Soil phosphorus dynamics across several management practices

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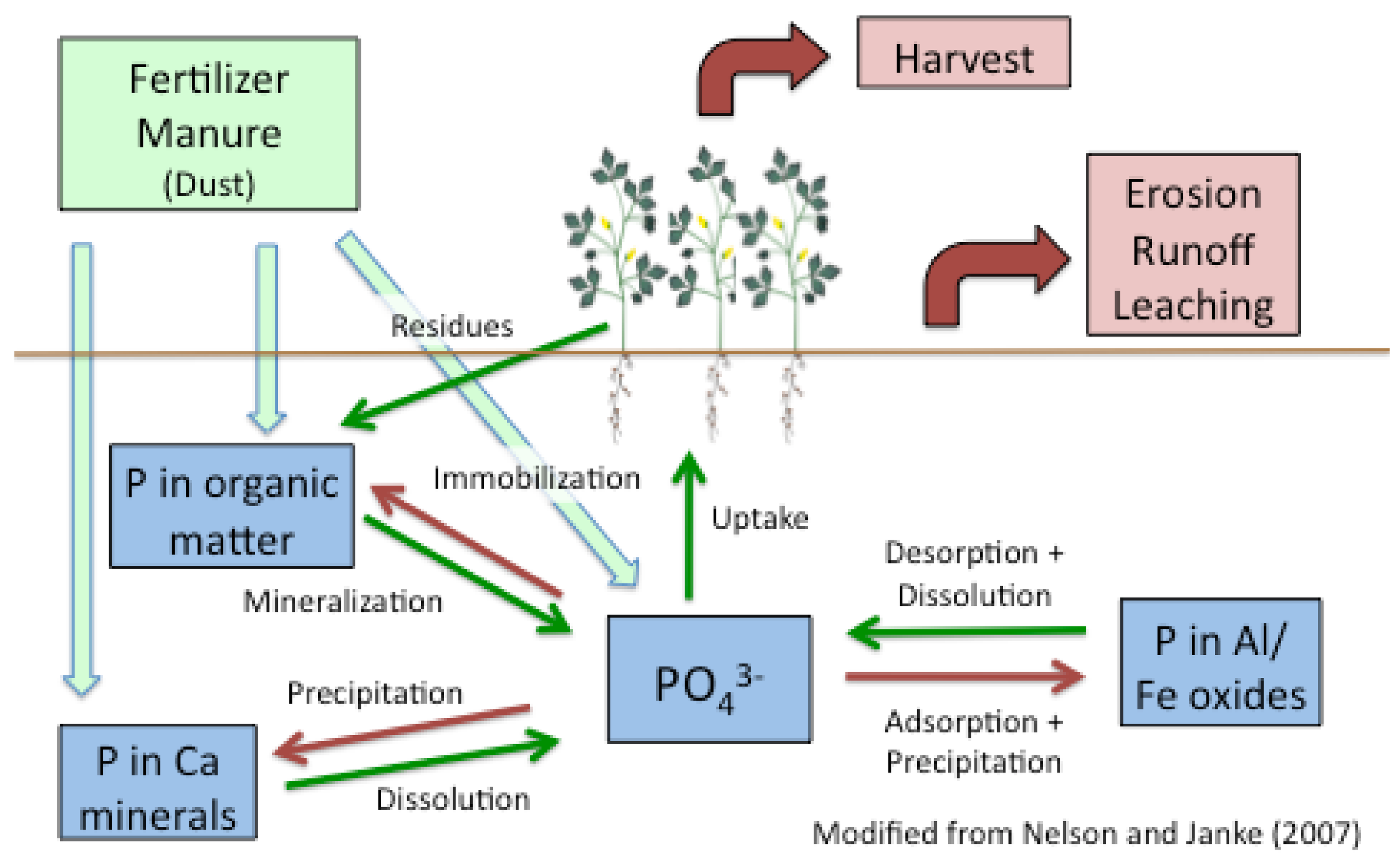
INTRODUCTION

Alternative fertilization strategies are needed to reduce costly mineral P inputs while maintaining yields and soil fertility. Increasing the use of compost and cover crops could help reduce mineral P inputs. Compost recycles P found in wastes whereas cover crops reduce soil P losses and could mobilize soil P bound to soil minerals (calcium minerals and aluminum/iron oxides) and organic matter. In this study we examined how composted poultry manure and legume cover crops (LCC) affect long-term soil P dynamics under different management practices.



Modified from Nelson and Janke (2007)

METHODS

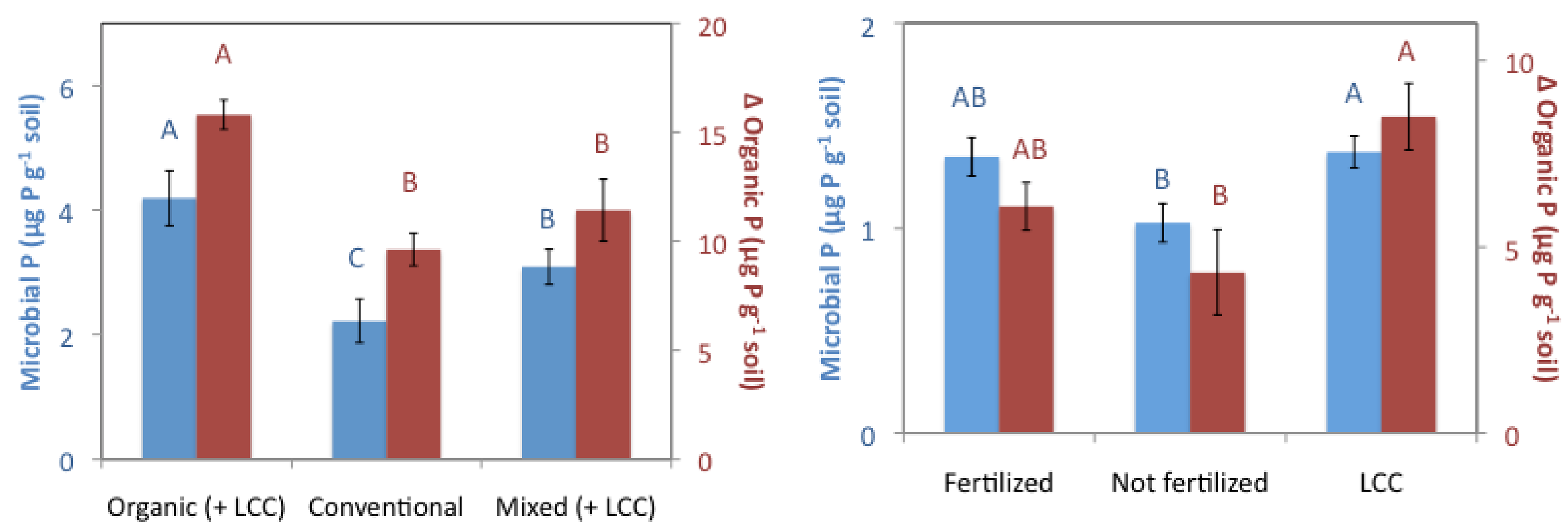
We collected 0-30cm soil samples from six treatments in the LTRAS experiment (fertilization based on N, not P) to determine changes in soil P dynamics after 18 years:

- Irrigated wheat/tomato under organic (manure + LCC), conventional (mineral fertilizer), and mixed (reduced mineral fertilizer + LCC) management, with variable P inputs.
- Rainfed wheat/fallow fertilized with urea, unfertilized, and fertilized by LCC via N-fixation. None fertilized with P.

We measured microbial P with chloroform fumigation, sorption capacity and P saturation with Langmuir isotherms and several organic and inorganic P pools with Hedley fractions. Hedley fractions were also measured on archived soils from 1993 to determine changes (Δ) over time.

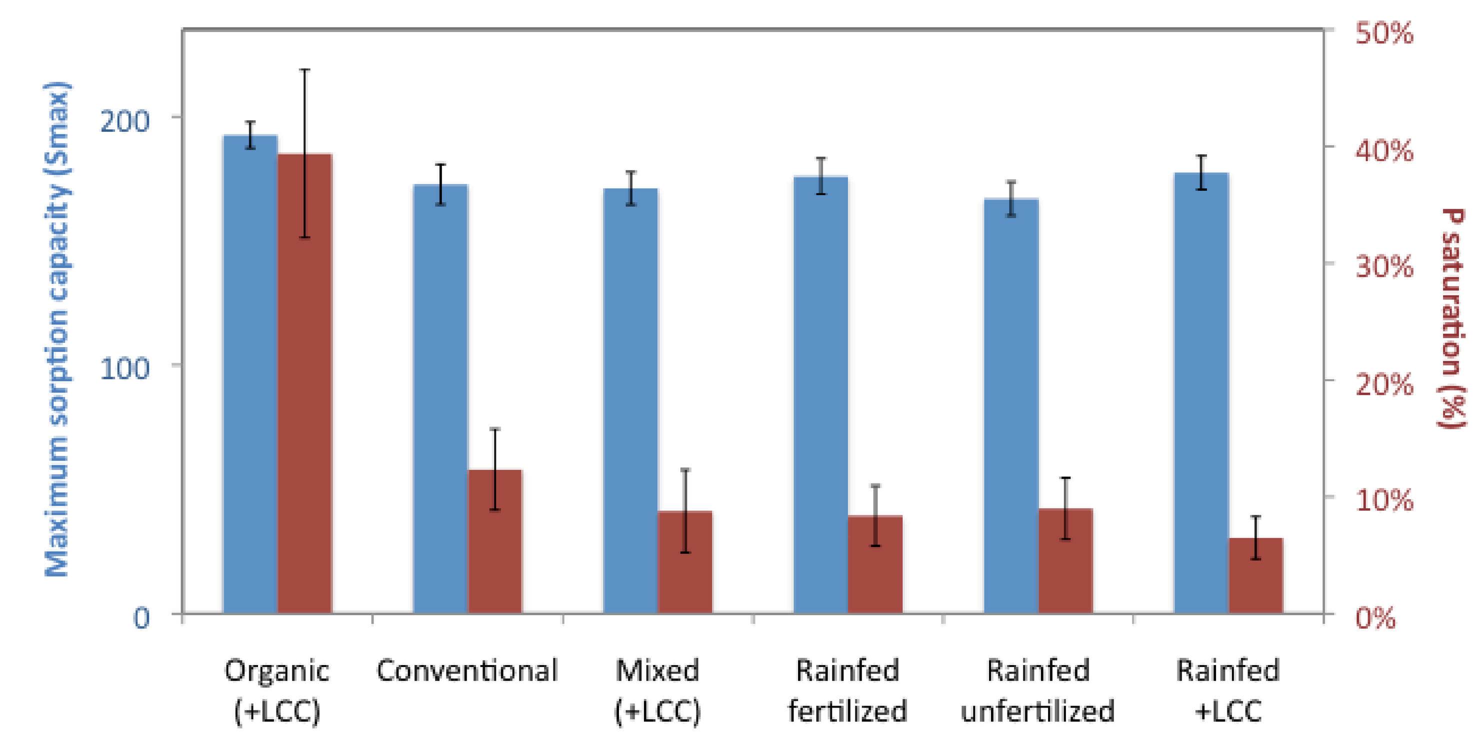
RESULTS

Microbial and Organic P



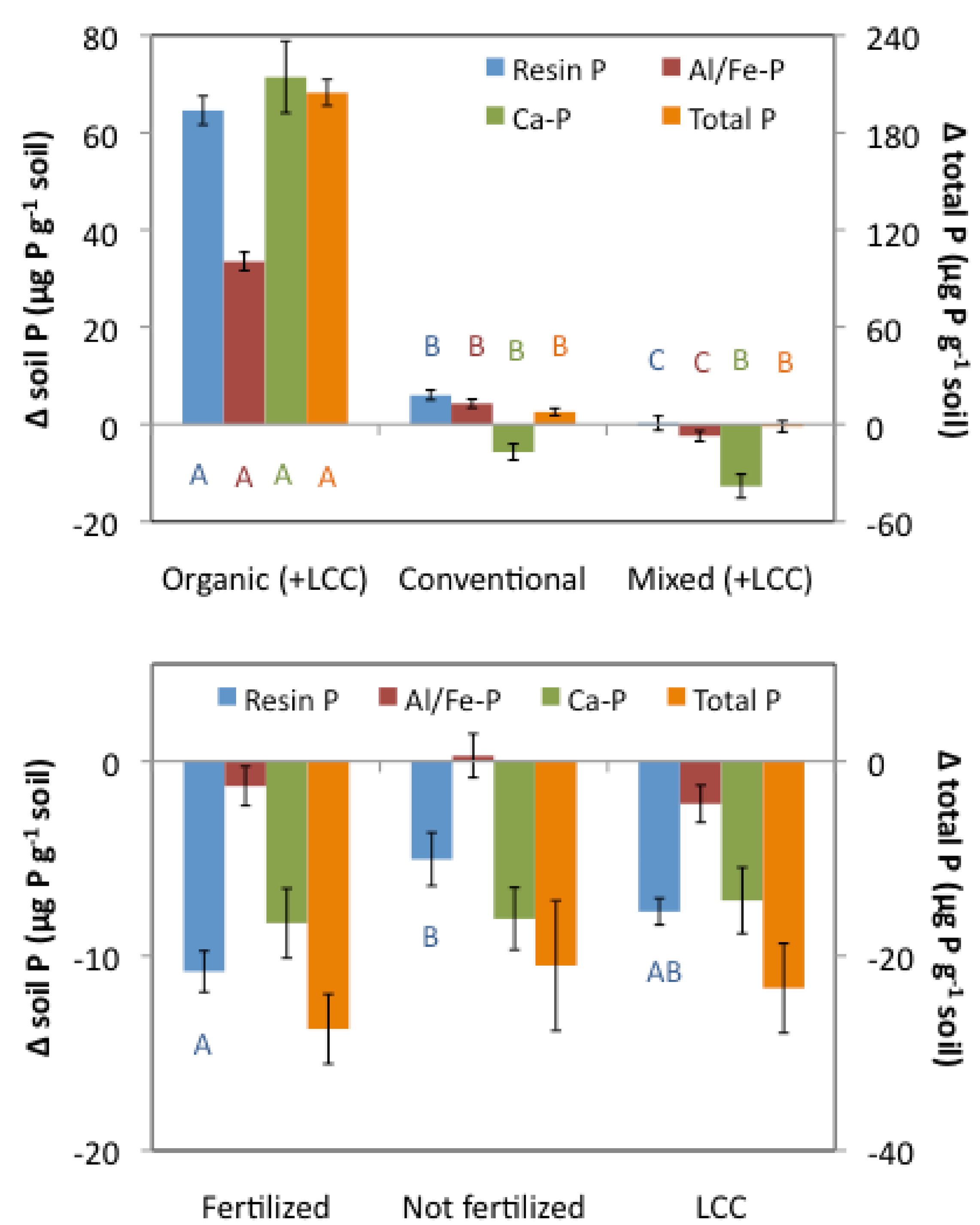
- Irrigated (left): composted manure, and cover crops to a lesser extent, increased microbial and organic P ($p < 0.001$ for both).
- Rainfed (right): cover crops increased microbial and organic P vs. unfertilized fallow ($p < 0.05$ for both).
- Stronger cover crop effects with more recent incorporation (6 mo. vs. 18 mo.).

P sorption capacity and saturation



- Sorption capacity unaffected by cover crops or composted manure.
- P saturation 3-5 fold higher with composted manure in the top 30 cm of soil.

Inorganic and Total P



- Irrigated (top): composted manure increased all P pools (by 3-4 fold for labile resin P) and total soil P. Cover crops had small effects, which were blurred by differences in P inputs ($p < 0.001$ for all).
- Rainfed (bottom): no cover crop effect; wheat yields drove changes in soil P ($p < 0.01$ for resin P ; $p > 0.05$ for others).
- Only plots under mixed management had no net P depletion or gain.

CONCLUSIONS

- Composted poultry manure had strong effects on long-term (18 years) soil P dynamics, increasing total soil P by 30% - 40% and other P pools by 20% - 400%. Soil P saturation was also 3 - 5 times higher compared to systems without composted manure.
- Cover crops increased organic and microbial P but left other P pools and sorption dynamics unaffected. Differences in P inputs limit our capacity to determine LCC effects in irrigated plots.
- P accumulation in organic plots increases risks of P loss via leaching and runoff while P depletion in rainfed systems reduces soil fertility.

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