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Various methods have been used to evaluate the vascularization of leaves. One method which has been widely used is based upon the vein length per unit area of the blade. Plymale and Wylie (1944) measured the total length of veins per unit area for a few species of woody dicots. This unit has been shown by the studies of Philpott (1947) to be a slightly less reliable expression of the vascularization of Ficus leaves than the intervascular interval, a term defined and used by Wylie (1939). Schuster (1908, 1910) measured the total length of veins per unit area for a number of species of dicots and monocots, but included only one grass.

For dicotyledon leaves vein length determinations are not an easy nor quick method since it involves measurements of composit drawings made from serial paradermal sections.

A fairly simple method has been devised for the calculating of vein length for grass leaves. The short cuts allowed are due to the striate venation of grass leaves in contrast to the reticulate venation of dicotyledons, and the closed venation of grass leaves whereas most dicots are characterized by open venation.

Striate venation and relatively long, narrow form of the blade of many grasses allow the assumption that the longitudinal veins are locally parallel. The author (1948) has shown that for at least one grass a nearly constant measurement throughout the length of the blade is the intervascular interval. Closed venation lends a regular pattern to veins.

The number of longitudinal veins per width of the unit multiplied by the length of the unit gives the total length of longitudinal veins per unit area. To determine the number of veins per unit width the *vein interval,* the distance between the centers of adjacent veins as determined from cross sections, is divided into the width of the unit.

To this must be added the length of cross veins. This poses an additional problem for these veins are neither parallel nor may their frequency be determined by the study of cross sections of the blade. In most cases the cross veins are embedded and only in a few grasses may one estimate their frequency from observations of the surface of the leaf. Their small size renders clearing agents such as glycerine or chloral hydrate ineffective. Paradermal sec-

tions in most cases allow direct measurements of the factors needed to determine their total length.

The frequency of cross veins in the length of the leaf has been called by Lenz (1932) the *islet length.* By using this the number of cross veins per unit length may be determined. This cannot be multiplied by the width of the unit directly for the following reasons:

Since cross veins are not at right angles to the longitudinal veins a factor must be applied which will increase their length with their increasing obliqueness. When *A* represents the acute angle between a longitudinal vein and a cross vein, the cosecant of A will represent length of the cross vein to the perpendicular between longitudinal veins.

The width of longitudinal veins must be deducted from the length of cross veins. Another factor is applied to the width of the unit which will reduce it by the *Average vein width* for the number of veins in the width of the unit.

The number of cross veins per unit length when multiplied by the width of the unit after the two factors have been applied gives the total length of cross veins per unit area.

The sum of the lengths of longitudinal and cross veins equals the vein length per unit area.

$$\frac{1 \times 1}{\text{Vein Interval}} + \frac{1 \times 1 \times \csc A \times \left(1 - \frac{\text{Average Vein Width}}{\text{Vein Interval}}\right)}{\text{Islet length}} =$$

Vein length per unit area.

It will be seen that this formula involves four different measurements: vein interval, average vein width, islet length, and the angle A. The first two may be made from cross sections and the last two from paradermal sections. The first three are ordinary micrometer measurements but the last is somewhat unusual. By placing in one ocular of a binocular microscope a straight pointer extending at least to the center of the field and in the other ocular a micrometer scale upon which a circle of thirty-six dots have been placed, the acute angle which cross veins make with longitudinal veins may be measured. The dots represent intervals of ten degrees and readings may be judged at five degree intervals. The curving nature of the cross veins makes greater refinement in the measurement of angles unnecessary.

Since most micrometer measurements are made in microns and since cosecant values are not generally given in tables a more usable form of the equation is as follows:

$$\frac{10{,}000}{\text{Vein Interval}} + \frac{10{,}000 \times \left(1 - \frac{\text{Average Vein Width}}{\text{Vein Interval}}\right)}{\text{Islet length} \times \sin A} = \text{Vein}$$

length in centimeters per square centimeter.

The value of this formula is that it allows a wide sampling of leaf tissue and the averages of several leaves of a species may be brought together easily. The result is a more accurate value for the species than could be obtained from several measured drawings.

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