ASSESSING DIFFERENT SOURCES OF PHOSPHORUS FERTILIZER ON NITRATE LEACHING IN THE FALL PERIOD AND ITS EFFECT ON THE FOLLOWING CORN

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ABSTRACT

Illinois nutrient loss reduction strategy is questing to reduce nitrate and phosphorus (P) loss by 25 and 15% by 2025. Fall applied ammonium-based P fertilizers could result in both nitrate and phosphate loss during the fallow period. Two ways to minimize these losses are by utilizing urease and nitrification inhibitors and also assessing other sources of P including triple superphosphate (TSP) and dissolved air flotation (DAF) that separates solids from liquid manure. A four-times replicated experiment was initiated in fall 2023 with Randomized Complete Block Design and five treatments in Agronomy Research Center, Carbondale, IL. Treatments were fertilizers [Control, TSP, DAF (Dissolved Air Flotation), MAP, & MAPI (MAP + urease and nitrification Inhibitor)], timing (fall & spring) and application type (surface & tilled). Data on nitrous oxide emissions, nitrate leaching, soil test phosphorous (STP), and total N were recorded during fall and spring prior to planting of corn (*Zea mays* L.) and agronomic observations (plant height, LAI & NDVI) were also recorded for corn. Our results indicated that DAF increased STP more than MAP when surface applied. Over winter and spring, nitrate form of N availability and leaching losses were less under DAF and TSP compared to MAP or MAPI, suggesting that inhibitor did not reduce N availability and leaching from MAP source when applied in fall. Corn growth was slightly higher under DAF compared to other fertility treatments indicating it can be as a potential replacement source to the synthetic P fertilizers.

INTRODUCTION

Effective nutrient management is crucial for reducing environmental impacts in agriculture, especially with the growing concerns around phosphorus (P) and nitrogen (N) losses. Fall-applied ammonium-based P fertilizers are known to contribute to nitrate leaching and phosphate runoff during fallow periods, posing risks to water quality and soil health (Duncan et al., 2017; Eghball and Power, 1999; Kleinman et al., 2002). To address these challenges, strategies such as the use of urease and nitrification inhibitors have been developed to slow N transformations and reduce losses. Additionally, innovative technologies like Dissolved Air Flotation (DAF), which separates solids from liquid manure, offer potential to reduce P and N losses by concentrating nutrients in the solid fraction. This study aims to explore the potential of DAF-separated solids as a replacement for conventional phosphorus sources, while assessing their impact on crop

yield and soil health. By investigating these alternatives, we seek to contribute to more sustainable nutrient management practices in agriculture.

MATERIALS AND METHODS

In 2023, a field experiment was initiated at Southern Illinois University Agronomy Research Center in Carbondale, IL by employing a randomized complete block design replicated four times. Treatments were fertilizers [Control, TSP, DAF, MAP, & MAPI (MAP + urease and nitrification Inhibitor)], timing (fall & spring) and application type (surface & tilled).

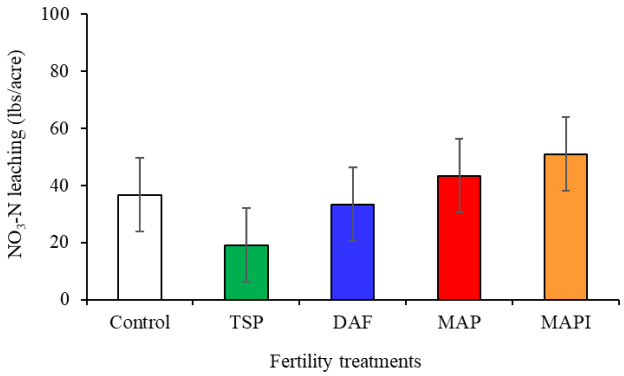
Soil samples were collected in mid-November at 0-2- and 2-6-inch depth. Ion exchange resin lysimeters were then placed in 20 ft wide by 40 ft long plots. Following this, fall treatments were applied. Surface application treatments included closed vented aluminum chambers to estimate nitrous oxide emissions and resin lysimeters to measure N and P leaching losses during the fallow period. Gas samples were collected 14 times during the fallow period using syringes at 0, 15, 30, and 45 minutes on each sampling day. These samples were analyzed for N_2O using gas chromatography. Resin lysimeters were harvested before spring application and analyzed for nitrate-N concentrations using OI analytical flow solution. Throughout the fallow period (November-May), monthly soil samples were collected from 0–6-inch depth and analyzed for total N (nitrate-N and ammonium-N) and soil test phosphorus (STP). Spring treatments were applied on May 28, 2024, prior to corn planting on May 30, 2024.

During the corn growing period, regular agronomic observations were made at different growth stages (V3, V6, V9, R1, R3, and R6). These included measurements of plant height, leaf area index (LAI), and normalized difference vegetation index (NDVI) up to the V9 stage. Data were evaluated for normality of residuals and analyzed using SAS statistical software. Results with $p < 0.05$ were considered significant.

RESULTS & DISCUSSION

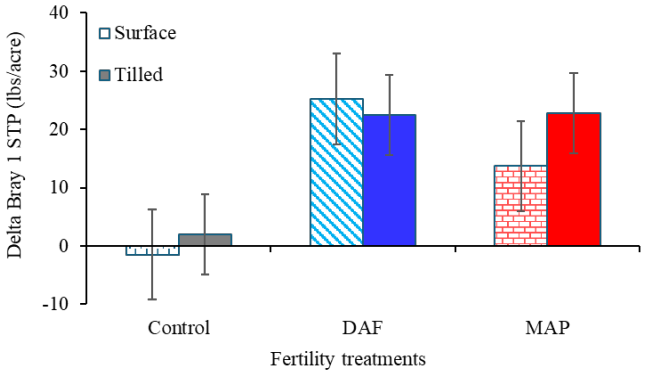
Nitrate Leaching

Although not statistically significant, the treatments TSP (56% and 63%, respectively) and DAF (23% and 34%, respectively) showed lower NO_3-N leaching compared to MAP and MAPI, this shows that inhibitor did not reduce NO_3-N leaching from the MAP source, in this site-year, indicating a relative advantage of DAF or TSP as a potential substitute for water-soluble phosphate fertilizers like MAP in lowering N losses (Leon et al., 2023).



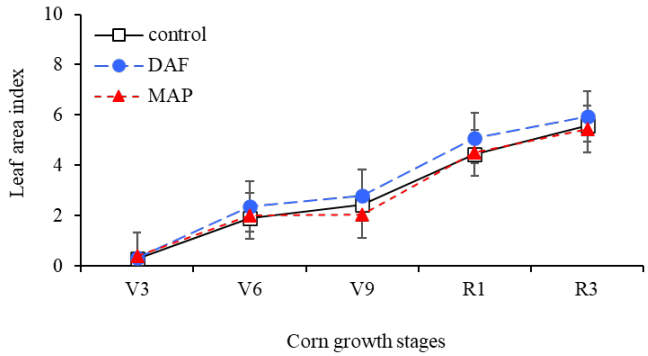
Soil Test Phosphorus

According to the Illinois Agronomy Handbook recommendations, 9 lbs acre^{-1} of P_2O_5 increases STP by 1 lb acre^{-1}. However, this is not consistent with our results, as DAF built more STP than MAP, suggesting less P fixation with DAF.



Fall Applied P fertilizers on Corn Growth

Corn growth was slightly higher (P = 0.06) with DAF and MAP treatments compared to the control. This suggests that DAF and MAP provided sustained N availability throughout the corn growth period.



Preliminary Conclusion

In this preliminary trail, we observed that nitrate-N leaching can be reduced during the fall period by 50% and 13%when TSP and DAF were used as the source of fertilizer compared to control. Using inhibitors in this site-year did not reduce nitrate-N leaching as compared to MAP. In this site-year, we observed slightly quicker corn growth with DAF compared to the other treatments, but this quicker growth was minimal. Multiple site-years are required to draw a firm conclusion on P fertilizer source in corn cropping systems.

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