ARKANSAS WATER RESOURCES CENTER

AWRC

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Optimal WTR application rate to minimize phosphorus release from floodplain soils

Background

- Excess phosphorus (P) in waterbodies often leads to water quality issues (i.e., odors, fish kills, algal blooms, etc.)
- Most point sources are now regulated to reduce nutrient input, but nonpoint sources are still problematic
- Runoff from agricultural areas can contribute large amounts of P to streams and rivers
- The P from runoff can be stored in the soils in and near the waterbodies

The problem

- Floodplain soils that have stored this legacy P from runoff may now be a source of P to the watershed

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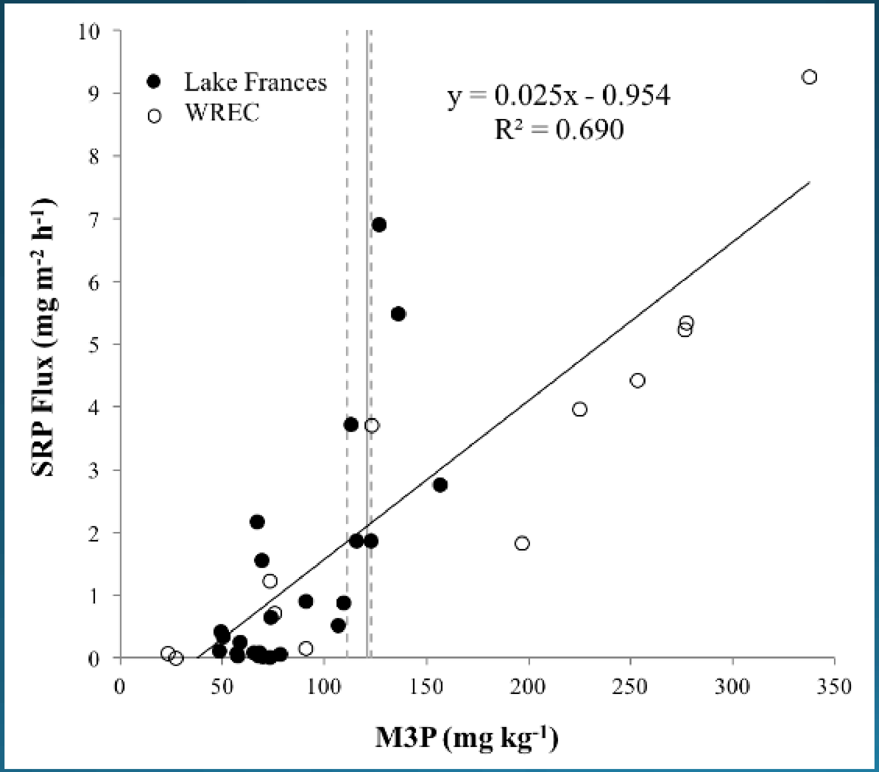


The problem

- Floodplain soils that have stored this legacy P from runoff may now be a source of P to the watershed
- Dissolved P in runoff increases as STP increases as does the potential for release during inundation
- How can we manage this source of P originating from these floodplain soils?

Potential solution

- WTRs are a chemical byproduct of the drinking water treatment process containing coagulation agents such as aluminum sulfate, ferric sulfate, ferrous sulfate, etc.
- The high aluminum and iron content of the WTRs make them especially good at binding to phosphorus
- When applied to soils, the residuals have been shown to significantly reduce dissolved P in runoff

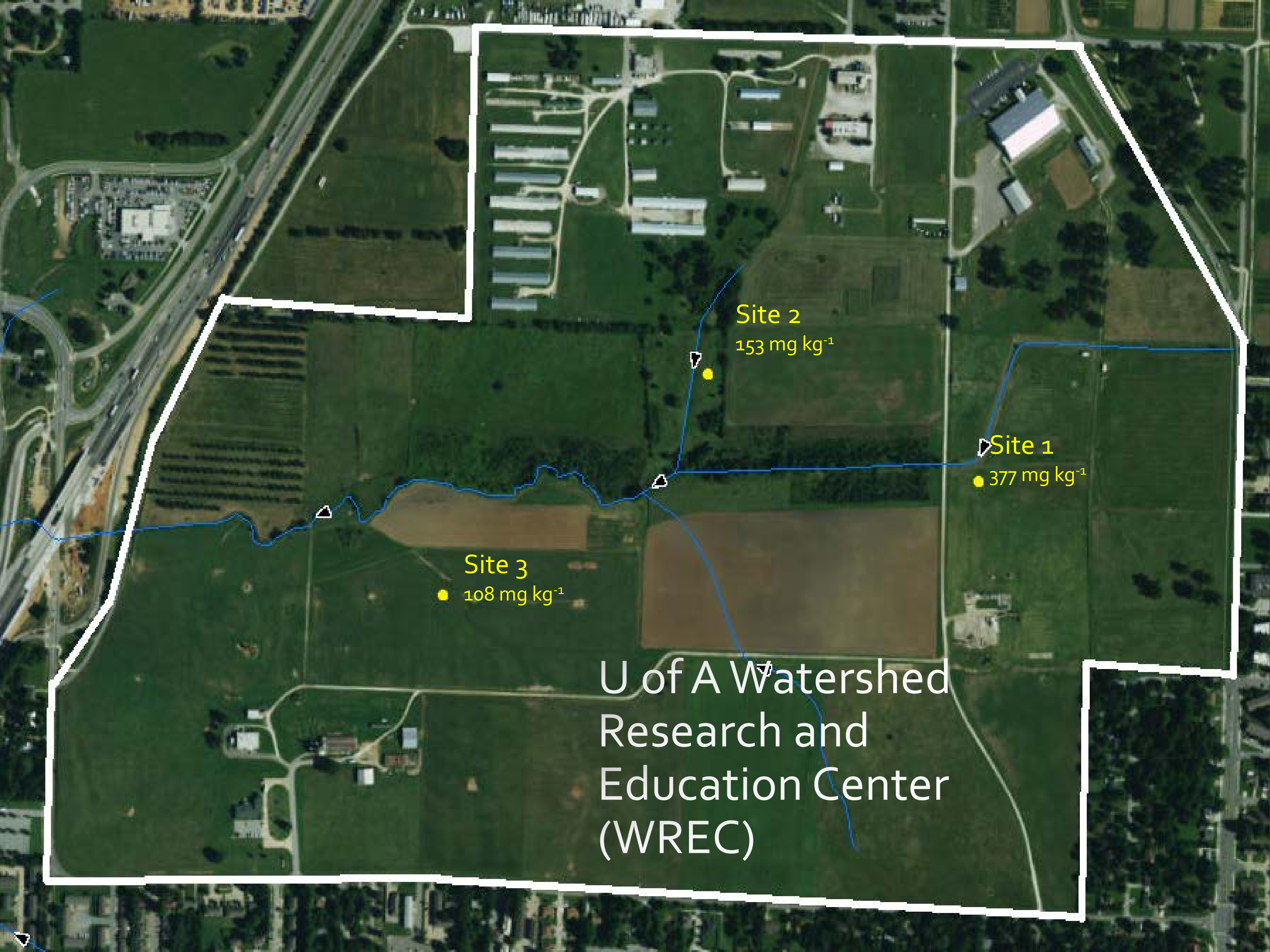



WTRs

Research objective

- Objective:

  Determine the application rate at which liquid WTRs are most efficient at reducing P release.



Site 2
153 mg kg-1
Site 1
377 mg kg-1
Site 3
108 mg kg-1
U of A Watershed Research and Education Center (WREC)

Methods

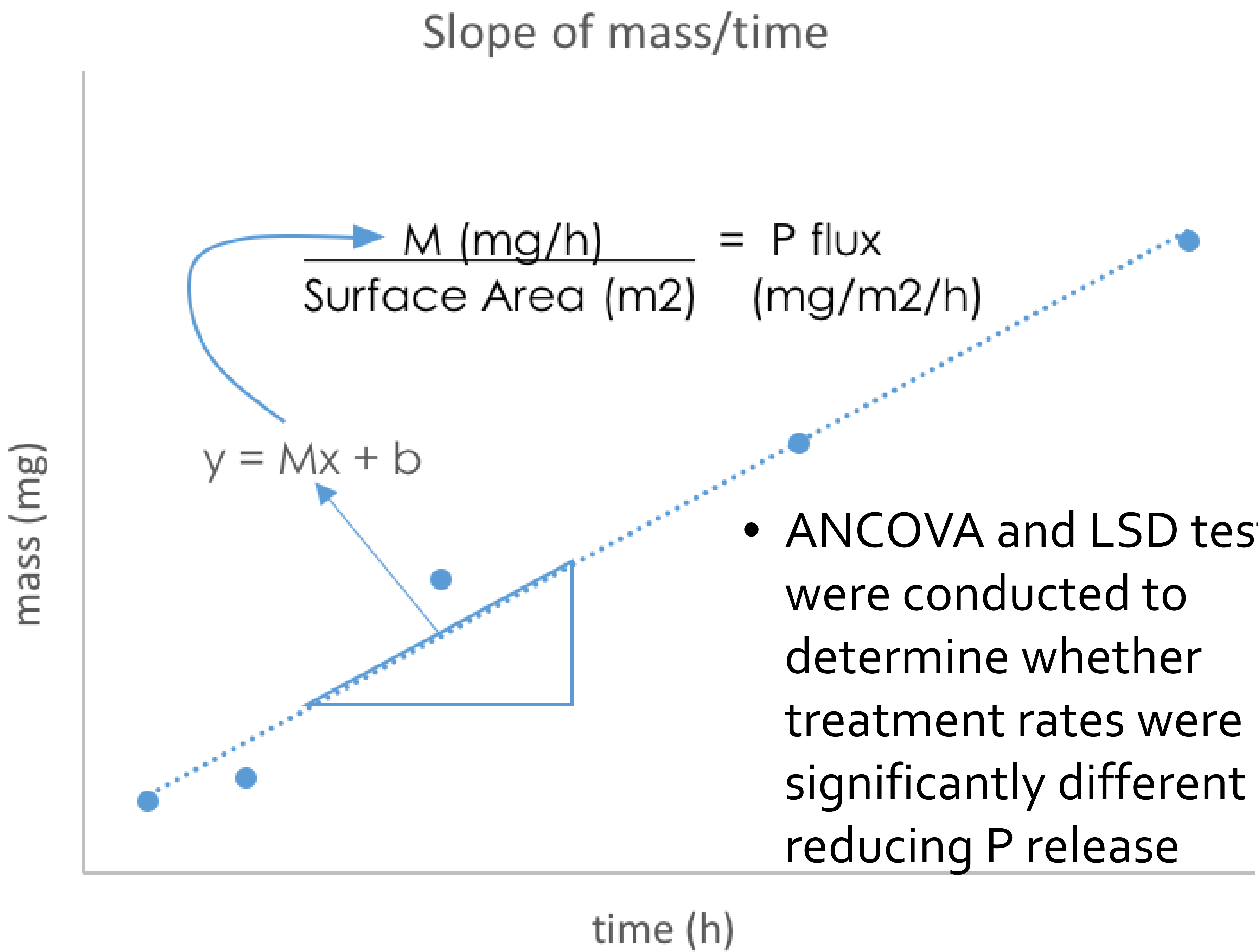
- Cores were collected from each of the 3 sites
  - 21 cores
  - 6 treatment rates, 1 control
  - 3 replicates
- Cores taken to the lab and fitted with filters

Methods

- WTRs (~2% solids) were applied to the soil, covering as much of the surface as possible
- 6 treatment rates:

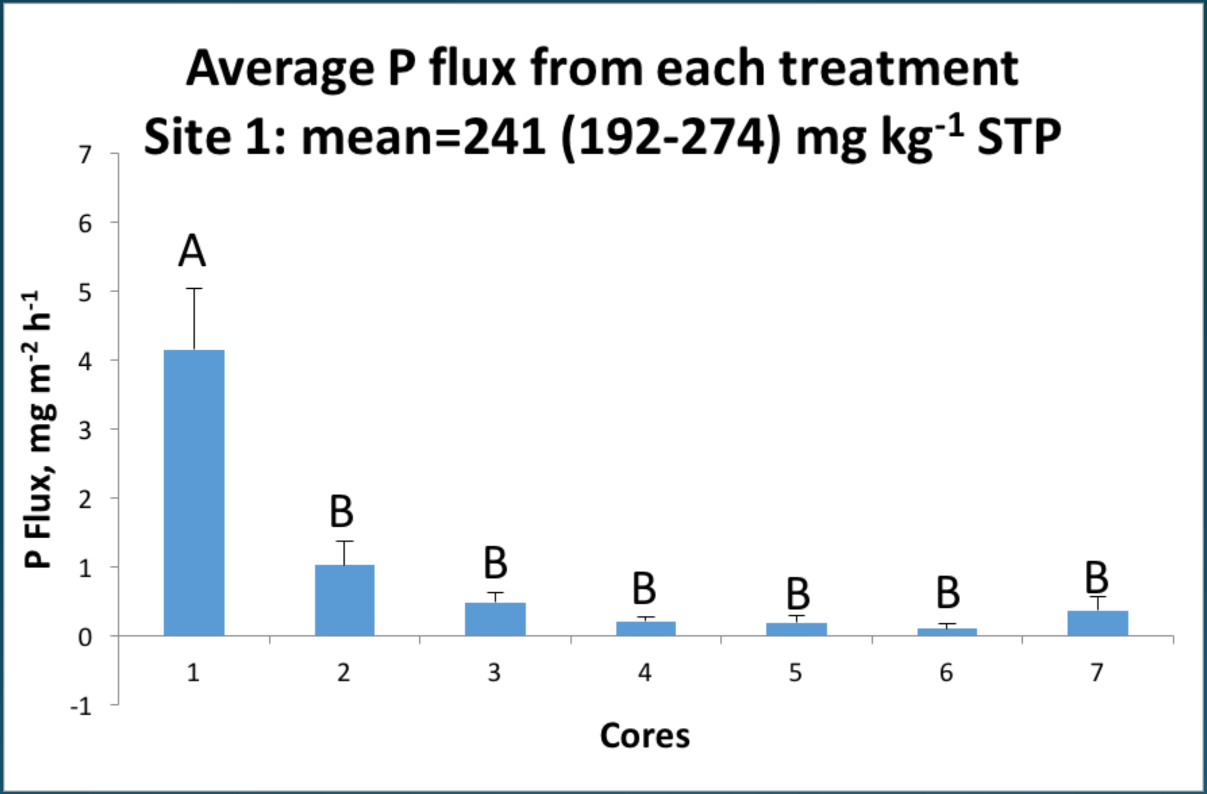
1	0.005 L	~220 kg ha^{-1}
2	0.01 L	~440 kg ha^{-1}
3	0.03 L	~1300 kg ha^{-1}
4	0.05 L	~2200 kg ha^{-1}
5	0.07 L	~3100 kg ha^{-1}
6	0.1 L	~4400 kg ha^{-1}

- Cores were allowed to drain overnight, then inundated with 1L overlying water
- Water samples were taken periodically throughout 8 h
- Samples analyzed for SRP



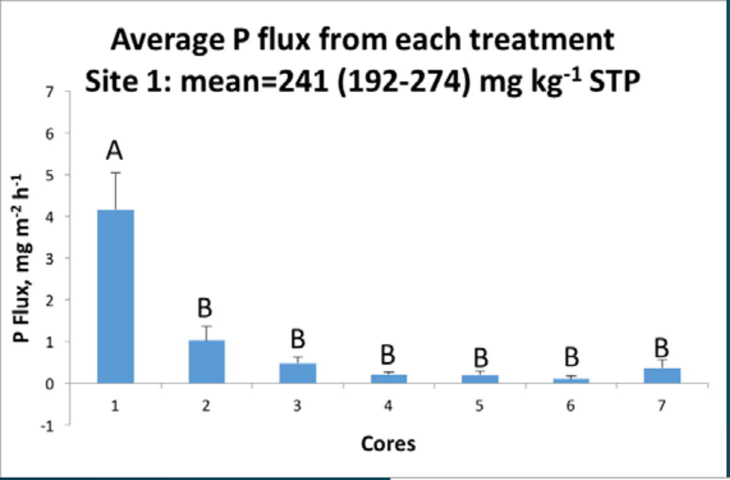
- ANCOVA and LSD tests were conducted to determine whether treatment rates were significantly different in reducing P release

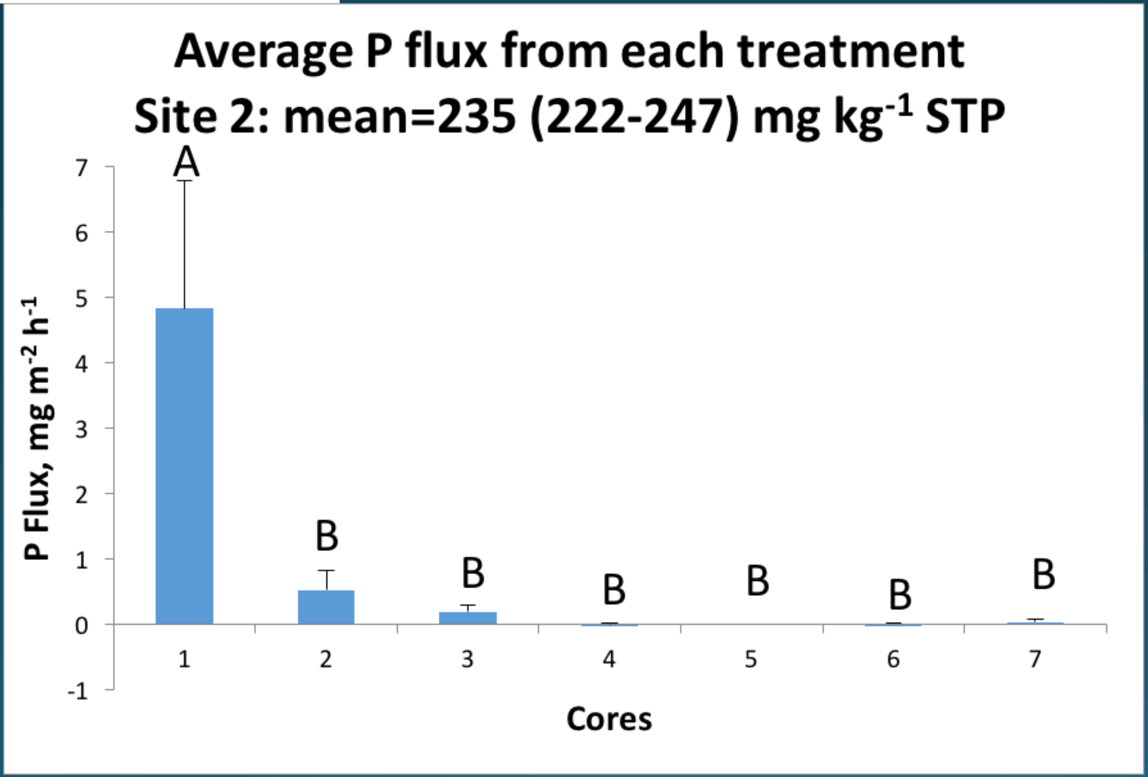
Results

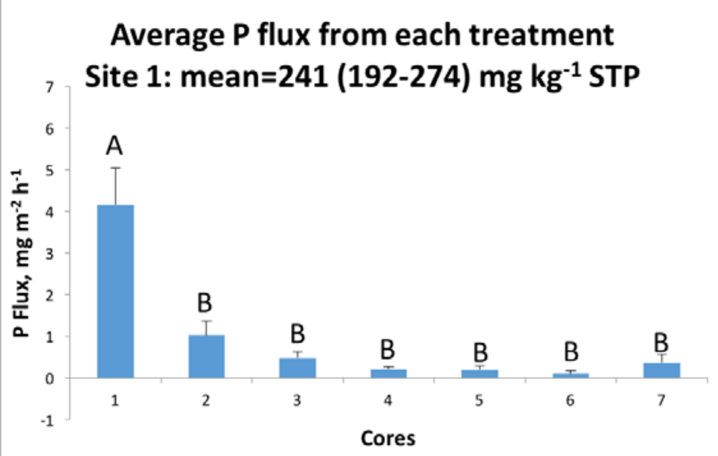


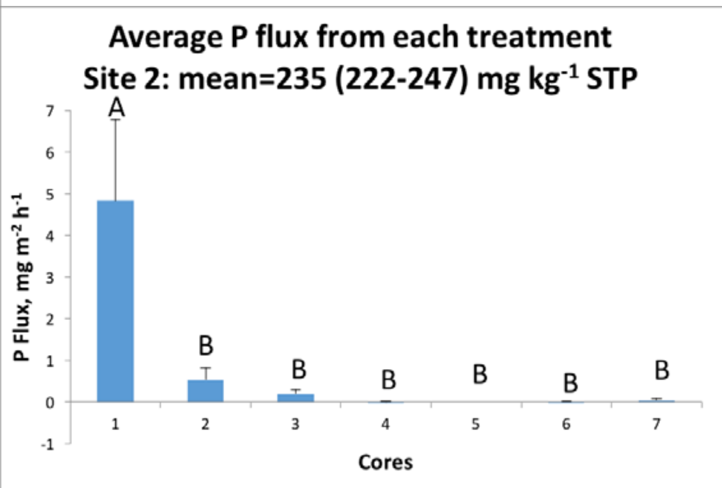
WTR treatments were not significantly different from one another

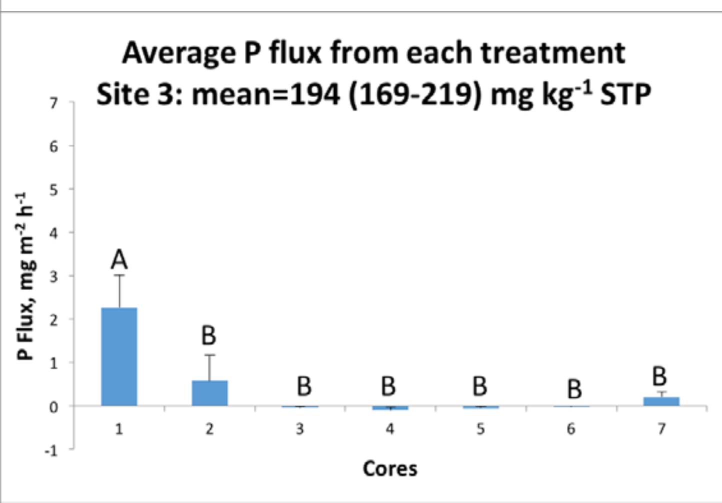
Results


Average P flux from each treatment
Site 1: mean=241 (192-274) mg kg-1 STP
P Flux, mg m-2 h-1
Cores
A
B
B
B
B
B
B
7
6
5
4
3
2
1
0
-1
1
2
3
4
5
6
7


Average P flux from each treatment
Site 2: mean=235 (222-247) mg kg-1 STP
P Flux, mg m-2 h-1
Cores
A
B
B
B
B
B
B
7
6
5
4
3
2
1
0
-1
1
2
3
4
5
6
7







Results

- STP was not very different across experimental runs
- WTR treatments were not significantly different from one another
- Even at the smallest WTR treatment level, there was still a significant reduction in P release

Put it into context…

- Similar to what we saw, Razali et al. (2007) and Elliott et al. (2002) found that even at small quantities, WTRs adsorbed large amounts of P from the water
- Haustein et al. (2000) saw that greater STP levels required larger quantities of WTRs in order to achieve target reductions
- Gallimore et al. (1990) observed that buffer strips of WTRs were more effective than broadcasting in reducing SRP in runoff
- Agyin-Birikorang et al. (2007) found that broadcasted WTRs were still effective after 7 years

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Effectiveness of a drinking-water treatment sludge in removing different phosphorus species from aqueous solution

M. Razali, Y.Q. Zhao, M. Bruen

Influence of Water Treatment Residuals on Phosphorus Solubility and Leaching

H.A. Elliott [*a], G.A. O'Connor[b], P. Lu[b] and S. Brinton[b]

Aluminum-Containing Residuals Influence High-Phosphorus Soils and Runoff Water Quality

G. K. Haustein, T. C. Daniel,* D. M. Miller, P. A. Moore, Jr., and R. W. McNew

ABSTRACT

Phosphorus (P) loading in surface water can degrade water quality. Previous research has shown that soil test P levels are directly correlated to runoff P levels and that aluminum (Al) will bind P in the soil. Both water treatment residuals (WTR) and HiClay Alumina (HCA) are readily available waste materials high in Al. Water treatment residuals and HCA are by-products of the potable water treatment and commercial alum production process, respectively. Our ob-

toxic, but excessive P loadings into water bodies promote the production of the toxic form of *Pfiesteria* (Kratch, 1997). In the fall of 1997, after a particularly bad outbreak of *Pfiesteria* along the east coast, the popular press blamed the poultry producers for accelerated eutrophication of surface waters (Cohen, 1997).

With the importance of controlling runoff P having been established, it is important to understand the rela-

Water Treatment Residual to Reduce Nutrients in Surface Runoff from Agricultural Land

L. E. Gallimore, N. T. Basta,* D. E. Storm, M. E. Payton, R. H. Huhnke, and M. D. Smolen

ABSTRACT

Application of animal manures in excessive amounts can result in surface runoff of nutrients and degradation of surface water. Best management practices that use chemical or by-products to sorb nutrients can reduce nutrient loss from agricultural land. The objective of this work was to determine the ability of water treatment residual (WTR) to reduce N and P runoff from land treated with poultry litter. Different WTR (ABJ or WISTER) were used in two experiments at

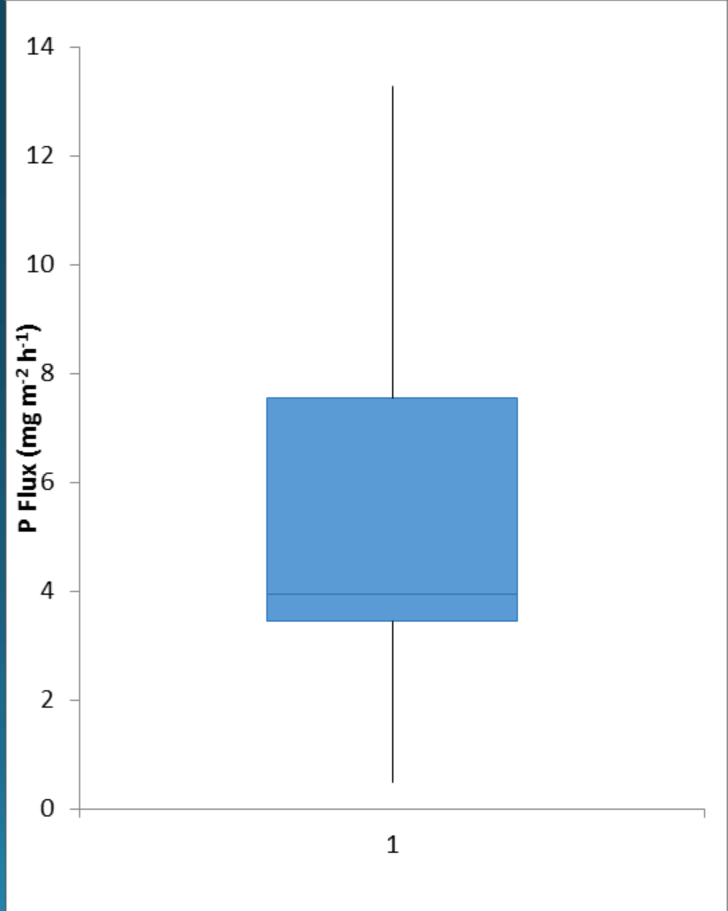
Several best management practices (BMPs) have potential to reduce nutrients in surface runoff. One BMP involves decreasing soluble P by mixing poultry litter with Ca, Al, or Fe chemical amendments (Moore and Miller, 1994). Soluble P in poultry litter was reduced from >2000 to <1 mg P kg^{-1} by mixing CaO, $CaCO_3$, alum, or $FeSO_4$ with poultry litter (Moore and Miller,

Long-Term Phosphorus Immobilization by a Drinking Water Treatment Residual

Sampson Agyin-Birikorang[a], George A. O'Connor [*a], Lee W. Jacobs[b], Konstantinos C. Makris[c] and Scott R. Brinton[a]

What did we find?

- Typically WTRs are applied in solid form (~20% solids)
- A site in NW Arkansas has applied solid WTRs for 4 years at 22417 kg ha^{-1}
- We took soil cores to see how STP and P flux varied across the field
    - STP ranged from 200-900 in top 2 cm and increased with depth
    - Still seeing release rates (~3-13 mg P m^{-2} h^{-1}) after years of solids application
- Liquid WTRs allow a more uniform coverage, leading to reduced P release



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Questions?