18 Measurements of Internal Water Status and Transpiration

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I. INTRODUCTION

This chapter provides an interpretative account of the most promising techniques presently available for transpiration and internal water status measurement. Space limitations restrict this treatment to four main types of measurements of most interest. These are tissue water content, tissue water potential $\psi$, vacuolar osmotic pressure $\Pi$, and stomatal aperture and transpiration. Additional detail can be found in the references cited.

II. MEASUREMENTS OF TISSUE WATER CONTENT

Tissue water content measurements are generally made on leaves but have also been reported for most tissues and organs, including particularly stem sections and fruit. For nonphotosynthetic tissue, expression of the water content on a dry weight basis, analogous to that used for soils, is generally quite satisfactory. The tissue is generally sampled and weighed to give a fresh weight $W_f$, oven dried to constant weight at a temperature 85 to 90°C, and reweighed to give a dry weight $W_d$, and the water content $(W_f - W_d)$ expressed as a percentage of the dry weight, thus: $100 (W_f - W_d) / W_d$. Expression of the results on a fresh weight basis [i.e., $100 (W_f - W_d) / W_f$] is unsatisfactory for almost all purposes because the denominator is not a constant. For leaf tissue, expression on a dry weight basis may also be unsatisfactory for the same reason since the dry weight changes diurnally due to photosynthesis and, over longer periods, due to growth.

For leaf tissue a much better denominator appears to be turgid water content, obtained by floating the tissue in water until the water deficit existing at the time of sampling is eliminated. The turgid weight $W_t$ may be then introduced to the "relative turgidity" expression developed by Weatherley (1950, 1951), and now often called "relative water content." Thus:

$$\text{relative water content (or relative turgidity)} = 100 \frac{(W_f - W_d)}{(W_t - W_d)}.$$

It can also be introduced to the "wasser defizit" or water deficit term developed by Stocker (1929):