Letter to the Editor

Re: Measuring Soil Respiration with a Gas Chromatograph

Current interest in soil biological activity as an indicator of soil health has prompted renewed research on CO_2 respiration methodologies. A recent non-technical summary in *CSA News* magazine (Hmielowski, 2018)[1] describes a gas chromatograph (GC_ method developed at Oklahoma State University for this purpose (McGowen et al., 2018).[2] Their novel approach suggests possible advantages of time, labor, and precision for labs, due to its semi-automatic and miniaturized nature, compared with Solvita, a commercial soil respiration method developed in Maine and widely used by soil labs offering soil health analysis. Solvita utilizes a carbonate-buffer gel chemistry and was originally developed as an inexpensive and rapid method to substitute for more cumbersome base-trap titration methods.

We appreciate both the choice to highlight an article about using soil CO_2 as an indicator of soil health and the writer's skill at summarizing the original article, making the results accessible to a wide range of interested readers. We also appreciate the chance to present related information designed to clarify a couple of points.

Hmielowski states that "both tests measure CO_2 from dried, sieved soil samples." More specifically, both tests (Solvita and GC) measure CO_2 from *rewetted* dried, sieved soil samples. The protocol for rewetting, among other factors such as drying temperature, will influence results. The authors of the original paper, ourselves,[3] and others have explored the effects of some of these factors on CO_2 release to ensure accurate, reproducible results. Hmielowski describes the GC method as "instantaneous" and suggests that it "may be faster" than the Solvita method. As stated in the original paper, the GC method is capable of analyzing eight samples per hour. Both methods require setup, a 24-hour period of CO_2 accumulation, and then analysis. The GC method, although partially automated, is probably not faster than the Solvita method.

One of the factors that may influence the amount of CO_2 released from rewetted dried soil is the ratio of headspace volume to soil in the jars or tubes used. We have determined that Solvita performs better in 475-mL jars than in the 265-mL jars commonly used (both containing 40 g soil). This addresses the concern raised in the original paper about over-saturation of Solvita at higher values: the larger jars dilute the CO_2 concentration to be within an acceptable range. This is likely to eliminate or minimize the need for dilution and sample re-run with the Solvita method, again suggesting Solvita is as fast as the GC method to perform.

Two different infrared (IR) methods were employed to validate Solvita response in situ: Solvita jars affixed with gas sample ports for IR (front row); and "IRTH" jars with IR and Solvita inside the same jar.

As the author stated, the Solvita and GC values were highly correlated, with the Solvita values approximately six times greater than the GC values. In order to explore this discrepancy, we communicated with the authors of the original paper, and the Oklahoma State staff graciously provided our team, in a single-blind manner, the same set of soils from which these conclusions were drawn. We carried out respiration protocols in several different configurations, including using three different infrared gas analyzers (Li-Cor 7000, CZ COZIR IR Cell, and ER Columbus Instrument Respirometer). Overall, the GC method appears to yield results that are significantly lower than other methods. We speculate that the miniaturized sample tube (5 g soil in a 20-mL tube) may be problematic, possibly because the small quantity of soil is so difficult to moisten properly in small tubes that aerobic respiratory suppression is occurring. As Hmielowski states "understanding how the results may differ and finding ways to compare the data in a meaningful way is important." We agree and plan to continue work in this area, as do others. This discussion, and area of research in general, is an example of a fruitful partnership between private and public soil testing laboratories, something we endorse and hope to see occurring more frequently in an effort to best serve the agricultural community and other stakeholders.

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[1] *CSA News* magazine: See https://bit.ly/2PqNPuJ.

[2] *Agricultural & Environmental Letters* (doi:10.2134/ael2018.02.0008). See https://bit.ly/2N8KyhZ.

[3] Presentation at the 2015 International Annual Meeting of ASA, CSSA, and SSSA. See https://bit.ly/2RFGiK3.