SEASON-LONG COMPARATIVE EFFECTIVENESS OF POLYACRYLAMIDE AND FURROW MULCHING TO REDUCE SEDIMENT LOSS AND IMPROVE WATER INFILTRATION IN FURROW IRRIGATED ONIONS

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Summary

Polyacrylamide (PAM) and straw mulch were tested to measure their ability to reduce soil erosion and increase water infiltration in furrow irrigated onions. The experiment was conducted in a Nyssa silt loam with a 3 percent slope. The length of the furrows was 245 ft. The PAM was applied at a rate of 1 lb/ac during the early part of the first irrigation in each furrow, and 0.5 lb/ac in subsequent irrigations. The straw mulch was applied to the bottom of the irrigation furrows as a single application at 563 lb/ac. During twelve furrow irrigations, the untreated furrows lost an average seasonal total of 60.1 t/ac soil, while the straw plots lost 5.3 t/ac soil and the PAM plots lost 6.2 t/ac soil. Straw mulching decreased the amount of sediment loss by 91 percent. PAM decreased the amount of sediment loss by 90 percent.

Straw mulching increased water infiltration from 23.6 to 69.8 percent of the applied water. PAM increased water infiltration from 23.6 to 53.1 percent of the applied water in this experiment.

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Introduction

Polyacrylamide (PAM), is a long chain polymer. It is used as a flocculating agent in several industrial processes, including the reduction of soil erosion during the irrigation of row crops. Polyacrylamide binds the soil together making it more difficult for water to break off soil particles. It also acts as an agent to settle already suspended soil particles. It gathers and carries sediment to the bottom of the furrow, instead of off the field.

PAM was marketed rather unsuccessfully to treat the tilled soil layer, but due to the large amounts necessary the product was considered uneconomical. Recent laboratory studies using new products and application techniques have shown PAM can be used

in small quantities to increase soil infiltration rates and reduce erosion (Shock, et. al. 1994; Trout, et. al. 1993).

Straw mulch has been used to reduce erosion and increase water infiltration in Malheur County for several years. Manual straw mulching is very laborious and time consuming, but there are machines on the market that work very effectively. Straw mulch is applied mechanically to the bottom of the furrow, where it impedes the progress of the water. By slowing the water, erosion is reduced and the larger wetted area in the furrow bottom improves infiltration.

Three different phosphorus rates were applied on this field as well, 0 lb/ac, 100 lb/ac, and 400 lb/ac. Both phosphorus rates and the furrow mulching have been repeated on every crop in the rotation in the same plots at this site for six years. PAM treatments were added in 1994 and continued in 1995.

The purpose of this experiment was to evaluate the value of straw mulch and PAM in erosion prevention and infiltration improvement.

Procedures

The experiment was conducted in a Nyssa silt loam with a 3 percent slope (Figure 1). Previous crops with the identical straw and phosphate treatments were as follows: potatoes in 1990, onions in 1991, sugar beets in 1992, wheat in 1993, and potatoes in 1994. Harvested potato beds were left idle over the winter of 1994. Spring field work consisted of deep ripping in two directions, disking and one groundhog operation before phosphate rates were applied. Twenty-two inch beds were made, then harrowed in preparation for planting. No pre-emergent herbicide was used except one application of Roundup at 1.5 pt/ac.. The field consisted of 30 plots, each plot was 245 ft long and 44 inches wide. There were twelve plots without straw or PAM, twelve plots treated with straw, as well as four PAM plots. The onion variety Vision was planted on April 17. The field was cultivated on June 1. On June 13 straw mulch was mechanically applied to the furrow bottoms in twelve of the plots, at a rate of 563 lb/ac. There were no other cultivations after the straw mulch was applied. During every furrow irrigation, PAM was applied to each furrow of the four plots. The rate of 1 lb/ac was applied during the first irrigation and 0.5 lb/ac during subsequent irrigations. The correct amount of PAM was applied to each furrow each irrigation by measuring out a PAM stock into a bucket with a valve at the head of each furrow. The PAM solution was metered into the water at a rate that would put approximately 80 percent of the solution into the furrow during the initial water advance during the irrigation. Furrows were irrigated at the rate of 2 gal/min. Inflow and outflow measurements were taken hourly for every irrigation measured. Imhoff cones were used to measure the sediment loss at the same time outflow measurements were taken.

Granular matrix sensors (Watermark Soil Moisture Sensors, Irrometer Co., Riverside, CA) were used to measure the soil water potential. Six sensors were placed in a PAM

plot, six in a check plot, and six in a straw plot (Figure 1). Two of the six sensors were placed at 61.25 feet, two were placed 122.5, and two were placed 183.75 feet from the top of the field in each of the plots that were measured. The sensors were buried at a depth of 8 inches, and approximately 8 inches from the center of the hill (directly lined up in the onion row). Sensors were read daily at 8 AM starting July 18 using a 30 KTCD meter (Irrometer Co., Riverside, CA).

The onions were irrigated for emergence by sprinklers without PAM, at a rate of approximately 0.1 ac-in/ac per hour, four times over a period of six weeks, starting on April 22 (Table 1). A total of 3.2 ac-in/ac of water was applied in this manner. All subsequent irrigations were 24 hour furrow irrigations (Table 1). The field was furrow-irrigated twelve times starting on June 22. On all but two of the furrow irrigations, inflow, outflow and sediment loss data were collected. The data from those two irrigations, the second and the fourth, was estimated by averaging the data from the irrigation immediately preceding and following the one that was skipped.

Roundup at 1.5 pints per acre was broadcast, sprayed pre-emergence on May 2. Poast at 16 oz/ac and 10 oz/ac of Buctril were applied on May 20. On June 12, 20 oz/ac of Poast, 12 oz/ac of Buctril, and 12 oz/ac of Goal were applied. On July 10, 16 oz/ac of Poast, 12 oz/ac of Buctril, and 12 oz/ac of Goal were applied. To minimize residual effects for the following growing season, lay-by herbicides were not used . Sprayed Poast at 20 oz./ac on July 31 in strawed plots only. One hand weeding was necessary.

The onions were lifted and harvested at the end of September. Onions were stored until mid December then graded out from storage.

Results

Onion results and phosphate fertilizer effects on onion yield are not reported here (February 12, 1996). Onions in the plots without phosphate had root phosphate levels below 2000 ppm (Figure 3), but phosphate did not effect onion yields. Onion yields and grade were drastically increased by the use of furrow mulching from 370 cwt/ac for the untreated check to 703 cwt/ac for the furrow mulched plots (Table 2). PAM did improve onion grade, since jumbo onions increased from 161 cwt/ac in the check to 247 cwt/ac in the PAM treated plots.

The soil remained wetter when the water was treated with PAM or the furrows were mulched with straw (Figure 2). Both the check and the PAM plots occasionally became too dry.

Irrigation water treated with PAM significantly increased infiltration and reduced sediment loss . Seasonal total sediment loss averaged 60.1 t/ac from the check plots compared with 6.2 t/ac lost from the PAM plots and 5.3 t/ac lost from the furrow mulched plots (Figure 4). Season total water infiltration increased from 13.2 ac-in/ac in

the check plots to 28.9 ac-in/ac in the PAM plots and 40.2 ac-in/ac in the furrow mulched plots (Figure 5). PAM and straw mulching did not differ significantly in preventing sediment loss, but straw was significantly better than PAM at increasing infiltration (LSD (0.05)=6.30 ac-in/ac). Runoff was reduced by both PAM and furrow mulching, but there was significantly less runoff with a single furrow mulching at 563 lb of straw/ac than with twelve successive applications of PAM (LSD (0.05)=6.28 ac-in/ac).

The relative amounts of applied water, infiltration, and runoff are described in Figures 6 and 7.

Sediment losses from the untreated check treatment ranged from four to more than six tons per acre per irrigation, and were undiminished all season (Figure 8). Onion vegetation never grew to the extent to contribute to a reduction in erosion potential. As the soil became more stable with time, the progressive erosion narrowed the bottom of the irrigation furrow. Sediment losses from the PAM treated plots started very low, increased slightly mid-season, then declined. Later in the season various spots in the furrow irrigated with PAM treated water began to fill. Furrows treated with straw mulch had very low amounts of sediment loss early in the irrigation season and proportionally more past mid-season. The poorer late season erosion control compared with the early season may have been caused by decomposition of the straw, burial of straw, and the failure of the onions to provide cover to help reduce late season erosion. The water infiltration in the straw mulched furrows was also greater earlier in the season (Figure 9).

Conclusions

PAM and straw both cause a considerable reduction in sediment loss. While both also increase infiltration and reduce runoff, a single application of straw mulch increased infiltration and reduced runoff more than twelve repeated PAM applications in this trial. PAM was associated with an improvement in onion grade in this trial. Furrow mulching was associated with a large increase in total yield, a large improvement in onion grade, and an increase in cullage.

Literature Cited

"Comparative cost and effectiveness of polyacrylamide and straw mulch on sediment loss from furrow irrigated potatoes." Malheur Experiment Station, Oregon State University, Ontario, OR, Special Report 947, pp 128 - 137.

Thomas J. Trout, R. E. Sojka, R.D. Lentz. 1993. "Polyacrylamide effect on furrow erosion and infiltration," USDA Research Service

Table 1. Irrigation schedule for the B3 onion field. The field is a Nyssa silt loam with a 3 percent slope, 12 plots were treated with 563 lb/ac of straw mulch, 4 were irrigated with PAM treated water, and the remaining twelve were check plots. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

Furrow irrigation #	Date	Duration	Method
	April 22	8 hrs	Sprinkler
	May 26	12 hrs	Sprinkler
	June 3	4 hrs	Sprinkler
	June 5	8 hrs	Sprinkler
1	June 22	24 hrs	Furrow
2	June 29	24 hrs	Furrow
3	July 5	24 hrs	Furrow
4	July 12	24 hrs	Furrow
5	July 18	24 hrs	Furrow
6	July 24	24 hrs	Furrow
7	July 28	24 hrs	Furrow
8	August 2	24 hrs	Furrow
9	August 15	24 hrs	Furrow
10	August 8	24 hrs	Furrow
11	August 21	24 hrs	Furrow

Table 2. Response of onion yield and grade after storage to the repeated use of PAM or furrow mulching to reduce erosion in a field with three percent slope. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

	Rot	#2	Small	Medium	Jumbo	Colossal	Total	Total Jumbo
					3-4 "	> 4"		> 3"
	cwt/ac							
Check	8	0	45	155	162	0	370	162
Straw	73	17	14	69	492	38	703	530
PAM	13	3	37	94	247	0	394	247
LSD (0.05)	40	4	10	28	55	11	59	56

Figure 1. The location of the watermark soil moisture sensors in B3, the field is a Nyssa silt loam planted to onions. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

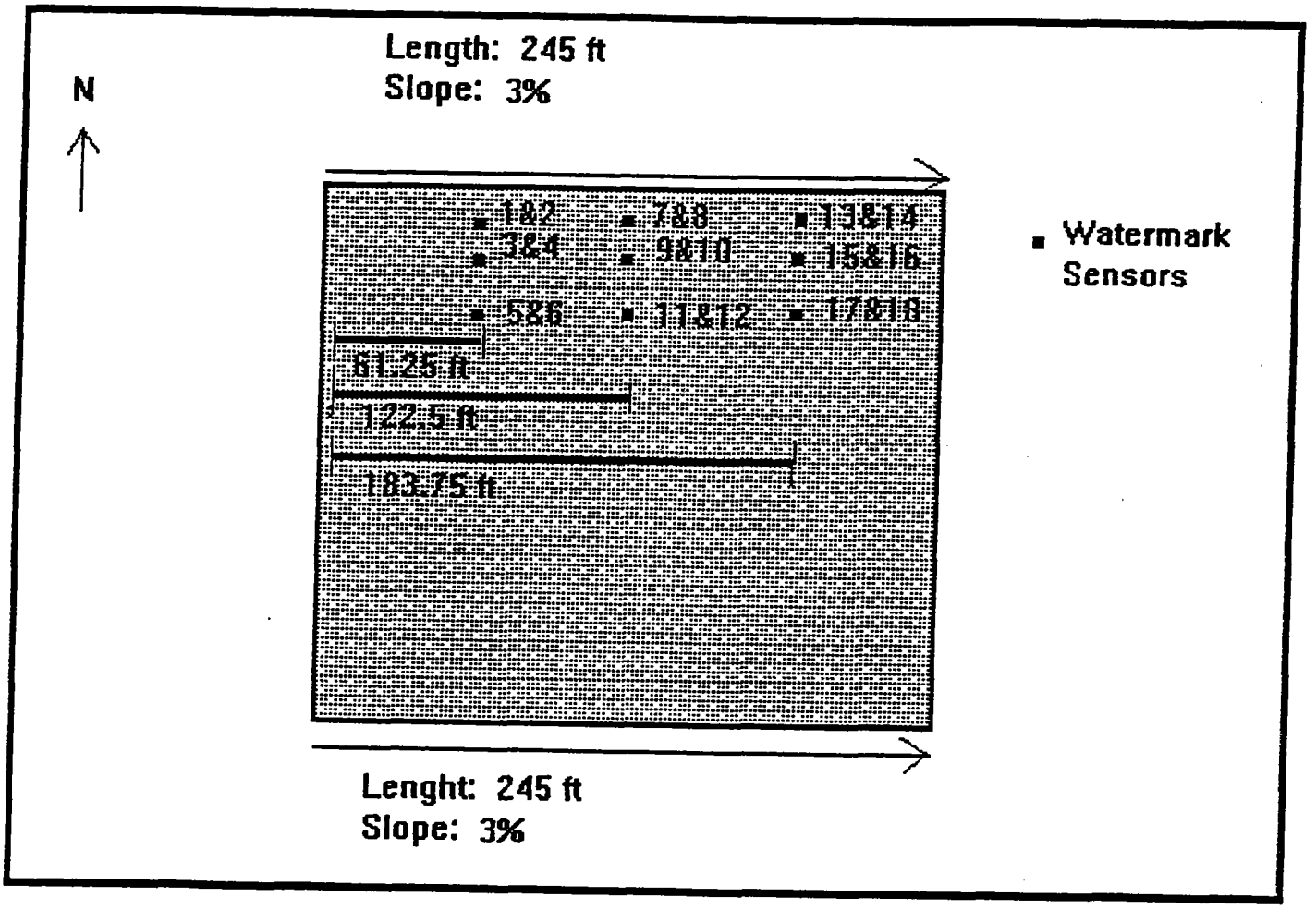

Figure 2. Soil water potential at 8-inch depth in onion hills. Furrow irrigated onions were treated with soil applied furrow mulching at a rate of 563 lb/ac, PAM treated irrigation water, or an untreated check. The field was a Nyssa silt loam with a 3 percent slope. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

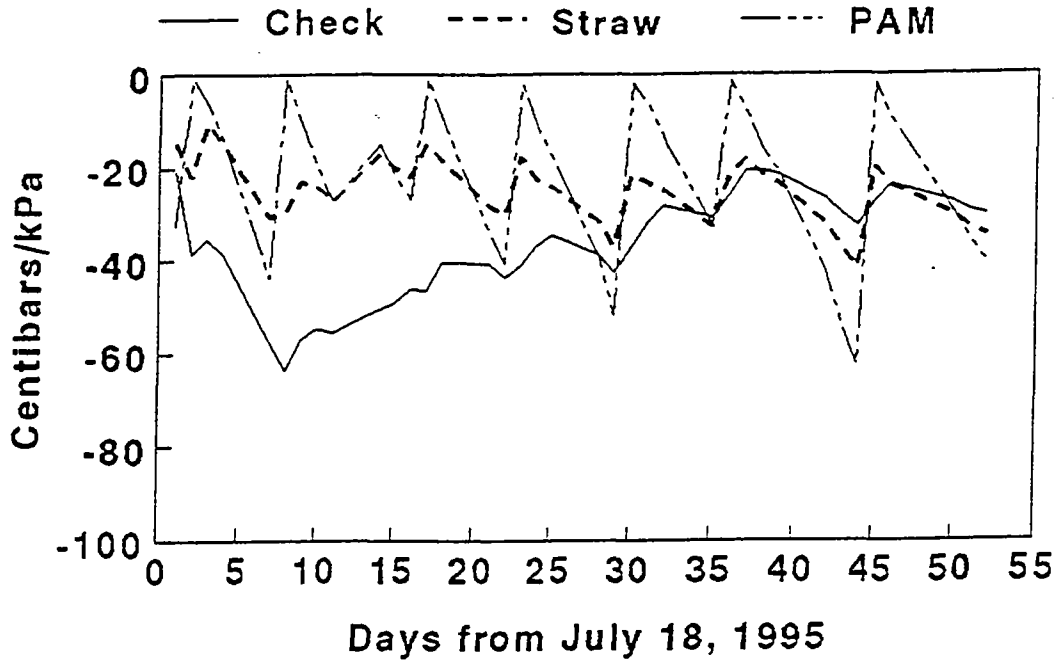

Figure 3. Onion root phosphate as a function of phosphate, furrow mulching at a rate of 563 lb/ac, and time. The field was a Nyssa silt loam with a 3 percent slope planted to onions. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

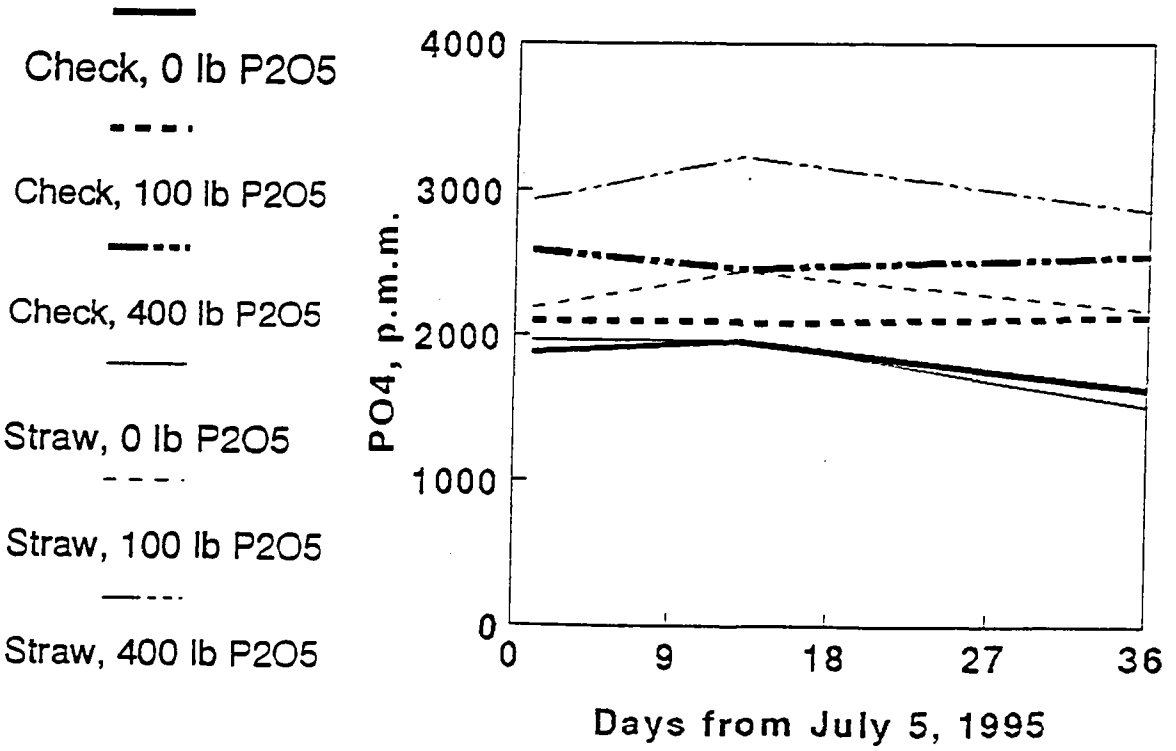

Figure 4. Season total average sediment loss in furrow irrigated onions over twelve irrigation of a Nyssa silt loam with a 3 percent slope in field B3, LSD (0.05) = 6.3 t/ac. The straw mulch was applied at a rate of 563 lb/ac, the PAM was applied during each irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

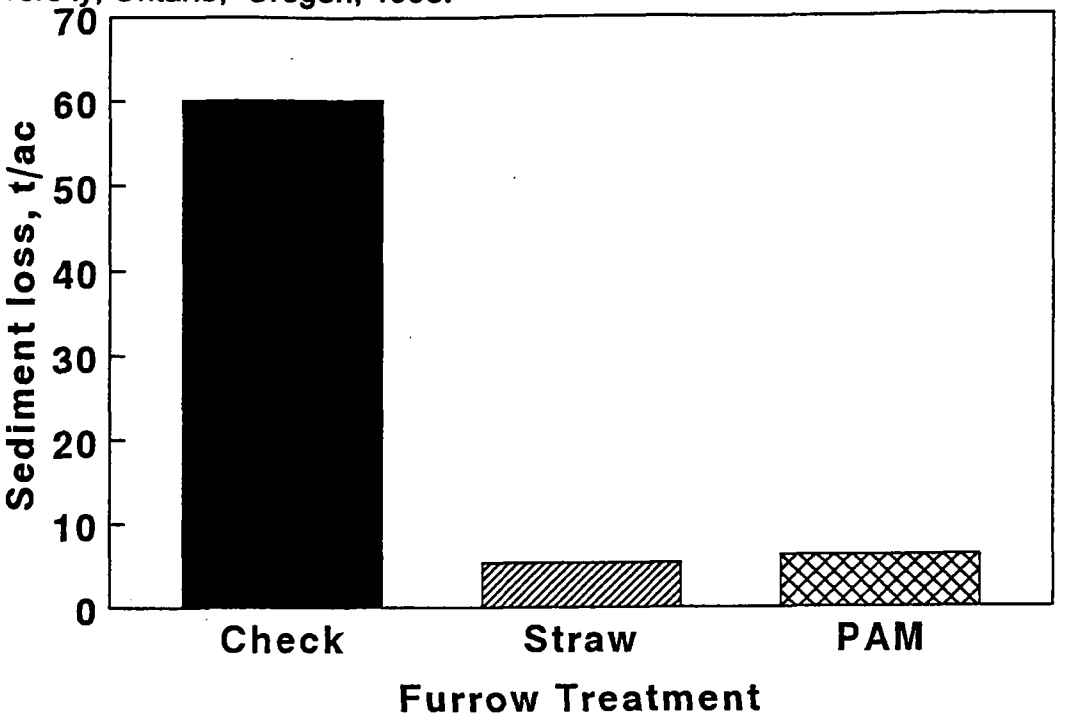

Figure 5. Seasonal total average infiltration of furrow irrigated onions over twelve irrigations of a Nyssa silt loam, with a 3 percent slope in B3, on 245 foot long runs, LSD (0.05) = 6 ac in/ac. Straw mulch was applied at a rate of 563 lb/ac, PAM was applied during each irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

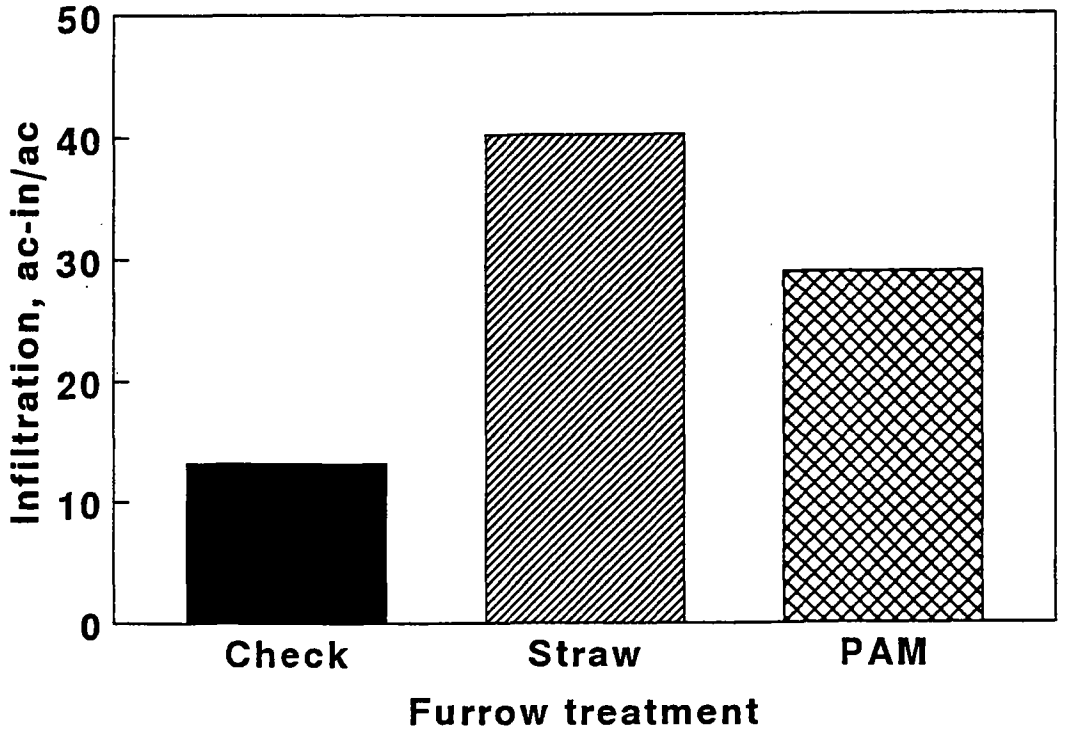

Figure 6. Season average effect of straw mulch, applied at a rate of 563 lb/ac, or PAM, applied during each irrigation, on infiltration and runoff on furrow irrigated onions during 12 irrigations of a Nyssa silt loam with a 3 percent slope, on 245 foot long runs, LSD (0.05) = 6 ac in/ac. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

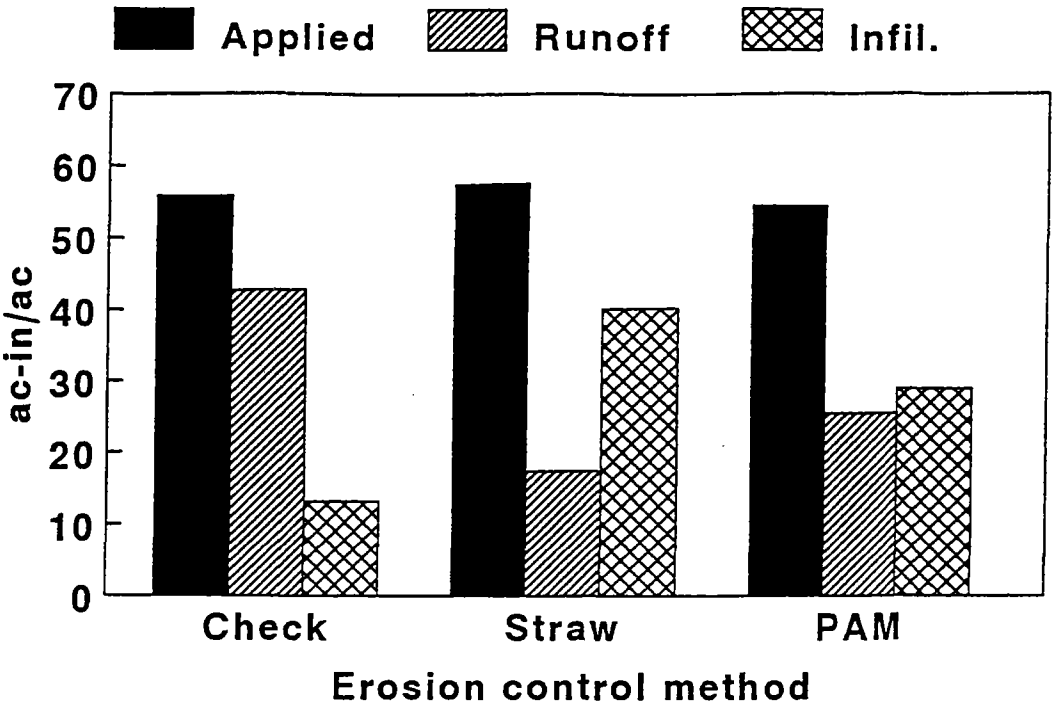

Figure 7. Season average effect of straw mulch or PAM on the percent infiltration and runoff in furrow irrigated onions during twelve irrigations of a Nyssa silt loam with a 3 percent slope. Straw was applied at a rate of 563 lb/ac, PAM was applied during each irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

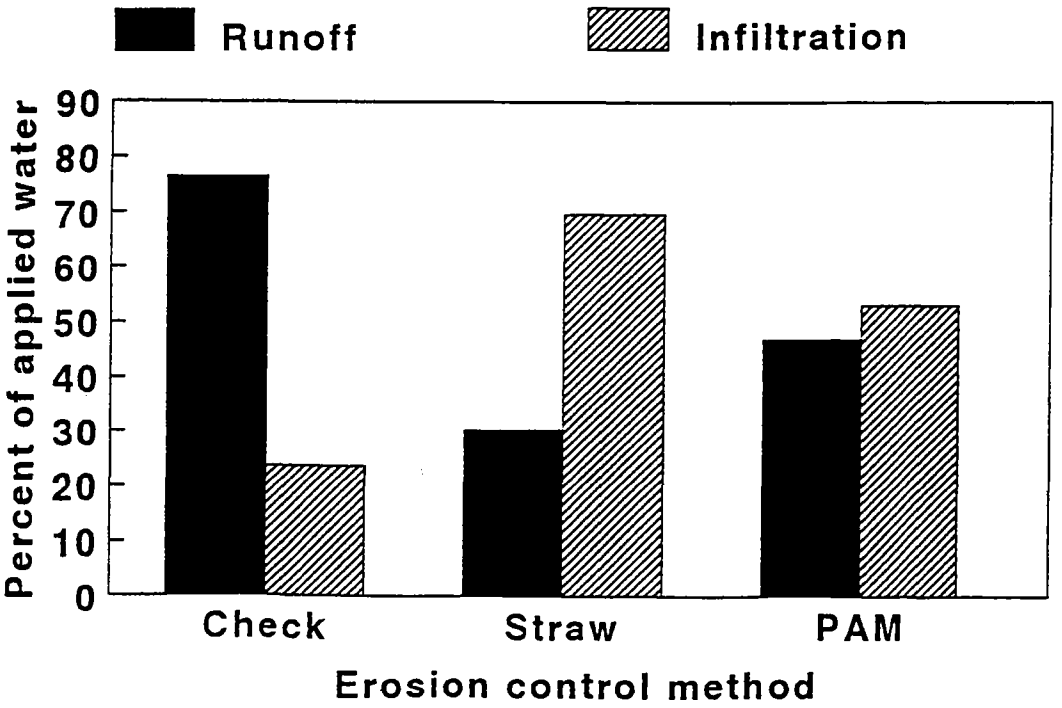

Figure 8. Average sediment loss during sequential furrow irrigations over a Nyssa silt loam with 3 percent slope. The field was planted to onions, 12 furrows were treated with 563 lb/ac straw mulch, 4 with PAM during each, and the remainder were left untreated. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.

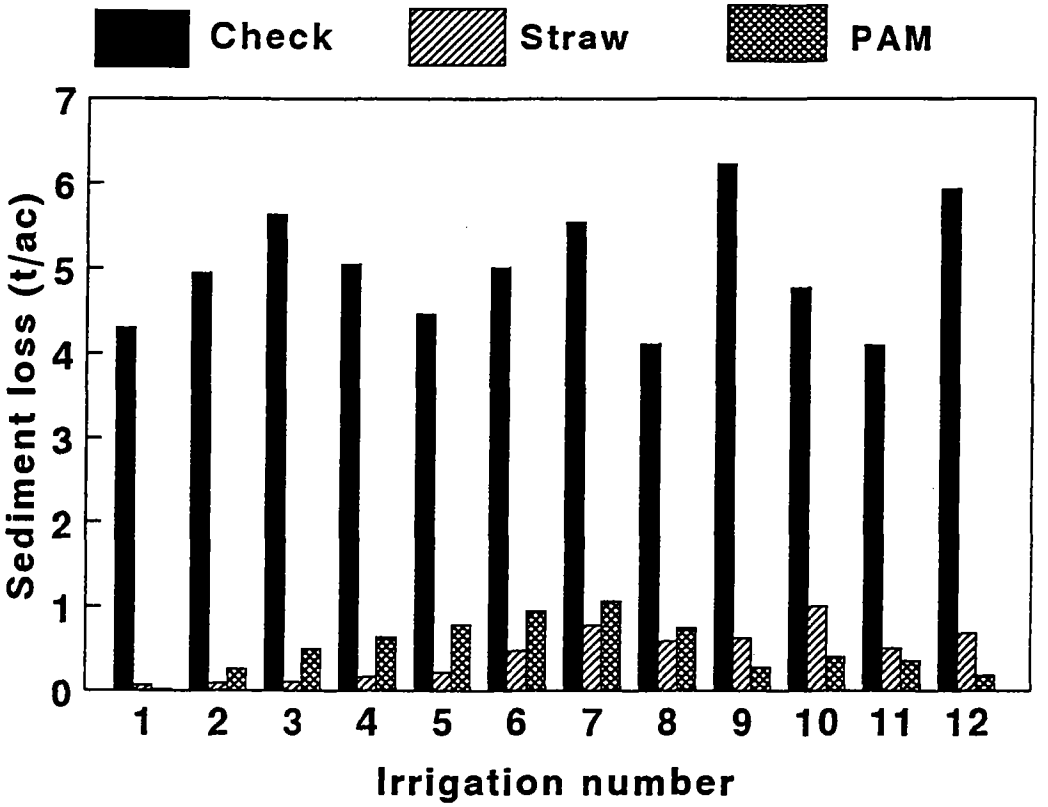

Figure 9. Average infiltration in onions grown in a Nyssa silt loam with a 3 percent slope. Straw was applied at a rate of 563 lb/ac, PAM was applied during each irrigation. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1995.