PLANTS AND WATER: WHY THEY USE WHAT THEY DO

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For much of the world, water remains a limiting resource for agricultural production. In the U.S. where we have the wealth to provide machinery, genetic material, fertilizers and pesticides to enhance production, crop water needs continue to be a formidable obstacle to increasing food and fiber production. With all the magic that technology has wrought upon agriculture, why don't we have plants that use less water? Since less than 1% of the water used by plants is required for metabolism and less than 5% is required to meet the water storage needs within most plants, this question seems reasonable. Photosynthesis is the process whereby plants convert carbon dioxide in the air to carbohydrates in biomass, using light as the energy source. For cells inside of a leaf to get access to carbon dioxide, the plant must provide a pathway for this gas to diffuse from the open atmosphere into the leaf as well as providing a pathway for the waste product, oxygen, to diffuse from inside the leaf to outside. Because all cells in the plant leaf must remain bathed in water to stay alive, this same pathway for carbon dioxide to gain entry to the leaf allows water vapor to exit that same leaf with oxygen. Neither plants, through evolution, nor humans with their creativity have found a way to allow carbon dioxide and oxygen to diffuse without allowing water vapor to diffuse too.

Transpiration is also important in cooling plant leaves in warm climates, where productivities tend to be the highest if water is available. Reducing transpiration without affecting photosynthesis would cause plant leaves to be hotter and increase the risk of over heating. The transpiration stream also carries nutrients in the soil solution to the plant roots and sustains the movement of nutrients within the plant transport system.

Experts continue to debate why transpiration is so large compared to the biomass requirements of plants, but because all known terrestrial plants make use of the simple diffusion properties of gasses to get carbon dioxide and lose water and oxygen, changing this reality is not likely to be a fruitful path for improving the water-use efficiency of plants. That being said, much can be done to affect the distribution of water use over the life cycle of plants in environments that are water limited, to choose the most water-efficient plants for various environments, to capture rain water by wise soil and crop management, and to be wise stewards of the water resources that we do have.

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