FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: GHG EMISSIONS

Reference 33

Han, Z; Walter, MT; Drinkwater, LE 2017 N_2O emissions from grain cropping systems: a meta-analysis of the impacts of fertilizer-based and ecologically-based nutrient management strategies NUTRIENT CYCLING IN AGROECOSYSTEMS, 107, 335-355. 10.1007/s10705-017-9836-z

Background and objective

Understanding how agricultural management practices impact nitrous oxide (N_2O) emissions is prerequisite for developing mitigation protocols. They conducted an extensive analysis of all management practices to assess the full range of options currently available for N_2O mitigation. They also quantified the trade off between N_2O mitigation and yield outcomes in grain cropping systems. Here, only results regarding the effect of green manures on N_2O emissions are reported.

Search strategy and selection criteria

An exhaustive literature search of studies investigating N_2O emissions from grain cropping systems was conducted with ISI-Web of Science for articles published before June 2014. Because the first search produced a limited numbers of papers for enhanced efficiency fertilizers, cover crops and diversified rotations, we conducted a second search focusing on these practices in December 2015 to increase the size of the database and enable meta-analysis of these practices. Only studies conducted in field conditions that were at least one growing season in duration were included. The authors included cover crop studies that measured N_2O emissions from cover crop growth periods, cash crop growth periods or both, and examined these sub-groups separately.

Data and analysis

It was performed an unweighted meta-analysis because roughly more than half of the studies did not report a measure of variance. Bias-corrected 95% Confidence Intervals (95% CIs) were generated through a bootstrapping procedure in MetaWin 2.0 (5000 iterations). The effect sizes was explored with categorical variables such as soil texture, fertilizer rates and manure forms and continuous variables such as manure pH and manure C:N ratios to examine how specific management regimes impact N_2O emissions.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
21	Arable crops	Cover crops (with distinction between legume and non-legume)	Bare soil with the same treatments than in the intervention	Metric: 1) N_2O emissions; 2) N_2O emissions along the whole year; 3) N_2O emissions during cover crop season; 4) N_2O emissions during cash crop season; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	68.75

Results

- The cover crop treatment did not result in significant differences in area-scaled N_2O emissions (whole year measurements) compared to the control.
- Six studies (19 observations) measured N_2O during only the cover crop growth period. An additional nine studies (37 observations) measured N_2O emissions during only grain crop growth, after cover crops had been killed or incorporated. The remaining six studies measured N_2O emissions during both cover crop and grain crop growth, but only three of these studies reported the two crop phases separately. Using the data available for each crop phase, we found that N_2O emissions from cover crop growth periods were 58% lower (bootstrapping 95% CI −81 to −27%) compared to bare fallows.
- N_2O emissions, from cash crop growth periods and whole-year measurements, were non-significanly different compared to bare fallows. When the authors excluded the six observations from legume cover crops they found a slightly greater average reduction of 66% with a similar level of variation (bootstrapping 95% CI ranging from-87 to-29%) suggesting that living cover was the primary driver, regardless of the N acquisition strategy.
- All studies reporting N_2O emissions during the cash crop growing season compared "controls" receiving N fertilizer to treatments receiving N fertilizer plus cover crop biomass. As a result, the cover crop treatments received an average of 89 kg N ha^{-1} more N compared to the controls with total C and N additions varying greatly, depending on cover crop biomass and species. On the low end, grass cover crops producing less than 1.5 Mg dry weight of biomass added only 9–31 kg N ha^{-1} while highly productive legume cover crops added 156–279 kg ha^{-1} of additional N.
- It has been found a significant positive correlation between the LRR for N_2O emissions and the extra N inputs from both legume and non-legume cover crop.

Factors influencing effect sizes

- N fertilisation rate : Based on the 12 studies reporting N_2O emissions in cover cropping systems during the cash crop growth periods in conjunction with cover crop N content, we found a significant positive correlation between the LRR for N_2O emissions and the extra N inputs from both legume and non-legume cover crops.
- Period : Six studies (19 observations) measured N_2O during only the cover crop growth period. An additional nine studies (37 observations) measured N_2O emissions during only grain crop growth, after cover crops had been killed or incorporated. The remaining six studies measured N_2O emissions during both cover crop and grain crop growth, but only three of these studies reported the two crop phases separately. Using the data available for each crop phase, we found that N_2O emissions from cover crop growth periods were 58% lower (bootstrapping 95% CI −81 to −27%) compared to bare fallows. N_2O emissions, from cash crop growth periods and whole-year measurements, were non-significanly different compared to bare fallows.

Conclusion

We found strong evidence that replacing bare fallows with covers crops (both legume and non-legume) reduced N2O emissions in the cover crop period, while on the whole year no effect was recorded.