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Abstract

In the Midwestern United States, agriculture is a source of income and a way of life for many people as well as a globally valuable resource, so finding a way to maintain agricultural production while addressing growing water quality issues has become a growing concern. Winter cover crops can decrease nutrient leaching and provide other benefits to water and soil quality, but the associated costs and uncertainties can deter farmers and investors from adopting this practice. Crop intensification, or double cropping, can provide similar benefits to a winter cover crop while providing a second source of income, though the impacts of fertilization for maximum yields are not well understood. A plot scale study was established at Southern Illinois University Carbondale's Agronomy Center to evaluate the effects of high, medium, and low fertilizer treatments in corn-soybean rotations that include winter wheat as a double crop, cereal rye as a cover crop, and no winter ground cover. Preliminary results indicate increased nitrate leaching due to fertilizer treatments in winter wheat compared to no fertilizer controls with no winter ground cover and cereal rye cover.

Experimental Design

Complete randomized design (CRD) with two winter crop rotations and four fertilizer inputs (none, low, medium, and high)

- 1: Corn-no cover crop-soybeans-no cover crop (C-N-S-N, control)
- 2: Corn-cereal rye cover crop-soybeans-cereal rye cover crop (C-R-S-R, maximum nitrate-N reduction control)
- 3: Corn-wheat-soybeans-no cover crop, medium (C-Wm-S-N)
- 4: Corn-wheat-soybeans-no cover crop, low (C-Wl-S-N)
- 5: Corn-wheat-soybeans-no cover crop, high (C-Wh-S-N)
- 6: Corn-wheat-soybeans-cereal rye cover crop, medium (C-Wm-S-R)
- 7: Corn-wheat-soybeans-rye cereal cover crop, low (C-Wl-S-R)
- 8: Corn-wheat-soybeans-rye cereal cover crop, high (C-Wh-S-R)

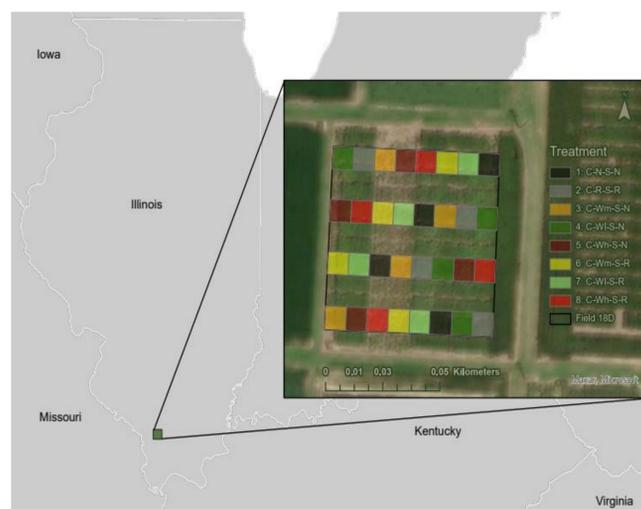
Fertilizer treatments:

- Low: 150 lbs of DAP and 40 lbs/acre of UAN at tillering, 40 lbs of N/acre of UAN at jointing
- Medium: 150 lbs of DAP and 70 lbs/acre of UAN at tillering, 70 lbs of N/acre of UAN at jointing
- High: 150 lbs of DAP in fall, 70lbs/acre of UAN at tillering, 70 lbs of N/acre of UAN at jointing

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021/ 2023	None				Corn				None			
2022/ 2024	None				Soybeans				None			
2021/ 2023	Cereal Rye				Corn				Cereal Rye			
2022/ 2024	Cereal Rye				Soybean				Cereal Rye			
2021/ 2023	None				Corn				Wheat			
2022/ 2024	Wheat				Soybeans				None			
2021/ 2023	Cereal Rye				Corn				Wheat			
2022/ 2024	Wheat				Soybeans				Cereal Rye			

Objectives

- Compare nitrate-N leaching in corn-soybean rotations with winter wheat (double cropping scenario) and cereal rye (best nutrient reduction scenario) as winter cover.
- Determine effects of different N treatments for winter wheat on nutrient losses.



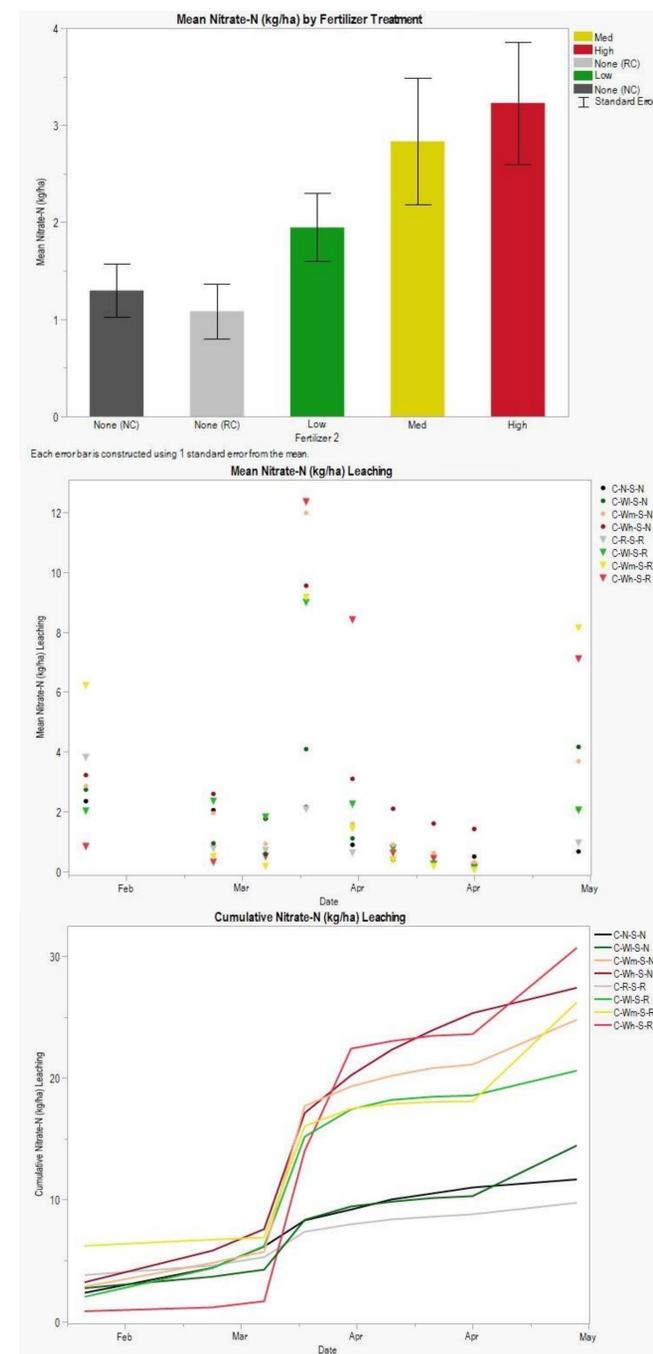
Methodology

Pan lysimeters were installed below the A horizon (18-35 cm depth). Collection area is 860 cm² (0.086 m²) with a 27.97 L reservoir. Soil water was collected after rainfall events exceeding 12 mm and total water volume was recorded. Samples were filtered using 45 µm filters and analyzed for nitrate using ion chromatograph. Loading rates were calculated using concentration and water volume.



Preliminary Results

- Nitrate-N leaching averaged across fertilizer treatment levels for all winter wheat plots showed higher levels of leaching in medium and high fertilizer treatment levels.
- Mean nitrate-N leaching by rotation and treatment levels over the winter cover season in 2022 showed expected spikes with the first samples following snow melt and following tillage (3/16) and jointing (5/3) fertilizer applications.
- Trends in mean nitrate-N leaching showed consistently lower levels in control treatments and less extreme spikes overall in low fertilizer levels.
- Cumulative nitrate-N leaching showed generally lower loads with more gradual increases in control treatments while treatments with fertilizer inputs showed higher loads with more extreme spikes.



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Discussion

- Higher levels of nitrate-N leaching were observed in rotations that included fertilizer inputs.
- High and medium fertilizer often had higher mean and cumulative nitrate-N loads with more extreme fluctuations throughout the sampling period.
- Low fertilizer levels were intermediate between controls and higher fertilizer treatments or followed trends of both depending on the crop rotation.
- Higher fertilizer treatments will likely lead to higher nitrate-N leaching compared to cereal rye cover crops or no ground cover with no fertilizer inputs, but lower levels of fertilization may show leaching rates that are not significantly different than controls.