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Identification of thermally stable varieties of wheat under late sowing conditions of rice based cropping system in Chhattisgarh

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Abstract
To find out the most suitable variety of wheat after harvest of rice under late sowing condition in Chhattisgarh plain region an experiment was conducted during *rabi* season of 2011-2012 at the Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur. The treatment combinations of five sowing dates (26 November, 06 December, 16 December, 26 December and 05 January) and four varieties (Kanchan, GW-273, Sujata and Amar) were laid out in a Split plot design with three replication. Result reveals that accumulated growing degree days (GDD) for different varieties under different thermal environments varied considerably from sowing to maturity. Different wheat varieties responded differently in terms of accumulated GDD at the time of maturity. Higher GDD was observed under D_1 (26 November) in varieties Sujata and Amar. highest PTU was observed in D_5 (05 January) in Kanchan and GW-273 while Sujata and Amar showed higher PTU value in D_1 (26 November). Similar trend was also found in case of the highest Heliothermal Units (HTU) was observed under D_5 (05 January) in varieties Kanchan and GW-273 where as Sujata and Amar showed the highest value of HTU in D_1 (26 November). In case of grain yield of wheat, dates of sowing significantly influenced grain yield (kg/ha) in different varieties. Maximum grain yield was observed in D_1 as compare to delayed sowings (D_2, D_3, and D4). Under the D_1 the grain yield was observed maximum in Sujata and minimum in Kanchan.

Keywords: Wheat, heat unit, GDD, PTU, HTU, yield

Introduction
The productivity of wheat in Chhattisgarh is very low (1108 kg/ha) as compared to the national average (2907 kg/ha). Solar radiation is the ultimate power source in the world and it plays an important role in terrestrial ecological systems and living organisms. Temperature based agrometeorological indices such as growing degree days (GDD) can be quite useful in predicting growth and yield of crops. Growing degree days are based on the concept that real time to attain a phenological stage is linearly related to temperature in the range between base temperature (T_b) and optimum temperature. The occurrence of different phenological event during growing season of any crop and the effect of temperature on plant growth can be inferred using accumulated heat units or growing degree days (GDD). The duration of each growth phase is a result of crop response to external environmental factors. The concept of heat units has been applied to correlate the phenological development of different crops to predict grain yield and phenological maturity (Swan *et al*., 1987) [7]. All India Co-coordinated Wheat Improvement Project released many wheat varieties suited for normal and delayed sowing conditions for different states. Short duration varieties like LOK–1, GW-273, and WH-147 are found suitable for this region. Lot of work has been done on dates of sowing in India. However, very little work has been done in Chhattisgarh on the effect of weather parameters particularly temperature during crop growing season. Looking in to this, the present experiment has been conducted to identify thermally stable varieties of wheat under late sowing conditions of rice based cropping system in Chhattisgarh.

Materials and Methods
The field experiment was carried out at the Research cum Instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur situated in Eastern Central part of Chhattisgarh. During crop growing period of *rabi* season (December to February) only 33.8 rainfall is received and hence wheat is mostly grown under irrigated conditions. Maximum and minimum temperature ranges between 24.4 ^{0}C to 42.6 ^{0}C and 10.0 ^{0}C to 27.5 ^{0}C (1 SMW and 22 SMW) during the year. Atmospheric humidity is normally higher during June to September thereafter, decreases during Rabi with increased sunshine hours. Six irrigations (excluding rainfall) were given to the crop for proper growth and development from sowing to maturity.

Come up irrigation was given just after sowing and the rest five irrigations were given at crown root initiation, tillering, late jointing, flowering and dough stages, respectively. The crop was harvested on different dates as per maturity of the respective varieties. Following heat units were used to identify the thermally stable varieties of wheat-

1. Growing degree days: Growing Degree Days (GDD) concept assumes that there is a direct and linear relationship between growth and development of plants Temperature and growth is dependent on the total amount of heat to which it is subjected during its life time. The growing degree days was computed by using following formula:

GDD = Σ [(Tx + Tn)/2 – Base temperature]

Where,
Tx = Daily maximum temperature
Tn = Daily minimum temperature

The base Temperature is defined as, "The temperature below which no plant physiological activity takes place" which is considered 5.0 for rabi crops.

2. Photothermal Unit (PTU)
PTU is calculated by multiplying GDD with maximum possible sunshine hours

PTU = GDD X N

Where,
N = maximum possible sunshine hour.

3. Heliothermal Unit (HTU)
HTU is calculated by multiplying GDD with actual sunshine hours (n) (Rajput, 1980).

HTU = GDD X n

Where,
n = actual sunshine hour.

Results and Discussion
In Chhattisgarh wheat is mostly grown under irrigated condition in command area and in tube well irrigated areas. The heat unit requirement of the crop completed earlier as compared to traditional wheat growing areas because of shorter winter span and higher temperature during grain filling and maturity stages. The results obtained from the data pertaining to GDD, PTU, HTU and grain yield accumulated by different wheat varieties under different thermal environment depicted in the table No. 1 to 4.

Growing degree day (GDD): Heat unit requirement or GDD has been used for characterizing the thermal response in wheat crop (Rajput *et al.,* 1987) [5] and other crops. Bright sunshine hours, maximum and minimum temperature during the growth period were recorded from meteorological observatory of the University Growing degree days (GDD) were computed by taking a base temperature 5 ^{0}C (Nuttonson, 1955). It was evident from the Table 1 that accumulated growing degree days (GDD) for different genotypes under different thermal environments varied considerably from sowing to maturity. Different wheat varieties responded differently in terms of accumulated GDD at the time of maturity. Higher GDD was observed under 26 November sowing (D_1) in varieties Sujata and Amar.
In case of Kanchan higher GDD was noticed under 05 January sowing followed by 26 December and 26 November sowing. Lower GDD was noticed under 16 December sowing. But, In case of GW-273 higher GDD was noticed under 26 November sowing and lowest was noticed under 26 December sowing. In general the GDD Showed fluctuating trend for Kanchan and GW-273, this may due to early maturity of crops under delayed sown condition because of higher temperature. On an average over the five dates of sowing all the varieties required similar (85.8 ^{o}C) GDD for emergence. But, after emergence the variation in GDD requirement was noticed for eg. Kanchan and GW-273 required 306.8 ^{o}C GDD and Sujata and Amar required 303.3^{o}C and 303.7 ^{o}C GDD, respectively at maturity. lowest 1844.8 ^{o}C GDD requirement was noticed for Kanchan while highest 2076.3 ^{o}C GDD requirement was noticed for Amar. This showed that Kanchan matured earlier as compared to Amar.
In case of variety Sujata and Amar, the GDD value was highest in 26 November followed by 06 December, 16 December and 26 December and 05 January at maturity. Decreased heat unit requirement with delay in sowing were also reported by Rajput *et al.,* (1987) [5] and Agrawal *et al.* (1999) [1]. Gill (2009) [3] also found that cumulative growing degree days (GDD) accumulated more during the reproductive phases as compared with the vegetative phases of wheat cultivars. The GDD is the effective selection criteria for screening thermotolerant lines of wheat.

Photo Thermal Unit (PTU): Different wheat varieties responded differently in terms of accumulated PTU at the time of maturity. Highest PTU was observed under 05 January sowing (D_5) in case of Kanchan and GW-273 while the Just reverse trend was observed in case of Sujata and Amar i.e. the height PTU was recorded under 25 November sowing. The data on PTU of different wheat varieties accumulated under varying sowing dates are given in Table 4.8. Photothermal unit (PTU) for different genotypes under different thermal environment varied considerably at maturity (Table 2). In case of variety Sujata and Amar the highest PTU was observed under 26 November sowing which decreased 26 November, 06 December, 26 December and 16 December. In case of GW-273 maximum PTU was observed in 05 January followed by 26 November, 26 December, 16 December and 06 December. The highest PTU value was observed in case of Kanchan under sowing date of 05 January which is followed by 26 December, 26 November, 16 December and 06 December. Singh *et al.* (2008) [6] also revealed that wheat sown on 5 Nov. and 20 Nov. recorded higher accumulated GDD, Heliothermal units; photo thermal unit and phenothermal index at all the phenopheses over sowing done on December 5th in which higher yield of wheat was recorded. Higher thermal units under 5 November and 20 November sowing were not found conducive for a better yield of wheat crop. Lesser value of cumulative PTI during crop period produces higher grain yield in December 5th sowing.

Helio Thermal Unit (HTU): Heliotermal unit (HTU) for different genotypes under different thermal environment varied considerably under maturity period (Table 3). In case of Kanchan the highest HTU was observed under 05 January followed by 26 December, 16 December, 06 December and 26 November. In case of GW-273 maximum HTU was

observed in 05 January followed by 16 December, 26 December, 26 November and 06 December. In variety Sujata the highest HTU was observed in 26 November followed by 06 December, 16 December, 26 December and 05 January. But in case of Amar highest HTU value was recorded on 26 November followed by 16 November, 06 December, 26 December and 05 January. The growing degree day GDD for entire crop growing period decreased with subsequent delay in sowing, where as HTU, PTU were decreased up to late sowing date (D_3) but increased under very late sowing date (D_4) condition.

The occurrence of different Phenological events during growing season of any crop and the effect of temperature on plant growth can be inferred using accumulated heat units or growing degree days (GDD). The duration of each growth phase is a result of crop response to external environmental factors. The concept of heat units has been applied to correlate the Phenological development of different crops to predict grain yield and physiological maturity (Swan *et al*., 1987) [7].

Grain yield (kg/ha): Grain yield as influenced by different sowing dates are given in Table 4. Varieties and sowing dates showed significant effect on grain yield. On the mean basis the variety Kanchan produced higher grain yield (3214.7 kg/ha) followed by Amar (3130.0 kg/ha), Sujata (3002.2 kg/ha) and GW-273 (2898.3 kg/ha). On an average wheat varieties sown on 06 December produced maximum grain yield followed by sowing on 16 December. The varieties Sujata, Kanchan and GW-273 produced maximum grain yield (3837.5 kg/ha, 3670.0 kg/ha and 3643.3 kg/ha respectively) when sown on 06 December (D2), whereas the variety Amar, sown on 26 December (D4) produced maximum grain yield (3875.0 kg/ha).

Table 1: Accumulated growing degree days (GDD) at different growth stages of wheat varieties under different thermal environments

Sowing dates	Emergence	C.R.I.	Tillering	Ear emergence	50% Flow.	Milking	Dough	Maturity
Kanchan								
D1-26 Nov.	90.5	349.2	776.7	964.3	1079.3	1191.7	1373.2	1848.5
D2-06 Dec.	83.7	315.2	718.7	923.9	1050.3	1185.0	1361.6	1813.8
D3-16 Dec.	71.8	291.9	730.8	924.7	1057.4	1178.0	1353.3	1810.2
D4-26 Dec.	81.4	303.5	767.5	978.5	1096.5	1195.8	1375.3	1855.2
D5-05 Jan.	102.0	274.5	830.0	1045.1	1147.5	1226.3	1407.0	1896.5
Mean	85.8	306.8	764.7	967.3	1086.2	1195.4	1374.1	1844.8
GW-273								
D1-26 Nov.	90.5	349.2	776.7	964.3	1094.9	1221.2	1431.2	1891.7
D2-06 Dec.	83.7	315.2	718.7	923.9	1050.3	1185.0	1398.7	1835.4
D3-16 Dec.	71.8	291.9	719.0	924.7	1076.6	1197.6	1390.0	1835.4
D4-26 Dec.	81.4	303.5	748.1	978.5	1096.5	1195.8	1375.3	1827.5
D5-05 Jan.	102.0	274.5	808.5	1045.1	1167.1	1271.1	1429.6	1870.7
Mean	85.8	306.8	754.2	967.3	1097.1	1214.1	1405.0	1852.1
Sujata								
D1-26 Nov.	90.5	349.2	931.4	1129.4	1339.1	1532.5	1706.6	2220.5
D2-06 Dec.	83.7	315.2	883.0	1069.7	1280.7	1455.2	1619.7	2129.7
D3-16 Dec.	71.8	274.3	844.3	1021.1	1234.8	1409.5	1579.3	2097.3
D4-26 Dec.	81.4	303.5	845.4	1000.0	1195.8	1355.4	1511.6	2013.2
D5-05 Jan.	102.0	274.5	830.0	983.0	1147.5	1293.6	1452.7	1922.0
Mean	85.8	303.3	866.8	1040.6	1239.6	1409.2	1574.0	2076.5
Amar								
D1-26 Nov.	90.5	349.2	1129.4	1129.4	1339.1	1532.5	1706.6	2220.5
D2-06 Dec.	83.7	315.2	1050.3	1050.3	1260.3	1435.3	1596.9	2101.5
D3-16 Dec.	71.8	291.9	1021.1	1021.1	1234.8	1409.5	1579.3	2097.3
D4-26 Dec.	81.4	303.5	1000.0	1000.0	1195.8	1355.4	1511.6	2013.2
D5-05 Jan.	102.0	259.1	1004.7	1004.7	1167.1	1317.7	1477.1	1949.0
Mean	85.8	303.7	1041.1	1041.1	1239.4	1410.0	1574.3	2076.3

Table 2: Accumulated Photothermal Units (PTU) at different growth stages of wheat varieties under different thermal environments

Sowing dates	Emerg-ence	C.R.I.	Tillering	Ear emergence	50% Flow.	Milking	Dough	Maturity
Kanchan								
D1-26 Nov.	1008.2	3816.8	8471.1	10523.4	11810.2	13098.3	15178.9	20806.5
D2-06 Dec.	906.8	3416.8	7821.1	10103.9	11551.9	13096.1	15310.0	20557.0
D3-16 Dec.	777.8	3169.4	7992.1	10214.7	11734.9	13117.0	15220.6	20703.6
D4-26 Dec.	881.8	3310.2	8498.3	10916.4	12299.9	13490.9	15645.5	21502.6
D5-05 Jan.	1115.3	3002.5	9313.7	11872.8	13102.2	14047.2	16215.6	22319.4
Mean	938.0	3343.1	8419.2	10726.2	12099.8	13369.9	15514.1	21177.8
GW-273								
D1-26 Nov.	1008.2	3816.8	8471.1	10532.4	11989.0	13437.0	15843.6	21325.5
D2-06 Dec.	906.8	3416.8	7821.1	10103.9	11557.9	13096.1	15575.8	20811.4
D3-16 Dec.	777.8	3169.4	7857.4	10214.7	11954.9	13352.8	15661.6	21006.6
D4-26 Dec.	881.8	3310.2	8276.0	10916.4	12299.9	13490.9	15645.5	21153.0
D5-05 Jan.	1115.3	3002.5	9067.3	11872.8	13337.4	14585.4	16487.4	21993**.2**
Mean	938.0	3343.1	8298.5	10728.0	12227.8	13592.4	15842.8	21257.9
Sujata								
D1-26 Nov.	1008.2	3816.8	10164.0	12384.9	14787.5	17015.1	19104.3	25301.8

D2-06 Dec.	906.8	3416.8	9634.6	11774.2	14192.3	16253.2	18227.2	24428.8
D3-16 Dec.	777.8	2976.3	9292.8	11318.9	13798.6	15895.6	17933.2	24311.2
D4-26 Dec.	881.8	3310.2	9391.7	11162.8	13490.9	15406.7	17281.1	23496.5
D5-05 Jan.	1115.3	3002.5	9313.7	11128.2	13102.2	14858.4	16764.6	22641.2
Mean	938.0	3304.5	9559.3	11553.8	13874.3	15885.8	17862.1	24035.9
Amar								
D1-26 Nov.	1008.2	3816.8	10012.5	12384.9	14787.5	17015.1	19104.3	25301.8
D2-06 Dec.	906.8	3416.8	9481.6	11551.9	13958.5	16015.1	17953.6	24073.0
D3-16 Dec.	777.8	3169.4	9292.8	11318.9	13798.6	15895.6	17933.2	24311.2
D4-26 Dec.	881.8	3310.2	9391.7	11162.8	13490.9	15406.7	17281.1	23496.5
D5-05 Jan.	1115.3	2834.6	9544.0	11388.6	13337.4	15144.0	17057.4	22982.0
Mean	938.0	3309.5	9544.5	11561.4	13874.6	15895.3	17865.9	24032.9

Table 3: Accumulated Heliothermal Units (HTU) at different growth stages of wheat varieties under different thermal environments

Sowing dates	Emerg-ence	C.R.I.	Tillering	Ear emergence	50% Flow	Milking	Dough	Maturity
Kanchan								
D1-26 Nov.	702.5	2133.3	5926.8	7733.9	8693.9	9753.1	11032.3	15478.0
D2-06 Dec.	209.8	2101.8	5708.3	7516.6	8695.4	9702.0	11021.1	15520.0
D3-16 Dec.	667.6	2508.8	6547.1	8373.0	9098.7	10145.2	11834.5	16293.0
D4-26 Dec.	704.7	2613.1	6892.3	8345.1	9394.2	10341.8	12164.3	16530.1
D5-05 Jan.	944.2	2625.7	7135.9	9172.4	10204.8	11011.4	12645.3	17040.3
Mean	645.7	2396.5	6442.0	8228.2	9217.4	10190.7	11739.5	16172.3
GW-273								
D1-26 Nov.	702.5	2133.3	5926.8	7733.9	8846.8	10025.6	11469.1	15912.8
D2-06 Dec.	209.8	2101.8	5708.3	7516.6	8695.4	9702.0	11377.7	15719.2
D3-16 Dec.	667.6	2508.8	6547.1	8373.0	9258.1	10337.8	12189.1	16540.4
D4-26 Dec.	704.7	2613.1	6892.3	8345.1	9394.2	10341.8	12164.3	16271.4
D5-05 Jan.	944.2	2625.7	6983.3	9172.4	10410.6	11464.4	12878.6	16789.5
Mean	645.7	2396.5	6411.5	8228.2	9321.0	10374.3	12015.8	16246.7
Sujata								
D1-26 Nov.	702.5	2133.3	7431.5	9190.5	11032.3	12351.3	14025.1	18952.7
D2-06 Dec.	209.8	2101.8	7124.7	8875.8	10328.6	11897.4	13550.2	18254.9
D3-16 Dec.	667.6	2367.6	7639.6	9018.7	10694.4	12384.1	14126.5	18687.0
D4-26 Dec.	704.7	2613.1	7562.7	8497.8	10341.8	11963.3	13536.4	17871.9
D5-05 Jan.	944.2	2625.7	7135.9	8552.0	10204.8	11694.2	13123.5	17274.9
Mean	645.7	2368.3	7378.8	8826.9	10520.4	12058.1	13672.3	18208.3
Amar								
D1-26 Nov.	702.5	2133.3	7301.3	9190.5	11032.3	12351.3	14025.1	18952.7
D2-06 Dec.	209.8	2101.8	7012.5	8695.4	10138.9	11734.6	13310.8	18080.0
D3-16 Dec.	667.6	2508.8	7639.6	9018.7	10694.4	12384.1	14126.5	18687.0
D4-26 Dec.	704.7	2613.1	7562.7	8497.8	10341.8	11963.3	13536.1	17871.0
D5-05 Jan.	944.2	2481.4	7286.7	8766.8	10410.6	11934.6	13374.8	17542.2
Mean	645.7	2367.6	7360.5	8833.84	10523.6	12073.6	13674.7	18226.6

Table 4: Grain yield (kg/ha) of wheat varieties under different thermal environments

Grain yield (kg/ha)						
Varieties	**D1-26 Nov**	**D2-06 Dec**	**D3-16 Dec**	**D4-26 Dec**	**D5-05 Jan**	**Mean**
Kanchan	2705.0	3670.0	3386.7	2983.3	3328.3	3214.7
GW-273	2800.0	3643.3	3415.0	2291.7	2341.7	2898.3
Sujata	2900.0	3837.5	3175.0	2808.3	2290.0	3002.2
Amar	2810.0	3333.3	2883.3	3875.0	2748.3	3130.0
Mean	2803.8	3621.0	3215.0	2989.6	2677.1	3061.3
	SEm ±	CD (P=0.05)	CV (%)			
D	85.5	244.7	9.5			
V	76.4	218.9				
DXV	170.9	489.4				

Conclusion

Different wheat varieties responded differently in terms of accumulated GDD at the time of maturity. The GDD requirement varied from 1844.8 to 2076.5 ^{0}C under different sowing dates. The heat unit requirement increased when sowing was delayed in Kanchan and GW-273. While it decreased in Sujata and Amar up to 26 December sowing then again increased. Under the D_1 variety Sujata found best in producing grain yield.

References

1. Agrawal KK, Sanker U, Upadhyay AP, Gupta VK. Accumulated heat unit requirements for different phenophases of wheat (*Triticum aestivum*) cultivars as influenced by sowing dates at Jabalpur. Journal of Agro meteorology. 1999; 1(2):173-176.
2. Anonymous. Agricultural statistics at a glance, 2010. Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India, 2010.

3. Gill DS. Agro-physiological traits for screening heat tolerant lines of wheat (*Triticum aestivum* L.) under late sown conditions. Indian J Agric. Res. 2009; 43(3):211-214.
4. Nuttonson MY. Wheat climatic relationship and use of phenology in ascertaining the thermal and photo thermal requirements of wheat. Am. Inst. Crop Ecol. Washington D.C, 1955.
5. Rajput RP, Deshmukh MR, Paradker VK. Accumulated heat units and phenology relationship in wheat as influenced by planting dates under late sown conditions. Journal of Agronomy Crop Science. 1987; 159:345-349.
6. Singh AK, Tripathi P, Adhar S. Heat unit requirements for phenophases of wheat genotypes as influenced by sowing dates. Journal of Agro meteorology. 2008; 10(2):209-212.
7. Swan JB, Schneider EC, Moncrief JE, Paulson WH, Peterson AE. Estimating crop growth yields and grain moisture from air growing degree-days and residue cover. Journal of Agronomy. 1987; 79:53-60.