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Short Communication

Change of Leaf Dimensions and Air Volume with Change in Water Content

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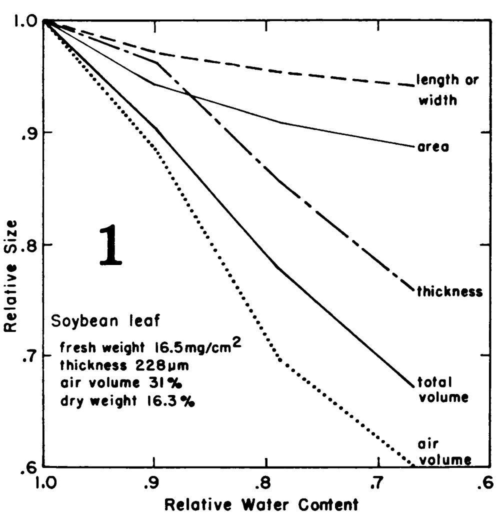
To estimate how the transfer of water, oxygen, and carbon dioxide might be affected by leaf water deficit, we should know how the leaf geometry depends on water status. To study this relationship, I measured the length, width, total volume, and air space volume of leaf pieces in the relative water content range from 1.0 to about 0.65.

For each experiment, 40 similar rectangular leaf pieces about 28 × 32 mm were cut from mature, fully turgid leaflets (soybean) or larger leaf pieces (maize), which had been floating on water for 2 hr. The original length, width, and weight of each piece was measured, and the pieces were divided into five groups of eight pieces. Groups 1 and 2 were used to measure parameters at full turgidity and groups 3, 4, and 5 were allowed to lose water so as to provide measurements at three different water contents.

The leaves of group 1 were vacuum-infiltrated with water, and their weight increase with infiltration was used as a measure of their internal air volume. The water-filled pieces were then weighed while submerged in water. The difference between the weights in air and in water was a measure of the total volume of each leaf piece. The "nonair" volume was the total volume minus the air volume. Finally, these pieces were dried at 100 C to give dry weight.

Group 2 leaves were infiltrated with silicone oil (Dow Corning[1] 200 fluid, viscosity 25 centistokes) instead of water, so as to avoid changing the water status of the leaves. The increase in weight, divided by the specific gravity of the oil, gave a slightly higher (about 0.75 percentage point) air volume measurement than did group 1. Some oil appeared to adhere to the leaf surface after the blotting, and the weight of this extra oil probably accounted for the higher air volume measurement. Turgid leaf pieces momentarily dipped in oil (without infiltration) and then blotted showed equivalent weight increases. Therefore, 1.0 mg was subtracted from each infiltrated weight of groups 2, 3, 4, and 5 to compensate for this external oil. Groups 3, 4, and 5 were allowed to dry to specific weights and were then infiltrated with oil for air volume measurements at those particular water contents. The nonair volume of each of these leaf pieces was taken to be the original (group 1) nonair volume minus the weight of water lost in drying, and the total volume was the air volume plus the nonair volume.

The length and width across the center of each piece was



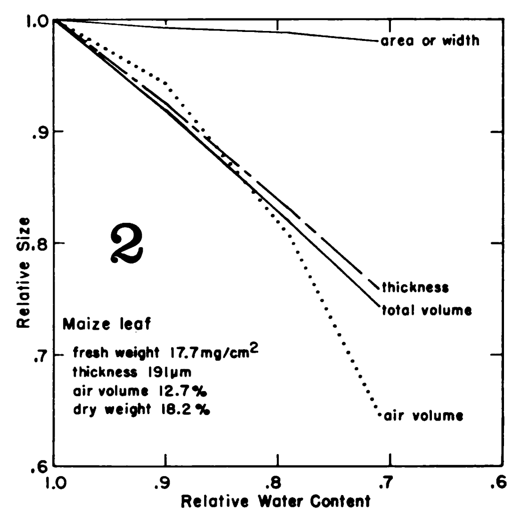


FIG. 1. Relative dimensions of a soybean leaf piece as functions of relative water content.
FIG. 2. Relative dimensions of a maize leaf piece as functions of relative water content.

[1] Trade names and company names are included for the benefit of the reader and do not imply endorsement or preferential treatment of the named product by the United States Department of Agriculture or University of Illinois.

measured, and the average thickness was calculated by dividing the total volume by the area.

Figures 1 and 2 show the parameters for one experiment with soybean leaves and one with maize leaves. The maize leaf pieces did not shrink as much in width as did the soybean pieces and did not change measurably in length.

The air volume of both the maize leaves and the soybean leaves decreased proportionately somewhat more than did the total volume. Such a decrease might be expected to increase the intercellular diffusion resistance, but a definite conclusion is not possible without a detailed knowledge of shape changes. Generally, the leaves acted about as we might expect such structures to act. That is, both the air volume and the nonair volume decreased as the leaves lost water. At our present state of knowledge of transport in leaves, it is probably appropriate to use a single estimate of diffusion resistance for the internal air path over the normal physiological range of water content.