

RESPONSE OF WHEAT (*TRITICUM AESTIVUM*) UNDER VARYING WEATHER ENVIRONMENT

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ABSTRACT:

A field experiment was conducted during Rabi 2007-08 and 2008-09 at Instructional Farm, Rajasthan College of Agriculture, Udaipur. The treatment comprises of four sowing dates (7th November, 19th November, 4th December and 19th December) and four irrigation levels (three, four, five and six). Result revealed that the magnitude of reduction in number of tillers/m row was more due to higher minimum temperature. The maximum heat units of 1701 degree days were recorded under 19th November sown crop with six irrigation (D₂I₆). The increase in 6.0 °C mean temperature between 90 to 105 DAS caused reduction in number of effective tillers/m/row at 105 DAS by 15.0 per cent. The highest grain yield was obtained under 19th November sown crop (D₂) followed by 7th November sown crop (D₁) during both the years. The mean temperature experienced during heading to milking was in the range of 14.5-15.0°C. and 18.0-19.0 °C during 2007-08 and 2008-09, respectively. The delay sowing caused reduction of 25.7 and 41.9 per cent grain yield in 4th December (D₃) and 19th December (D₄) sown crop, respectively as compared to 19th November sown crop (D₂). The highest heat use efficiency for total dry matter and grain yield (8.94 and 2.74 kg/ha/°C) was recorded under 7th November sown crop.

1. INTRODUCTION

Temperature is an important environment factor that affects plant development, growth and yield. Changes in seasonal temperature affect the productivity through the changes in phenological development process of the crop. Winter crops are especially vulnerable to thermal stress particularly in reproductive phase and differential response of temperature change to various crops has been noticed under different production environment (Kalra et al 2008). Hundal (2004) also observed that increase of temperature by 2°C in wheat resulted in 15-17 per cent reduction in grain yield. Next to paddy, wheat is an important winter season crop in the northern India. Cool weather during vegetative period and warm weather during maturity are ideal requirement for wheat. Wheat grain yields generally decline as temperature increases. Temperature stress intensity is severe under late sowing, causing reduction in the duration of later growth phases (Mavi and Tupper, 2005). Various phenophases of wheat is also sensitive to temperature. In recent past, the area and productivity of wheat in India is fluctuating due to climate change. Among the climatic variable air temperature is the most important that affects plant life. Taking cognizance of the fact mentioned above, present investigation was carried out to assess the impact of different weather environment on growth and productivity of wheat.

2. MATERIALS AND METHODS

A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) during Rabi season of 2007-08 and 2008-09. The geographical co-ordinates of the station are 24° 34'N latitude, 73° 42'E longitude and altitude of 582.2 m above mean sea level. The mean annual rainfall of the centre is 600.8 mm most of which (91.5 %) is contributed by south west monsoon during June to September. The winter rains contributed very negligible amount. The weekly mean maximum and minimum temperatures ranges from 23.3 to 33.0 °C and 5.1 to 14.9

°C, respectively during Rabi season. The soil was clay loam in texture having 240 kg N, 20.0 kg P₂O₅ and 290.6 kg K₂O/ha with pH 8.1 and EC of 1.12 d sm⁻¹ at 25°C. The experiment consisted of four sowing dates viz. 7th November (D₁), 19th November (D₂), 4th December (D₃) and 19th December (D₄), and four irrigation levels viz. three (I₃), four (I₄), five (I₅) and six (I₆). The experiment was laid out in split plot design with four replications. The wheat variety Raj-3077 was fertilized with 120 kg N, 40 kg P₂O₅/ha using a seed rate of 125 kg/ha.

3. RESULTS AND DISCUSSION

Early sowing experienced higher mean temperature during emergence to heading stage as compared to successive delay in sowing. Days taken to attain different phenophases Table-1 show that number of days required for emergence were increased from 4 to 6 days in D₁ to D₃. However, D₄ sowing took only five days. This might be due to increase in temperature during emergence stage which resulted into one day advance emergence as compared to D₃ sowing. A strong negative correlation (-0.963) was also observed between days requirement to emergence and mean temperature.

3.1 Heat Use Efficiency

Heat use efficiency was influenced due to different weather conditions and irrigation levels (Table-2). The highest heat use efficiency for total dry matter and grain yield (9.83 and 2.84 kg/ha/°C day) was recorded under normal sowing i.e. 17th November sown crop. Subsequent delay in sowing resulted in decreased in heat use efficiency. Timely sowing of wheat crop seems to be essential for harnessing the good impact of prevailing weather conditions. Pragyani Kumari *et al* (2009) also reported that timely (normal) wheat crop exhibited maximum heat use efficiency of 2.23 kg grain/ha/degree day.

Treatment		Phenophases						
		Emergence	CRI	Tillering	Heading	Milking	Dough	Maturity
I ₃	D ₁	4	21	34	61	96	121	126
	D ₂	5	22	34	66	98	113	121
	D ₃	6	23	33	73	99	107	117
	D ₄	5	23	31	72	92	100	110
I ₄	D ₁	4	21	34	61	97	122	126
	D ₂	5	22	34	66	99	113	123
	D ₃	6	23	33	71	101	107	117
	D ₄	5	23	31	72	92	101	113
I ₅	D ₁	4	21	34	61	97	123	128
	D ₂	5	22	34	68	98	117	126
	D ₃	6	23	33	76	101	110	121
	D ₄	5	23	31	73	92	104	113
I ₆	D ₁	4	21	34	62	97	125	130
	D ₂	5	22	34	68	99	118	129
	D ₃	6	23	33	74	101	110	121
	D ₄	5	23	31	74	92	106	116

Table 1: Days Taken to Attain Different Phenophases of Wheat

Sowing Date	Heat Units (^o Cday)	HUE of Total Dry Matter (Kg/ha/ ^o Cday)	HUE for Grain Yield (Kg/ha/ ^o Cday)
7 th November	1656.0	8.94	2.74
17 th November	1613.0	9.83	2.84
4 th December	1583.6	8.52	2.15
19 th December	1568.3	7.67	1.69
Irrigation levels			
Three	1559.4	7.72	1.69
Four	1584.5	8.54	2.42
Five	1629.1	9.03	2.54
Six	1647.8	9.65	2.76

Table 2: Accumulated Heat Units and Heat Unit Efficiency of Wheat

3.2 Effect of Temperature

Mean temperature experienced during different phenophases of wheat are presented in Table-3. Data revealed that year 2008-09 experienced higher mean temperature during tillering to heading stage and heading to milking stage as compared to that experienced in 2007-08 in each sowing date. Later sowing dates i.e. 4th December and 19th December experienced higher mean temperature during heading to milking stage and milking to dough stage during both the years. In the year 2007-08, 4th December and 19th December sown crop experienced 6.3 and 8.5 °C higher mean temperature, respectively over 4th November sown crop (14.6 °C) during heading to milking stage. Similarly, these two dates also experienced higher mean temperature by 4.6 and 6.5 °C over 4th November sown crop (19.4 °C) during milking to dough stage. Similar trends were also recorded during the year 2008-09. It was observed that year 2008-09 experienced more temperature throughout the crop season and it was above normal and 2007-08 in each meteorological week. The deviation in maximum and minimum temperatures was more during 2009 as compared to 2008. With regards to effective tillers/m row length (Table-4), the highest number of effective tiller/m row at 90 DAS was recorded in 17th November sown crop (D₂) during the both the years. Year 2008-09 experienced higher maximum, minimum and mean temperature between 75 to 90 DAS in each sowing date as

compared to year 2007-08. The mean temperature was 5.6 °C more under 19th November and 5.2 °C more under 7th November during 2008-09 as compared to 2007-08.

It has been reported that an average temperature of 15 °C during grain formation is optimum for maximum grain weight (Chowdhary and Wardlaw, 1978 and Fischer, 1985). The deviation in maximum and minimum temperatures above and below optimum value is found to influence the plant activities in many ways, the cumulative effects of which are observed in yield. Temperatures above 25 °C during this period tend to depress grain weight. When temperature is high, too much energy is lost through the process of transpiration by the plant and reduced residual energy results in poorer grain formation and lower yields. Until maximum tillering stage wheat crop sown on all the dates grew in a moderate air temperature regime but after this stage all later stages of later sown crops from late jointing onwards, were exposed to comparatively higher temperature regimes and causing earlier maturity of crops.

Heading to milking stage, the most thermally sensitive stage, late sown crops were exposed to higher air temperature (20.0 °C to 23.0 °C) compared to earlier sown crops (14.5 to 18.9 °C) and it was further increased till maturity of the crop (Table-3) with every

delay in wheat sowing beyond normal date the risk of sterility increases. The risk would be more in case of the abnormal rise in temperature. Hence, timely sowing (19th November) of wheat crop may escape the risk of temperature rise and sterility at flowering

stage. Pragyani Kumari *et al* (2009) also reported that the maximum differences of 7.5 °C in temperature were observed at the milking stage between very late and normal sown conditions.

Sowing Dates	Tillering to Heading Stage		Heading to Milking Stage		Milking to Dough Stage	
	Y ₁	Y ₂	Y ₁	Y ₂	Y ₁	Y ₂
7 th November	17.2	20.0	14.5	17.7	19.4	18.4
19 th November	16.8	17.8	15.0	18.9	21.7	19.5
4 th December	14.5	18.1	20.8	20.0	24.0	24.7
19 th December	15.1	18.7	23.0	22.7	25.9	23.2

Table 3: Mean Temperature During Different Phenophases of Wheat

Y₁ = 2007-08, Y₂ = 2008-09

Sowing Dates	Effective Tillers/m 90 Das		Temperature Between 75 to 90 DAS (°C)					
	Y ₁	Y ₂	Y ₁	Y ₂	Y ₁	Y ₂	Y ₁	Y ₂
7 th November	179	165	21.7	28.1	4.9	8.9	13.3	18.5
19 th November	188	167	22.1	27.9	4.1	9.6	13.1	18.7
4 th December	180	164	30.7	33.3	9.0	13.4	19.9	23.3
19 th December	150	145	32.1	33.8	13.8	13.6	22.9	23.7

DAS = Days after sowing Y₁ = 2007-08, Y₂ = 2008-09

Table 4: Effective Tillers/m row at 90 DAS as Influenced by Temperatures

3.4 Yield

Grain yield was significantly influenced by different sowing dates and irrigation levels. The highest grain yield was recorded in 19th November sown crop, which was at par with 7th November sown crop during both the years. The crop sown on 4th December and 19th December significantly reduced grain yield by 25.7 and 41.9

percent in 2007-08 and 27.9 and 45.9 per cent in 2008-09, respectively. (Table 5). The maximum harvest index of 30.6 per cent was recorded under 7th November sown crop during 2007-08 while in year 2008-09, 19th November sown crop recorded the maximum harvest index of 29.2 per cent. The harvest index indicates the magnitude of allocation of dry matter from leaves and stems to sink (grain).

Sowing Dates	Grain Yield (kg/ha)		Harvest Index (%)	
	Y ₁	Y ₂	Y ₁	Y ₂
7 th November	4543	4089	30.6	29.0
19 th November	4573	4101	28.8	29.2
4 th December	3399	2957	25.0	26.2
19 th December	2659	2219	21.2	20.4
CD (P= 0.05)	391.3	255.0	-	-
Irrigation levels				
Three	2636	2471	20.9	19.9
Four	3842	3349	28.2	27.5
Five	4141	3628	27.9	28.1
Six	4555	3918	28.5	29.3
CD (P= 0.05)	312.6	212.4	-	-

Table 5: Effect of Sowing Dates and Irrigation Levels on Yield and Harvest Index of Wheat

The present study show that the allocation of dry matter (photosynthates) to sink was drastically reduced due to temperature. This is evidenced that higher temperatures were experienced during heading to milking stage and milking to dough stage during both the years (Table-3). Temperature during these two phenophases also adversely affected number of tillers/m row and test weight. Reduction in these two yields attributes under later sowing dates proved the low translocation of photosynthates which resulted in drastic yield reduction. High temperature stress at grain filling stage decreased grain yield and test weight of wheat from

19.7 % to 28.3 % (Zhang *et al.*, 2008). Rane and Nagarajan (2004) also reported that high temperature at the time of grain filling is one of the major constraints in increasing productivity of wheat in tropical countries like India. Tripathi *et al* (2001) also reported that late sowing beyond December 10th (< 17.6 °C) progressively decreased the grain yield of wheat due to shorter duration and high temperature during grain formation stage. Vishwanathan and Chopra (2001) reported the late sown crop experienced 6-8 °C warmer temperature during grain development than crop sown at normal time.

CONCLUSION

The above findings on the response of wheat crop to different weather environments, suggest that under the agro climatic conditions of Rajasthan state normal sowing (around 7th to 20th November) of wheat crop has to be advocated so that the farmers get improved yield.

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