FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: SOIL BIOLOGICAL QUALITY

Reference 19

Hallama, M; Pekrun, C; Lambers, H; Kandeler, E 2019 Hidden miners - the roles of cover crops and soil microorganisms in phosphorus cycling through agroecosystems NA 10.1007/s11104-018-3810-7

Background and objective

Phosphorus (P) is a limiting nutrient in many agroecosystems and costly fertilizer inputs can cause negative environmental impacts. Cover crops constitute a promising management option for sustainable intensification of agriculture. However, their interactions with the soil microbial community, which is a key driver of P cycling, and their effects on the following crop, have not yet been systematically assessed. In order to analyze the general effects of cover cropping on main crop performance in terms of P nutrition, the authors conducted a meta-analysis. They also assessed more specific effects, such as the multiple ways in which cover crops, interacting with microbes, influence P dynamics and P uptake of the main crop, as well as different cover crop-main crop combinations.

Search strategy and selection criteria

An initial search in 2017 for online available publications using Scopus with the key-words ("phosphorus" AND "cover crop" OR "green manure" OR "catch crop") yielded 638 matches that were screened by title and abstract. The literature cited in the studies meeting our criteria was also screened, and we expanded the search further using Google Scholar. The authors selected those studies that reported the effects on main crop yield and P uptake/P concentration, soil P and/or soil biological parameters related to P cycling (phosphatase activity, microbial biomass P, or abundance of AMF) and included a control treatment without cover crops. Phosphorus-mobilizing carboxylates are rarely measured in field studies and could not be included in the meta-analysis. We used only studies with cover crops and main crops grown in rotation, excluding intercropping or living mulch. Greenhouse experiments were excluded, as were agroforestry and grassland studies. Soil biological properties and available P were determined after termination of the cover crop or during growth of the main crop. Experimental factors such as main crop species and/or other factors (e.g., soils, tillage) and data from different years were treated as separate experiments within a study.

Data and analysis

Linear mixed models with study as fixed effect and the interaction of study and experiment as random effect were fitted using the package lme4 v1.1-15 (Bates et al. 2015) in R v3.4.3 (R-Core Team 2013) and R-Studio v1.1.423 (RStudio 2013). Graphs were produced with the packages ggplot2 v2.2.1 (Wickham 2009) and cowplot v0.9.2 (Wilke 2017) with estimates from emmeans v1.1 (Lenth 2018) and percentages calculated with plyr v1.8.4 (Wickham 2011). As variance or related parameters were not reported in several studies, the observations were weighted by the number of replicates in each experiment with the weights-statement in the lmer function (all studies had a balanced design). Different models were compared using ML estimation, whereas the final models were fitted with REML. The structure of the fitted models and the F-tests obtained with the package lmerTest v2.0-36 (Kuznetsova et al. 2017) were provided in Table S3 using sjPlot

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
25	Annual crops (Maize, wetland rice, soybean, cereals, vegetables, cotton, Brassicaceae)	Cover crops	No cover crop	Metric: 1) Arbuscular mycorrhizal fungi abundance/colonization; 2) Microbial Phosphorous; 3) Phosphatase activity; Effect size: Standardized difference of the considered metrics between intervention and control	81.25

Results

- Datasets for the soil biological variables included data from seven studies with 60 observations for mycorrhizal abundance, four studies with 53 observations for phosphatase activity, and two studies with 30 observations for Pmic.
- Abundance of AMF spores and root colonization increased after mycorrhizal cover crops (cover crop mixtures, Fabaceae and Poaceae), but did not change or increased only slightly after non-mycorrhizal cover crops (Brassicaceae and Lupinus sp.).
- Cover cropping generally increased Pmic significantly; with Poaceae, Fabaceae, and Lupinus sp. resulting in the greatest increases, around 25%, but only the effect of Poaceae was significant.
- Extracellular phosphatase activity increased around 20% after cover cropping, with Brassicaceae treatments tending to result in the smallest increases over the control, and with Fabaceae, lupins, and Poaceae having the largest effect.
- NULL

Factors influencing effect sizes

- Soil P content : Much stronger increase in AMF abundance in soils low in P-available compared with high-P-available soils.

Conclusion

Cover crops (depending on the type) either enhance or have no effect on the soil microbial community.