FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: SOIL BIOLOGICAL QUALITY

Reference 5

Muhammad, I; Wang, J; Sainju, UM; Zhang, SH; Zhao, FZ; Khan, A 2021 Cover cropping enhances soil microbial biomass and affects microbial community structure: A meta-analysis Geoderma 381, 114696 10.1016/j.geoderma.2020.114696

Background and objective

Cover crops have been increasingly grown for improving soil health and crop production and minimizing environmental impact compared to no cover crop. Systematic documentation of cover cropping effects on soil microbial abundance and community structure, however, is scarce. Synthesize the overall effect of cover cropping, cover crop species, and residue management practices on soil microbial community abundance and structure under different soil and climatic conditions. The authors hypothesized that (1) cover cropping would have an overall positive effect on soil microbial community abundance and structure compared to no cover cropping, (2) such effect will vary with cover crop species and residue management practice, and (3) soil and climatic conditions of various regions will alter the effect of cover crop on soil microbial biomass and community abundance.

Search strategy and selection criteria

To quantify the effect of cover crop on soil microbial community abundance and structure, a search on these parameters was carried out in peer review journals from 1990 to 2019 in Web of Science and Google Scholar. i. Experiments should be conducted in the field and data for legume, nonlegume, and/or mixed cover crops should be compared with no cover crop (fallow) in a region with similar soil and climatic conditions. Studies with no control treatment (or fallow) were discarded. ii. Data comparing the effect of legume, nonlegume, and/or mixed (legume + nonlegume + oilseed crops) cover crops on soil microbial properties were selected. iii. Treatments should be replicated at least three times and mean values shown with standard deviation (SD) or standard error (SE). iv. Where different rates of fertilization were applied to crops following cover crops, only treatments with the recommended fertilizer rates based on the regions were selected. If different fertilizer types were used to supply nutrients, mean values of nutrients among fertilizer types were calculated and used for the study.

Data and analysis

Random model MetaWin 2.1 (Sinaure Associate Inc., Sunderland, USA) was used to compute the mean effect size at bias-based bootstrap 95% confidence intervals (CIs). The effect of cover crop was considered significant if the 95% CIs did not overlap the vertical zero line.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
81	Not specified	Cover crops	no cover crop (fallow) . all other aspects of management held constant like in the intervention.	Metric: 1) total phospholipid-derived fatty acid (PLFA); 2) microbial biomass C (MBC); 3) microbial biomass N and (MBN); 4) total bacteria; 5) total fungi; 6) fungi/bacteria ratio; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	75

Results

- Cover crop overall increased PLFA, MBC, and MBN by 24, 40, and 51%, respectively, compared to no cover crop ($P \leq 0.05$). The categorical meta-analyses revealed that PLFA and MBC increased with legume and nonlegume compared to mixed cover crops ($P \leq 0.05$).
- Cover crops increased total bacteria by 15% and total fungi by 19% compared to no cover crops ($P \leq 0.05$). Increases for total bacteria and fungi for legume cover crops were 23 and 16% and for nonlegume cover crops were 10 and 26%, respectively. Such differences, however, were not significant for mixed cover crops.
- NULL
- NULL
- NULL

Factors influencing effect sizes

- Termination method : Incorporation of cover crop residue into the soil increased PLFA compared to surface placement ($P \leq 0.05$). Removal of cover crop residue reduced MBN compared to residue incorporation or surface placement. Incorporation of cover crop residue into the soil increased total bacteria compared to surface placement of the residue or removal from the soil ($P \leq 0.05$), but residue management has no effect on RR of cover crop on total fungi, although all residue management practices showed positive effect. Residue incorporation enhanced the fungi/bacteria ratio compared to residue removal.
- Soil texture : The RR of PLFA was greater in clay loam than other soil textures, although only 10 observations were available ($P \leq 0.05$). The RR of MBC was lower in clay and silty clay loam but greater in loam when compared with other soil textures. Similarly, the MBN with cover crops was lower in silt loam than other textures except of sandy soil. Cover crops enhanced soil bacteria growth compared to no cover crop in most textures, except for clay loam and silty clay loam, where the RR was not significant ($P > 0.05$). The RR of bacteria was greater in sandy clay loam than silt loam and sandy loam soils. Similarly, cover crop increased total fungi in most soil textures, except sandy loam and clay. Cover crop increased the fungi/bacteria ratio compared to no cover crop and the RR of the fungi/bacteria ratio was greater in silty clay loam than clay loam and silt loam ($P \leq 0.05$). Cover crop reduced the fungi/bacteria ratio in sandy clay loam soils ($P \leq 0.05$), and had a non-significant effect in sandy loam.
- Soil pH : the RRs of MBC and MBN related nonlinearly to soil pH. The RRs of MBC and MBN declined as soil pH increased to 6.5, after which they increased with further increase in pH. The RR of cover crop for total fungi and bacteria increased linearly with soil pH.
- Annual precipitation : The RR of cover crop for total bacteria decreased linearly with increased annual precipitation

Conclusion

Compared to no cover crop, cover crop overall enhanced phospholipid-derived fatty acids, microbial biomass carbon and nitrogen by 24, 40, and 51%, respectively. Soil total bacteria and total fungi, and the groups in them increased by 7–31% with cove crop compared to no cover crop. Fungi were affected more by cover crop than bacteria as indicated by the greater fungi/bacteria ratio.