CHAPTER 4

Decreasing Transpiration and the Effect Upon Growth

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According to a simple but reliable theory, transpiration can be decreased with a certain, but relatively smaller, decrease in photosynthesis. The challenge is to accomplish this in practice or even to decrease transpiration without an accompanying decrease in photosynthesis. This chapter will review the simple theory, describe some natural ways that transpiration is decreased, examine artificial means of decreasing transpiration and its effect on photosynthesis, and describe an experiment in stomatal closure of maize.

I. THEORY

The transpiration stream is carried from the pores that store water in the soil to the arid atmosphere through a series of conductors: the soil itself, cells of the root, the xylem, cells or spaces of the leaf, the epidermis and its stomata, and the air itself. In the simple, and therefore clear and useful view of a physicist, the plant and its environment are merely a series of conductors. In each conductor, the same amount of water flows, and the ratio of the change in impetus or potential that drives the stream divided by the resistance is the quantity of flow per unit of time (van den Honert, 1948). Theoretically, then, decreasing transpiration is only a matter of increasing the resistances. Since, however, a substantial increase in resistance will be accompanied by a substantial decrease in water potential or hydration at the exit, thought must be given to the consequences of this decreased hydration before a resistance is increased and the flow is shrunk. The natural control evolved in plants is a guide to us.

The resistance of the soil is too small to affect transpiration materially until the soil has dried to about 10 bars suction, about 10% volumetric water content in a sandy loam (Gardner, 1960). In the root, in the xylem, and in the cells of the leaf within the epidermis the resistance is so slight that transpiration decreases