

A note on the relationship of soil temperature with some meteorological factors

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INTRODUCTION

Among the climatic factors that influence crop growth, temperature is one of the most important. Crops differ in their optimum requirements of temperature for satisfactory growth and also in their tolerance to high or low temperatures. The temperature condition of a locality cannot be controlled by man but it is to some extent possible to mitigate their rigour by recourse to various practices.

Both atmospheric temperature and soil temperature are of importance. Increase in atmospheric temperature will step up evaporation and transpiration losses and consequently increase water requirements of crops. Soil temperature is important in many ways. Certain amount of heat is necessary for seed germination and plant growth. When the soil temperature falls below or exceeds the optimum for a given crop, the rate of growth gets adversely affected. Microbial activity of the soil is also influenced by soil temperature. According to Schiller (1961) the optimum soil temperature for the utilisation of potassium is 24°C. The soil moisture tension relationship also gets affected by soil temperature. Richards and Weaver (1944) state that as temperature is lowered soils generally retain more moisture at tension of 1/3 atmosphere than at 15 atmospheres tension. This would therefore mean that moisture conductivity and moisture extraction will be affected by soil temperature variations.

At the Agricultural Meteorological Observatory established at Central Coconut Research Station, Kasaragod, soil temperature data are being regularly recorded twice daily (7-30 and 2-30 I. S. T.) at depths of 5 cm., 15 cm., 30 cm., 2', 4', 6' and 10' depths. A preliminary examination of the data gathered for the past four years was done to study the trend of relationship of soil temperature with some meteorological factors. Since the temperature recorded at 5 cm. depth was found to be affected most by the weather changes, the investigation in the first instance was limited to the observation made at that depth. The results are summarised in this note.

MATERIALS AND METHODS

Data of soil temperature recorded at 5 cm. depth along with that of maximum temperature, relative humidity and duration of bright sunshine relating to the period 1958-1961 were utilised for the study. The daily records were made use of for working out weekly averages for 52 standard weeks of the year. The year was divided into the following three periods roughly on the basis of rainfall distribution in the locality.

<i>Period</i>	<i>No of standard weeks</i>
Hot weather period	— 18 (January 1st to May 6th)
South-west monsoon	— 20 (May 7th to September 23rd)
North-east monsoon	— 14 (September 24th to December 31st)

The influence of the meteorological factors on soil temperature was studied separately for the different periods by calculating the appropriate correlation coefficients.

RESULTS AND DISCUSSION

Total correlation coefficients were worked out every year for various pairs of factors under consideration, *viz.*, soil temperature, maximum temperature, duration of sunshine and relative humidity. The year-wise figures were quite similar and hence were averaged over the four-year period. The results are summarised below:—

	Maximum temperature	Duration of sunshine	Relative humidity
<i>Hot weather period</i>			
Soil temperature	0.5629*	0.3057	0.3376
Maximum temperature		-0.0848	0.2398
Duration of sunshine			0.0927
<i>South-west monsoon period</i>			
Soil temperature	0.8309**	0.9247**	-0.8802**
Maximum temperature		0.7870**	-0.8755**
Duration of sunshine			-0.8185**
<i>North-east monsoon period</i>			
Soil temperature	0.6450*	0.8708**	-0.5463*
Maximum temperature		0.7429**	-0.8115**
Duration of sunshine			-0.7157**

* Significant at 5 per cent level.

** Significant at 1 per cent level.

It is seen that soil temperature is influenced in both the south-west and north-east monsoon periods positively by maximum temperature and duration of sunshine and negatively by relative humidity. No such direct relationship is discernible in the hot weather season. The weather factors among themselves are found related in the south-west and north-east monsoon periods. Thus maximum temperature is positively influenced by duration of sunshine and negatively by relative humidity. The association between sunshine and relative humidity is negative and significant. Since the weather factors are correlated among themselves the total correlation between soil temperature and each of the other factors will not give a true picture of the association. It is necessary to work out partial correlation coefficients to know which of the correlations are real and which spurious. The correlations thus obtained will show how the total correlation is affected when their association with a third factor is allowed for.

The partial correlation data obtained are given below:—

Correlation between	Factor or factors allowed for	Value of partial correlation coefficient	
		S.W. monsoon	N.E. monsoon
Soil temperature and maximum temperature	Sunshine	0.4393	-0.0058
Soil temperature and maximum temperature	Relative humidity	0.2631	0.4120
Soil temperature and sunshine	Maximum temperature	0.7890**	0.7656**
Soil temperature and sunshine	Relative humidity	0.7492**	0.8202**
Soil temperature and relative humidity	Maximum temperature	-0.5679*	-0.0513
Soil temperature and relative humidity	Sunshine	-0.5638*	0.2240
Soil temperature and sunshine	Maximum temperature and relative humidity	0.7316**	0.7852**

The data show that only the correlation between soil temperature and sunshine remains steady and positive and highly significant in both the seasons when the influence of maximum temperature and / or relative humidity has

been eliminated. The correlation between soil temperature and maximum temperature has disappeared in all cases showing thereby that the significance observed in total correlation has been due to the indirect influence of sunshine. The partial correlation between soil temperature and relative humidity during S. W. monsoon period continued to be significant though it suffered a reduction in value, when maximum temperature or sunshine is held constant showing thereby that relative humidity is also of some importance during that season. Similar result is not observed during the north-east monsoon.

The great importance of sunshine in relation to soil temperature is obvious as the sun is the source of heat. Not all the energy radiated by the sun to the earth reaches the surface of the earth. According to Mohr and Van Baren (1954) only less than 50 per cent reach the earth directly and unchanged, 20 per cent is absorbed in the atmosphere and transferred into heat and some 35 per cent is dispersed in the atmosphere as diffused radiation. The amount of radiation is also influenced by the condition of the atmosphere such as presence of particles of dust which scatter and reduce the strength of the radiation and of water vapour which has an absorbing effect.

It is the direct radiation reaching the earth and absorbed by the soil that is mainly responsible for raising the temperature of the surface layer. The disposal of the solar radiation received at soil surface is considerably influenced by soil properties such as colour and thermal conductivity, the latter in turn depending upon chemical composition, moisture content and the pore space or apparent density (Dravid, 1940). In the study under consideration which is concerned only with one soil type (red loam soil), explanation for the variation observed in the different seasons has to be sought for on the basis of actual quantity of radiation received and soil moisture content. Soil moisture is largely influenced by the intensity and duration of rainfall. In the absence of data on these aspects, it is considered hazardous to attempt to explain the observations made in the different seasons. However, the apparent absence of correlation between soil temperature and duration of sunshine in the hot weather might be due to the fact that the range of variation in period of sunshine is small and is not sufficient to make any appreciable change of soil temperature at 5 cm. depth. On the contrary, in the other two seasons the variation is often considerable and of sufficient magnitude to cause parallel changes in soil temperature leading to high and significant correlation. More detailed discussion is not warranted at this stage and is postponed to a later date when the additional data now being gathered will become available.

SUMMARY

A preliminary study of the relationship of soil temperature at 5 cm. depth in the red loam soil of the Central Coconut Research Station, Kasaragod with weather factors such as maximum temperature, period of sunshine and relative humidity was carried out for three different seasons of

the year. There is indication to show that sunshine is having the maximum influence and relative humidity a little. Among the seasons, no clear cut association was seen during the hot weather period. The difficulty of drawing any firm conclusion from the admittedly insufficient data has been indicated.

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