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Accumulated heat unit requirements for different phenophases of wheat (*Triticum aestivum*) cultivars as influenced by sowing dates at Jabalpur

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ABSTRACT

In soybean-wheat cropping system, sowing of wheat crop often gets delayed which affects its phenology and productivity.Two wheat varieties viz., WH147and Lok1were sown at three different times. Early plantings not only accumulated higher growing degree days but also resulted in higher heat-use efficiency and grain yield. The phenothermal index was nearly constant with a mean value of 14.3 for both the varieties and for different dates of plantings from sowing to flowering stage of wheat crop. The two varieties did not differ significantly in their response to the different thermal regimes.

Key words : Wheat, Growing degree days, Heliothermal unit

Temperature is an important weather variable which determines the productivity levels, particularly for *rabi* - winter crops. Growing degree days or heat unit requirement has been used for characterising thermal response in wheat (Rajput *et al.*,1987) and other crops (Billore *et al.*,1992, Shanker *et al.*,1996). In Madhya Pradesh, replacement of *kharif* rainy season fallow with soybean (*Glycine max L.* Merr.) crop is a major development that took place during the last two decades. In soybean-wheat cropping system, sowing of wheat crop is often delayed, and has important implications on crop productivity. Results of a study on the effect of delayed sowing on phenological development of wheat crop and its implications on crop productivity are presented.

MATERIALS AND METHODS

Two popular varieties of wheat WH147and Lok1 were sown on three different dates during *rabi* winter season of 1987,88 and 89 on the research farm of the University. Three dates of sowing consisted of an early (Mid Nov., D_1), normal (Early Dec., D_2) and late sowing (End Dec., D_3). Crop was raised using recommended agronomic package for irrigated wheat on the soil classified as Vertisols which was low in N, medium in P and high in K content with near normal pH.

Periodical observations on phenological development, dry-matter accumulation and grain yield were recorded. Growing degree days were calculated using base temperature of 5°C from daily mean temperature (Nuttonson, 1955). The photothermal units are the product of growing degree days and photoperiod;heliothermal units are the product of growing degree days and actual sunshine hours (Rajput, 1980).

RESULTS AND DISCUSSION

On the basis of date of sowing , mean maturity periods of wheat were 119,110 and

Table 1 : Duration of occurrence and accumulated heat units from sowing to different phenostages and yield of wheat (average for three seasons)

Duration days	Emergence	Crown root initiation	Tillering	Jointing	Flowering	Milking	Dough	Maturity
Date of planting								
Early	8	23	42	63	81	92	108	119
Normal	8	22	42	60	76	92	101	110
Late	8	22	37	56	73	86	97	103
Varieties								
WH-147	8	24	41	61	78	90	104	112
LOK-1	8	21	39	58	76	89	100	112
Growing degree days								
Date of planting								
Early	128	369	599	861	1091	1397	1623	1858
Normal	114	311	572	814	1078	1340	1545	1751
Late	103	313	537	819	938	1326	1541	1698
Varieties								
WH-147	115	343	588	855	1133	1383	1610	1810
LOK-1	119	314	555	808	1083	1335	1529	1728
Heliothermal units								
Date of planting								
Early	1167	2527	4192	6655	9001	10508	12145	13931
Normal	1715	3388	5279	7503	8007	11616	13032	14519
Late	3231	4474	6109	8040	8365	12379	14086	15607
Varieties								
WH-147	1662	3540	5296	7205	9885	11718	13270	14808
LOK-1	2055	3386	5091	7149	9398	12494	12795	14564
Photothermal units								
Date of planting								
Early	1439	3129	5364	9479	10779	13727	16015	18546
Normal	2108	4361	6748	10545	11754	15246	17233	19482
Late	4035	5853	7888	11170	9228	15218	18769	20841
Varieties								
WH-147	2507	5542	6845	9766	12887	15418	17734	19854
LOK-1	2548	4352	6488	9405	12230	14765	16944	19387

Grain yield of wheat (Kg ha^{-1})

Early-2744, Normal-2044, Late-1939, WH-147-2420, LOK-1-2262

103 days (Table 1) under early, normal and late sowing respectively. Likewise mean maturity period for varieties was 112 and 109 days respectively for WH147 and Lok1. Grain yield was maximum (2744 kg ha^{-1}) under early sowing and minimum (1939 kg ha^{-1}) under late sowing; whereas under late planting Cv.Lok 1 was more productive than WH 147. For three sowings and two varieties of wheat crop the accumulated growing degree days ranged between 1690 to 1858 from sowing to maturity. The heliothermal units ranged from 13931 to 15602 and for latitude 23°09'N possible photothermal units for this period ranged from 18546 to 20849. As the planting was delayed, lesser number of growing degree days were recorded between sowing to maturity. In contrast, an increasing number of total photothermal and heliothermal units were accumulated for the successive delayed plantings.

For both varieties practically equal number of growing degree days were recorded from sowing to flowering. However, to attain maturity D_1 required the highest value of growing degree days (1950), and it was followed by D_2 and D_3. For maturity, variety WH 147 required higher growing degree days than the variety Lok1. To attain maturity D_1 required lowest heliothermal units (13931) or photothermal units (18546) followed by D_2 and D_3. The decreased heat unit requirements with delayed sowing for flowering of wheat is in confirmation of earlier observation of Rajput *et al.* (1987).

Heat use efficiency (HUE) was calculated to determine the number of growing degree days required to produce unit amount of grain yield (yield/growing degree day). The first date of sowing (D_1) shows the highest value of HUE $14.8*10^{-3}$ and the lowest ($11.4*10^{-3}$) in case of D_3. This suggests that as the planting was delayed, crop was exposed to sub-optimal thermal regimes and thereby in successive plantings later in the season, both the varieties were less efficient in heat use. Both the wheat varieties have the equal value of HUE ($13.4*10^{-3}$ q/growing degree days)

The accumulated phenothermal units required per growth day between each two consecutive phenostages for different combinations called phenothermal index were computed and presented in Table 2. This shows the complex relationship of the duration of

Table 2 : Phenothermal indices for different times of planting of two wheat varieties

	Sowing to flowering	Flowering to milking	Flowering to dough	Flowering to maturity
Date of Planting				
Early	13.5	23.5	19.7	20.1
Normal	14.0	16.5	18.7	19.8
Late	13.0	18.0	18.8	20.2
Varieties				
WH-147	14.5	20.6	18.7	19.8
Lok-1	14.0	17.8	18.2	19.3

time between phenostages to the prevailing ambient temperature and their compensatory adjustment under field conditions in a single parameter. The phenothermal index is expressed as degree day per growth day (Sastry *et al.*, 1982). From Table 2 it is clear that irrespective of sowing dates and varieties, the index during sowing to flowering stage was nearly constant with a mean value of 13.8. However the indices in the different stages, in between flowering to maturity gradually increased from a mean value of 13.8 between sowing to flowering, to 19.8 from flowering to maturity. The indices for entire crop season showed very little variation from 15.6 to 16.5 between the different planting dates and varieties.

It can be concluded that successive delayed plantings required lesser number of growing degree days during crop growth period. Early plantings not only accumulated higher growing degree days but also resulted in higher heat use efficiency. The phenothermal indices are nearly constant for both the varieties and dates from sowing to flowering stage of wheat crop. Its mean value is 13.8. The mean value of phenothermal index for whole crop growing period is 14.7. Two varieties did not differ significantly in their response to varying thermal regimes with in the season.

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