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# Effect of restricted irrigation levels on yield attributes and yield of various varieties of wheat (*Triticum aestivum* L.).

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**Abstract**
A field experiment was conducted to study the effect of irrigation levels on performance of timely sown wheat varieties at Crop Research Station Masodha, Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya 224229 (U.P.) during *Rabi* 2016-17. The experiment was laid out in split plot design with three replications. The treatment consisted of three irrigation levels ($I_1$- no irrigation, $I_2$- one irrigation at CRI, $I_3$- two irrigations, first at CRI and second at boot leaf stage) in main plots and six varieties viz. HI 1612, HD 2888, C 306, K8027, HD 3171 and K 1317in sub plots. Maximum number of effective tillers (287 $m^{-2}$), length of ear (8.95 cm), number of grains $ear^{-1}$ (41.93), grain weight $ear^{-1}$ (1.43 g), test weight (39.29 g), grain yield (33.18 q $ha^{-1}$), straw yield (47.53 q $ha^{-1}$), and biomass yield (80.71 q $ha^{-1}$) were recorded with variety K 1317 which was at par with HI1612 and significantly superior over rest of the varieties. Regarding irrigation levels, maximum number of effective tillers (314.56 $m^{-2}$), length of ear (8.97 cm), number of grains $ear^{-1}$ (44.16), grain weight $ear^{-1}$ (1.36 g), test weight (38.24 g), grain yield (33.45 q $ha^{-1}$), straw yield (47.78 q $ha^{-1}$) and biomass yield (81.23 q $ha^{-1}$) were recorded with two irrigations (first at CRI and second at Boot leaf stage) which was significantly superior than rest of the irrigation levels.

**Keywords:** Irrigation level, varieties, yields, wheat, yield attributes

## Introduction

Wheat (*Triticum aestivum* L.) is a staple food of the world and belongs to family Poaceae (Gramineae). It is a $C_3$ plant primarily grown in temperate regions and also at higher altitude under tropical climatic areas in winter season. Wheat is the single most important cereal crop that has been considered as integral component of the food security system of the several nations.It has been described as the 'King of cereals' because of the acreage and high productivity which also occupies a prominent position in the international food grain trade.Wheat provides nearly 55% of the carbohydrate and 20% of food calories which is consumed by two billion people (36% of the world population) as staple food.It is said that as a food, wheat is more nutritive as compared to the other cereals. It has good nutrition profile with 12.1 per cent protein, 1.8 per cent lipids, 1.8 per cent ash, 2.0 per cent reducing sugars, 6.7 per cent pentose's, and provides 314 Kcal/100g of food. Wheat is also a good source of minerals and vitamins *viz*., calcium (37 mg/100g), iron (4.1 mg/100g), thiamine (0.45mg/100g), riboflavin (0.13mg/100g) and nicotinic acid (5.4mg/100mg). Unlike other cereals, wheat contains a high amount of gluten, the protein that provides the elasticity necessary for excellent bread making. Hard wheat is high in protein (10-17%) and yields a flour rich in gluten, making it particularly suitable for yeast breads.

Wheat ranks first in the world among the cereals both in respect of area (221.68 million hectare) and production (728.28 million metric tonnes) with productivity of wheat 3.29 tonnes per hectare.In India, it is grown in an area of 30.47 million hectare, production of 95.85 million tonnes with a productivity of 3.15 tonnes per hectare (FAS/USDA 2014-15).

Major wheat producing countries in the world are China, India, USA, France, Russia, Canada, Australia, Pakistan, Turkey, UK, Argentina, Iran and Italy. These countries contributes about 74.82% of the total world wheat production.

As far as India is concerned, about 91% of the total wheat production is contributed by six northern statesviz. Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, and Bihar. Among them, Uttar Pradesh ranks first with respect to area (9.85 mill. ha) and production (25.22 million tonnes) but the productivity is much lower (2561 kg $ha^{-1}$) than Punjab (4492 kg $ha^{-1}$) and Haryana (4574 kg $ha^{-1}$) (Agricultural Statistics at a Glance 2015) [1].

Water is a key input among all the inputs however, water for irrigation is a scarce resource therefore efficient utilization of irrigation water is essential. Optimum use of water for irrigation permits better utilization of all other production factors and leads to increased yield per unit area and time. Efficient water management requires a thorough study of plant water relationship, climate, agronomic practices and economic assessment. In cultivation of high yielding wheat varieties, irrigation assumes greater importance because during growing season of weather remains relatively dry. The judicial application of water calls for immediate attention and this is possible only by following some scientific basis for water application to the crop. One such scientific approach particularly in water scarcity area is critical crop growth stage approach for scheduling of irrigation.

## Materials and Methods

The present investigation entitled effect of restricted irrigation levels on growth of various varieties of wheat (*Triticum aestivum* L.). was carried out during Rabi season 2016-17.The experiment was conducted at Crop Research Station Masodha, Narendra Deva University of Agriculture and Technology Kumarganj, Ayodhya 224229 (U.P.), which is geographically situated between 26.47ºN latitude to 82.12ºE longitude and at an altitude of 113 m above mean sea level on Faizabad, Sultanpur Road about 5 km away from Faizabad city. The climate of district Faizabad is semi-arid with hot summer and cold winter. The site is located in typical saline-alkali belt of Indo-Gangetic alluvium of eastern Uttar Pradesh. An experiment was carried out with 18 treatment combinations, comprised of three irrigation levels and six wheat varieties in split plot design. Three irrigation levels *viz.* ($I_1$) no irrigation, ($I_2$) one irrigation at CRI and ($I_3$) two irrigations at CRI and Boot leaf stage were kept in main plot and six varieties *viz.* ($V_1$) HI1612, ($V_2$) HD2888, ($V_3$) C306, ($V_4$) K8027, ($V_5$) HD3171 and ($V_6$) K1317 were kept in sub plots. The experiment was replicated three times. The seed rate of wheat was 100 kg hectare$^{-1}$ seed and all the cultural practices were performed as per technical programme. The soil of experimental field was silty loam texture with low organic carbon (0.40%) and nitrogen (185 kg ha$^{-1}$), medium in phosphorus (22 kg ha$^{-1}$) and potassium (262 kg ha$^{-1}$). The wheat varieties was sown on 10 November 2016. All the yield contributing and yield parameters *viz.* number of effective tillers m$^{-2}$, length of ear (cm), number of grains ear$^{-1}$, grain weight ear$^{-1}$, test weight (g), grain yield (q ha$^{-1}$), straw yield (q ha$^{-1}$), biomass yield (q ha$^{-1}$) were recorded.

## Results and Discussion

### Yield Attributes

The various levels of irrigation and different varieties of wheat significantly affected the number of effective tillers m$^{-2}$ (Table 1 and Fig. 1). As regards to the irrigation levels, maximum number of effective tillers m$^{-2}$ was recorded with $I_3$ (two irrigations, first at CRI and second at Boot leaf stage) which was significantly superior over $I_2$ (one irrigation at CRI) and $I_1$ (no irrigation). It might be due to timely supply of water at the critical stages *i.e.*, CRI and Boot leaf stage. Thus, under maximum moisture level (two irrigations) was most favourable for vegetative growth and development resulted into higher number of effective tillers m$^{-2}$. The findings are in support to those of Ali *et.al.* (2010) [3], Ngwako and Mashiqa (2013) [13], Aslam *et al.* (2014) [5], Ahmad and Kumar (2015) [2] and Bedarkar *et al.* (2017) [7]. In case of varieties the maximum number of effective tillers m$^{-2}$ was recorded with variety K 1317 which was at par with HI 1612 and significantly superior over rest of the varieties.

The length of spike of wheat was significantly influenced by various irrigation levels and different varieties of wheat (Table 1 and Fig. 1). As regards irrigation levels, the maximum length of ear was recorded with $I_3$ (two irrigations, first at CRI and second at Boot leaf stage) which was at par with $I_2$ (one irrigation at CRI) and significantly superior over $I_1$ (no irrigation). Increase in length of ear (cm) at higher level of irrigation could be possible due to maintenance of constant water supply to the plants, which maintained various metabolic processes and increases the photosynthetic activity of plants. Increase in length of ear (cm) due to increased irrigation levels was also reported by Atikullah *et al.* (2014) [6] and Ahmad and Kumar (2015) [2]. In case of varieties the maximum length of ear was recorded with variety K 1317 which was significantly superior to K 8027 and at par with rest of the varieties.

The number of grains ear$^{-1}$ of wheat was influenced significantly by irrigation levels and various varieties of wheat (Table 1 and Fig. 1). Number of grains ear$^{-1}$ increased significantly with increase in number of irrigations. Maximum number of grains ear$^{-1}$ was recorded with $I_3$ (two irrigations, first at CRI and second at Boot leaf stage) which was significantly superior over $I_2$ (one irrigation at CRI) and $I_1$ (no irrigation). With adequate moisture, the plant height, LAI and dry matter accumulation was highest which contributed to highest yield attributes due to increased photosynthesis activity of leaves. Besides, translocation of photosynthates from source to sink, higher uptake of potassium under optimum moisture condition also lead to better yield attributes. Due to this maximum number of grains ear$^{-1}$ was recorded under $I_3$ (two irrigations, first at CRI and second at Boot leaf stage). The increase in number of grains ear$^{-1}$ due to increase in irrigation levels was reported by Khokhar *et al.* (2010) [10], Ngwako and Mashiqa (2013) [13], Aslam *et al.* (2014) [5], Ahmad and Kumar (2015) [2] and Bedarkar *et al.* (2017) [7]. In case of varieties the maximum number of grains ear$^{-1}$ was recorded with variety K 1317 which was at par with HI 1612 and significantly superior over rest of the varieties.

The grain weight ear$^{-1}$ was influenced significantly by irrigation levels and various varieties of wheat (Table 1 and Fig. 1). Data revealed that grain weight ear$^{-1}$ increased significantly with the increase in number of irrigations. Maximum grain weight ear$^{-1}$ was recorded with $I_3$ (two irrigations, first at CRI and second at Boot leaf stage) which was at par with $I_2$ (one irrigation at CRI) and significantly superior over $I_1$ (no irrigation). This was due to availability of water at critical stages of crop growth which contributed to higher yield attributes resulting in increased grain weight ear$^{-1}$. Among varieties maximum grain weight ear$^{-1}$ was recorded with variety K1317 which was significantly superior over rest of the varieties.

Test weight of grains of wheat was influenced significantly by the various levels of irrigation and different varieties of wheat (Table 1 and Fig. 1). Data revealed that test weight increased significantly with increase in number of irrigations. Maximum test weight was recorded with $I_3$ (two irrigations, first at CRI and second at boot leaf stage) which was at par with $I_2$ (one irrigation) and significantly superior over $I_1$ (no irrigation). A regular supply of water or irrigation throughout the growing season results in an increase in dry matter accumulation in the grain, and the plumpness of the grain will increase. Test weight depends on the plumpness of the grain. Similar findings were reported by Karam *et al.* (2009) [9] and Ahmad

and Kumar (2015). In case of varieties the maximum test weight was recorded with variety K 1317 which was at par with HI 1612 and significantly superior over rest of the varieties.

**Yields**

The grain yield of wheat was influenced significantly by various levels of irrigation and different wheat varieties (Table 2 and Fig. 2). Grain yield increased significantly with increase in number of irrigations. Maximum grain yield of wheat was recorded with $I_3$ (two irrigations, first at CRI and second at Boot leaf stage) which was significantly superior over $I_2$ (one irrigation at CRI) and $I_1$ (no irrigation). This was certainly due to adequate moisture availability, which contributed to better growth parameters and yield attributes which resulted in higher grain yield. The increase in grain yield (q $ha^{-1}$) due to increase in irrigation levels was reported by Kumar and Pannu (2012) [11], Ngwako and Mashiqa (2013) [13], Aslam *et al.* (2014) [5] and Bedarkar *et al.* (2017) [7]. In case of varieties the maximum grain yield of wheat was recorded with variety K 1317 which was at par with HI 1612 and significantly superior over rest of the varieties.

The straw yield of wheat was affected significantly by different levels of irrigation and various varieties of wheat (Table 2 and Fig. 2). Straw yield increased significantly with increase in number of irrigations. Maximum straw yield of wheat was recorded with $I_3$ (two irrigations, first at CRI and second at Boot leaf stage) which was significantly superior over $I_2$ (one irrigation at CRI) and $I_1$ (no irrigation). Poor moisture supply during critical stages reduced the yield attributes and resulted in poor grain and straw yield in $I_2$ and $I_1$. Similar findings were reported by Mitra *et al.* (2006) [12] and Idnani and Kumar (2012) [8]. In case of varieties the maximum straw yield of wheat was recorded with variety K 1317 which was at par with HI 1612 and significantly superior over rest of the varieties of wheat.

The biomass yield of wheat was influenced significantly by various levels of irrigation and different varieties of wheat (Table 2 and Fig. 2). Biomass yield increased significantly with increase in number of irrigations. Maximum biomass yield of wheat was recorded with $I_3$ (two irrigations, first at CRI and second at Boot leaf stage) which was significantly superior over $I_2$ (one irrigation at CRI) and $I_1$ (no irrigation). Biomass yield is a sum of grain yield and straw yield. Due to availability of water in $I_3$ treatment the grain yield and straw yield is higher and in turn the biomass yield is high. In case of varieties the maximum biomass yield was recorded with variety K 1317 which was at par with HI 1612 and significantly superior over rest of the varieties of wheat.

**Conclusion**

Two irrigations (first at CRI and second at Boot leaf stages) and Variety "K1317" gave higher values of most of the all yield attributes and yields *viz.* number of effective tillers $m^{-2}$, length of ear (cm), number of grains $ear^{-1}$, grain weight $ear^{-1}$, test weight (g), grain yield (q $ha^{-1}$), straw yield (q $ha^{-1}$), biomass yield (q $ha^{-1}$). Therefore it is concluded that wheat variety K 1317 with two irrigation (first at CRI and second at Boot leaf stage) should be sown for higher yield in restricted irrigation condition.

**Table 1:** Effect of different treatments on yield contributing characters of wheat crop

| Treatments | Number of effective tillers $m^{-2}$ | Length of ear (cm) | Number of grains $ear^{-1}$ | Grain weight $ear^{-1}$ (g) | Test weight (g) |
|---|---|---|---|---|---|
| No irrigation | 223.33 | 7.65 | 32.01 | 1.19 | 36.94 |
| One irrigation (at CRI) | 281.67 | 8.56 | 39.37 | 1.32 | 38.01 |
| Two irrigation (first at CRI and second at Boot leaf stage) | 314.56 | 8.97 | 44.16 | 1.36 | 38.24 |
| SEm± | 3.07 | 0.17 | 0.45 | 0.01 | 0.36 |
| CD (P=0.05) | 10.03 | 0.68 | 1.48 | 0.04 | 1.19 |
| HI 1612 | 286.67 | 8.90 | 41.79 | 1.30 | 39.22 |
| HD 2888 | 265.89 | 8.62 | 36.60 | 1.28 | 37.09 |
| C 306 | 259.44 | 8.43 | 35.58 | 1.28 | 35.93 |
| K 8027 | 265.00 | 7.87 | 36.28 | 1.19 | 36.94 |
| HD 3171 | 275.11 | 8.68 | 38.89 | 1.27 | 37.90 |
| K 1317 | 287.00 | 8.95 | 41.93 | 1.43 | 39.29 |
| SEm± | 3.12 | 0.20 | 0.49 | 0.01 | 0.39 |
| CD (P=0.05) | 9.01 | 0.60 | 1.42 | 0.03 | 1.13 |

**Table 2:** Effect of different treatments on grain yields, straw yields, biomass yields and harvest index of wheat

| Treatment | Grain yield (q $ha^{-1}$) | Straw yield (q $ha^{-1}$) | Biomass yield (q $ha^{-1}$) |
|---|---|---|---|
| (A) Irrigation levels | | | |
| No irrigation | 24.17 | 34.36 | 58.52 |
| One irrigation (at CRI) | 30.23 | 42.94 | 73.17 |
| Two irrigation (first at CRI and second at Boot leaf stage) | 33.45 | 47.78 | 81.23 |
| SEm± | 0.24 | 0.50 | 0.75 |
| CD (P=0.05) | 0.97 | 2.04 | 3.02 |
| (B) Varieties | | | |
| HI 1612 | 32.61 | 46.31 | 78.92 |
| HD 2888 | 26.03 | 36.60 | 63.63 |
| C 306 | 27.90 | 39.40 | 67.30 |
| K 8027 | 26.35 | 37.44 | 63.79 |
| HD 3171 | 29.64 | 42.87 | 72.51 |
| K 1317 | 33.18 | 47.53 | 80.71 |
| SEm± | 0.53 | 0.75 | 1.26 |
| CD (P=0.05) | 1.54 | 2.18 | 3.66 |

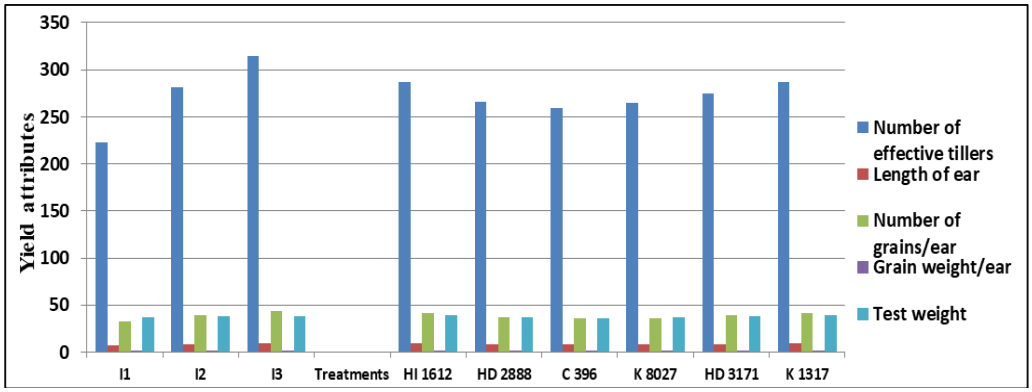


**Fig 1:** Effect of different treatment on yield attributes at various growth stages of crop

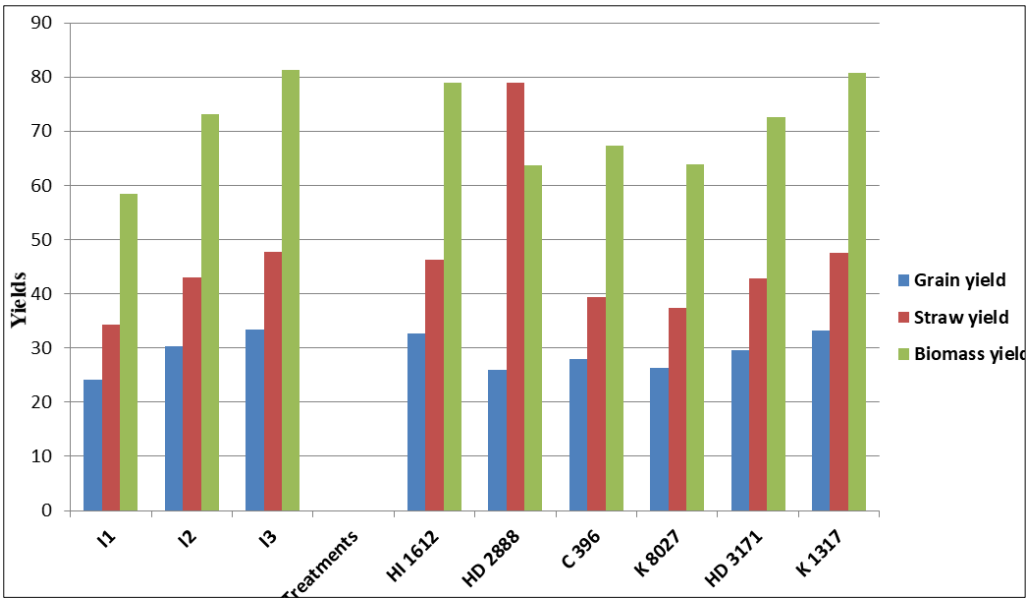


**Fig 2:** Effect of different treatments on yields at various stages of crop

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