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This Week's Citation Classic

Shimshi D. A rapid field method for measuring photosynthesis with labelled carbon dioxide. *J. Exp. Bot.* **20**:381-401, 1969.
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A portable apparatus was designed for rapid measurement of photosynthesis in the field. Short (20 s) pulses of air containing $^{14}CO_2$ were passed over a small leaf area enclosed in a transparent miniature chamber, and the sample was subsequently processed for liquid scintillation counting. [The *SCI*® indicates that this paper has been cited in over 115 publications since 1969, making it the 8th most-cited paper published in this journal.]

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"As an irrigation scientist at the Gilat Experiment Station (Negev, Israel), I had been studying physiological responses of field crops to water stress. My approach was to go out to the field and ask the plants, 'How do you feel today?' and expect them to give me a sensible answer, such as the degree of stomatal opening, the internal water status, and the rate of photosynthesis. These indices of plant performance are extremely variable within a field plant population, and, furthermore, they have an inherent daily march, constantly changing from dawn to dusk; therefore, any attempt to characterize the response of a plant population to a range of water stress regimes required methods by which numerous measurements of a given index could be made in a relatively short period. This was especially problematic with photosynthesis; the common method available then was the use of an infrared gas analyzer, which was not portable and its operation rather slow.

"I came upon the $^{14}CO_2$ method suggested by Austin and Langdon,[1] and set out to 'portabilize' it for fieldwork. After tinkering with odds and ends of discarded items (a used liquid propane bottle, a blood-pressure sphygmomanometer, a motorcycle tire valve), I had a clumsy contraption which, surprisingly, worked fairly reliably in the field. In this apparatus a supply of pressurized air, labelled with $^{14}CO_2$, was passed for 20 s over a small leaf area enclosed in a transparent clamp, which served as a micro-cuvette; a small disk was punched out of this area, and after processing it for liquid scintillation counting, the rate of photosynthesis could be determined from the sample radioactivity.

"I was quick to publish the apparatus, but I soon regretted my haste, for within a few weeks I made many improvements in the original version (which I have not published subsequently), which speeded up field operation, sometimes up to 100 measurements per hour, with the help of one assistant. In the processing of the leaf sample for liquid scintillation counting, I discarded the wet combustion with chromic acid in favor of ethanol extraction followed by extraction in dilute HCl. Curiously enough, I was at first puzzled at finding that the radioactivity of the air in the apparatus was declining steadily; I was about to ask the question whether ^{14}C had indeed a half-life of over 5,000 years, before realizing that rust inside the compressed air cylinder acted as a CO_2-absorber, and adequate measures were taken to prevent this reaction.

"I think the paper was cited often because it fulfilled a methodological need for mass collection of data of photosynthesis in the field. Despite the crudeness of the original method, it was apparently well accepted by crop physiologists. Many of them have since made ingenious improvements of the method;[2] the basic approach, however, is still there."

1. **Austin R B & Langdon P C.** A rapid method for the measurement of rates of photosynthesis using $^{14}CO_2$. *Ann. Bot.* **31**:245-54, 1967.
2. **Johnson H B, Rowland P G & Ting I P.** Tritium and carbon-14 double isotope parameter for simultaneous measurements of transpiration and photosynthesis. *Photosynthetica* **13**:409-19, 1979.