Soil Temperatures.

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THE temperatures attained by the soil at different depths below its surface are of importance in agriculture and depend upon a number of factors, the more important of which are enumerated below:—

1. Duration and intensity of solar radiation.

2. Colour and cover (*e.g.*, vegetation) of the soil which determines the fraction of the solar radiation which is absorbed by the soil surface.

3. The thermal conductivity of the soil which again varies with:

(*a*) the chemical composition,

(*b*) the water content, and

(*c*) the pore space or apparent density.

4. Air movement or convection above the soil surface.

5. Radiation exchange, especially in the long wave-length or infra-red region of the spectrum between the atmosphere and the soil surface.

An account of the heat balance at the ground surface would involve the careful measurement of the numerous factors mentioned above at a number of representative places. For a preliminary survey of this problem, however, it is possible to eliminate the variations of some of the factors and study the influence of each separately.

First of all, the variation due to climatic differences from place to place may be eliminated by bringing sufficiently large soil samples to one place of observation. N. K. Johnson and E. L. Davies[1] have measured temperatures at a depth of one centimetre in blocks of Tar, Macadam, Bare-Earth, Sand, Rubble, and Bare Clay 1 metre square and 15 cm. deep. In view of the fact that the samples were 15 cm. deep, their results may be expected to represent the joint effects of the colour and composition of the materials used.

A simpler way of arranging such experiments is outlined below:—

(1) The physical and chemical properties of the soil may be kept identical by working with blocks of the local soil in the natural condition and varying only the "cover" or surface by sprinkling a very thin layer (about 1 or 2 mm. thick) of each foreign soil over its assigned plot. Then only the "colour" or "albedo" factor varies from plot to plot.

(2) The effect of varying the physical and chemical composition of the soil may be studied by working with blocks of different soils of sufficient depth and covering the surfaces of all the blocks with the same soil, preferably the local soil.

At the Agricultural Meteorological Observatory, Poona, the first part of the above programme, *viz.*, a preliminary study of the effects of surface covers on the local soil, was commenced during the winter of 1933-34. The effects of covering the local black cotton soil with:

(i) a very thin layer of chalk powder,

(ii) a very thin layer of charcoal powder, and

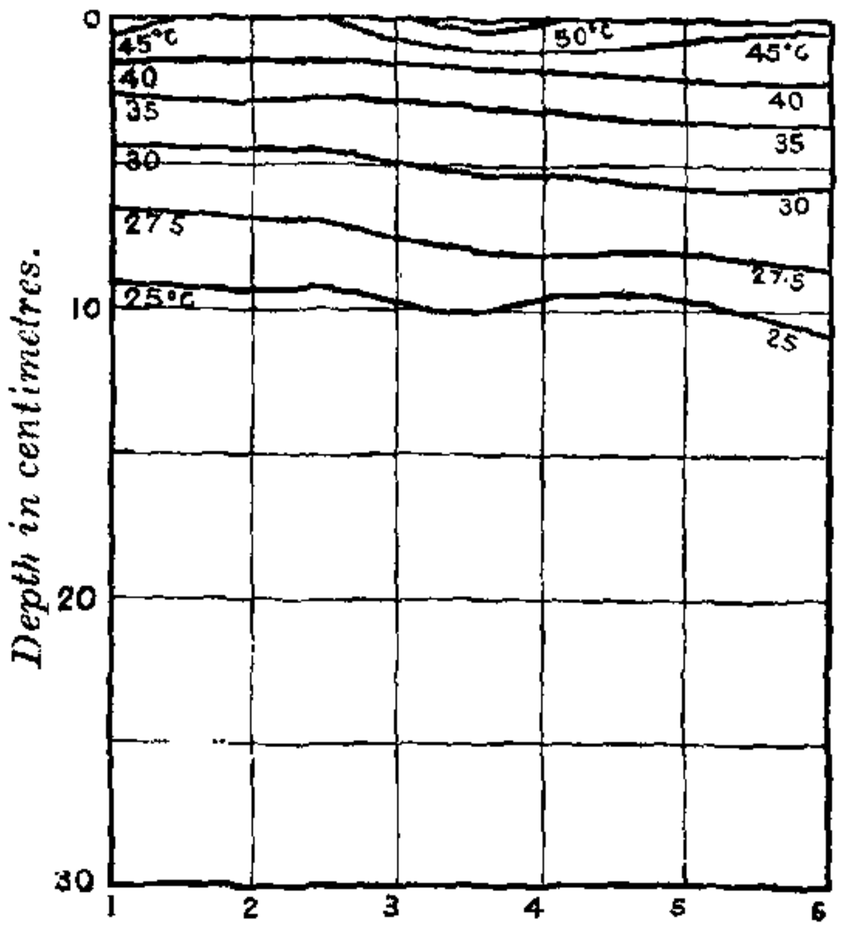
(iii) wetting just the surface of the soil with known quantities of water,

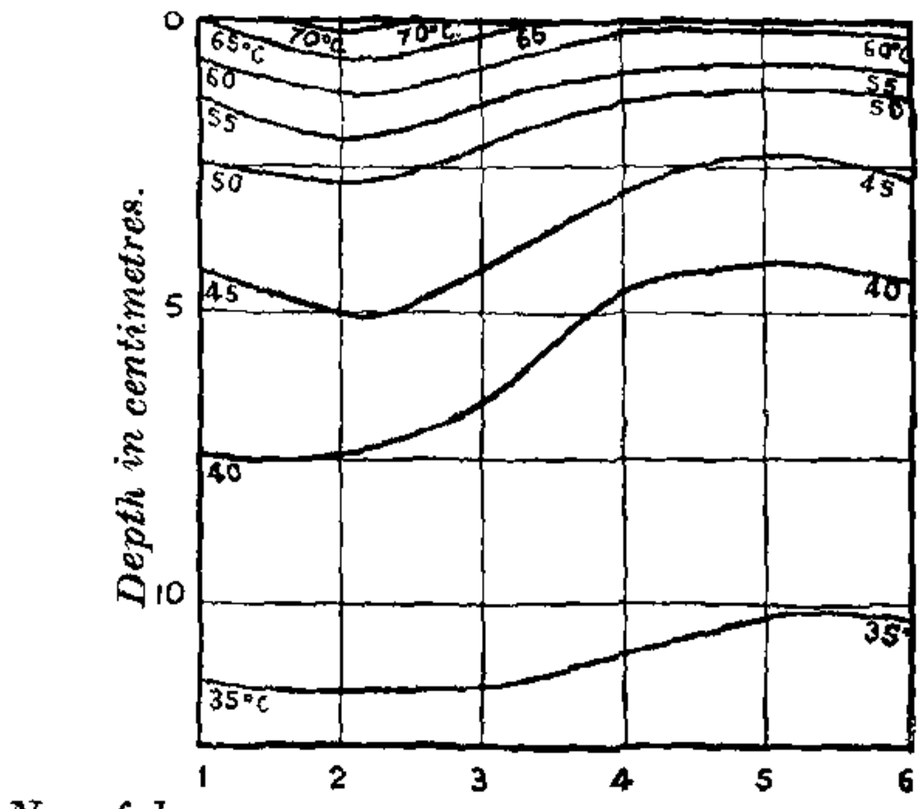
was studied by taking simultaneous two-hourly readings of the soil temperature in two plots one of which was kept as the control and the other was given the treatments referred to above successively. Before commencing each experiment the two plots were kept similar for a sufficient period so as to equalise the initial conditions.

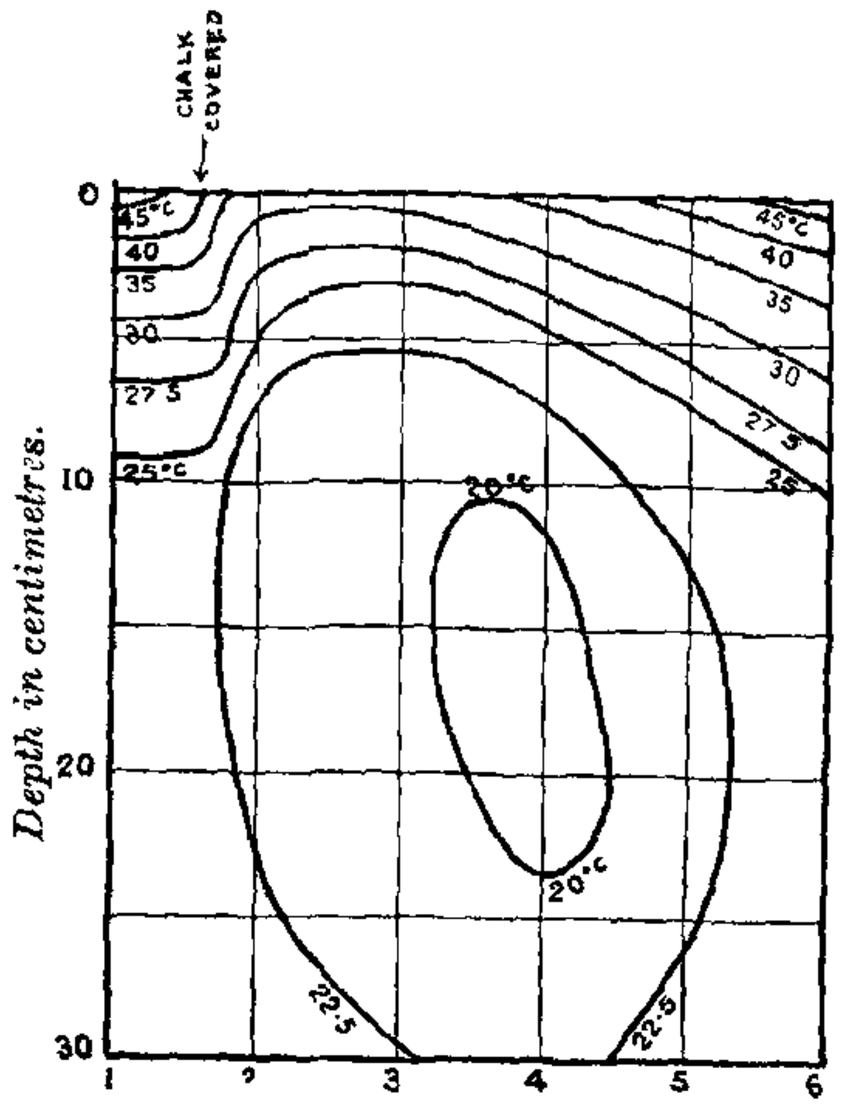
The results obtained in the case of chalk powder and watering to an extent equal to $\frac{1}{2}''$ rain are shown in Figs. 1 and 2.

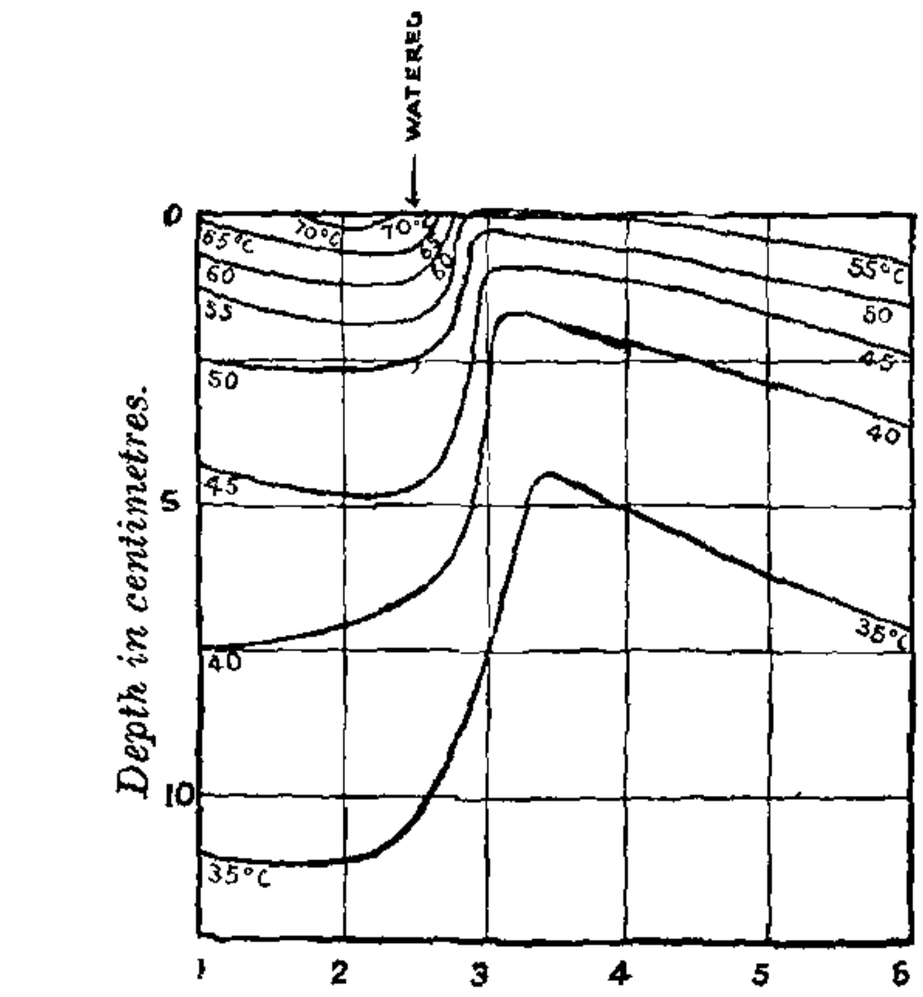
Figs. 1 (*a*) and (*b*) are isopleths of the weekly mean temperatures at 1400 hours in the afternoon in the control and chalk covered plots respectively. The abscissæ refer to the successive weeks and the ordinates refer to the depths below surface. The plots were similar during the 1st week. The layer of chalk powder was given at the beginning of the 2nd week and kept on during the 2nd, 3rd and 4th weeks. At the end of the 4th week the chalk coating was removed. The very conspicuous lowering of the soil temperatures during the 2nd, 3rd and 4th weeks in the experimental plot is shown by the rapid approach of the isotherms towards the surface. It is also interesting to note that it took nearly two weeks after removal of the chalk for the temperatures to equalise in the two plots.

[1] *Quarterly Journal of the Roy. Met. Soc.*, 1927, **53**, 45.









Figs. 1 (a) & 1 (b).—Effect of a thin layer of chalk powder on weekly mean soil temperatures at 1400 hrs. I.S.T. (25-12-33 to 1-2-34). (*a*) Control; (*b*) Chalk put on at the beginning of the 2nd week.

Figs. 2 (a) & 2 (b).—Effect of watering the surface on daily soil temperatures at 1400 hrs. I.S.T. (1-5-34 to 6-5-34). (*a*) Control; (*b*) Surface moistened on 3-5-34.

Figs. 2 (*a*) and (*b*) are the isopleths of daily temperatures at 1400 hours in the control and the surface-wetted plots respectively. The wetting was done at 6 a.m. on the 2nd day. The sudden cooling communicated to the various soil layers is clearly brought out by the rapid approach of the isotherms towards the surface on the 2nd day. The recovery from the effects of wetting was gradual and the temperatures had not yet quite equalised even on the 6th day.

The effect of covering the soil with charcoal powder was less conspicuous because the local soil is already black or nearly black in colour.

This year soil samples of different varieties of colour and texture have been secured from different parts of India and experiments with five plots are being commenced. The effect of different intensities of wetting as well as of a vegetative cover are also included in the programme.