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# Studies on accumulated thermal unit of rice (*Oryza sativa* L.) cultivars under varying crop growing environment

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**Abstract**
A field experiment was conducted during *kharif season* 2018 entitled "Studies on accumulated thermal unit of rice (*Oryza sativa* L.) cultivarsunder varying crop growing environment." in sandy loam soil of N.D. University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The experiment consisted of nine treatment combinations comprised of three transplanting dates *viz.* July 15th, July 25th and August 04th and three varieties viz., NDR-97, NDR-2064 and BPT-5204. Results reveal that different phenophases of rice markedly varied with only dates of transplanting but also different weather variables which ultimately create the different crop growing environment to harvest the yield accordingly. Accumulated thermal unit was recorded in crop growing environment on July 15th (2158.5 $^0$C days) at all the phenophases followed by July 25th (2059.7 $^0$C days) and August 04th (1934.5 $^0$C days) transplanting while among the cultivars BPT-5204 (2223.5 $^0$C days) was recorded maximum thermal unit due to occurrence of long duration variety.

**Keywords:** Thermal unit, growing environment, growing degree days (GDD), rice

## Introduction
Rice (*Oryza sativa* L.) being the staple cereal food crop, grown in India, providing one third of calories requirement for more than 70% of Indian population. More than 90% of world's rice is grown and consumed in Asia, known as rice bowl of the world. To focus attention on the importance of rice in global food security and necessity rice production and productivity, United Nation General Assembly in 2002, first time declared to celebrate the year 2004 as International year of rice with the name of "Rice is Life". The heat unit concept assumes that a direct and linear relationship between growth and temperature is advantageous for the assessment of yield potential of a crop in different weather conditions. Reaumur was the first to suggest that duration of particular stages of growth is directly related to temperature summation. Knowledge of accumulated GDD can provide an estimate of harvest date as well as crop development stage. However, the impact of temperature, bright sunshine hour as well as day length on the growth habits of this crop are not well documented. The present experiment has been undertaken to address this lacunae (Malo *et al.*, 2018) [7]. The extreme climatic conditions, particularly high temperature, reduce the plant growth and yield significantly (Satake and Yoshida, 1978) [8]. The crop growth response is mainly influenced by the microclimate of crop canopy. Microclimatic environment in the crop refers to the interception of photo synthetically active radiation, prevailing wind speed, soil moisture availability, relative humidity and concentration of CO2.

Temperature and light radiation are key factors affecting crop production. During crop growth period, the occurrence of various phenological events can be estimated by computing accumulated growing degree days (Gouri *et. al*., 2005) [4]. Accumulated growing degree days (GDD) provides an estimate of harvest date as well as development stages of crop (Ketring and Wheless, 1989) [6]. Various developmental stages as well as harvest date of crop can be estimated from the knowledge of accumulated GDD. Thermal time can be used as a tool for characterizing thermal responses in different crops as it is an independent variable to describe plant development (Dwyer and Stewart, 1986) [2]. Hence, the study was taken up to find out the thermal heat units requirement for different rice varieties, viz. NDR-97, NDR-2064 and BPT-5204.

## Materials and Methods

The field experiments was conducted at N. D. University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during *kharif* season of 2018 situated at a distance of about 40 km. away from Ayodhya district headquarter on Ayodhya Raibarelly road. The geographical situation of experimental site lies at latitude 26° 47'North longitude 82° 12' East and altitude of 113 meter from mean sea level in the Indo-genetic alluvium of Eastern Uttar Pradesh. The experiment was carried out in Randomized Block Design (Factorial) and replicated four times. The experiment comprised of three crop growing environment i.e. 15$^{th}$July, 25$^{th}$ July and 04$^{th}$ August with three varieties i.e. NDR-97, NDR-2064 and BPT-5204. Fertilizers were applied @120:60:60 N: $P_2O_5$: $K_2O$ kgha$^{-1}$. 1/3$^{rd}$ of Nitrogen and total phosphorous and potash were applied as basal application just before puddling and incorporated in the top 15 cm soil. Remaining dose of nitrogen was applied as top dressing in two equal doses at tillering and at panicle initiation stages. The soil of the experimental field was silty loam in texture and medium in fertility having pH 8.5.

Accumulated thermal unit of different phenol phases were calculated by using following formula;

$$ATU = \sum_{i=1}^{n} G.D.D.$$

Where,
i= 1, 2, 3…….. n is the number of day.

$$G.D.D. = \frac{(Tmax + Tmin)}{2} - Tbase$$

Where,
Tmax = Daily maximum temperature (°C)
Tmin = Daily minimum temperature (°C)
Tbase = Minimum threshold/base temperature (°C)
For *Oryza* species, A base is considered 10 °C (Ghadekar, 2001) [3].

**Table 1:** Accumulated thermal unit (ATU) as affected by different crop growing environment of rice cultivars

| Treatments | Accumulated thermal unit ($^0$C days) | | | | | |
|---|---|---|---|---|---|---|
| | Tillering | Panicle initiation | Flowering | Milking | Dough stage | Physiological Maturity |
| **Crop Growing environment** | | | | | | |
| 15$^{th}$July | 1130.9 | 1426.9 | 1647.4 | 1881.9 | 2048.6 | 2158.5 |
| 25$^{th}$July | 1069.6 | 1337.8 | 1566.2 | 1802.8 | 1956.9 | 2059.7 |
| 04$^{th}$ August | 1233.4 | 1331.5 | 1445.2 | 1647.2 | 1808.7 | 1934.5 |
| **Cultivars** | | | | | | |
| NDR-97 | 991.1 | 1176.9 | 1331.5 | 1505.9 | 1630.2 | 1728.3 |
| NDR-2064 | 1170.8 | 1269.1 | 1463.3 | 1629.3 | 1960.5 | 2079.9 |
| BPT-5204 | 1370.1 | 1518.7 | 1861.7 | 2011.2 | 2096.8 | 2223.5 |

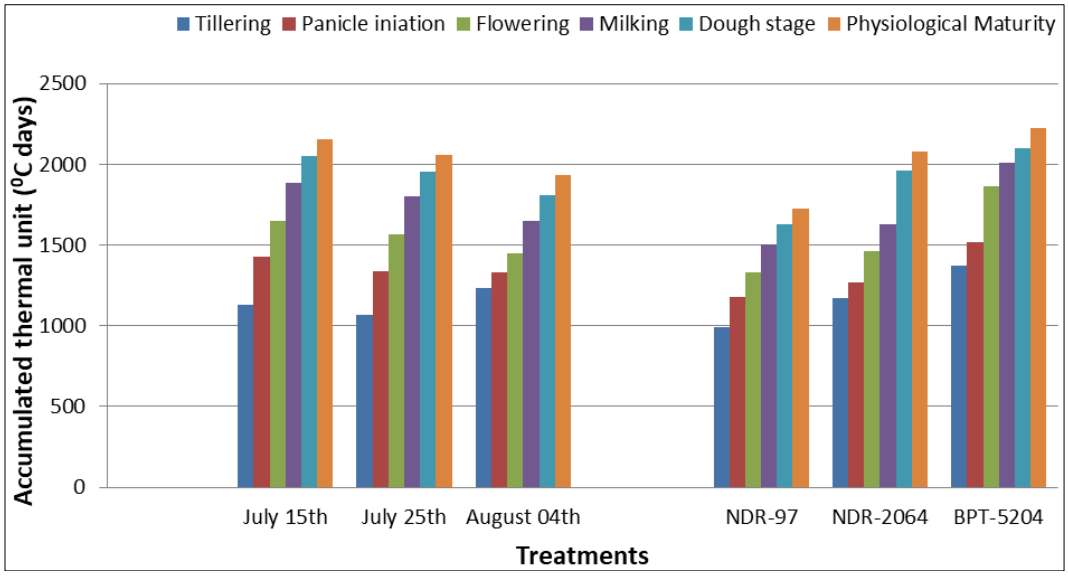


**Fig 1:** Accumulated thermal unit as affected by different crop growing environment of rice cultivars

## Results and Discussion

### Accumulated thermal unit

Accumulated thermal unit at different phenol phases were calculated during crop season of 2018. Maximum accumulated thermal unit (2158.5°C days) was recorded in crop growing environment of July 15$^{th}$ followed by July 25$^{th}$ (2059.7°C days) due to fulfillment of required thermal unit in longer duration and lowest was recorded in August 04$^{th}$ (1934.5°C days) growing environment due to occurrence of less duration of crop. Among the cultivars, maximum thermal unit was recorded maximum in variety BPT-5204 (2223.5°C days) followed by NDR-2064 (2079.9°C days) mainly due to optimum growth of treatment caused by longer duration. Similar results were reported by Halder *et al.* (2010) [5].

## Conclusions

The present study indicates that the application of heat units provides a scientific basis for determining the effect of temperature and radiation or photoperiod on phenological behavior of a standing crop. It was concluded that maximum

accumulated thermal unit (2158.5°C days) was recorded in crop growing environment of July 15th. Among the cultivars, the maximum thermal unit was recorded in variety BPT-5204 (2367.2°C days).

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