International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(1): 745-750

Received: 08-11-2017
Accepted: 09-12-2017

MK Nayak
Department of Agricultural Meteorology, College of Agriculture, CCS Haryana Agricultural University, Hisar, Haryana, India

Raj Singh
Department of Agricultural Meteorology, College of Agriculture, CCS Haryana Agricultural University, Hisar, Haryana, India

Anil Kumar
Department of Agricultural Meteorology, College of Agriculture, CCS Haryana Agricultural University, Hisar, Haryana, India

Madho Singh
Department of Agricultural Meteorology, College of Agriculture, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence
MK Nayak
Department of Agricultural Meteorology, College of Agriculture, CCS Haryana Agricultural University, Hisar, Haryana, India

Correlation and regression study on wheat (*Triticum aestivum*) under different growing environments

MK Nayak, Raj Singh, Anil Kumar and Madho Singh

Abstract
An experiment was conducted at Department of Agricultural Meteorology, CCS HAU, 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 & 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 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) Strip plot design was adopted with four replications. The main aim of this study was to compute the correlation and regression results. Both maximum and minimum temperature at vegetative stage was positively correlated with yield and yield attributes in both the years. Minimum temperature at vegetative stage also had positive correlation except the parameters like length of spike, number of grains, seed yield and harvest index in 2013-‘14 year. Both maximum and minimum temperature that prevailed during reproductive stage was negatively correlated in both the years. RH (m) and RH (e) at vegetative stage had negative but positively correlated at reproductive stage in both the years. Wind speed and rainfall negatively correlated at vegetative and reproductive stages in both the years. Dry matter production was directly and linearly related with IPAR. The slope value of the regression line showed that D_1 was highly efficient in utilizing PAR for dry matter production. The irrigation treatment I_3 was more efficient in utilizing PAR as compared to other irrigation treatments in 2013-14 & 2014-15. The accumulated heat unit was found to have direct liner relationship with dry matter production.

Keywords: growing environments, irrigation levels, wheat phenophases, correlation and regression anlysis

Introduction
Wheat (*Triticum aestivum* L.) is one of the most important cereal crops globally. It provides about 20% of total food calories for human race. Among the major cereal grown in India, wheat stands second next to rice in area and production, but stands first in productivity. Wheat cultivation in India is very old. India covers about 29.9 million hectares area with total production of 93.9 million tonnes and productivity of 31.40 q/ha. (Anon., 2012) [1]. Haryana ranks fifth in wheat production in country and contributes around 13.3% towards national production from 8.9% of total wheat growing area in the country. The area, production and productivity, averaged over last five years are 2.3 million ha, 9.3 tonnes and 4.0 tonnes ha^{-1}, respectively. The minimum growth temperature for wheat is 3-4 °C, the optimum temperature about 25 °C, and the maximum from about 30-32 °C. Climatic factors like temperature, solar radiation and rainfall effect crop yield all over the world. 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 (IPCC, 2007) [5]. Pre anthesis and post- anthesis high temperature and heat may have huge impacts upon wheat growth, and stress reduced the photosynthetic efficiency of crop (Wang *et al.,* 2011) [11]. You *et al.,* (2009) [12] observed significant reduction in yield due to rise in 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 during reproductive stages and differential response of temperature change (rise) to various crops has been noticed under different production environments (Kalra, 2008) [7]. It is necessary to understand the knowledge of plant environment interaction for increasing the production of crop. Wheat is a photosensitive and thermo sensitive long day crop.

Solar radiation interception play major role in dry matter production. Solar radiation interception, which is a crop dependent coefficient, is widely used in crop simulation models and in the physiological interpretation of crop responses to the environment and management practices (Kemanian *et al*., 2004) [8]. In the present paper, an attempt was made to assess radiation of wheat sown on different dates and irrigation levels. 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. Irrigation missing at some critical growth stage sometime drastically reduces grain yield (Chauhan *et al*., 2008) [3] due to lower test weight. Similarly, over irrigation also sometimes tends to decrease grain yield instead of increasing yield (Kahlown and Azam, 2002) [6].

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. All recommended agronomic practices viz. fertilizer application, irrigation etc. recommended for the place were applied to the crop. The observations of leaf area, biomass production and photosynthetically active radiation (PAR) were taken on the same day at different phenological stages. The plant samples were dried in the hot air oven till constant weight. The PAR was measured with point quantum sensor by keeping the sensor above the crop surface and at ground surface inside the crop canopy. The reflected PAR was also measured keeping the sensor inverted above the crop. The daily intercepted photosynthetically active radiation (IPAR) was calculated as per the procedure adopted by Rosenthal and Gerik (1991) [9].

Intercepted PAR: The daily IPAR was calculated using the following expression: IPAR=PAR $(1-e^{-kf})$

Where,

K (Extinction coefficient) = ln (I/Io)/f (Monsi and Saeki, 1953)

F = Cumulative leaf area index of foliage layer

Io = Radiation energy at the top of the canopy

I = Radiation energy at a level inside the crop canopy

Results and Discussion

The correlation coefficient of yield and yield attributes with weather parameters for different sowing environment of wheat crop are presented in Table 1& 2. Maximum temperature (T_{max}), minimum temperature (T_{min}), BSS and potential evapotranspiration (PE) were positively correlated with the entire yield and yield attributes during the vegetative stage and maximum temperature, minimum temperature, relative humidity (RH) (E), BSS and potential evapotranspiration were negatively correlated at reproductive stage in 2013-14 whereas wind speed (WS) and rainfall were negatively correlated during both vegetative and reproductive stage in 2013-14. Maximum temperature, BSS and potential evapotranspiration were positively correlated at vegetative stage while minimum temperature, relative humidity (M & E) and wind speed were negatively correlated at vegetative stage during 2014-15 with yield and yield attributes. Relative humidity (M & E) was positively correlated at reproductive stage whereas maximum temperature, minimum temperature, wind speed, BSS and potential evapotranspiration were negatively correlated at reproductive stage in 2014-15. Rainfall (RF) was negatively correlated at both stage of wheat with yield and yield attributes.

Table 1: Correlation coefficient between yield and yield attributes with weather parameters during the year 2013-14

Weather parameters	Pheno phases	TL/plant	Length of spk	Spkl/spke	No. of grns/spke	Seed yd	Strw yd	Bio.Yd	HI (%)	Test Wt.
T_{Max}	Veg. stage	0.53*	0.79**	0.72**	0.81**	0.69**	0.76**	0.74**	0.39	0.70**
	Rep. stage	-0.59*	-0.80**	-0.80**	-0.85**	-0.76**	-0.83**	-0.82**	-0.44	-0.77**
T_{Min}	Veg. stage	0.50*	0.75**	0.61*	0.75**	0.62*	0.65**	0.65**	0.40	0.62*
	Rep. stage	-0.58*	-0.80**	-0.80**	-0.84**	-0.75**	-0.82**	-0.81**	-0.43	-0.77**
RH (M)	Veg. stage	-0.54*	-0.78**	-0.70**	-0.80**	-0.69**	-0.74**	-0.73**	-0.42	-0.69**
	Rep. stage	0.55*	0.76**	0.79**	0.82**	0.74**	0.83**	0.80**	0.40	0.76**
RH (E)	Veg. stage	-0.53*	-0.77**	-0.74**	-0.81**	-0.70**	-0.78**	-0.76**	-0.38	-0.71**
	Rep. stage	0.58*	0.79**	0.80**	0.84**	0.76**	0.83**	0.81**	0.44	0.76**
WS	Veg. stage	-0.50*	-0.74**	-0.74**	-0.78**	-0.67**	-0.77**	-0.74**	-0.34	-0.70**
	Rep. stage	-0.62*	-0.81**	-0.82**	-0.86**	-0.78**	-0.83**	-0.83**	-0.49*	-0.80**
BSS	Veg. stage	0.51*	0.76**	0.74**	0.79**	0.67**	0.77**	0.74**	0.34	0.70
	Rep. stage	-0.60*	-0.81**	-0.79**	-0.86**	-0.77**	-0.83**	-0.82**	-0.46	-0.77**
PE	Veg. stage	0.43	0.66**	0.55*	0.69**	0.56*	0.61*	0.60*	0.35	0.56*
	Rep. stage	-0.62	-0.79	-0.84	-0.87	-0.82	-0.86	-0.86	-0.53	-0.82
RF	Veg. stage	-0.05	-0.06	-0.25	-0.13	-0.13	-0.25	-0.20	0.08	-0.18
	Rep. stage	-0.68	-0.82	-0.75	-0.87	-0.77	-0.74	-0.77	-0.58	-0.77

** Significant at (P=0.01) level of significance

* Significant at (P=0.05) level of significance

Table 2: Correlation between yield and yield attributes with weather parameters during the year 2014-15

Weather parameters	Pheno-phases	TL/plant	Length of spk	Spkl/spke	No. of grns/spke	Seed yd	Straw yield	Bio.Yd	HI (%)	Test weight (gm)
T_{Max}	Veg. stage	0.52*	0.51*	0.61*	0.56*	0.49*	0.69**	0.60*	0.08	0.53*
	Rep. stage	-0.54*	-0.80**	-0.86**	-0.81**	-0.68**	-0.88**	-0.80**	-0.25	-0.80**
T_{Min}	Veg. stage	0.21	-0.22	-0.11	-0.12	-0.05	0.00	-0.02	-0.10	-0.15
	Rep. stage	-0.54*	-0.79**	-0.86**	-0.80**	-0.69**	-0.88**	-0.80**	-0.26	-0.79**
RH (M)	Veg. stage	-0.27	-0.26	-0.35	-0.29	-0.53*	-0.73**	-0.65**	-0.13	-0.57*
	Rep. stage	0.47	0.82**	0.87**	0.83**	0.70**	0.85**	0.79**	0.34	0.82**
RH (E)	Veg. stage	-0.53*	-0.65**	-0.75**	-0.69**	-0.58*	-0.80**	-0.70**	-0.13	-0.66**
	Rep. stage	0.53*	0.82**	0.87**	0.83**	0.68**	0.88**	0.80**	0.25	0.81**
WS	Veg. stage	-0.46	-0.76**	-0.83**	-0.76**	-0.63**	-0.84**	-0.75**	-0.20	-0.75**
	Rep. stage	-0.49*	-0.86**	-0.73**	-0.76**	-0.66*	-0.71**	-0.70**	-0.43	-0.73**
BSS	Veg. stage	0.54*	0.56*	0.65**	0.62*	0.51*	0.73**	0.64**	0.09	0.58*
	Rep. stage	-0.54*	-0.80**	-0.84**	-0.81**	-0.65**	-0.87**	-0.78**	-0.21	-0.79**
PE	Veg. stage	0.41	0.19	0.35	0.28	0.29	0.43	0.37	0.02	0.24
	Rep. stage	-0.62*	-0.78**	-0.85**	-0.82**	-0.79**	-0.86**	-0.84**	-0.49*	-0.80**
RF	Veg. stage	-0.34	-0.80**	-0.74**	-0.72**	-0.53*	-0.73**	-0.64**	-0.13	-0.72**
	Rep. stage	-0.43	-0.22	-0.33	-0.27	-0.34	-0.41	-0.38	-0.15	-0.25

** Significant at (P=0.01) level of significance

* Significant at (P=0.05) level of significance

Regression analysis

Relationship between IPAR and dry matter among different dates of sowing and irrigation level are depicted in Figure 1 & 2. A direct and significant linear relationship was observed between dry mater and IPAR under different dates of sowing and irrigation level. The slope of regression line varies among different treatments. These results were in conformity with those observed by Gallagher and Biscoe (1977) [4] who reported that dry matter production was found to be closely related to the amount of IPAR. The slope value of regression line show that growing environment of wheat D_1 (last week of Oct.) and irrigation level I_4 (CRI + jointing +anthesis and dough stage) were highly efficient in utilizing of IPAR for dry matter production in both year 2013-14 and 2014-15 (Fig.1 & 2). Absorption of radiation increased from tillering to the flag leaf, since most of the vegetative growth took place during this period in all dates of sowing. The poor absorption towards maturity is due to decline in leaf area because of senescence of leaves at this time. Absorption of radiation decreased with delay in dates of sowing due to shortened vegetative growth phase and lower leaf area in late sown crops with early anthesis. This early anthesis in late sown crops incurred a yield loss through reduction in absorption of PAR by the canopy. Similar results were reported by Russel *et al.* (1982) [10]. The trend was reversed for transmitted radiation, which went on to decrease with the advancement of crop age. Reflection of radiation increased from emergence and then decreased up to flag leaf, and again increased up to physiological maturity in all the dates of sowing.

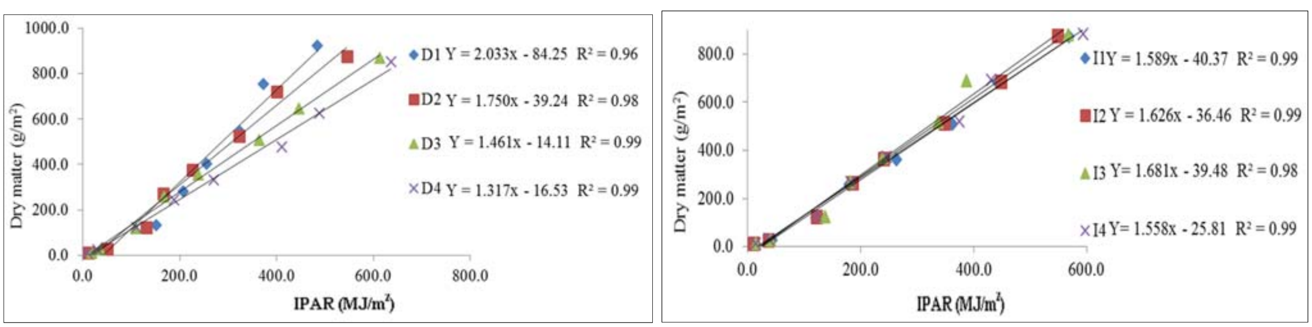

Fig 1: Relationship of dry matter production with intercepted photosynthetically active radiation under different growing environments during the *Rabi* season 2013-14

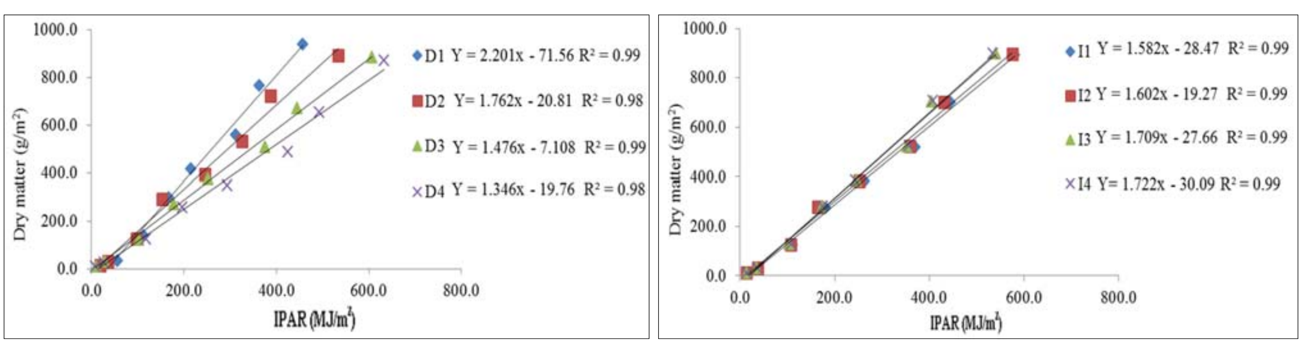

Fig 2: Relationship of dry matter production with intercepted photosynthetically active radiation under different growing environments during the *Rabi* season 2014-15

Dry matter and energy indices

Accumulated heat units showed direct liner relationship with dry matter production in all growing environment and irrigation levels. Thermal efficiency of wheat crop sown D_1 (last week of Oct.) and irrigation level I_4 (CRI + jointing +anthesis and dough stage) for dry matter production was maximum followed by D_2, D_3, D_4 and I_3, I_2, I_1, respectively in both the year 2013-14 and 2014-15 (Fig.3 & 4).

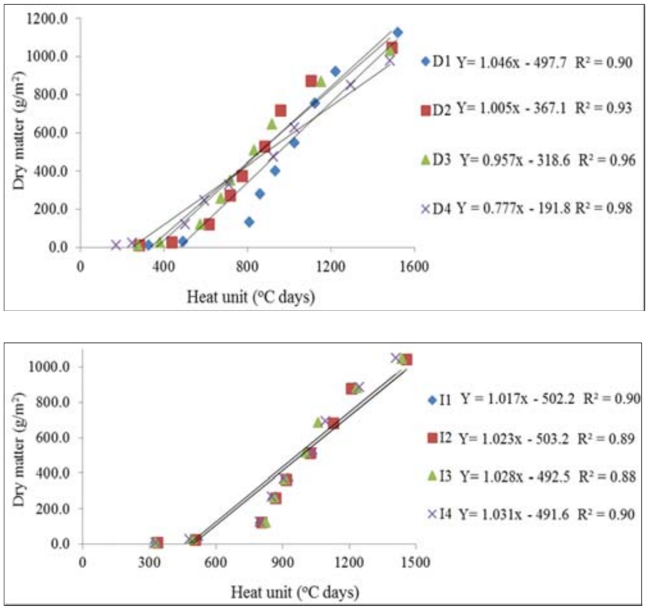

Fig 3: Relationship of dry matter production with heat unit (GDD) under different growing environments during the Rabi season 2013-14

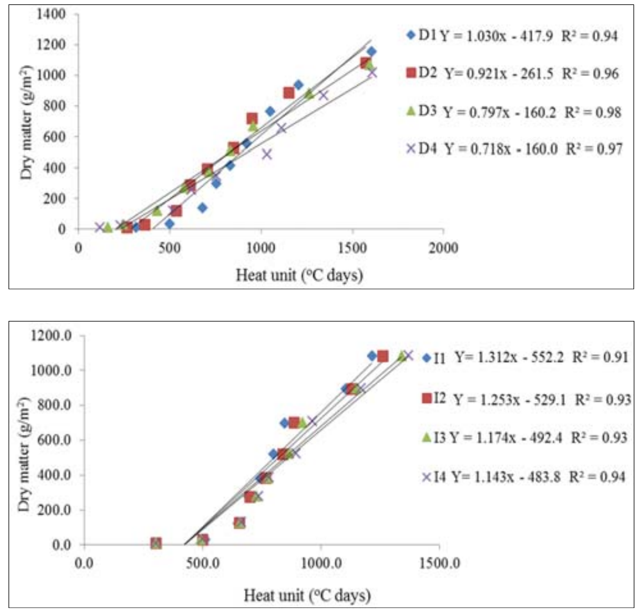

Fig 4: Relationship of dry matter production with heat unit (GDD) under different growing environments during the Rabi season 2014-15

Wheat yield and energy indices

Relationship of IPAR with wheat seed yield, straw yield and biological yield quantified and depicted in figure 5 & 6 by pooling the data for date of sowing and irrigation level. A linear relationship was found between IPAR and seed yield, straw yield and biological yield in 29, 43 and 36% explain predictability in the year 2013-14 and 39, 90 and 87% in 2014-15, respectively (Fig. 5 & 6).

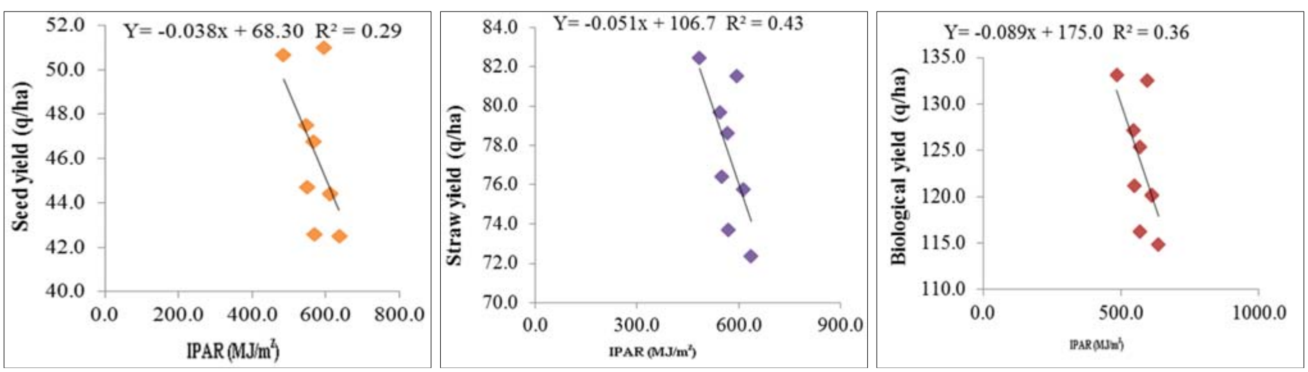

Fig 5: Relationship of seed yield, straw yield and biological yield with energy indices under different growing environments during the Rabi season 2013-14

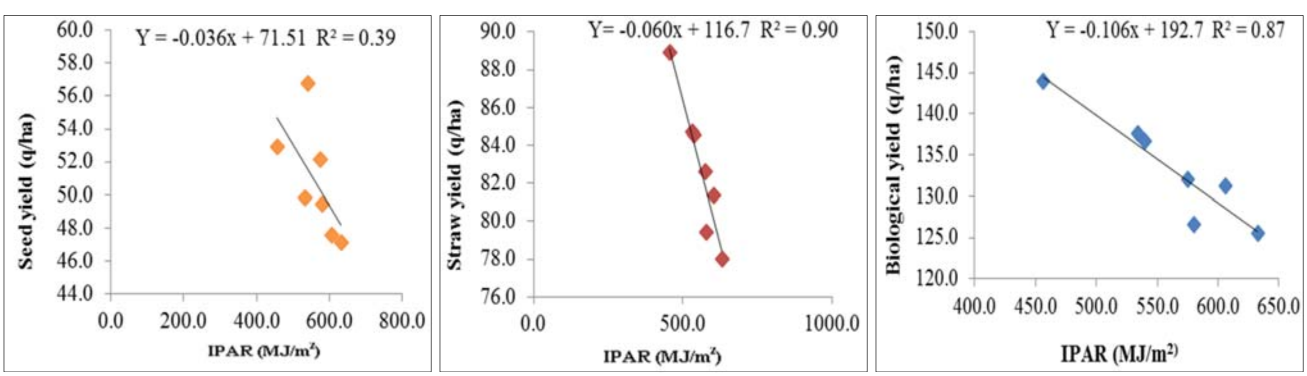

Fig 6: Relationship of seed yield, straw yield and biological yield with energy indices under different growing environments during the Rabi season 2014-15

Conclusion

The results showed that maximum temperature, BSS and potential evapotranspiration were positively correlated with yield and yield attributes of wheat during vegetative stage whereas maximum temperature, minimum temperature, wind speed, BSS, potential evapotranspiration (PE) and rainfall were negatively correlated in both of the year, respectively. D_1 (last week of Oct.) and I_4 (CRI+jointing+anthesis and dough stage) treatment highly efficient tos utilizing the IPAR and accumulated heat units to produce maximum dry matter. So timely sown D_1 can be considered as optimum sowing time with I_4 irrigation level at semi-arid condition.

References

1. Anonymous. State-wise area, production and yield of wheat crops in India for the year 2012-13. Source-FAOSTAT and IGC report. 2012; 654:86.
2. Anonymous. http://agriharyana.nic.in/crop wise area.htm, 2010.
3. Chauhan CPS, Singh RB, Gupta SK. Supplemental irrigation of wheat with saline water. Agric. Water. Manage. 2008; 95:253-258.
4. Gallagher JN, Biscoe PV. Weather, dry matter production and yield In: J.J. Landsberg and C.V. cutting (Editors) Environmental effect on Crop Physiology. Academic Press, London. 1977, 75-100.
5. IPCC. Parry ML, Canziani OF, Palutik of PJ, Van der Linden P, Hanson CE. (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. 2007; 976.
6. Kahlown, Azam. Individual and combined effect of water logging and salinity on crop yields in the Indus basin. J of Inter. Commu. Irrig. and Drain. 2002; 51(4):329-338.

7. Kalra N. Effect of increasing temperature on yield of some winter crops in North West India. Cur. Sci. 2008; 94(1):82-88.
8. Kemanian AR, Claudio Stockle O, David R. Huggins. Variability of Barley Radiation-Use Efficiency. Crop Science. 2004; 44:1662-1672.
9. Rosenthal WD, Gerik TJ. Radiation use efficiency among cotton cultivars. Agron. J. 1991; 85:655-658.
10. Russell G, Ellis RP, Brown J, Milbourn GM, Hayter AM. The development and yield of autumn and spring sown barley in south-east Scotland. Annals of Applied Biology. 1982; 100:167-78.
11. Wang X, Cai J, Jiang D, Liu F, Dai T, Cao V. Pre-anthesis high-temperature acclimation alleviates damage to the flag leaf caused by post-anthesis heat stress in wheat. Journal Plant Physiology. 2011; 168(6):585-593.
12. You L, Rosegrant MW, Wood S, Sun D. Impact of growing season temperature on wheat productivity in China. Agriculture Meteorology. 2009; 149:1009-1014.