Demonstration of Polyacrylamide (PAM) to Reduce Erosion on Onions in the Arkansas River Valley of Colorado

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Soil loss due to erosion when furrow irrigating onions can be high in the Arkansas Valley of Colorado as onions are irrigated from 7 to 15 times during a growing season. These irrigations are usually applied at fairly high furrow flow rates to reduce the amounts of water applied as onions are considered shallow rooted. The root zone will average between 15 and 18 ins. when fully developed and excessive amounts of irrigation water will go beyond this depth and leach nutrients away from the crop as well as eroding the furrows.

Erosion can be extremely costly with onions as seen in studies in the Valley. Yields were reduced from 1277.8 (50 lb) sacks/ac on non-eroded areas in the middle of the field to 392.2 sacks/ac when eroded furrow cuts were 10 ins. at the top of the field and 996.7 sacks/ac at the lower end of the field where furrows were filled with the eroded soil (Table 1).

Erosion not only affected yields but also bulb size and, as a result, gross returns per acre. The area with deep cuts at the top of the field produced no Jumbo sized onions while Jumbos made up the greatest percentage of the yield in the middle area of the field with yields of Jumbos ranging up to 941.2 sacks/ac. Again, as with yield, sediment filled furrows at the lower end of the field lowered the Jumbos to 764.7 sacks/ac (Table 2). Erosion reduced gross return from $6,455.88/ac in the non-eroded middle part of the field to $1,724.67 on the eroded areas at the top of the field and $4,729.58 in the sediment filled lower end of the field. This erosion cost the producer a significant reduction in profits.

Table 1. Onion Production Demonstration
Yield and Gross Return per Acre
Patterson Hollow HUA, Otero County, 1995.

Replications*	Yield 50 lb. Sacks per Acre	Gross Return $/Acre**
1	392.2	1.724.67
2	415.0	1.866.83
3	915.0	4.213.23
4	1277.8	6.455.88
5	996.7	5.044.12
6	996.7	4.729.58
AVERAGE	832.2	4.005.72

*Replications from top to bottom of field
**Based on size, weights and prices on 9-15-95

Table 2. Onion Production Demonstration
Size, Value and Gross Return
Patterson Hollow HUA, Otero County, 1995.

Rep*	Jumbo-$5.25/sack**		Medium-$4.50/sack**		Pre-Pack-$4.25/sack**	
1	Sacks/Ac	$/Ac	Sacks/Ac	$/Ac	Sacks/Ac	$/Ac
2	0	0	232.0	1044.12	160.1	680.55
3	42.5	223.04	241.8	1088.24	130.7	555.55
4	192.8	1012.25	526.1	2367.65	196.1	833.33
5	941.2	4941.17	336.6	1514.71	0	0
6	764.7	4014.71	173.2	779.41	58.8	250.00
Ave.	375.8	1973.05	470.6	2117.65	150.3	638.89
	386.2	2027.37	330.1	1485.29	116.0	493.05

*Replications from top to bottom of field
**Based on Size, Weights and Prices on 9-15-95

In an effort to reduce soil erosion, a demonstration was started on the Walter Family Farm near Manzanola, Colo., in 1995 applying a soil stabilizing PolyAcrylaMide (PAM) in irrigation water diverted from the river to a field of onion. In previous studies by the USDA-ARS near Kimberly, Idaho, the use of PAM has reduced erosion up to 99% while increasing infiltration rates up to 50% (1).

The PAM was applied in the irrigation water on the silty clay loam soil at three dates through the growing season using two different methods. On the first two dates, PAM, a granular material, was dissolved in a tank of water and the solution was dribbled into the irrigation ditch water about 100 ft before being applied to the field through siphon tubes. On the third date, the PAM, as a dry granule, was dribbled from a dispenser into the irrigation ditch water at the same location. This second method removed the need for the large tank and similar results were obtained when comparing erosion losses to the first two applications.

On the first date, untreated irrigation water was applied on two alternate sets of 20 rows (30 in.) on a 1400 ftlong field with a 1% slope using 1.5-in. siphon tubes at the rate of 16.5 gal/min/row. The sets were complete in

12 h. The water from the PAM-treated tank was then dribbled into the irrigation ditch at the rate of 2.0 lb of material per ac and two different alternate sets of 20 rows were irrigated using 2.0-in. siphon tubes with a flow rate of 29.0 gal/min/row. The tank was emptied by the time the irrigation water had reached the end of the field. The set was completed in 7.5 h with similar lateral soak as compared to the untreated irrigation set. Water samples were taken at the end of each set and total dissolved solids (TDS), nitrate-nitrogen and sediment determinations were made.

Even with a 78% higher application rate which resulted in 0.5 ins.-per-ac more irrigation water being applied, runoff water loss was reduced 52% and the sediment loss was reduce 83% by the use of PAM. The untreated areas lost a total of 475 lbs-per-ac of sediment while the PAM-treated areas lost 80 pounds per acre (Table 3).

During the second application on July 11 and 12, 1.5-in. tubes were used on both the PAM-treated rows and the untreated rows. Again, two sets of 20 rows (30 in.) were used in each treatment and 16.5 gal/min was applied to each row in both the untreated and the PAM-treated areas. A total of 5.5 ins. per ac was applied to both areas but runoff from the PAM-treated areas was 0.57 ins. per ac or 29.6% less than the 0.81 ins. per ac from the untreated areas. Sediment loss from the PAM-treated areas was 270 lbs per ac or 29% less than the 379 pounds per acre lost from the untreated areas (Table 4).

The difference in the percent of reduction in sediment loss between the first and second dates may have been that the onions were cultivated prior to the first date but were not cultivated prior to the second application date. Due to cultivation, the water furrows were rough during the first application but were slick due to previous irrigation and rainfall during the second date of application.

On the third date, after the field had been cultivated, two sets of 20 rows (30 in.) were used in each treatment and 16.5 gal/min was applied to each row in both the untreated and PAM-treated areas. However, during this application, 24-h sets were used due to extremely dry and hot conditions and a total of 10.7 ins. per acre of irrigation water was applied. Even with these high amounts of water being applied, runoff losses were low. Runoff on the PAM-treated areas was 0.48 ins. or 44% less than the 0.85 ins. per acre of runoff on the untreated areas. As a result of this runoff, the PAM-treated areas lost 62 lbs per ac of sediment or 77% less than the 275 lbs per acre lost on the untreated areas (Table 5).

On this date, different from the first two dates, the granular PAM was dribbled into the irrigation ditch from a dry applicator. The dry PAM was applied at the rate of 2 lb of material per ac, a similar rate to the other two applications. The method of sampling was similar in each of the application periods taking the sample at the end of the set.

Results of these three dates of application and the overall results from sampling of all irrigations but the first one in March indicate the effectiveness of PAM in reducing the amount of sediment loss (Table 6). Overall sediment loss was reduced by 58.5 % which indicate there was some carryover effect of the PAM beyond the irrigation date when it was applied (Table 7). These results show that irrigation runoff was reduced on the PAM-treated areas.

Table 3. Irrigation, Runoff and Sediment Amounts On Onions
PAM vs. CHECK
Patterson Hollow Water Quality Project
Walter Family Farm, June 15/16, 1995

Treatment	Irrigation				Runoff		% LESS Than CHECK
	Set Time	GPM per Row	Inches per Acre	Sediment Pounds per Acre	Inches per Acre	Sediment Pounds per Acre	
PAM	7.5	29.0	6.0	1254	0.43	80	83
CHECK	12.0	16.5	5.5	1359	0.89	477	

Table 4. Irrigation, Runoff and Sediment Amounts
PAM vs. CHECK
Patterson Hollow Water Quality Project
Walter Family Farm, July 11/12, 1995

Treatment	Irrigation				Runoff		% LESS Than CHECK
	Set Time	GPM per Row	Inches per Acre	Sediment Pounds per Acre	Inches per Acre	Sediment Pounds per Acre	
PAM	12.0	16.5	5.5	640	0.57	270	29
CHECK	12.0	16.5	5.5	617	0.81	379	

Table 5. Irrigation, Runoff and Sediment Amounts on Onions
PAM vs. CHECK
Patterson Hollow Water Quality Project
Walter Family Farm, July 31-August 2, 1995

Treatment	Irrigation				Runoff		% LESS Than CHECK
	Set Time	GPM per Row	Inches per Acre	Sediment Pounds per Acre	Inches per Acre	Sediment Pounds per Acre	
PAM	24.0	16.5	10.7	1203	0.48	62	77
CHECK	24.0	16.5	10.7	1235	0.85	275	

Similar onion yields of 628 and 611 sacks/ac were produced on the untreated and PAM-treated areas, respectively (Table 8). Excessive stands of bindweed during the late season may have affected yields, bulb size and returns as these yields were significantly lower than other fields in the area that did not have these excessive stands of bindweeds.

Literature Cited

1. Sojka, R.E., and Lentz, R.D., 1994. Polyacrylamide (PAM). A New Weapon in the Fight Against Irrigation-induced Erosion. USDA-ARS Northwest Irrigation & Soils Research Lab Station Note #01-94 (Revised).

Table 7. Total Irrigation and Runoff Water, Total Dissolved Solids, Nitrate-Nitrogen and Sediment on Check and PAM Treated Water with Onions
Patterson Hollow Water Quality Project
Walter Family Farm, 1995

TREATMENT	Irrigation Amounts* Inches/Acre	Total Dissolved Solids* Pounds/Acre	Nitrate-Nitrogen* Pounds/Acre	Sediment* Pounds/Acre
PAM	33.2	4863	7.1	7027
% Less Than Check	-1.5	3.6	13.4	-4.3
CHECK	32.7	5043	8.2	6724
	Runoff Inches/Acre			
PAM	2.49	346	0.59	676
% Less Than Check	32.7	39.5	22.4	58.5
CHECK	3.70	572	0.76	1629

*Does not include first irrigation

Table 8. Yield, Irrigation Amounts and Efficiency on Onions
PAM vs. Check
Patterson Hollow Water Quality Project
Walter Family Farm, 1995

Treatment	Yield 50 Lb. Sack/Acre	Irrigation Amount Inches/Acre	Irrigation Efficiency Sacks/Inch-Water
PAM	611	38.7	15.8
Check	628	38.2	16.4

No significant difference in yield at 5%

Table 6. Irrigation and Runoff Amounts, Total Dissolved Solids, Nitrate-Nitrogen and Sediment for Irrigation Season
PAM vs. CHECK
Patterson Hollow Water Quality Project
Walter Family Farm, 1995

Date	Treatment	Irrigation Amounts Inches/Acre	Total Dissolved Solids (TDS) Pounds/Acre	Nitrate-Nitrogen Pounds/Acre	Sediment Pounds/Acre
June 15	INFLOW				
	PAM	6.0	811	2.0	1299
	CHECK	5.5	755	1.2	1359
	RUNOFF				
	PAM	0.43	61	0.14	80
	CHECK	0.89	125	0.24	477
June 29	INFLOW				
	PAM	5.5	1479	1.2	1108
	CHECK	5.5	1439	0.7	1024
	RUNOFF				
	PAM	0.31	84	0.1	58
	CHECK	0.34	92	0.1	120

Date	Treatment	Irrigation Amounts Inches/Acre	TDS Pounds/Acre	Nitrate-Nitrogen Pounds/Acre	Sediment Pounds/Acre
July 11	INFLOW				
	PAM	5.5	616	1.2	1024
	CHECK	5.5	640	1.0	1086
	RUNOFF				
	PAM	0.57	64	0.1	270
	CHECK	0.81	94	0.2	379
July 22	INFLOW				
	PAM	5.5	687	0.9	1442
	CHECK	5.5	809	2.2	1274
	RUNOFF				
	PAM	0.70	83	0.1	208
	CHECK	0.81	100	0.2	379
July 31	INFLOW				
	PAM	10.7	1203	1.7	2155
	CHECK	10.7	1235	1.7	1981
	RUNOFF				
	PAM	0.48	54	0.1	62
	CHECK	0.85	161	0.1	275
TOTAL	INFLOW				
	PAM	33.2	4798	7.1	7027
	CHECK	32.7	4878	6.9	6724
	RUNOFF				
	PAM	2.49	346	0.6	676
	CHECK	3.70	572	0.8	1629

Table 6. Continued