

Impact of meteorological variables on the growth and development of wheat varieties

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ABSTRACT

A field experiment was conducted during 1998-99 winter season with eight wheat varieties and three dates of sowing in split plot design with three replications. The magnitude of linear growth rate and duration of its phase largely determined the dry matter accumulation. Duration of linear phase was cultivar specific and strongly influenced by radiation, sunshine hours and saturation deficit, and explained about 70 per cent of its variations. The duration of sowing to anthesis and anthesis to maturity in different wheat cultivars was strongly affected by the same. Multiple regression explained 87 per cent of linear growth duration when significant meteorological variables were taken into account. Also sowing to anthesis and anthesis to maturity duration's were explained to 75 and 93 per cent variations when solar radiation, sun shine hours, saturation deficit were taken into account.

Key Words: Growth and Development, Wheat, Meteorological variables

Crop development is dynamic and fragile in the vicinity of earth-atmosphere interface and this has to support normal growth and development of crop plants. In the course of conversion of radiant energy into chemical energy through photosynthesis, the extent of crop growth change depends on magnitude of environmental deviation. All the stages of growth and development of wheat are sensitive to temperature fluctuations and contribute to rate of development (Wier *et al.*, 1986). There is paucity of information on the variety-weather response studies. Pre-anthesis period is strongly influenced in terms of spikelet and floral or kernal numbers by the environment.

Sowing time is another factor, where in crop growth is decided by the environment. Even under optimum conditions small variations in temperature influenced the

growth and development of wheat (Savin and Nicolas, 1996). Hence an experiment was planned to study the variety-environment interaction in wheat under field condition.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 1998-99 using eight wheat varieties in main plots {HT90, HTG47, HT51, HTG36, WH147M, WH147, HD2285 and SG70} and three dates of sowing in sub-plots (25th Nov., 10th and 25th Dec.). The design was split plot and replicated thrice. The gross plot size was 6.0 x 2.4 m with row and plant spacing of 20 and 5 cm, respectively. Locally recommended cultural practices were adopted. Plant height, leaf area index, dry matter accumulation, grain yield attributes were recorded at 15/20 days interval from 30 days after sowing. Irrigation was applied at

sowing, crown root initiation, jointing, anthesis and dough stages. Crop growth rate (CGR) was computed as $(DW_2 - DW_1) / (t_2 - t_1)$, where DW_2 and DW_1 are the above ground dry biomass of the crop from the ground area ($g\ m^{-2}$) collected on days t_2 and t_1 , respectively. Initiation of linear growth rate period was determined from the graph when double ridge stage started with rapid accumulation of dry matter, whereas its termination was at the stage when growth rate started declining.

RESULTS AND DISCUSSION

Dry matter accumulation in different wheat varieties (Table 1) showed wide difference in crop growth rate during different phenophases. In relation to plants growth pattern three phases were important: the first phase where individual plant may be distinguished and plants do not shade each other (slow increase in growth rate), second phase when crop does cover the ground completely (growth rate is constant), and third phase when crop is heading towards maturity (growth rate decreased sharply). Growth rate of cultivar WH147M was higher among all the cultivars on different dates of observations followed by cultivar HD2285 and HT90. Major part of dry matter accumulation is largely determined by the magnitude of linear growth rate and its duration (van Heemst, 1986). Ritchie and Ne Smith (1991) used simple form of estimating total biomass as a product of the average growth rate and growth duration. It was observed that the duration of linear phase period is cultivar specific strongly influenced by weather experienced during this linear phase. The average linear growth period in the present experiment was of 50 days duration when wheat was sown around 25th November, but

decreased to 30 days by delaying sowing till 25th of December irrespective of varieties. The average linear growth period was of 47, 46, 45, 40, 40, 36, 32, 32 days in WH147M, SG70, HTG36, HT90, HTG47, HT51, WH147 and HD2285 varieties, respectively during the wheat growing season.

The growth rates were influenced by absorption of incoming solar radiation and temperature, whereas duration of linear growth period was strongly influenced by the radiation, sunshine hours and saturation deficit over the crop (Fig.1) each explaining 70 to 73 per cent variations in the duration of linear crop growth period. With increase in these parameters the linear growth period decreased. Spiertz and Vos (1986) and Charles Edwards and Vanderlip (1986) reported the strong influence of radiation and temperature on the rate and duration in growth phases of wheat. The following multiple regression, including three weather variables, explained 87 per cent variations in duration of linear growth period.

Duration of linear growth period (days)

$$= 60.9 - 2.21T - 0.154 Rs - 1.11SS - 1.85SD$$

$$(2.796) \quad (-1.823) \quad (-0.27) \quad (-1.254)$$

$$(R^2 = 0.87, F = 17.82)$$

where, T is mean temperature in °C, Rs is incoming solar radiation in $MJ\ m^{-2}\ day^{-1}$, SS is sunshine in hours, SD is average saturation deficit in millibars and figures in the parenthesis are t values for coefficients of each parameter. The duration of sowing to anthesis and anthesis to maturity in different cultivars reflected similar influence (Figs. 2 and 3). Solar radiation, temperature and saturation deficit explained 50 to 70 per cent variations in pre-anthesis period. With

Table 1: Effect of different treatments on dry matter accumulation (*g plant⁻¹*) in wheat cultivars during 1998-99.

Treatments	Tillering	Jointing	Flag leaf emergence	Anthesis	Dough	Maturity	Harvest
25 th Nov.	0.18	0.50	2.28	11.00	14.31	16.45	
10 th Dec.	0.16	0.32	1.20	9.49	12.67	14.51	
25 th Dec.	0.15	0.28	0.90	8.43	11.97	12.94	
Mean	0.1633	0.366	1.466	9.64	12.98	14.63	
CD at 5%	0.006	0.06	0.009	0.060	0.121	0.0059	
HT 90	0.16	0.39	1.51	9.43	12.47	14.28	
HTG 47	0.18	0.39	1.44	9.45	12.52	14.38	
HT 51	0.15	0.36	1.37	9.40	12.50	14.33	
HTG 36	0.15	0.39	1.46	9.58	12.44	14.60	
WH 147M	M 0.20	0.45	1.58	11.40	14.78	16.88	18.60
WH 147	0.13	0.36	1.35	9.07	12.10	13.88	
HD 2285	0.15	0.38	1.45	9.53	12.15	14.29	
SG 70	0.17	0.40	1.47	9.30	12.53	14.42	
Mean	0.161	0.39	1.45	9.64	12.68	14.63	
CD 5%	0.010	0.010	0.014	0.098	0.198	0.0095	

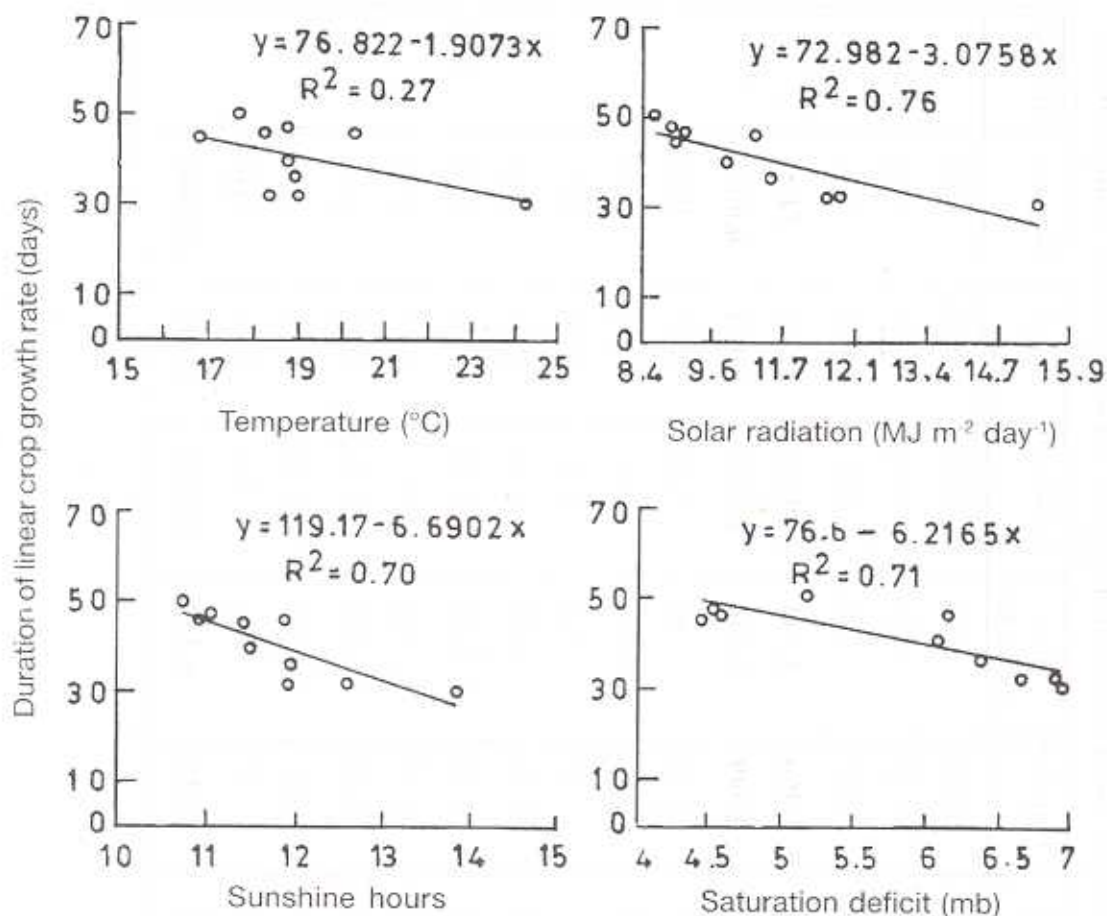


Fig. 1: Duration of linear growth rate period as influenced by temperature, radiation, sunshine hours and saturation deficit.

increasing levels of solar radiation, saturation deficit and temperature, the duration of sowing to anthesis linearly decreased from 107 to 73 days among different sowing dates and varieties. In the 25th November sowing saturation deficit was lower which helped in providing 107 days of pre-anthesis period as compared to late sown dates where the duration was only of 70 days. The following

multiple regressions were obtained using these three weather variables for quantifying pre-anthesis and post-anthesis durations, explaining their 75 and 93 per cent variability, respectively.

$$\begin{aligned} \text{Duration of sowing to anthesis (days)} \\ = -0.8 + 7.51T + 0.012Rs - 6.35SD \\ (2.45) \quad (0.315) \quad (-5.445) \\ (R^2 = 0.75, F = 19.985) \end{aligned}$$

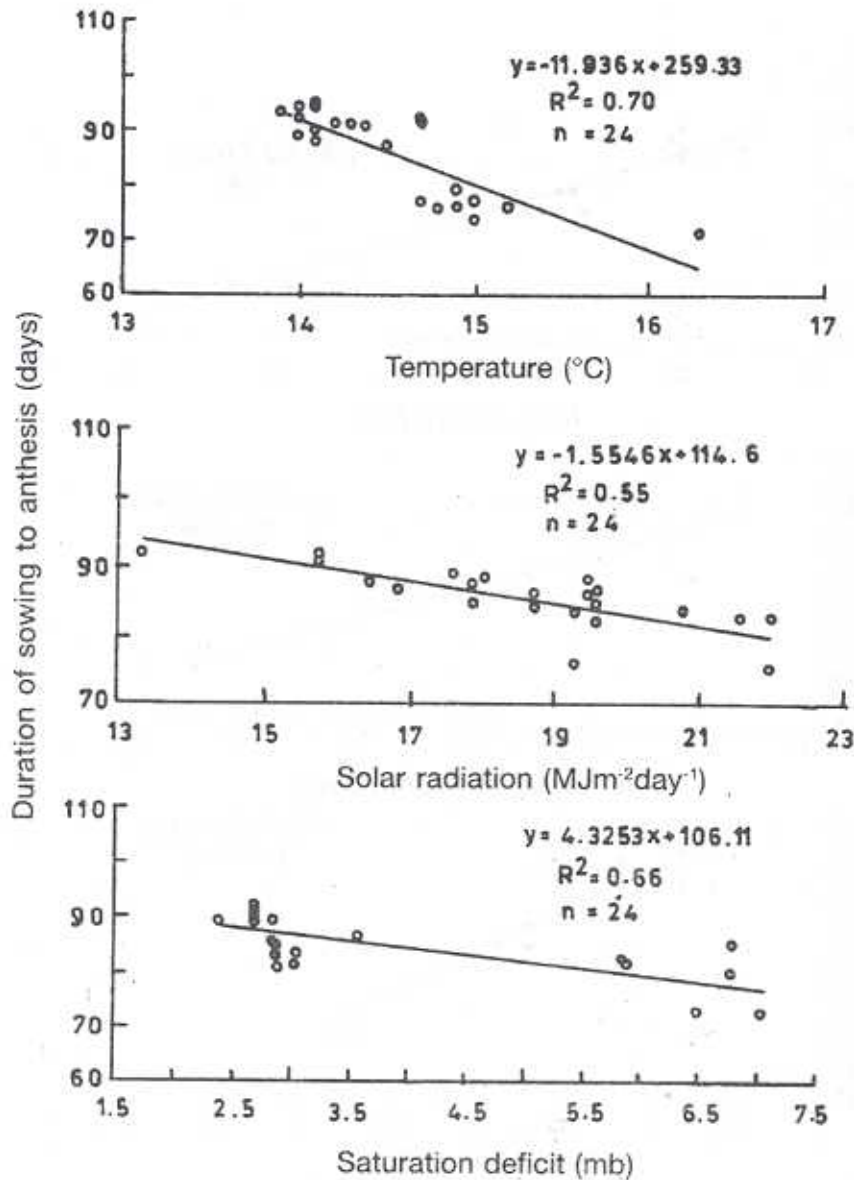


Fig. 2 : Duration of sowing to anthesis period of wheat as influenced by temperature, solar radiation and saturation deficit.

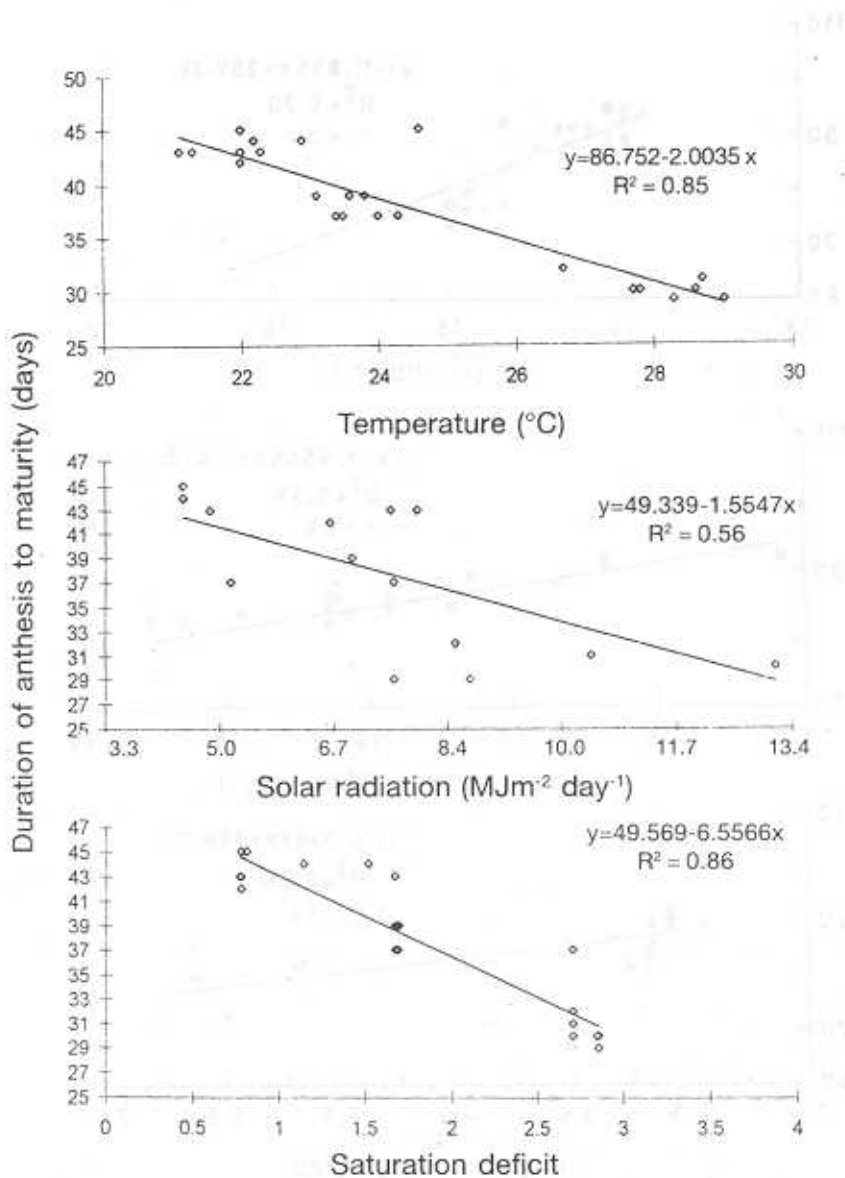


Fig. 3 : Duration of anthesis to maturity period of wheat as influenced by temperature, incoming solar radiation and saturation deficit.

Duration of anthesis to maturity (days)
 $= 52.2 - 0.76 T - 0.146 R_s + 3.77 SD,$
 (-2.913) (-2.215) (4.624)
 ($R^2 = 0.93, F = 107.7$)

The values in the parenthesis refer to t values for the corresponding coefficients of weather variables.

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