morning. On both occasions, the leaves from normal plants were usually definitely cooler than air temperature, while leaves from the diseased plants were usually as warm as air temperature or slightly warmer. Thus with one pair of leaves, the leaf from the root-rot plant raised the thermometer to 101° F. from an initial air-temperature reading of 100° F., while the leaf from the normal plant lowered the reading to 95° F. Invariably, leaves from the plants with root rot were at least slightly warmer than the corresponding leaves from normal plants. The differences between the temperatures of individual pairs of leaves ranged from 0.5° to 6.0° F. higher for leaves from the plants with root rot than for the corresponding leaves from normal plants. The average difference for 11 pairs of cotton leaves was nearly 3° F. Two pairs of leaves from adjoining normal and root-rot fig trees similarly showed differences of 2.5° and 3° F.

Measurements with Thermocouples

Some thermocouple measurements were made later in the season, using a large portable demonstration galvanometer and a multiple thermocouple outfit (designed for radiation measurements).[3] The sensitive units consisted of two flat plates, each containing 26 antimony-bismuth thermocouples mounted flat on the plates. The larger disks in which the thermocouple plates were set were mounted about 25 mm apart, facing in opposite directions. The entire outfit was taken into the field and used inside a shaded box. Each measurement was made by pressing the selected leaf, folded, against one of the thermocouple plates, using a soft pad to hold it against the entire surface; while the other thermocouple plate was always at air temperature. Deflection of the galvanometer was thus directly proportional to the differences between the leaf temperatures and air temperatures. The sensitivity of the outfit was such that a deflection of one division (nearly 1 cm) on the large scale was equivalent to 2.25° F., and accurate readings could be made to about 0.5° F.

Measurements made on September 15, 1930, with the thermocouples, agreed in general with the previous results. Leaves of the normal cotton plants were generally cooler than air temperature, ranging from 2.5° above air temperature to 4.5° below and for 11 leaves averaging 1.5° F. below air temperature. Leaves from root-rot plants varied from 1.3° below air temperature to 6.5° above, with the average for 24 leaves at 1.2° F. above air temperature. The average difference between temperatures of the leaves from normal and root-rot cotton plants was thus nearly the same as in the July series. Thermometer readings of temperatures of leaves from some of these plants, taken periodically, agreed fairly well with the thermocouple readings.

Increase of temperature of cotton leaves has been shown by Eaton and Belden[4] to be closely correlated with decreases in the transpiration rates; and they note also (p. 11) that increase in temperature of cotton leaves, wilting in this case from a shortage of soil moisture, may become perceptible to the touch several hours to a day in advance of visible wilting of the leaves. There can be no doubt that the heightened temperatures of the leaves of plants with Phymatotrichum root rot are similarly due to the decrease in water supply, which agrees with the usual conception of the immediate cause of death of plants from this disease. The assumption is that plants succumb as the result of mechanical interruption of the transpiration stream by the rotting of the roots. This breakage of the flow of water, often just below the surface of the ground, is so marked that we have frequently observed, around the base of freshly-wilted cotton plants, the exudation of water in amounts sufficient to wet the soil around the plants, this exudation from the injured portions of the roots presumably being induced by the continued pressure from the uninjured portions of the roots below the area involved by the disease.

Summary

Leaves from plants wilted from Phymatotrichum root rot were as much as 6.5° F. warmer than air temperature, while leaves from normal plants were usually cooler than air temperature. Series of measurements made with mercury thermometers and by thermocouples showed that in July and in September, 1930, leaves from root-rot cotton plants averaged about 3° F. warmer than leaves from normal plants.

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[3] This equipment was made available through the courtesy of Dr. O. W. Silvey, head of physics department, A. and M. College of Texas.

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[4] Frank M. Eaton and Galen O. Belden, "Leaf Temperatures of Cotton and Their Relation to Transpiration, Varietal Differences, and Yield," U. S. Dept. Agr. Tech. Bul. 91, 1929.