YIELD AND QUALITY OF FOUR POTATO CULTIVARS IN RESPONSE TO PAM (Polyacrylamide) TREATMENT OF IRRIGATION WATER

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Summary

Russet Burbank, Shepody, Frontier Russet, and Ranger Russet potatoes were tested for their response under furrow irrigation to PAM-treated irrigation water. The use of PAM was associated with an increase in US Number One tubers for Russet Burbank and Shepody varieties.

Introduction

Polyacrylamide (PAM) is a slightly water-soluble polymer and is a highly potent flocculent. PAM has been shown to significantly reduce soil erosion (90-95 percent reduction) associated with surface irrigation when applied to irrigation water. The PAM application rate for effective erosion control is approximately 1 lb/acre/irrigation for the first few irrigations (Sojka and Lentz, 1993). The need for PAM in subsequent irrigations is not well established.

PAM has been shown to maintain soil water infiltration rates during the season and to reduce the compaction of the soil caused by surface irrigation (Terry and Nelson, 1986; Wallace et al., 1986). Furrow-irrigated potato production with PAM-treated water could result in an increase in tuber yield and quality and more "mellow" soil at harvest.

Procedures

The trial was conducted on an Owyhee silt loam previously planted to soybeans at the Malheur Experiment Station. A soil sample taken from the top foot on March 24, 1994, showed a pH of 7.7, 1.3 percent organic matter, 18 CEC, 11 ppm nitrate-N, 11 ppm ammonium-N, 28 ppm phosphorus, 361 ppm potassium, 2,407 ppm calcium, 499 ppm magnesium, 266 ppm sodium, 6.1 ppm zinc, 3.0 ppm iron, 2.6 ppm manganese, 1.8 ppm copper, 30 ppm sulfur, and 0.6 ppm boron. The field was bedded into 36-inch hills in the spring of 1994. Two-ounce seed pieces were planted April 27 at 9-inch spacing. Thimet 20G at 3 lb ai/ac was sidedressed along with urea at 80 lb N/ac on May 12. Prowl at 1 lb ai/ac and Dual at 2 lb ai/ac were sprayed over the entire soil surface on May 16 and incorporated with a Lilliston. Urea at 40 lb N/ac was water, run on June 25.

Sixteen granular matrix sensors (GMS, Watermark Soil Moisture Sensors Model 200, Irrometer Co., Riverside, CA) were installed in the top foot of soil and 4 GMS were installed in the second foot of soil. Sensors were used to measure soil water potential in each of the PAM-treated and untreated blocks. 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 top of the sensor was 6 inches from soil surface). Half of the first foot GMS were located on the wheel side of the hill and the other half were located on the non-wheel side of the hill. The GMS in the second foot of soil were offset 6 inches from the hill top and centered 20 inches below the hill surface (the top of the sensor was 18 inches from soil surface). GMS had been previously calibrated to soil water potential. Sensors were read five times per week from June 10 to September 4. Irrigations were started when the average soil water potential in the first foot of soil dried to -50 kPa. Only every other furrow was irrigated at each irrigation, with the irrigated furrows alternating from irrigation to irrigation. The durations of furrow irrigations were 24 hours from June 3 through July 17 and were 12 hours from July 22 through August 27.

PAM (Polyacrylamide) was applied as an aqueous solution at 1 lb/ac during the first two irrigations and at 0.2 lb/ac during subsequent irrigations (Table 1). The PAM solution was applied directly into the irrigation water by way of a K-Box in the transmission line in order to enhance mixing with the irrigation water. PAM application rate was adjusted so that 80 percent of the PAM was applied during the advance time and the remainder of the PAM was applied during the rest of the irrigation set.

Prior to harvest, two soil bulk density samples at 2-inch depth and offset 6 inches horizontally from non-wheel furrow bottoms were taken on September 29 from each replicate of each treatment. Four penetrometer readings were also taken in the same locations in each replicate.

All tubers were harvested September 30 and evaluated for yield and grade. A representative 20-tuber subsample was stored for determination of tuber specific gravity and tuber stem-end fry color in early November.

Results and Discussion

Irrigation water treated with PAM was associated with a significant increase in total and US Number One tuber yield for Russet Burbank, and in a significant increase in US Number One and US Number One >10 oz tuber yield for Shepody (Table 2). The proportion of US Number One tubers for Shepody was higher with PAM (Table 3). There were no significant changes in tuber stem-end fry color or tuber specific gravity associated with PAM application (Table 4).

The average soil water potential in the potato hills (wheel and non-wheel sides) at 8- inch depth for the PAM-treated and untreated plots was similar during the season (Figure 1). The soil water potential in the top foot of soil on the wheel-traffic side of the hills remained higher (wetter) in the PAM-treated plots during the season (Figure 2). At the 20-inch depth the soil water potential remained wetter in the PAM-treated plots than in the untreated plots (Figure 3).

Soil bulk density was slightly lower in the PAM-treated non-wheel furrows than in the untreated non-wheel furrows (1.076 and 1.153 g/cm^3, respectively, significant at P = 0.10). The PAM-treated non-wheel furrows had lower penetrometer readings than the non-wheel furrows without PAM (1.73 and 3.52 kg/cm^2, respectively, significant at P = 0.01). Post-harvest plowing was judged subjectively to be easier in the PAM- treated soil.

Conclusions

These results suggest that PAM treatment of irrigation water may increase tuber grade and yield for certain varieties of furrow irrigated potatoes. Soil strength was decreased with repeated PAM applications. Repeated measurements over years and sites are necessary for reliable management guidelines.

Literature cited

Sojka, R.E. and R.D. Lentz, 1993. Polyacrylamide (PAM) A new weapon in the fight against irrigation-induced erosion. USDA-ARS Soil and Water Management Research Unit, Station Note # 01-94.

Terry, R.E. and S.D. Nelson. 1986. Effects of Polyacrylamide and irrigation method on soil physical properties. Soil Science, V 141, #5, pp. 317-320.

Wallace, A., G.A. Wallace, and A.M. Abouzamzam. 1986. Effects of soil conditioners on water relationships in soils. Soil Science, V. 141, #5 pp. 346-352.

Table 1. Irrigation dates and PAM applications to furrows for the PAM-treated plots. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994.

Irrigation	Date	Furrow irrigated	PAM rate lb/ac
1	6-3	wheel traffic	1
2	6-9	non-wheel	1
3	6-13	wheel traffic	0.2
4	6-17	non-wheel	0.2
5	6-20	wheel traffic	0.2
6	6-24	non-wheel	0.2
7	6-29	wheel traffic	0.2
8	7-1	non-wheel	0.2
9	7-6	wheel traffic	0.2
10	7-10	non-wheel	0.2
11	7-17	wheel traffic	0.2
12	7-19	non-wheel	0.2
13	7-25	wheel traffic	0.2
14	7-29	non-wheel	0.2

15	8-4	wheel traffic	0.2
16	8-8	non-wheel	0.2
17	8-14	wheel traffic	0.2
18	8-17	non-wheel	0.2
19	8-26	wheel traffic	0.2

Table 2. Yield response of four potato cultivars to PAM-treated irrigation water. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994.

Variety	Treatment	Potato yield by market grade											Total yield
		US Number One				US Number Two				Total	Rot	Undersize	
		4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	total	marketable			
		cwt/ac											
Russet Burbank	No PAM	53.1	72.9	33.4	159.4	29.4	54.7	49.1	133.1	292.5	5	81.9	379.4
	PAM	88.7	88.3	54.8	231.9	35.2	57	57	149.2	381	4	89.8	474.8
	Average	70.9	80.6	44.1	195.6	32.3	55.8	53.1	141.2	336.8	4.5	85.8	427.1
Shepody	No PAM	45.2	84.4	105.8	235.4	21.1	34.5	58.8	114.4	349.8	4.8	45.3	399.9
	PAM	50.8	106.2	154.8	311.8	8.7	27.5	44.8	81	392.8	11	46	449.8
	Average	48	95.3	130.3	273.6	14.9	31	51.8	97.7	371.3	7.9	45.6	424.8
Frontier Russet	No PAM	65.6	93.6	123.5	282.7	14.5	12	28.6	55	337.7	8.4	57.3	403.5
	PAM	53.6	89.9	100.5	244.1	6.6	13.9	25.7	46.2	290.3	2.3	42.7	335.3
	Average	59.6	91.8	112	263.4	10.6	12.9	27.1	50.6	314	5.3	50	369.4
Ranger Russet	No PAM	67.8	117.6	104.2	289.6	13.5	27.1	22.8	63.5	353.1	9.4	61.8	424.4
	PAM	65.1	102.1	99.1	266.3	20	41.5	44.7	106.2	372.4	3	61.7	437.1
	Average	66.5	110	101.6	278	16.7	34.3	33.8	84.8	362.8	6.2	61.8	430.8
All varieties	No PAM	57.9	92.1	91.7	241.8	19.6	32.1	39.8	91.5	333.3	6.9	61.6	401.8
	PAM	64.5	96.6	102.3	263.5	17.6	35	43.1	95.6	359.1	5.1	60	424.3
LSD(0.05) Trt		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
LSD(0.05) Variety		12.8	ns	24.8	41	5.2	13.1	12.9	24.6	ns	ns	11.5	49
LSD(0.05) Trt X Var.		18	ns	35	57.9	7.4	ns	18.2	35.8	ns	ns	ns	69.4

Table 3. Market grade distribution response of four potato cultivars to PAM- treated irrigation water. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994.

Variety	Treatment	Potato market grade distribution										
		US Number One				US Number Two				Total	Rot	Under size
		4-6 oz	6-10 oz	>10 oz	total	4-6 oz	6-10 oz	>10 oz	total	marketable		
		%										
Russet Burbank	No PAM	13.7	18.4	8.7	40.8	8.2	14.6	13.8	36.6	77.4	1.3	21.3
	PAM	18.9	18.1	11	48	7.5	12.2	12	31.7	79.6	0.8	19.6
	Average	16.3	18.2	9.9	44.4	7.8	13.4	12.9	34.1	78.5	1.1	20.4
Shepody	No PAM	11.5	21	26.5	58.9	5.2	8.5	14.7	28.4	87.4	1.3	11.3
	PAM	11.5	23.8	34.1	69.5	2	6.1	9.6	17.6	87.1	2.3	10.6
	Average	11.5	22.4	30.3	64.2	3.6	7.3	12.2	23	87.2	1.8	10.9
Frontier Russet	No PAM	16.3	23.5	29.9	69.8	3.5	3	6.8	13.4	83.1	2.7	14.2
	PAM	15.7	26.8	30.7	73.2	2	4	7.5	13.4	86.7	0.7	12.6
	Average	16	25.1	30.3	71.5	2.7	3.5	7.1	13.4	84.9	1.7	13.4
Ranger Russet	No PAM	16.1	27.3	24.6	67.9	3.2	6.5	5.5	15.3	83.2	2.2	14.7
	PAM	14.2	22.3	22.9	59.4	4.7	9.8	11.3	25.8	85.2	0.7	14.1
	Average	15.5	25.3	23.6	64.4	3.9	8	7.9	19.8	84.2	1.4	14.4
All varieties	No PAM	14.4	22.6	22.4	59.3	5	8.2	10.2	23.4	82.8	1.9	15.4
	PAM	15.3	23	24.6	62.9	4	8	9.8	21.8	84.6	1.1	14.2
LSD(0.05) Trt		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
LSD(0.05) Variety		2.5	4.3	5.3	5.6	1.5	2.6	2.9	5.9	3.5	ns	2.7
LSD(0.05) Trt X Var.		3.6	ns	ns	7.9	2.2	ns	4.1	8.3	ns	ns	ns

Table 4. Effect of PAM-treated irrigation water on tuber quality of four potato cultivars. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994.

Variety	Treatment	Fry color	Spec. gravity
		% reflectance	
R. Burbank	No PAM	26.8	1.069
	PAM	29.9	1.071
Shepody	No PAM	44.5	1.075
	PAM	44.8	1.073
F. Russet	No PAM	37.2	1.074
	PAM	35.2	1.075
R. Russet	No PAM	42.3	1.084
	PAM	41.8	1.087
All varieties	No PAM	37.7	1.075
	PAM	37.9	1.077
LSD (0.05) Treatment		ns	ns
LSD (0.05) Variety		2.5	0.004
LSD (0.05) Trt x var		ns	ns

Figure 1. Soil water potential over time at 8-inch depth in potato hills furrow irrigated with PAM-treated and untreated water. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994.

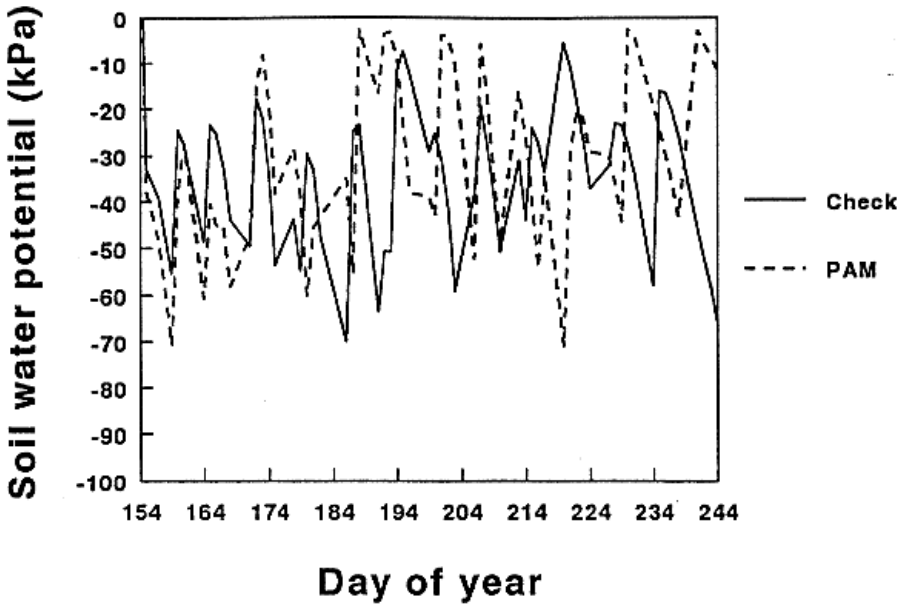

Figure 2. Soil water potential over time at 8-inch depth in the wheel-traffic side of potato hills furrow irrigated with PAM-treated and untreated water. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994.

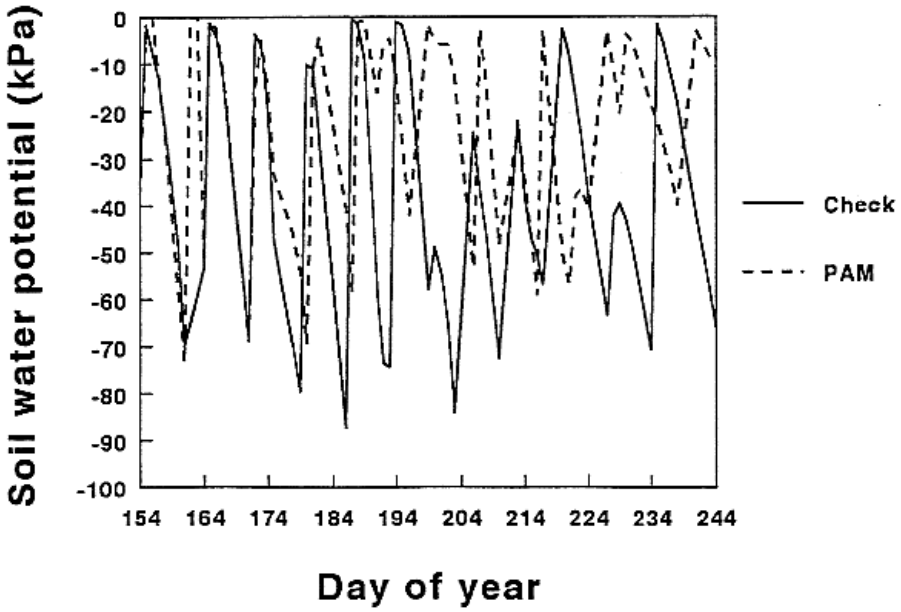

Figure 3. Soil water potential over time at 20 cm depth in potato hills furrow irrigated with PAM-treated and untreated water. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1994.