Evaluating Cover Crops' Ability to Reduce Phosphorus in Agricultural Runoff through Meta-Analysis

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Introduction

- Phosphorus (P) in agricultural runoff is a nutrient that originates from fertilizers and manure, and
- P is often the limiting nutrient for algae growth in some lake systems (Zaimes & Schultz 2002)
- Freshwater temperature is likely to increase with climate change, increasing blooms by as much as 20% in some lakes (Sharma et al. 2015)
- One best management practice (BMP) recommended for reducing runoff and sedimentation and improving soil health is planting cover crops
- However, few studies have analyzed the efficacy of cover crops to reduce P in runoff

Research Question

What is the efficacy of cover crops to reduce phosphorus loss from agricultural soil and to reduce P in runoff?

Purpose

- *Conduct a review of literature regarding the effect of cover crops on P in agricultural soil and runoff*
- *Synthesize data from existing peer-reviewed research to statistically analyze cover crops' efficacy*
- *Improve understanding of how cover crops affect P in cover crop fields compared to bare soil*
- *Provide decision-makers with better data to inform policies and procedures regarding water pollution*

Runoff Results

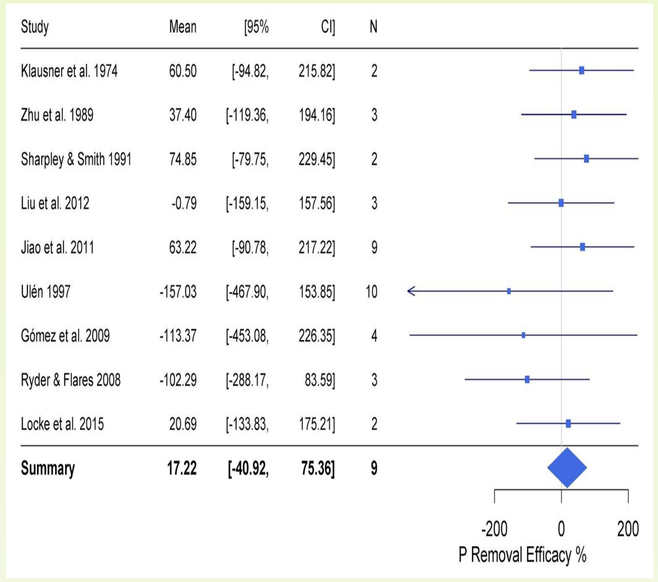

Figure 1. Forest plot results for studies measuring cover crops' efficacy of removing P from runoff, with standardized mean effect size, confidence intervals, and sample size.

Soil Results

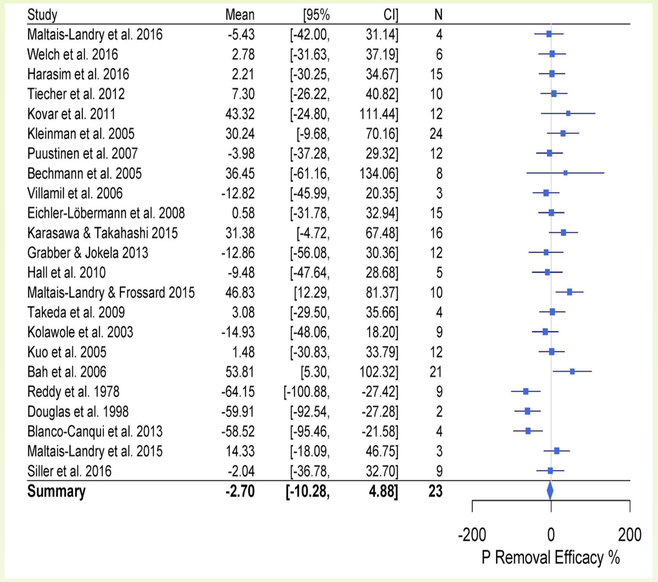

Figure 2. Forest plot results for studies measuring P retention efficacy in soil, with standardized mean effect size, confidence intervals, and sample size.

Discussion

- Effect sizes for runoff and soil accumulation indicate that cover crops may reduce P in runoff and retain P in soil
- However, results are not statistically significant
- Extreme weather events or increased rainfall may have affected studies in which P loss from soil increased under cover crops
- Soil may reach P saturation after cover cropping for many seasons
- Total P loss from soil does not necessarily indicate increased eutrophication potential
- Cover crops may reduce algae growth by utilizing bioavailable inorganic P in soil, making it lower in runoff

Literature Review Methods

Operational Definion: Cover crops are crops that cover the soil and are planted primarily for seasonal cover and conservation purposes (Kaspar et al. 2006, NRCS 2010).

Search Terms: "cover crop*"; "phosph*"; "water quality"; "runoff"

Databases: Google Scholar, ScienceDirect, Proquest, ACSESS Digital Libraries

Rye and clover cover crops, Randle Farms

Statistical Analysis Methods

1. Google Sheets database used to compile 262 data points from 32 peer-reviewed studies
2. Recorded location, P type, vegetation type, runoff, P measured in runoff and sediment from bare and cover cropped soil, soil type, additives, rainfall, & study length
3. Individual P removal efficacy calculated

   For runoff:

   $E = 100(\text{control P} - \text{experiment P})/\text{control P}$

   For soil:

   $E = 100(\text{experiment P} - \text{control P})/\text{control P}$
1. Chosen for its ability to account for variation between study conditions and methods, the random-effects meta-analysis (Borenstein et al. 2010) was used to calculate an overall cumulative effect size, standard deviation, and 95% confidence interval

Future Work

- Replace studies with insufficient data
- Evaluate inorganic P using same parameters
- Analyze cover crop efficacy under:
  - Different weather conditions
  - Different vegetation types
  - Greenhouse vs. field grown

References

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