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Muhammad, I., Sainju, U.M., Zhao, F., (...), Fu, X., Wang, J. 2019 Regulation of soil CO₂ and N₂O emissions by cover crops: A meta-analysis Soil and Tillage Research 192, pp. 103-112 10.1016/j.still.2019.04.020

Background and objective

Cover crops provide multiple agronomic and environmental benefits, such as enhanced soil carbon sequestration, aggregation, water infiltration, and reduced erosion and nutrient leaching compared with no cover crop. However, little is known regarding the effect of cover crop species, biomass quality and quantity, and method of residue placement on greenhouse gas (GHG) emissions. The objectives were to: 1) quantify the effect of cover crop characteristics and residue management on CO₂ and N₂O emissions in various regions with different soil and climatic conditions, 2) determine which cover crop management practice can reduce GHG emissions. Here, only results regarding the effect of green manures on SOC are reported.

Search strategy and selection criteria

Peer-reviewed research articles published before June 2017 were searched in Google Scholar and Web of Science with the following keywords and phrases: "nitrous oxide emissions, carbon dioxide emissions, greenhouse gas emissions, cover crop, green manure, or catch crop". Only studies that reported both N₂O and CO₂ emissions, cover crops grown between harvesting and planting of cash crops, and cash crops with similar management practices, such as irrigation, fertilization, and tillage practices were selected for the study. Studies that lack mean values, replications, and standard error or standard deviation of the mean were discarded.

Data and analysis

All graphical results were conducted using GetData graph digitizer 2.26. The authors used a random model MetaWin 2.1 to compute the mean effect size and generate 95% bootstrapped confidence intervals (CIs).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
48	Arable crops	1) Cover crops (overall). All or part of the N fertilizer rate was added as green manure; 2) Mix cover crops. All or part of the N fertilizer rate was added as green manure; 3) Legume cover crops. All or part of the N fertilizer rate was added as green manure; 4) Non-legume cover crops. All or part of the N fertilizer rate was added as green manure; 5) Incorporation of mix cover crops. All or part of the N fertilizer rate was added as green manure; 6) Mix cover crops removed.	Bare soil with the same treatments than in the intervention	Metric: Soil nitrogen content; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	62.5

Results

- The RRs of cover crops compared to no cover crop were positive for Soil total nitrogen (STN). Cover crops increased soil total nitrogen by 12% compared to no cover crop.
- Incorporation of cover crop residue into the soil increased both STN, while having no effect on STN with residue removal.
- The STN was greater with legumes than with nonlegumes or mixed cover crops.
- NULL
- NULL

Factors influencing effect sizes

- Cover crop type : The soil total nitrogen was greater with legumes than with nonlegumes or mixed cover crops.
- Cover crop residue management : Incorporation of cover crop residue into the soil increased soil total nitrogen compared to residue removal.

Conclusion

Cover crops increased soil total nitrogen by 12% compared to no cover crop. Incorporation of cover crop residue into the soil increased soil total nitrogen, while having no effect with residue removal.