APPENDIX J: MANURE TREATMENT

Calcium Enhanced Precipitation of Swine Manure: Supporting Concepts and Lab Scale Trial Findings

Contents

List of Supplemental Tables and Figures 2

Summary 3

Background 3

Methods 4

Overview 4

Setting Amendment Rates 5

Collection of Manure Slurry 6

Amendment of Manure Slurry 6

Preliminary Findings 8

Amended Slurry Leachate 9

Amended Slurry Precipitate 9

Conclusions 10

Supplemental Figures and Tables 12

List of Tables

Table 1. Chemical amendment rates based a 5% (mL/mL) target mixture rate of Ca hydroxide to manure slurry and 17 liters of manure slurry. 5

Table 2. Chemical additions associated with the various amendment rates. 6

List of Figures

Figure 1. Clear test bottles after 30 % (wt/wt) $Ca(OH)_2$ slurry was added to 500 ml of manure at the rates of 0, 10, 20, 30, 40, 60, 80, and 100 mL/L and allowed to settle. Based on both the clarity of the top liquid and settled solids a target rate of 50 mg/L (5%) was select for the chemical amendment trial. .... **Error! Bookmark not defined.**

Figure 2. Relationship between solids content of the precipitate three hours after addition of three lime amendments, where the target amendment (i.e., 1.0) is equivalent to 5% volume basis (i.e., 50 mL lime to 1000 mL slurry). Values are average of four replicates. 8

Figure 3. Relationship between water extractable P concentrations of leachate three hours after addition of three lime amendments, where the target amendment (i.e., 1.0) is equivalent to 5% volume basis (i.e., 50 mL lime to 1000 mL slurry). Values are average of four replicates. .... **Error! Bookmark not defined.**

Figure 4. Relationship between water extractable P concentrations of the precipitate three hours after addition of three lime amendments, where the target amendment (i.e., 1.0) is equivalent to 5% volume basis (i.e., 50 mL lime to 1000 mL slurry). Values are average of four replicates. . 10

List of Supplemental Tables and Figures

Table S 1. Descriptive code format for chemically treated manure samples. 16

Table S 2. Analysis results summary from chemically treated manure samples. For each set of amendment replicates the minimum, maximum, mean, standard deviation sample, and coefficient of variation (%), and concentration reduction are provided. The concentration reduction (%) was calculated as the concentration of the ((1CSOM Mean – Analysis Mean of interest)/ 1CSOM Mean)*100). 17

Figure S 1. Work area being set up after the 1,363 L tank was filled with manure and set up in agitation mode to keep manure solids in suspension. Green hose drains the tank. Blue hose discharges into tank via internal mixing nozzles. Bottom front center of tank is location of valve used to extract 17 L manure samples for treatment. 12

Figure S 2. Inlet nozzles inside the manure slurry collection tank, configured to mix manure slurry as it is pumped from holding pond 1. 13

Figure S 3. Collection bucket lined with filter bag prior to addition of manure slurry and chemical amendment. 14

Figure S 4. Buckets containing manure leachate and suspended filter bags prior to being placed under awning for weather protection and 10-day storage. 15

Figure S 5. Relationship between matrix manure % Solids (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 42

Figure S 6. Relationship between matrix manure pH and treatment rate. Refer to descriptive code table for interpretive information. 43

Figure S 7. Relationship between matrix manure Total Kjeldahl N (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 44

Figure S 8. Relationship between matrix manure ammonium-N (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 45

Figure S 9. Relationship between matrix manure nitrate-N (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 46

Figure S 10. Relationship between matrix manure total P (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 47

Figure S 11. Relationship between matrix manure total K (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 48
Figure S 12. Relationship between matrix manure total Ca (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 49
Figure S 13. Relationship between matrix manure water extractable P (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 50
Figure S 14. Relationship between matrix manure ammonium-N / total Kjeldahl N (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 51
Figure S 15. Relationship between matrix manure water extractable P / Total P (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 52
Figure S 16. Relationship between matrix manure total Kjeldahl N / total P (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information. 53

Summary

1. A mixture of locally sourced lime and hydrated lime amendments, decreased water-soluble P concentrations of the liquid and precipitate or solids fraction of holding pond slurry. Use of an off-the-shelf granular agricultural grade lime product, had no consistent effect on water-soluble P concentration.
2. Hydrated lime amendments tended to enhance the effectiveness of separation of solids from liquid in manure slurry, as related to increasing the percent solids and P concentration of the separated solids. In principle, this would be beneficial for transport of P off the generating farm.
3. Hydrated lime amendments appeared to increase manure slurry pH sufficiently to increase N loss via ammonia volatilization. If manure slurry was viewed as a N fertilizer, the increased loss of N would not be desirable. If air quality was a concern, the increased loss of N would not be desirable.
4. Use of granular agricultural grade lime at the rates used, had no consistent effect on the solids separation process for manure slurry from the C&H Farm.
5. Despite certain potential benefits of lime amendment providing options available to the Farm to manage the slurry in compliance with nutrient management planning requirements, all amendments presented economic, logistical, and labor constraints severely limit their viability for adoption.

Background

An important consideration of liquid manure solids separation is the fate and economic value of the resulting liquid and solids fractions. The desired properties of the separated fractions, operator preferences, regulatory considerations, and economics should determine the type and degree of treatment.

Research has shown that amendment with aluminum, iron, and calcium compounds can increase the concentration of phosphorus (P) and manure solids into a lower moisture manure product. Such chemical amendment, preferentially separates the manure into a P-rich portion for transport to more distant locations for utilization, and a P-poor portion for use closer to the farm. In contrast to aluminum and iron, calcium in the form of $CaCO_3$ (Ag lime) or $Ca(OH)_2$ (Hydrated Lime) are often uses as soil amendments for beneficial soil pH modification. In addition, manure amendment with calcium compounds should result in calcium phosphate compounds, which are a common source of P fertilizers. In addition, due to the fact that P is a finite resource, it is desirable to retain P availability in manure solids for beneficial use, where P is needed for optimal crop production. In the area of alternative manure solids usage via thermal energy conversion (gasification), there is interest on the effects of calcium on energy conversion and bio-char production.

For this reason, we investigated the effectiveness of calcium (Ca) binding with manure P to enhanced natural settling of manure solids. Depending on the chemical and physical properties of the settled solids, the necessary mechanical and structural components of a manure separation system could be designed to meet the nutrient and transportation needs, and hopefully economic constraints of the farm enterprise.

A guiding concept any manure treatment technology is to generate a by-product that has value as a fertilizer, can be transported large distances (in this case, out of the Buffalo River Watershed), or provides a farmer with options to match manure applications to pasture needs and nutrient offtake. A direct benefit of such treatment technology would be to minimize nutrient accumulations in soil beyond optimal levels for pasture / crop production and thereby reducing the potential for nutrient runoff. In addition, because P is a finite resource, it is desirable to retain P in manure for beneficial use, where needed for optimal pasture / crop production.

For this reason, we investigated the effectiveness of calcium (Ca) binding with manure P enhanced by natural settling of manure solids. In principal, after addition of Ca to manure various Ca phosphate compounds are formed, which settle out with manure solids. Depending on the chemical and physical properties of the settled solids, the necessary mechanical and structural components of a manure separation system could be designed to meet the transportation needs and hopefully economic constraints of the farm enterprise.

Methods

Overview

This research treated liquid swine manure with hydrated lime, $Ca(OH)_2$, and agricultural lime, $CaCO_3$. The hydrated lime was added to manure slurry in either a liquid slurry form (30% by weight) or as a dry powder. The agricultural lime was added in the dry fine granular form. The three calcium sources were added to the manure at 3 amendment levels with 3 replicates. A non-amendment control for each chemical source and additional final non-amendment control were also processed. The resulting 31 mixtures were sampled prior to separation via gravity settling in containers lined with 150 micron filter bags. After allowing time for settling, the filter bags were lifted from the containers and allowed to drain prior to collecting leachate from the containers and precipitate from the filter bags. The remaining material was left in the containers and filter bags for storage under ambient conditions but protected from precipitation for 10 days before being sampled again.

Setting Amendment Rates

Due to the variability of swine manure, it was appropriate to set the amendment chemical addition rates on the day of the trail using the manure to be treated in the trail. The 30% (gm/gm) hydrated lime slurry was added at the rate of 0, 10, 20, 30, 40, 60, 80, and 100 ml/l to manure in clear bottles. After mixing and allowing the solids to settle, it was determined via visual inspection to set the base line full Ca amendment rate at 50 mL/L of 30% hydrated lime slurry per liter of manure (Figure 1). The corresponding 1/2X rate and 2X rates would be 25 mL/L and 100 mL/L. Stoichiometric calculations determined the equivalent elemental Ca amendment rates for the dry hydrated and agricultural lime as 1/2X, 1X, and 2X rates (Table 1).

Figure 1. Clear test bottles after 30 % (wt/wt) $Ca(OH)_2$ slurry was added to 500 ml of manure at the rates of 0, 10, 20, 30, 40, 60, 80, and 100 mL/L and allowed to settle. Based on both the clarity of the top liquid and settled solids a target rate of 50 mg/L (5%) was select for the chemical amendment trial.

Table 1. Chemical amendment rates based a 5% (mL/mL) target mixture rate of Ca hydroxide to manure slurry and 17 liters of manure slurry.

Chemical and form	Amendment rate			
	O x Target rate	½ x Target rate	1 x Target rate	2 x Target rate

Ca Hydroxide, 30% (gm/gm) slurry	0 mL	425 mL	850 mL	1700 mL
Ca Hydroxide, dry powder	O gm	154 gm	307 gm	614 gm
Ca Carbonate, dry fine granular	O gm	207 gm	415 gm	830 gm

Collection of Manure Slurry

An on-farm system to chemically and physically treat manure slurry would likely take place the manure slurry as it is discharged from the barns and before it enters holding Pond 1. Thus, a manure slurry collection and mixing system was designed for this chemical trial (Supplemental Figure S1). On the day of the trial (September 4, 2014), a pump was used to capture a portion of the manure discharged from the barns into holding Pond 1 as one of the manure pits was being drained. The captured manure was pumped into a 360-gallon tank (i.e., 1,363 L) via two mixing nozzles to ensure uniform mixing of the manure slurry in the tank (see Figure S2 for nozzle configuration).

Once this tank was filled, a discharge valve was opened to drain a portion of the collected manure into holding Pond 1. By adjusting the discharge valve and pump throttle, the manure flow rate into and out of the tank were balanced resulting in the tank manure volume remaining fixed (Figure S1). This balanced-flow process continued until the manure pit in the barn had been drained and a composite sample of all the manure slurry from the drained pit was collected. After manure was collected was completed, valves were closed so that the pump continually mixed manure slurry in the tank for the remainder of the trial (Figure S1).

Amendment of Manure Slurry

Using one of the tank's valves, manure was drained from the tank into 5-gallon buckets in 17-liter volumes as needed for the chemical amendment. For each chemical amendment, rate, and replication combination 17 L of manure slurry was drained from the tank into a bucket (Table 2). The desired amount of chemical was added and mixed into the manure using a battery-powered drill with attached stirring paddle. Before any settling could occur, the mixture was poured into a second bucket lined with a 150 micron filter bag (see Figure S3). A subsample was collected as it was poured into the lined bucket. At this time, the lined bucket was set aside and the suspended solids allowed time to settle.

After settling each filter bag was lifted from its bucket and allowed to drain into the bucket for 3 minutes. Samples of the concentrated manure slurry (precipitate) in the filter bag and the leachate from the bucket were sampled for analysis. This process was repeated until three replicates of each chemical/rate combination in Supplemental Table S1 had been prepared.

Table 2. Chemical additions associated with the various amendment rates.

Chemical addition per liter of liquid manure

Amendment	Rate	Water mass [1]	Wet mass [1]	Dry mass [2]	Ca mass [3]
		mL/L	gm/L	gm/L	gm/L
Manure only[4]	0.0	-	1000	-	-
$Ca(OH)_2$ slurry (LS)	1/2X	25	30.10	9.03	4.89
	1X	50	60.21	18.06	9.77
	2X	100	120.42	36.13	19.55
$Ca(OH)_2$ (HL)	1/2X	-	9.03	9.03	4.89
	1X	-	18.06	18.06	9.77
	2X	-	36.13	36.13	19.55
$CaCO_3$ (AL)	1/2X	-	12.20	12.20	4.89
	1X	-	24.40	24.40	9.77
	2X	-	48.80	48.80	19.55

[1] Includes mass of water in Lime Slurry. Assumes Hydrated Lime and Ag. Lime Moisture content to be 0% when it might have been in <3% range.

[2] Mass of Ca(OH)2 and CaCO3 only added assuming chemicals 100% pure when there where likely slight levels of impurities.

[3] Mass of Ca added assuming chemicals 100% pure when there where likely various forms of Ca compounds and impurities within the Ag lime used.

[4] In calculations Liquid manure density assumed equal to water as this is standard assumption and assumed %TS would be <5%. The measured %TS was just under 2%.

Once the manure from the filter bags were sampled, tripods were used to suspend them above their respective bucket (Figure S4). The combination of buckets and tripods were placed under a fenced in awning, which allowed for full air movement while protecting them from rainfall and damage from animals.

After 5 days, the filter bags were dry enough that they were placed on tables to reduce the potential for wind damage and rewetting of the bags. On September 15, 2014, a total of 10 days after treatment, the manure slurry mixture in the filter bags and leachate in the 5-gallon buckets was mixed and sampled for analysis. The remaining precipitate from the filter bags was delivered for energy content analysis.

A total of 93 samples were collected the day the manure was treated, with an additional 62 samples collected after storage for 10 days. Each sample was analyzed for total solids (TS), pH, total N (N), ammonium-N (NH_4-N), nitrate-N (NO_3-N), total P (P), total potassium (K), total Ca (Ca), and water extractable P (WEP)

Preliminary Findings

Preliminary assessment of the three lime products to act as a flocculation agent to enhance precipitation of slurry solids and to sequester P in a less available form are detailed in Supplementary Figures S5 through S16. With the exception of nitrate-N, the coefficient of variation associated with the control samples prior to filtering was 6% or less. These low values, coupled with the fact that the control samples were collected over the course of the sampling day, indicate that a homogenous manure mixture was maintained.

Amendment of manure slurry with each of the three lime products increased flocculation of solids (Figure 2). Hydrated lime was most effective, followed by Ag lime and locally sourced lime.

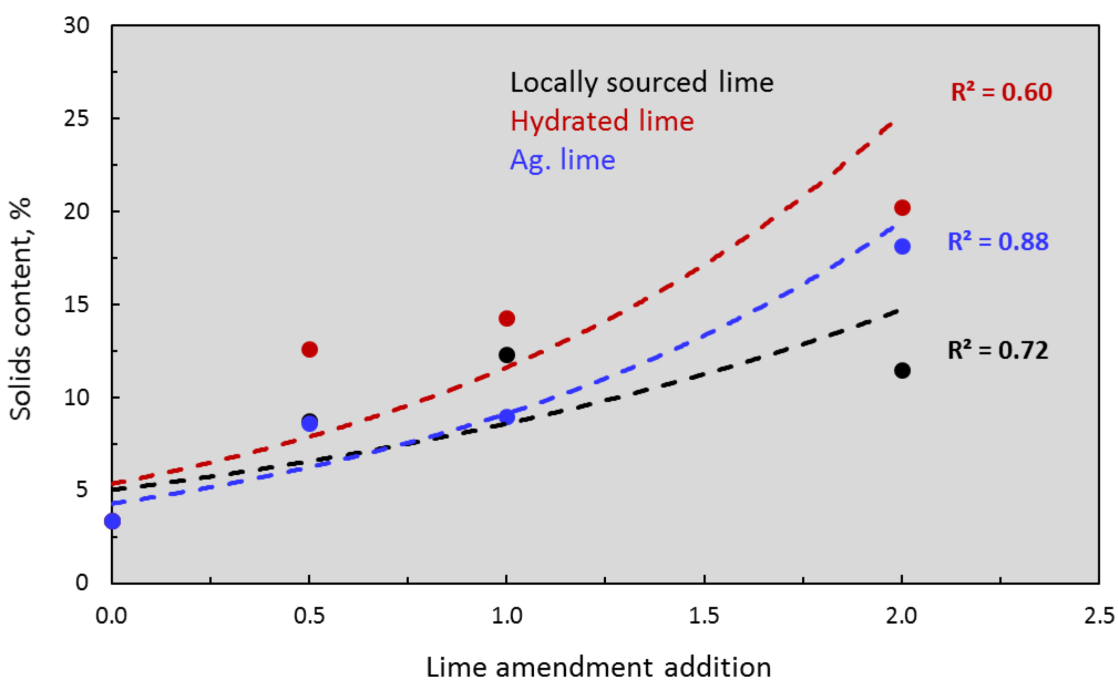


Figure 2. Relationship between solids content of the precipitate three hours after addition of three lime amendments, where the target amendment (i.e., 1.0) is equivalent to 5% volume basis (i.e., 50 mL lime to 1000 mL slurry). Values are average of four replicates.

Addition hydrated lime amendment increased pH of the manure mixture. Higher amendment levels resulted in higher pH levels (Table S2). Addition of the pre-mixed lime slurry was more effective than the same Ca addition of dry lime powder. At the rates added, the Ag lime did not influence the pH of amendment mixture. This may be due in part to the Ag lime rate calculation procedures likely overestimated the Ca concentration in the lime. With increasing amendment rates, total N concentration decreased. In addition to the mass addition-dilution effect mentioned above, the elevated pH levels suggest that ammonia volatilization may be occurring.

Amended Slurry Leachate

Locally sourced lime and hydrated lime were appreciably more efficient at decreasing the water-soluble P concentration of amended slurry leachate, where samples were collected three hours after slurry amendment (Figure 3). In fact, the water-soluble concentration of slurry leachate amended with target levels of locally sourced and hydrated lime (i.e., 5% by volume) were just a respective 7 and 33% of control concentrations. The agricultural grade lime amendment only decreased water-soluble P concentration 41% compared to the control (Figure 3 and Table S2).

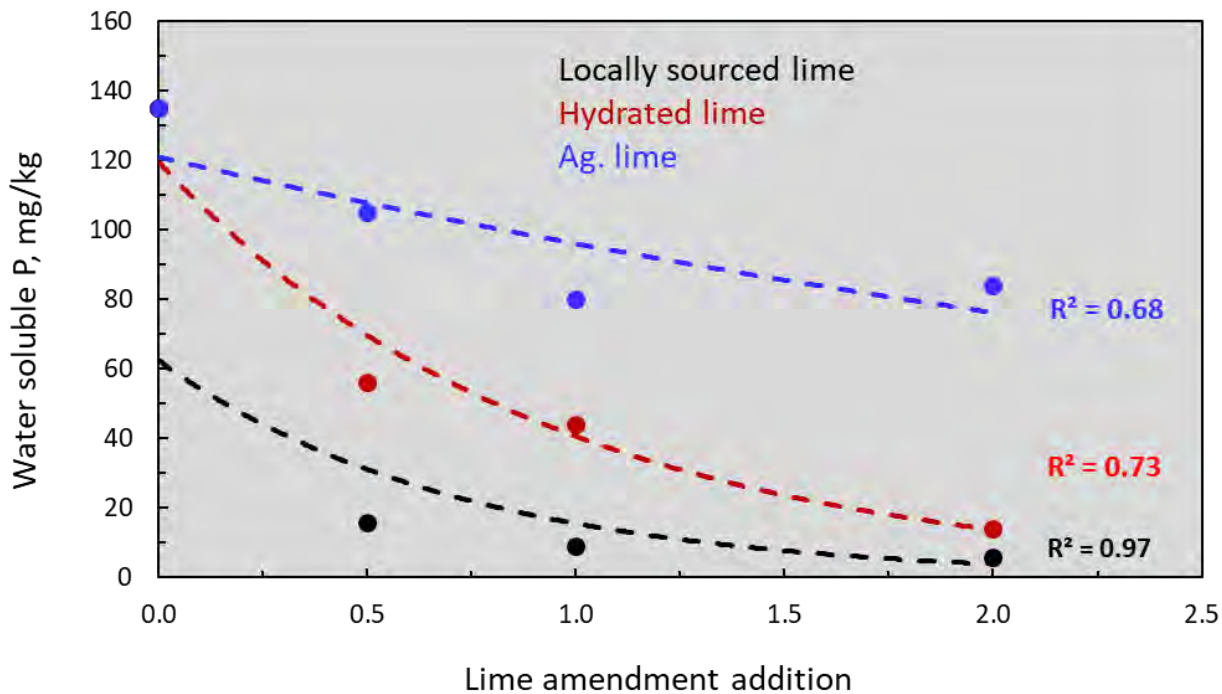


Figure 3. Relationship between water extractable P concentrations of leachate three hours after addition of three lime amendments, where the target amendment (i.e., 1.0) is equivalent to 5% volume basis (i.e., 50 mL lime to 1000 mL slurry). Values are average of four replicates.

Amended Slurry Precipitate

The precipitated material remaining after liquid removal by filtration, were also affected differentially by lime amendments. Figure 4 shows locally sourced and hydrated lime decreased water soluble P concentration of the precipitate material (target amendment was 6 and 4% of the control, respectively), while agricultural grade lime actually increased water soluble P concentration nearly three-fold. Why agricultural lime increased water soluble P concentration is unknown at the present time and further research is needed.

The separation process resulted in higher total P concentrations in separated slurry solids than original pre-treatment mixture and separated leachate. There was a statistically significant decrease in total P concentration as hydrated lime amendment rates increased (Table S2). Because of the total P increase, leachate had the highest water-soluble to total P ratio, with the separated solids the lowest. This effect is likely partially the result of increasing mass additions associated with increasing amendment rates.

Separation increase the total N to total P ratio in the leachate, while decreasing the ratio in the solids, with the hydrated lime amendments enhancing this trend (Table S2). However, the total N to total P ratios also decreased during storage, being more pronounced with the hydrated lime amendment. This is likely the result in ammonium-N loss during storage.

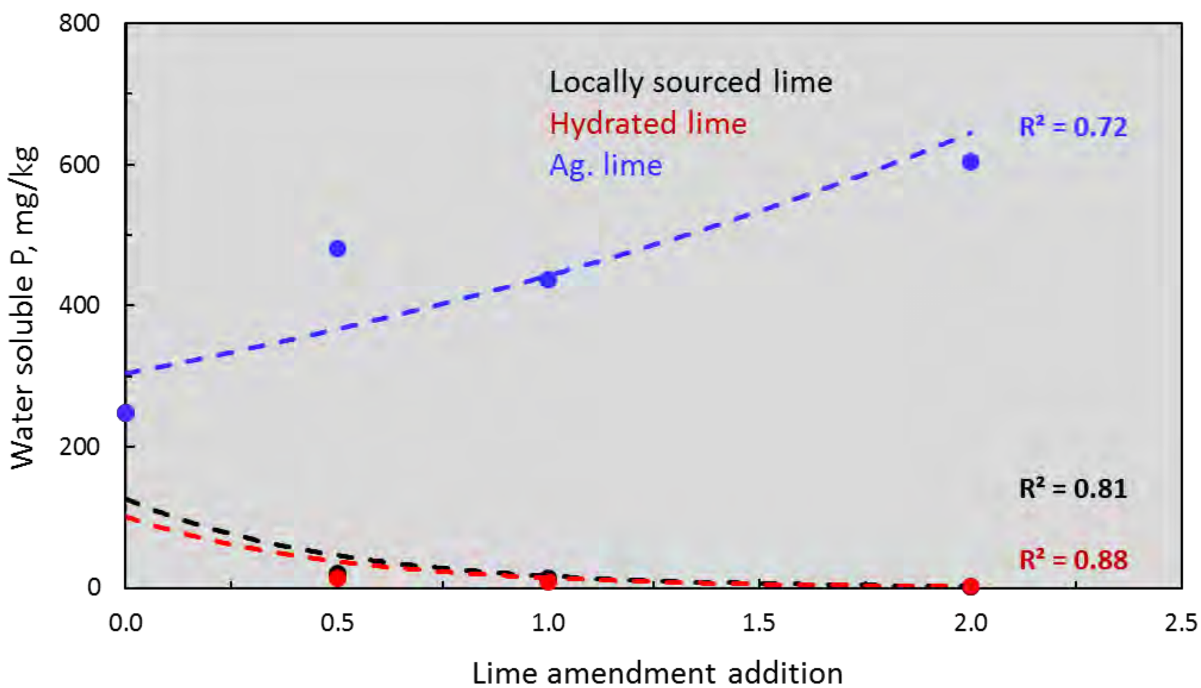


Figure 4. Relationship between water extractable P concentrations of the precipitate three hours after addition of three lime amendments, where the target amendment (i.e., 1.0) is equivalent to 5% volume basis (i.e., 50 mL lime to 1000 mL slurry). Values are average of four replicates.

Conclusions

The general findings were:

1. Hydrated lime amendments tended to enhance the manure solids separation effectiveness as related to increasing the % Solids and P concentration of the separated solids. In principle, this would be beneficial for transport of P off the generating farm.
2. Hydrated lime amendments also increased the manure pH enough that N losses via ammonia volatilization seemed to be increased. If the manure were viewed as a desirable N fertilizer, the increased losses would not be desirable. If air quality were, it atmospheric ammonia emissions would not be desirable.
3. Use of granular agricultural grade lime at the rates used, had no consistent effect on the solids separation process.

In addition to these findings, there are several considerations in the design, financing, and operation of a chemically enhanced gravity separation system. The first is the legal implications. It is generally understood that in Arkansas liquid manures must be applied to land permitted by ADEQ for that purpose. Currently ADEQ's Regulation No 5 provides the only method to remove this requirement is the manure to be composted. Manure solids separation may enable composting but it will not meet the requirements by itself. As a result, unless the regulations are revised or reinterpreted, solids separation may facilitate off farm transportation, the manure destination would still be a permitted site. This would likely restrict the potential for off farm sale of the separated manure solids that could conceptually offset increase manure management costs.

The second consideration relates to the procurement and management of the chemical amendments. In addition to the purchase of the chemicals delivery to, storage on, and metering to the manure must be accomplished. While a formal cost analysis of infrastructure, procurement, and labor cost was not made, it is anticipated that the costs would be greater than the current approach of land application on land within reasonable transport distance to the farm.

The increased N losses due to ammonia valorization would also reduce the fertilizer value of the remaining liquids that would be land applied on the generating farm. It would also increase concerns regarding atmospheric ammonia emissions. Addressing these concerns would require additional expenditures related to infrastructure and management costs.

Given these considerations, it is more practical and sustainable from an individual farm perspective to not invest in enhanced gravity separation via hydrated lime amendments. Rather the practice of local land application of some combination of manure top water, higher solids content bottom water, or an agitated mixture is more sustainable. However, with this approach sufficient land needs to be available to allow manure to be applied at rates that maintain soil test P levels near agronomic levels.

Despite the potential benefits of lime treatment providing options to manage slurry in compliance with nutrient management planning requirements, all presented economic, logistical, labor, and legal constraints severely limit their viability for adoption.

Supplemental Figures and Tables

Figure S 1. Work area being set up after the 1,363 L tank was filled with manure and set up in agitation mode to keep manure solids in suspension. Green hose drains the tank. Blue hose discharges into tank via internal mixing nozzles. Bottom front center of tank is location of valve used to extract 17 L manure samples for treatment.

Figure S 2. Inlet nozzles inside the manure slurry collection tank, configured to mix manure slurry as it is pumped from holding pond 1.

Figure S 3. Collection bucket lined with filter bag prior to addition of manure slurry and chemical amendment.

Figure S 4. Buckets containing manure leachate and suspended filter bags prior to being placed under awning for weather protection and 10-day storage.

Table S 1. Descriptive code format for chemically treated manure samples.

Treatment		
	Ca source/Rate/Material sampled/ Day sample collected/Replicate	
Example	LS 1 M 1 A	
Interpretation	Lime Slurry, 1 x target rate, mixed, day of treatment, first replicate	
Ca Source		
LS	Lime Surry on 30% wt. basis	
HL	Hydrated lime dry powder	
AL	Ag Lime Dry granules	
CS	Control sample	
Rate		
0	Control no additive	
0.5	1/2 x Target Rate	
1	1 x Target Rate	
2	2 x Target Rate	
Material Sampled		
M	Mixed after Ca addition prior to filtering	
L	Leachate after filtration	
P	Precipitate after filtration	
Day Sample Collected		
1	Sampled day of treatment	
2	Sampled after days of storage	
Replication		**Control Sample Details**
A	1st Replicate	Control Sample collected prior to LS samples
B	2nd Replicate	Control Sample collected prior to HS samples
C	3rd Replicate	Control Sample collected prior to AL samples
D	4th Replicate	Control Sample collected after AL samples

Table S 2. Analysis results summary from chemically treated manure samples. For each set of amendment replicates the minimum, maximum, mean, standard deviation sample, and coefficient of variation (%), and concentration reduction are provided. The concentration reduction (%) was calculated as the concentration of the ((1CSOM Mean – Analysis Mean of interest)/ 1CSOM Mean)*100).

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
	%		- mg/kg	- -					
1CS0MA	1.94	7.5	1735	849	0.18*	858	1387	664	168
1CS0MB	1.92	7.6	1863	811	0.76	880	1364	774	165
1CS0MC	1.96	7.6	1782	835	0.18*	873	1322	739	173
1CS0MD	1.98	7.6	1918	835	0.18*	881	1373	737	180
1CS0M Min	1.98	7.5	1735	811	0.18*	858	1322	664	165
1CS0M Max	1.98	7.6	1918	849	0.76	881	1387	774	180
1CS0M Mean	1.95	7.6	1824	832	0.32	873	1361	728	172
1CS0M Std	0.03	0	82	16	0.29	10	28	46	6
1CS0M CV%	1.39	0.4	4	2	91.35	1	2	6	4
1CS0LA	0.96	7.6	1476	803	0.18*	325	1335	176	152
1CS0LB	0.89	7.6	1289	730	0.18*	318	1358	207	141
1CS0LC	1.08	7.6	1467	737	0.18*	428	1323	299	144
1CS0LD	0.94	7.6	1486	743	0.18*	315	1272	246	102
1CS0L Min	0.89	7.6	1289	730	0.18*	315	1272	176	102

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1CS0L Max	1.08	7.6	1486	803	0.18*	428	1358	299	152
1CS0L Mean	0.97	7.6	1429	753	0.18*	346	1322	232	135
1CS0L Std	0.08	0	94	33	0	54	37	53	22
1CS0L CV%	8.27	0.4	7	4	0	16	3	23	16
1CS0PA	2.5	7.5	2037	851	0.18*	1090	1431	926	226
1CS0PB	2.67	7.5	1940	803	0.18*	1166	1393	1086	213
1CS0PC	4.53	7.3	2709	782	0.18*	2068	1368	1974	300
1CS0PD	3.86	7.3	2689	810	0.18*	1763	1327	1717	258
1CS0P Min	2.5	7.3	1940	782	0.18*	1090	1327	926	213
1CS0P Max	4.53	7.5	2709	851	0.18*	2068	1431	1974	300
1CS0P Mean	3.39	7.4	2344	812	0.18*	1522	1380	1426	249
1CS0P Std	0.97	0.1	413	29	0	472	44	500	39
1CS0P CV%	28.75	1.2	18	4	0	31	3	35	15
1LS½MA	3.09	12	1684	516	0.35	837	1337	5118	33
1LS½MB	3.22	12	1768	557	0.18*	953	1348	5241	31
1LS½MC	3.13	12	1658	593	0.48	906	1355	5235	31
1LS½M Min	3.09	12	1658	516	0.18*	837	1337	5118	31

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1LS½M Max	3.22	12	1768	593	0.48	953	1355	5241	33
1LS½M Mean	3.15	12	1703	555	0.33	898	1347	5198	32
1LS½M Std	0.07	0.1	57	38	0.15	58	9	69	1
1LS½M CV%	2.15	0.7	3	7	45.59	6	1	1	2
1LS½LA	0.91	10	1252	570	0.18*	101	1320	299	19
1LS½LB	1.06	13	833	497	0.18*	45	1258	872	9
1LS½LC	0.92	10	1145	583	0.18*	115	1305	356	20
1LS½L Min	0.91	10	833	497	0.18*	45	1258	299	9
1LS½L Max	1.06	13	1252	583	0.18*	115	1320	872	20
1LS½L Mean	0.96	11	1077	550	0.18*	87	1294	509	16
1LS½L Std	0.09	1.5	218	47	0	37	32	316	6
1LS½L CV%	9.03	13	20	8	0	42	3	62	38
1LS½PA	8	12	2358	610	0.35	2355	1430	15573	21
1LS½PB	10.1	12	2611	653	0.18*	2787	1345	17487	22
1LS½PC	8.05	13	2447	612	0.18*	2371	1416	14752	21
1LS½P Min	8	12	2358	610	0.18*	2355	1345	14752	21
1LS½P Max	10.1	13	2611	653	0.35	2787	1430	17487	22

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1LS½P Mean	8.71	12	2472	625	0.23	2505	1397	15937	21
1LS½P Std	1.2	0	129	25	0.1	245	46	1403	0
1LS½P CV%	13.8	0.1	5	4	42.46	10	3	9	1
1LS1MA	4.5	13	1597	658	0.41	802	1291	9317	8
1LS1MB	4.81	13	1434	629	0.46	861	1288	10133	6
1LS1MC	4.78	13	1887	648	0.18*	909	1320	10124	9
1LS1M Min	4.5	13	1434	629	0.18*	802	1288	9317	6
1LS1M Max	4.81	13	1887	658	0.46	909	1320	10133	9
1LS1M Mean	4.7	13	1639	645	0.35	858	1300	9858	8
1LS1M Std	0.18	0	230	15	0.15	54	18	469	1
1LS1M CV%	3.74	0.1	14	2	43.43	6	1	5	16
1LS1LA	0.96	13	891	398	0.18*	22	1222	592	9
1LS1LB	1	13	980	507	0.18*	34	1201	709	9
1LS1LC	0.89	13	1011	474	0.18*	35	1270	690	11
1LS1L Min	0.89	13	891	398	0.18*	22	1201	592	9
1LS1L Max	1	13	1011	507	0.18*	35	1270	709	11
1LS1L Mean	0.95	13	961	460	0.18*	30	1231	664	9

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1LS1L Std	0.05	0	62	56	0	7	35	63	1
1LS1L CV%	5.52	0.1	6	12	0	24	3	9	11
1LS1PA	11.54	13	2739	705	0.18*	2138	1299	23213	11
1LS1PB	11.62	13	2719	683	0.35	2167	1280	23904	14
1LS1PC	13.76	13	3208	762	0.5	2754	1339	29446	17
1LS1P Min	11.54	13	2719	683	0.18*	2138	1280	23213	11
1LS1P Max	13.76	13	3208	762	0.5	2754	1339	29446	17
1LS1P Mean	12.31	13	2889	716	0.34	2353	1306	25521	14
1LS1P Std	1.26	0	277	41	0.16	347	30	3416	3
1LS1P CV%	10.22	0.1	10	6	47.74	15	2	13	24
1LS2MA	7.45	13	1584	676	0.18*	779	1222	16820	1
1LS2MB	7.23	13	1615	633	0.35	746	1228	16842	1
1LS2MC	7.14	13	1602	590	0.18*	832	1248	17245	1
1LS2M Min	7.14	13	1584	590	0.18*	746	1222	16820	1
1LS2M Max	7.45	13	1615	676	0.35	832	1248	17245	1
1LS2M Mean	7.27	13	1600	633	0.23	785	1233	16969	1
1LS2M Std	0.16	0	16	43	0.1	43	14	239	0

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1LS2M CV%	2.15	0.1	1	7	42.46	6	1	1	32
1LS2LA	1.07	13	938	457	0.18*	27	1200	942	6
1LS2LB	1.2	13	916	440	0.18*	27	1217	999	5
1LS2LC	1.06	13	858	491	0.18*	25	1207	938	6
1LS2L Min	1.06	13	858	440	0.18*	25	1200	938	5
1LS2L Max	1.2	13	938	491	0.18*	27	1217	999	6
1LS2L Mean	1.11	13	904	463	0.18*	26	1208	959	6
1LS2L Std	0.08	0	41	26	0	1	9	34	0
1LS2L CV%	6.92	0.1	5	6	0	5	1	4	4
1LS2PA	12.66	13	2184	653	0.18*	1731	1262	34284	4
1LS2PB	11.25	13	1975	580	0.18*	1487	1245	30856	2
1LS2PC	10.42	13	1972	617	0.18*	1411	1251	28106	2
1LS2P Min	10.42	13	1972	580	0.18*	1411	1245	28106	2
1LS2P Max	12.66	13	2184	653	0.18*	1731	1262	34284	4
1LS2P Mean	11.45	13	2044	617	0.18*	1543	1253	31082	3
1LS2P Std	1.13	0	121	36	0	167	8	3095	1
1LS2P CV%	9.91	0.1	6	6	0	11	1	10	34

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1HL½MA	2.84	10	1783	646	0.18*	955	1398	4951	43
1HL½MB	3.02	10	1838	606	0.18*	937	1378	5042	34
1HL½MC	2.7	9.8	1791	691	0.18*	922	1410	3873	57
1HL½M Min	2.7	9.8	1783	606	0.18*	922	1378	3873	34
1HL½M Max	3.02	10	1838	691	0.18*	955	1410	5042	57
1HL½M Mean	2.85	10	1804	648	0.18*	938	1395	4622	45
1HL½M Std	0.16	0.2	30	43	0	17	16	650	12
1HL½M CV%	5.61	2.2	2	7	0	2	1	14	26
1HL½LA	0.93	9.1	1213	711	0.18*	187	1327	422	51
1HL½LB	0.94	8.9	1246	707	0.18*	220	1351	405	57
1HL½LC	0.98	8.9	1294	721	0.18*	259	1344	432	58
1HL½L Min	0.93	8.9	1213	707	0.18*	187	1327	405	51
1HL½L Max	0.98	9.1	1294	721	0.18*	259	1351	432	58
1HL½L Mean	0.95	9	1251	713	0.18*	222	1341	419	56
1HL½L Std	0.03	0.1	41	7	0	36	12	14	4
1HL½L CV%	2.79	1.3	3	1	0	16	1	3	7

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1HL½PA	14.43	13	3020	838	0.18*	3098	1350	29408	16
1HL½PB	13.37	13	3011	777	0.18*	2574	1222	24630	14
1HL½PC	10.05	13	2606	798	0.18*	2282	1329	19686	14
1HL½P Min	10.05	13	2606	777	0.18*	2282	1222	19686	14
1HL½P Max	14.43	13	3020	838	0.18*	3098	1350	29408	16
1HL½P Mean	12.62	13	2879	804	0.18*	2651	1300	24575	15
1HL½P Std	2.29	0	237	31	0	414	68	4861	2
1HL½P CV%	18.13	0.1	8	4	0	16	5	20	10
1HL1MA	3.56	12	1812	592	0.18*	924	1356	6953	14
1HL1MB	3.68	13	1779	596	0.18*	942	1365	8687	15
1HL1MC	3.78	13	1697	614	0.52	839	1339	6863	13
1HL1M Min	3.56	12	1697	592	0.18*	839	1339	6863	13
1HL1M Max	3.78	13	1812	614	0.52	942	1365	8687	15
1HL1M Mean	3.68	13	1763	601	0.29	902	1354	7501	14
1HL1M Std	0.11	0.1	60	12	0.2	55	13	1028	1
1HL1M CV%	3.05	1.1	3	2	68.86	6	1	14	6
1HL1LA	0.93	9.2	1290	683	0.18*	185	1329	406	56

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1HL1LB	0.91	9.4	1249	683	0.18*	141	1320	392	41
1HL1LC	0.91	9.6	1245	689	0.18*	135	1281	464	36
1HL1L Min	0.91	9.2	1245	683	0.18*	135	1281	392	36
1HL1L Max	0.93	9.6	1290	689	0.18*	185	1329	464	56
1HL1L Mean	0.92	9.4	1261	685	0.18*	154	1310	421	44
1HL1L Std	0.01	0.2	25	3	0	27	25	38	11
1HL1L CV%	1.21	2	2	0	0	18	2	9	24
1HL1PA	11.19	13	2668	741	0.18*	2611	1323	23139	15
1HL1PB	15.05	13	2704	860	0.18*	2638	1276	33244	7
1HL1PC	16.61	13	2726	783	0.67	2731	1245	39822	5
1HL1P Min	11.19	13	2668	741	0.18*	2611	1245	23139	5
1HL1P Max	16.61	13	2726	860	0.67	2731	1323	39822	15
1HL1P Mean	14.28	13	2699	795	0.34	2660	1281	32068	9
1HL1P Std	2.79	0	29	60	0.29	63	39	8404	5
1HL1P CV%	19.53	0.1	1	8	84.27	2	3	26	60
1HL2MA	6.21	13	1717	580	0.18*	871	1336	13766	4
1HL2MB	6.05	13	1734	598	0.5	800	1269	13828	5

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1HL2MC	6.12	13	1693	550	0.18*	840	1337	14929	5
1HL2M Min	6.05	13	1693	550	0.18*	800	1269	13766	4
1HL2M Max	6.21	13	1734	598	0.5	871	1337	14929	5
1HL2M Mean	6.12	13	1715	576	0.28	837	1314	14174	4
1HL2M Std	0.08	0	20	24	0.19	35	39	654	0
1HL2M CV%	1.3	0.1	1	4	66.16	4	3	5	9
1HL2LA	0.89	12	1133	511	0.18*	58	1294	409	17
1HL2LB	0.99	13	1149	529	0.18*	53	1323	559	12
1HL2LC	0.99	13	1155	522	0.18*	56	1282	503	13
1HL2L Min	0.89	12	1133	511	0.18*	53	1282	409	12
1HL2L Max	0.99	13	1155	529	0.18*	58	1323	559	17
1HL2L Mean	0.96	12	1145	521	0.18*	56	1300	490	14
1HL2L Std	0.06	0.2	11	9	0	3	21	76	3
1HL2L CV%	6.15	1.6	1	2	0	5	2	16	18
1HL2PA	20.51	13	2301	648	0.18*	2086	1173	52339	3
1HL2PB	21.31	13	2343	654	0.18*	1999	1158	54756	3
1HL2PC	18.94	13	2336	736	0.18*	1884	1192	47195	3

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1HL2P Min	18.94	13	2301	648	0.18*	1884	1158	47195	3
1HL2P Max	21.31	13	2343	736	0.18*	2086	1192	54756	3
1HL2P Mean	20.25	13	2327	679	0.18*	1990	1174	51430	3
1HL2P Std	1.21	0	23	49	0	101	17	3862	0
1HL2P CV%	5.96	0.1	1	7	0	5	1	8	1
1AL½MA	2.24	7.5	1765	819	0.18*	873	1340	1766	193
1AL½MB	2.22	7.5	1851	842	0.18*	861	1361	1860	190
1AL½MC	2.33	7.5	1872	862	0.18*	907	1357	1746	185
1AL½M Min	2.22	7.5	1765	819	0.18*	861	1340	1746	185
1AL½M Max	2.33	7.5	1872	862	0.18*	907	1361	1860	193
1AL½M Mean	2.26	7.5	1829	841	0.18*	880	1353	1791	189
1AL½M Std	0.06	0	57	22	0	24	12	61	4
1AL½M CV%	2.67	0.1	3	3	0	3	1	3	2
1AL½LA	0.91	7.6	1323	693	0.18*	270	1264	210	153
1AL½LB	0.9	7.6	1335	719	0.18*	291	1310	250	92
1AL½LC	0.93	7.6	1351	766	0.18*	308	1346	270	71
1AL½L Min	0.9	7.6	1323	693	0.18*	270	1264	210	71

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1AL½L Max	0.93	7.6	1351	766	0.18*	308	1346	270	153
1AL½L Mean	0.91	7.6	1336	726	0.18*	290	1307	243	105
1AL½L Std	0.02	0	14	37	0	19	41	31	42
1AL½L CV%	1.99	0.4	1	5	0	7	3	13	40
1AL½PA	9.39	7.2	3207	855	0.18*	2950	1308	15912	531
1AL½PB	7.33	7.3	2991	874	0.18*	2273	1258	11874	402
1AL½PC	9.17	7.3	2972	874	0.18*	2681	1266	13791	509
1AL½P Min	7.33	7.2	2972	855	0.18*	2273	1258	11874	402
1AL½P Max	9.39	7.3	3207	874	0.18*	2950	1308	15912	531
1AL½P Mean	8.63	7.3	3056	868	0.18*	2635	1277	13859	481
1AL½P Std	1.13	0.1	131	11	0	341	27	2020	69
1AL½P CV%	13.09	1.1	4	1	0	13	2	15	14
1AL1MA	2.57	7.5	1828	868	0.18*	851	1353	3083	214
1AL1MB	2.83	7.5	1853	819	0.18*	929	1364	3586	220
1AL1MC	2.75	7.5	1817	829	0.18*	895	1344	3851	214
1AL1M Min	2.57	7.5	1817	819	0.18*	851	1344	3083	214
1AL1M Max	2.83	7.5	1853	868	0.18*	929	1364	3851	220

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1AL1M Mean	2.72	7.5	1833	839	0.18*	892	1354	3506	216
1AL1M Std	0.13	0	19	26	0	39	10	390	4
1AL1M CV%	4.91	0.1	1	3	0	4	1	11	2
1AL1LA	1.07	7.6	1361	736	0.18*	352	1316	615	84
1AL1LB	0.9	7.6	1319	776	0.18*	271	1291	270	75
1AL1LC	0.97	7.6	1350	764	0.18*	292	1336	351	82
1AL1L Min	0.9	7.6	1319	736	0.18*	271	1291	270	75
1AL1L Max	1.07	7.6	1361	776	0.18*	352	1336	615	84
1AL1L Mean	0.98	7.6	1343	759	0.18*	305	1315	412	80
1AL1L Std	0.09	0	22	21	0	42	23	180	5
1AL1L CV%	8.81	0.2	2	3	0	14	2	44	6
1AL1PA	7.25	7.3	2674	824	0.18*	1922	1274	13517	370
1AL1PB	11.62	7.2	3085	874	0.18*	2588	1194	26354	530
1AL1PC	8	7.2	2718	847	0.18*	2233	1343	15489	413
1AL1P Min	7.25	7.2	2674	824	0.18*	1922	1194	13517	370
1AL1P Max	11.62	7.3	3085	874	0.18*	2588	1343	26354	530
1AL1P Mean	8.95	7.2	2826	848	0.18*	2248	1270	18454	438

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1AL1P Std	2.34	0.1	226	25	0	333	75	6913	83
1AL1P CV%	26.12	1.3	8	3	0	15	6	37	19
1AL2MA	3.33	7.5	1891	929	0.18*	867	1318	6264	234
1AL2MB	3.25	7.5	1877	852	0.18*	874	1368	6361	230
1AL2MC	3.33	7.5	1852	846	0.18*	872	1372	6757	228
1AL2M Min	3.25	7.5	1852	846	0.18*	867	1318	6264	228
1AL2M Max	3.33	7.5	1891	929	0.18*	874	1372	6757	234
1AL2M Mean	3.3	7.5	1873	876	0.18*	871	1353	6461	231
1AL2M Std	0.05	0	20	46	0	4	30	261	3
1AL2M CV%	1.45	0	1	5	0	0	2	4	1
1AL2LA	0.98	7.6	1319	759	0.18*	290	1313	494	78
1AL2LB	1.19	7.6	1372	758	0.18*	350	1312	920	89
1AL2LC	1.08	7.6	1334	732	0.18*	312	1300	682	84
1AL2L Min	0.98	7.6	1319	732	0.18*	290	1300	494	78
1AL2L Max	1.19	7.6	1372	759	0.18*	350	1313	920	89
1AL2L Mean	1.08	7.6	1342	750	0.18*	317	1308	699	84
1AL2L Std	0.11	0	27	15	0	30	7	213	6

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
1AL2L CV%	9.73	0.1	2	2	0	10	1	31	7
1AL2PA	19.63	7.2	2600	787	0.18*	2330	1233	36401	626
1AL2PB	14.88	7.2	3014	823	0.18*	2444	1252	38626	533
1AL2PC	19.84	7.3	3284	817	0.18*	2551	1160	47155	657
1AL2P Min	14.88	7.2	2600	787	0.18*	2330	1160	36401	533
1AL2P Max	19.84	7.3	3284	823	0.18*	2551	1252	47155	657
1AL2P Mean	18.12	7.2	2966	809	0.18*	2442	1215	40727	605
1AL2P Std	2.8	0	344	19	0	111	48	5676	65
1AL2P CV%	15.48	0.6	12	2	0	5	4	14	11
2CS0LA	1.11	8	991	483	0.18*	499	1536	246	127
2CS0LB	1.21	8	874	420	0.18*	516	1515	845	147
2CS0LC	1.09	8.1	881	406	0.18*	476	1555	220	147
2CS0LD	1.09	8.1	969	462	0.18*	509	1538	263	125
2CS0L Min	1.09	8	874	406	0.18*	476	1515	220	125
2CS0L Max	1.21	8.1	991	483	0.18*	516	1555	845	147
2CS0L Mean	1.12	8	929	443	0.18*	500	1536	393	137
2CS0L Std	0.06	0.1	60	36	0	18	16	302	12

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2CS0L CV%	5.41	0.8	6	8	0	4	1	77	9
2CS0PA	27.7	8.8	9652	1153	1.05	12692	3053	14069	1059
2CS0PB	26.73	8.9	12258	1151	1.05	14631	3542	16162	977
2CS0PC	25	8.1	8605	760	1.05	12413	3975	13003	1222
2CS0PD	30.69	9	12838	1266	1.05	15026	3694	15962	1246
2CS0P Min	25	8.1	8605	760	1.05	12413	3053	13003	977
2CS0P Max	30.69	9	12838	1266	1.05	15026	3975	16162	1246
2CS0P Mean	27.53	8.7	10838	1083	1.05	13690	3566	14799	1126
2CS0P Std	2.39	0.4	2034	221	0	1329	386	1524	129
2CS0P CV%	8.67	4.6	19	20	0	10	11	10	11
2LS½LA	1	8.5	335	65	0.18*	178	1527	755	27
2LS½LB	1.03	8.8	341	66	0.18*	184	1416	739	25
2LS½LC	1.16	8.3	440	94	0.18*	288	1450	1182	38
2LS½L Min	1	8.3	335	65	0.18*	178	1416	739	25
2LS½L Max	1.16	8.8	440	94	0.18*	288	1527	1182	38
2LS½L Mean	1.06	8.5	372	75	0.18*	217	1465	892	30
2LS½L Std	0.09	0.2	59	17	0	62	56	252	7

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2LS½L CV%	8.27	2.5	16	22	0	29	4	28	24
2LS½PA	28.61	9.2	4051	254	1.05	9551	2491	65309	196
2LS½PB	23.83	8.3	3988	82	3.05	9929	2628	67821	227
2LS½PC	31.64	8.9	4140	172	1.05	9770	2769	65084	184
2LS½P Min	23.83	8.3	3988	82	1.05	9551	2491	65084	184
2LS½P Max	31.64	9.2	4140	254	3.05	9929	2769	67821	227
2LS½P Mean	28.03	8.8	4060	169	1.72	9750	2629	66071	203
2LS½P Std	3.94	0.5	76	86	1.16	190	139	1519	22
2LS½P CV%	14.05	5.3	2	51	67.35	2	5	2	11
2LS1LA	1.07	13	190	17	0.18*	92	1541	1172	10
2LS1LB	0.95	13	207	43	0.45	62	1435	848	10
2LS1LC	0.93	12	193	35	0.18*	58	1408	755	10
2LS1L Min	0.93	12	190	17	0.18*	58	1408	755	10
2LS1L Max	1.07	13	207	43	0.45	92	1541	1172	10
2LS1L Mean	0.98	13	197	32	0.27	71	1461	925	10
2LS1L Std	0.08	0.1	9	13	0.16	19	70	219	0
2LS1L CV%	7.64	0.4	5	42	58.82	26	5	24	3

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2LS1PA	34.58	13	4072	178	1.05	9053	2767	104067	35
2LS1PB	32.26	13	4137	157	5.39	7509	2104	88832	26
2LS1PC	30.78	13	3934	155	2.19	7633	2116	85937	32
2LS1P Min	30.78	13	3934	155	1.05	7509	2104	85937	26
2LS1P Max	34.58	13	4137	178	5.39	9053	2767	104067	35
2LS1P Mean	32.54	13	4047	164	2.88	8065	2329	92945	31
2LS1P Std	1.91	0	103	13	2.25	858	379	9740	5
2LS1P CV%	5.88	0.2	3	8	78.26	11	16	10	15
2LS2LA	2.02	13	196	44	0.18*	120	1429	3193	4
2LS2LB	1.71	13	161	36	0.18*	67	1453	2158	4
2LS2LC	2	13	212	47	0.18*	111	1367	3190	5
2LS2L Min	1.71	13	161	36	0.18*	67	1367	2158	4
2LS2L Max	2.02	13	212	47	0.18*	120	1453	3193	5
2LS2L Mean	1.91	13	190	42	0.18*	99	1416	2847	5
2LS2L Std	0.17	0	26	6	0	28	44	597	1
2LS2L CV%	9	0.1	14	14	0	28	3	21	15

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2LS2PA	34.18	13	1316	138	1.05	5520	1872	128405	20
2LS2PB	33.78	13	3234	146	1.05	5521	1920	125661	21
2LS2PC	33.53	13	2500	174	1.05	5511	1740	117627	21
2LS2P Min	33.53	13	1316	138	1.05	5511	1740	117627	20
2LS2P Max	34.18	13	3234	174	1.05	5521	1920	128405	21
2LS2P Mean	33.83	13	2350	153	1.05	5517	1844	123898	21
2LS2P Std	0.33	0	968	19	0	6	93	5602	1
2LS2P CV%	0.97	0.2	41	13	0	0	5	5	5
2HL½LA	0.54	8.2	420	198	0.18*	128	879	277	37
2HL½LB	0.6	8.2	453	217	0.55	148	920	268	38
2HL½LC	0.65	8	519	215	0.18*	233	1118	440	42
2HL½L Min	0.54	8	420	198	0.18*	128	879	268	37
2HL½L Max	0.65	8.2	519	217	0.55	233	1118	440	42
2HL½L Mean	0.6	8.2	464	210	0.3	170	972	328	39
2HL½L Std	0.05	0.1	50	11	0.22	56	128	97	3
2HL½L CV%	8.82	1.3	11	5	72.17	33	13	29	7
2HL½PA	31.84	12	4857	317	2.19	10120	2856	80281	57

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2HL½PB	31.75	13	4519	419	2.31	10691	2898	69858	51
2HL½PC	34.16	13	4148	420	4.53	11973	4206	80854	23
2HL½P Min	31.75	12	4148	317	2.19	10120	2856	69858	23
2HL½P Max	34.16	13	4857	420	4.53	11973	4206	80854	57
2HL½P Mean	32.58	13	4508	385	3.01	10928	3320	76998	43
2HL½P Std	1.37	0.1	355	59	1.32	949	767	6190	18
2HL½P CV%	4.19	0.7	8	15	43.78	9	23	8	42
2HL1LA	1.18	8.3	601	207	0.18*	316	1524	897	45
2HL1LB	1.16	8.4	562	208	0.18*	299	1546	1147	40
2HL1LC	1.26	8.3	553	196	0.18*	300	1581	1198	46
2HL1L Min	1.16	8.3	553	196	0.18*	299	1524	897	40
2HL1L Max	1.26	8.4	601	208	0.18*	316	1581	1198	46
2HL1L Mean	1.2	8.3	572	204	0.18*	305	1551	1081	44
2HL1L Std	0.05	0	26	6	0	9	29	161	3
2HL1L CV%	4.26	0.5	4	3	0	3	2	15	8
2HL1PA	41.55	13	3803	142	1.05	7187	1737	133242	12
2HL1PB	36.82	13	3255	136	1.05	7229	2240	119635	17

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2HL1PC	38.34	13	3177	131	1.05	6208	2059	138827	21
2HL1P Min	36.82	13	3177	131	1.05	6208	1737	119635	12
2HL1P Max	41.55	13	3803	142	1.05	7229	2240	138827	21
2HL1P Mean	38.91	13	3412	137	1.05	6875	2012	130568	17
2HL1P Std	2.41	0	341	5	0	578	255	9871	5
2HL1P CV%	6.21	0.1	10	4	0	8	13	8	29
2HL2LA	1.07	9.6	216	42	0.45	183	1292	1500	18
2HL2LB	1.3	12	242	21	0.18*	132	1539	1063	13
2HL2LC	1.41	12	329	62	0.18*	204	1511	1721	11
2HL2L Min	1.07	9.6	216	21	0.18*	132	1292	1063	11
2HL2L Max	1.41	12	329	62	0.45	204	1539	1721	18
2HL2L Mean	1.26	11	262	42	0.27	173	1447	1428	14
2HL2L Std	0.17	1.6	59	21	0.16	37	135	334	4
2HL2L CV%	13.68	14	23	50	58.82	21	9	23	26
2HL2PA	36.12	13	2657	118	1.05	7463	1987	128798	11
2HL2PB	39.26	13	2942	111	1.05	5563	1915	144154	9
2HL2PC	39.3	13	2498	100	1.05	5666	2154	148989	13

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2HL2P Min	36.12	13	2498	100	1.05	5563	1915	128798	9
2HL2P Max	39.3	13	2942	118	1.05	7463	2154	148989	13
2HL2P Mean	38.23	13	2699	110	1.05	6231	2019	140647	11
2HL2P Std	1.82	0	225	9	0	1069	123	10542	2
2HL2P CV%	4.77	0.2	8	8	0	17	6	7	15
2AL½LA	1.18	8	1002	495	0.18*	491	1485	822	162
2AL½LB	1.21	8	933	420	0.18*	500	1494	815	158
2AL½LC	0.67	7.9	644	377	0.18*	280	1054	88	115
2AL½L Min	0.67	7.9	644	377	0.18*	280	1054	88	115
2AL½L Max	1.21	8	1002	495	0.18*	500	1494	822	162
2AL½L Mean	1.02	7.9	860	431	0.18*	423	1345	575	145
2AL½L Std	0.3	0.1	190	60	0	125	251	422	26
2AL½L CV%	29.91	1	22	14	0	29	19	73	18
2AL½PA	47.66	8.6	9825	1071	1.05	10570	2718	113632	1436
2AL½PB	60.96	8.6	7554	807	1.05	10985	2850	147508	1909
2AL½PC	52.86	8.6	8470	1071	1.05	11909	2785	120942	1739
2AL½P Min	47.66	8.6	7554	807	1.05	10570	2718	113632	1436

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2AL½P Max	60.96	8.6	9825	1071	1.05	11909	2850	147508	1909
2AL½P Mean	53.83	8.6	8617	983	1.05	11155	2785	127360	1695
2AL½P Std	6.7	0	1143	152	0	686	66	17827	240
2AL½P CV%	12.45	0.4	13	15	0	6	2	14	14
2AL1LA	1.34	8.1	948	475	0.18*	490	1595	1268	151
2AL1LB	1.34	8	954	447	0.36	492	1542	1332	151
2AL1LC	1.33	8	956	436	0.18*	514	1565	1382	140
2AL1L Min	1.33	8	948	436	0.18*	490	1542	1268	140
2AL1L Max	1.34	8.1	956	475	0.36	514	1595	1382	151
2AL1L Mean	1.34	8	952	453	0.24	499	1567	1327	147
2AL1L Std	0.01	0.1	4	20	0.11	13	26	57	7
2AL1L CV%	0.48	0.7	0	4	45.22	3	2	4	4
2AL1PA	72.86	8.7	3962	813	1.05	11283	3212	139127	1929
2AL1PB	54.15	8.2	9354	818	1.05	8525	2180	170099	1658
2AL1PC	59.2	8.9	5333	705	1.05	13064	3249	127705	1644
2AL1P Min	54.15	8.2	3962	705	1.05	8525	2180	127705	1644
2AL1P Max	72.86	8.9	9354	818	1.05	13064	3249	170099	1929

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2AL1P Mean	62.07	8.6	6216	779	1.05	10957	2880	145644	1744
2AL1P Std	9.68	0.3	2802	64	0	2287	607	21936	161
2AL1P CV%	15.59	3.9	45	8	0	21	21	15	9
2AL2LA	1.44	8.1	931	454	0.18*	431	1528	1826	147
2AL2LB	1.34	8.1	951	452	0.18*	436	1510	1835	145
2AL2LC	1.3	8.1	874	444	0.18*	416	1536	1688	141
2AL2L Min	1.3	8.1	874	444	0.18*	416	1510	1688	141
2AL2L Max	1.44	8.1	951	454	0.18*	436	1536	1835	147
2AL2L Mean	1.36	8.1	918	450	0.18*	428	1525	1783	144
2AL2L Std	0.07	0	40	5	0	10	13	82	3
2AL2L CV%	5.27	0.3	4	1	0	2	1	5	2
2AL2PA	69.06	8.7	4961	802	1.05	9912	2544	155240	1765
2AL2PB	71.56	8.8	3226	497	1.05	3432	947	213582	1514
2AL2PC	69.92	8.7	5631	674	1.05	6936	1762	185573	1656
2AL2P Min	69.06	8.7	3226	497	1.05	3432	947	155240	1514
2AL2P Max	71.56	8.8	5631	802	1.05	9912	2544	213582	1765
2AL2P Mean	70.18	8.8	4606	658	1.05	6760	1751	184798	1645

Sample code	% Solids	pH	Total Kjeldahl N	Ammonium -N	Nitrate-N	Total P	Total K	Total Ca	Water extractable P
2AL2P Std	1.27	0.1	1241	153	0	3243	799	29179	126
2AL2P CV%	1.81	0.9	27	23	0	48	46	16	8

* Sample was below the laboratory Detection Limit of nitrate-N. For summary calculations was set to ½ of the Detection Limit since the value may have been greater than zero, nor was it at or above the detection limit of 0.35 mg/l.

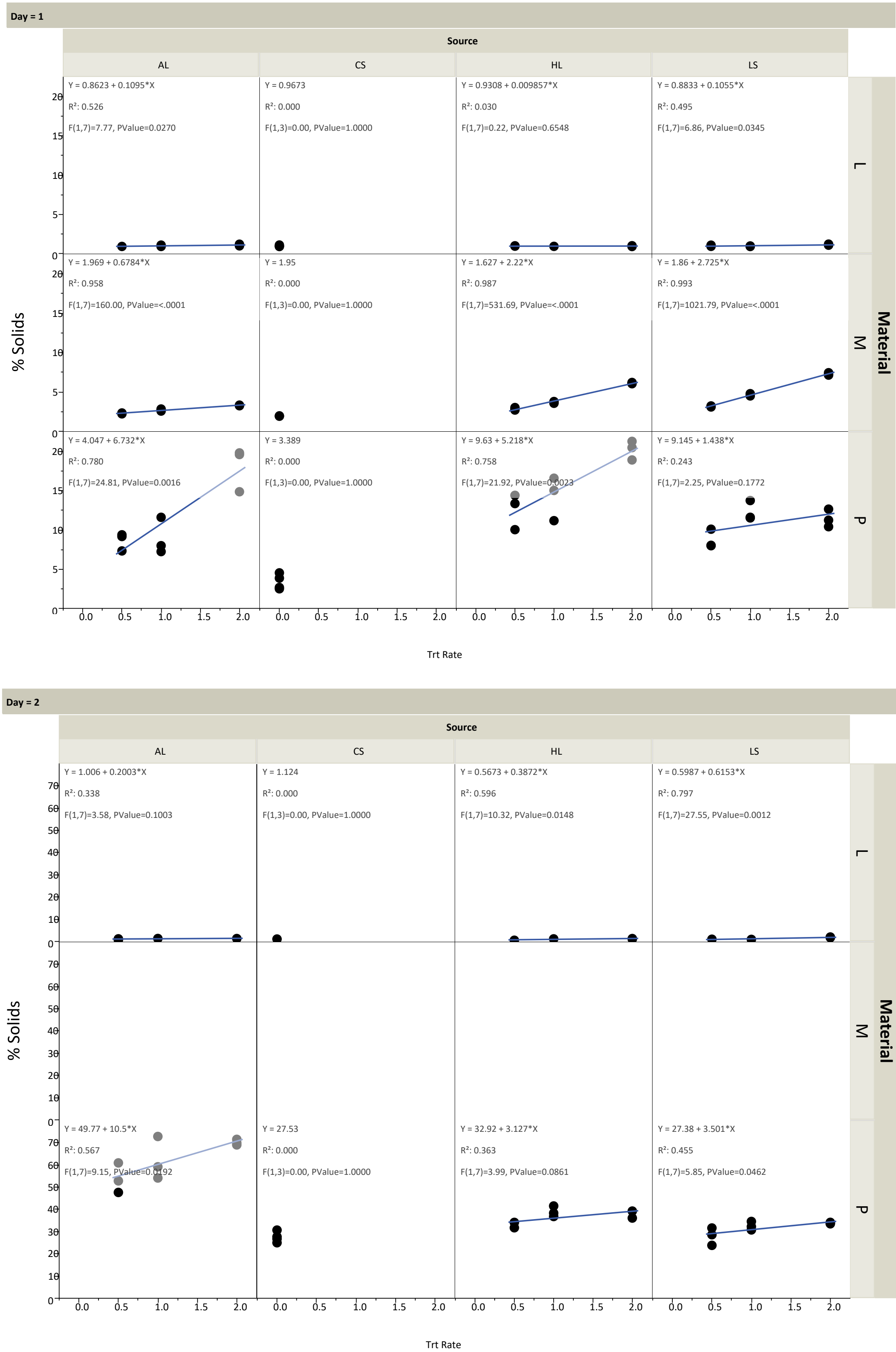
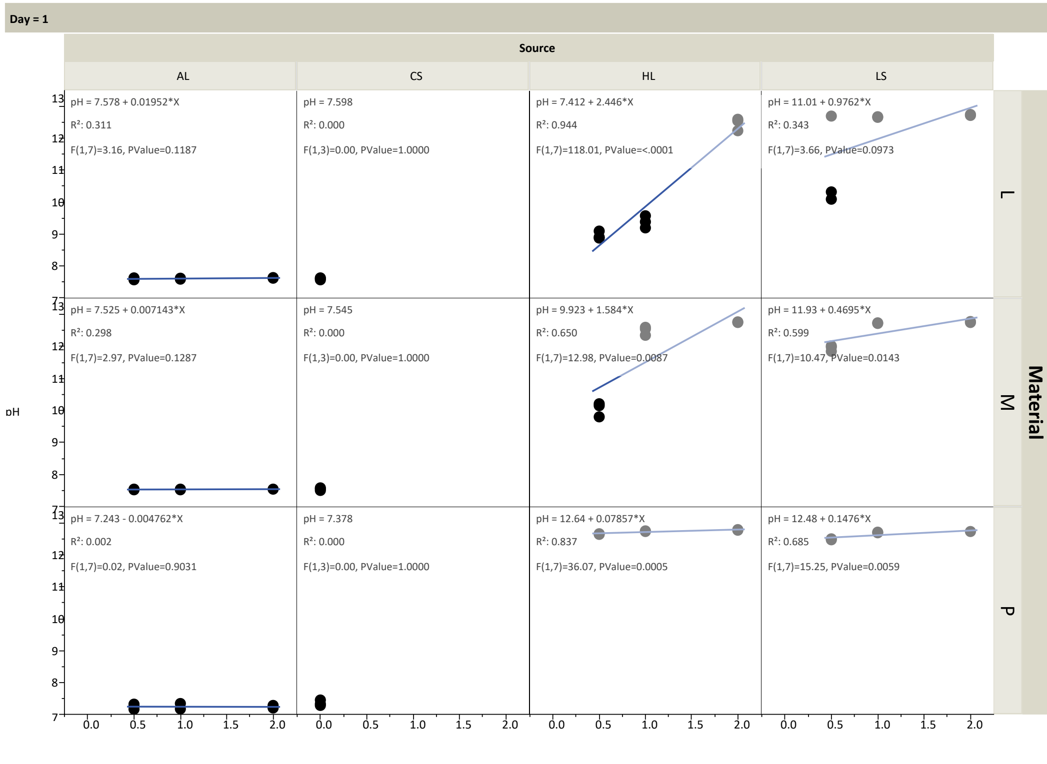


Figure S 5. Relationship between matrix manure % Solids (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.



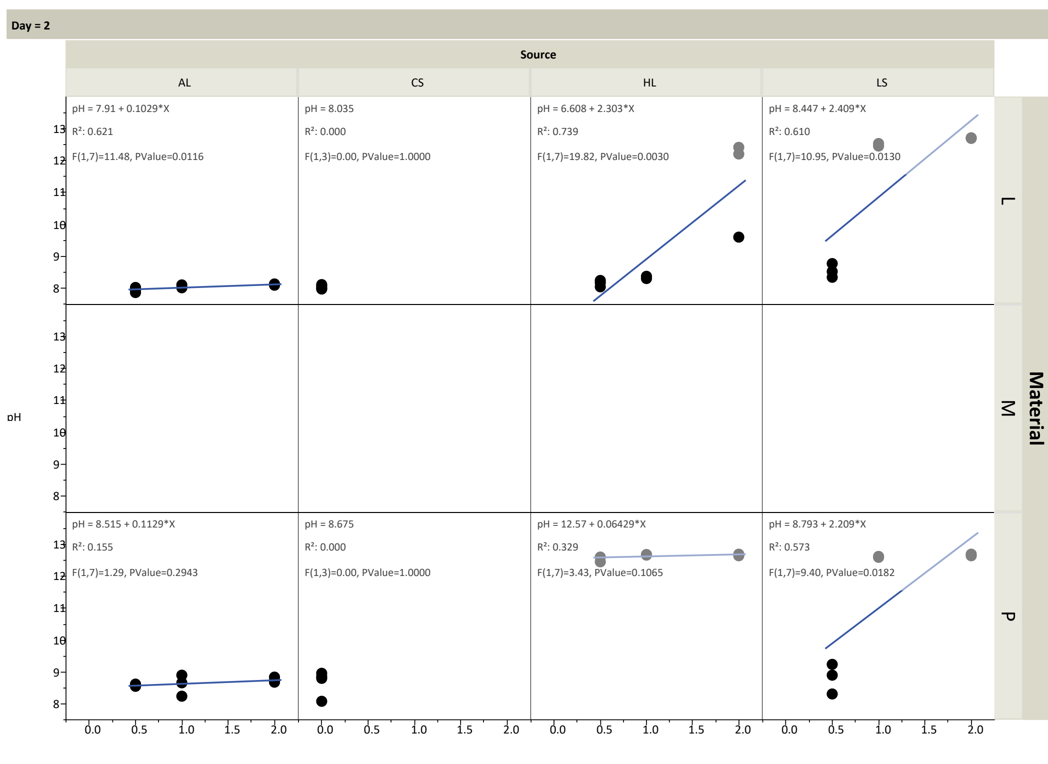
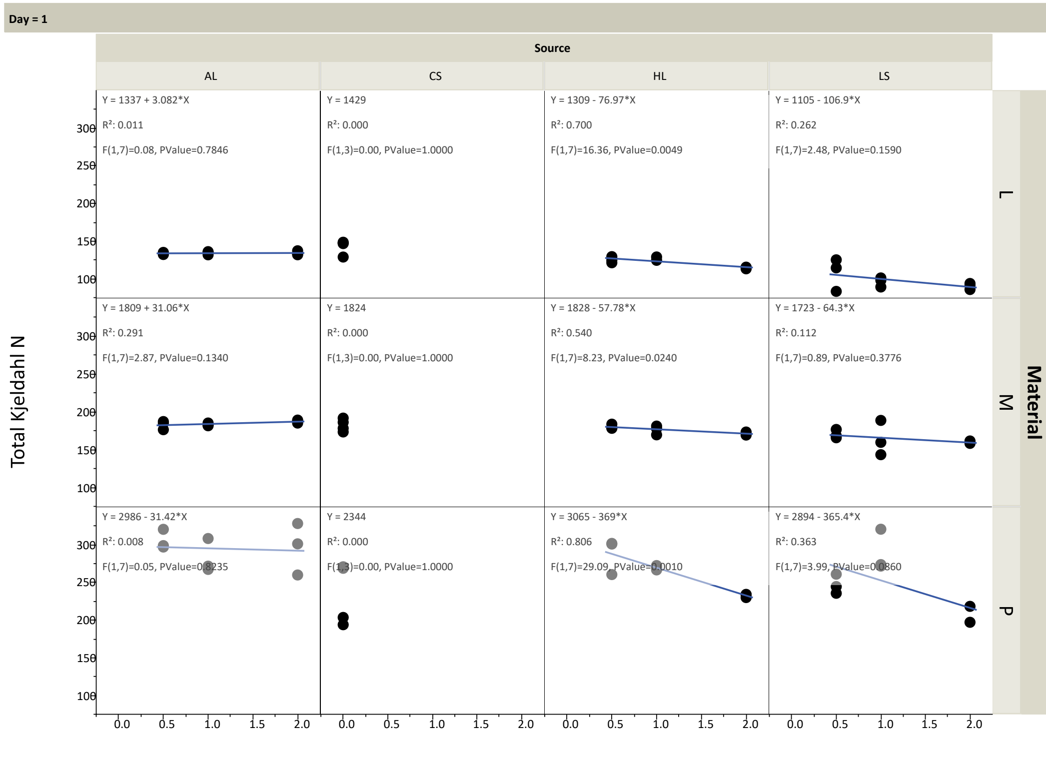


Figure S 6. Relationship between matrix manure pH and treatment rate. Refer to descriptive code table for interpretive information.



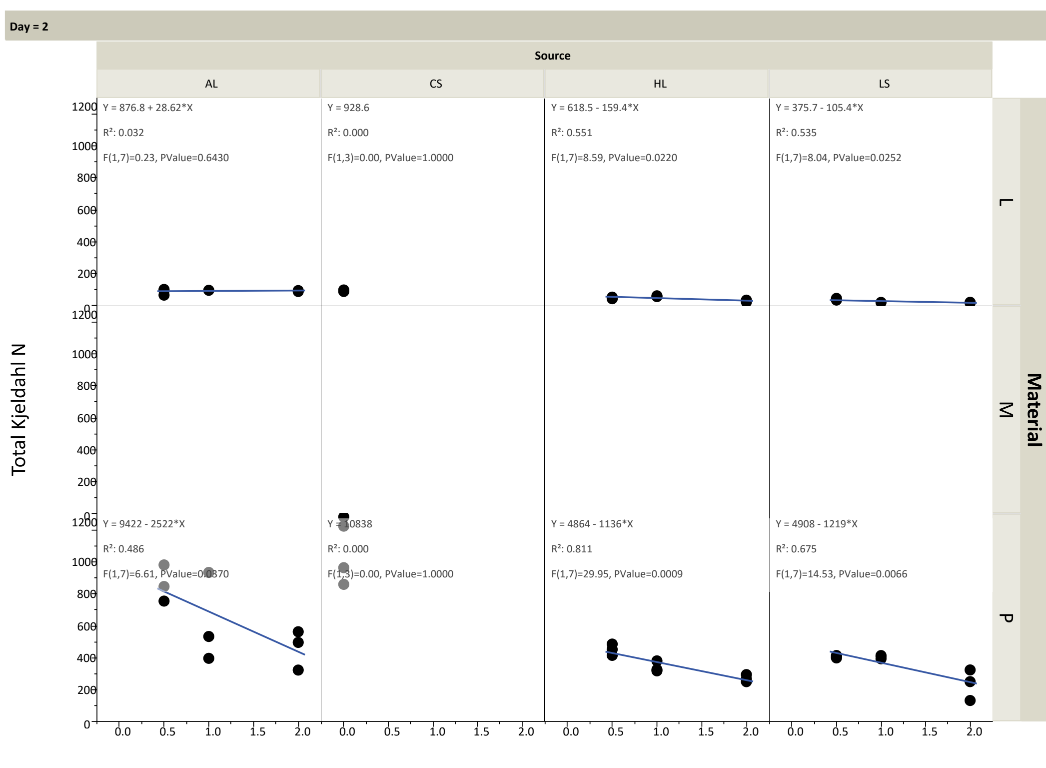


Figure S 7. Relationship between matrix manure Total Kjeldahl N (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.

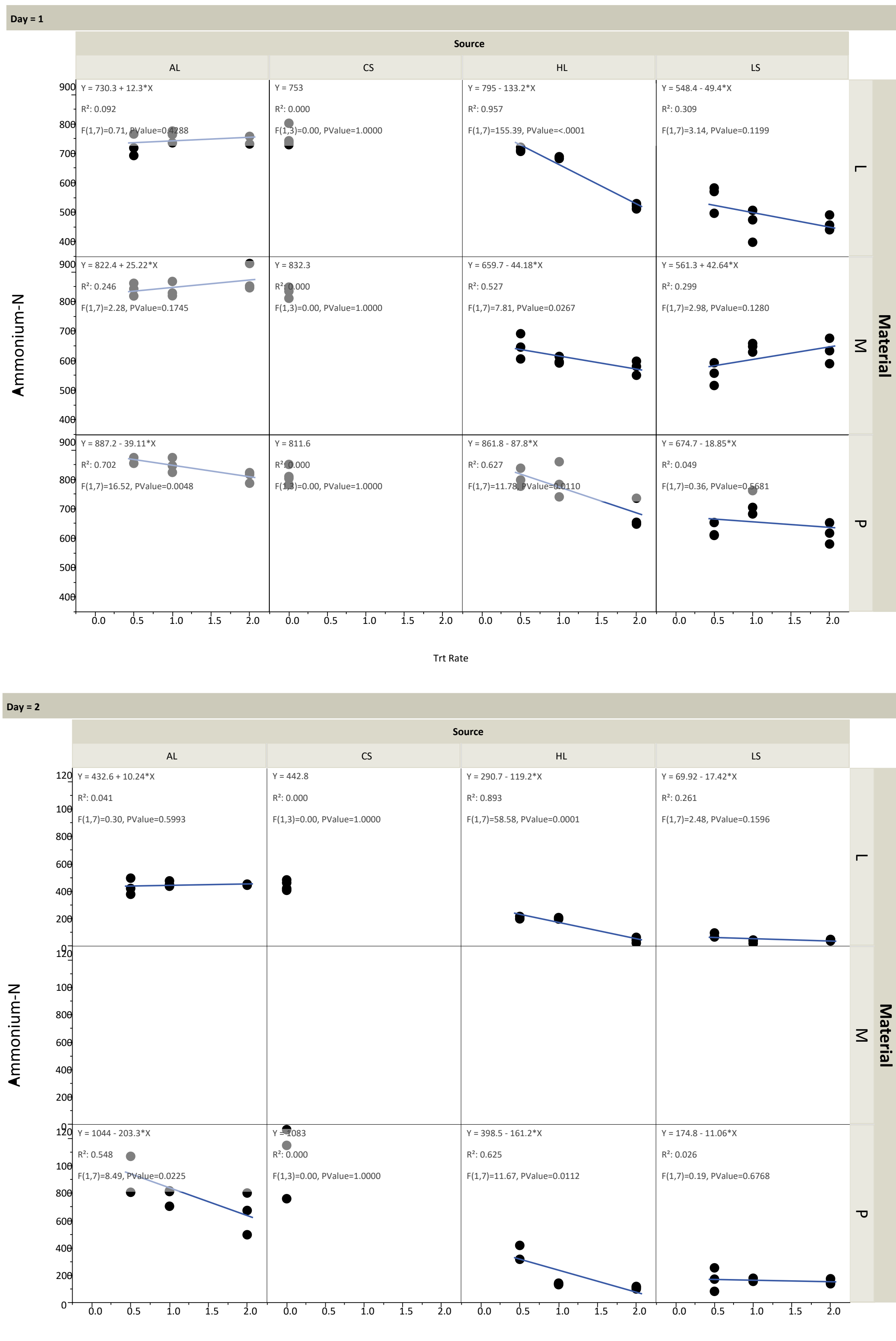


Figure S 8. Relationship between matrix manure ammonium-N (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.

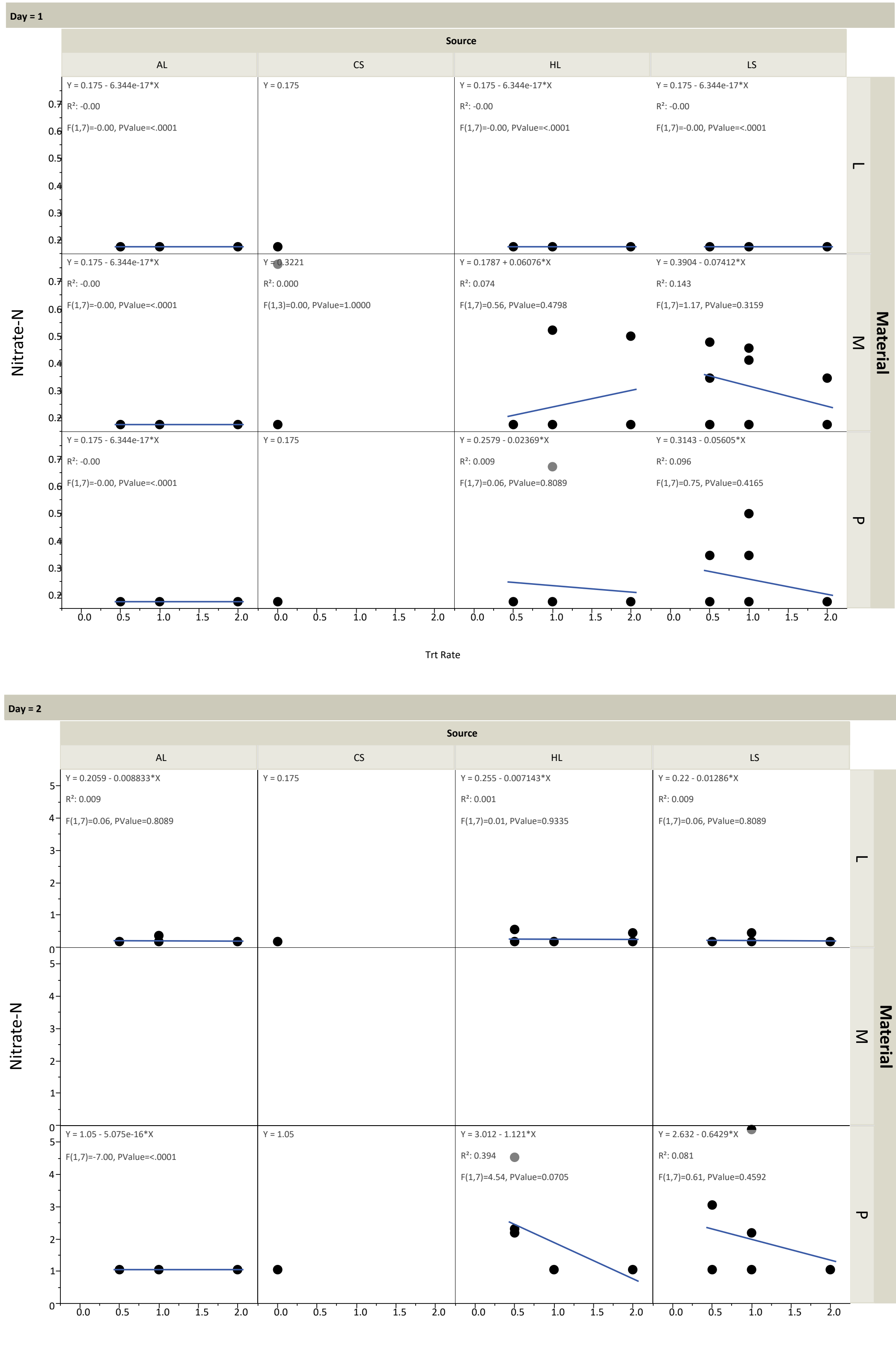
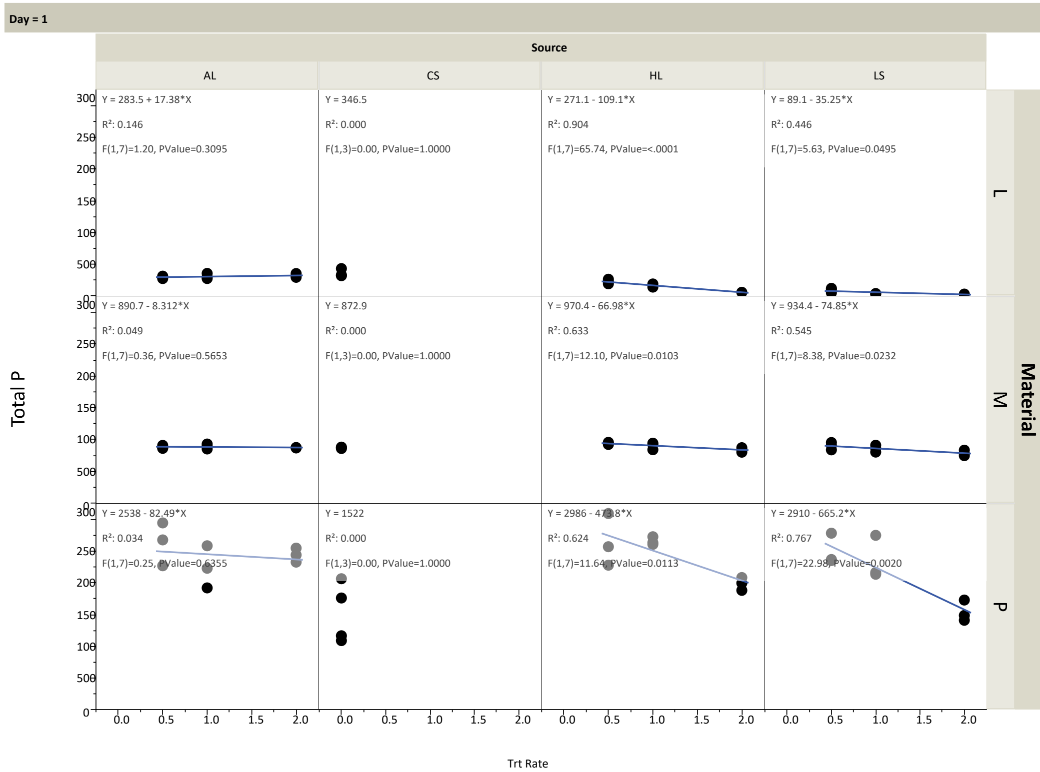


Figure S 9. Relationship between matrix manure nitrate-N (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.



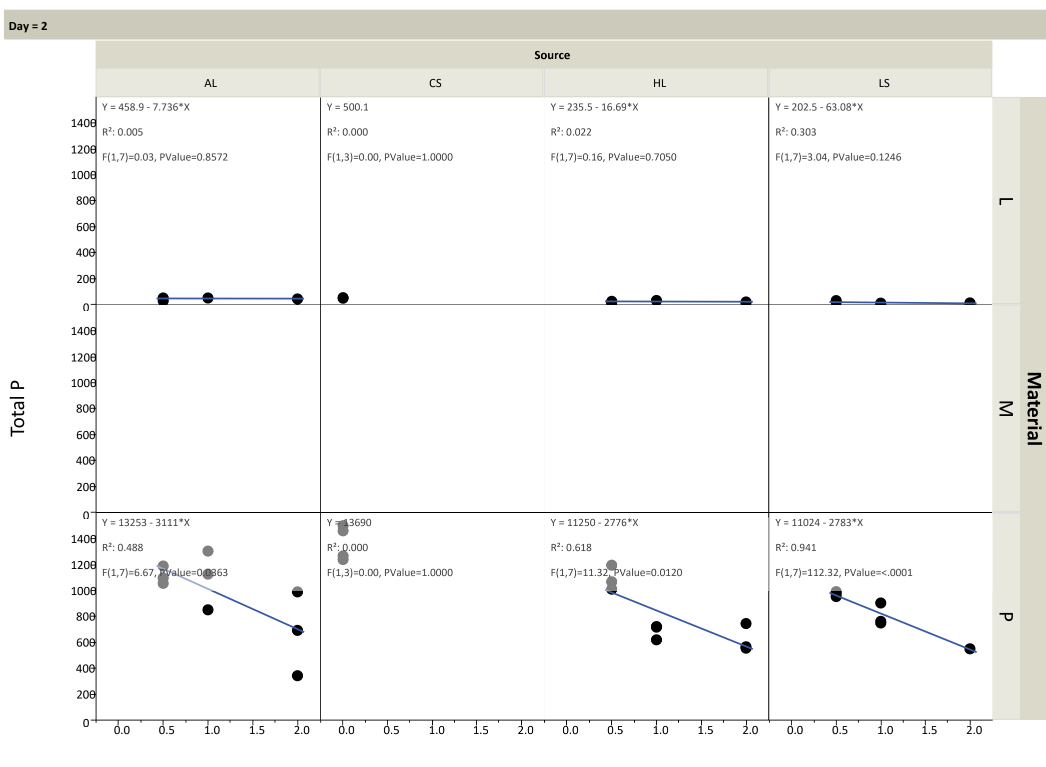


Figure S 10. Relationship between matrix manure total P (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.

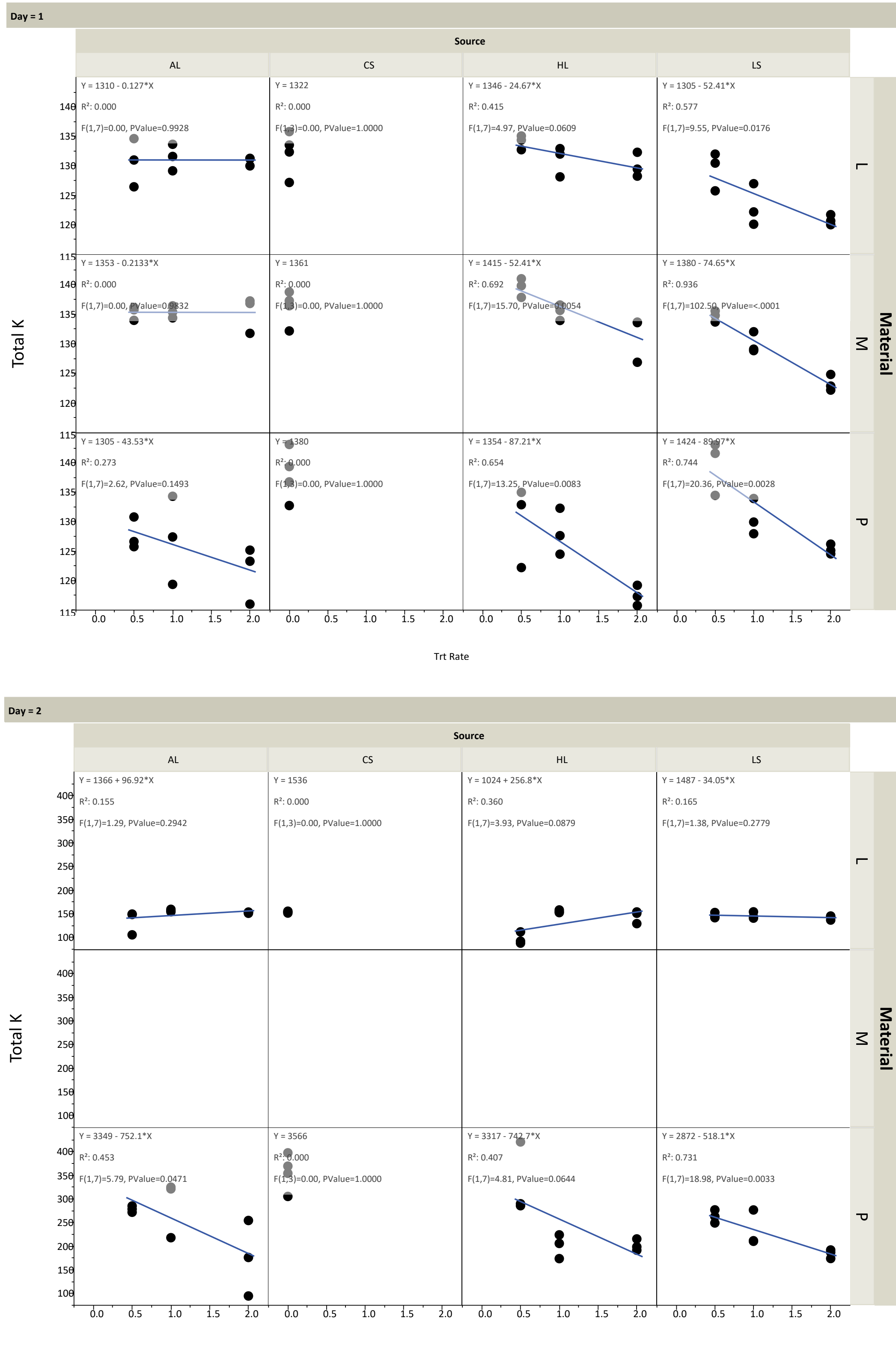
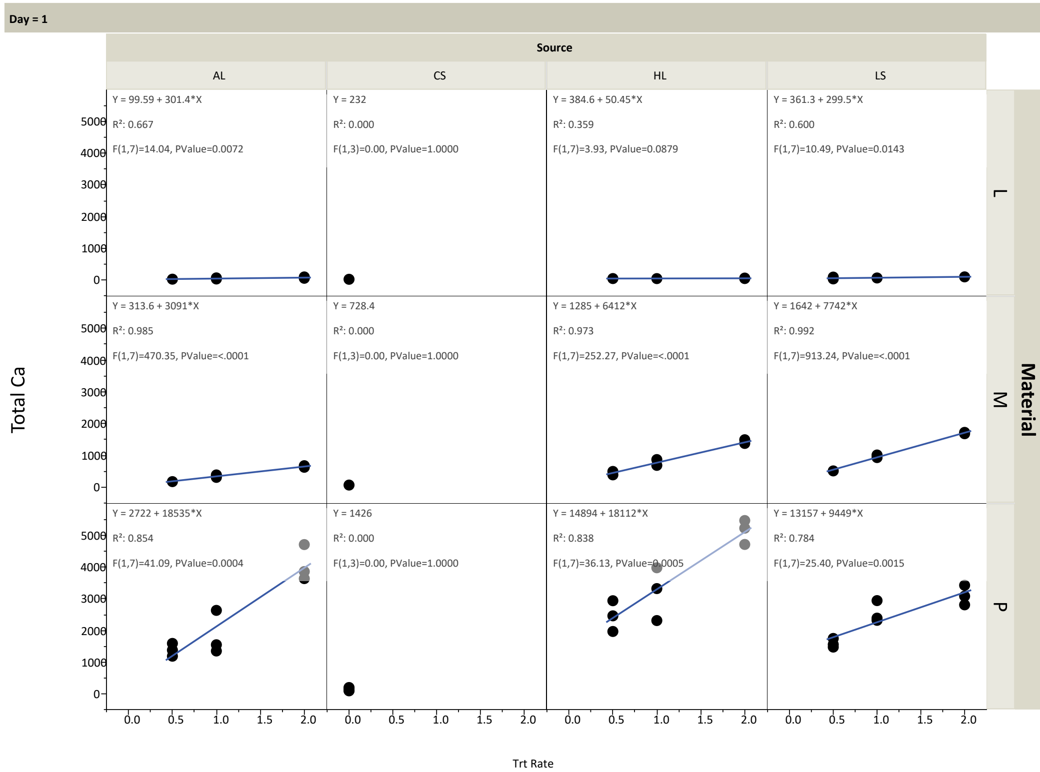


Figure S 11. Relationship between matrix manure total K (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.



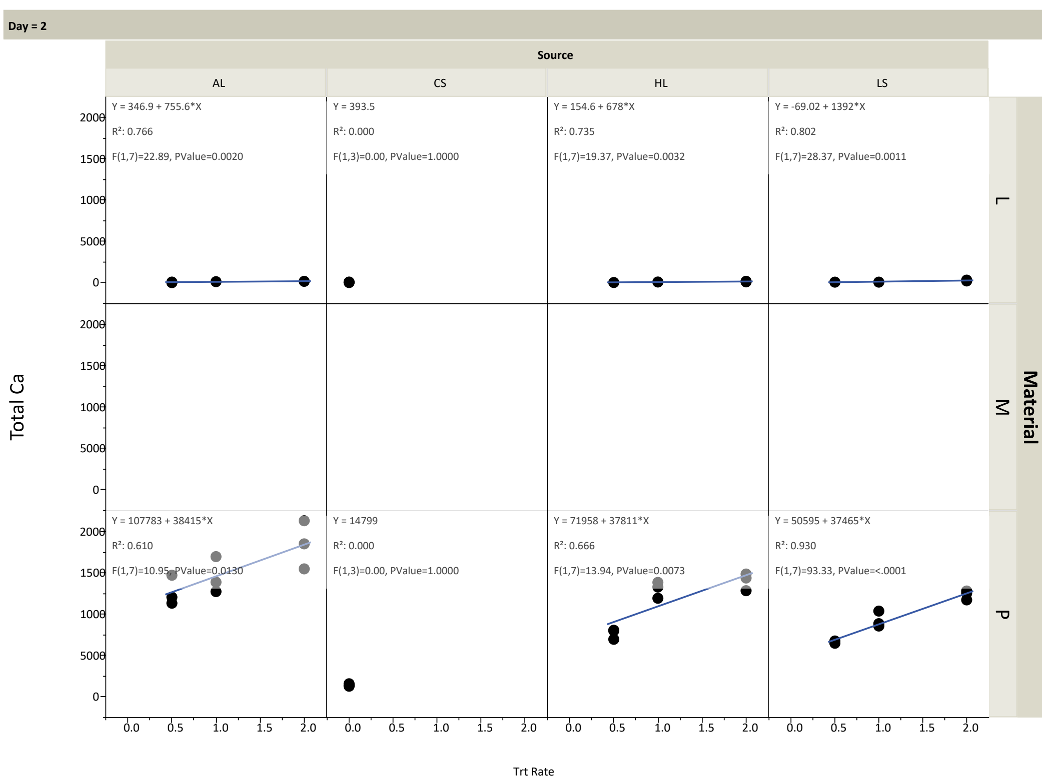


Figure S 12. Relationship between matrix manure total Ca (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.

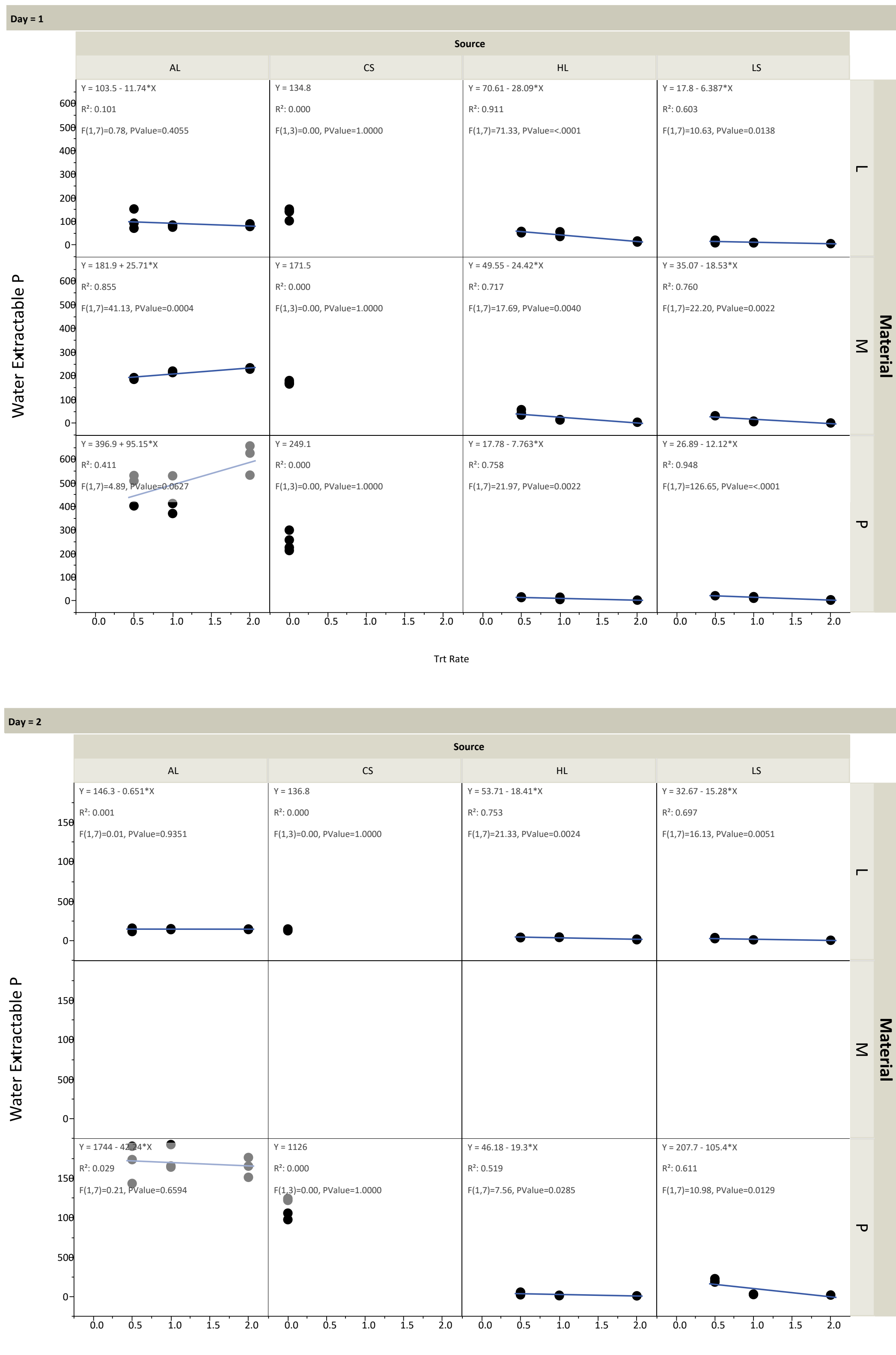
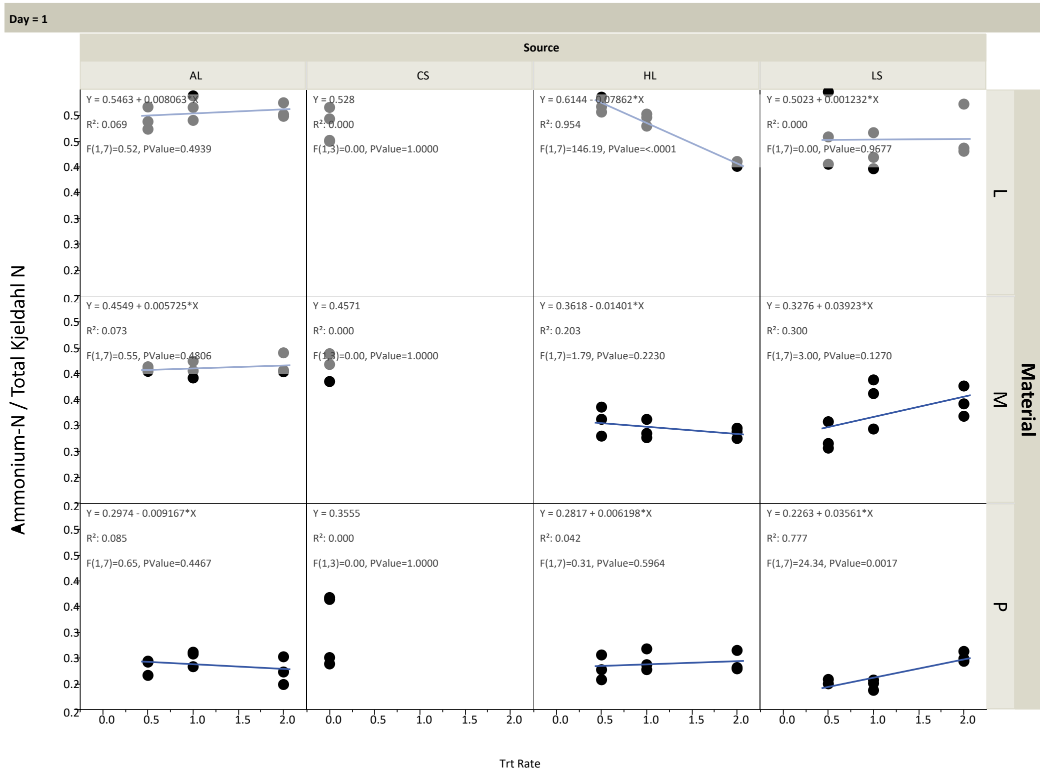


Figure S 13. Relationship between matrix manure water extractable P (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.



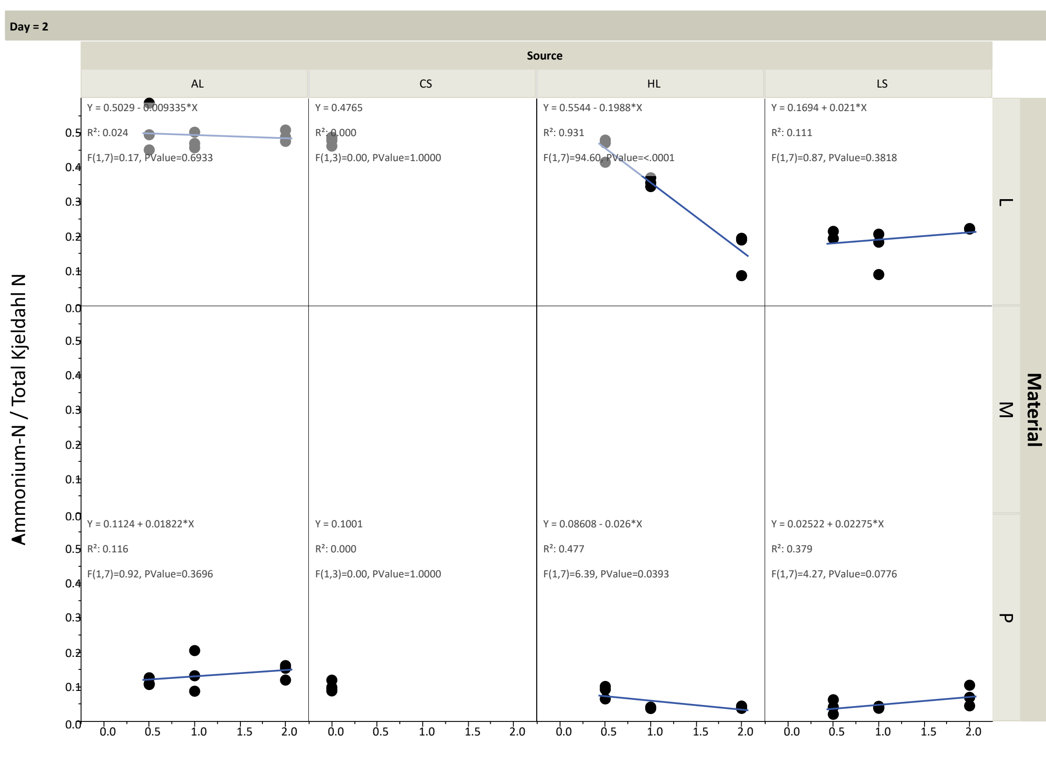
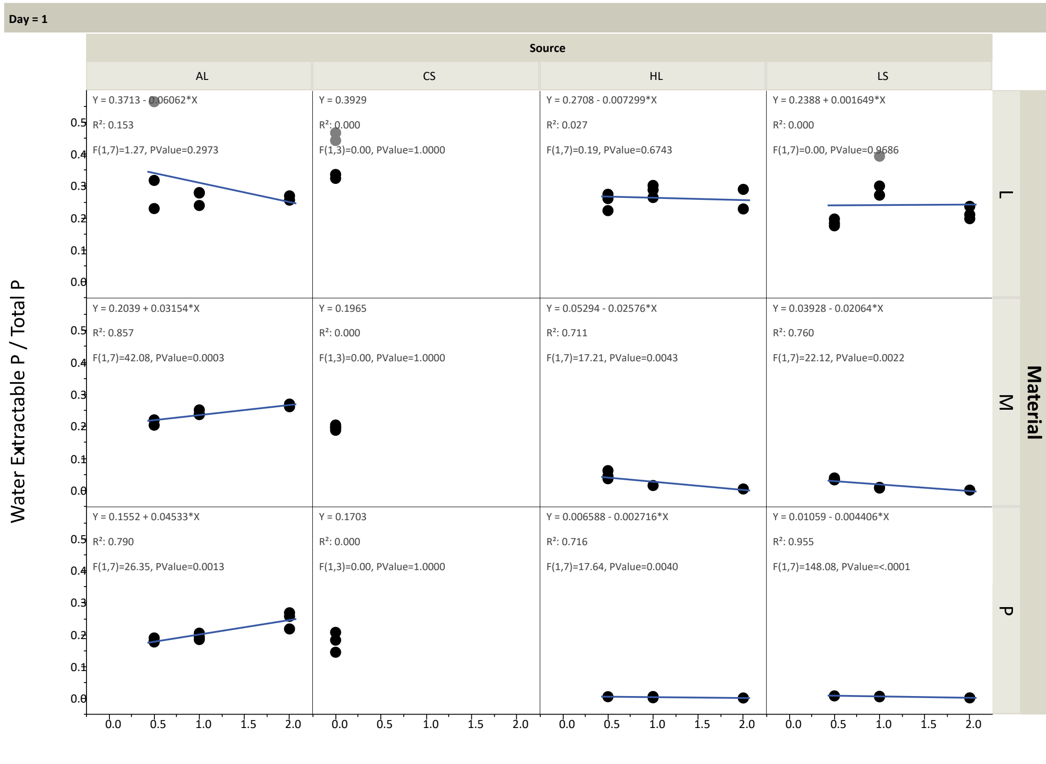


Figure S 14. Relationship between matrix manure ammonium-N / total Kjeldahl N (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.



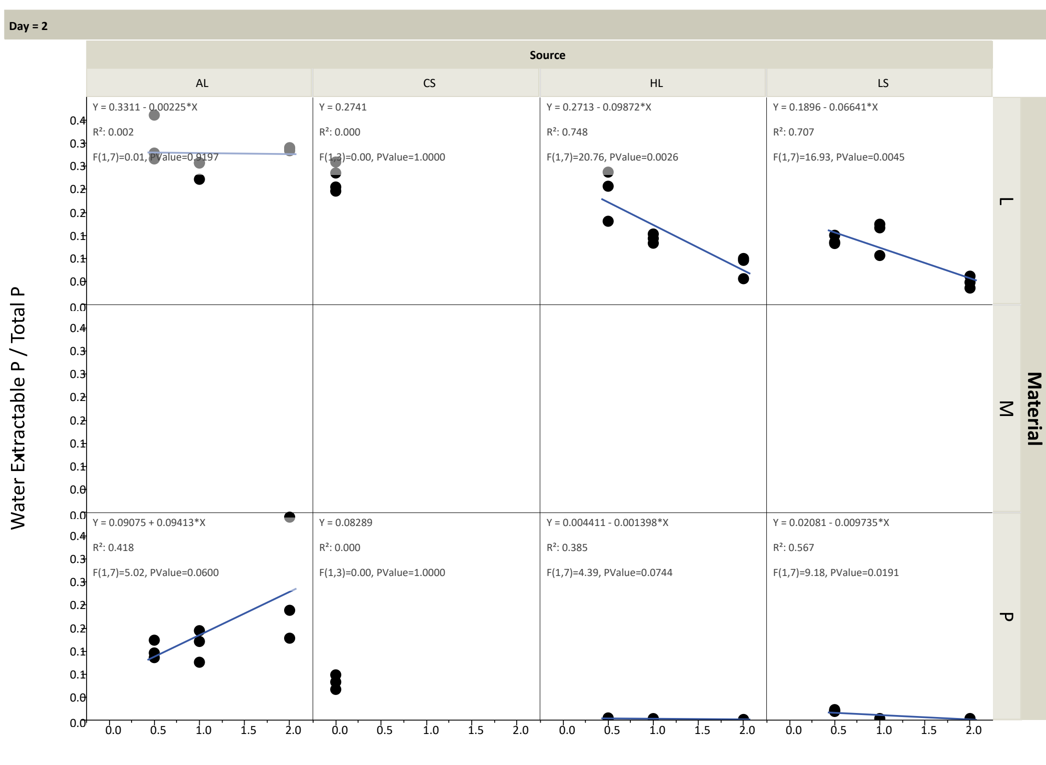


Figure S 15. Relationship between matrix manure water extractable P / Total P (mg/L as is) and treatment rate. Refer to descriptive code table for interpretive information.

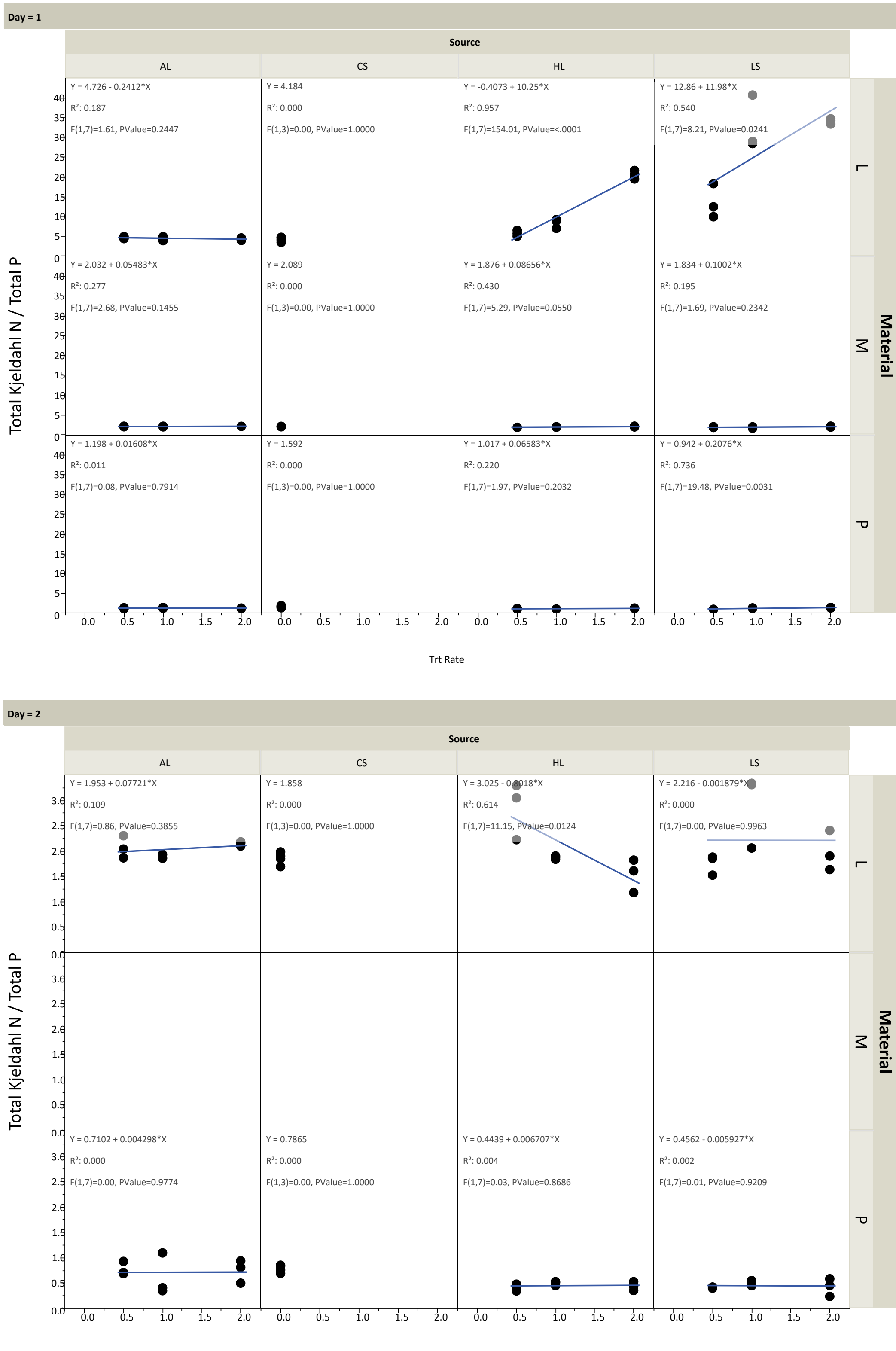


Figure S 16. Relationship **between matrix manure to**tal Kjeldahl N / **t**otal P (mg/L as is) **and treatment rate**. Refer to descriptive code table for interpretive information.