CC/NUMBER 27
JULY 4, 1983

This Week's Citation Classic

van Bavel C H M, Nakayama F S & Ehrler W L. Measuring transpiration resistance of leaves. *Plant Physiol.* **40**:535-40, 1965.
[US Water Conservation Lab., Tempe, and Soil and Water Conservation Res. Div., Agricultural Res. Serv., US Dept. Agriculture, AZ]

This report proposes and validates a simple and rapid field method for measuring the epidermal resistance to water vapor diffusion of plant leaves. Thereby, it makes it possible to evaluate the role of vegetation and, particularly, of leaf stomata in the transpiration phase of the natural, and of the agricultural, hydrologic cycle. [The *SCI*® indicates that this paper has been cited in over 120 publications since 1965.]

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April 28, 1983

"Since the mid-1950s it has become apparent that plant transpiration could not be viewed simply as a micrometeorological process, but that the role of leaf anatomy and of stomatal action should be accounted for. But it was not known in 1963, when I and my colleagues Nakayama and Ehrler developed the leaf resistance meter, as it was then named by us, how this parameter could be measured in absolute terms, and with a portable and relatively inexpensive field instrument. We were aware of a development by E.F. Wallihan,[1] then at the Citrus Experiment Station in Riverside, California. He was concerned with the foliar feeding of citrus trees, and wanted to ascertain that leaf stomata would be open when spray application was made. I realized that just a few steps needed to be taken to change his stomatal aperture sensor to a quantitative instrument.

"These steps were: (a) a simple but adequate physical analysis; (b) a design of a clamp-on device to measure vapor flux density through the epidermis under known conditions; (c) a calibration procedure; (d) a portable, light, and reliable meter, to be connected to the leaf sensor; and (e) a demonstration that this measurement could, indeed, be used to calculate the transpiration of the entire plant accurately. Our paper contained all of these elements, plus clear directions for construction and use of the device.

"I attribute the wide use of the paper to its comprehensive nature, its simple language, and its timeliness. Later, I showed how the measurement could explain the fact that citrus orchards used less water than most other crops in the climate of Southern California.[2] I had a great time taking the instrument along on trips, and showing my colleagues how an argument about stomatal reaction to light, drought, CO_2 level, etc., could be quickly settled on the spot in one or two minutes. The best proof of the need for this publication at the time was its successful commercialization, which involved many improvements contributed by others. Now, the method is automated, digitized, and the accuracy has been improved; yet, the principle and its usefulness remain unchanged.

"The leaf resistance meter has been analyzed in great detail by others, and has been the subject of at least one PhD dissertation.[3-5] It is now a standard chapter in methodology handbooks.[6] Not a profound nor an abstruse development, it seems to have been just the right mix of a biological problem, a physical approach, and sound engineering. It is the kind of contribution that I always admired in others, and in which I still take the greatest satisfaction."

1. **Wallihan E F.** Modification and use of an electric hygrometer for estimating relative stomatal apertures. *Plant Physiol.* 39:86-90, 1964.
2. **van Bavel C H M, Newman J E & Hilgeman R H.** Climate and estimated water use by an orange orchard. *Agr. Meteorol.* 4:27-37, 1967.
3. **Stigter C J.** Leaf diffusion resistance to water vapour and its direct measurement. I. Introduction and review concerning relevant factors and methods. *Mededelingen Landbouwhogeschool Wageningen* 72:1-47, 1972.
4. **Stigter C J, Bitrale J & Lammers B.** Leaf diffusion resistance to water vapour and its direct measurement. II. Design, calibration and pertinent theory of an improved leaf diffusion resistance meter. *Mededelingen Landbouwhogeschool Wageningen* 73:1-55, 1973.
5. **Stigter C J & Lammers B.** Leaf diffusion resistance to water vapour and its direct measurement. III. Improved diffusion porometer in growth rooms and fields of Indian corn. *Mededelingen Landbouwhogeschool Wageningen* 74:1-76, 1974.
6. **Slavik B.** *Methods of studying plant water relations.* New York: Springer-Verlag, 1974. 449 p.