DOES DIVERSIFICATIONS REDUCE FALL NITRATES: Data from WICST

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INTRODUCTION

Fall soil nitrate-N levels are an indirect measure of the synchrony between nitrogen availability during the growing season and crop nitrogen uptake in agricultural fields. Also, between late fall and the following spring these nitrates can leach below the rooting zone and be lost to the agricultural system. As a result, fall monitoring of soil nitrates is one measure of potential environmental impact of alternative production systems. For this reason we monitored nitrate-N on all 14 phases of the six cropping systems in the Wisconsin Integrated Cropping Systems Trials (WICST) at two locations in southern Wisconsin.

MATERIALS AND METHODS

In 1990, the trial was initiated at Arlington and Elkhorn, Wisconsin on silt loam soils developed under prairie vegetation. The trial compares three cash-grain systems and three forage based systems. Plots are 0.7 acres in size, all phases are present every year and each system is replicated four times at both locations. In late October/early November, we sampled the plots for fall nitrates. Each sample consisted of six cores that were taken as 3-paired samples across the plot and bulked at 0-12 inches, 13 to 24 inches and 25-36 in depths. Initially (1990-1996) sampling was done by hand with a 1-in. diameter probe and subsequently (1997-2003) with a truck mounted 1.25-in. diameter hydraulic probe. Each year samples were taken from adjacent land to serve as non-agricultural, background checks.

All phases of the six systems were up and running by 1993, and until 1998, the treatments were equivalent at both sites. Shortly thereafter the Elkhorn site was terminated and the trial continues at the Arlington site. Nitrate-N was extracted from the top 3 feet of soil using a 2M KCl extractant and analyzed with a Lachet Flow Injection Analyzer. The SAS ProcMix model was used for this analysis, where year and block where considered random variables.

RESULTS

When averaged over rotation phases, the ranking of the systems fall soil nitrate-N levels were nearly the same at both locations. Continuous corn (CS1) had the highest levels at both sites, and the rotationally grazed paddocks (CS6) had the lowest levels at Arlington, while the chemical free grain system (CS3) was lowest at Elkhorn (**Fig. 1 and 2**). Somewhat surprisingly, the no-till corn soybean system (CS2) operated under Best Management Practices was very similar in fall nitrates to the two dairy rotations amended with manure (CS4 and CS5). The chemical free grain system (CS3) and the rotational grazing (CS6) were among the lowest at both sites and not significantly different from each other. All six cropping systems left nitrate-N levels that were significantly above the standard background level in Wisconsin of 50 lbs nitrate-N/3 feet (Bundy, 1994).

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Fig. 1. Cropping Systems Fall Nitrates

Mean and 90% Confidence Intervals
Arlington (1993-2003)

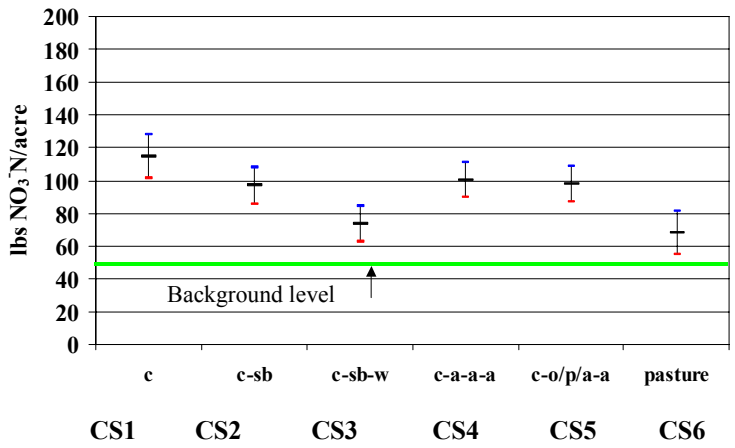
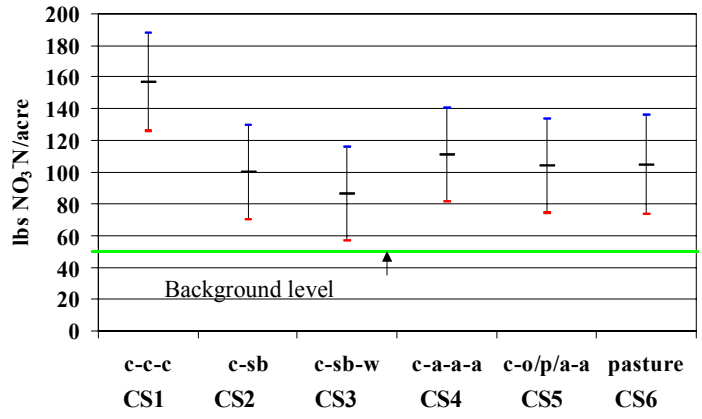


Fig. 2. Cropping Systems Fall Nitrates

Mean and 90% Confidence Intervals
Elkhorn (1993-1996)



Corn was the "hot" phase in the dairy rotations due to the combination of legume credits plus manure **(Fig. 3 and 4)**. In the grain rotations, continuous corn had the highest nitrate-N levels, but the corn and soybean phases of systems CS2 and CS3 were nearly equivalent. The wheat/red clover phase in the chemical free system (CS3) had the lowest mean nitrate-N levels at both sites and it was the only phase that was not significantly different from the background level at both sites. This was probably due to the production of wheat with only soil organic matter mineralization and soybean legume credits and then the vigorous growth of red clover that was only undercut, not incorporated in the late fall. In this system wheat yields averaged 54 bu/a and corn yields were 146 bu/a. (WICST Technical Report, 2003).

Fig. 3. Crop Phase Fall Nitrates
Mean and 90% Confidence Intervals
Arlington (1993-2003)

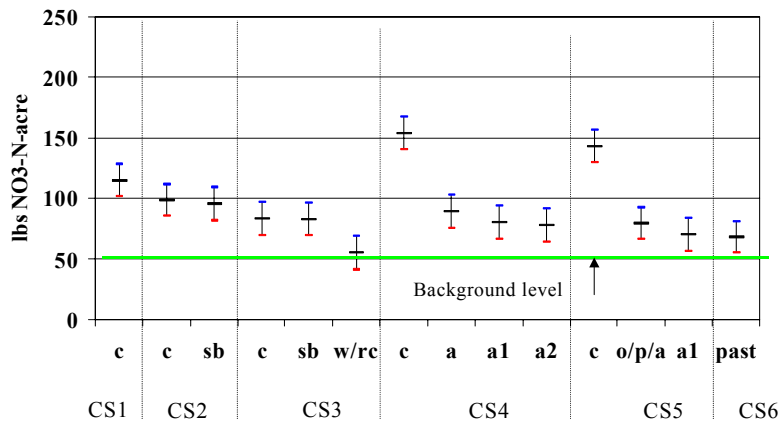
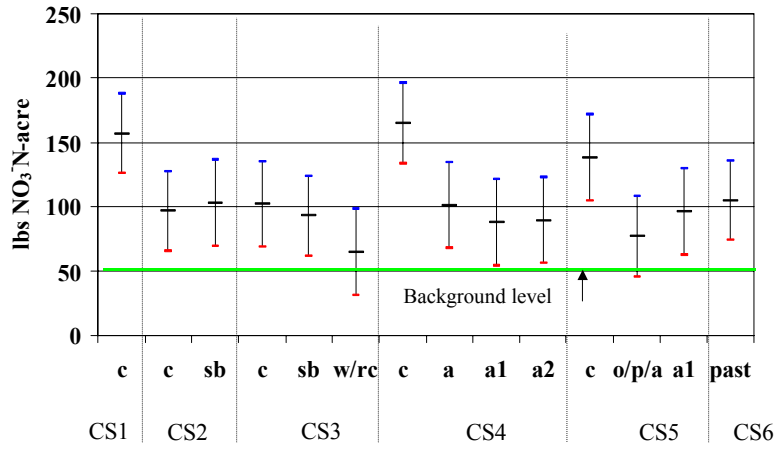


Fig. 4. Crop Phase Fall Nitrates
Mean and 90% Confidence Intervals
Elkhorn (1993-1996)



CONCLUSIONS

This work suggests that all the agricultural systems studied did have significantly higher levels of fall nitrates than the background level of 50 lbs nitrate-N/3 feet. Also, both the forage based and grain based systems resulted, on average, in equally high levels of fall nitrate-N. The most benign systems were the chemical free grain (CS3) and rotational grazing forage (CS6) systems. The highest fall soil nitrate-N levels were associated with corn production especially when corn received both legume-N and manure-N. With both the grain and forage systems, the lowest fall nitrate-N levels were associated with the most diversified cropping systems.

CITATIONS

Bundy, L. 1994. Soil nitrate test for Wisconsin cropping systems. UW Extension Bulletin A3624. University of Wisconsin Madison, WI.

WICST 9th Technical Report. 2003. Wisconsin Integrated Cropping Systems Trial Ninth Technical Report 2001, 2002 Agronomy Department mimeo University of Wisconsin Madison, WI.