

# Effect of Temperature at Different Dates of Sowing on Growth and Yield of Wheat under Irrigated Conditions of Eastern UP

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**ABSTRACT:** Wheat (*Triticum aestivum* L.) is the most important crop in the world in terms of area harvested and the second most important food crop in the developing world after rice. To meet the increased demand of the exploding world population by 2050, wheat production needs to increase by 60%. However, wheat yields are currently limited by several environmental stresses, and temperature stress is a major one among them. This review focuses on the impact of temperature stress on wheat plants and effect of temperature at different dates of sowing on growth and yield of wheat under irrigated conditions of eastern UP.

**KEYWORDS:** *Triticum aestivum*, sowing, temperature, growth, yield, irrigated, UP

## I. INTRODUCTION



Wheat is a grass widely cultivated for its seed, a cereal grain which is a worldwide staple food. The many species of wheat together make up the genus *Triticum*; the most widely grown is common wheat (*T. aestivum*). The archaeological record suggests that wheat was first cultivated in the regions of the Fertile Crescent around 9600 BCE. Botanically, the wheat kernel is a type of fruit called a caryopsis.[1,2]

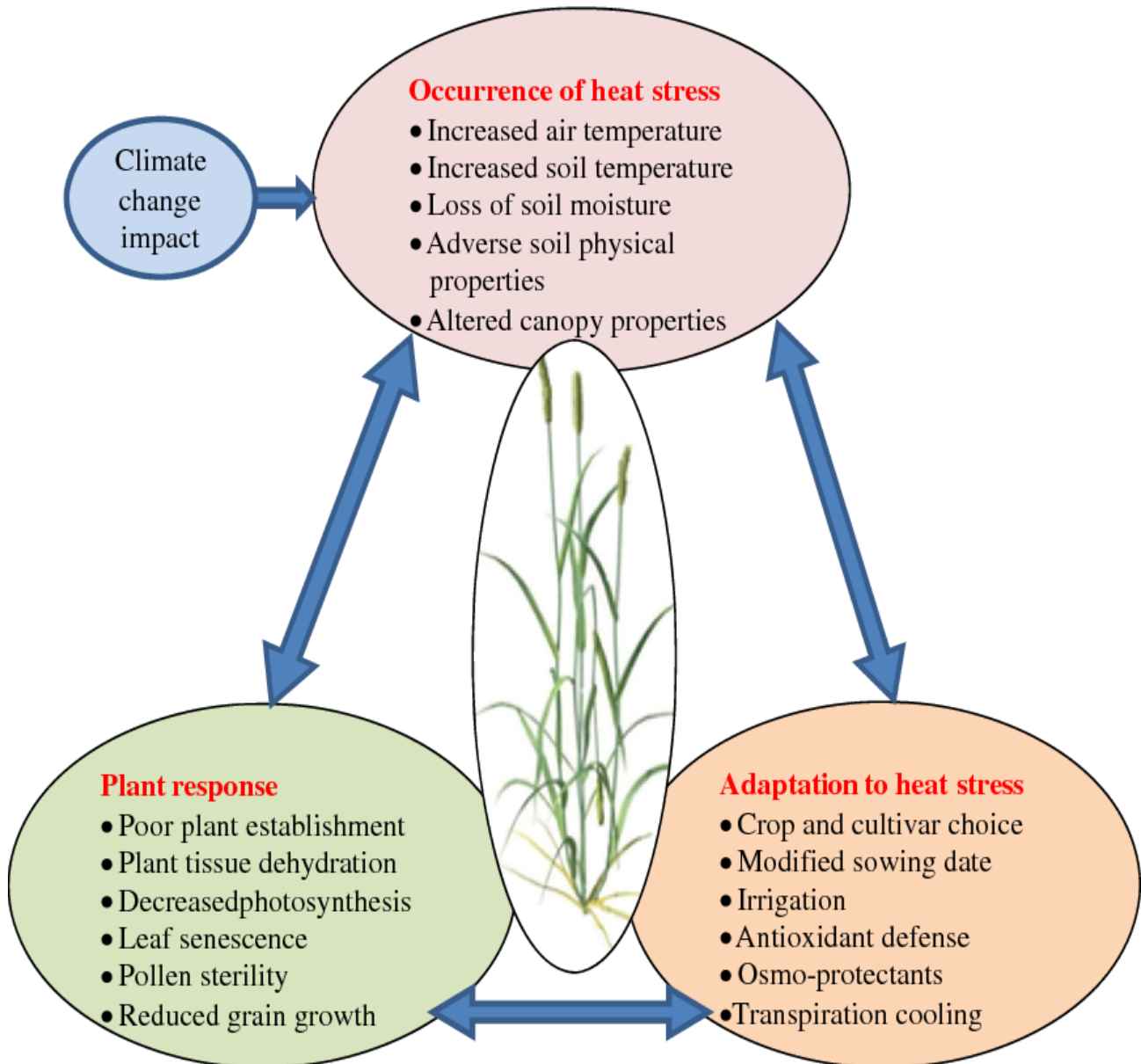
High temperature stress during anthesis or grain filling stage decreased photosynthetic rate (17 and 25%, respectively) and grain yield plant<sup>-1</sup> (29 and 44%, respectively), and increased thylakoid membrane damage (61 and 68%, respectively) compared to their respective control (OT). HT stress during anthesis or grain filling stage increased the molar percentage of less unsaturated lipid species [36:5- monogalactosyldiacylglycerol (MGDG) and digalactosyldiacylglycerol (DGDG)]. However, at grain filling stage, HT stress decreased the molar percentage of more unsaturated lipid species (36:6- MGDG and DGDG). There was a significant positive relationship between photosynthetic rate and grain yield plant<sup>-1</sup>, and a negative relationship between thylakoid membrane damage and photosynthetic rate.



### Sheaved wheat

Low temperatures during the early morning hours have had detrimental effects on winter wheat in some areas of eastern UP. However, cooler spring temperatures that have slowed the winter wheat development this year may have actually been beneficial to producers, as later-maturing wheat is not as susceptible to injury from freezing temperatures.

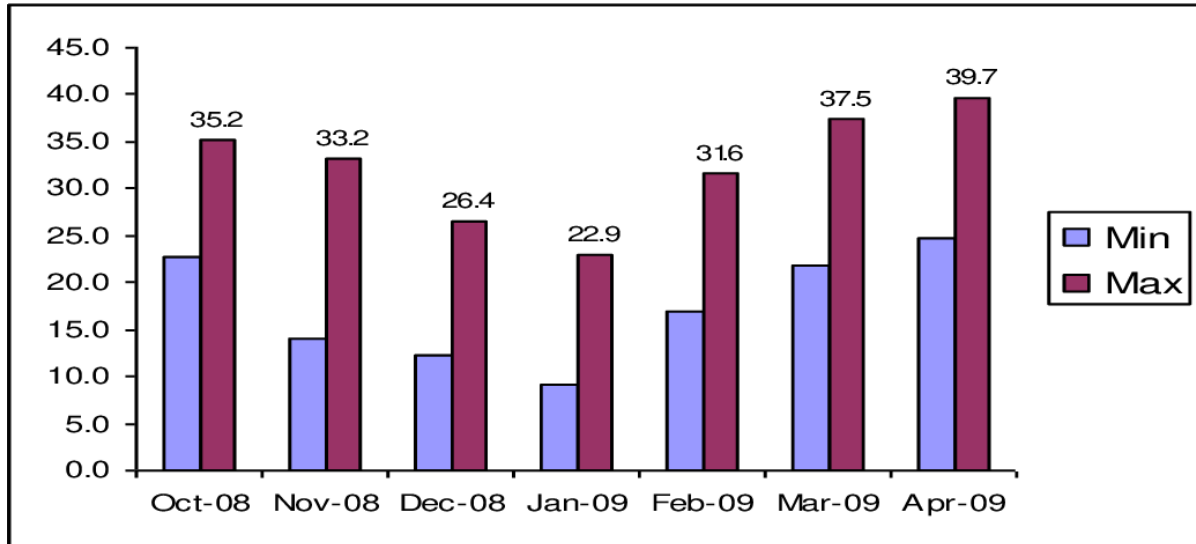
Although growth stage or maturity of the wheat is probably the most important factor, there are other factors, which can also affect the impact of freezes on winter wheat. Length and severity of frost event, plant moisture content, elevation and topography and a thinner canopy can all increase susceptibility of winter wheat to low temperatures. In addition, some varieties may also be more susceptible to a freeze than others. With current annual production at over 600 million tonnes, wheat is the third largest crop in the world behind corn and rice, and an essential source of carbohydrates for millions of people. While wheat is grown over a wide range of environments, it is common in the major wheat-producing countries for grain filling to occur when soil moisture is declining and temperature is increasing. Average global temperatures have increased over the last decades and are predicted to continue rising, along with a greater frequency of extremely hot days.[3,4]



Such events have already been reported for major wheat growing regions in eastern UP of India. However, the direct impact of past temperature variability and changes in averages and extremes on wheat production has not been quantified. Attributing changes in observed yields over recent decades to a single factor such as temperature is not possible due to the confounding effects of other factors. By using simulation modelling, we were able to separate the impact of temperature from other factors and show that the effect of temperature on wheat production has been underestimated. Surprisingly, observed variations in average growing-season temperatures of  $\pm 2$  °C in the main wheat growing regions of Uttar Pradesh can cause reductions in grain production of up to 50%. Most of this can be attributed to increased leaf senescence as a result of temperatures  $>34$  °C. [5,6] Temperature conditions during grain filling in the major wheat growing regions of the world are similar to the Indian conditions in Uttar Pradesh during grain filling. With average temperatures and the frequency of heat events projected to increase with global warming, yield reductions due to higher temperatures during the important grain-filling stage alone could substantially undermine future global food security. Adaptation strategies need to be considered now to prevent substantial yield losses in wheat from increasing future heat stress.[7,8]

II. DISCUSSION

Temperature is increasing continuously at the rate of 0.15-0.17 °C per decade since the industrial revolution. It is influencing agricultural crop productivity.

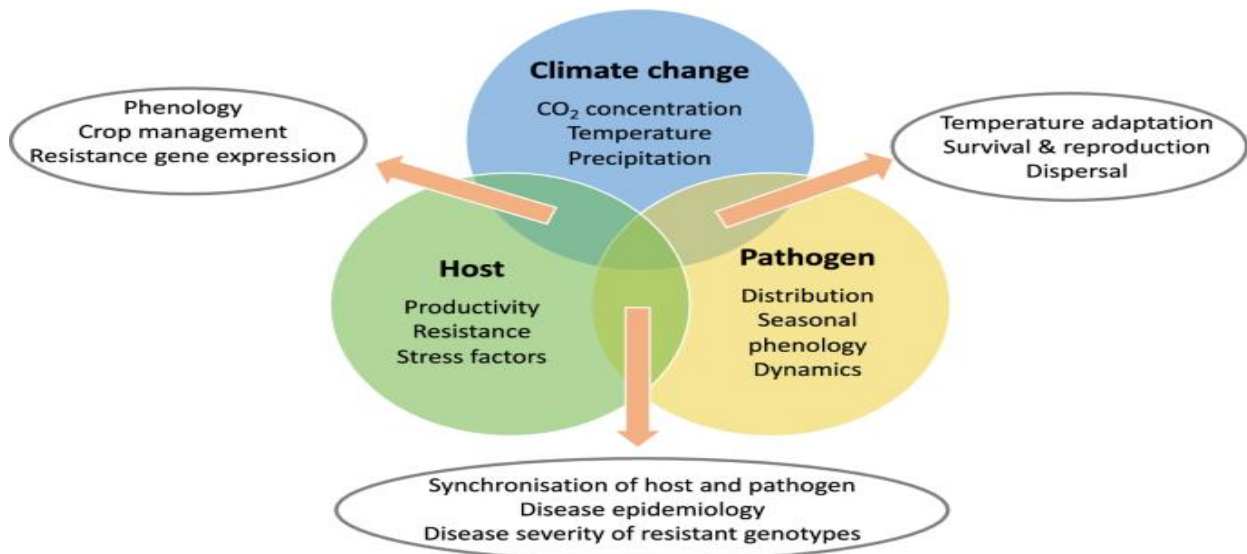


Effect of high temperature on grain yield

Therefore, thermotolerance strategies are needed to have sustainability in wheat yield under higher temperature. However, improving thermotolerance in the wheat is a challenging task for crop scientists. Therefore, this review work was conducted with the aim of providing information on the wheat response in three research areas, i.e., physiology, breeding, and advances in genetics, which could assist the researchers in improving thermotolerance. The optimum temperature for wheat growth at the heading, anthesis, and grain filling duration is  $16 \pm 2.3$  °C,  $23 \pm 1.75$  °C, and  $26 \pm 1.53$  °C, respectively. The high temperature adversely influences the crop phenology, growth, and development. The pre-anthesis high temperature retards the pollen viability, seed formation, and embryo development. The post-anthesis high temperature declines the grain accumulation, stem reserve carbohydrates, and translocation of photosynthates into grains. A high temperature above 40 °C inhibits the photosynthesis by damaging the photosystem-II, electron transport chain, and photosystem-I. [9,10] Our review work highlighted that genotypes which can maintain a higher accumulation of proline, glycine betaine, expression of heat shock proteins, stay green and antioxidant enzymes activity viz., catalase, peroxidase, super oxide dismutase, and glutathione reductase can tolerate high temperature efficiently through sustaining cellular physiology. Similarly, the pre-anthesis acclimation with heat treatment, inorganic fertilizer such as nitrogen, potassium nitrate and potassium chloride, mulches with rice husk, early sowing, presoaking of a 6.6 mM solution of thiourea, foliar application of 50 ppm dithiothreitol, 10 mg per kg of silicon at heading and zinc ameliorate the wheat crop against the high temperature. [11,12] Finally, it has been suggested that modern genomics and omics techniques should be used to develop thermotolerance in wheat in areas specifically eastern UP in India.

III. RESULTS

There have been some extremely high temperatures in eastern Uttar Pradesh. [13]



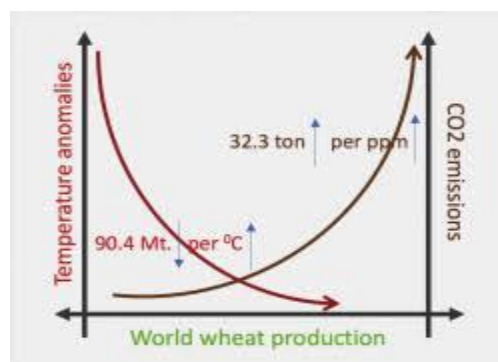
The wheat in these regions will likely be most affected by the heat stress this year since the crop was behind in development and therefore the hot temperatures matched more sensitive phases of the grain-filling period. In other parts of India, wheat is mostly mature or near physiological maturity and should not suffer from the consequences of the heat stress as much.

The effects of hot temperatures on wheat grain development and yield depend on the stage of development of the wheat, the moisture conditions of the soil, and how long the extreme heat lasts. Damage may be minimal in fields where the wheat is at the late dough stages of development. However, where the wheat is still in the milk stages of kernel development, the wheat may experience reductions in test weight and poor grain fill. [14,15]

Wheat begins to suffer when temperatures get above ~81 degrees F. At these temperatures, photosynthesis slows down and stops, but the rate of respiration continues to increase. Basically, the plants begin to use more sugars than they can produce by photosynthesis. At ~91 degrees F, key enzymes begin to break down and stop functioning. As a consequence, the plant does not accumulate sugar (starch) on the grains during heat stress, which results in decreased wheat yield. Protein accumulation, on the other hand, seems to be unaffected by high temperatures and occurs normally under heat stress conditions. Due to a decrease in sugar accumulation coupled with normal rates of protein accumulation, wheat under heat stress tends to have a greater percent protein content. [16]

IV. CONCLUSION

A period of high heat will also destroy membranes of chloroplasts and chlorophyll molecules. Once destroyed, these compounds will not be replaced. [17]



This will result in permanent browning of the leaves. As wheat approaches the 5-leaf stage, head initiation begins. Although it's microscopic at this time, the parts that become the spikelets and kernels are already being formed. Like tillering, temperature also greatly influences the number of spikelets. The average spikelet counts decline almost by a third from 17 to 13. Although cooler daytime temperatures would be desirable to maximize the yield potential, don't feel completely discouraged or disillusioned.[18]

Wheat has a great ability to compensate among yield components. If the conditions during anthesis and grain fill are favorable for wheat, the crop will put its energy in additional kernels per spikelet (three to four rather than two to three) and larger kernels.

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