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Effect of Growing Environments and Irrigation Levels on Phenology and Interception of PAR in Wheat Crop

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ABSTRACT

The field experiment was conducted at Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar (Lat.: 29^0 10' N, Log.: $75^0$36' E & 215.2 m above msl), Haryana, India during the rabi season of 2013-14, 2014-15 and 2015-16, respectively. Experiment was laid out with four growing environments (D_1-last week of Oct., D_2-second week of Nov., D_3-last week of Nov., and D_4- second week of Dec.) along with four irrigation levels, irrigation applied at different phenophases (I_1-CRI, I_2- CRI and heading, I_3- CRI+ jointing and milking, I_4- CRI+ jointing +anthesis and dough stage). The design was strip plot with four replications. The main objective of work was to effect in growing environment and irrigation scheduling on phenology. The intercepted PAR calculated for wheat crop. Phenophases of wheat crop from CRI to physiological maturity (PM) having less difference in all growing years. The results revealed that the intercepted PAR (IPAR) differed due to variation in dates of sowing. IPAR values increased linearly from CRI to dough stage (DS). Higher values of IPAR was obtained in D_4I_4, D_4I_1 and D_3I_1 where as lower IPAR values in D_1I_2, D_1I_4 and D_1I_4 treatments during the year 2013-14, 2014-15 and 2015-16, respectively to the other treatments. Dry matter production was found to be closely related to the amount of IPAR under different growing environment at Hisar conditions.

Key words: *Growing environments, irrigation levels, wheat phenophases, intercepted PAR*

INTRODUCTION

The wheat *(Triticum aestivum L.)* crop is one of the most important cereal crops globally. Among the major cereal grown in India, In wheat case stands second position next to rice in area and production, but stands first in productivity. Wheat cultivation in India is very old at wider range of climatic adaptability and elevation. India covers about 30.2 million hectares area with total production of 93.5 million tonnes and productivity of 30.9 q/ha[1]. The area, production and productivity, averaged are 2.5 million ha, 11.3 tonnes and 4.4 tonnes ha^{-1}, respectively[1].

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The base temperature were varies from 3-5 ^{0}C and growth temperature minimum of wheat is 3-4 °C, the optimum temperature about 25 °C, and the maximum from tolerance temperature range about 30-32 °C. Climatic factors like rabi season minimum and maximum temperature, solar radiation and rainfall effect crop yield all over the world. Foggy weather conditions and heavy rainfall have detrimental effect and promote the yellow rust disease in wheat crop at Haryana during 4th to 9th SMW.

Changes in climatic variables like rise in temperature and decline in rainfall may be more frequent in future as suggested by the Intergovernmental Panel on Climate Change[3] during the critical phenophases of wheat like pre anthesis and post- anthesis high temperature and heat load may have huge impacts upon wheat growth, and stress was reduced the photosynthetic efficiency of crop[11].You *et al*[12]., was observed significant reduction in yield due to rise in air temperature and concluded that a 1.8°C rise in temperature caused 3-10% reduction in wheat yields. Winter crops are vulnerable to high temperature (>22^{0}C mean temperature) during reproductive stages and differential response of temperature change (rise) to various crops has been noticed under different growing or production environments[5]. Crop is exposed to a variety of weather conditions during its different phenophases of their growth which resulting in large variations in growth rate and yield, respectively. For quantifying the thermal relation of crops, thermal units approach is widely used[6] and has been further modified to include photothermal units and heliothermal units[7]. Sowing time of wheat is one of the most important factors that governs the crop phonological development and efficient conversion of biomass in to economic yield through the assimilation by crop. Normal period of sowing has longer growth duration, (prolonged reproductive phases) which consequently provides an opportunity to accumulate more biomass as compared to late sowing (shirked the reproductive phases) and henceforth manifested in higher grain and biological yield[10]. Whereas the delayed sowing the wheat crop is exposed to sub-optimal temperatures at established and supra-optimal temperature at reproductive phases that leads to forced maturity and reduction in grain yield[9]. Water is essential at every developmental phase of crop growth starting from seed germination to crop maturity for harvesting the maximum potential of wheat. There is a positive correlation between grain yield and irrigation frequencies to sustain the longer moisture availability to crop. Irrigation missing at some critical growth stage sometime drastically reduces grain yield[2] due to lower test weight and alter the physiological process. Similarly, over irrigation also sometimes tends to decrease grain yield instead of increasing yield[4].

MATERIAL AND METHODS

The field experiment was conducted at agro meteorology observatory, Department of Agricultural Meteorology, CCS Haryana Agricultural University, Hisar (Lat.: 29^0 10' N, Log.: 75^{0}36' E & 215.2 m above msl), Haryana, India during the Rabi season in the year 2013-14 and 2014-15. Experiment was laid out with four growing environments (D_1-last week of Oct., D_2-second week of Nov., D_3-last week of Nov., and D_4- second week of Dec.) along with four irrigation levels was applied at different phenophases (I_1-CRI, I_2-CRI and heading, I_3- CRI+ jointing and milking, I_4- CRI+ jointing +anthesis and dough stage) under strip plot design with four replication at semi arid climatic condition of Hisar zone. The number of days to attain various phenophases was determined to following the sampling method and randomly selected five plants in all the plots visually by the number of days taken, from the sowing date to attained respective phenophases up to physiological maturity. Maximum and minimum temperatures used for study were taken from agro-meteorological observatory from the experimental field. The daily intercepted photosynthetically active radiation (IPAR) was calculated as per the procedure adopted by Rosenthal and Gerik[8]:

$$PAR = R_s \times 0.49$$

Where, Rs is solar radiation received at the surface of the earth.

$$IPAR = (1 - e^{-kf}) PAR$$

Where, K is extinction coefficient and f is leaf area index. K was calculated by the expression:

$$K = In (I/I_0)/f$$

Where, I_0 is incident radiation at the top of the crop canopy and I is radiation energy at the bottom of the crop canopy.

RESULTS AND DISCUSSION

Phenological studies

The days taken from sowing to CRI, tillering (TL), jointing (JT), booting (BT), heading (HD), anthesis (AT), milking (ML), dough stage (DS) and physiological maturity (PM) of wheat crop under different growing environments and irrigation levels are presented in table 1, 2 & 3. Different irrigation levels were not much significantly notified to variation in days taken, for CRI under different respective growing environments. The days taken for CRI were 21 to 22 days. The results of phenology of wheat crop under different dates of sowing that the duration of different phenophases started slightly decreasing, from jointing phases and continued in all the stages as the sowing was delayed after D_1 (last week of Oct.). The decrease in duration at these stages also varied differently for different irrigation level treatments in the respective year. The highest effect of thermal stress on phenophases was observed in I_3 (CRI + jointing and milking) and I_4 (CRI +jointing +anthesis and dough stage) whereas least effect of thermal stress was observed in I_1 (CRI) and I_2 (CRI and heading) irrigation level.

Table 1: Effect of growing environments and irrigation levels on different wheat phenology (days) during the growing season 2013-14

Growing Environments	Phenophases								
	CRI	TL	JT	BT	HD	AT	ML	DS	PM
D_1	21	34	66	76	88	98	108	120	145
D_2	22	36	64	78	84	96	104	118	143
D_3	23	38	67	77	83	95	103	119	138
D_4	22	35	65	75	86	101	107	122	131
Irrigation levels									
I_1	21	36	64	75	87	99	108	121	140
I_2	22	35	65	77	85	98	109	119	141
I_3	21	34	68	76	84	96	102	121	139
I_4	21	33	63	74	83	99	105	122	137

Table 2: Effect of growing environments and irrigation levels on different wheat phenology (days) during the growing season 2014-15

Growing Environments	Phenophases								
	CRI	TL	JT	BT	HD	AT	ML	DS	PM
D_1	23	37	69	79	91	101	110	123	148
D_2	21	38	65	77	87	97	106	122	144
D_3	21	36	64	77	87	98	107	123	139
D_4	22	40	67	76	87	103	107	119	130
Irrigation levels									
I_1	22	39	67	79	90	102	110	124	142
I_2	22	38	66	76	88	100	108	123	141
I_3	22	37	65	77	87	99	105	120	140
I_4	22	38	65	77	86	99	105	119	138

Table 3: Effect of growing environments and irrigation levels on different wheat phenology (days) during the growing season 2015-16

Growing Environments	Phenophases								
	CRI	TL	JT	BT	HD	AT	ML	DS	PM
D_1	22	36	69	78	90	100	111	122	147
D_2	21	37	66	78	86	98	105	121	145
D_3	22	35	64	77	88	97	106	124	140
D_4	21	39	66	75	87	104	107	120	129
Irrigation levels									
I_1	23	38	67	78	89	103	109	124	141
I_2	21	37	67	77	88	101	107	122	142
I_3	22	38	66	78	86	98	106	121	141
I_4	22	37	65	76	87	98	105	120	139

Characteristics of Intercepted PAR on wheat

IPAR values of wheat crop under different dates of sowing and irrigation levels are depicted in Fig.1, 2 and 3. The results found that a increasing trend of IPAR at different phenological stage of wheat in all the growing environments. Absorption of radiation increased from tillering (TL) to heading (HD) stage since most of the vegetative growth took place during this period in all the dates of sowing. The poor absorption towards maturity due to decline in leaf area because senescence of leaves at this time and chlorophyll contain were demised and reduced the physiological process. Significant difference was only found on IPAR between sowing date. The crop sown on D_4 (second week of Dec.) showed the highest IPAR (635.7 MJ/m^2) and I_4 (CRI + jointing +anthesis and dough stage) irrigation level (593.2 MJ/m^2) followed by D3, D2, D_1 sowing dates and I_1, I_3 and I_2 irrigation level respectively in the year of 2013-14 depicted in the fig.1, where as higher value IPAR during the growing year 2014-15 was obtained D_4 (632.2 MJ/m^2) and I_1 (580.2 MJ/m^2) as compare to other dates of sowing and irrigation level (Fig.2). But in the case of 2015-16 growing year highest IPAR values were obtained by D_3 (619.3 MJ/m^2) and I_1 (568.7 MJ/m^2) followed by D_2, D_4, D_1 and I_2, I_3 and I_4 respectively (Fig.3).

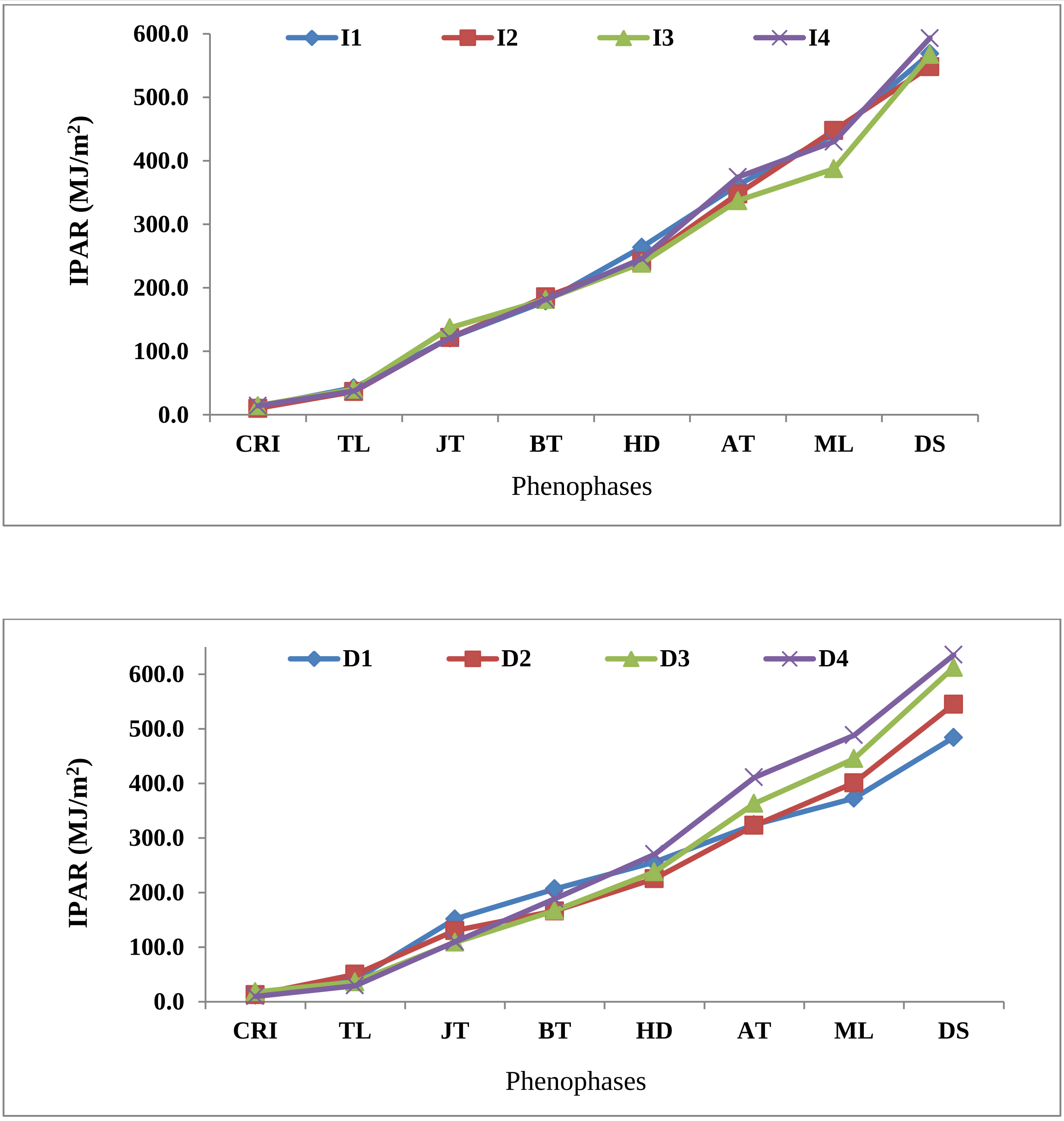
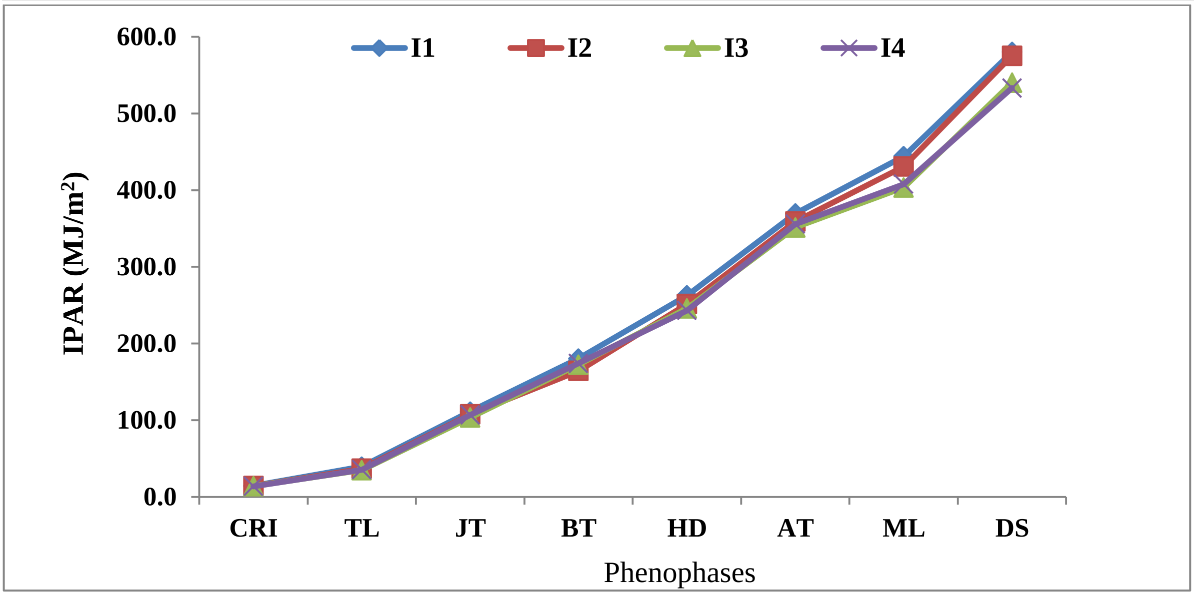


Fig. 1: Effect of growing environments and irrigation levels on intercepted PAR at various phenophases of wheat (2013-14)



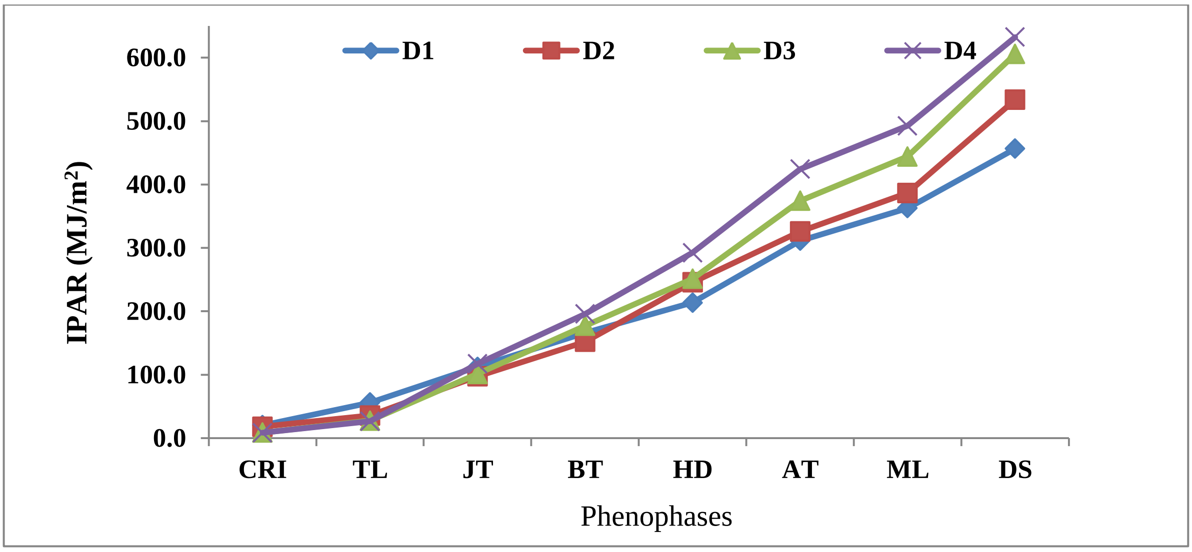
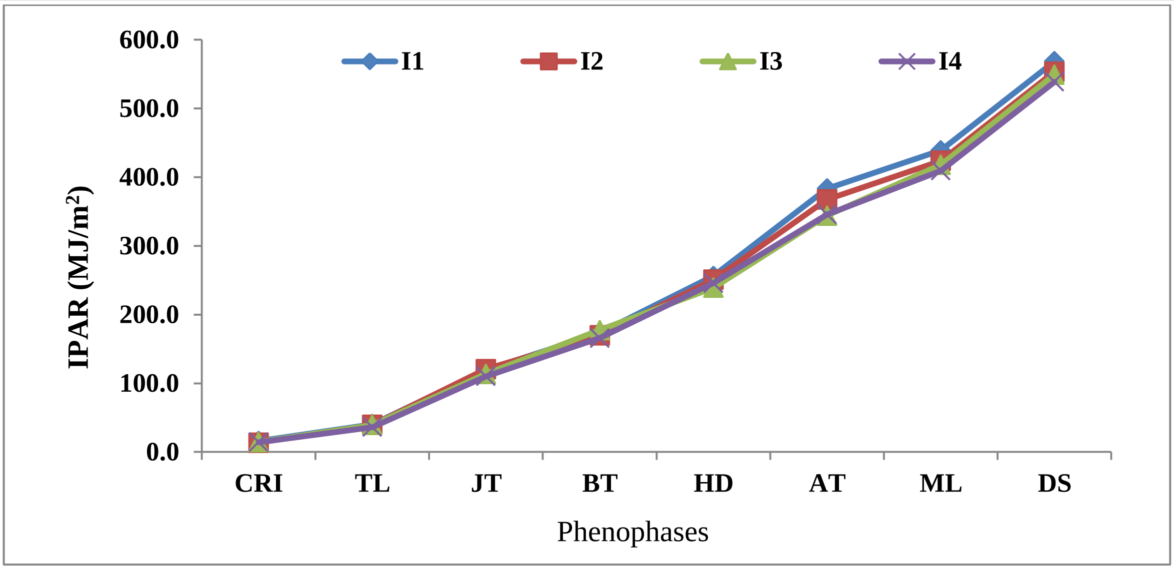


Fig. 2: Effect of growing environments and irrigation levels on intercepted PAR at various phenophases of wheat (2014-15)



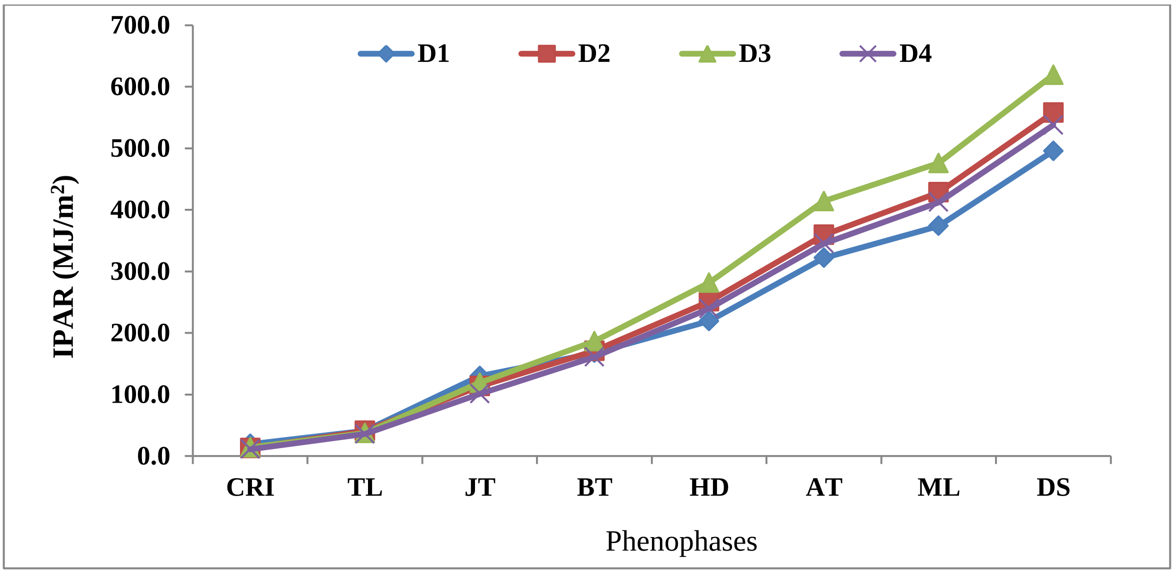


Fig. 3: Effect of growing environments and irrigation levels on intercepted PAR at various phenophases of wheat (2015-16)

CONCLUSION

The wheat crop with growing environment on D_1 (last week of Oct.) and I_2 (CRI+ heading) irrigation level took maximum days for maturity and late sown wheat crop recorded lesser days for physiological maturation due to thermal stress and shrinking the reproductive phase due to attained the higher thermal degree day. The highest IPAR was obtained by D_4 (second week of Dec.) sowing with I_1 (CRI) irrigation level.

REFERENCES

1. Anonymous, Progress report of all India coordinated wheat and barley improvement project 2015-16, Director's report ed. G P Singh, ICAR- Indian institute of wheat and barley research, Karnal, India, p **96**. (2016).
2. Chauhan, C.P.S., Singh, R.B. and Gupta, S.K., Supplemental irrigation of wheat with saline water. *Agric. Water. Manage.* **95:** 253-258 (2008).

3. IPCC Parry, M.L., Canziani, O.F., Palutikof, P.J., Van der Linden P. and Hanson, C.E. (Eds.). *Climate change : Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. Cambridge, UK, 976pp. (2007).
4. Kahlown and Azam Individual and combined effect of water logging and salinity on crop yields in the Indus basin. *J. Int. Comm., Irrig. and Drain.*, **51(4):** 329-338 (2002).
5. Kalra, N., Effect of increasing temperature on yield of some winter crops in North West India. *Cur. Sci.*, **94(1):** 82-88 (2008).
6. Ramteke, S.D., Chetti., M.B. and Salimath, P.M., Heat unit requirement of chickpea genotypes for various phenological stages during kharif and rabi seasons, *Annals Plant Physiology*, **10(2):** 176-181 (1996).
7. Rao, V.U.M, Singh., D. and Singh, R., Heat use efficiency of winter crops in Haryana, *J. Agrometeorol*., **1(2):** 143-148 (1999).
8. Rosenthal, W.D. and Gerik, T.J., Radiation use efficiency among cotton cultivars. *Agron. J.*, **85:** 655-658 (1991).
9. Sardana, V., Sharma, S.K. and Randhawa, A.K., Performance of wheat cultivars under different sowing dates level of nitrogen under rainfed conditions. *Annals Agric. Res.*, **20** : 60-63 (1999).
10. Singh, S. and Pal, M., Growth, yield and phonological response of wheat cultivars to delayed sowing. *Indian J. Pl. Physiol.*, **8:** 277-287 (2003).
11. Wang, X., Cai, J., Jiang, D., Liu, F., Dai, T. and Cao, V., Pre-anthesis high-temperature acclimation alleviates damage to the flag leaf caused by post-anthesis heat stress in wheat. *J. Plant Physio.* **168(6):** 585-593 (2011).
12. You, L., Rosegrant, M.W., Wood, S. and Sun, D., Impact of growing season temperature on wheat productivity in China. *Agriculture Meteorology*, **149:** 1009-1014 (2009).