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Short Comminucation

Heat unit requirement of wheat cultivars under varying thermal regimes at Jabalpur

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Wheat (*Triticum aestivum* L.) is one of the most important staple food crop cultivated in 43 countries of the world. The climatic conditions, mostly temperature influence the wheat production to a great extent across the globe. Wheat is highly vulnerable to high temperature and delayed sowing exposes of its grain filling stage (Pandey *et al.*, 2015). Therefore, heat stress imposed to plant due to delayed sowing is considered as most significant abiotic stress affecting wheat cultivation. Optimum temperature required during wheat anthesis and grain filling ranges between 12-22□%C and exposures to temperature above 30□%C at pre or post anthesis stage reduces the grain filling rate in wheat and thereby decreases the grain yield and quality. Changes in optimum temperature at different phenological stages of crop affect initiation and duration of different phenophases and finally crop yields. Temperature based agro-meteorological indices such as growing degree day (GDD), helio-thermo unit (HTU) and photo-thermo unit (PTU) can be quite useful in predicting growth and crop yield (Prakash *et al.,* 2017).

Field experiment was conducted during the *rabi* season of 2014-15 to 2015-16 at Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV),Jabalpur, Madhya Pradesh (23°09' N and 79° 58' E and at an altitude of 411m above mean sea level). Experiment was laid in split-plot design with three replication. The main plots consisted of three sowing dates i.e. 30th November, 20th December and 10th January, while three heat tolerant cultivars *viz.* MP 1203, MP 3336 and GW 173. Crop was sown manually with a row spacing of 22.5 cm. The amount of water through irrigation was delivered 250 mm during the crop growing period.

Weather data were collected from the Agrometeorological Observatory of Department of Physics and Agro-meteorology, College of Agriculture Engineering, JNKVV, Jabalpur. Agro-meteorological indices were computed for different phenophases by adopting procedure laid out by Rajput (1980).The GDD accumulated by the crop for different phenological stages were computed as:

$$GDD\ (^{\circ}C\ day) = \Sigma\ (T_{max} + T_{min})/2) - T_b$$

Where, T_{max}=Daily maximum temp. (°C), T_{min}=Daily minimum temp. (°C), T_b = base temp. (°C). HTU for particular phenophases of interest were determined according to the equation:

$$HTU\ (^{\circ}C\ day\ hours) = \Sigma\ (GDD \times BSS),$$

Where, BSS = Bright sunshine hours (hrs). PTU was calculated by using the following equation:

$PTU = GDD \times L$, Where, L = Maximum possible day length (hrs).

Heat use efficiency (HUE) for grain was obtained as:

$$HUE\ (kg\ ha^{-1}\ {}^{o}C day) = Yield\ (kg\ ha^{-1}) \times Accumulated\ GDDs\ ({}^{o}C\ day)$$

Results indicated that the number of days taken to attain various phenological stages varied with dates of sowing as well as due to variety (Table 1). Except at emergence stage when delayed sowing resulted in late emergence, all the stages attained under early sowing (30th November) took more number of days in comparison to delayed sowing. All the stages showed similar pattern. The physiological maturity was maximum (111 days) under 30thNovember, sowing followed by 101 days under 20th December and 91 days under 10th January sowing. The early attainment of stages under delayed sowing was mainly due to higher temperature experienced by the crop under delayed sowing. This is also evident from the fact that the total GDD accumulated under different dates of sowing did not differ much in comparison to variation in duration (Table 2). Though the duration of physiological maturity under 10th January sown crop was 10 days less than that attained under 20th December sowing, the GDD accumulation was higher under late sown condition.

Among varieties, cultivar MP1203 took lesser days in initial staged upto CRI stage in comparison to other two

Table1: Phenological development in growth duration of wheat varieties as influenced by sowing time (Pooled data of two seasons)

Treatment	Emergence	CRI	Heading	Anthesis	Milking	Dough	Physiological maturity	Harvest maturity
Sowing dates								
30th November	6	16	68	76	85	97	111	114
20th December	8	16	62	70	78	89	101	103
10th January	9	15	57	64	71	81	91	93
Cultivars								
MP 1203	7	14	71	77	87	95	105	107
MP 3336	8	16	57	65	74	86	100	102
GW 173	8	16	58	65	73	86	99	101

Table 2: Grain yield and heat use efficiency (HUE) of wheat varieties under different sowing (Pooled data of two seasons)

Treatment	Grain yield (kg ha^{-1})	GDD (°C days)	HTU* (°C days hr)	PTU* (°C days hr)	HUE (kgha^{-1} °C day^{-1})
Sowing dates					
30th November	4202	1531	11503	16900	2.76
20th December	3761	1453	11341	16397	2.62
10th January	3051	1474	12021	17070	2.08
Cultivars					
MP 1203	3597	1575	12438	17880	2.28
MP 3336	4055	1442	11230	16264	2.82
GW 173	3362	1439	11197	16223	2.35

cultivars. Thereafter from heading to physiological maturity MP1203 took maximum number of days to attain each stages in comparison to cultivar MP3336 and GW173. MP1203 matured in 105 days followed by MP3336 in 100 days and GW173 in 99 days. This might be due to inherent character of the varieties.

Crop sown on 30th November accumulated the maximum GDD (1531°Cday) at maturity stage as compared to rest of sowing date (Table 2). Cultivar MP1203 accumulated the maximum GDD (1575°Cday).Crop sown on 10th January required the highest helio-thermal units (12021˚C day hours) for maturity.This might be due to the presence of lower temperature and sunshine hours for more days under normal or late sown condition in comparison to very late sown crop. Among cultivars, MP 1203 took highest HTU (12438˚C day hours) for maturity (Table 2). Crop sown on 10th January required the maximum value of PTU (17070˚C day hours) for maturity as compared to other sowing dates. Cultivar MP 1203 took the highest PTU (17880˚C day hours) for maturity compared to cultivars MP3336 and GW173.The crop phenology are largely dependent on genetic and environmental factors viz. temperature, RH, sun shine hours (Amrawat *et al*., 2013).

Among sowing dates, 30th November registered the maximum yield (4202 kgha^{-1}), which was significantly superior to other sowing dates (Table 2). However, 20th December sown crop showed superiority over 10th January sowing in producing the grain yield. Increases in grain yield by 30th November sowing over 20th December and 10th January sowing were 11.7 and 37.7 per cent, respectively. Reduction in yield in late sown crop might be due to the detrimental effect of higher temperature (>32 °C) during reproductive phase of crop causing poor grain filling. All these results of the present experiment are highly agreed with the finding of Kumar *et al.* (2013)

Among cultivars, MP 3336 exhibited significantly higher grain yield (4055 kg ha^{-1}) compared to other cultivars (Table 3). However, cv. MP1203 (3597 kg ha^{-1}) registered superiority over GW 173 (3362 kg ha^{-1}) with respect to grain yields. This might be due to the genetic makeup of the particular cultivar. These results are in close agreement with those of Kumar *et al.* (2013).

Highest heat use efficiency for yield was 2.76 kg ha^{-1}°C day^{-1} in30th November sown crop, while lowest values were recorded with 10thy January sowing (2.08 kg ha^{-1}°C day^{-1}) during both the years (Table 3).This might be due to higher temperature remained in reproductive phase cause detrimental effect on dry-matter and grain yield (Jhanji and Gill, 2011).Among the cultivars, MP 3336 recorded the highest HUE (2.82 $kgha^{-1}$°C day^{-1}) as compared to rest cultivars (Table.2).The cv.MP 3336 registered highest HUE than GW 173 and MP 1203 during both the years. This might be due to the inherent characteristics of cultivars.

REFERENCES

Amrawat, T., Solanki, N.S., Sharma, S.K., Jajoria, D. K. and Dotaniya, M. L. (2013). Phenology growth and yield of wheat in relation to agrometeorological indices under different sowing dates. *African J. Agri. Res.,* 8(49): 6366 -6374.

Jhanji, S. and Gill, D. S. (2011). Phenological development and heat unit requirement of wheat under different dates of sowing. *Indian J. Agri. Res.,* 45(2): 161-166.

Kumar, S., Alam, P. and Ali, N. (2013).Response of wheat (*Triticum aestivum* L. emend. Fori. & Paol.)varieties to sowing dates.*J. Res,* (BAU)25(1): 56-59.

Pandey, G.C., Mamrutha, H.M., Tiwari, R., Sareen, S., Bhatia, S., Siwach, P., Tiwari, V.,Sharma, I. (2015). Physiological traits associated with heat tolerancein breadwheat (Triticum aestivum L.). *Physiol. Mol. Biol. Plants,* 21 (1): 93–99.

Prakash, V., Mishra, J.S., Kumar, R., Kumar, R., Kumar, S., Dwivedi, S.K., Rao, K.K., and Bhatt, B.P. (2017).Thermal utilization and heat use efficiency of sorghum cultivars in middle Indo-Gangetic Plains. *J. Agrometeorol.,*19(1): 29-33.

Rajput, R. P. (1980). Response of soybean crop to climate and soil environments. Ph.D. Thesis. Indian Agricultural Research Institute, Pusa, New Delhi.

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