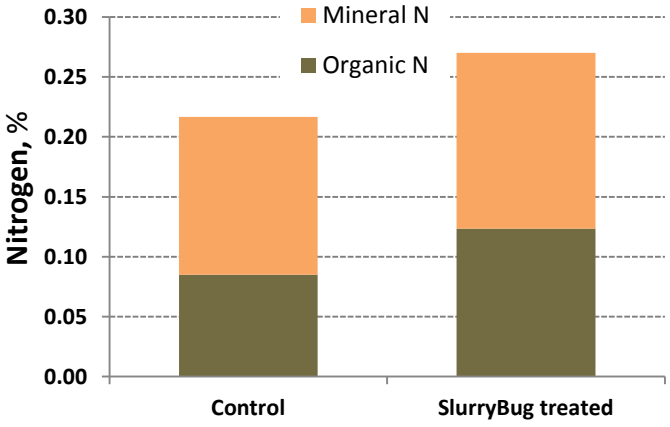

Figure 3. The division of Total Nitrogen between organic and mineral N at the end of the trial (week 12). Kingshay Slurry Additive Trial 2011

This increased mineral N (NH_4) in the treated slurry is potentially worth approximately £0.14 per tonne freshweight of slurry (based on the price of AN @ £330/tonne). Increased Total N, however, may be as a result of bacterial N which is likely to be more quickly plant available. On the assumption that all increases in Total N are either a result of increased levels of NH_4 or other readily available forms, the increased plant available N could potentially be 530 g /tonne freshweight of treated slurry with a value of an additional £0.51 per tonne.

2.4 Slurry Dry Matter (DM)

A reduction in slurry DM may indicate an increase in solids accruing together as a crust or sedimentation to the bottom of the test barrel (monthly sampling of slurry was taken below the crust layer). Differences between the treated slurry and control were not significant although the SlurryBug treated slurry did have a tendency to have a higher DM compared to control (Figure 4).

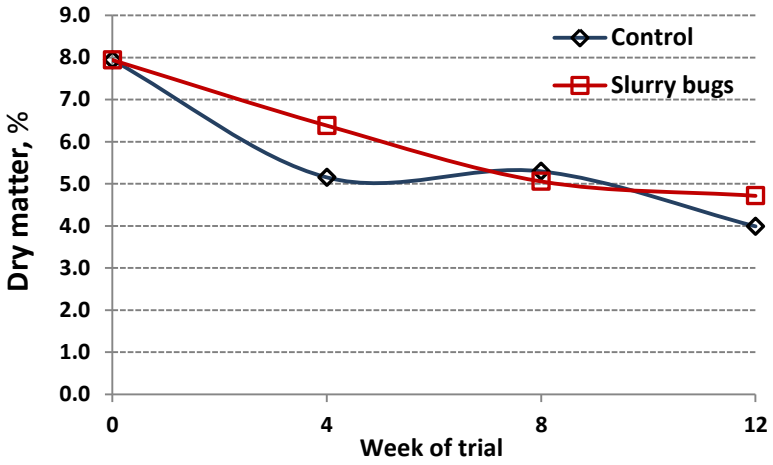

Figure 4. Change in Dry matter over the 12 week trial period. Envirosystems SlurryBugs compared with control. Kingshay Slurry Additive Trial 2011

2.5 Slurry crust measurement

Slurry crust measurements indicated that crust weight, shear strength and depth were less for the treated slurry although these differences were not statistically significant (Appendix 1 Table 4).

2.6 Mineral levels

No significant changes in mineral levels in the slurry were measured.

3 Summary

SlurryBugs and SlurryBooster slurry additive treated slurry produced a slurry with a significantly greater level of Total N and Ammonium N compared with a non treated control over a 12 week trial period. This equated to an increase in the value of the treated slurry by up to £0.51 /tonne (fresh weight) of slurry.

Slurry dry matter was not significantly different for the SlurryBugs treated slurry compared with the control. No significant difference was determined for crust formation between the SlurryBugs treated slurry and the control.

Based on the results of this trial SlurryBugs slurry additive could improve the level of plant available Nitrogen from stored slurry. The economic benefit will depend on the cost of the product relative to the potential benefit.

Appendix 1

Table 1

Slurry parameter means. End of Week 4 – Envirosystems SlurryBugs

		Control	SlurryBugs	Difference	SEM	P=0.05	LSD
Total Nitrogen	% w/w	0.240	0.277	0.04	0.0119	**0.128**	0.063
NH4 Nitrogen	% w/w	0.0975	0.1195	0.022	0.0005	**0.028**	0.016
Nitrate Nitrogen	% w/w	<0.01	<0.01	0.00	n/a	n/a	n/a
Total Phosphorous (P)	% w/w	0.025	0.032	0.01	0.00236	0.235	0.018
Total Potassium (K)	% w/w	0.204	0.210	0.01	0.0121	0.791	0.085
Total Magnesium (Mg)	% w/w	0.040	0.047	0.01	0.00232	0.181	0.015
Total Sulphur (S)	% w/w	0.018	0.022	0.00	0.00149	**0.039**	0.004
Total Copper (Cu)	mg/kg	4.710	6.667	1.96	0.598	0.156	3.784
Total Zinc (Zn)	mg/kg	7.613	10.777	3.16	0.984	0.145	5.837
Total Sodium (Na)	% w/w	0.030	0.030	0.00	0.00099	1.00	0.007
Total Solids	%	5.153	6.383	1.23	0.438	0.281	3.617
Total Calcium (Ca)	mg/kg	1,007	1,192	185.33	70.4	0.189	407.1
pH		7.23	7.19	-0.04	0.0378	0.642	0.317
Chloride (Cl)	mg/kg	708	714	6.00	27.8	0.911	204.92
BOD	mg/l	15,033	13,000	-2033	796	0.315	6583.9
TVC Anaerobic 5 days 22C	cfu/g	5,900,000	5,533,333	-366,667	1,041,607	0.68	3,308,369
TVC Anaerobic 1 day 37C	cfu/g	1,733,333	1,733,333	0	138,243	1.00	1,739,036
TVC Aerobic 5days 22C	cfu/g	13,100,000	13,866,667	766,667	2,094,822	0.63	5,860,089
TVC Aerobic 1 day 37C	cfu/g	17,000,000	9,033,333	-7,966,667	2,186,385	0.071	19,623,083

Table 2

Slurry parameter means. End of Week 8 – Envirosystems SlurryBugs

		Control	SlurryBugs	Difference	SEM	P=0.05	LSD
Total Nitrogen	% w/w	0.250	0.283	0.033	0.00843	**0.01**	0.014
NH4 Nitrogen	% w/w	0.118	0.140	0.022	0.0058	**0.021**	0.014
Nitrate Nitrogen	% w/w	<0.01	<0.01	0.000	n/a	n/a	n/a
Total Phosphorous (P)	% w/w	0.032	0.030	-0.001	0.00139	0.625	0.01
Total Potassium (K)	% w/w	0.288	0.291	0.003	0.0097	0.770	0.034
Total Magnesium (Mg)	% w/w	0.049	0.047	-0.001	0.00165	0.716	0.014
Total Sulphur (S)	% w/w	0.022	0.021	-0.000	0.0012	0.808	0.005
Total Copper (Cu)	mg/kg	4.487	4.227	-0.260	0.227	0.485	1.319
Total Zinc (Zn)	mg/kg	9.617	9.133	-0.483	0.451	0.574	3.127
Total Sodium (Na)	% w/w	0.030	0.030	-0.000	0.0065	0.742	0.004
Total Solids	%	5.297	5.057	-0.240	0.325	0.736	2.671
Total Calcium (Ca)	mg/kg	1,245	1,175	-70.000	56.8	0.474	344.258
pH		7.22	7.25	0.023	0.184	0.594	0.16
Chloride (Cl)	mg/kg	880	878	-2.000	30.8	0.966	176.58
BOD	mg/l	16,817	15,167	-1650.00	535	0.277	4793.23
TVC Anaerobic 5 days 22C	cfu/g	2,933,333	1,300,000	-1,633,333	761,322	0.361	5,985,141
TVC Anaerobic 1 day 37C	cfu/g	1,023,333	1,200,000	176,667	210,086	0.770	2,279,101
TVC Aerobic 5days 22C	cfu/g	13,166,667	7,700,000	-5,466,667	2,362,014	0.433	24,191,382
TVC Aerobic 1 day 37C	cfu/g	13,800,000	7,600,000	-6,200,000	2,344,071	0.301	19,285,250

Table 3

Slurry parameter means. End of Week 12 – Envirosystems SlurryBugs

		Control	SlurryBugs	Difference	SEM	P=0.05	LSD
Total Nitrogen	% w/w	0.217	0.270	0.05	0.012	**0.004**	0.014
NH4 Nitrogen	% w/w	0.132	0.147	0.015	0.034	**0.001**	0.0007
Nitrate Nitrogen	% w/w	<0.01	<0.01	0.00	n/a	n/a	n/a
Total Phosphorous (P)	% w/w	0.024	0.028	0.00	0.001	0.081	0.005
Total Potassium (K)	% w/w	0.244	0.264	0.02	0.00896	0.444	0.091
Total Magnesium (Mg)	% w/w	0.041	0.045	0.00	0.00117	0.186	0.009
Total Sulphur (S)	% w/w	0.015	0.018	0.00	0.0009	0.131	0.005
Total Copper (Cu)	mg/kg	2.847	3.730	0.88	0.219	0.080	1.144
Total Zinc (Zn)	mg/kg	6.077	7.400	1.32	0.412	0.140	2.385
Total Sodium (Na)	% w/w	0.031	0.032	0.00	0.00104	0.762	0.011
Total Solids	%	3.990	4.715	0.73	0.187	0.073	0.894
Total Calcium (Ca)	mg/kg	1,040	1,184	143.17	47.4	0.113	226.688
pH		7.21	7.33	0.12	0.0361	0.162	0.231
Chloride (Cl)	mg/kg	806	831	25.00	22.4	0.650	203.625
BOD	mg/l	14,750	16,575	1825.00	680	0.323	6041.78
TVC Anaerobic 5 days 22C	cfu/g	1,250,000	3,466,667	2,216,667	766,205	0.198	5,024,263
TVC Anaerobic 1 day 37C	cfu/g	1,050,000	736,667	-313,333	102,035	0.217	757,784
TVC Aerobic 5days 22C	cfu/g	10,333,333	5,600,000	-4,733,333	1,591,784	0.272	13,561,847
TVC Aerobic 1 day 37C	cfu/g	8,200,000	10,733,333	2,533,333	1,011,160	0.182	5,411,068

Table 4

Slurry crust parameter means. End of week 12. Envirosystems SlurryBugs

Parameter	Control	SlurryBugs	Difference	SE	P=0.05	LSD
Depth (cm)	11.833	10.170	-1.33	0.494	0.270	3.8
Shear (kPa)	2.483	1.795	-0.69	0.17	0.066	0.805
Weight (kg)	16.607	14.513	-2.09	0.796	0.214	5.006
Bulk density (g cm^{-3})	1.191	1.205	0.01	0.087	0.954	0.662