



Substituting MAP and DAP with TSP Maintains Soybean Yield While Avoiding N Loss

Andrew Margenot, Associate Professor, University of Illinois Urbana-Champaign
 Yuhei Nakayama, PhD Candidate, University of Illinois Urbana-Champaign

ISA CHECKOFF PROGRAM PROJECT

Comprehensive evaluation of phosphorus best management practices for soybean to increase nutrient use efficiency, profitability, and water quality

CURRENT SITUATION

- Modern Illinois soybean production entails high phosphorus (P) demand based on high grain P concentration with yield steadily increasing over the past decades¹
- Soybeans account for ≈40% of P removal² in a typical corn-soy rotation

CHALLENGE TO SOLVE

- Recommendations by the Illinois Agronomy Handbook for soybean P management are outdated
 - Year of last update of P fertilizer recommendations unknown (likely pre-1970)
 - Blanket critical soil test P value across soil types, and not specific to soybean
 - Soybean treated as residual feeder: application at start of corn-soy rotation
 - Limited quantitative recommendations on P fertilizer placement and timing specific to soybean
- MAP and DAP are ≈80% of total P fertilizer used in Illinois³ but can be an overlooked source of nitrogen (N) loss given N fertilization is generally unnecessary for soybean
- TSP (0-46-0) altogether avoids N losses from MAP or DAP

RECOMMENDATIONS BASED ON RESEARCH

- Depending on the availability of TSP, consider using TSP in place of DAP or MAP for soybean (in corn-soy or soy-soy rotations) – especially for fall application
- Since accurate estimation of maintenance rate is difficult at short timespans (<2 years), longer-term management (3-6 years) to balance overall P input (P fertilizer applied) and output (grain P removal) may be more practical
- Spring application for MAP and DAP minimizes N losses
- Broadcasting is more practical; no yield advantages of banding over broadcast were observed in the current study
- Soybean production systems can be prone to N loss even without N applied as MAP or DAP, especially in higher organic matter soils. As a result, practices reducing this background N loss (e.g., cover cropping) are still beneficial

RESEARCH APPROACH

Two-year P fertilization field trials (randomized complete block design) at Urbana, IL (Mollisols), and Ewing, IL (Alfisols), under consecutive soybean in 2021-2022

SOURCE		RATE		TIMING & PLACEMENT
MAP	X	MAINTENANCE 75% MAINT.	X	FALL BROADCAST
DAP				SPRING BROADCAST
TSP				SPRING BANDING

[1] G Schnitkey, N Paulson, C Zulauf and J Baltz. "Corn and Soybean Yields in 2022." farmdoc daily (12):188, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, December 13, 2022.

[2] MB Villamil, ED Nafziger and GD Behnke. "New grain P and K concentration values for Illinois field crops." Crop, Forage & Turfgrass Management 5, no. 1 (2019): 1-7.

[3] Illinois Department of Agriculture. "2021 Fertilizer Tonnage By Grades". <https://agr.illinois.gov/plants/fertilizer/fertilizer-reports.htm>

KEY FINDINGS

Yield and thus P removal were similar across tested P sources, rates, timing-placement at the two sites over two years (Fig. 1).

- **Source:** TSP as good as MAP and DAP for yield – and avoids N loss
- **Rate:** 75% maintenance rate was permissible
 - However, maintenance rate was overestimated by 31% on average due to lower grain yield than expected
- **Timing-placement:** fall vs. spring, broadcast vs. banding did not matter for yield

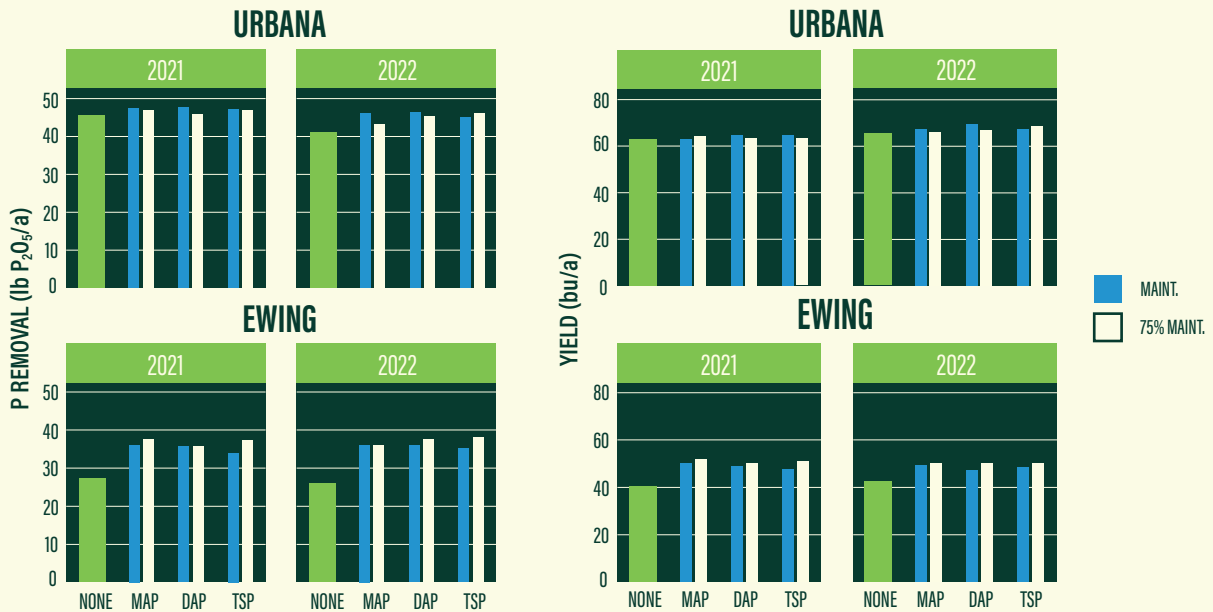


Fig. 1. Soybean Grain Yield (bu/a) and P Removal (lb P₂O₅/a) at the Two Sites Over Two Years, Average by Source x Rate Treatments

Confirmed expected benefits of using TSP over MAP and DAP for water quality (Fig. 2).

- TSP resulted in 45 and 27 lb NO₃-N/a lower nitrate leaching compared to DAP and MAP on average, respectively, but only under fall broadcast application in the 1st year
- Baseline nitrate leaching was up to 8 times higher than highest amount of N co-applied as P fertilizer (DAP at maintenance rate) under Mollisols and extremely variable over time (up to 13-15 times difference within each site)
- Generally higher leaching under Mollisols (calls for site-specific management), and higher leaching after soybean (at least for Mollisols)
- Minimal off-season leaching from Alfisols in the 2nd year potentially due to weed presence, notably little barley (*Hordeum pusillum*)

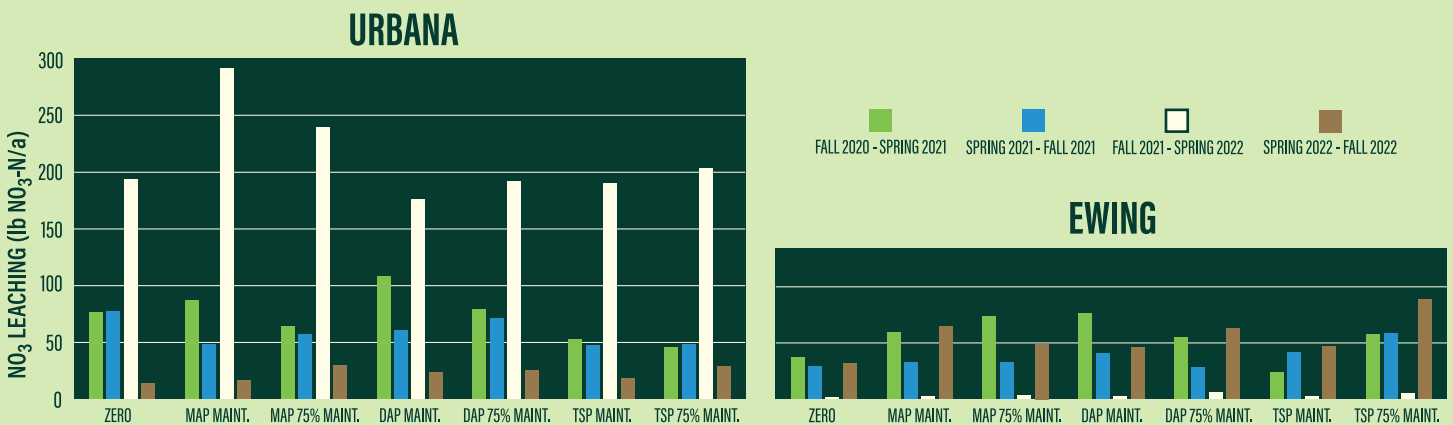


Fig. 2. Nitrate Leaching from Fall Broadcast Treatments Across Four Time Points of Leaching Estimation

Learn more about this project and its findings at:

<https://www.ilsoyadvisor.com/comprehensive-evaluation-of-phosphorus-best-management-practices/>

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The Illinois Soybean Association (ISA) checkoff and membership programs represent more than 43,000 soybean farmers in Illinois. The checkoff funds market development and utilization efforts while the membership program supports the government relations interests of Illinois soybean farmers at the local, state and national level through the Illinois Soybean Growers (ISG). ISA upholds the interests of Illinois soybean producers through promotion, advocacy and education with the vision of becoming a market leader in sustainable soybean production and profitability. For more information, visit the websites www.ilsoy.org and www.ilsoygrowers.com.