

**THERMAL REQUIREMENTS OF WHEAT UNDER DIFFERENT GROWING ENVIRONMENTS OF TARAI REGION (UTTARAKHAND)**

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**KEYWORDS:** Growing Degree Days, Phenothermal Index, Heat use Efficiency, Wheat Genotypes and Sowing Dates.

**ABSTRACT:**

Temperature is one of the most important elements of the climate which determines the potential productivity level particularly for winter crops. Heat unit requirement or growing degree days (GDD) has been used for characterizing the thermal response in wheat crop. The quantification of heat use efficiency (HUE) is useful for the assessment of yield potential of a crop in different growing environments. A field experiment was carried out during *Rabi* season of 2007-08 and 2008-09 at the Crop Research Centre (CRC) of G. B. Pant University of Agriculture & Technology, Pantnagar to quantify GDD requirement of different phenophases of wheat with two genotypes as influenced by three sowing dates. Pantnagar is situated at 29° N latitude, 79.3° E longitude and at an altitude of 243.8 m above mean sea level. The area lies in the 'Tarai' belt located in the foot hills of Himalayas. The area falls under sub-humid subtropical climate with an annual rainfall about 1400 mm, out of which 80 percent is received during SW monsoon. The studies revealed that the wheat sown on 20 November, accumulated higher number of GDDs and low PTI with higher HUE, among the genotypes tried. In case of PBW-343 higher GDD was recorded followed by WH-542 during almost all the phenophases of wheat for the year 2007-08 and the trend was also similar during the year 2008-09. Among the sowing dates, crop sown on 09 January accumulated higher PTI for PBW-343 over WH-542 during the study period. The HUE value was highest for the crop sown on 20 November with genotype PBW-343; it decreased with the delayed sowings. Among the sowing dates, higher grain yield was observed with low value of PTI for the crop sown on 20 November during both the years. High value of HUE gave good yield and it decreased with the delayed sowing.

**1. INTRODUCTION**

Temperature is an important weather parameter that affects plant growth, development and yield. Winter crops are vulnerable to high temperature during reproductive stages and differential response of temperature change (rise) to various crops has been noticed under different production environments (Kalra *et al* 2008). Hundal (2004) observed that a 2 °C increase in temperature in wheat or rice resulted in 15-17 percent decrease in grain yield of both crops but beyond that the decrease was very high in wheat. Cool weather during vegetative period and warm weather during maturity are ideal requirements for wheat (Mavi, 1986). Light response i.e. photoperiodism, which not only controls the temperature factor but also regulates the vegetative growth as well as flowering of the plants, is important weather element for wheat crop to assess the thermal response and its requirement during different phenophases to harvest potential yield. Changes in seasonal temperature affect the grain yield mainly through bringing changes in phenological development processes. Heat unit requirement or GDD has been used for characterizing the thermal response in winter wheat crop (Rajput *et al* 1987; Shanker *et al* 1996). The quantification of heat use efficiency (HUE) is useful for the assessment of yield potential of a crop in different environment.

**2. MATERIALS AND METHODS**

A field experiment was carried out during *Rabi* season of 2007-08 and 2008-09 at the Crop Research Centre (CRC) of G. B. Pant University of Agriculture & Technology, Pantnagar to quantify

GDD requirement of different phenophases of wheat with two genotypes viz. PBW-343 and WH-542 as influenced by three sowing dates viz. 20 November, 15 December and 09 January along with three replications. Soil of the experimental field was silty clay loam. The experiment was conducted in split-plot design (SPD). Pantnagar is situated at 29° N latitude, 79.3° E longitude and at an altitude of 243.8 m above mean sea level. The area lies in the 'Tarai' belt located in the foot hills of Himalayas. The area falls under sub-humid subtropical climate with an annual rainfall about 1400 mm, out of which 80 percent is received from mid June to September during SW monsoon. Maximum and minimum temperature (Fig.1) during the crop growing period of wheat was recorded from meteorological observatory of the University. Heat unit concept has been applied to correlate phenological development in crops to predict sowing and maturity dates (Mills, 1964; Nuttonson, 1955). GDD were calculated using base temperature of 5 °C from daily mean temperature.

$$GDD = \sum \left( \frac{T_{max} + T_{min}}{2} \right) - T_b$$

Phenothermal index (PTI), the ratio of degree days to the number of days between two phenological stages was calculated as;

$$PTI = \frac{GDD \text{ between two phenological stages}}{No. of days taken between two phenophases}$$

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Heat use efficiency (HUE) for grain yield was obtained as;

$$HUE = \frac{\text{Grain Yield (kg ha}^{-1}\text{)}}{\text{Accumulated heat units } ^\circ\text{C day}}$$

### 3. RESULTS AND DISCUSSION

#### 3.1 Growing Degree Day (GDD)

Higher GDD was recorded with 20<sup>th</sup> November sowing followed by 15<sup>th</sup> December sowing at almost all the phenophases of wheat, while the lowest GDD was obtained with sowing done on 09<sup>th</sup> January in both the years (Table 1a & 1b). At maturity stage, higher GDD was recorded in case of genotype PBW-343 followed by genotype WH-542 among all the sowing dates tried. In 2007-08 maximum GDD (1601.35) was recorded for PBW-343 followed by WH-542 (1548.80) on 20<sup>th</sup> November sowing (Table 1a). Also, similar results were found for 2008-09 (Table 1b). GDD decreased with late sowing for all the genotypes in both the years. Decreased heat units requirement with delay in sowing were also reported by Rajput *et al*, 1987; Agrawal *et al*, 1999 and Singh *et al*, 2008.

#### 3.2 Phenothermal Index (PTI)

Phenothermal index mostly decreased till jointing to 50% flowering stage during all the sowing dates and genotypes in both the years. Maximum PTI (13.31-22.51 in 2007-08 and 17.46-24.43 in 2008-09) was recorded during maturity stage. In the year 2007-08, among the sowing dates, maximum PTI (22.51) was recorded at 09<sup>th</sup> January sowing for the genotype PBW-343 followed WH-542 (21.34) (Table 2). Also similar results were found in the year 2008-09; maximum PTI (24.43) was recorded for PBW-343 followed by WH-542 (22.94) on 09<sup>th</sup> January sowing (Table 2). Kumari *et al* (2009) also reported similar results.

#### 3.3 Heat Use Efficiency (HUE)

Amongst the date of sowing, timely sown wheat crop (20<sup>th</sup> November) exhibited maximum HUE of 2.93 kg grain ha<sup>-1</sup> deg days<sup>-1</sup> for the genotype PBW-343 followed by WH-542 (2.89 kg grain ha<sup>-1</sup> deg days<sup>-1</sup>) in both the years (Table 3). HUE was found to be decreased with late sowing for both the genotypes during studying period. Timely sowing (normal) of wheat crop, in this region, seems to be essential for harnessing the good impact of the prevailing weather conditions.

#### 3.4 Yield Response of Wheat

Timely sown wheat crop (20<sup>th</sup> November) with an average seasonal air temperature of 16.3 °C produced highest yield of 4691.53 kg ha<sup>-1</sup> in 2007-08 and 4191.53 kg ha<sup>-1</sup> in 2008-09 with an average seasonal air temperature of 17.9 °C. With every 25 days delay in sowings an increase in average seasonal air temperature (17 to 18.6 °C) caused reduction in yield by 13 to 26 percent in the year 2007-08, whereas in 2008-09 an increase in average seasonal air temperature (18.8 to 20.4 °C) caused reduction in yield by 15 to 29 percent (Table 3).

### CONCLUSION

It is therefore, concluded that sowing of wheat crop on 20<sup>th</sup> November required higher GDD during crop growth period with higher HUE and lesser PTI requirement than sowing on 15<sup>th</sup> December and 09<sup>th</sup> January. In 2007-08, 20<sup>th</sup> November sowing recorded maximum grain yield to the extent of 13.17 % higher over 15<sup>th</sup> December sowing and 26.53 % over 09<sup>th</sup> January sowing in case of PBW-343 indicating optimum thermal regime. Maximum grain yield was also recorded in 2008-09 with the crop sown on 20<sup>th</sup> November sowing which was 14.74 % and 29.7 % higher than 15<sup>th</sup> December and 09<sup>th</sup> January sowings for PBW-343 respectively. The response of wheat crop to different thermal regimes, suggests that under the given agroclimatic conditions of Uttarakhand, the wheat crop sown on 20<sup>th</sup> November proved to be beneficial as the farmers can keep good harvest.

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