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RESEARCH ARTICLE

Effect of weather in relation to dates of sowing and varieties on productivity of wheat (*Triticum aestivum* L.)

RAKESH KUMAR AND GAURAV MAHAJAN

SUMMARY

To assess the effect of thermal and radiation regimes on wheat a field experiment consisted of three dates of sowing starting from 20th November at fortnightly interval up to 20th December and three varieties of wheat, was carried out at Students Instructional Farm, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.). The results showed that the wheat crop matured in 119 ± 8 days. Crop sown on early date took more thermal time as compared to other dates of sowing. The day length and bright sun shine hours also affected the occurrence of different phenophases of wheat cultivars. The heat use efficiency decreased with delay in sowing. The dry matter production was linearly related with accumulated heat units and HTU. Weather parameters *viz.*, cumulative evaporation rate (r^2 =0.925), mean temperature (max.) (r^2 =0.912), mean temperature (min.) (r^2 =0.833) and cumulative heat (r^2 =0.590) were significantly positively correlated with the grain yield.

Key Words : Sowing dates, Variety, Weather, Wheat, Yield attributes, Yield

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In India, wheat is a second most important food crop after rice. Weather parameters are uncontrolled factors in the increment or reduction of grain production. So, decision of sowing time, selection of cultivar, irrigation scheduling, dose of fertilizer and its time of application and integrated herbicidal management etc. must be considered in reference of weather and its impact on crop needs under certain cardinal levels of various factors of environment. The weather conditions that prevail during crop growth period decides yield potential, even though all inputs required by the crop are supplied at optimum level. Surface air and soil temperature, light intensity and its brightness, relative humidity etc. were the elements of weather for optimum physiological functioning. These requirements are not only varying from species to species but also may be different for the various stages of crop development.

Humidity exerts direct effect on crop growth by influencing the availability of net energy, outbreak of pest, disease, foliar spray etc. Aerial humidity needs to be taken into account as an important factor in studies of crop weather relationship (Arkely, 1963). Wind speed also influences transpiration directly by removal of humid air accumulated near the leaves canopy and by forcing out the air from stomata cavities (Penman, 1963). Edaphic factors like soil moisture, aeration and soil temperature are largely affected by rainfall. Considering the above fact points, that there is considerable importance of crop-weather relationship. The present study was therefore, taken under investigation to find the effect of weather in relation to dates of sowing and varieties on productivity of wheat (*Triticum aestivum* L.).

MEMBERS OF THE RESEARCH FORUM

Author to be contacted :
GAURAV MAHAJAN, Department of Agronomy, College of Agriculture (J.N.K.V.V.), REWA (M.P.) INDIA
Email: gauravmahajan79@gmail.com

Address of the Co-authors:
RAKESH KUMAR, Department of Agronomy, College of Agriculture (J.N.K.V.V.), REWA (M.P.) INDIA

MATERIAL AND METHODS

The field experiment was conducted during the *Rabi* season of 2003-04 and 2004-05 at Students' Instructional Farm, Department of Agronomy, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.). The experimental sites was situated at 26^0 23' North latitude and 80^0 18' East longitudes and categorized as subtropical semi-arid track. The soil of experimental plot was sandy loam having poor nitrogen (53 kg/ha), medium in phosphorus (34.2 kg/ha) and rich in potassium (240kg/ha). The experiment was laid out in split plot design keeping three sowing dated *viz.*, D_1 (20th of November), D_2 (05th of December) and D_3 (20th of December) in main plots and three varieties V_1 (HD 2285), V_2 (K 8804) and V_3 (K 9107) in sub-plots with four replications. The experimental plot received uniform fertilizer dose 120 kg N/ha, 25.8 kg P/ha and 49.8 kg K/ha through urea, diammonium phosphate and muriate of potash, respectively. The half dose of nitrogen and full dose of phosphorous and potassium were applied as basal and remaining half dose of nitrogen was applied in two equal split at tillering and panicle initiation stages of wheat. All the wheat cultivars, at the distance of 22.5 cm from row to row, were sown as per treatment using a seed rate of 100 kg/ha. Crop weather relationship was studied using different parameters recorded at different stages of growth such as CRI, tillering, jointing, panicle initiation, milking, dough and maturity, for every treatment by tagging five plants, by visiting the field at days interval flowering was determined when 50 per cent of spikes were visible in the center of plot. The crop was considered to attain physiological maturity when 95 per cent of the ear head has turned from green to yellow. The dry matter production was determined by cutting one meter of row length from two areas of each plot at various developmental stages. The data on all the weather parameters prevailed during the period of experimental crop were obtained from Students' Instructional Farm surface observatory of the University. The total rainfall during cropped period was 73.4 mm. The maximum temperature varied from 12.7^0C to 41.7^0C and minimum 4.4^0C to 27.1^0C. The mean relative humidity percentage ranged from 91.5 per cent to 35.5 per cent at maturity. Wind velocity ranged from 1.1 to 10.1 kmph. Evaporation rate ranged from 0.1 to 10.5 mm. Saturated vapour pressure ranged from 5.6 to 17.9 mm of mercury. With the help of this data, heat units or growing degree days (GDD) concept was proposed to explain the relationship between growth duration and temperature. This observation was found out at different stages by using formula as described by Nagi (1962).

$$\mathbf{GDD} = \Sigma\left\{\left[\frac{\mathbf{MaxT + MinT}}{\mathbf{2}}\right] - \mathbf{Thresholdtemp.(5^0C)}\right\}$$

where,

T = Temperature

Thermal sensitivity index (TSI), was per cent range of duration to maturity and average duration to maturity, was used to categories the wheat genotypes to their response to thermal stress. It was found out by formula as under :

$$\mathbf{TSI} = \frac{\mathbf{Range\ of\ duration\ to\ maturity}}{\mathbf{Average\ duration}}\mathbf{x100}$$

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Phenology :

The crop sown late took more days (68) for panicle initiation compared to crops sown earlier at fortnight's intervals. A similar trend was observed in case of physiological maturity. The crops sown on D_1, D_2 and D_3 matured in 116, 119 and 122 days, respectively with standard deviation of 3 days (Table 1). The wheat crop sown in second fortnight of November matures early by 6 days compared to the crop sown in second fortnight of December due to increase in temperature at the reproductive phase. The standard deviation showed that the days to occurrence of different stages differed with dates and more deviation was observed during dough stage (16 days), while the difference in maturity was not much (3

Table 1: Effect of different thermal regimes on phenology of wheat varieties and thermal stress tolerance (%) (mean of two years)

Treatments	CRI	Tillering	Jointing	Panicle initiation	Milking	Dough	Maturity	Thermal sensitivity index (%)
Sowing dates								
D_1	25.0	33.0	43.3	59.3	94.3	103.0	116.0	-
D_2	27.3	35.3	48.7	65.3	98.0	106.7	118.7	-
D_3	29.0	39.3	51.0	68.3	100.7	78.3	121.7	-
Mean	27.1	35.9	47.7	64.3	97.7	96.0	118.8	-
S.D.±	2.0	3.2	3.9	4.6	3.2	15.4	2.8	-
Varieties								
V_1	24.0	34.0	47.3	56.3	104.7	112.3	125.3	12.1
V_2	27.0	34.7	46.7	68.7	95.0	104.3	120.0	11.8
V_3	30.3	39.0	49.0	68.0	93.3	71.3	111.0	12.3
Mean	27.1	35.9	47.7	64.3	97.7	96.0	118.8	-
S.D.±	3.2	2.7	1.2	6.9	6.1	21.7	7.2	-

Where, D_1 (20th of November), D_2 (05th of December), D_3 (20th of December), V_1 (HD 2285), V_2 (K 8804) and V_3 (K 9107).

days) among the dates of sowing. Among the varieties V_1 took more number of days to reach various stages, while the time taken by other varieties did not vary much. Singh *et al.* (2003) also observed similar results of different phonological stages in wheat genotypes under arid environment. Early maturing variety V_1 took mean 116 days to reach maturity with a range of 108 to 122 days at different dates of sowing, variety V_2 took mean 119 days to reach maturity with a range of 111 to 125 days, whereas the late maturing variety V_3 took mean 122 day to reach maturity with a range of 114 to 129 days. The thermal sensitivity index (TSI), of different wheat genotypes was calculated and was found that varieties HD 2285 (12.1), K 8804 (11.8) and K 9107 (12.3) were moderately sensitive to thermal stress as TSI values were in the range of 10.1-15.0.

Growing degree days

The thermal times accumulated for attaining different phenophases are presented in Table 2. The wheat crop took 1563 degree days for maturation with a standard deviation of 46 days. The early sown crop required more thermal time in comparison with crop sown on later dates and it might be due to increase in mean temperature which shortened later stages of wheat crop. Similar type of results was found by Agrawal and Upadhyay (2009) for central India research at Jabalpur. Among the varieties, V_3 took higher thermal time for maturity as compared to other varieties. The variety V_2 accumulated 1567 degree days heat units followed by variety V_3 (1582) for attaining maturity. Accumulation of more heat units by variety V_3 than other varieties may be due to more days taken by the variety to complete growth cycle. Singh *et al.* (2003) were of the same opinion when they worked with different varieties of wheat.

Heat use efficiency :

Heat use efficiency was computed to determine the

Table 2: Cumulative thermal times (days ºC) acquired to attain different phenophases in wheat under different treatments (mean of two years)

Treatments	CRI	Tillering	Jointing	Panicle initiation	Milking	Dough	Maturity
Sowing dates							
D_1	286.9	484.6	635.5	1011.2	1201.4	1471.0	1614.6
D_2	233.7	413.0	570.0	927.6	1136.8	1332.5	1529.6
D_3	236.6	403.4	553.3	1046.4	1275.5	1413.3	1543.2
Mean	252.4	433.7	586.2	995.1	1204.6	1405.6	1562.5
S.D.±	29.9	44.4	43.4	61.0	69.4	69.6	45.7
Varieties							
V_1	240.6	423.1	567.7	949.8	1183.4	1380.4	1539.2
V_2	252.7	441.0	599.4	1020.4	1213.0	1417.5	1566.6
V_3	263.9	436.9	591.5	1015.1	1217.3	1419.0	1581.6
Mean	252.4	433.7	586.2	995.1	1204.6	1405.6	1562.5
S.D.±	11.7	9.4	16.5	39.4	18.5	21.8	21.5

Where, D_1 (20th of November), D_2 (05th of December), D_3 (20th of December), V_1 (HD 2285), V_2 (K 8804) and V_3 (K 9107).

Table 3: Effect of sowing dates on heat use efficiency(kg ha^{-1} ºC day^{-1}) in wheat cultivars (mean of two years)

Treatments	CRI	Tillering	Jointing	Panicle initiation	Milking	Dough	Maturity	Mean
Sowing dates								
D_1	1.8	3.4	4.3	6.1	7.9	8.7	7.9	5.7
D_2	2.1	3.9	4.6	6.6	8.3	9.6	8.5	6.2
D_3	2.0	3.9	4.8	5.8	7.1	8.9	8.3	5.8
Mean	2.0	3.7	4.6	6.2	7.8	9.1	8.2	5.9
S.D.±	0.2	0.3	0.3	0.4	0.6	0.5	0.3	0.3
Varieties								
V_1	2.1	3.7	4.5	6.3	8.1	9.4	8.4	6.1
V_2	1.8	3.5	4.3	5.7	7.7	8.8	8.1	5.7
V_3	2.0	4.0	4.8	6.4	7.5	9.0	8.2	6.0
Mean	2.0	3.7	4.6	6.2	7.8	9.1	8.2	5.9
S.D.±	0.1	0.3	0.3	0.4	0.3	0.3	0.2	0.2

Where, D_1 (20th of November), D_2 (05th of December), D_3 (20th of December), V_1 (HD 2285), V_2 (K 8804) and V_3 (K 9107).

biomass production per unit of growing degree days for different wheat varieties. The heat use efficiency increased with the advancement of crop age up to dough stage there after, it decreased due to leaf senescence and biomass accumulation more in grains as compared to other parts of plants. Kumari *et al.* (2009) also reported that the heat use efficiency decreases with delayed sowing. The early sown crop has higher heat use efficiency as compared to crop sown on later dates, due to higher biomass production. The mean heat use efficiency was 5.7, 6.2 and 5.8 kg ha^{-1} ºC day^{-1} by wheat sown on D_1, D_2 and D_3 to attain the physiological maturity. The maximum heat use efficiency was found in early sown wheat crop at dough stage compared to crop sown on later dates. The heat use efficiency among various varieties also increased with the advancement of crop growth stages up to dough stage and decreased thereafter up to physiological maturity due to leaf senescence. Among all the varieties tested V_1 had found maximum heat use efficiency (9.4 kg ha^{-1} ºC day^{-1}) (Table 3).

Result of eight weather parameters were taken during the course of investigation, individually calculated with the grain yield and it was found that weather parameters were highly correlated with the grain yield of wheat. Out of all the eight parameters studied, the four weather parameters *viz;* cumulative evaporation rate (r^2=0.925), mean temperature (max.) (r^2=0.912), mean temperature (min.) (r^2=0.833) and cumulative heat (r^2=0.590) were significantly positively correlated with the grain yield. Whereas, the rest parameters, mean relative humidity (r^2=0.923), mean wind velocity (r^2=0.648) and saturated vapour pressure (r^2=0.752) were significantly negatively correlated with the grain yield. No correlation was found between constant quality of rainfall and grain yield of wheat (Table 4).

Table 4 : Regression equation between grain yield (q/ha) and different meteorological parameters

Weather parameters	
Total rainfall (mm)	Y = 600.64 + 8.00 X
Cum. Pan evaporation (mm)	Y = 1132.90 +0.159 X
Cum. Heat units (mm)	Y = 998.38 + 0.116 X
Mean T max(^{0}C)	Y = 1111.4 + 3.035 X
Mean T min (^{0}C)	Y = 1187.5 + 0.028 X
Ave. Relative humidity (%)	Y = 1357.6 - 2.317 X
Ave. Wind speed (Kmph)	Y = 1220.9 - 7.303 X
Saturated vapour pressure	Y = 1197.8 - 0.83 X

REFERENCES

Agrawal, K.K. and Upadhyay (2009). Thermal indices for suitable sowing time of chickpea in Jabalpur region of Madhya Pradesh. *J. Agro met*., **11**(1):89-91.

Arkely, R.J.(1963). Relationship between plant growth and transpiration. *Hilgardia,* **34**: 559-584.

Kumari, P., Wadood, A., Singh, R.S. and Kumar, R. (2009). Response of wheat crop to different thermal regimes under the agro climatic conditions of Jharkhand. *J. Agro met*., **11** (1): 85-88.

Nagi, L. (1962). Jopanica rice its breeding and culture in fundamentals of crop rice science. *Souichi Yoshido*. IRRI. pp.4-46.

Penman, H.L. (1963). Vegetation and hydrology tech. Commun 53, Common Wo Bur. Agric.p.105.

Singh, M., Niwas, R., Bishnoi,O. P. and Sharma, K. (2003). Phenology of wheat cultivaers in relation to thermal indices under different management practices. *Haryana. Agric. Univ. J. Res*., **33**:23-28.