KENTUCKY

Conservation Tillage and Filter Strips Trap Potential Water Contaminants

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The question of potential contamination of rivers, streams and other natural water bodies with sediment, nutrients and pesticides in agricultural runoff is an important water quality issue. Conservation tillage is effective in decreasing soil exposure to rainfall, thus decreasing runoff and sediment. Vegetative filters slow runoff, thus allowing sediment, nutrients and pesticides to deposit. Combining the advantages of both should lead to maximum contaminant removal.

Recent research shows that conservation tillage and vegetative filter strips are highly effective in reducing sediment, nutrient and pesticide losses in runoff.

Kentucky Studies

Two studies were conducted on land with 9 percent slope to evaluate the movement of sediment, nutrients and pesticides from cropland and trapping by vegetative filters under simulated rainfall conditions. In the first study, 150 lb/A nitrogen (N) as ammonium nitrate, 92 lb/A P_2O_5, and 2 lb a.i. atrazine/A were broadcast 24 hours before a rainfall simulator applied 2.5 in/hour for 2 hours total (1 hour rain, 24 hours rest, 30 min. rain, 30 min. rest, and 30 min. rain). Tillage treatments were no-till (NT), chisel plow (CP), and conventional tillage (CT). In the second study, trapping efficiency of a fescue-bluegrass mixture was evaluated with three filter lengths (15, 30 and 45 feet) below either no-till or conventional tillage areas receiving 150 lb N/A as ammonium nitrate and 2 lb a.i. atrazine/A 24 hours before 2.5 inches of simulated rain, then three weeks rest, and 2.5 inches more rain.

In the first study, runoff volume, sediment, nitrate-nitrogen (NO_3-N), ammonium-nitrogen (NH_4-N), phosphorus (P) and atrazine were reduced with decreased tillage intensity (**Table 1**). The NT had no runoff and no sediment during the first rain event (R1). During the second rain event (R2) the NT had some runoff but still no sediment. Compared with CT, the NT reduced sediment by 98 percent, and the CP reduced it by 79 percent.

Lower runoff volumes with decreased tillage intensity reduced the losses of NO_3-N, NH_4-N, P and atrazine. The NT system reduced NO_3-N losses by 86 percent and 71 percent compared with CT and CP, respectively. More modest reductions in NH_4-N loss were evident for NT compared to CT (58 percent) and CP (38 percent). Total N loss, related to that applied, ranged from 0.6 percent for NT to about 2.9 percent for CT.

Total P loss was greatest from CT even though P concentration in the runoff was higher from the NT system, clearly indicating that the greater P loss from CT was due to the higher runoff volume. The total P loss for CT was 75 percent and 125 percent greater than CP and NT, respectively. The N and P losses expressed as a percentage of the total N and P fertilizer applied could have come from: (1) N and P loosely bound to the sediment that was

TABLE 1. Runoff volume and losses of sediment, nitrate-nitrogen, ammonium-nitrogen, P and atrazine as affected by tillage and simulated rainfall.

Tillage system	Rainfall event			
	R1	R2	R3	Total
	runoff volume, inches			
NT	—	0.05	0.25	0.30a
CP	0.12	0.32	0.70	1.14b
CT	0.37	0.60	0.80	1.77b
	sediment loss, tons/A			
NT	—	0.00	0.13	0.13a
CP	0.22	0.62	0.67	1.51b
CT	1.47	2.27	3.17	6.91c
	nitrate-nitrogen loss, lb N/A			
NT	—	0.09	0.36	0.45a
CP	0.27	0.45	0.80	1.52b
CT	0.98	1.07	1.16	3.21c
	ammonium-nitrogen loss, lb N/A			
NT	—	0.09	0.36	0.45A
CP	0.27	0.18	0.27	0.72B
CT	0.45	0.36	0.27	1.08C
	P loss, lb/A			
NT	—	<.01	0.27	0.28a
CP	0.09	0.09	0.18	0.36ab
CT	0.27	0.18	0.18	0.63b
	atrazine loss, g/A			
NT	—	1.40	5.40	6.8a
CP	4.2	3.10	4.70	12.0ab
CT	10.9	2.60	3.10	16.6b

Totals followed by small letters are significantly different at P<.05; totals followed by capital letters are significantly different at P<.10.

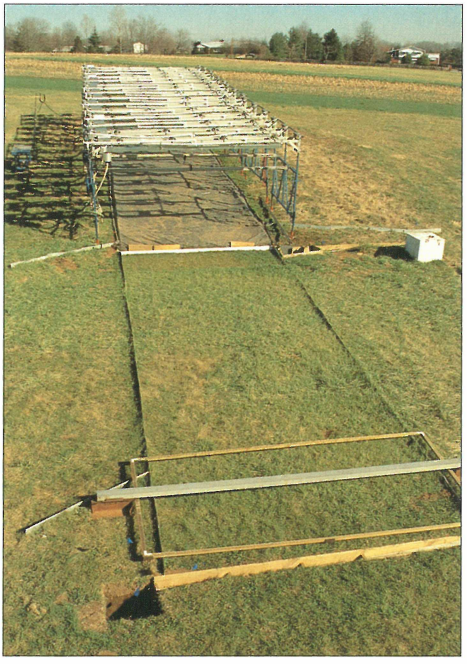
lost, but that was readily exchanged, (2) N and P loosely associated with organic matter or exchanged from organic matter, and/or (3) N and P from the applied fertilizer. So the actual percentage loss from the fertilizer applied may have been slightly less than the numbers shown when one considers the other sources of soluble ammonium, nitrate, and P loss in the system.

The total soluble NH_4-N and NO_3-N loss in the CT treatment was 2.9 percent of the total N applied as ammonium nitrate. This loss was nearly two-fold greater than in the CP treatment and nearly five-fold greater than in the NT treatment. The actual soluble P loss (as phosphate) was 1.6 percent of the total P applied with the fertilizer in the CT, 0.9 percent in the CP, and 0.7 percent in the no-till treatment. The higher total atrazine loss from CT was related to the higher runoff volume. The NT system reduced atrazine losses by 43 percent compared with CP, and 60 percent compared with CT.

In the second study, the vegetative filter strips were very effective in trapping sediment, water, NO_3-N and atrazine that left either NT or CT areas above the filters when channelization in the filters was not present (**Table 2**). All efficiencies were above 90 percent for the four parameters, indicating a high trapping capacity for all lengths. The 30 foot filters were slightly more effective with time than the 15 foot

length, which was attributed to the greater length and area. The development of rivulets in the 45 foot filters directed runoff into a few prominent small channels which had the most noticeable effect on water trapping. Overall, the 30 foot filters had the greatest trapping efficiency for water and all contaminants. However, it appeared that the most effective combination of tillage and filter was NT with the 45 foot filter (data not shown).

The small reductions or no change in trapping of contaminants, compared to a larger change in water trapped, suggested that the contaminants were filtered out more effectively than water. Even though NO_3-N fertilizer and pesticides were broadcast just before simulated rainfall, very little of these components left the filters regardless of length, and particularly when grass height was maintained at 2 inches. On-farm vegetative filters are more likely to be maintained at greater heights with longer time intervals between clipping.



RESEARCH with a rainfall simulator has found significant benefits from use of vegetative filter strips to reduce runoff of potential water contaminants from crop fields.

Summary

In conclusion, these studies indicate that as tillage intensity decreased (CT>CP>NT), the losses of runoff water, sediment, NO_3-N, NH_4-N, P and atrazine were significantly decreased. The 30 foot filters were more consistent than 15 foot filters in reducing water volume, sediment, NO_3-N and atrazine.

As crop producers embrace no-till systems these data suggest that contaminants in runoff water will be significantly reduced compared to more conventional tillage systems. Vegetative filters can be highly useful in removing additional contaminants from cropland using any type of tillage system but should provide the cleanest runoff when combined with no-till.

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TABLE 2. Mean trapping efficiency of vegetative filters for four components lost from cropped plots (mean of NT and CT).

Filter width	Sediment	Water	Nitrate-nitrogen	Atrazine
	% trapped			
15 ft	96	96	94	93
30 ft	99	97	98	99
45 ft	99	91	97	98