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# Effect of sowing time, planting methods and irrigation scheduling on yield response, water and radiation-use efficiencies of wheat (*Triticum aestivum* L.) in North India

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**ABSTRACT**

*A field experiment was conducted during the winter season (rabi) of 2015-16 and 2016-17 at J. V. College, Baraut (Baghpat), U.P., to evaluate the photosynthetically active radiation (PAR) interception, yield response, water and radiation use efficiencies of wheat (Triticum aestivum L.) in response to sowing time, planting methods and irrigation treatments, Wheat variety 'WH1105' was sown on two dates (10 and 20 November) under two planting method and three irrigation treatments (1, 3 post sowing irrigation at CRI stages, flag-leaf emergence and soft dough stages $I_2$, $I_1$ + $4^{th}$ irrigation during the mid week of March, and $I_3$ recommended 4 post sowing irrigation) with 4 replication. Crop sown on 10 November under bed planting $I_2$ irrigation treatment had the maximum dry matter accumulation, leaf area index, number of effective tillers, ear length, grain/ear and 1,000 grain weight as composed to the other treatments, The PAR interception was also higher in 10 November sowing under bed planting with $I_2$ irrigation treatment, which had direct effect on radiation-use efficiency (RUE) of the crop. Water use efficiency (WUE) was higher (12.5 and 11.4 kg/ha/mm) under I, treatment followed by $I_3$ treatment (12.3 and 10.6 kg/ha/mm) and the lowest in $I_2$ treatment (10.5 and 9.3 kg/ha/mm). The grain yield WUE and RUE were higher by 5-10, 10-15 and 1-5 % respectively under bed planting during both seasons. Significant and positive correlation (r) of grain yield with yield-attributing character viz. no. of effective tillers (0.71), grains (0.76) ear length (0.74), 1000 grain weight (0.65) water (0.76) and RUE (0.69) were observed with pooled analysis.*

## 1. Introduction

Wheat is the most important cereal crop in the world widely cultivate around 220 million ha to ensure food security in 94 countries. This experiment climate variability is one of the most significant factors influencing year to year crop production, even in high yield and high-technology agricultural areas (Bhan and Behera, 2014). The vulnerability of wheat yield is expected to increase in future due to expected rise in future temperature. The increase in temperature can adversely may amount to the extent of 38 and 50% respectively, with 5°C rise in temperature (Aggarwal and Rani, 2009). So, adoption of resources-conservation technologies (RCTs) for enhancing crop productivity and resource use efficiency (RUE) is very important besides achieving sustainability in agriculture. The time of sowing is one of the most important non-monetary inputs for optimizing crop growth according to prevailing agro-climatic condition (Singh et. al. 2011). Early planting of wheat give the highest early planting of wheat give the highest yield then delayed one due to long-growing duration and better growth and development during to rapid seedling and uniform emergence along with higher leaf area and fertile tillers (Tanveer et. al. 2003). Along with time of sowing, wheat like other field crops responds method. Despite its high yield potential, yield/ha is low in India compared to other wheat producing countries. Better irrigation and soil management techniques are needed to improve water use efficiency (Majeed et. al., 2015). Different RCTs include mainly bed planting, zero tillage and laser-land levelling of fields.

The comparison of wheat on flat and bed layout at farmer's field indicates significant saving in irrigation water application. It is believed that and increase in agricultural water productivity is the key approach to miligate water storage and to reduce environmental problems. Water productivity is a useful indicator for quantifying the impact of irrigation-scheduling decisions with regarded to water management. Irrigation interval largely depends on environmental conditions, stage of the crop and rainfall received. In view of the climate changes, there in an urgent need to conserve the natural resource base for agriculture. Also to meet the increasing food demand, the productivity of the rice-wheat cropping system must be increased and continued. Keeping all this view, the present study was planned to investigate photosponse, water and radiation use efficiency of winter wheat in response to sowing dates, planting method and irrigation treatment under north India condition.

## 2. Material and Methods

The experiment was conducted on wheat during the winter seasons (rabi) of 2015-16 and 2016-17 at the Research Farm, agronomy Janta Vedic College Baraut (Baghpat), U.P. Wheat variety 'WH-1105" was sown on 2 dates (10 November and 20 November) under 2 planting method (flat planting and bed planting) and 3 irrigation levels ($I_1$, 3 post-sowing irrigation at (R1 stages) flag leaf emergence and soft dough stages, $I_2$, $I_1$ + $4^{th}$ irrigation during the medium week of March, and $I_3$ recommended 4 post-sowing irrigation) with 4 replications in a split-split-plot design during both the seasons. The periodic dry-mater accumulation was recorded at 15 day intervals. The data on grain yield and yield attributes were recorded at harvest.

The leaf area was recorded at 30 days interval using plant canopy. The leaf-area index was measured by placing the sensor once above the canopy followed by placing the sensor once above the canopy followed by placing it at 4 different points below the crop canopy diagonally across the hours.

Line quantum sensor was used to measure the amount of incoming, reflected and transmitted PAR in the range of 400-700 nm. Diurnal cycles of photosynthetically active radiation (PAR) were taket at hourly interval at different technological stages. The PAR interception was calculated by using the following formula.

$$PAR\ interception = \frac{PAR(I) - [PAR\ (T) + PAR(R)]}{PAR\ (I)} \times 100$$

where, PAR (I) – PAR incoming above the canopy;

PAR (T) – PAR transmitted to the ground;

PAR (R) – PAR reflected from the canopy;

Radiation use efficiency (RUE) was calculated as ;

$$RUE\ (g/MJ) = \frac{Grain\ yield\ (kg/ha)}{Accumulated\ intercepted\ photosynthetically\ active\ radiation\ (AIPAR)}$$

$$AIPAR\ (MJ/m^2/day) = 0.007826 \times PAR(MJ/m^2/S) \times BSS$$

Where, BSS, Bright sunshine hours of that particular day, water-use efficiency (WVE) was calculated as per Hussain and AL-Jaloud, (1995)

$$WVE\ (kg/ha/mm) = \frac{Grain\ Yield\ (kg/ha)}{Water\ use\ (mm)}$$

The data were statistically analysed using split-split-plot design. All the comparisons were made at 5% level of significance.

## 3. Result and Discussion

### Leaf-area index

The first data of sowing (10 November) had higher leaf-area index than (30 November) sowing during both year mat booting stage of wheat (Table 1). Alam (2013) also reported higher LA1 at booting stage which then declined up to grain-filling stage. The delay in sowing beyond the normal date resulted in decrease in LAI, also revealed that leaf-area index decreased significantly with delay in sowing of crop. Among the planting method, maximum LAI was observed at booting stage in bed planting as compared to flat planting during stage in bed planting as compared to flat planting during both the years. However, the effect of different irrigation teatments on LAI at booting stage was found to be non-significant during both the year under study.

### Dry matter accumulation

Maximum dry matter accumulation (DMA) was recorded at harvest under 10 November-sown crop as compared to 20 November sown crop during 2015-16 and 2016-17 (Table 1). crop sown early received higher incident radiation and accumulation more temperature over the duration of its growth influencing leaf appearance, canopy closure and interception of photosynthetic active radiation (Martini et. al., 2009). Higher level of interception PAR is positively related to above ground biomass accumulation (Pardo et. al., 2017). Planting method significantly affected the DMA during both year. Bed planting of wheat recorded higher DMA at harvesting as compared to flat planting during both year. The significant higher DMA was also obtained by applying I irrigation extra under $I_2$ treatment (CRI+flag-leaf emergence+soft dough+during the medium of march compared to $I_3$ treatment and last in $I_1$ treatment during both the year.

### Photosynthetically active radiation

The photosynthetically active radiation (PAR) interception was recorded maximum to 90 DAS and decreased afterwards as crop progressed towards the maturity. The date of sowing affected the PAR interception and it decreased with delay in sowing. The PAR interception was higher under 10 November sowing then 20 November sowing during both year which might be sowing to bhugher LAI and longer duration of crop under 10 November sowing as compared to 20 November sowing . The PAR interception also differed with the planting method. The PAR recorded at different phenological stages was higher under the bed planting than that under flat planting during both the reasons. This might be owing to higher LAI and better plant stand obtained under bed planting, thus results. PAR interception was higher under $I_2$ treatment followed by $I_3$ and $I_1$ treatment. These results may be attributed to higher LAI under bed planting and $I_2$ irrigation treatment.

### Yield-attributing characteristics

It was observed that significantly higher number of effective tillers were produced in 10 November sowing as compared 20 November sowing during both the year (Table 2). Normal sowing prolongs the duration of tillering and producers more number of tillers and effective tillers (Kamrozzaman et. al. 2016). The maximum number of effective tillers/m$^2$ were observed in bed planting as compared to flat planting. The $I_2$ irrigation treatment result in significant higher no. of effective tillers, followed by $I_3$ irrigation treatment and $I_1$ irrigation treatment during both the winter seasons. The number of grain/ear were significantly affected by sowing dates, planting method and irrigation treatments. The grain/ear were found maximum in 10 November sowing compared to 20 November sowing during both the year. Higher number of grains/ear were recorded in bed planting than flat planting significantly higher number of grain/ear were obtained under $I_2$ treatment, followed by $I_3$ and $I_1$ treatment. The maximum ear length was observed in 10 November sowing compared to 20 November sown crop. Significantly higher ear length was recorded under $I_2$ treatment, followed by $I_3$ treatment and $I_1$ treatment during both seasons. The 1,000 grain weight was higher in 10 November sowing as compared to 20 November sowing. The significantly higher grain weight was recorded in $I_2$ than $I_3$ and $I_1$ treatment during both the year.

**Grainyield**

The sowing date planting method and irrigation treatment siginificantly affected the grain yield of wheat (Table 2). The highest grain yield was recorded in 10 November sown crop. While the lowest was recorded 20 November sown crop during both the year. The decrease in grain yield with late sowing might be due to shrivelled grains, resulting from lower 1,000 grain weight bed planting resulted higher grain yield than flat planting during both the years. Wang et. al. (2011) also revealed that yield difference between two planting system varied between 6.6 and 12% in favour of raised bed planting. The grain yield was also influenced by different irrigation treatment (Table 2). Maximum grain yield was obtained under $I_2$ as compared to $I_3$ and $I_1$ treatments.

**Water use efficiency (WUE)**

It was observed that 10 November sown crop exhibited more water use efficiency consumptive water use, its rate and WUE decreased in proportion with delay in sowing time. Timely sown wheat crop utilized water at its maximum rate, while late-sown crop utilized water at its lower rate during crop-growth period. This may be due to the fact that the late-sown crop production less photosynthates than normal sown crop. The highest WUE was recorded under bed planting as compared to flat planting during both the years. Higher WUE in bed planting mighe be owing to increased grain yield as well as saving in irrigation water. Hossin et. al. (2004) reported that all permanent bed tillage systems showed substantial water saving (32%) over conventionally tillage on the flat bed. Mollah et. al. (2009) also indicated that, bed planting of water saved 41 to 48% irrigation water over flat planting. Among the irrigation treatments, WUE was higher under $I_1$, followed by $I_3$ and lowest in $I_2$ treatment.

**Radiation-use efficiency (RUE)**

The highest radiation use efficiency (RUE) was observed in 10 November sowing than 20 November sowing during both the years. It decreased with delay in sowing which might be due to higher LAI and more radiation interception by the early-sown crop which decreased with delay in sowing. The highest RUE was recorded under bed planting as compared to flat planting during both the years. The substantial decrease in LAI during the whole growing season in flat planting crop might have caused large reduction in the amount of PAR absorbed by the crop, therefore RUR in the flat planting was significantly lower than that of bed planting. Better performance of crop depends on availability of irrigation water especially at various growth stages. The RUE was higher under $I_2$ than $I_3$ and $I_1$ treatment during the both year.

**Relationships of grain yield with yield attributes and water use efficiency**

The grain yield was significantly and positively correlated with effective tillers, number of grain/ear, ear length, 1000 grain weight, WUE and RUE during both the years (Table 3). The pooled data analysis of two year also showed the positive and siginificant relationship of yield attributes, WUE and RUE with grain yield. Kashif and Khaliq (2004) reported that yield components viz. effective tillers has significantly contributed towards grain yield. They also noted that grains/ear and 1000 grain weight were the main contributors to grain yield in wheat. Li at. al. (2006) showed that RUE appeared to be closely and positively associated with the no. of grains and ultimately to grain yield.

It is concluded that wheat grain yield can be increased by bed planting over the flat planting. It also improved the WUE and RUE. The crop soon on 10 November under bed planting with 4 irrigaltion at CRI, flag-leaf emergence, soft dough stage and the medium week of march had higher growth and grain yield as compared to the other treatments.

**Table 1. Maximum leaf-area index and dry-mater accumulation of wheat under different dates of sowing, planting method and irrigation during winter of 2015-16 and 2016-17.**

| Treatment | Leaf-area index at booting stage | | Dry matter accumulation ($g/m^2$) at physiological maturity | |
|---|---|---|---|---|
| | 2015-16 | 2016-17 | 2015-16 | 2016-17 |
| **Date of sowing** | | | | |
| 10 November | 4.01 | 3.41 | 1620.70 | 1512.80 |
| 20 November | 3.46 | 2.86 | 1492.00 | 1372.50 |
| **SEm ±** | **0.13** | **0.16** | **34.22** | **26.32** |
| **CD (P=0.05)** | **0.39** | **0.51** | **106.10** | **81.60** |
| **Planting method** | | | | |
| Flat Planting | 3.62 | 2.96 | 1509.0 | 1360.60 |
| Bed Planting | 3.86 | 3.31 | 1603.6 | 1524.80 |
| **SEm ±** | **0.06** | **0.10** | **20.77** | **29.97** |
| **CD (P=0.05)** | **0.18** | **0.31** | **64.40** | **92.90** |
| **Irrigation treatment** | | | | |
| $I_1$ | 3.62 | 3.06 | 1496.0 | 1380.10 |
| $I_2$ | 3.82 | 3.21 | 1634.8 | 1525.40 |
| $I_3$ | 3.76 | 3.13 | 1538.1 | 1422.60 |
| **SEm ±** | **0.02** | **0.03** | **27.74** | **33.42** |
| **CD (P=0.05)** | **NS** | **NS** | **86.00** | **103.6** |

*$I_1$, 3 Post-sowing at CRI, flag-leaf emergence and soft dough stages. $I_2$, $I_1$ + 4 irrigation during the medium week of March $I_3$ recommended 4 post-sowing irrigation.

**Table 2. Grain yield and yield attributes of wheat under different dates of sowing, planting methods and irrigation.**

| Treatment | Yield attributes | | | | | | | | Grain yield t/ha | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of effective tillers/m$^2$ | | No. of grain/ear | | Ear length/ear | | 1,000 grain weight (g) | | | |
| | 2015-16 | 2016-17 | 2015-16 | 2016-17 | 2015-16 | 2016-17 | 2015-16 | 2016-17 | 2015-16 | 2016-17 |
| **Date of sowing** | | | | | | | | | | |
| 10 Novemeber | 448.8 | 42.6 | 53.9 | 51.0 | 11.00 | 10.6 | 34.3 | 33.1 | 4.79 | 4.54 |
| 20 Novemeber | 390.4 | 358.4 | 47.3 | 42.9 | 9.60 | 9.3 | 30.3 | 28.4 | 4.49 | 4.16 |
| **Sem ±** | **5.3** | **3.9** | **1.9** | **1.7** | **0.10** | **0.2** | **1.2** | **0.4** | **0.01** | **0.09** |
| **CD (P=0.05)** | **16.5** | **12.1** | **5.9** | **5.3** | **0.30** | **0.7** | **3.7** | **1.1** | **0.03** | **0.27** |
| **Planting method** | | | | | | | | | | |
| Flat planting | 409.3 | 373.9 | 47.1 | 43.3 | 9.90 | 9.3 | 30.2 | 28.6 | 4.44 | 4.20 |
| Bed planting | 430.1 | 406.0 | 54.0 | 49.7 | 10.70 | 10.5 | 34.4 | 32.9 | 4.85 | 4.51 |
| **Sem ±** | **6.3** | **7.9** | **2.1** | **1.6** | **0.20** | **0.3** | **1.0** | **0.8** | **0.03** | **0.10** |
| **CD (P=0.05)** | **19.4** | **24.6** | **6.40** | **5.1** | **0.76** | **0.9** | **3.0** | **2.4** | **0.08** | **0.31** |
| **Irrigation treatment** | | | | | | | | | | |
| $I_1$ | 394.8 | 359.3 | 46.4 | 41.8 | 9.3 | 9.1 | 30.1 | 28.7 | 4.53 | 4.03 |
| $I_2$ | 447.8 | 421.6 | 54.9 | 52.5 | 11.2 | 10.4 | 34.4 | 32.8 | 4.75 | 4.62 |
| $I_3$ | 416.5 | 389.1 | 50.6 | 46.2 | 10.5 | 10.1 | 32.4 | 30.8 | 4.66 | 4.42 |
| **Sem ±** | **6.5** | **7.1** | **1.2** | **1.3** | **0.3** | **0.3** | **0.7** | **0.6** | **0.1** | **0.1** |
| **CD (P=0.05)** | **20.3** | **21.9** | **3.8** | **4.1** | **0.86** | **0.7** | **2.3** | **1.8** | **0.17** | **0.29** |

**Table 3. Correlation of grain yield of wheat with yield attributes and WUE.**

| Parameters | Grain yield | | |
|---|---|---|---|
| | 2015-16 | 2016-17 | Pooled |
| No. of effective tillers | 0.78 | 0.61 | 0.71 |
| No. of grain/ear | 0.71 | 0.69 | 0.76 |
| Eat length | 0.65 | 0.79 | 0.74 |
| 1,000 grain weight | 0.50* | 0.75 | 0.65 |
| WUE | 0.58 | 0.83 | 0.76 |
| RUE | 0.74 | 0.70 | 0.69 |

P = 0.05, *P = 0.10

## References


1. Aggarwal, P.K. and Swaroop-Rani, D.N. 2009. Assessment of climate change impacts on wheat production in India. (In) *Global Climate Change and Indian Agriculture-case studies from ICAR Network Project,* Aggarwal, P.K., Indian Council of Agricultural Research, New Delhi, pp. 5-12.
2. Alam, M.S. 2013. Growth and yield potentials of wheat as affected by management practices. *African journal of Agricultural Research* **8**(47): 6,068-6,074.
3. Bhan, S. and Behera, U.K. 2014. Conservation agriculture in India-Problems, prospectus and policy issues. *International Soil and Water Conservation Research* **2**: 1-12.
4. Hossain, I., Islam, K., Meisner, C.A. and Islam S. 2004. Effect of planting method and nitrogen levels on the yield and yield attributes of wheat. *Journal of Biological Sciences* **14**: 127-130.
5. Kashif, M. and Khaliq, I. 2004. Heritability, correlation and path coefficient analysis for some metric traits in wheat. *International Journal of Agriculture and Biology* **6**: 138-142.
6. Kamrozzaman, M. M., Khan, M. A. H., Ahmed, S. and Sultana, N. 2016. Growth and yield of wheat at different dates of sowing under chrland ecosystem of Bangladesh. *Journal of Bangladesh Agriculture University* **14**: 147-154.
7. Li, Q.Q. Y.H.,Wu, W., Yu, S.Z., Zhou, X B, Dong, Q.Y. and Yu, S.L. 2006. Effects of straw mulching and irrigation on solar energy utilization efficiency of winter farmland China. *Journal of Applied Ecology* **17** : 243-246.
8. Majeed, A., Muhmood, A., Niaz, A., Javid, S., Ahmad, Z. A., Hussain, S. S. and Shah, A. H. 2015. Bed planting of wheat (*Triticum aestivum* L.) improves nitrogen use efficiency and grain yield compared to flat planting. *The Crop Journal* **3**: 118-124.
9. Martini, M.Y., McKenzie, B.A., Moot, D.J., Hill, G.D and de Ruiter, J.M. 2009. Dry-matter accumulation of oats sown at five different sowing dates. *Agronomy Journal of New Zealand* **39**: 71-80.
10. Mollah, M.I.U., Bhuiya, M.S.U. and Kabir, M.H. 2009. Bed planting – A new crop establishment method for wheat in Rice-Wheat cropping system. *Journal of Agriculture and Rura Development* **7**: 23-31.
11. Prado, S.A., Gallardo, J.M., Kruk, B.C. and Miralles, D. J. 2017. Stratagies for yield determination of bread wheat and two-row barley growing under different environments: A comparative study. *Field Crops Research* **203**: 94-105.
12. RWC-CIMMYT. 2003. *Addressing resources conservation issues in rice-wheat systems of south Asia. a resource book*, Rice-Wheat Consortium for the Indo-Gangetic Plains – International Maize and Wheat Improvement Centre. New Delhi, India.
13. Singh, A., Singh, D. Kang J.S. and Aggarwal, N. 2011. Management practices to mitigate the impact of high temperature on wheat; A review. *HOABJ* **2**: 11-22.
14. Tanveer, S. K., Hussain, I., Kissana, N.S., Abbas, S.G. and Sohail, M. 2003. Influence of various planting methods on yield components and economics yield of wheat. *Asian Journal of Plant Sciences* **2**: 811-813.
15. Wang, F., Kong, L., Sayre, K., S., Si, J., Feng, B. and Zhang, B. 2011. Morphological and yield responses of winter wheat (*Triticum aestivum* L.) to raised bed planting in Northern China. *African Journal of Agricultural Research* **6**: 2,991-2,997.