Polyacrylamide Effectiveness in Reducing Soil and P Loss from Agricultural Fields

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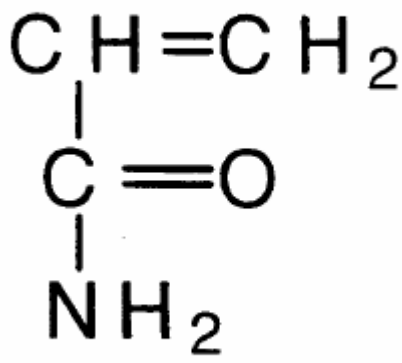
Outline

- Introduction to Polyacrylamide (PAM)
  - Basic Chemistry
  - Past uses
  - How it works
- Field Test Setup
- Results
  - Sediment Load Reduction
  - Phosphorus Load Reduction

Polyacrylamide (PAM)

- Long Molecular Chain Polymer
- Composed of repeating Acrylamide (AMD) Monomer Units along with other co-monomer (OH^-) units

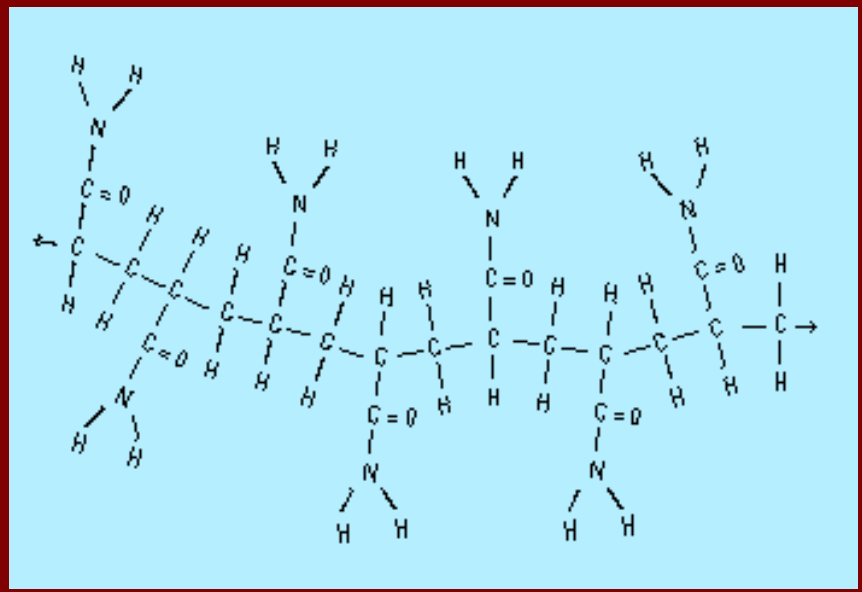
FIG. 1.
Acrylamide (AMD).



MW = 71.08

PAM for Soil Erosion

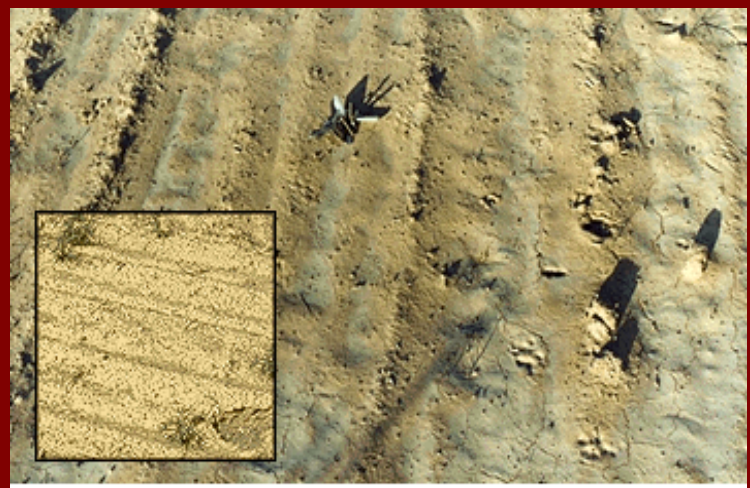
- Characteristics of most PAMs used for soil erosion applications
  - (Malik and Letey, 1991; Shainberg et al., 1990; Green et al., 2000)
  - Anionic
  - Moderate Percent Hydrolysis (~20%)
  - High Molecular Weight
- Achieved through chemical synthesis processes



How it helps prevent Erosion

- Raindrop Impact Effect
  - Soil Crusting
    - Impact destabilizes soil fraction
    - Fine fractions infiltrate
    - Clogging of sub-soil pores
    - Reduces infiltration rate thus increases surface runoff

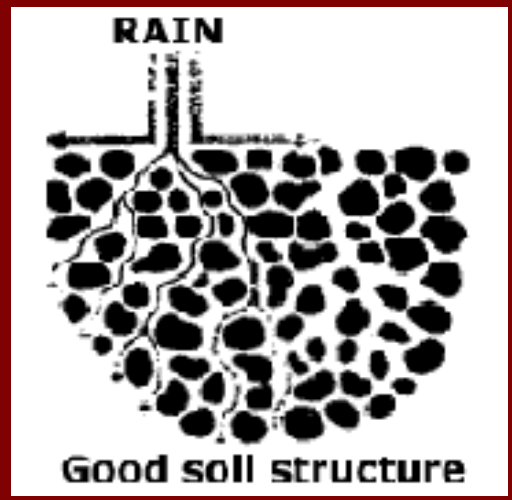
From water on the web



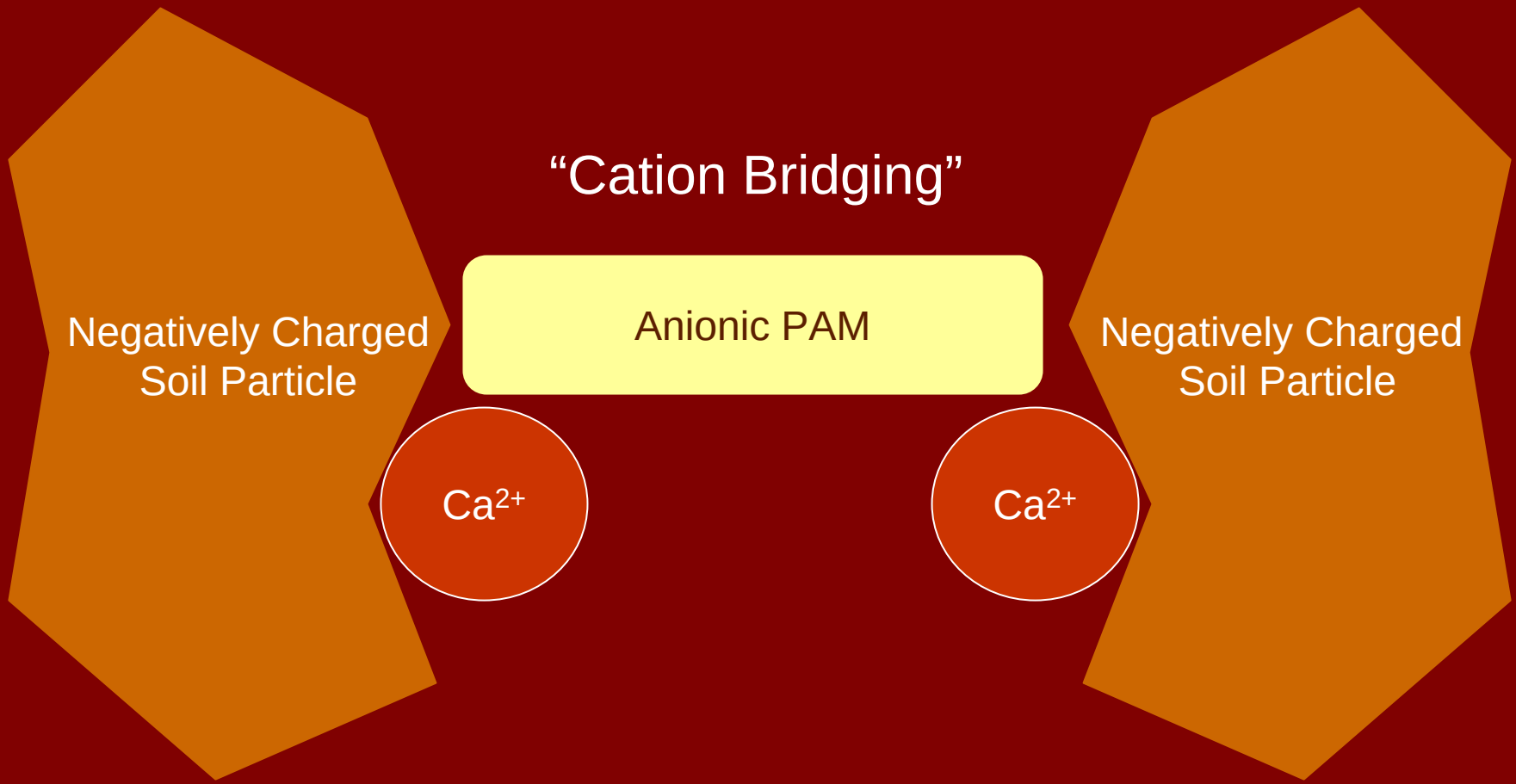
ABOVE & INSET: Suface crust following cultivation and rainfall.

PAM's Effect on Soil Structure

- Binds soil particles together
- Prevents dispersion of small clay particle due to raindrop impact
  - Results in more stable soil structure, increased infiltration and reduced surface runoff
- Has been shown to be more effective in the presence of electrolytes (i.e. Ca^{2+})



PAM 101


“Cation Bridging”
Negatively Charged Soil Particle
Anionic PAM
Negatively Charged Soil Particle
Ca^{2+}
Ca^{2+}

PAM Application

- Previous PAM application studies
  - Irrigation water
    - addition of PAM in small amounts
  - Furrow irrigation stabilization with PAM

PAM Application

- Recently surface applied PAM in rain-fed agricultural areas has been tested
- Studied at very high application rates
  - (20 kg/ha up to 80 kg/ha)
- Has not been widely tested at lower “agronomic” rates

Experimental Approach

- Test PAM's effectiveness and longevity of reducing soil and P loss from agricultural fields at two locations in Wisconsin
  - Arlington Agricultural Research Station
  - UW-Platteville Pioneer Farm

Experimental Approach

- Surface applied PAM emulsion at a low application rate

  (5 kg ha^{-1})
  - **Soil Net EM-1000-50**, a liquid emulsion of polyacrylamides, calcium, inorganic salts, water, oil and surfactant

PAM Tests

- Rainfall Simulation
  - Each plot exposed to the same rainfall intensity (~3.0 in hr^{-1})
  - Simulation for 30 minutes after initial runoff occurred
  - 3 replicates

Experimental Approach

- Rainfall Simulator
  - 10’ x 10’ x 8’
  - set up over each plot for testing
    - Paired control and treatment

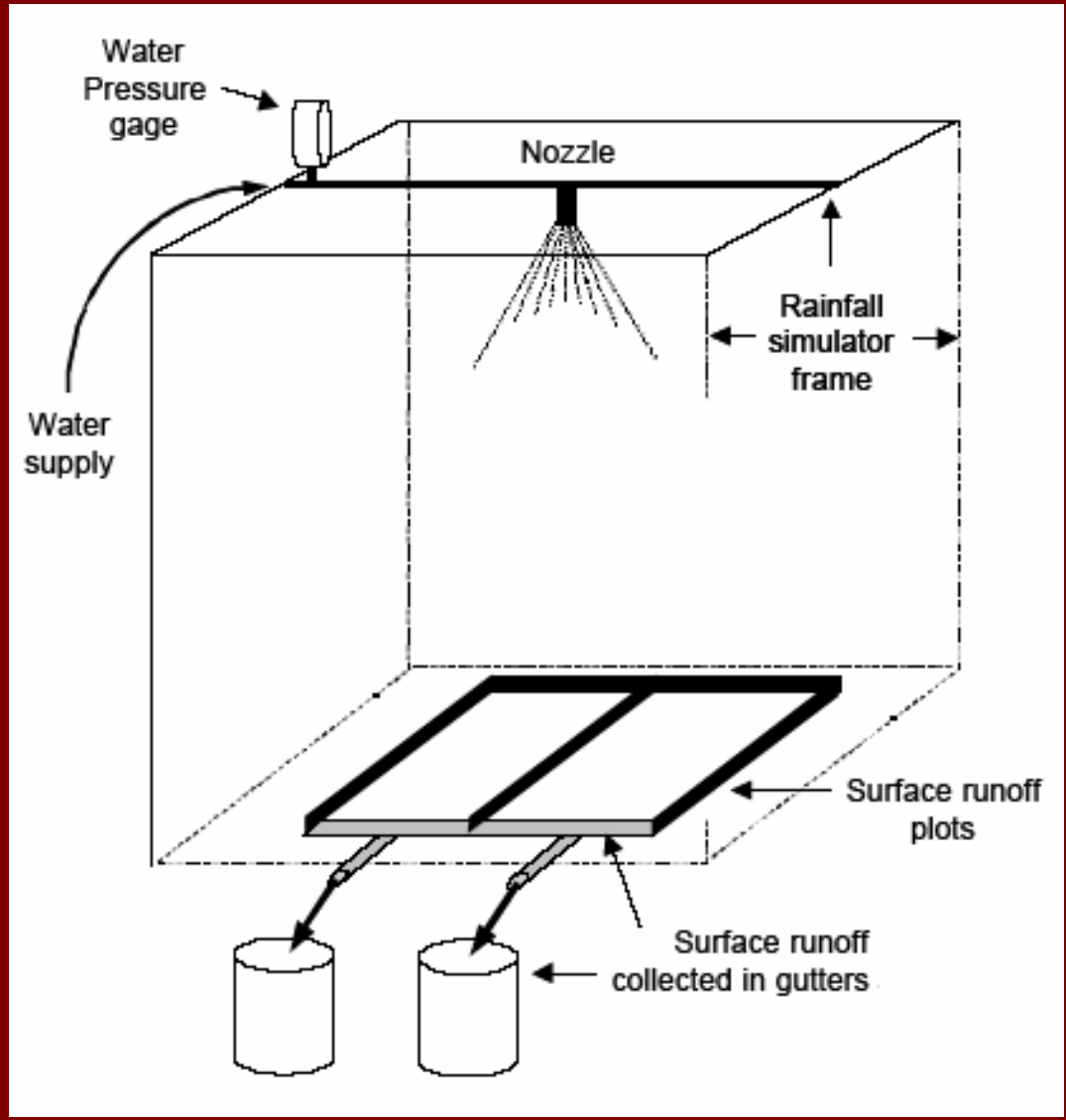


Image Adapted from the National Phosphorus Research Project

Rainfall Simulator

Tarps hung to prevent wind effects

Nozzle simulating rainfall

Rainfall Simulator

Field setup: Generator, 500 gallon tank, pump, rainfall simulator

Experimental Approach

- Samples taken in 5 minute intervals from start of runoff
  - Sediment concentration and flow rate calculated
    - Used to calculate sediment load
  - Analyzed for total phosphorus

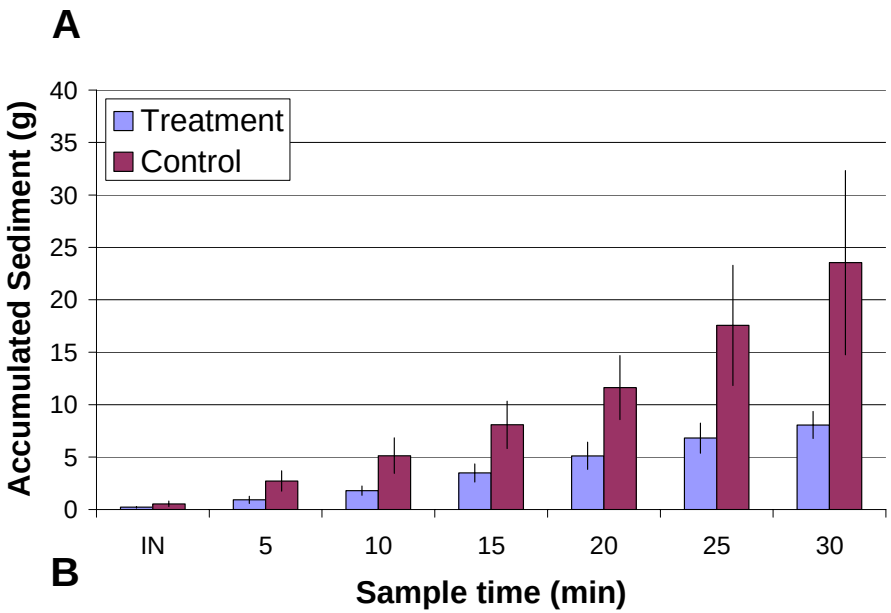
PAM Test Intervals

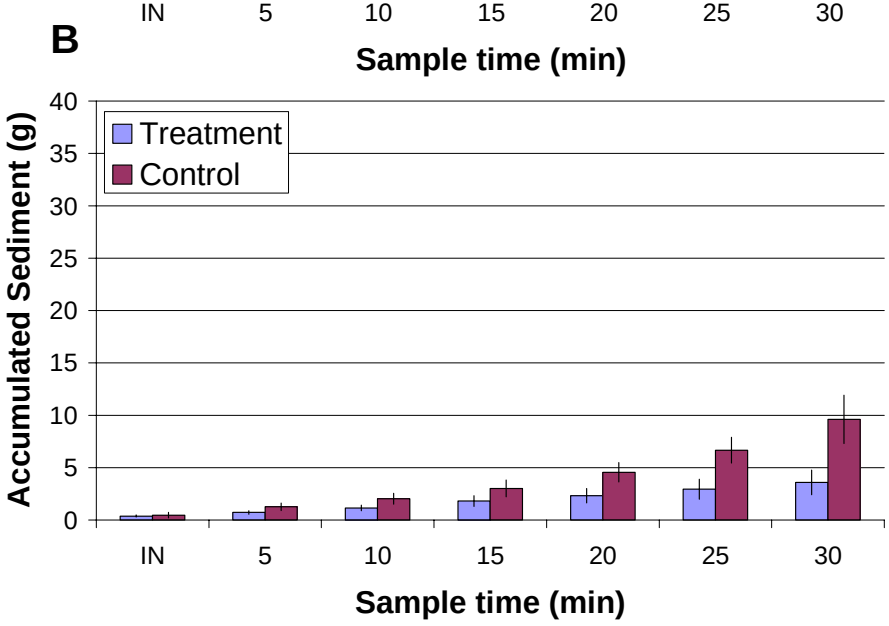
- 2-day interval
  - PAM application two days prior to testing (approximately two weeks after planting)
- 3-week interval
  - PAM application three weeks prior to testing (approximately four weeks after planting)
- 11-week interval
  - PAM application 11 weeks prior to testing (approximately 13 weeks after planting)

Results

- Sediment Load

2-Day Interval





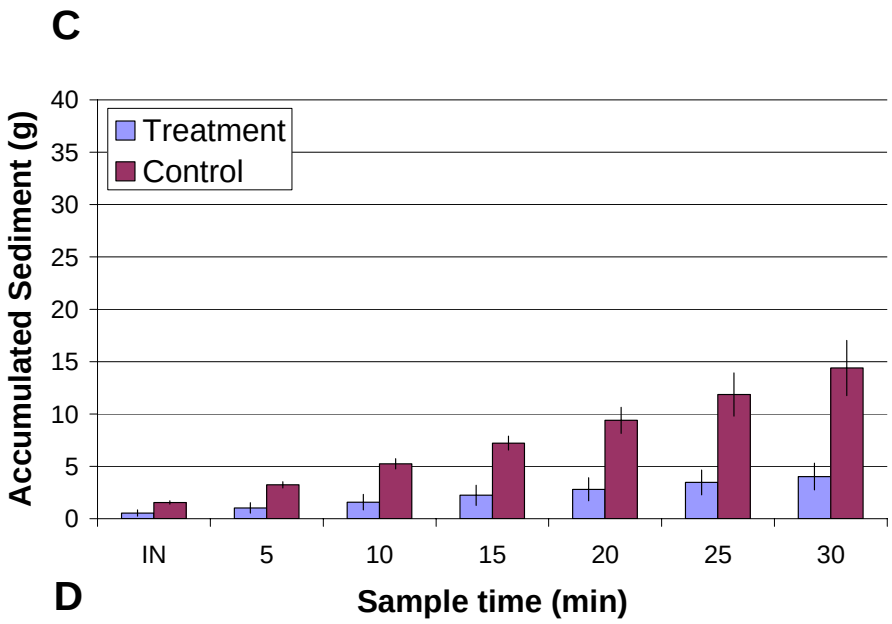
Platteville Pioneer Farm

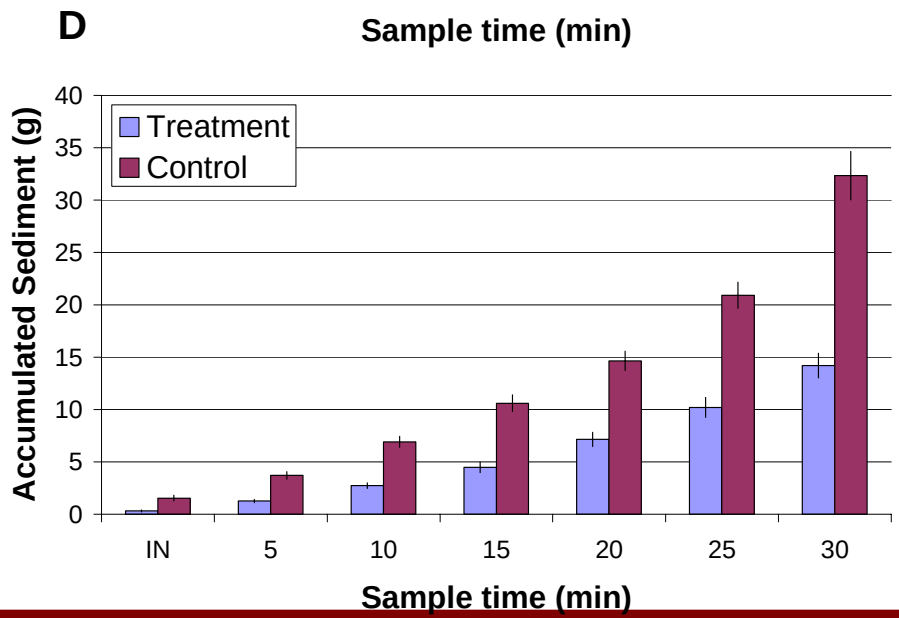
Sample Time	% Reduction
IN	60.8
5	66.0
10	65.1
15	56.8
20	56.0
25	61.2
30	**65.8**

Arlington Agricultural Research Station

Sample Time	% Reduction
IN	18.4
5	42.8
10	43.4
15	39.7
20	49.0
25	55.8
30	**62.6**

3-week Interval





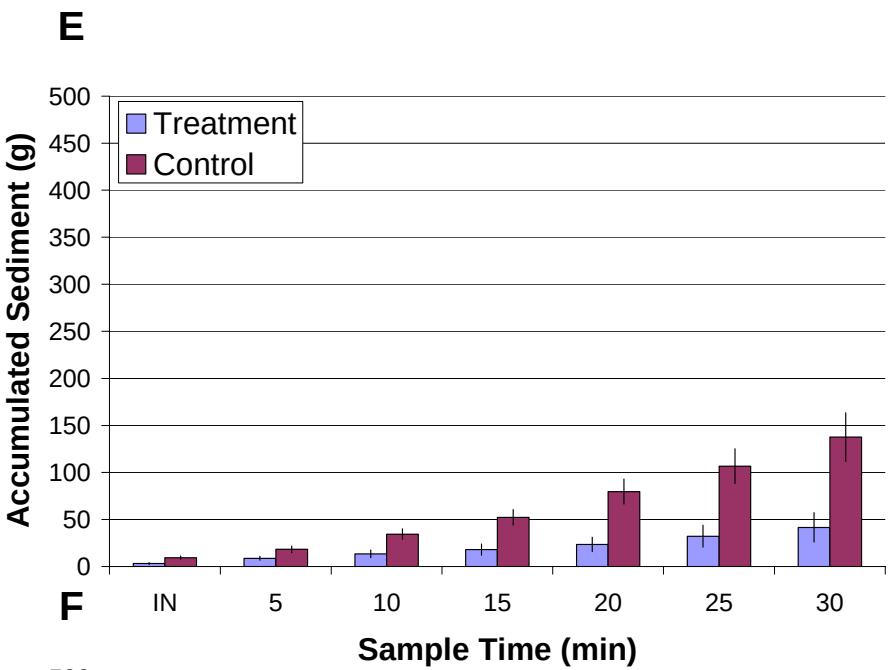
Platteville Pioneer Farm

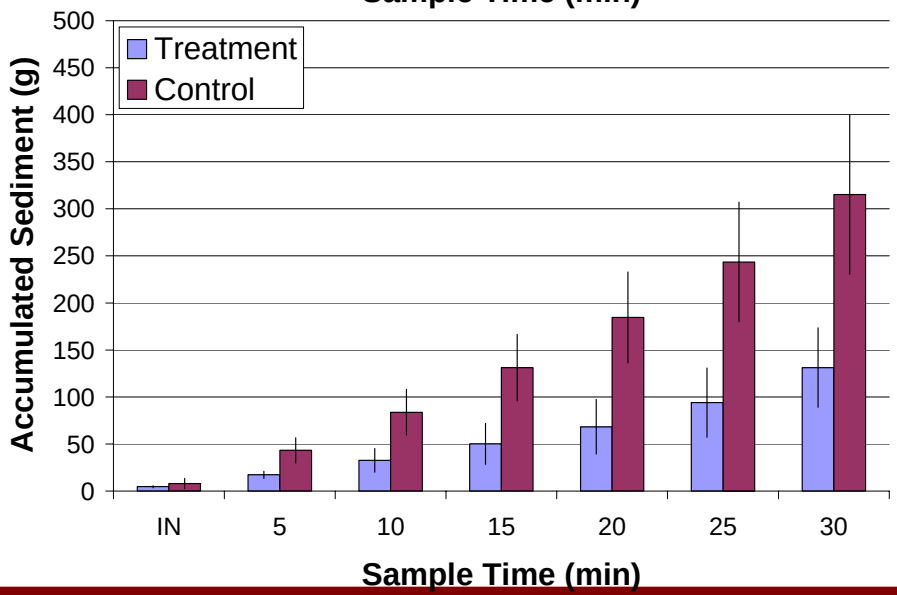
Sample Time	% Reduction
IN	65.1
5	68.4
10	69.7
15	69.0
20	70.1
25	70.7
30	**72.0**

Arlington Agricultural Research Station

Sample Time	% Reduction
IN	78.7
5	66.0
10	60.5
15	57.7
20	51.2
25	51.2
30	**56.1**

11-week Interval





Platteville Pioneer Farm

Sample Time	% Reduction
IN	54.6
5	39.3
10	45.1
15	49.5
20	55.7
25	53.9
30	**51.3**

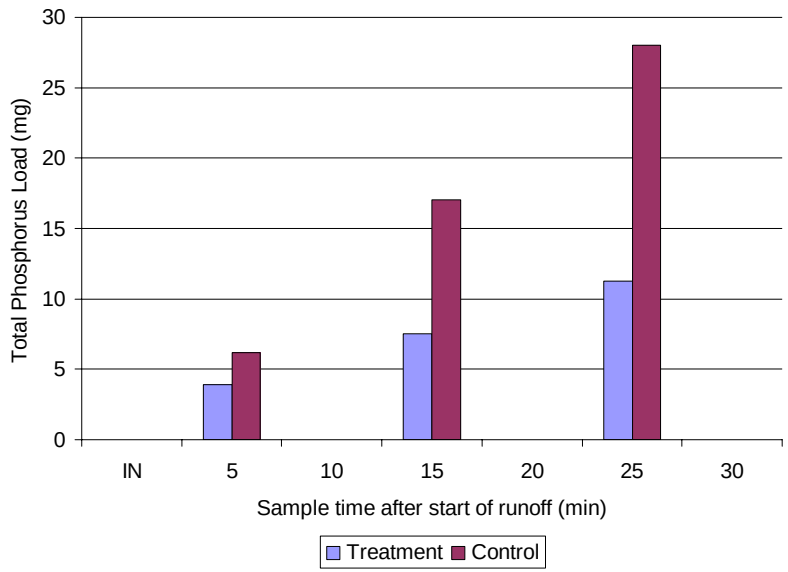
Arlington Agricultural Research Station

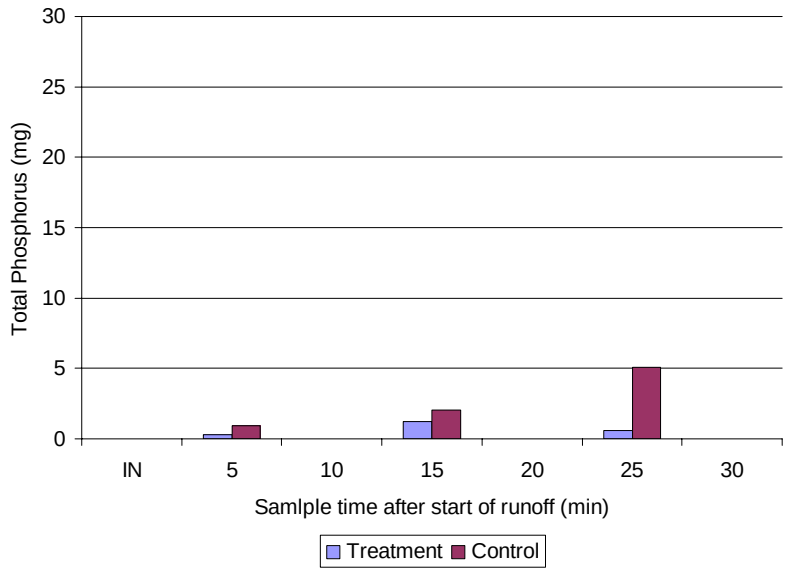
Sample Time	% Reduction
IN	41.6
5	60.1
10	61.0
15	61.8
20	62.9
25	61.4
30	**58.4**

Results

- Sediment Load
- Total Phosphorus

2-day Interval





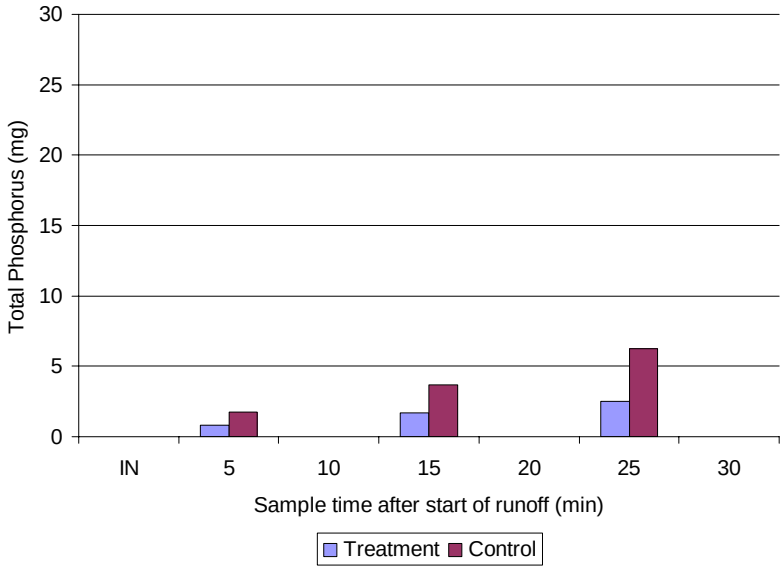
Platteville Pioneer Farm

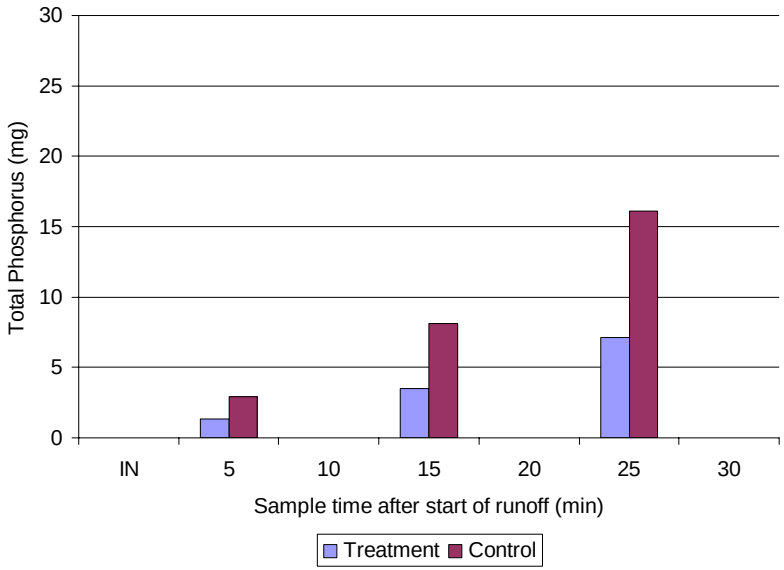
Sample Time	% Reduction
IN	-
5	37.1
10	-
15	55.6
20	-
25	**59.9**
30	-

Arlington Agricultural Research Station

Sample Time	% Reduction
IN	-
5	70.5
10	-
15	39.4
20	-
25	**88.7**
30	-

3-week Interval





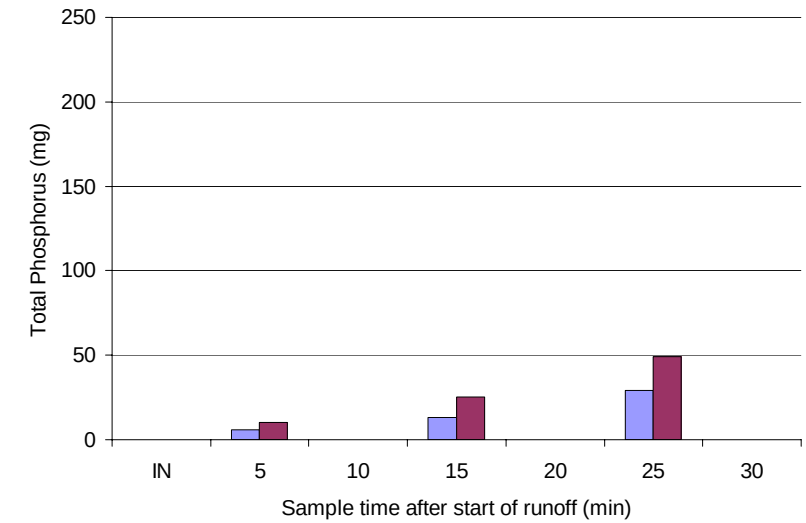
Platteville Pioneer Farm

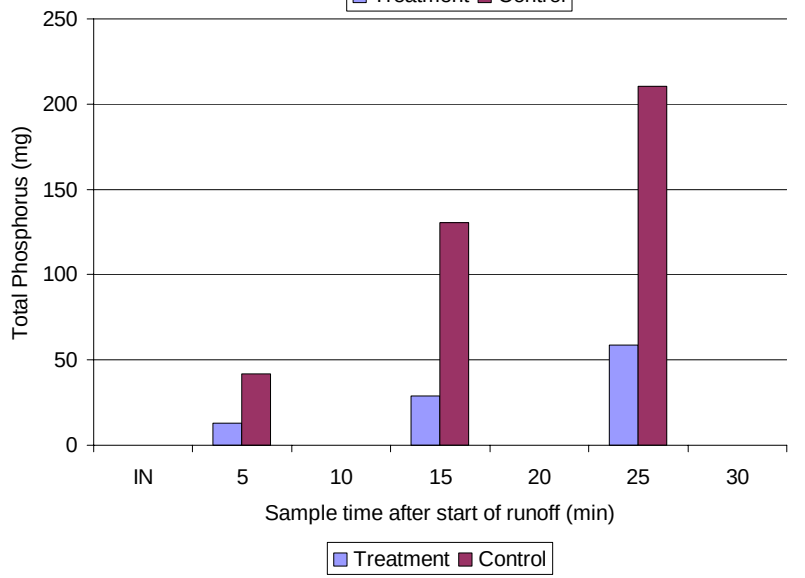
Sample Time	% Reduction
IN	-
5	53.7
10	-
15	53.4
20	-
25	**60.0**
30	-

Arlington Agricultural Research Station

Sample Time	% Reduction
IN	-
5	53.3
10	-
15	56.7
20	-
25	**55.7**
30	-

11-week Interval





Platteville Pioneer Farm

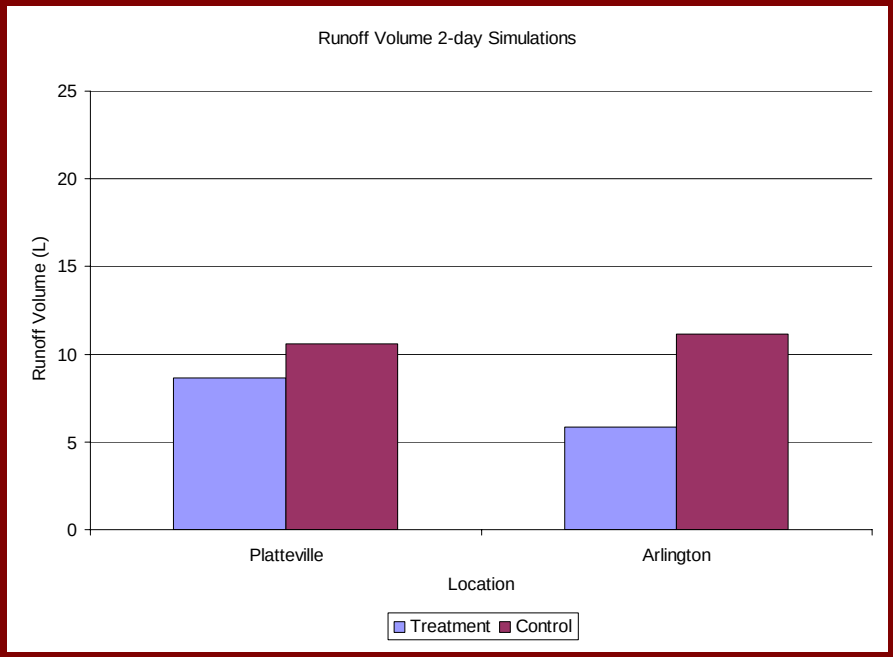
Sample Time	% Reduction
IN	-
5	42.1
10	-
15	47.7
20	-
25	**40.9**
30	-

Arlington Agricultural Research Station

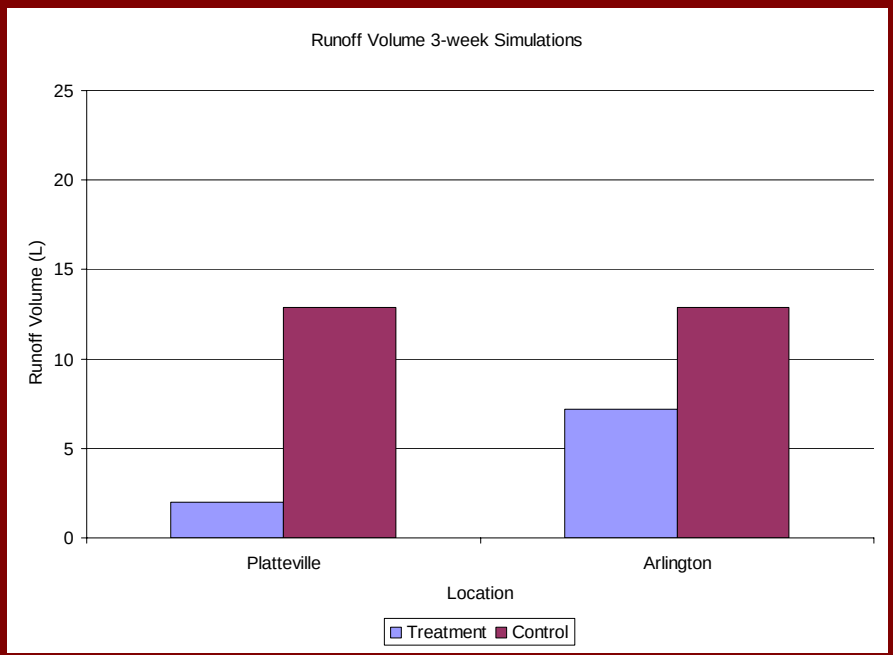
Sample Time	% Reduction
IN	-
5	68.9
10	-
15	78.0
20	-
25	**72.0**
30	

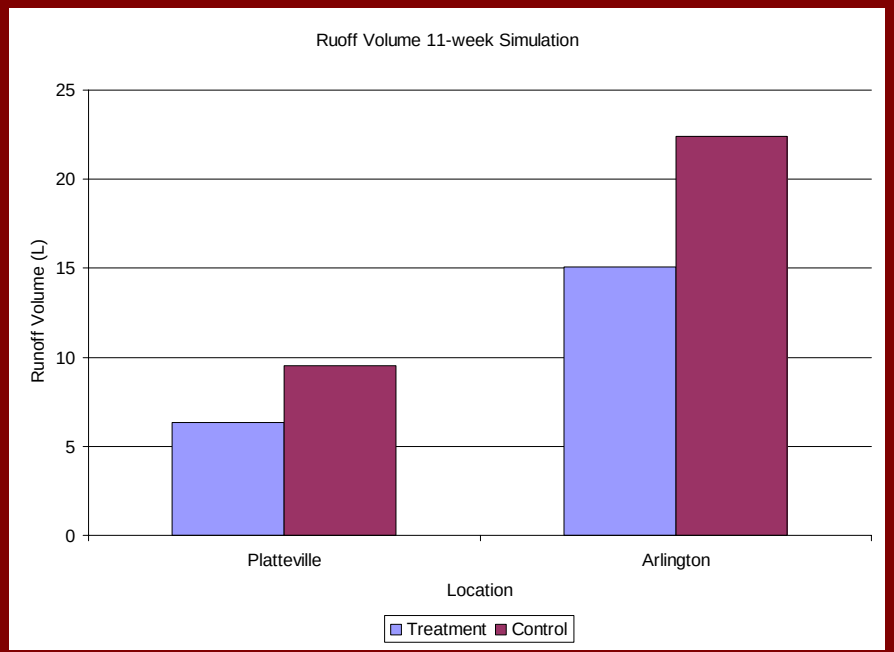
Results

- Sediment Load
- Total Phosphorus
- Runoff Volume



Total Runoff Volume reduced during each test





Summary

- Plots that received 5 kg/ha (4.5 lb/ac) Soil Net EM-1000-50 showed:
  - Lower total sediment losses (51-72% reduction)
  - Lower runoff volumes (18-84% reduction)
  - Lower total P losses (41-89% reduction)
- Effects were evident at 11 weeks after application

Feasibility

- Soil Net EM-1000-50
  - Effectively Reduced Soil and P loss throughout the growing season
  - Estimated Cost – approximately $10/acre
- Potential Applications:
  - Following low-residue cropping systems (soybeans, corn silage), before canopy is established
  - Highly erodable soils

Thank You!

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