A Summary of Data on Soil and Air Temperatures at the North Appalachian Experimental Watershed, Coshocton, Ohio

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During the course of an investigation on the effects of land use on soil and water conservation, considerable data have been obtained on soil and air temperatures on woodland, meadow, and cultivated watersheds. The purpose of collecting these data has been to obtain information on all factors that influence the hydrology of small watersheds. The effect of frost in this connection is well known. In unfrozen soils, temperatures affect soil water movement indirectly through their influence on germination of seeds, plant growth, transpiration, evaporation, and condensation. The influence of temperatures on viscosity and surface tension may apply to percolation of water through soil.

The effect of soil and air temperatures on agricultural hydrology is not a simple one because of the indirect effects of temperatures on various factors affecting the growth of plants and on soil water movement. Examples of such indirect effects are the influence of soil temperature on microbiological activities, on the rate of organic matter decomposition, and on plant diseases. Requests from widely scattered sources for information on soil temperatures have encouraged the presentation of a summary of the soil and air temperatures given herein.

REVIEW OF LITERATURE

Probably the most intensive study of soil temperature was made by Wollny in Germany (13). He studied the influence of aspect, slope, soil moisture content, and season on soil temperatures. He found the range of temperature to be the greatest on the south slope. He also found the maximum temperature to shift back and forth over the southern aspects. Also that temperature differences between exposures were greater, the steeper the slope. Geiger (7) in Munich has presented numerous data on micro-climatology. In this country most of the soil temperature studies were concerned primarily with frost conditions affecting fruit in orchards. Smith (12) and Bliss (3), both from California, have presented data on soil temperature in orchards. Smith found the annual temperature ranges were 15°, 10°, and 20°F at depths of 4, 6, 12, and 10, and 12 feet respectively. McClatchie (9) conducted experiments in Arizona showing the annual range of temperature decreases with soil depth down to 15 feet. He found the annual range at 5 feet varied 20-25°F; at 10 feet from 15-20°F; and at 15 feet from 10-15°F. He estimated that at the area investigated, the soil temperature would remain constant at a depth of 50 feet. Fitton and Brooks (5) have summarized soil temperature data up to 1931. Aiken (1) presented data on the effect of aspect of slope on climatic factors in Iowa. He found that on the basis of heat injury the slopes would rank in the order west, south, east, and north. Soil temperatures in forest areas were presented by Fowells (6) and by Daubenmire (4). The former presented data on a temperature profile in forest cover. Daubenmire showed that maximum and minimum temperaures occur at the soil surface. Baum (2) reviewed data on change of temperature with height in the layer of air near the ground. Russell (11) states that roots flourish best at a lower temperature than the shoots, and they suffer considerably if the temperature rises too high.

Soil temperature data from the Coshocton Station were presented by Post and Dreibelbis (10) in connection with studies on frost penetration. Harold and Dreibelbis (8) in their presentation of lysimeter data have included soil temperature measurements in connection with a study of evapo-transpiration and condensation.

EXPERIMENTAL PLAN AND PROCEDURE

The data presented in this paper were collected at the North Appalachian Experimental Watershed near Coshocton, Ohio. The area lies in the humid region at 40° 22' north latitude. The vegetal covers studied were corn, wheat, meadow, and woodland. On the rotation watershed (109) the soil is Muskingum silt loam and the woodland watershed (111) is on Muskingum loam. The former has an eastern aspect with a 13% slope while the latter has a western aspect with a slope of 22%.

Thermographs were used to obtain continuous records of canopy and soil temperatures. Temperature was measured by Bourdon thermograph tubes buried in the soil. The first measurements were obtained at 2-inch, 18-inch, and 36-inch height in the canopy and at 2-inch, 12-inch, and 24-inch, depths in the soil. This plan was changed in 1942 and records obtained in the 5/8-inch, 3-inch, 6-inch, 12-inch, and 24-inch depths in the soil and 2-inch and 30-inch heights in the canopy. The experimental error in the thermograph tubes is about 1°F and in some cases may be as high as 2°F. For many hydrologic purposes this error can be tolerated. In most cases it is believed the experimental error is less than 1°F. For more detailed studies soil thermometers with a pointed metal end were employed. These were all calibrated before field use. Also mercury thermometers were used in connection with studies on the influence of aspect on soil temperature and with studies of mulch culture. These thermometers were checked before use and had an error of <0.2°F.

Soil moisture was determined by tensionmeters, gypsum blocks, and the gravimetric method.

RESULTS

NUMBER OF FROST FREE DAYS

The number of frost free days at the 2-inch height for a 10-year period are presented in Table 1. Temperatures obtained at this height have more practical value from an agronomic and hydrologic viewpoint than those obtained at greater heights. Of the 10 years there were only 3 months in the year when no frost occurred—June, July, and August. The 10-year average for May and September showed only a few days of frost in these months. The other months are quite variable. Even January in 1944, 1947, and 1950 had 10, 10, and 11 frost free days, respectively.

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