This Week's Citation Classic®

CC/NUMBER 23
JUNE 8, 1987

Jenkinson D S & Powlson D S. The effects of biocidal treatments on metabolism in soil—V. A method for measuring soil biomass. *Soil Biol. Biochem.* 8:209-13, 1976.
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This paper describes a new method for measuring microbial biomass in soil: soil is fumigated with chloroform, then the chloroform is removed, the soil incubated, and carbon dioxide evolution measured. Carbon in microbial biomass is derived from the difference between carbon dioxide evolution by fumigated and unfumigated soil. [The *SCI*® indicates that this paper has been cited in over 205 publications.]

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March 18, 1987

When a soil is fumigated and the fumigant removed, there is a transient increase in evolution of carbon dioxide—the "flush." K. Störmer gave the correct explanation in 1908: the flush is caused by the decomposition of the organisms killed during fumigation by those that survive.[1] His explanation was forgotten and overlain by theories of a sort more appealing to biologists, for example, that the flush is caused by the elimination of a toxic factor or by a fumigant-induced tilt to the balance between competing sections of the soil population.

If the flush is indeed caused by the decomposition of killed organisms, then its size should provide a measure of the original soil biomass, assuming that (1) nearly (but not quite) all the organisms are killed by the fumigant and (2) a constant proportion of the carbon in the killed population is metabolised to carbon dioxide when different soils are incubated. These and related assumptions were tested in a series of papers published by David Powlson and me in 1976,[2-6] of which the *Citation Classic* was the fifth.

I did not start the research aiming to develop a method to measure microbial biomass in soil. My interest in biomass measurements arose from work I had been doing at Rothamsted in the early 1960s on two very different topics—the fractionation of soil organic matter and the effects of soil sterilization on plant growth. This led me to think about the flush caused by fumigation and eventually to revive the long-forgotten explanation that it came from the decomposition of killed organisms. The idea that the flush caused by fumigation could give a measure of soil microbial biomass was first published in 1966,[7] but that paper faded almost without trace, although it did provide an opportunity for one or two distinguished microbiologists to point out how ill-advised it was for a chemist to meddle in biological matters. Fortunately, I was encouraged to continue working on soil microbial biomass. I was also lucky that Powlson came to work with me at Rothamsted in 1968, and indeed, most of the work in the five papers on the effects of biocidal treatments on metabolism in soil can be found in the PhD thesis he submitted to the University of Reading in 1972.

The paper was cited so frequently because it met the need for a method of measuring microbial biomass in soil that was easier to use than the tedious and inaccurate microscopic counting methods then available. Several other methods of measuring soil microbial biomass have since been developed, mostly calibrated against our fumigation-incubation method. The development of these new methods opened the way for the spate of papers that have been published over the last 10 years on the soil microbial biomass, its turnover, and its role in nutrient cycling, and the way in which organisms survive in the harsh world of the soil.[8]

1. **Störmer K.** Über die Wirkung des Schwefelkohlenstoffs und ähnlicher Stoffe auf den Boden (Intraedaphic effects of carbon disulfide and related compounds). *Zbl. Bakt. Parasit. Infektionskr. Hyg. Abt. 2* 20:282-8, 1908.
2. **Jenkinson D S & Powlson D S.** The effects of biocidal treatments on metabolism in soil—I. Fumigation with chloroform. *Soil Biol. Biochem.* 8:167-77, 1976. (Cited 55 times.)
3. **Powlson D S & Jenkinson D S.** The effects of biocidal treatments on metabolism in soil—II. Gamma irradiation, autoclaving, air-drying and fumigation. *Soil Biol. Biochem.* 8:179-88, 1976. (Cited 55 times.)
4. **Jenkinson D S, Powlson D S & Wedderburn R W M.** The effects of biocidal treatments on metabolism in soil—III. The relationship between soil biovolume, measured by optical microscopy, and the flush of decomposition caused by fumigation. *Soil Biol. Biochem.* 8:189-202, 1976. (Cited 55 times.)
5. **Jenkinson D S.** The effects of biocidal treatments on metabolism in soil—IV. The decomposition of fumigated organisms in soil. *Soil Biol. Biochem.* 8:203-8, 1976.
6. **Kudeyarov V N & Jenkinson D S.** The effects of biocidal treatments on metabolism in soil—VI. Fumigation with carbon disulphide. *Soil Biol. Biochem.* 8:375-8, 1976. (Cited 10 times.)
7. **Jenkinson D S.** Studies on the decomposition of plant material in soil. II. Partial sterilization of soil and the soil biomass. *J. Soil Sci.* 17:280-302, 1966. (Cited 80 times.)
8. **Jenkinson D S & Ladd J N.** Microbial biomass in soil: measurement and turnover. (Paul E A & Ladd J N, eds.) *Soil biochemistry.* New York: Marcel Dekker, 1981. Vol. 5. p. 415-71. (Cited 90 times.)

CC/AB+E 982