The Effect of Topography and Rye Cover Crop on Soil Nitrate Dynamics in a Corn-Soybean Rotation

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Introduction

Excess nitrate present in the soil either during or after the growing season poses the risk of nitrate entering waterways either via runoff or deep percolation, and resulting in eutrophication of surface waters.

Study objective

The objective of this study is to explore the effect of topography and the use of a rye cover crop on soil nitrate dynamics in a corn-soybean rotation. The data were collected to develop and validate a field-scale 3D model of crop growth that accounts for surface topography.

Methods

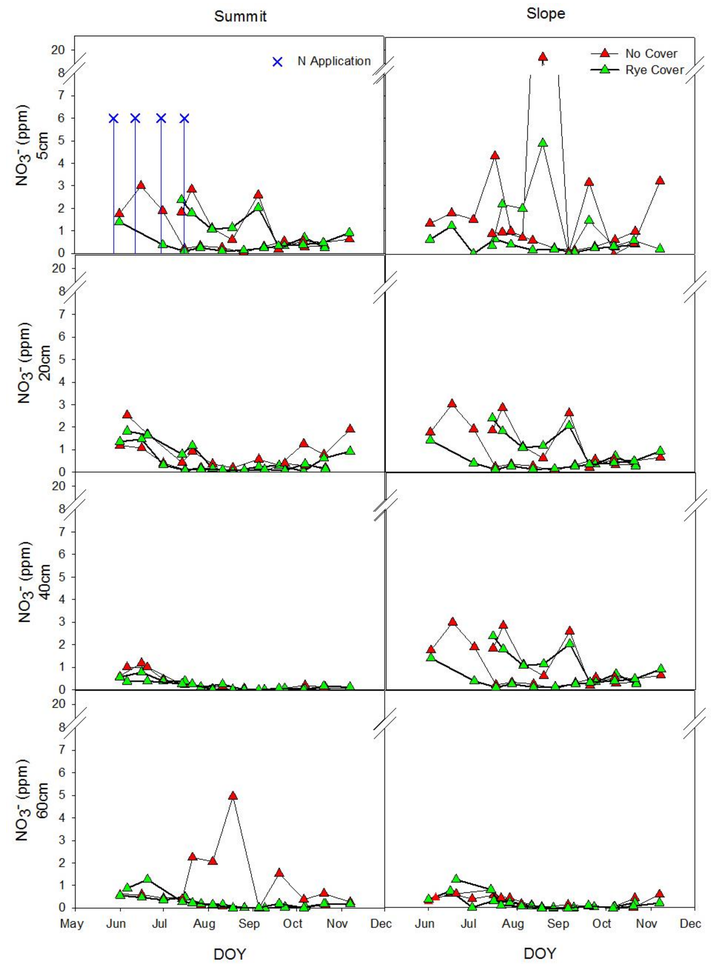
Continuous monitoring of water, NO3 and NH4 contents in the soil at multiple depths and locations representing different topographical elements (). Yield data were collected over four years. These data will be used in a modified DSSAT-3D crop simulation model to (1) examine how soil nitrate dynamics vary with topography and (2) whether the use of a rye cover crop influences those dynamics.

Results

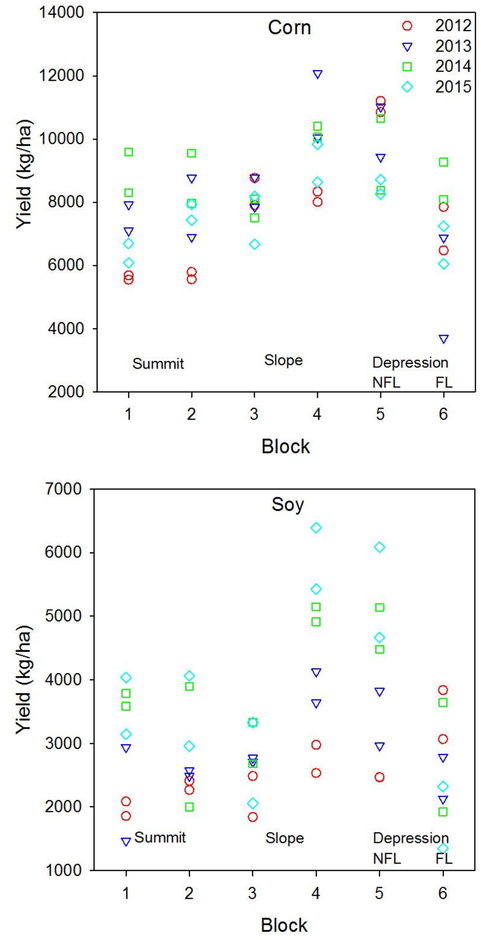
Field monitoring showed that N dynamics varied by topographical position. The main mechanism of nitrate loss in summit areas was infiltration, with nitrate peaks visible at 60cm depth in late summer. Depth and timing exceeded plant uptake ability. Loss via runoff was present in slope areas, with high nitrate levels at 5cm depth throughout the season. This effect appeared to be partially mitigated by the presence of a rye cover crop. N lost via runoff accumulated in depression areas and was taken up by plants.

Yield was also affected by topographical position, with yield in depression areas remaining observably higher than in slope or summit areas. This was most likely due to increased water availability in depressions, possibly accompanied by higher availability of nutrients due to runoff from slopes.

Two years of Nitrate dynamics in corn plots, 5cm to 60cm depth



Dynamics of corn and soybean yield (Kg/Ha) at three topographical elements over four years



Conclusions

- Nitrate losses via runoff occur, reducing the opportunity of plant uptake. Rye as a cover crop mitigated slope runoff of nitrate. Incorporating N fertilizer rather than surface application prevents nitrate loss due to runoff as well.
- Summit losses of N via deep percolation can be curbed by preventing over-application of N in summit areas.
- Depression areas experience an influx of nitrate from surrounding slopes, and will therefore acquire a surplus of nutrients. Taking this N influx from slopes into account when applying N in depression areas will allow for lower N application rates in depression areas.

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