POLYACRYLAMIDE - A METHOD TO CONTROL EROSION

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Soil erosion due to irrigation can range from zero, on many center pivot irrigated fields to over 30 tons per acre per year on intensely farmed furrow irrigated fields. These high soil erosion losses occur primarily from furrow irrigated fields with slopes greater than 3% or on soil prone to erosion. Yet the total amount of top soil lost each year is greater on furrow irrigated fields having slopes of 1-3% than on fields with slopes greater than 3%. This happens simply because there are far more acres planted on a 1-3% slope. To reduce the total amount of soil that is lost due to irrigation means we must reduce sediment loss on any field with a potential for erosion.

The loss of topsoil can mean a long term reduction in soil productivity, crop yield and the life expectancy of downstream storage reservoirs. In the short term, it means producers or county governments are faced with reuse pits or borrow ditches filled with top soil that must be removed. To avoid a loss, the producer must spread the soil back on the field to try and maintain soil productivity. To sustain Nebraska's soil resource means we must use different methods to reduce or eliminate soil erosion.

WHERE DOES SOIL LOSS OCCUR?

Center pivots account for only a small portion of the total soil that is eroded. The majority of soil that is lost under pivots is due to runoff when precipitation comes faster than what the soil can take in during a given period of time. During irrigation, runoff and associated soil loss should be minimal for center pivots. When designed properly, center pivot systems will apply water at or below the rate at which the soil can take in water. Using this design criteria, little water should move from the point of application and therefore soil cannot be eroded. If you're experiencing runoff and subsequent soil erosion, address this potential problem first.

Furrow irrigation is a major contributor to soil loss. With nearly half of the irrigated acres in Nebraska under furrow irrigation, reducing soil erosion here could have a significant impact on maintaining top soil for future generations. Furrow irrigation is a major contributor because unlike a center pivot that uses a pipe to transport the water prior to distribution, furrow irrigation uses the soil as the transmission line and distributes the water along the irrigation furrow. To have a reasonably uniform irrigation, it is necessary to have runoff. Unfortunately, with runoff water comes soil, and often lots of soil. When the water leaves the field and movement of the water slows sediment begins to settle out at the end of the field and in borrow ditches.

To gage how much sediment is being lost from furrow irrigated fields, one can look at some of the concrete irrigation ditches installed just 30 - 40 years ago. Some of these ditches are now far above the field level. Another way to gage soil loss is to consider the number of times the ends of fields have to have soil removed so water in the furrows can reach the end of the field. The furrow erosion process is slow. For example, a field that has lost 2 ft of top soil in the last 40 years, lost only about ½ inch each year. This amount of loss would go unnoticed without a permanent structure, like a concrete ditch, to compare to. Even though the process is slow, the top soil is gradually being removed and fields are becoming less productive.

METHODS TO CONTROL SOIL EROSION

Center Pivots should not have runoff and soil erosion due to irrigation unless there are design problems. If intake rate is of concern under a pivot, consider some type of soil tillage to increase the rate of water infiltration. If infiltration cannot be increased, use tillage to create surface storage. Water that is stored or puddled on the soil surface can infiltrate into the soil at a later time. Another practice is conservation tillage which leaves residue on the soil surface. During irrigation or rainfall the residue will take part of the energy out of water droplets that otherwise would break down soil structure and reduce infiltration. The soil infiltration rate also increases by having residue mixed in the surface soil. In this situation, the residue helps maintain open pores for water to infiltrate. Similar to tillage, residue can also increase surface storage capacity by stopping the flow of water.

Of equal importance is evaluation of the sprinkler package. For low pressure systems, it may be necessary to use a different sprinkler or increase pressure. These changes will allow water to be applied over a larger area thus reducing the application rate. For more information on controlling irrigation runoff from center pivots and the associated water loss from different sprinkler packages, see *Water Loss from Above-Canopy and In-Canopy Sprinklers,* NebGuide G97-1328 and *Application Uniformity of In-Canopy Sprinklers,* NebGuide G97-1337.

Vegetative filter strips on the edge of the pivot can also slow runoff and prevent soil erosion. Although filter strips can prevent soil from moving off of a field, it still allows soil to be moved to the edge of the field. See NebFact NF97-352 *Vegetative Filter Strips for Agriculture,* for more information on using filter strips.

Furrow Irrigation. A number of things have been tried or introduced to help reduce the amount of sediment being lost with furrow irrigation. Some research has involved putting straw or growing grass in the furrows to slow the water and keep sediment on the field. Conservation tillage, like with center pivots, slow the water down in the furrow and can reduce soil loss. Although for many irrigators, slowing water advance, especially during the first irrigation, is not advantageous. These procedures can help reduce sediment loss but they also impact the efficiency of irrigation.

WHAT IS POLYACRYLAMIDE?

Polyacrylamide or PAM is a long chain polymer that acts as a strengthening agent to bind soil particles together. With particles held together, water can no longer easily move the larger and heavier particles of soil. USDA researchers in Kimberley, Idaho began working with PAM in the early 1990's. They worked with PAM as a method to reduce erosion in furrow irrigation. Tests in Idaho have shown soil erosion in furrows to be reduced by over 95% when compared to irrigation without the polymer added. Polyacrylamide can be purchased both as a dry material or in a liquid formulation.

WHAT ARE THE BENEFITS OF PAM?

Benefits of using polyacrylamide may go beyond erosion control. If the soil in the furrow can be held in place, this means more water can be put down individual furrows without causing erosion. Getting water to the end of the field can be difficult. The ability to put more water in the furrow without having erosion can reduce furrow advance time and improve irrigation performance.

Holding the soil in place can also be a big advantage when furrows are small or the soil is loose from cultivation. In many cases furrows are eroded at the top of a field. As water moves down the field less water is in the furrow so the water advance slows. As the water slows, the ability of water to carry soil particles is reduced and soil begins to settle to the bottom of the furrow. In another case a field may have more slope at the top of the field than at the bottom. The faster moving water at the top of the field erodes the soil. When the water in the furrow slows in the flatter portion of the field sediment begins to settle out. In these cases, as sediment continues to be deposited, the furrows get shallower. This can sometimes occur within one irrigation and in other cases it may take several irrigations. Either way, the result is the furrow eventually fills with soil and water begins to flood adjacent rows. Furrow identity in the lower portion of the field can be completely lost which can impact irrigation performance and yield. The use of PAM can reduce this problem by not allowing the soil to erode. Furrows can be maintained both at the top and bottom portions of the field.

Using polyacrylamide has also been shown to increase the intake rate of some soils. This occurs as a result of the soil particles binding together. Small particles are not dispersed as with normal irrigation when they are carried in the water to block larger pores. During the first irrigation soil intake rate is normally high. If using PAM causes an increase in the intake rate of the soil, changes in water management must be made. For example, increasing furrow stream size is needed to account for the increase in the intake rate of the soil so water advance remains acceptable. See *Managing Furrow*

Irrigation Systems, NebGuide G91-1021 for more information on advance time and stream size selection for efficient furrow irrigation.

Soil erosion can occur in furrows even though only small stream sizes are used. As the season progresses, the furrows become narrow deep channels that carry the water. In some cases these narrow channels can be 12-18 inches deep or more. When this occurs, water is being applied at a 12-18 inch depth below the most active portion of the root zone. Without a constant source of water, it is difficult to move water up in the soil profile. The result can be plant water stress for any crop but especially for shallow rooted crops like dry beans and soybeans.

APPLICATION OF POLYACRYLAMIDE

If adding PAM to an open ditch, keep the point of discharge at least 2 ft away from the water. If turbulence in the water is causing splashing, move the applicator far enough away that water does not contact the container. Small droplets of water can cause the PAM to clog and stop flowing. Another concern with using PAM is the type of water being used for irrigation. If the water source is filled with sediment, it is possible to settle out the sediment before the water is diverted into furrows. Although this does not affect the effectiveness of the PAM, it could cause a sediment buildup in the head ditch or gated pipe.

Pam should be applied at a rate of 10 ppm. Again, different soil types react differently. It is possible to get good erosion control using a lower rate but higher rates may be needed for other soils.

Before the water with PAM is applied to the soil, make sure it has been mixed with the irrigation water well. In an open ditch, let the water pass over at least one drop or some obstruction in the ditch that will cause turbulence before water is diverted into the furrows. In some cases you may have to create the drop in order to mix the material in the water. In gated pipe, the swirling action in the pipe will generally cause enough mixing within the first 2-3 joints of pipe.

Having the PAM mixed with the water well is important to get maximum effectiveness. This means that before the gates are opened or the tubes are set, the PAM must be mixed in the water. This will cause the soil particles in the upper reaches of the furrows to be bound together and less susceptible to erosion where stream flow is the highest.

The furrow is considered treated once the water reaches the end of the field. Additional polymer is normally not required for that irrigation. In many cases producers are finding that applying PAM only during the first portion of the irrigation provides adequate protection and reduces erosion to acceptable levels.

If cultivation or ditching occurs after PAM has been applied in a furrow, its effectiveness in controlling erosion is essential lost. After cultivation, it is recommended to reapply PAM. Although the PAM does not remain all season long, there is some erosion control benefit for the irrigation following application. This again will depend on soil type, field slope and irrigation furrow stream size.

RESEARCH RESULTS

Research has been conducted at the Panhandle Research and Extension Center in Scottsbluff in both 1996 and 1997. Furrow stream size was approximately 12 g.p.m. Field slope was only 0.2% and field length was 1000 ft. The soil was a Tripp very fine sandy loam. The crop grown was dry beans in 30 in. rows with every other row irrigated. In both years furrow advance time to 1000 ft and the sediment loss (tons/ac) were measured

In 1996, three treatments were tested PAM, no PAM and patch PAM. The patch PAM treatment was sprinkling PAM in the dry furrow before water was started. Advance time was similar for all treatments. The amount of soil loss was greatest for the no PAM treatment and the least for the PAM treatment. The patch PAM treatment, although providing some reduction in erosion, was not as effective as the PAM treatment.

Four treatments were compared in 1997, PAM, no PAM, surge with PAM and surge with no PAM. Advance time to 1000 ft was similar for all four treatments during the three irrigations. However, the advance times for the treatments using PAM were slightly below the advance times for the treatments with no PAM.

If a producer is using surge and tries PAM, particular attention should be paid to furrow advance time. Surge irrigation through its wetting and drying process tends to seal the surface of the soil and reduce intake rate. This in turn advances water down the field faster. On the other hand, on many soils PAM tends to increase intake as a result of maintaining open pores on the soil surface.

CONCLUSIONS

Polyacrylamide can control soil erosion that occurs while furrow irrigating. However, like many farming practices, its use and effectiveness can vary from field to field based on slope and soil type. The use of PAM is relatively new and will require individuals to try different things until recommendations can be developed for specific soil textures and field slopes.

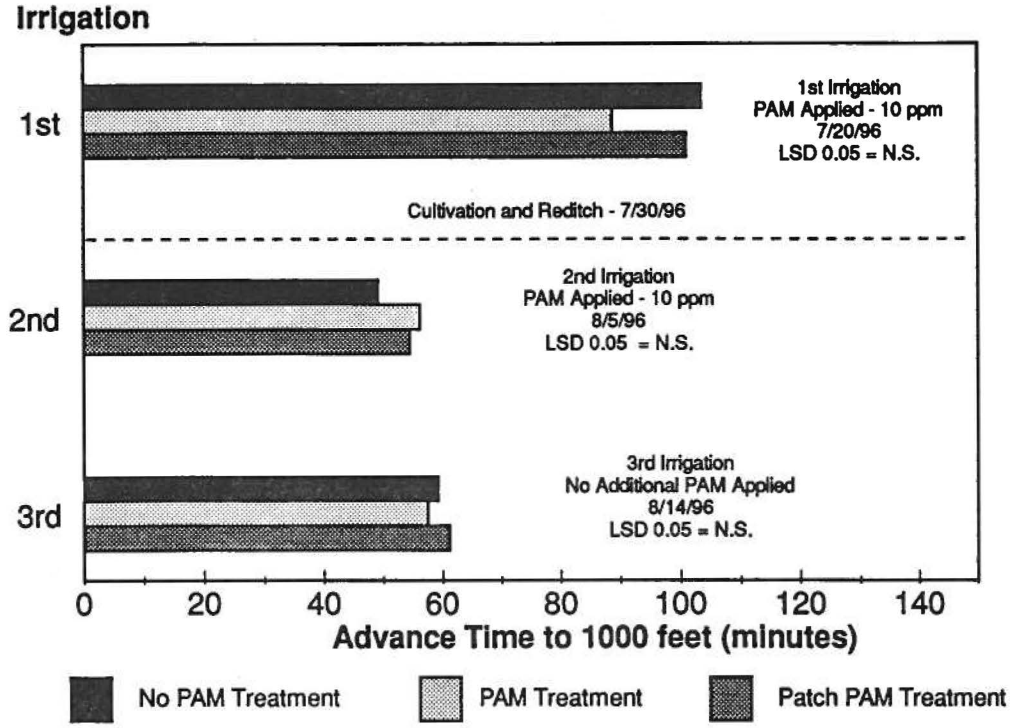

Figure 1. 1996 Furrow advance time to 1000 feet for each irrigation , treatments of no PAM, PAM, and patch PAM.

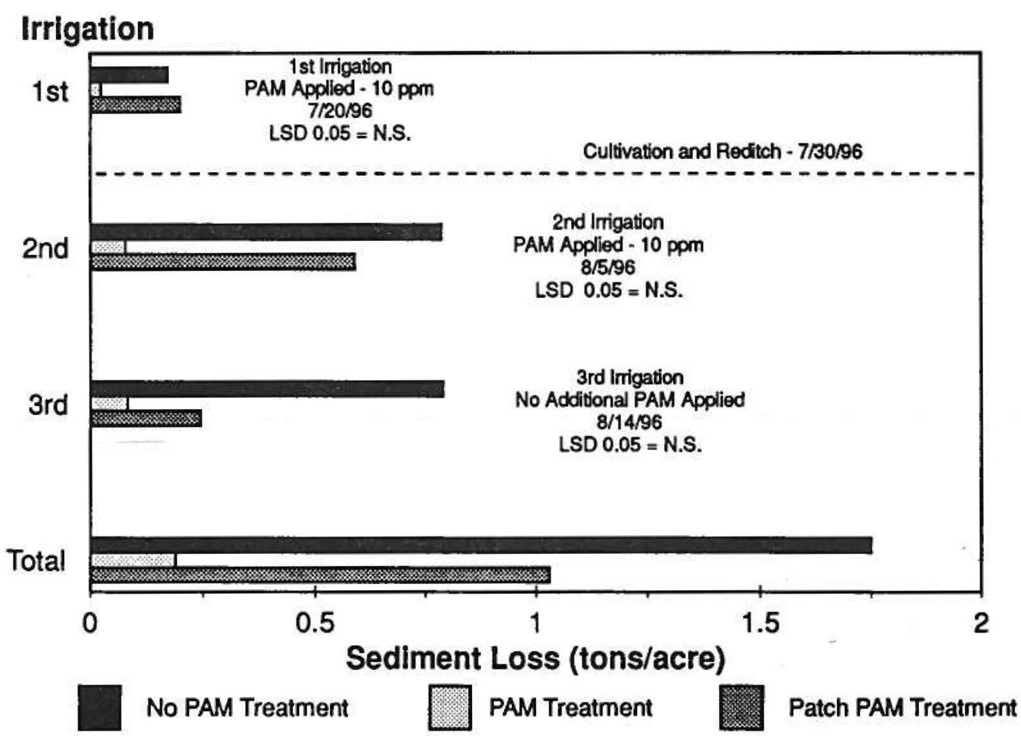

Figure 2. 1996 Sediment Loss (tons/acre) for each irrigation and total sediment loss (tons/acre) for treatments of no PAM, PAM, and patch PAM.

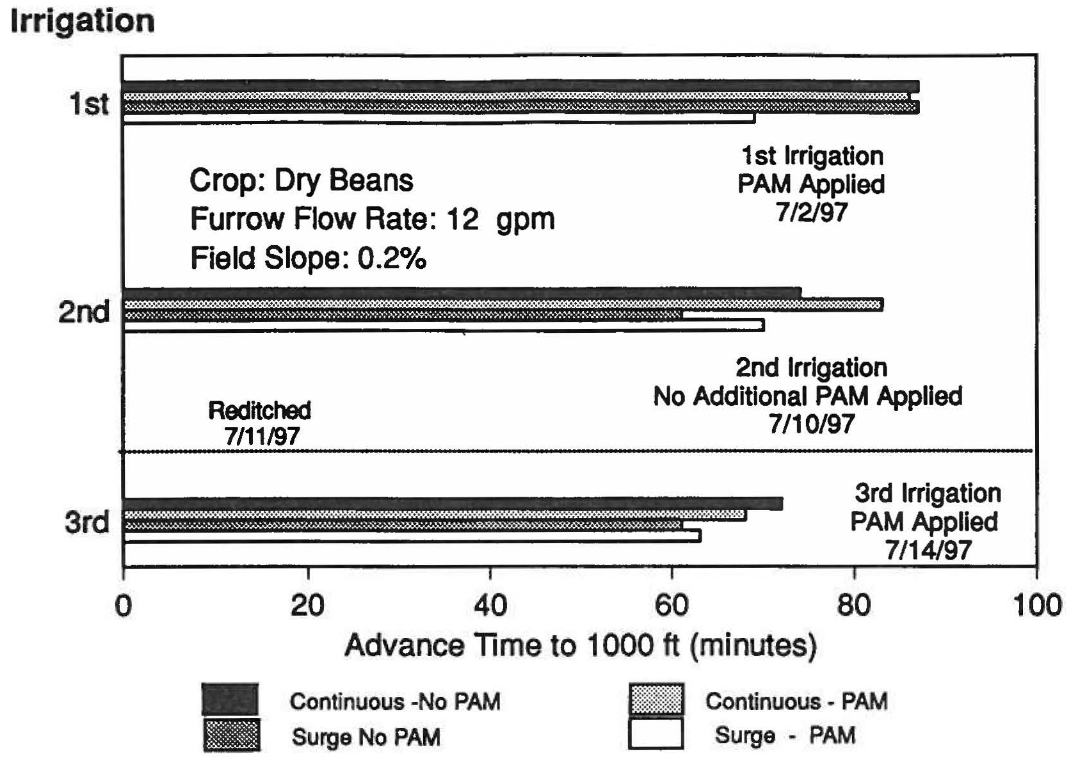

Figure 3. 1997 Furrow advance time to 1000 feet for each irrigation , treatments of no PAM continuous irrigation, PAM continuous irrigation, no PAM surge irrigation and PAM surge irrigation.

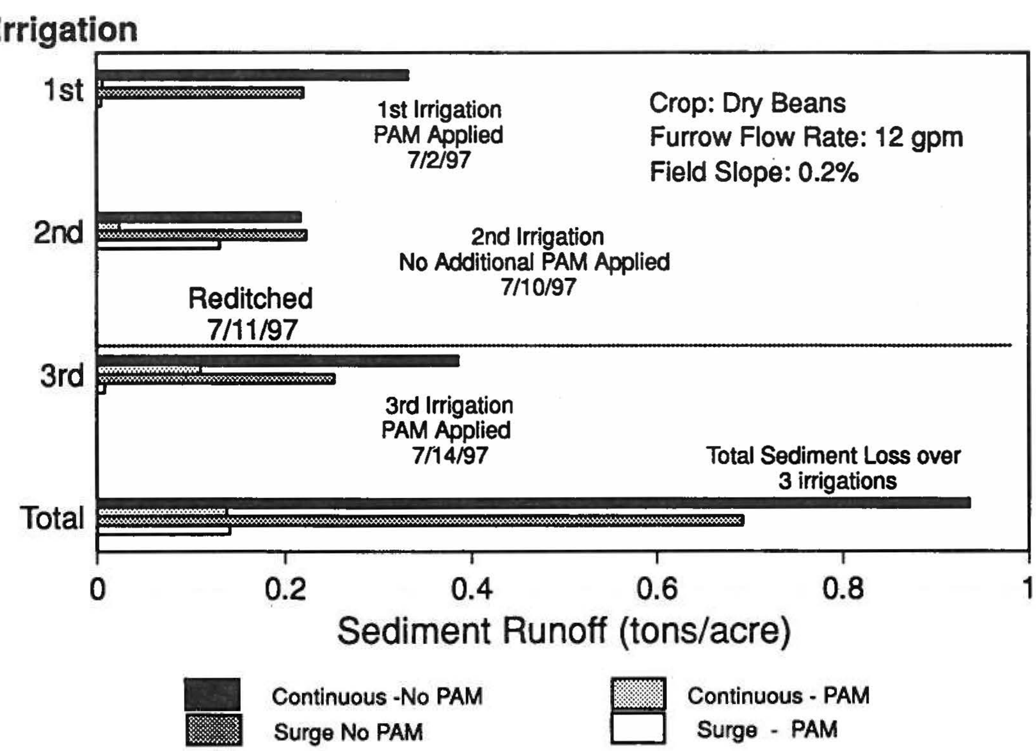

Figure 4. 1997 Sediment Loss (tons/acre) for each irrigation and total sediment loss (tons/acre) for treatments of no PAM continuous irrigation, PAM continuous irrigation, no PAM surge irrigation and PAM surge irrigation.