Studies on heat unites on various phenophases of wheat (*Triticum aestivum*) under different growing environment

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**Abstract**

The present investigation entitled “Studies on Heat unites on various phenophases of wheat (*Triticum aestivum*) under different growing environment” was carried out during Rabi season of 2016-2017, at the Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur to find out the wheat varieties under late sowing conditions in a rice based cropping system. The treatment combinations of three sowing dates (1st December, 11th December and 21st December,) and three varieties (Ratan, GW-273, and GW-366) were laid out in a randomized block design with three replication. The value of GDD, PTU, HTU, RUE and HTU for different varieties were recorded and maximum value in these parameter was found highest in GW-273 under D1 (1st December) growing environment.

**Keywords:** Heat unites (GDD, PTU, THU, HUE, RUE), varieties (Ratan, GW-273, GW-366), yield, dates of sowing

**Introduction**

Wheat is the world’s number one cereal crop after rice, grown under diverse agro-climatic conditions, contributing nearly one-third of total food grains production. This grown is not only in the temperate zone but also in tropical and sub-tropical zone tropical and sub-tropical zones. It can be cultivated as high as 3500 meters above mean sea level. Major wheat producing countries of the world are China, India, United States of America, France, Russia, Canada, Germany, Turkey, Australia, Ukraine, and Pakistan. In the world, an area under cereals is 685.67 million hectare with the production of 2239.39 metric tons and productivity of 3093 kg ha-1. In India crop is grown in an area of 302.27 lakh ha. with the production 93.50 million tons and productivity of 3093 kg ha-1. (Annual report 2015-16) [2]. Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally (Breiman and Graur, 1995) [4]. It is an annual plant that belongs to the grass family Poaceae, tribe Triticeae, and subtribe Triticineae. It is thought to have originated on the Eurasian continent, a starting point from which man spread it throughout the world, including China and Central Europe (Haider, 2012).

Three main species commonly grown in the world including India are the common wheat (*Triticum aestivum*), Marconi or durum wheat (*T. durum*) and emmer wheat (*T. dicoccum*) maximum area are covered by *T. aestivum* out of 3 species. In India, more than 80% of the total wheat area is under this species where as 12% and 1% area under Marconi and emmer wheat. (Draganka *et al*, 2004).

India has a large area under wheat and about 90% of total wheat production is contributed by five states viz., Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, and Rajasthan. The other wheat producing states are Bihar, Gujarat, Jammu and Kashmir, Maharashtra, West Bengal and Chhattisgarh. India the total food grain production for the year 2004 was 212.05 million tons and wheat occupies an area of 2.63 million hectares with the production of 7.2 millions tons and productivity of 2716.98 kg ha-1 (Anonymous, 2010) [3].

**Material and Methods**

The field experiment was carried out at the Research and Instructional farm of Indira Gandhi Krishi Vishwavidyalaya;
The present experiment was conducted during three consecutive tabi seasons of 2016-17. Four prominent wheat cultivars, viz., Ratan GW-273 and GW-366 were used and cultivated in a factorial Randomized Block Design (RBD) with three sowing dates 1 December (D1), 11th December (D2) and 21st December (D3). The GDD, PTU, HTU, Intercepted PAR and HUE were computed by using following formula:

1. Growing degree days (GDD)

\[ \text{GDD} = \frac{(T_x + T_n)}{2} - \text{Base temperature} \]

Where,

\( T_x \) = Daily maximum temperature
\( T_n \) = Daily minimum temperature

2. Photo thermal unit (PTU)

PTU is calculated by multiplying GDD with maximum possible sunshine hours

\[ \text{PTU} = \text{GDD} \times N \]

Where,

\( N \) = maximum possible sunshine hour.

3. Heliothermal unit (HTU)

HTU is calculated by multiplying GDD with actual sunshine hours (n).

\[ \text{HTU} = \text{GDD} \times n \]

Where,

\( n \) = actual sunshine hour.

4. Heat use efficiency (HUE)

Heat use efficiency (HUE) for total dry matter was obtained as under

\[ \text{HUE (g/m}^2/\text{0 day)} = \frac{\text{Biomass (g/m}^2)}{\text{GDD (0 days)}} \]

5. Radiation use efficiency (RUE)

Radiation Use Efficiency (RUE) of different varieties recorded under different growing environments varied considerably (Table 5). On the mean basis higher RUE value was observed under D1 (1st December) sowing followed by D2 (11th December) D3 (21st December) sowing. Among the varieties GW-273 showed better in terms of RUE followed by Ratan and GW-366. In case of GW-273 maximum RUE was observed in D1 (1st December) following by D3 (21st December) and D2 (11th December). In Ratan variety the highest RUE was observed in 11th December followed by 1st December and 21st December. But in case of GW-366 highest RUE value was recorded on 11th December followed by 21st December and 1st December. Lowest RUE was observed under D3 (21st December) sowing in the all varieties.
### Table 1: Accumulated growing degree days (GDD) at different growth stages of wheat varieties under different growing environments

| Sowing dates | Emergence | CRI | Tillering | Penicle initiation | Booting | Penical emergence | Flowering | Milking | Dough | Maturity | Harvest |
|--------------|------------|-----|-----------|-------------------|---------|------------------|-----------|---------|-------|----------|---------|
| D1 - 1 December | 103       | 318 | 502       | 721               | 811     | 886              | 1118      | 1281    | 1491  | 1627     | 1876    |
| D2 - 11 December | 91        | 267 | 448       | 707               | 787     | 850              | 1024      | 1211    | 1483  | 1684     | 1776    |
| D3 - 21 December | 63        | 265 | 430       | 708               | 813     | 882              | 1089      | 1265    | 1472  | 1591     | 1773    |

### Table 2: Accumulated photothermal units (PTU) at different growth stages of wheat varieties under different sowing dates

| Sowing dates | Emergence | CRI | Tillering | Penicle initiation | Booting | Penical emergence | Flowering | Milking | Dough | Maturity | Harvest |
|--------------|------------|-----|-----------|-------------------|---------|------------------|-----------|---------|-------|----------|---------|
| D1 - 1 December | 1119      | 3468| 5489      | 7895              | 8929    | 9791             | 12457     | 14381   | 16667 | 19661    | 21917   |
| D2 - 11 December | 995       | 2923| 4912      | 7834              | 8753    | 9475             | 11697     | 13715   | 16982 | 18533    | 20543   |
| D3 - 21 December | 690       | 2912| 4727      | 7931              | 9130    | 9932             | 12408     | 14523   | 17229 | 18272    | 20317   |

### Table 3: Accumulated heliothermal units (HTU) at different growth stages of wheat varieties under different sowing dates

| Sowing dates | Emergence | CRI | Tillering | PI | Booting | Penical emergence | Flowering | Milking | Dough | Maturity | Harvest |
|--------------|------------|-----|-----------|----|---------|------------------|-----------|---------|-------|----------|---------|
| D1 - 1 Dec.  | 769        | 2491| 3804      | 5299| 6153    | 6751             | 8560      | 10118   | 12143 | 13025    | 15501   |
| D2 - 11 Dec. | 765        | 2155| 3194      | 5304| 6044    | 6647             | 8146      | 9854    | 12006 | 12964    | 14612   |
| D3 - 21 Dec. | 501        | 1792| 2992      | 5443| 6084    | 6645             | 8857      | 9533    | 11941 | 13881    | 14360   |

### Table 4: Heat use efficiency (HUE) at different growth stages of wheat varieties under different growing environments

| Varieties  | Heat use efficiency (g/m² deg. Day) |
|------------|-------------------------------------|
|            | D1-1 December | D1-11 December | D1-21 December | Mean |
| Ratan      | 0.47          | 0.44           | 0.41           | 0.44 |
| GW-273     | 0.43          | 0.45           | 0.39           | 0.42 |
| GW-366     | 0.42          | 0.39           | 0.43           | 0.41 |
| Mean       | 0.44          | 0.43           | 0.41           | 0.41 |

### Table 5: Radiation use efficiency (RUE) at different growth stages of wheat varieties under different growing environments

| Varieties  | Radiation use efficiency (g MJ-1) |
|------------|----------------------------------|
|            | D1-1 December | D1-11 December | D1-21 December | Mean |
| Ratan      | 1.20          | 1.25           | 1.18           | 1.21 |
| GW-273     | 1.27          | 1.17           | 1.23           | 1.22 |
| GW-366     | 1.10          | 1.12           | 1.02           | 1.08 |
| Mean       | 1.19          | 1.18           | 1.14           |      |

### Conclusion

Based on the above findings it was concluded that under 1 December as it produced higher plant height, dry matter, length of spikes, number of effective tillers, test weight, harvest index, as compared to sowing on 11th December and 21st December. However D1 growing environment are best for getting higher yield in all wheat varieties. With respect to the heat units viz., growing degree days, Helio thermal unit, photo thermal unit the early sowing of wheat on 1st December (D1) is also suitable for wheat cultivation in Chhattisgarh plain region and variety GW-273 is suitable cultivar for getting higher grain yield.

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