Science Societies

Crop yield, nitrous oxide emissions following swine manure application

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Swine manure is sprayed on growing alfalfa with a research-scale manure applicator. Photo by Joann Lamb.

- There is contradictory evidence regarding the effect on yields and nitrous oxide emissions of swine manure in place of synthetic fertilizers.
- A meta-analysis was conducted to reduce some of the confusion, finding that overall, swine manure does not impact yield or nitrous oxide emissions.
- Crop yields were consistently reduced when manure was applied on the surface of a field vs. below the surface and when applied to soils with high clay content vs. coarsely textured soils.

The adage “Reduce, Reuse, Recycle” also has a place in agriculture. One example is replacing synthetic fertilizer with swine manure, which can provide crops the same nutrients and cut down on the cost of buying and transporting synthetic fertilizer. However, many farmers are reluctant to make the switch because of conflicting information or inconclusive results.

Some studies and anecdotal evidence show yields can be improved by using swine manure in place of synthetic fertilizer while others show a yield decrease. When it comes to harmful nitrous oxide emissions, the story is the same; it's increased in some studies but not in others. To help sort through the myriad of studies and results that have been published, Peter O'Brien and his team at the USDA-ARS and Iowa State University performed a meta-analysis to summarize these findings that was recently published in *Agricultural & Environmental Letters* (

https://doi.org/10.2134/ael2019.07.0024).

“The hesitation from farmers may be warranted because there is a lot of contradictory evidence out there,” O'Brien says. “We aimed to summarize published research findings on these two topics to reduce some of that confusion as well as to identify some common characteristics that may be present when responses to swine manure and synthetic fertilizer do not match up.”

Applying swine manure to fields can come with many benefits, such as an overall increase in resource use efficiency. It can provide nutrients that crops need and reduce the cost of purchasing other fertilizer. An added bonus can be avoiding the expense of disposing of the manure another way, and if the manure is sourced locally, transportation costs can be low.

Nitrous oxide—an important greenhouse gas with agriculture as its biggest source—comes from soil microbes transforming nitrogen applied to fields, from both synthetic fertilizer and livestock manures. When applying swine manure, it's important to consider nitrous oxide emissions and reduce them as much as possible.

However, these yield benefits and clear ways to reduce nitrous oxide emissions haven't necessarily been seen in every study on swine manure application, leading to confusion. That is what motivated O'Brien and his team to undertake a meta-analysis of these studies. They had to precisely choose parameters to investigate and only include studies that met a predetermined set of criteria.

No Overall Impact on Yield, Nitrous Oxide Emissions

Overall, the meta-analysis, which included 39 studies, showed that swine manure does not impact yield or nitrous oxide emissions. However, they also performed what is

called a moderator analysis to try to pull apart the data further and look for some practices that may be more beneficial than others.

“Data input into the analytical model is designed to standardize information across studies to allow for meaningful comparisons from research conducted under a variety of different circumstances,” he says. “We found that previous research findings regarding yield differences with swine manure application were not necessarily inconsistent, but rather that they were indicative of important systematic differences that were identified in the meta-analysis.”

The findings of the meta-analysis show, for example, that manure application did not always result in the same yield response when compared with synthetic fertilizer. But they did gleam some helpful insights, such as that manure applied on the surface of a field consistently reduced crop yields compared with subsurface application. They found a similar result with some soil types; soils with high clay content experienced a reduction in yield compared with more coarsely textured soils.

There were also inconsistences in nitrous oxide emissions, which they learned were likely due to high variability both within and between studies. Much of the variability, O'Brien says, may come from the lack of a standard methodology when measuring and reporting these emissions.

“Both timing and length of measurement period play a huge role in quantifying N_2O emissions, such that comparing results from eight days to a season-long cumulative total can result in highly variable, even contradictory, findings,” he explains. “This points to a real need for more research and a standardization of how we quantify these variables, so we can more accurately compare studies.”

While broad recommendations are difficult because of varying effects depending on location, soil texture, climate, and application method, their meta-analysis does give crop producers some insights. O'Brien says the best recommendation, one that many already follow, is that no single practice is suitable in every application. Farmers should work to learn the characteristics of their fields and work with researchers and other professionals to identify site-specific circumstances and best practices.

“Meta-analyses are not necessarily new to agricultural research, but we do believe they are underutilized, possibly because not all researchers understand what they are and how they may be used,” O'Brien says. “This type of research is critical to help researchers reach out to producers with the most accurate, relevant information.”

Dig Deeper

View the full open access article, “Crop Yield and Nitrous Oxide Emissions following Swine Manure Application: A Meta-Analysis,” in *Agricultural & Environmental Letters* at **https://doi.org/10.2134/ael2019.07.0024**.

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