Dear Editor:

Adjusting Photosynthetic Responses to Constant Stomatal Apertures

In a recent paper (1), Akita and Moss attempted to correct photosynthetic responses of maize (Zea mays L.) and wheat (Triticum aestivum L.) leaves to constant stomatal apertures. Unfortunately, the method used was subject to large errors which invalidated the authors' conclusions regarding the apparent Michaelis constants for CO₂ and the initial slopes of light response curves.

Akita and Moss used Gastra's (2) equation to describe the diffusion of CO₂ during photosynthesis:

$$P_{\text{net}} = \frac{(c_a - c_e)}{(r_s + r_s + r_m)}$$  \[1\]

where $P_{\text{net}}$ is net photosynthesis, $r_s$, $r_s$, and $r_m$ respectively, are the boundary layer and stomatal and mesophyll resistances to CO₂ uptake, and $c_a$ and $c_e$ are the CO₂ concentrations in the ambient air and at the carboxylation site. Equation 1, however, is only useful under CO₂-limited conditions (3), since it is only then that $r_m$ behaves as a constant resistance. Also, the assumption that the CO₂ concentration at the carboxylation site is zero is only valid in the absence of respiration in the light. This situation is approximated only in the low O₂ treatments.

If CO₂ supply is limiting photosynthesis it is possible to correct observed photosynthetic rates to a constant stomatal resistance by using the following equation, based on [1] above,

$$P_{\text{cor}} = P_{\text{net}} \frac{(r_s + r_s + r_m)}{(r_s + r_s + r_m)}$$  \[2\]

where $P_{\text{cor}}$ is the corrected photosynthetic rate, and $(r_s + r_s)$ is the constant gas-phase resistance to which all values are corrected. It will be seen that this equation differs from that used by Akita and Moss because it includes $r_m$. Omission of $r_m$ will exaggerate the correction factor used to derive $P_{\text{cor}}$. If, however, photosynthesis is not entirely CO₂-limited, this correction is invalid. This is because, under such conditions, $r_m$ is not constant and any $r_m$ calculated from equation 1 is not a good measure of the importance of the intracellular processes in controlling the rate of photosynthesis (4).

Taking, for example, the data in Fig. 1 and 2 of Akita and Moss (1), and assuming that the data apply to comparable plants, one can calculate response curves relating $P_{\text{net}}$ to $c_w$ (the CO₂ concentration at the cell wall) using Gastra's (2) equation:

$$c_w = c_a - P_{\text{net}} (r_s + r_s).$$  \[3\]

If one does this, it can be seen that the carboxylation systems of both the maize and the wheat leaves were close to CO₂-saturation at an ambient CO₂ concentration of 0.07%, so that the method used by Akita and Moss to obtain $P_{\text{cor}}$ was invalid.

One method for determining a $P_{\text{cor}}$ which is not subject to the criticisms mentioned involves two steps. The first step is to the left at intermediate values of $c_a$ (saturation more rapidly).

It is difficult to correct light response curves to constant stomatal apertures, since it is necessary to have, not only the stomatal apertures, but also complete $P_{\text{net}}/c_w$ curves for each light intensity used. Although this information was not given by Akita and Moss (1), the initial slopes of their response curves should be little affected by changes in stomatal conductance at low light intensities and not CO₂ supply will be limiting the rate of photosynthesis.

REFERENCES


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Letters to the Editor:

Nomenclatural Notes on Glycine L.

Numerous binomials have been applied to the cultivated and wild soybean (Glycine) species by various authors and under the Agricultural Research Service recognizes the need for correct binomials for these species. Verdcourt discussed these name changes in Taxon 15:34-36 (1966) and in his monograph (1970).


One wild soybean is Glycine soja Sieb. ex Zucc. A recent synonym is G. ussuriensis Regel & Maack.