International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

I J F B S International Journal of Fauna And Biological Studies

E-ISSN: 2347-2677
P-ISSN: 2394-0522
IJFBS 2018; 5(1): 198-199
Received: 01-11-2017
Accepted: 02-12-2017

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Heat units requirement of wheat crop influenced by genotypes and different thermal environments in Chhattisgarh plain zone

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Abstract
The present experiment was carried out during *rabi* season of 2016-17 at the research cum instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh to find out the heat units requirement of wheat crop influenced by genotypes and different thermal environments in Chhattisgarh plain zone. Raipur is located in south-eastern part of Chhattisgarh belongs to Chhattisgarh plain zone at latitudes, longitudes and altitudes of $21^0$16' N, $81^0$36' E and 289.5 m above mean sea level respectively. The experiment was laid out in factorial Randomized Block Design with three replications and two factors. First factor (thermal environment) viz., D_1 – 15 Nov. and D_3 – 15 Dec, second factor was varieties (3); V_1 -CG 1013, V_2-Kachan, and V_3 –HD 2967. The fertilization, irrigation and management practices as recommended in the packages of practices for wheat crop in the Chhattisgarh plain zone were strictly applied. The weather data required for the study were collected from the Agrometeorological Observatory of the Department of Agrometeorology, of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh. The results observed in this experiment indicate that highest values heat units (GDD, PTU & HTU) recorded when crop sown on D_1-15^{th} Nov. followed by D_2 – 30 Nov. In case of *cv.* HD-2967 accumulated highest GDD, PTU and HTU.

Keywords: GDD, HTU, PTU and wheat

Introduction
Wheat (*Triticum species*) is a crop of global significance. It is grown in diversified environments. It is a staple food of millions of people. Approximately one-sixth of the total arable land in the world is cultivated with wheat. Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally (Breiman and Graur, 1995) [1]. The climatic conditions, mostly temperature influence the wheat production to a great extent across the globe. Seasonal temperature is an important climatic factor which has profound effects on the yield of *rabi* crops. Change in seasonal temperature affect the grain yield, mainly through phenological development processes. Winter crops are especially vulnerable to high temperature during reproductive stage and differential response of temperature change (rise) to various crops has been noticed under different production environments (Kaur and Hundal, 2007) [4]. Wheat is highly vulnerable to high temperature and delayed sowing exposes of its grain filling stage (Pandey *et al*., 2015) [2]. Germination takes longer period at lower temperature and as the temperature increase the rate of germination increases. Wheat is long day plant, temperature ranging between 20^o to 25 ^{o}C is ideal for seed sowing and germination. Whereas the optimum temperature for vegetative growth ranges from 16^o to 22 ^{o}C. During grain development wheat requires a mean maximum temperature of about 25 ^{o}C for at least 4-5 weeks.

Material and Methods
Field experiment was carried out at the research cum instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during the *rabi* season of 2016-17. Raipur is located in south-eastern part of Chhattisgarh belongs to Chhattisgarh plain zone at latitudes, longitudes and altitudes of $21^0$16' N, $81^0$36' E and 289.5 m above mean sea level respectively. The experiment was laid out in factorial Randomized Block Design with three replications and two factors. First factor (thermal environment) viz., D_1 – 15 Nov. D_2 – 30 Nov. and D_3 – 15 Dec, second factor was varieties (3); V_1 -CG 1013, V_2-Kachan, and V_3 –HD 2967. The fertilization, irrigation and management practices as recommended in the packages of practices for wheat crop in the Chhattisgarh plain zone were strictly applied.

The weather data required for the study were collected from the Agrometeorological Observatory of the Department of Agrometeorology, of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh. The heat unit indices viz., growing degree days (GDD), heliothermal unit (HTU), and photothermal units (PTU) were calculated to quantify the thermal heat requirements. All these indices were calculated as follows:

Growing degree days (GDD) $=\Sigma (T_{Max} + T_{Min}) /2-T_{Base}$

Where T_{Max} and T_{Min} are the maximum and minimum temperatures (°C) of the day and T_{Base} is base temperature which was taken as 10°C (Whiley *et al*., 1991) [3].

Heliothermal units (HTU) = GDD × actual bright sunshine hour (n)

Photothermal units (PTU) = GDD × maximum possible bright sunshine hours (N)

Results and discussion

Accumulated growing degree days (GDD)

The accumulated growing degree days (GDD) for different genotypes under different thermal environments varied considerably at maturity stage presented in Table 1. Different wheat genotypes responded differently in terms of accumulated GDD. The highest accumulated GDD was observed under D_1 (15th Nov.) sowing in variety HD-2967 (2011) followed by D_3 (15th Dec.) sowing (1938) in the same variety.

In case of Kanchan higher accumulated GDD was noticed under D_1 (15th Nov.) sowing (1850) and lowest was noticed under D_2 (30th Nov.) sowing (1766) Similarly CG1013 variety showed highest accumulated GDD at maturity was noticed under D_1 (15th Nov.) sowing (1829) followed by D_2 (30th Nov.) sowing (1766) and D_3 (15th Dec.) sowing (1741).

Accumulated Photo Thermal Unit (PTU)

The accumulated Photo Thermal Unit (PTU) for different genotypes under different thermal environments presented in table 1 at maturity stage. The highest PTU (22817) noticed in HD-2967 when crop on 15th November (D_1) followed by 15th December (D_3) sowing (22592) in the same genotype at maturity. In genotype Kanchan higher PTU (20833) observed under 15th November (D_1) followed by 15th December (D_3) as a value 20799 and lowest PTU was observed when crop sown on 30th November (D_2) (20116). Similar pattern was showed by CG-1013.

Accumulated Helio Thermal Unit (HTU)

The variation in mean daily temperature and bright sunshine hour among three sowing dates resulted in varied accumulated heliothermal units at maturity stage and life cycle of wheat crop. In the all genotype 15th Nov. (D1) sowing of wheat recorded highest summed value at maturity (16252) in HD-2967 followed by Kanchan (15095) and least in CG-1013 (14934). As sowing was delayed, the accumulated helio thermal unit values also decreased. In 30th Nov. (D2) sowing HD-2967, Kanchan and CG-1013 recorded the HTU values 15519, 14182, 14182 respectively. Though 15thDec. (D3) sowing crop being experienced with greater temperature and bright sunshine hour during heading to maturity accumulated more HTU in all the genotypes even the less number of day than the 30th Nov. (D2) sowing crop as HD-2967 recorded highest HTU (16040) followed by Kanchan (14748). Similar result reported by Sen *et al*., 2015 [5].

Table 1: Different thermal indices (GDD, PTU and HTU) in wheat crop at maturity stage influenced by different varieties under different thermal environments.

Sowing dates	GDD	PTU	HTU
***Cv.* CG-1013**			
D1	1829	20631	14934
D2	1766	20116	14182
D3	1741	20130	14286
Cv. Kanchan			
D1	1850	20883	15095
D2	1766	20116	14182
D3	1794	20799	14748
Cv. HD-2967			
D1	2011	22817	16252
D2	1915	21902	15519
D3	1938	22592	16040

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