Calculation of Transpiration and Assimilation for samples of varying leaf area.
Tonsor Lab Nov 2 2007

Equations used by LiCor 6400 for automatic calculations

Transpiration

$$E_W = \frac{\mu_e\left(w_c - w_e\right)}{s_L 10^5\left(1 - \frac{w_c}{1000}\right)}$$

Parameter	LiCor Output	Description	Units
E_W	Trmmol	Transpiration rate	mmoles $m^{-2}s^{-1}$
μ_e	Flow	Air flow rate entering leaf chamber	μmoles s^{-1}
w_c	H2OR	Mole fraction H_2O vapor refer. air	mmoles H_2O / mole air
w_e	H2OS	Mole fraction H_2O vapor sample air	mmoles H_2O / mole air
s_L	Area	Leaf area	cm^2

Net Photosynthesis

$$A_C = \frac{\mu_e\left(c_c - c_e\right)}{100 s_L} - c_c E_W$$

Parameter	LiCor Output	Description	Units
A_C	Photo	Carbon assimilation rate	μmoles $m^{-2}s^{-1}$
μ_e	Flow	Air flow rate entering leaf chamber	μmoles s^{-1}
c_c	CO2R	Mole fraction CO_2 reference air	μmoles CO_2 / mole air
c_e	CO2S	Mole fraction CO_2 sample air	μmoles CO_2 / mole air
s_L	Area	Leaf area	cm^2
E_W	Trmmol	Transpiration of H_2O vapor	mmoles $m^{-2}s^{-1}$

Adjustment for variable leaf area

$$E_{Wadj} = \frac{s_L}{s_A}\left[\frac{\mu_e\left(w_c - w_e\right)}{s_L 10^5\left(1 - \frac{w_c}{1000}\right)}\right]$$

$$E_{Wadj} = \frac{s_L}{s_A} E_W \quad \textit{where } S_L = \textit{the cuvette default leaf area}$$

$$S_A = \textit{the actual leaf area}$$

$$\textit{set } \frac{s_L}{s_A} = S_{adj}$$

$$\textit{so} \quad E_{Wadj} = S_{adj} E_W$$

LiCor suggests the following formula for calculating Ac, once we have adjusted their formula for variable leaf areas in the cuvette:

$$A_{Cadj} = S_{adj}\left[\frac{\mu_e\left(c_c - c_e\right)}{100 s_L}\right] - c_c E_{Wadj}$$

$$= S_{adj}\left[\frac{\mu_e\left(c_c - c_e\right)}{100 s_L}\right] - \frac{c_c S_{adj} E_W}{1000}$$

$$= S_{adj} A_C$$

NOTE that the LiCor people neglected to adjust for the fact that they output A_C in micromoles and E_W in millimoles. Therefore their formula for adjusting A_C to account for E_W requires that the term involving E_W be divided by 1000 to put it in millimolar units as well.

Transpiration adjustment written in terms of LiCor 6400 output variables
AreaAdj = Area/AreaMeasured
E_{Wadj} = AreaAdj*E_W
A_{Cadj} = AreaAdj*A