Polyacrylamide (PAM) Effects on Irrigation and Sediment Yield

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Introduction

Irrigated crop production is critical to global agricultural output. Surface irrigation, predominantly furrow irrigation, accounts for more than 60% of the earth's 600 million acres and about one-half of Nebraska's 8 million acres. Irrigation associated erosion seriously impacts irrigation's ability to sustain its 2- to 3-fold yield advantage over dryland agriculture. In Nebraska, soil erosion due to surface irrigation is estimated to average between 7-8 ton/ac/yr. Erosion is also a significant contributor to non-point source pollution including: sediment; biochemical oxygen demand (BOD); phosphorus; nitrates; and various pesticides.

Top soil, which is necessary for crop production, is difficult, if not impossible, to replace when removed from a field. To limit erosion, erosion-related non-point source contamination, and to sustain production levels on furrow irrigated fields, cost-effective top soil maintenance is necessary.

Polyacrylamide, an environmentally safe industrial flocculent, widely used in the municipal water treatment and food processing industries, has the potential to significantly reduce furrow-irrigation-induced erosion. PAM is a long-chain, high molecular weight polymer that when mixed with irrigation water stabilizes near-surface soil particles by forming polymer "nets" around existing soil aggregates. Polymer-stabilized aggregates are less likely to disintegrate during irrigation. PAM reduces erosion by maintaining the integrity of the top few millimeters of the soil's structure and essentially keeps sediments in place.

Maintaining the surface structure during an irrigation can also alter the infiltration or water intake rate. Increased infiltration will mean an increase in furrow advance time. Recent improvements in irrigation technology and furrow irrigation management practices have increased water application uniformity and improved irrigation efficiency. To maintain these gains, best PAM-specific furrow irrigation management practices must be defined.

PROCEDURES

The study was conducted on cooperator fields in the Panhandle and South Central areas of Nebraska. There were a total of seven study sites in 1999 and 2000. Fields were selected to represent the range of soil textures found in Nebraska. Site descriptions are given below.

Site 1	Tripp Very Fine Sandy Loam, 0.8% slope, 1.8 in/ft water holding capacity, 1999.
Site 2	Kenesaw Silt Loam, 0.5% slope, 2.6 in/ft water holding capacity, 1999.
Site 3	Ortello fine Sandy Loam, 0.5% slope, 1.8 in/ft water holding capacity, 1999.
Site 4	Mitchell Silt Loam, 1.9% slope, 1.8 in/ft water holding capacity, 2000.
Site 5	Tripp Very Fine Sandy Loam, 0.8% slope, 1.8 in/ft water holding capacity, 2000.
Site 6	Kenesaw Silt Loam, 0.5% slope, 2.6 in/ft water holding capacity, 2000.
Site 7	Ortello fine Sandy Loam, 0.5% slope, 1.8 in/ft water holding capacity, 2000.

Furrow irrigation treatments included: 1) conventional irrigation; 2) conventional irrigation with PAM; 3) surge irrigation; and 4) surge irrigation with PAM. Treatments were replicated four times at each site. Alternate-furrow irrigation was the standard practice at each site. Fields were cultivated and ditched prior to the first irrigation. No additional tillage was done after the first irrigation. PAM was injected into the water at 10 ppm and mixed prior to distribution on the field. PAM was injected in the water only during the first irrigation.

Measured irrigation parameters were furrow inflow and outflow and irrigation advance times to the end of the field. Runoff samples were collected from each treatment on an expanding time scale – more samples earlier and fewer samples as runoff continues. Samples were analyzed for sediment content for each event using Imhoff cones. A calibration curve was developed for each site to determine sediment content based on the Imhoff cone reading.

PAM TRIAL RESULTS

Furrow advance time and sediment discharge from the individual field trials are given in Figures 1-3 for the first three irrigations, respectively. Using surge during the first irrigation resulted in furrow advance times that were nearly equal to or less than the corresponding conventional irrigation treatment, with the exception of Site 7. Overall, the PAM treated furrows had furrow advance times that were equal to or greater than the corresponding no PAM treated furrow.

Sediment loss was reduced when PAM was added to the irrigation water for both surge and conventional irrigation treatments. Neither surge or conventional irrigation was consistently better for reducing sediment loss. At site four, field slope was 1.9% compared to 0.8 and 0.5% for the other sites. At this location, PAM significantly reduced sediment loss from nearly 1 ton/ac to nearly zero.

At those sites having field slope of 0.8% or less, total sediment loss with or without PAM, was less than 0.1 ton/ac. For fields with relatively mild slopes, the use of PAM may not be practical.

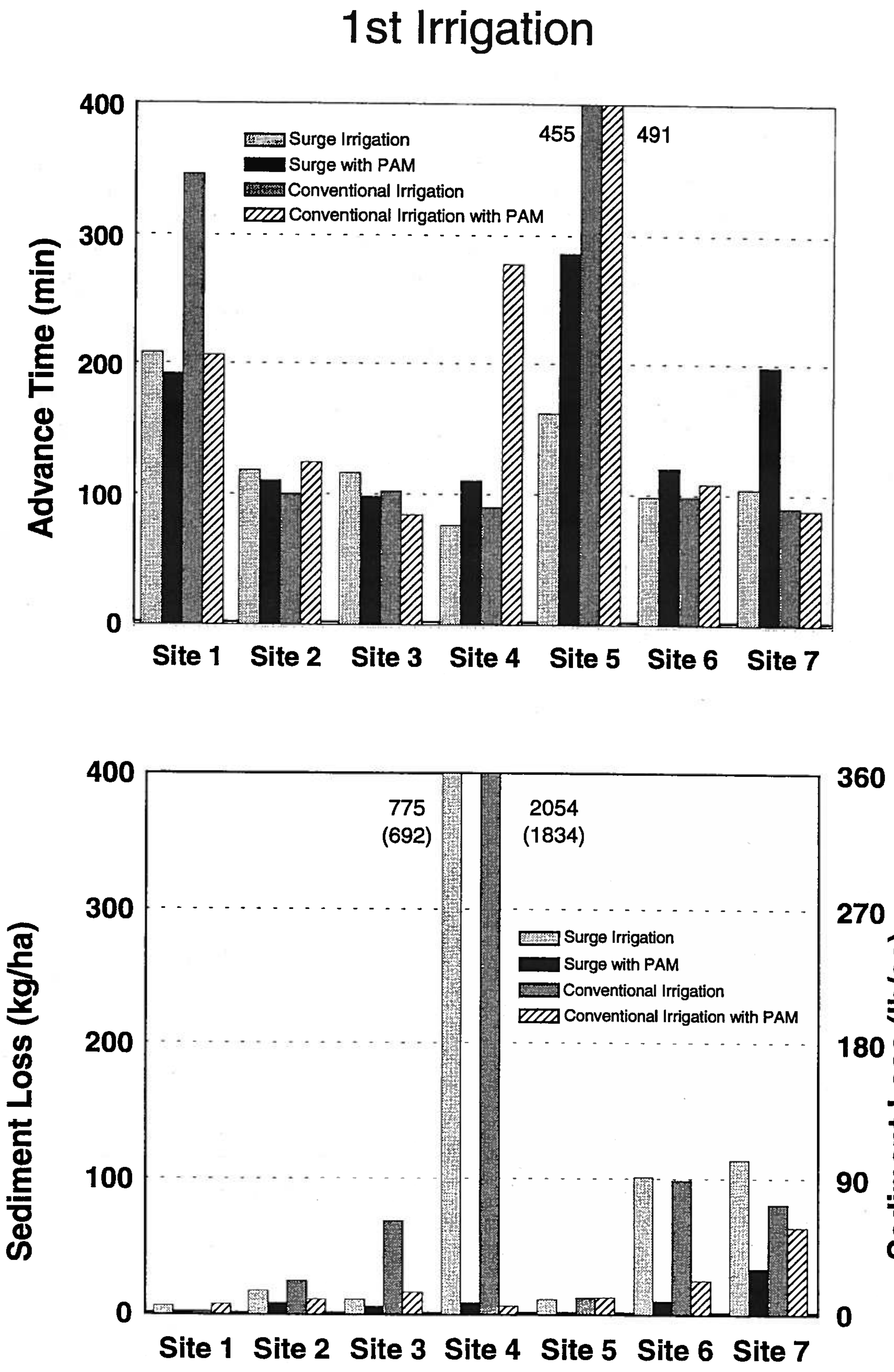

Figure 1. Advance time and sediment loss during the 1st irrigation for 7 sites.

2nd Irrigation

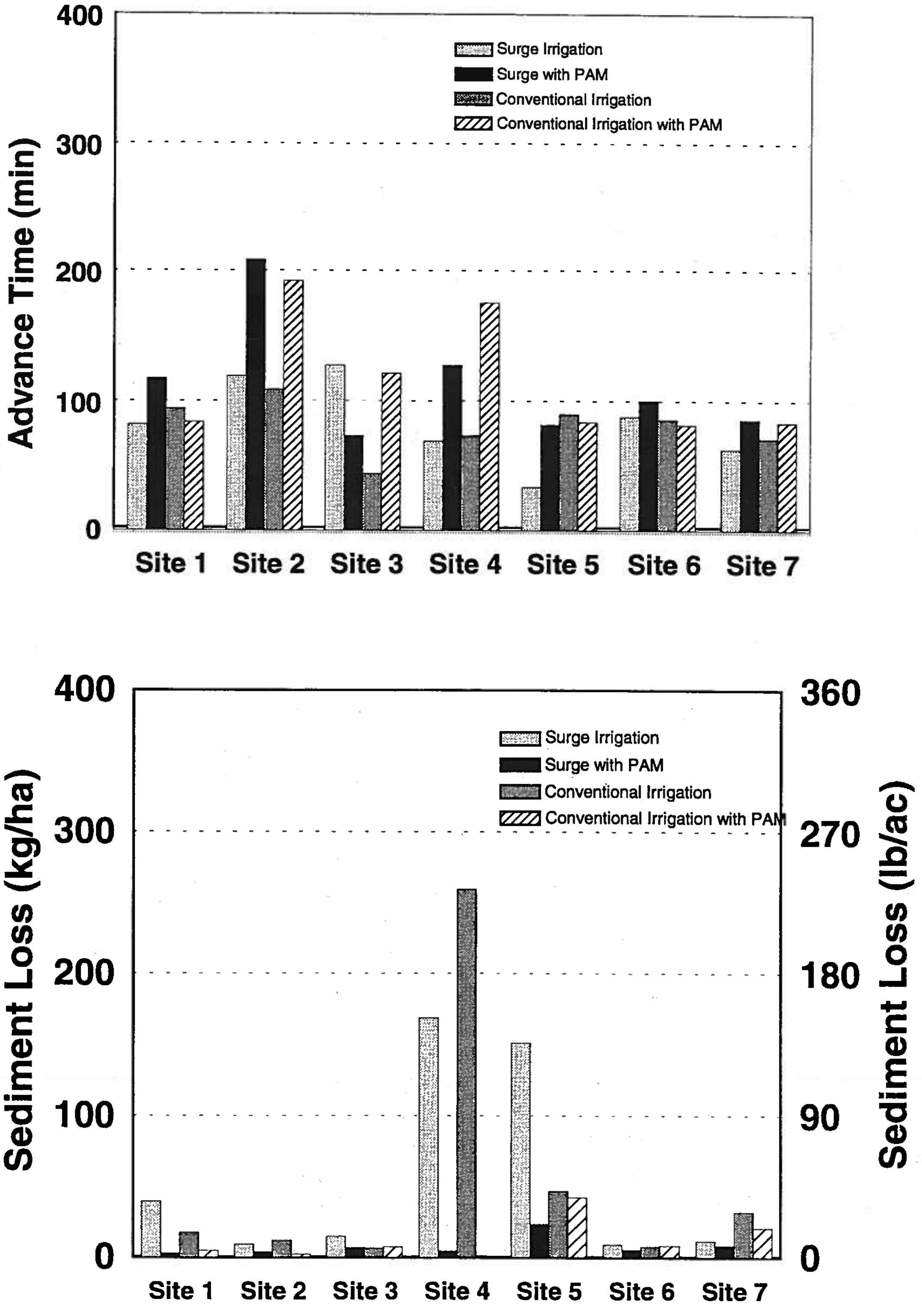

Figure 2. Advance time and sediment loss during the 2nd irrigation for 7 sites.

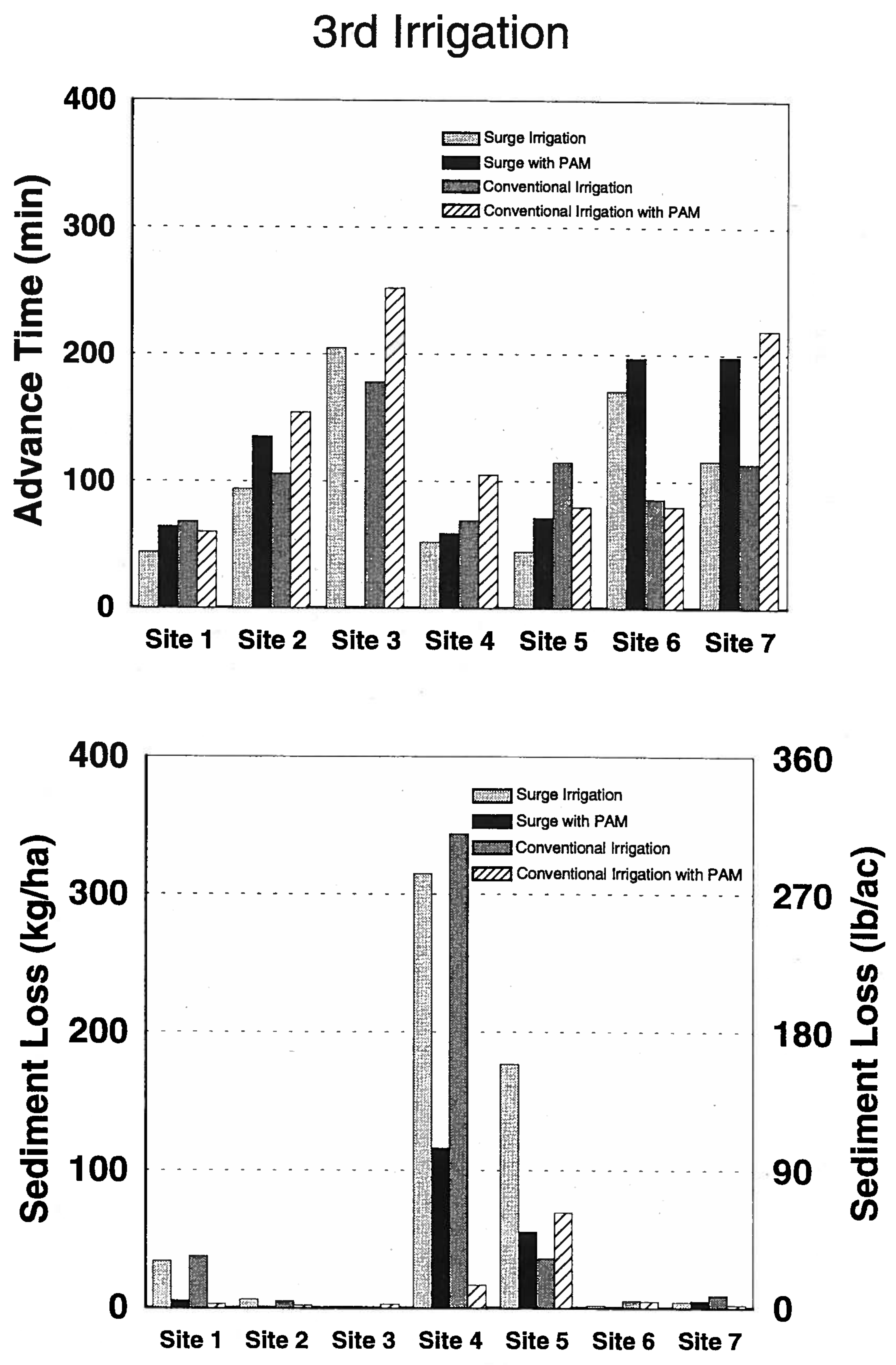

Figure 3. Advance time and sediment loss during the 3rd irrigation for 7 sites.