USING POLYACRYLAMIDE (PAM) TO ENHANCE IRRIGATION EFFICIENCY

When irrigation water is applied to soil, topsoil is gradually lost in irrigation runoff. Obviously, this loss will be greater on fields with steeper slopes. Topsoil loss will result in a long-term reduction in soil productivity, loss of fertilizer nutrients, and downstream pollution of reservoirs and streams.

Furrow irrigation can be a major contributor to soil loss because it uses the soil as the water transmission line. In most cases, the resulting water runoff with its inevitable soil load is necessary because it is needed to provide reasonably uniform irrigation in most fields (Nebraska 2008).

PAM is a flocculent that is widely used in municipal water treatment, paper manufacturing, and food processing. When applied to soil with irrigation, it binds to clay particles, resulting in larger, heavier particles which are harder to dislodge. This increased cohesiveness of soil particles on the soil surface makes soil more resistant to the erosive forces of water flowing over it. PAM preserves a more pervious pore structure during irrigation, and thus allows increased infiltration of irrigation water that is applied to the soil surface (PAM USDA-ARS).

Results from numerous studies have shown that PAM increases the resistance of soil on the surface to dislogdement and subsequent movement down the furrow that is caused by water flow, thus reducing soil loss during irrigation (Oregon 2008).

The majority of research with PAM use in irrigated crops has been conducted in the Midwest and Western US. USDA researchers in Kimberly, Idaho began investigations with PAM in the early 1990's to determine its utility for reducing soil erosion from furrow irrigated fields.

Some general guidelines for PAM use are:

- Loose soil is more erodible; thus, soil losses during irrigation are greatest when the soil is loose. Therefore, PAM should be used at the first irrigation if the soil has been disturbed by cultivation or is loose from lack of rain. If soil is undisturbed following the first PAM application, following irrigation(s) can be applied with no or a reduced rate of PAM (PAM USDA-ARS; Oregon 2008).

- Regardless of the form of PAM that is applied, it needs turbulence to dissolve in water. Even though dry forms require more turbulent mixing than liquid forms, all forms need to be added to incoming water at a turbulent point. Without adequate mixing, PAM will not immediately dissolve and PAM globules will form, which can clog injector systems, sprinkler nozzles, and gated pipe irrigation systems (Nebraska 2008; PAM USDA-ARS).

- PAM can be injected directly into sprinkler systems, but likely will require a lower rate than is applied through furrow irrigation (Calif.).

- A liquid formulation of PAM applied with an injector pump is recommended in a closed pipe system. Turbulence resulting from the swirling action in gated pipe will usually cause enough mixing of PAM with the water in the first two or three sections of solid pipe that can be placed at the well output point (Nebraska 2008).

- In some cases, PAM application can be stopped when water has advanced over only 50% of the furrow length. This will control erosion in the top portion of the field and thus reduce sediment deposits in the bottom portion of the field. Also, PAM cost will be reduced (Nebraska 2008).

- If water for irrigation contains a high amount of sediment, the sediment may settle out before water reaches the irrigation furrows. This may result in sediment buildup in the pipe and a subsequent reduced flow (Nebraska 2008).

- PAM applied with irrigation water results in and maintains higher infiltration rates than is normal with untreated water. Thus, irrigation practices will have to be adjusted to prevent over-watering, especially on soils that have a high inherent infiltration rate (Nebraska 2008; PAM USDA-ARS).

- The most common form of PAM is the dry granular form (Oregon 2008).

- The PAM product label should give application rates based on water flow rate. However, different soil textures and field slopes may show different results when equal amounts of PAM are applied, and the application concentration may require adjustment based on the clarity of the runoff leaving the field (Nebraska 2008).

- PAM's are available in several formulation types, with the two most common being dry granular and inverse emulsions. The dry forms of PAM have a higher concentration of the active ingredient. All PAM forms should be stored in cool dry areas away from direct sunlight. Full potency shelf life for most forms is only about a year (USDA-ARS Idaho).
- A description of application methods and applicators is provided in most of the below publications, especially (Nebraska 2008; Oregon 2008; PAM Primer).

- When applied according to the NRCS standard, PAM losses from a field do not exceed 5% of applied amounts. PAM levels in runoff fell below acceptable limits in 300-1500 ft. of travel in tail water ditches (PAM Primer)

- PAM is not harmful to the environment, and degrades safely into harmless organic molecules in the weeks following application. Because PAM limits soil erosion, its use can prevent nonpoint source pollutants, including soil and its contained contaminants of nutrients and pesticides, from leaving the field (Oregon 2008; Calif.). In Idaho research, PAM applied with furrow irrigation reduced sediment in runoff by 94% and increased net infiltration by 15% (PAM Primer).

The following points are from the PAMphlet (USDA-ARS Idaho).

- Always add PAM slowly to turbulent water; never add water to PAM.

- PAM stabilizes existing soil structure but cannot improve soil structure.

- It is essential that no untreated water wet the furrow ahead of PAM-treated water. Untreated water destroys soil structure of erodible soils before PAM treatment, thus greatly reducing PAM's effectiveness. Wet furrows also reduce infiltration of PAM-treated water. Thus, the first drop of water to reach the furrow during irrigation should

already contain the desired amount of dissolved PAM.

- If using PAM in a sprinkle-irrigation system, pressurize the pipe and ensure that water is being delivered before injecting PAM into the system.

- If irrigation water is high in sediment, adding PAM to the flow can cause settling of the sediment in the gated pipe.

- Do not over-apply PAM.

- When using PAM, increase furrow inflow rates to prevent excessive infiltration at the upper end of the field.

- Benefits from using PAM with sprinkler irrigation are much less dramatic than when used with furrow irrigation.

PAM is not a silver bullet for improving the quality of water that leaves the field during irrigation. Rather, it is one tool that can be used to manage irrigation runoff quality, especially when using furrow irrigation.

There has been little if any research with PAM that is applied with irrigation on the loam and clay soils in the Midsouth. Thus, the above statements and points should be investigated with the furrow irrigation systems that are used on the large acreage of fairly level sites in the Midsouth. It may be that soil loss from these sites will not justify the extra effort and cost associated with PAM use.

Conversely, PAM's use may be justified where irrigation is applied through sprinkler systems on the sloping, erodible soils in the non-Delta portion of the region. Again, this should be investigated through research before producers invest in this tool.

Using PAM is not a casual decision. Rather, its use/need/benefit should be thoroughly investigated to determine if the extra effort and cost are worthwhile.

The above summary points and the information in the above-cited references, along with the information in the below additional references, should provide the necessary guidance for this decision.

Using Polyacrylamide to Reduce Soil Erosion–Nebraska Extension

Polyacrylamide: just the facts–Montana Extension

Make polyacrylamide work for you –Oregon Extension

A guide to using PAM polymers for control of irrigation runoff –Monterey County, Calif.

The PAMphlet: a concise guide for safe and practical use of polyacrylamide for irrigation-induced erosion control and infiltration management–USDA-ARS PAM Research Page

PAM Primer–a brief history of PAM and PAM-related issues–USDA-ARS Idaho

PAM in furrow irrigation, an erosion control breakthrough–USDA-ARS Idaho

Polyacrylamide (PAM) for irrigation runoff management–USDA-ARS Idaho

Tips for PAM in Furrow Irrigation–USDA-ARS Idaho

PAM Research–PAM Research Page–USDA-ARS Idaho

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