Assessment of Temperature Characteristic for Agriculture in Nashik District

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Abstract:

Solar radiation is abundant in study region due to a tropical location of the study area. But it varies significantly from one season to another. An individual element of weather like temperature can influence crops in particular ways. In this context, temperature value available at two stations namely Malegaon and Ozhar were obtained and averages two decades (1985-2005) were calculated to find out the thermal conditions (Table 1 and Fig. 1) in Nashik District. Therefore, in present study the efforts are taken to know the thermal characteristics of study region for suitability of agro-environment. The expected changes in temperature over the next 30−50 years are predicted to be in the range of 2−3 °C. Analysis revealed that daily minimum temperatures will increase more rapidly than daily maximum temperatures that would have detrimental effects on grain yield.

Key words: temperature variability, agricultural plants, grain crops, productivity

Introduction

Temperature is a primary factor affecting the rate of plant development. Rate of plant growth and development is dependent upon the temperature surrounding the plant and each species has a specific temperature range represented by a minimum, maximum, and optimum. Occasionally, adverse weather conditions can affect the production, if it is experienced during critical stages of growth.

Warmer temperatures expected with climate change and the potential for more extreme temperature events will impact plant productivity. Pollination is one of the most sensitive phenological stages to temperature extremes across all species and during this developmental stage temperature extremes would greatly affect production. The major impacts of warmer temperatures are during the reproductive stage of development and in all cases grain yields are significantly reduced by as much as 50 % from a normal temperature regime. In contrast, the quality of fruit is also adversely affected in humid climates (Patil and Shewale 2003).

An individual element of weather like temperature can influence crops in particular ways. Therefore, in present study the efforts are taken to know the thermal characteristics of study region for suitability of agro-environment.

Aim and Objectives of study: The purpose of this paper is to provide an overview of effects of temperature on production of agricultural plants. In this context, the present work was attempted with objectives

i) To understand the temperature characteristics of Nashik District.

ii) To assess the suitability of temperature conditions for agricultural enterprise.

Data Base and Methodology: Temperature value available at two stations namely Malegaon and Ozhar were obtained and statistical averages of two decades (1985-2005) were calculated to find out the thermal conditions (Table 1 and Fig. 1) in Nashik District.

Review of Literature:

Rate of plant growth and development is dependent upon the temperature surrounding the plant and each species has a specific temperature range represented by a minimum, maximum, and optimum. These values were summarized by Hatfield et al. (2008, 2011) for a number of different species typical of grain and fruit production. The expected changes in temperature over the next 30−50 years are predicted to be in the range of 2−3 °C. (Intergovernmental Panel Climate Change, IPCC, 2007). Extreme events occurring during the summer period would have the most dramatic impact on plant productivity; however, there has been little research conducted to document these effects as found by Kumudini et al. (2014). A recent review by Barlow et al. (2015) on the effect of temperature extremes, frost and heat, in wheat revealed that frost caused sterility and abortion of formed grains while excessive heat caused reduction in grain number and reduced duration of the grain-filling period. Analysis by Meehl et al. (2007) revealed that daily minimum temperatures will increase more rapidly than daily maximum temperatures leading to have detrimental effects on grain yield.

Discussion:

Weather plays a major role in determining the success of agricultural enterprises. Most field crops are dependent solely upon weather to provide life-sustaining water and energy. Occasionally, adverse weather conditions can affect the production, if it is experienced during critical stages of growth. For most plant species, vegetative development usually has a higher optimum temperature than for reproductive development. In general, extreme high temperatures during the reproductive stage will affect pollen viability, fertilization, and grain or fruit formation (Hatfield et al., 2008, 2011).

Maize pollen viability decreases with exposure to temperatures above 35 °C (Herrero and Johnson, 1980; Dupuis and Dumas, 1990). The effect of temperature is enhanced under high vapor pressure deficits because pollen viability (prior to silk reception) is a function of pollen moisture content which is strongly dependent on vapor pressure deficit (Fonseca and Westgate, 2005). Exposure to temperatures above 30 °C damaged cell division and amyloplast replication in maize kernels which reduced the size of the grain sink and ultimately yield (Commuri and Jones, 2001). Rice shows a similar temperature response to maize because pollen viability and production declines as daytime maximum temperature exceeds 33 °C and ceases when exceeds 40 °C (Kim et al., 1996). Current observations in rice reveal that anthesis occurs between about 9 to 11 am in rice (Prasad et al., 2006b) and exposure to high temperatures may already be occurring and will increase in the future. There is emerging evidence that differences exist among rice cultivars for flowering times during the day (Sheehy et al., 2005). Given the negative impacts of high temperatures on pollen viability, recent observations from Shah et al. (2011) suggest flowering at cooler times of the day would be beneficial to rice grown in warm environments.

As daytime temperatures increased from 30 to 35 °C, seed set on male-sterile, female fertile soybean plants decreased (Wiebbecke et al., 2012). This confirms earlier observations on partially male-sterile soybean in which complete sterility was observed when the daytime temperatures exceeded 35 °C regardless of the night temperatures and concluded that daytime temperatures were the primary factor affecting pod set (Caviness and Fagala 1973). In this context, an examination of table no. 1 show that

a) With the onset of southwest monsoon (rainy season) in the month of June, temperature starts decreasing. July, August, September and October are the months of moderate heat due to high humidity, cloudy skies the daytime temperatures are around 31°C.

b) The low daytime temperatures are recorded (28-30°C) in the months of winter viz. November, December and January.Of them, January is the coldest month having lowest minimum temperature (10°C). However rising daytime temp in the month of February (>31°C) and March (35°C)

c) Months of March, April and May are the hottest months of district. However, recent temperature records of Malegaon station revealed that the maximum temperature in May reaches up to 43 - 45°C. At the same time, high temperature during summer also leads to significant moisture loss from the soil surface and crop foliage through evapo-transpiration. That again creates more demand of water for irrigating crops.

Fig. No. 1 Nashik District: Maximum, Minimum and Mean Monthly Temp.

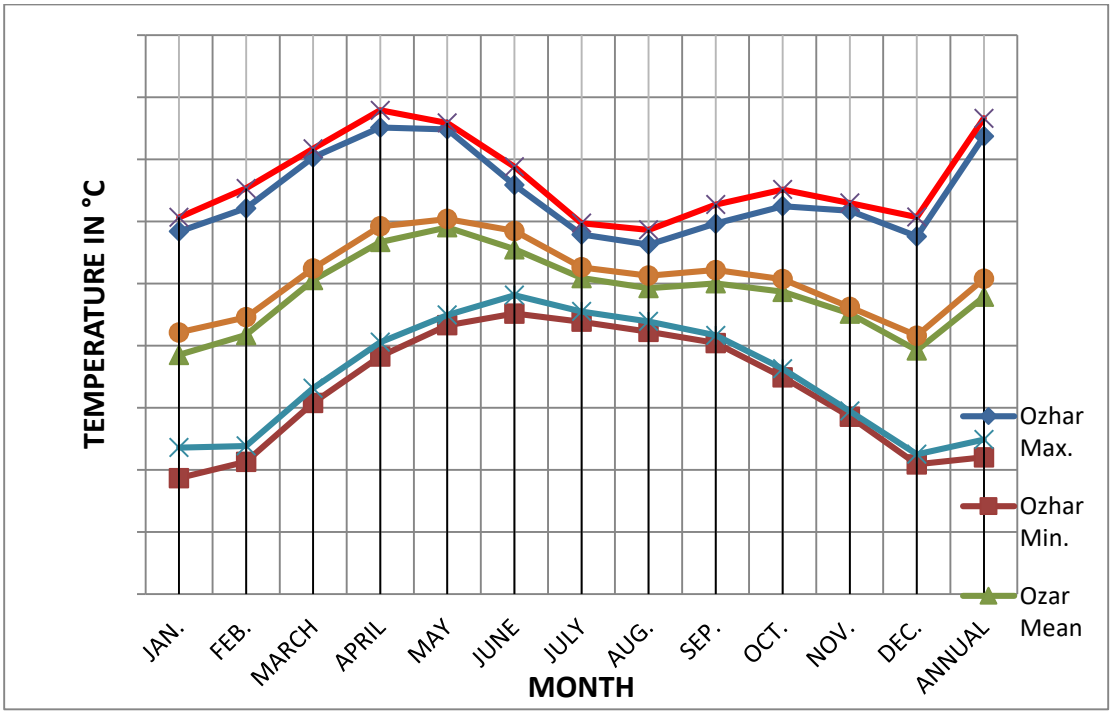

Table No. 1 Maximum, Minimum and Mean Monthly Temperature

Sr. No.	Month	Malegaon Station			Ozhar Station		
		Max. Temp(°C)	Min. Temp (°C)	Mean Monthly	Max. Temp (°C)	Min. Temp (°C)	Mean Monthly
1	Jan	28.2	11.8	21.1	29.2	9.3	19.3
2	Feb	32.7	11.9	22.3	31.1	10.6	20.9
3	Mar	35.9	16.6	26.2	35.2	15.4	25.3
4	April	37.9	20.3	29.6	37.6	19.1	28.3
5	May	39.9	22.5	30.2	38.2	21.6	29.5
6	June	34.4	24.1	29.2	32.9	22.6	27.8
7	July	32.4	22.8	26.3	31.8	21.9	25.4
8	Aug	31.5	21.9	25.6	31.1	21.1	24.6
9	Sept	29.3	20.8	26.1	29.8	20.2	25.0
10	Oct	31.5	18.1	25.4	31.2	17.4	24.3
11	Nov	29.9	14.7	23.1	30.9	14.3	22.6
12	Dec	28.1	10.1	20.8	28.8	10.4	19.6
	Annual	38.3	12.4	25.4	36.9	11.0	23.9

(Source: Compiled by researcher)

Findings:

I. In general, thermal conditions prevailing in the study area has adequate sunshine and warmth available throughout the agricultural year that is conducive to variety of crops. But exposure of plants to temperature extremes at the onset of the reproductive stage has a major impact on fruit or grain production across all species.

II. Two weather observatories namely Malegaon and Ozhar are located 80 km apart from one another, the former is in the eastern part while later in the western part of district obviously indicates the annual difference of 1-2°C in temperature values. Malegoan station located in the semiarid belt indicates high summer and cool winter temperatures compared to Ozhar station, which islocated in proximity to hilly areas in the west.

III. Temperature effects on plant growth and development is dependent upon plant species. Under an increasing climate change scenario there is a greater likelihood of air temperatures exceeding the optimum range for many species.

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