2.2.1 Influences of Plant Canopy and Physiological Stage of Growth on Actual Evapotranspiration

Actual ET may be less than potential ET much of the time during the production of an agricultural crop. Since ET, or evapotranspiration, is the combination of two processes, soil water evaporation (E) and plant transpiration (PT), or $ET = E + PT$, these two processes respond to variations in the physical environment in different ways. Soil water evaporation occurs on or near the soil surface, and the water vapor is transported to the bulk atmosphere. When a bare soil surface is saturated, soil water evaporation occurs at the potential evaporation rate (E_p), which is similar to open water surface evaporation and is determined by the environment only. As the soil surface begins to dry, water is conducted from subsurface soil regions toward the surface to replace that water lost by evaporation. As water continues to evaporate from the soil surface, soil below the surface begins to dry. As the soil dries, its ability to conduct water to the surface decreases to the point that evaporation of soil water becomes limited. Thus, soil water evaporation can be described in two stages: (1) the time during which soil E is at the potential rate, and (2) the time during which soil E is limited by soil water transport characteristics and E is below the potential E rate. Eventually, a state of essentially no soil E would be reached from the soil surface.

For soils exposed to wetting and drying cycles, soil water evaporation goes through cycles of being in Stages 1 and 2, depending on the frequency and amount of rainfall. Frequent rainfall tends to maintain soil evaporation at the potential rate (Stage 1), whereas low frequency rainfall patterns result in evaporation being limited by soil properties much of the time. Over a period of a week or a month, the actual E represents the integrated effects of wetting and drying cycles on soil water evaporation. Under normal crop growing conditions, usually the actual E over a period of a week or a month will be less than potential E for the same period. Management practices or rainfall distributions that tend to maintain a wet soil surface may considerably modify the actual E to the point that it approaches E_p during a week or month time period. Stewart and Mills (1967) and Stewart et al. (1969) present monthly and annual E and ET data for turfgrass cover, ranging from full cover to bare soil under different rainfall and water table depth conditions.

Plant transpiration represents water loss from plant leaves to the atmosphere. As water transpires from the leaves, the plant absorbs water from the bulk soil through its root system and transports it to the leaves to replace water transpired. Under well-watered conditions, the plants usually absorb enough water through their root systems to maintain transpiration rates at the potential rate, PT_p, determined by the environment. However, as the soil around the root system dries, the ability of the soil to conduct water to the roots decreases and plants can no longer