# A COMPARISON OF STRAW MULCHING AND PAM FOR POTATO PRODUCTION

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## Summary

Russet Burbank, Shepody, Frontier Russet, and Ranger Russet potatoes were tested for their response to furrow irrigation with either straw mulched furrows, PAM-treated irrigation water, or an untreated check on a Nyssa silt loam with approximately 1.5 percent slope. Neither straw mulching nor PAM resulted in a significant difference in potato yield or grade compared to the untreated check in 1996. Soil water potential at an 8-inch depth in the straw-mulched and PAM-treated plots remained wetter during the season with fewer irrigations compared to the untreated check. Irrigation-induced erosion was reduced by either straw mulching or PAM compared to the untreated check. The total sediment loss from five irrigations was reduced by 96 percent and 90 percent by straw mulching and PAM, respectively, compared to the check.

## Introduction

Irrigation-induced erosion is a serious problem in areas of irrigated agriculture. Polyacrylamide (PAM) is a water soluble polymer and is a high potency flocculent. PAM has been shown to significantly reduce soil erosion (90-95 percent reduction) associated with surface irrigation when applied to irrigation water. Straw mulching of furrow bottoms has also been shown to significantly reduce soil erosion associated with surface irrigation. Straw mulching and PAM have the potential to increase potato yield by reducing nutrient loss in sediment and by maintaining irrigation efficiency during the season.

## Procedures

The 1996 trial was conducted on a Nyssa silt loam with approximately 1.5 percent slope, following wheat at the Malheur Experiment Station. The field had been leveled in the past. Topsoil from the top half of the field had been removed over 30 years ago in order to fill a gully running through the center, resulting in large areas of low fertility. In addition, the field was deep plowed in 1985, inverting the soil profile. Nitrogen at 22 lb/ac and phosphorus at 103 lb/ac were broadcast and then the field was bedded into 36-inch hills in the fall of 1995. A soil sample taken from the top foot on April 23, 1996 showed a pH of 7.8, 1.1 percent organic matter, 18 meq per 100 g of soil cation exchange capacity, 9 ppm nitrate-N and 4 ppm ammonium-N, 11 ppm phosphorus, 793 ppm potassium, 4,500 ppm calcium, 299 ppm magnesium, 474 ppm sodium, 1.9 ppm zinc, 8.2 ppm iron, 9.1 ppm manganese, 1.1 ppm copper, 23 ppm sulfate-S, and 0.8 ppm boron.

Two-ounce seed pieces were planted April 20 at 9-inch spacing. On May 6, Thimet 20G insecticide at 3 lbs ai/ac was shanked-in with urea at 100 lb N/ac to both sides of the hill (Figure 1). The shanks were adjusted to place the urea in bands located at the same depth as the seed piece and offset 9 inches from the hill center. The hills were remade with a Lilliston cultivator. The herbicides Prowl at 1 lb ai/ac and Dual at 2 lbs ai/ac were broadcast on the entire soil surface on May 8 and incorporated with the Lilliston cultivator. Post-emergence nitrogen applications consisted of water-run urea at 44 lb N/ac on June 29 and at 30 lb N/ac on July 12.

The experimental design had the two erosion control treatments and the untreated check as main plots and the varieties (Russet Burbank, Shepody, Frontier Russet, and Ranger Russet) as split-plots within the main plots. The treatments were replicated six times.

Wheat straw at 800 lb/ac was applied to the furrow bottoms by hand on May 31. PAM was applied as an aqueous solution at 1 lb/ac during the first two irrigations and at 0.5 lb/ac during subsequent irrigations. The premixed PAM solution was applied directly into the irrigation water with a K-Box in the transmission line to enhance mixing with the irrigation water. The PAM application rate was adjusted so that 80 percent of the PAM was applied during the advance time and the remainder during the rest of the irrigation set. At each irrigation, every other furrow was irrigated, with the irrigated furrows alternating from irrigation to irrigation.

Six granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200, Irrometer Co., Riverside, CA) were installed in the top foot of soil and one GMS was placed in the second foot of soil in each plot. Daily sensor readings were used to schedule irrigations. The GMS in the top foot of soil were offset 6 inches from the hill top and centered 8 inches below the hill surface. The GMS in the second foot of soil were placed in the hill center and centered 20 inches below the hill surface. Half of the first foot sensors were located on the wheel traffic side of the potato hill and the other half were located on the non-wheel traffic side of the hill. Sensors were read at 8 AM five times per week from July 10 to September 1. Irrigations were started when the average soil water potential in the first foot of soil dried to -50 to -60 kPa. Irrigations were run individually for each treatment as needed. Inflow and outflow measurements were taken hourly for each of the first five irrigations. Imhoff cones were used to measure the sediment loss at the same time outflow measurements were taken.

Petiole samples were collected every two weeks from July 15 to August 15 from Shepody plants in each plot, and analyzed for nitrate. A complete petiole analysis of composite samples from Russet Burbank and Shepody plants from all treatments on July 12 showed deficiencies of nitrogen, potassium, sulfur, magnesium, manganese, and copper.

The fungicides Bravo at 0.56 lb ai/ac and Manex at 1.2 lb ai/ac were ground sprayed on June 19 and July 19, respectively, for preventive control of late blight. Zinc chelate at 0.02 lb Zn/ac and Copper sulfate at 0.12 lb Cu/ac were added to the Manex application on July 19 for correction of the nutrient deficiencies. Manex, at 1.2 lb ai/ac, contains 0.26 lb Mn/ac.

Plant available-N contributed from organic matter mineralization was determined by the buried bag method (Westermann and Crothers, 1980). A composite soil sample from each of the top two feet of soil in each plot was taken at the end of April and placed in plastic bags. The bags were sealed and placed back in the field at the appropriate depth. Every month a subset of the bags was removed for $NO_3$-N and $NH_4$-N analysis to determine a profile of N release over time. The available N content in the soil in the bags is a result of organic matter decomposition due to microbial activity, without the effects of leaching and plant uptake.

Four furrows in each treatment, at the middle of the field, were measured using a drop rod measuring device on September 2. Tubers from 40 feet in each plot were harvested on September 26 and evaluated for yield and grade. A subsample was stored and analyzed for tuber specific gravity and stem-end fry color in early November.

Differences between treatments and varieties were compared using ANOVA and least significant differences at the 5 percent level, LSD (0.05).

## Results and Discussion

A total of 329 hours of irrigation (16 irrigations) for the straw plots, 382 hours of irrigation (18 irrigations) for the PAM plots, and 430 hours of irrigation (20 irrigations) for the untreated plots, were necessary to maintain soil water potential at the 8-inch depth wetter than -60 kPa. Despite the higher number of irrigations, the soil water potential at the 8-inch depth in the untreated check plots became drier than -60 kPa more often than in the straw or PAM plots (Figure 1). The strawed plots were among the highest in average total infiltration per irrigation and total infiltration for the five irrigations measured (Table 1).

From May 1 to July 31 (main period of potato N uptake) N mineralization released 34 lb N/ac.

Petiole nitrate levels were below the sufficiency range (Jones and Painter, 1974) in all treatments on all sampling dates.

Neither straw mulching of the furrow bottoms nor PAM treatment of the irrigation water resulted in significant differences in tuber yield compared to the untreated check (Table 2). The soil at the trial site had low phosphorus and magnesium and very high sodium. The low fertility of the trial site might have limited tuber yield response to the improved soil moisture management in the straw mulched and PAM treated plots..

Neither straw mulching of the furrow bottoms nor PAM treatment of the irrigation water resulted in significant differences in tuber internal quality (Table 3).

At the end of the season, the untreated wheel and non-wheel furrows at the middle of the field showed evidence of more pronounced erosion than either the straw-mulched or PAM treated furrows (Figures 2 and 3). Average total sediment loss per irrigation and total sediment loss for the five irrigations measured was significantly lower for the straw- and PAM-treated plots than for the untreated plots. Straw mulching and PAM reduced total sediment loss from five irrigations by 96 percent and 90 percent, respectively, compared to the untreated check.

The higher number of irrigations applied to the untreated plots were not effective in maintaining the soil water potential at the 8-inch depth wetter than -60 kPa. Despite having the same infiltration as the untreated plots, the PAM plots required fewer irrigations to maintain the soil water potential at the 8-inch depth wetter than -60 kPa. Due to the more severe erosion in the untreated plots, the water flowed deeper in relation to the hill than in the PAM and straw plots, resulting in less effective wetting of the hill.

Nitrogen nutrition may have been limiting in this trial. Straw and PAM may have tended to reduce yields by increasing infiltration, hence inducing greater nitrate leaching below the potato root zone.

## Literature cited

Jones, J.P. and C.G. Painter, 1974. Tissue analysis: A guide to nitrogen fertilization of Idaho Russet Burbank Potatoes. University of Idaho, College of Agriculture, Cooperative Extension Service, Agricultural Experiment Station, Current information series # 240, June 1974.

Table 1. Effect of erosion control method on irrigation water infiltration and sediment loss during five irrigations. Malheur Experiment Station, Oregon State University,

| Treatment | Average | | Total | |
|---|---|---|---|---|
| | Infiltration | Sediment loss | Infiltration | Sediment loss |
| | ac-inch/ac | lb/ac | ac-inch/ac | lb/ac |
| Straw | 2.4 | 32.5 | 12.1 | 162.7 |
| PAM | 1.4 | 74.9 | 7.0 | 374.7 |
| Check | 1.8 | 778.3 | 8.8 | 3,891.4 |
| LSD (0.05) | 0.8 | 360.4 | 4.0 | 1,801.9 |

Table 2. Yield response of four potato cultivars to two erosion control methods. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1996.

| Variety | Treatment | Potato yield by market grade | | | | | | | | | Undersize | Rot | Total yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | US Number One | | | | US Number Two | | | | Marketable | | | |
| | | 4-6 oz | 6-10 oz | >10 oz | total | 4-6 oz | 6-10 oz | >10 oz | Total | | | | |
| | | cwt/ac | | | | | | | | | | | |
| Russet Burbank | Straw | 35.4 | 94.1 | 98.9 | 228.4 | 21.4 | 58.0 | 120.8 | 200.2 | 428.6 | 31.2 | 8.1 | 459.7 |
| | PAM | 22.6 | 82.3 | 102.9 | 207.8 | 16.0 | 34.7 | 133.0 | 183.7 | 391.5 | 28.0 | 20.2 | 419.5 |
| | Check | 39.7 | 108.6 | 145.9 | 294.2 | 10.9 | 37.3 | 110.8 | 159.1 | 453.3 | 27.7 | 0.0 | 481.0 |
| | Average | 32.6 | 95.0 | 115.9 | 243.5 | 16.1 | 43.3 | 121.5 | 181.0 | 424.5 | 9.4 | 29.0 | 453.4 |
| Shepody | Straw | 25.2 | 84.9 | 165.8 | 275.8 | 12.1 | 22.8 | 68.3 | 103.1 | 379.0 | 18.2 | 10.5 | 397.1 |
| | PAM | 20.5 | 62.5 | 153.8 | 236.8 | 12.3 | 19.9 | 71.0 | 103.3 | 340.1 | 14.3 | 0.0 | 354.4 |
| | Check | 29.2 | 107.4 | 167.3 | 303.9 | 11.4 | 15.6 | 48.5 | 75.5 | 379.4 | 19.9 | 0.0 | 399.3 |
| | Average | 25.0 | 84.9 | 162.3 | 272.2 | 11.9 | 19.4 | 62.6 | 94.0 | 366.1 | 3.5 | 17.5 | 383.6 |
| Frontier Russet | Straw | 16.8 | 66.9 | 204.7 | 288.3 | 6.0 | 12.4 | 79.6 | 98.0 | 386.3 | 22.0 | 2.1 | 408.3 |
| | PAM | 17.1 | 56.0 | 184.9 | 258.0 | 7.6 | 19.1 | 103.9 | 130.6 | 388.6 | 19.5 | 0.0 | 408.1 |
| | Check | 23.9 | 66.5 | 178.8 | 269.2 | 7.2 | 12.5 | 73.1 | 92.7 | 362.0 | 24.6 | 1.1 | 386.6 |
| | Average | 19.3 | 63.1 | 189.4 | 271.8 | 6.9 | 14.7 | 85.5 | 107.1 | 379.0 | 1.1 | 22.0 | 401.0 |
| Ranger Russet | Straw | 23.7 | 88.5 | 150.5 | 262.7 | 14.6 | 32.9 | 30.8 | 78.3 | 341.0 | 19.5 | 2.1 | 360.5 |
| | PAM | 20.9 | 98.9 | 170.7 | 290.4 | 11.6 | 20.4 | 35.8 | 67.9 | 358.3 | 18.4 | 0.0 | 376.7 |
| | Check | 21.9 | 91.0 | 189.6 | 302.5 | 8.9 | 27.2 | 56.7 | 92.8 | 395.3 | 20.7 | 2.6 | 416.1 |
| | Average | 22.2 | 92.8 | 170.2 | 285.2 | 11.7 | 26.8 | 41.1 | 79.7 | 364.9 | 1.6 | 19.5 | 384.4 |
| All varieties | Straw | 25.3 | 83.6 | 155.0 | 263.8 | 13.5 | 31.5 | 74.9 | 119.9 | 383.7 | 5.7 | 22.7 | 406.4 |
| | PAM | 20.3 | 74.9 | 153.1 | 248.2 | 11.9 | 23.5 | 85.9 | 121.4 | 369.6 | 5.0 | 20.1 | 389.7 |
| | Check | 28.7 | 93.4 | 170.4 | 292.5 | 9.6 | 23.2 | 72.3 | 105.0 | 397.5 | 0.9 | 23.2 | 420.7 |
| LSD (0.05) Treatment | | 5.8 | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| LSD (0.05) Variety | | 6.2 | 19.8 | 31.8 | ns | 4.8 | 11.1 | 21.6 | 28.8 | ns | 4.7 | ns | 51.0 |
| LSD (0.05) Trt X var | | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |

Table 3. Effect of erosion control treatments on tuber internal quality. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1996.

| Variety | Treatment | Stem-end fry color | Specific gravity |
|---|---|---|---|
| | | % reflectance | $g \cdot cm^{-3}$ |
| R. Burbank | Straw | 24.2 | 1.087 |
| | PAM | 23.4 | 1.089 |
| | No straw, no PAM | 24.3 | 1.087 |
| | Average | 24.0 | 1.088 |
| Shepody | Straw | 40.8 | 1.091 |
| | PAM | 38.6 | 1.095 |
| | No straw, no PAM | 44.8 | 1.109 |
| | Average | 41.4 | 1.098 |
| F. Russet | Straw | 32.8 | 1.095 |
| | PAM | 33.1 | 1.109 |
| | No straw, no PAM | 36.1 | 1.098 |
| | Average | 34.0 | 1.101 |
| R. Russet | Straw | 37.4 | 1.097 |
| | PAM | 35.3 | 1.092 |
| | No straw, no PAM | 37.1 | 1.097 |
| | Average | 36.5 | 1.095 |
| All varieties | Straw | 33.6 | 1.092 |
| | PAM | 32.6 | 1.096 |
| | No straw, no PAM | 35.5 | 1.098 |
| LSD (0.05) Trt | | ns | ns |
| LSD (0.05) Variety | | 3.8 | ns |
| LSD (0.05) Trt X Var | | ns | ns |

Fig 1. Soil water potential at 8-inch depth for furrow irrigated potatoes, Ontario, OR, 1996.

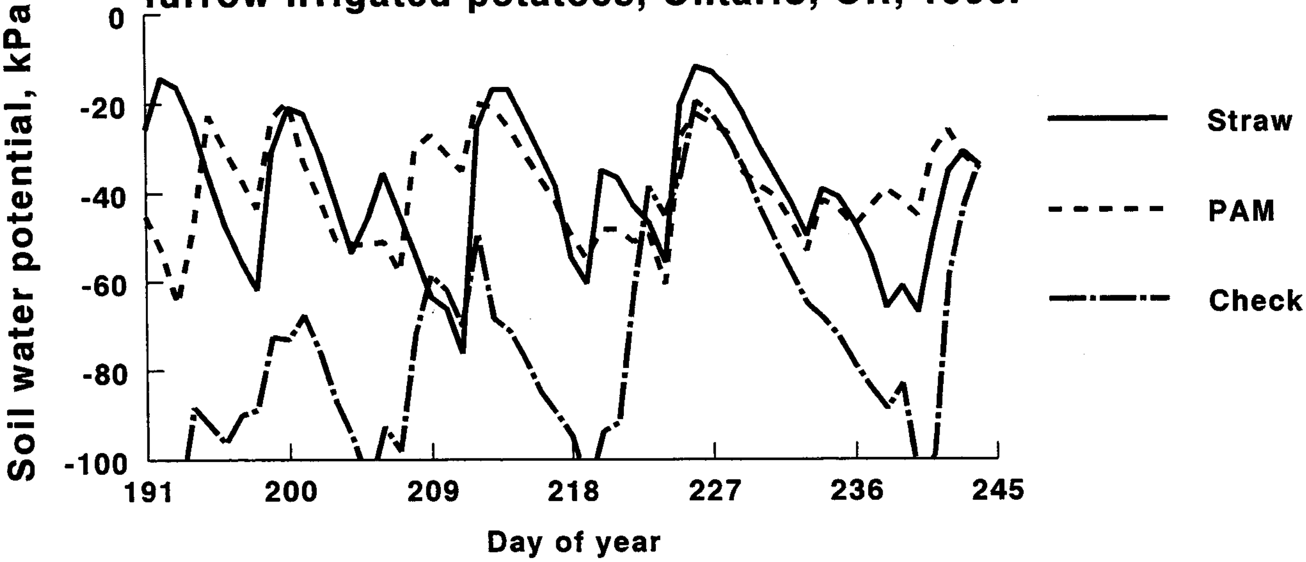


Fig 2. Furrow shape at field middle (200' from top) for wheel traffic furrows, Ontario, OR, 1996.

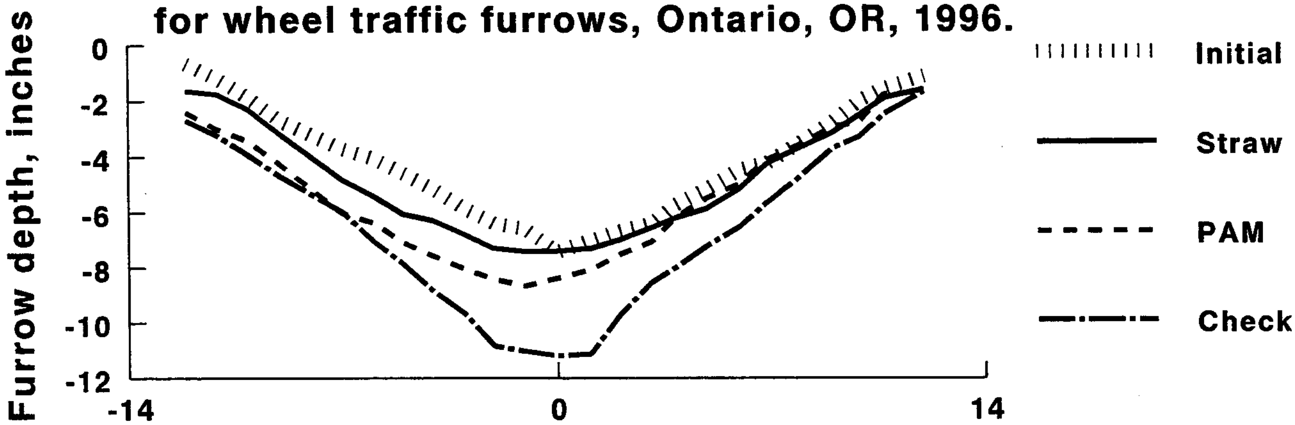


Fig. 3. Furrow shape at field middle (200' from top) for non-wheel furrows, Ontario, OR, 1996.