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Manure incorporation in no-till systems

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Quantifying odor reduction of manure incorporation methods

For those hoping to control nuisance odors from surface-applied manure, integrating manure into the soil rather than leaving it exposed seems like a matter of common sense. At the same time, practitioners and scientists need to confirm that manure incorporation actually curbs odors. Robin Brandt is helping to do just that.

As director of the Pennsylvania State University Odor Assessment Lab, Brandt studies ways to quantify agricultural odors—a surprisingly complex task, given how easily the human nose detects these aromas in the first place. The "gold standard" technique involves collecting large bags of malodorous air in the field, bringing them back to the lab, and using a sophisticated machine to dilute the samples with pure, odorless air.

A panel of expert "odor assessors" are then given whiffs of the diluted samples—starting with the most dilute and working toward the least—reporting each time whether they smell a difference between the diluted sample and two samples of purified air. The trial ends when an assessor first detects a difference, yielding the detection threshold.

The method does a good job of quantifying differences in odor concentration that would otherwise be very subjective; for example, a smell that's detectable when diluted 1,000-fold (1 part odor sample to 1,000 parts pure air) is four times stronger than one that's only detectable at a 250-fold dilution. But the technique is also expensive, time consuming, and uses whole-air samples that can become tainted by the sample bag itself. So, when Brandt began working with Doug Beegle and Peter Kleinman at Penn State on manure incorporation, he used a less costly field technique and a device called a Nasal Ranger Field Olfactometer.

Although it's used in the field, the Nasal Ranger allows odor assessors to evaluate serial dilutions of air samples through the device, just as they do with the laboratory machine. Similar to the lab method, too, the assessors report when they can first smell a difference between a diluted ambient sample and a purified puff of air, producing a detection value called dilutions-to-threshold (D/T).

Where field olfactometry differs substantially from the lab technique, though, is in its efficiency. In his manure incorporation study, for example, Brandt collected many more data points by employing multiple assessors equipped with Nasal Ranger units than he did with the laboratory method. And those extra data gave him the statistical power to identify subtle variations in the performance of four incorporation techniques: aeration, chisel injection, shallow disk injection, and high-pressure injection.

For instance, although aeration cut manure odors significantly over surface application (as did all the incorporation methods), it was significantly outperformed by chisel injection. Chisel injection, meanwhile, was statistically less effective at reducing odors than were shallow disk and high-pressure injection—both of which performed equally well.

The Nasal Ranger allows odor assessors to evaluate serial dilutions of air samples in the field. Photo courtesy of Robin Brandt.

What the findings suggest, Brandt says, is that field olfactometry offers a robust, sensitive, and less costly alternative to the lab method for those who need to measure farm odors precisely. Not that it can be done completely on the cheap, he adds. Odor assessors are paid for their time, and checking out the health of their noses also costs money.

"So, it's not without expense—it costs something. To do this in a regulatory mode I think would be a challenge," Brandt says. "But in high-value situations like research, I think it works beautifully."