Application Note

Light Interception and Biomass Production

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The conversion of light energy and atmospheric carbon dioxide to plant biomass is fundamentally important to both agricultural and natural ecosystems. The detailed biophysical and biochemical processes by which this occurs are well understood. At a less detailed level, though, it is often useful to have a simple model that can be used to understand and analyze parts of an ecosystem. Such a model has been provided by Monteith (1977). He observed that when biomass accumulation by a plant community is plotted as a function of the accumulated solar radiation intercepted by the community, the result is a straight line. Figure 1 shows Monteith's results.

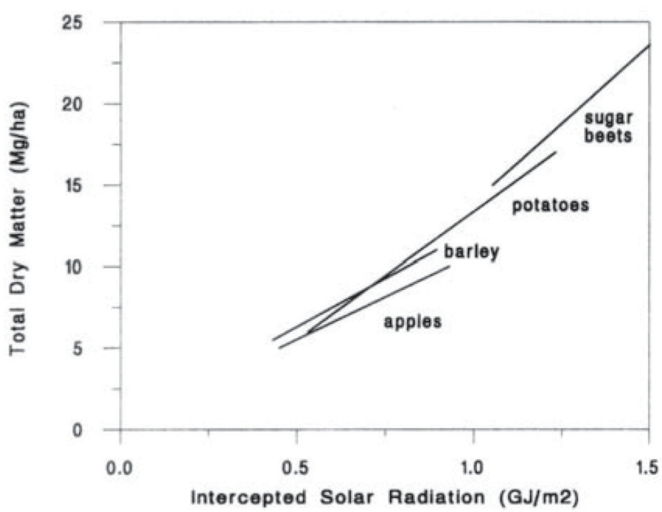

Figure 1. Total dry matter produced by a crop as a function of total intercepted radiation (from Monteith, 1977)

The mathematical model suggested by Fig. 1 is

$$A = efS_t$$

where A is biomass accumulation, St is the total solar radiation incident on the canopy, f is the fraction of incident radiation intercepted by the canopy, and e is the conversion efficiency for the canopy. For this calculation A typically has units of kg m^{-2} day-1. When St is the total solar radiation in MJ/day, e has a value of around 0.015 kg/MJ for C3 crop species. A number of experiments have shown that e is very conservative in situations where water, nutrients and temperature do not limit plant growth. Equation 1 is therefore useful for predicting maximum productivity. When stresses limit growth, it is often possible to quantify their effect either in terms of a reduction in conversion efficiency, e, or a decrease in interception, f. This allows experiments carried out under different conditions of light availability to be compared or normalized.

The AccuPAR LP-80 Ceptometer can be used to measure f, the fraction of incident radiation intercepted by the canopy.

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