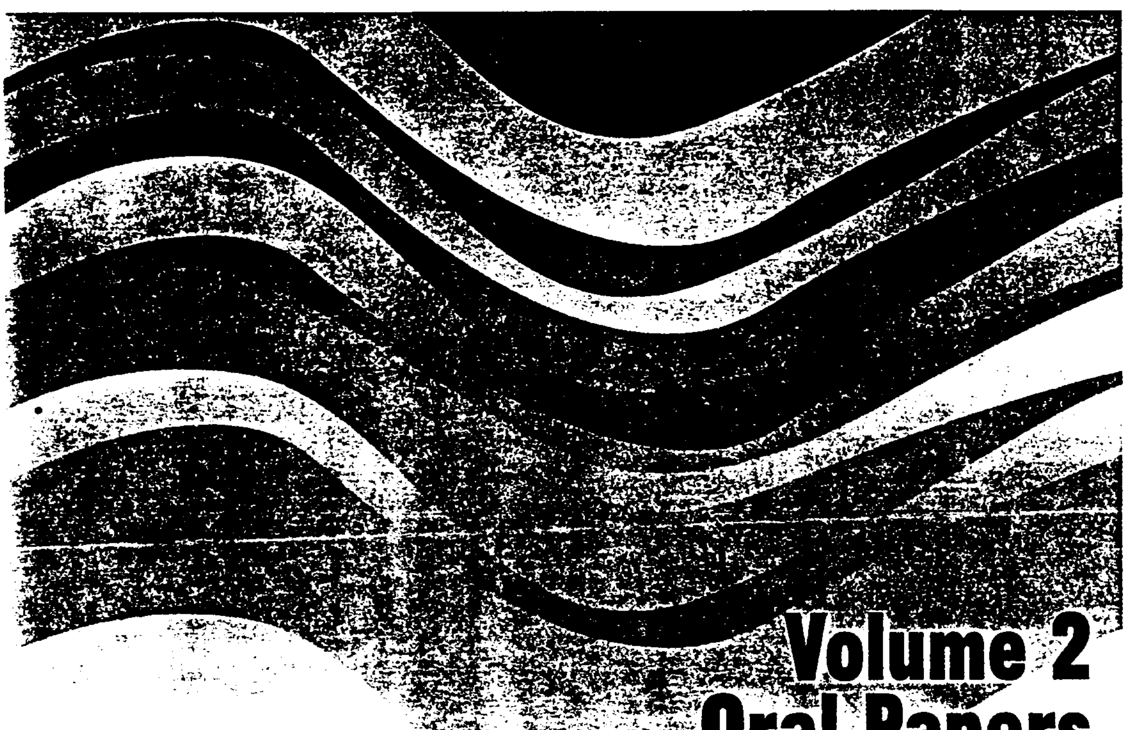
# Australian and New Zealand National Soils Conference 1996

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# Polyacrylamide as a Tool for Controlling Sediment Runoff and Improving Infiltration under Furrow Irrigation.

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## Introduction

Water-soluble anionic polyacrylamide (PAM) has been shown to be effective in controlling topsoil erosion, preventing sedimentation of waterways, and simultaneously improving infiltration rates for furrow irrigation in the western USA (Lentz *et al.* 1992; Lentz and Sojka 1994). PAM injected as a pulse into the irrigation stream as the water advances has a stabilizing effect on the surface soil in the furrow. Controlling sediment runoff under intensive irrigation has the dual advantage of conserving fertile topsoil and reducing downstream pollution from sediments in waterways, particularly suspended sediments. Topsoil losses of 5 - 50 tonnes $ha^{-1}$ $yr^{-1}$ have been reported from irrigated fields on erodible soils in the US Pacific Northwest. Polymers provide farmers with a practical and economic management tool for conserving soil and preventing sedimentation of waterways from irrigated fields. Increased net infiltration, which translates to more efficient water use, is a secondary benefit, especially for semi-arid and arid environments where water supplies are limited.

Results from field experiments on a highly erodible Portneuf silt loam (Durixerollic Calciorthid) in southern Idaho are presented comparing the efficacy of three different molecular weights of PAM for controlling sediment runoff and infiltration rates. Some potential environmental impacts of PAM applications under furrow irrigation are briefly discussed.

## Methods

A series of field experiments on furrow conditioning by PAM were conducted in the summer of 1995 on the USDA-ARS Northwest Irrigation and Soils Research Station farms at Kimberly, southern Idaho (Lentz and Sojka 1995, 1996). This paper concentrates on an experiment which evaluated anionic PAM of different molecular weights but with the same charge density and, simultaneously, compared both solution and solid applications. General results from another experiment examining plant uptake and PAM concentrations in the water downstream of application are also presented.

Anionic PAM was injected into the furrow irrigation stream from stock solutions of 2400mg $L^{-1}$ by peristaltic pump to give a concentration of 10mg $L^{-1}$ in the furrow as the water advanced to the end of the field. Thus PAM was applied only during the early stage of each irrigation. Three different molecular weights (MW) of polymer but with the same charge density were compared: Low MW 4-7 x $10^6$ g $mole^{-1}$, Medium MW 12-15 x $10^6$ g $mole^{-1}$ and High MW 14-17 x $10^6$ g $mole^{-1}$. Solid forms of Medium MW PAM were also applied as granules sprinkled under the irrigation spigot or down the furrow, or as small blocks placed under the spigot. Water application rates were 22.7 L $min^{-1}$ during the advance and 15.1 L $min^{-1}$ for the remainder of the 12-hour irrigations. A total of 6 irrigations were monitored over the growing season. Sediment yields were measured using the Imhoff cone method; flow rates were monitored with V-notch flumes designed for irrigation furrows; net infiltration was assessed from the difference between net inflow and outflow; and unsaturated infiltration rates (at potentials of -40mm and -100mm of water) were measured in the furrows the day after irrigation using tension infiltrometers. Beans (*Phaseolus vulgaris* L.) were grown on the experimental area. Further details on the techniques are given in Lentz *et al.* (1992) and Lentz and Sojka (1994,1995,1996).

A smaller plot experiment examined plant uptake and PAM concentrations in downstream water. Here polyacrylamide was tilled into the soil prior to planting, as well as injected into irrigation water. The application methods were generally the same as for those used in the other experiment but maize (*Zea mays* L.), potatoes (*Solanum tuberosum* L.) and sugar beet (*Beta vulgaris* L.) were grown in addition to beans (Barvenik *et al.* 1996).

## Results and discussion

The reduction in sediment runoff for the three molecular weights of PAM applied to the irrigation water is as follows: Low MW 50.9 - 91.5%; Medium MW 79.2 - 95.4%; High MW 71.1 - 95.9%.

Sediment runoff reductions of over 90% are consistent with previous studies which averaged 94%. The Medium and High MW PAM were more effective in controlling soil erosion than the Low MW polymer. The lower ranges of erosion reduction were achieved early in the growing season when wet climatic and soil conditions prevailed. This suggests that the efficacy of PAM for controlling erosion is reduced when the soil has been pre-wet by rain. However, more typical erosion control was achieved later in the season when dry conditions prevailed.

Field experiments by the USDA-ARS Kimberly team have shown that PAM is effective for erosion control whether it was applied as a solution, as dry granules or as dry blocks under the spigot inflow, or as dry granules spread along the furrow. PAM losses from the field are minimal when applied using recommended concentrations and methods. PAM is not mobile in soil and no uptake of the monomer acrylamide by the four crops was detected (Barvenik *et al.* 1996). Hence, the application of PAM using the prescribed methods does not appear to pose a risk to the environment or to human health.

Net infiltration over the furrow length for the 12-hour irrigation period from the PAM applications increased by an average of 10% (31mm for Control and 34mm for PAM-treated furrows). This compared reasonably well with previous studies which record about a 15% increase. Tension infiltrometry showed that unsaturated infiltration rates in the furrows were improved approximately 2-fold in furrows treated with High and Medium MW PAM. Unsaturated infiltration for furrows treated with Low MW and solid forms of PAM was similar to that for untreated furrows. The infiltration results indicate that polymer applications help to stabilise the surface soil pore geometry, thereby facilitating water movement into the soil from the furrow. PAM conditioning also prevented soil crusting at the time of plant emergence.

**Conclusions**

Polyacrylamide applied as a liquid or solid to the irrigation stream during the water advance stage is effective in controlling sediment runoff from furrow irrigation in the highly erodible soils of the US Pacific Northwest.

Medium and High MW PAM were more effective than a Low MW formulation. Net furrow infiltration rates and slightly unsaturated infiltration rates are improved by PAM applications. This demonstrates the positive impact of the polymer on the surface soil porosity. Plant uptake of acrylamide was not detectable. Aqueous PAM concentrations in runoff decreased below detectable limits downstream because PAM is readily adsorbed to settling sediment. Hence, our results suggest no adverse environmental effects or potential health risks if recommended procedures are followed.

**References**

Barvenik, F.W., Sojka, R.E., Lentz, R.D., Andrawes, F.F., and Messner, L.S. (1996). Fate of acrylamide monomer following application of polyacrylamide to cropland. *In* R.E.Sojka and R.D.Lentz (ed.) Managing irrigation-induced erosion and infiltration with polyacrylamide. Proc., Twin Falls, ID. 6-8May 1996. Univ. of Idaho/USDA-ARS and NRCS, Kimberly, ID.

Lentz, R.D., Shainberg, I., Sojka, R.E., Carter, D.L. (1992). Preventing irrigation furrow erosion with small applications of polymers. *Soil Science Society of America Journal* **56**, 1926-32.

Lentz, R.D., Sojka, R.E. (1994). Field results using polyacrylamide to manage furrow erosion and infiltration. *Soil Science* **158**, 274-82.

Lentz, R.D., Sojka, R.E. (1995). Polyacrylamide concentration changes and mass balance along treated, irrigation furrows. p 295 *In* Agronomy Abstracts, ASA, Madison, WI.

Lentz, R.D., Sojka, R.E. (1996). Polyacrylamide application to control furrow irrigation-induced erosion. *In* Erosion control technology - Bringing it home. Proc. 27th Annual Intern. Erosion Control Assoc. Conf., Seattle, WA 27Feb - 1 Mar 1996. IECA, Steamboat Springs, CO.