Effect of Cover Crops and Nitrogen Application Timing on Nutrient Loading through Subsurface Drainage

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The contribution of nitrate from tile drained agricultural fields of the Upper Mississippi River Basin to the hypoxic zone of the Gulf of Mexico continues to be an environmental issue for U.S. water quality. Nitrate leaching from artificially drained agricultural fields in the Upper Mississippi River Basin accounts for approximately 65% of nitrogen delivered annually to the Gulf of Mexico and studies have concluded that future research must focus on alternative nitrogen management practices that interact with soil nitrate in-field before it reaches the subsurface tile (Mcconnaughey, 2013). The addition of cover crops has been shown to be an effective in-field solution to nitrate leaching when nitrogen (N) was spring-applied (Williams and Weil, 2004; Kaspar et al., 2007). However, there is no data that demonstrates the potential of cover crops as a solution to reduce losses following fall-applied N in the Midwestern Corn Belt. Therefore, we evaluated fall application of N into a standing cover crop mixture of cereal rye and tillage radish as an adaptive management strategy.

The objectives of this study were to investigate the impact of nitrogen fertilizer application timing and cover crops on the distribution of soil inorganic N, plant N uptake, and the load of nitrate-nitrogen (NO_3-N) in subsurface drainage leachate. This experiment was conducted at the Illinois State University Nitrogen Management and Tile Drainage Research Site, in Lexington, IL. The experimental treatments included a zero control (no N fertilizer and no cover crops), fall-dominated (70% fall, 30% spring) N application with and without cover crops, and a spring-dominated (20% fall, 80% spring) N application with and without cover crops. A total rate of 225 kg N ha^{-1} was applied to all treatments, except the zero control. Spring cover crop sampling revealed an average biomass production of 1107 kg ha^{-1} and an average total N uptake of 53.5 kg N ha^{-1}.

Figure 1. Fall application of anhydrous ammonia into a living stand of cover crops (A); established cover crop stand of cereal rye and Daikon radish mixture in mid-November 2015 (B).

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Preliminary results following the first season of cover crop integration indicate that winter cover crops have the potential to reduce nitrate leaching and stabilize a greater concentration of soil NO_3-N in the agronomic and environmental depths of soil (0-80 cm), relative to the non-cover crop treatments. Data from the analysis of tile leachate for NO_3-N (kg ha^{-1}) indicated that moving the nitrogen application from the fall to the spring resulted in a 15% reduction in nitrate loss, adding cover crops to spring applied nitrogen resulted in a 22% reduction in nitrate loss, adding cover crops to fall applied nitrogen resulted in a 35% reduction in nitrate loss, and there was no difference in nitrate loss through the tile for spring and fall applications of nitrogen with the addition of cover crops. However, the average flow-weighted NO_3-N (mg/L) concentrations indicated that fall (6.1) > fall CC (5.3) > spring (4.4) > spring CC (3.7). First year treatment results of this study indicated that cover crops impacted the distribution of soil inorganic N and the loading of nitrate to the tile despite the N application timing.

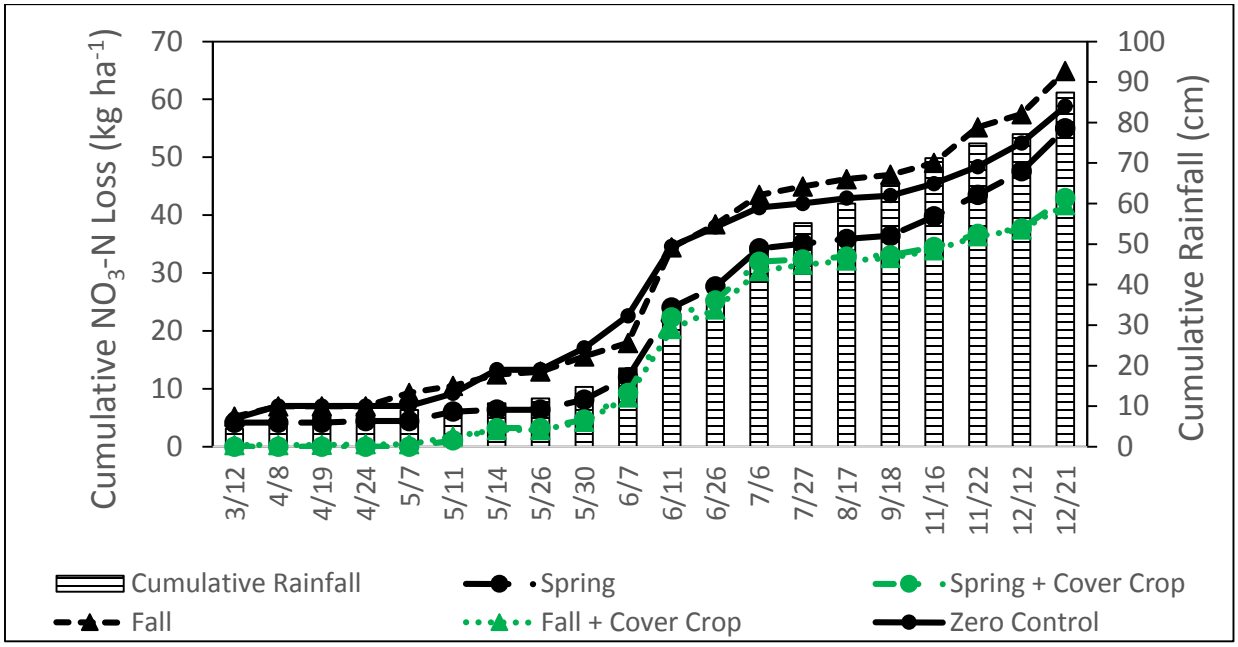

Figure 2. Cumulative nitrate nitrogen loss through tile drainage, and cumulative rainfall for fall- and spring-applied nitrogen treatments with and without cover crops and the zero control treatment that received no nitrogen application or cover crops.

References

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