



# Growth and Yield Performances of Wheat Genotypes under Restricted Irrigation in Eastern Sub-Himalayan Plains

Jince Mary M. Joy, Biplob Mitra, A.K. Singha Roy

10.18805/IJARE.A-5545

## ABSTRACT

**Background:** Water scarcity is one of the major problems faced by farmers for crop production. Productivity and sustainability of a crop like wheat which is highly susceptible to water stress could be affected the most. Identifying and growing such varieties of wheat which could thrive under restricted irrigation could solve the problem. The current study aimed to evaluate the performance of certain new wheat genotypes under restricted irrigation.

**Methods:** A field experiment was conducted in eastern sub-Himalayan plains during *Rabi* season, 2016-2017 to evaluate the performance of certain wheat genotypes under restricted irrigation. The experiment was laid out in a split plot design with three different levels of irrigation, viz., no irrigation, one irrigation at CRI stage, two irrigations at CRI and booting stage, randomly allotted in main plots; while six genotypes comprising HI 1612, HD 2888, C 306, K 8027, HD 3171 and K 1317 were randomly allocated in sub plots.

**Result:** It was observed that with increase in number of irrigation, the overall biomass production increased irrespective of genotypes. The highest biomass (7.38 t ha<sup>-1</sup>) was achieved in plots where two irrigations were given. Higher leaf area with increased plant height and tiller number as well as higher values of major yield components viz., number of spikes m<sup>-2</sup> and number of filled grain spike<sup>-1</sup> were also achieved in plots receiving two irrigations. The twice irrigated plot also exhibited higher yields (3.02 t ha<sup>-1</sup>) as compared to once irrigated plot. With increase in number of irrigation the grain yield increased significantly. Among the genotypes, HI 1612 reflected the maximum grain yield (2.76 t ha<sup>-1</sup>) under restricted irrigation though there was no significant variation in grain yield achieved with the other 5 genotypes except HD 3171.

**Key words:** Genotypes, Growth, Restricted irrigation, Wheat, Yield.

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the world due to its wide adaptability to various agro-climatic and soil conditions. The eastern Indo-Gangetic Plains (IGP) is characterized by widespread poverty and high population density and its resource-poor farmers are more susceptible to the risks of climate change which ultimately lead to lesser productivity of wheat in these states.

The present water supply for crop production is bound to decrease in near future due to increasing demand of water for drinking and industrial purposes. Therefore, important food crop like wheat which is highly susceptible to water stress will suffer the most. This will cause a challenge to the sustainability of wheat productivity. If exploitation of natural resources at the current level continues, productivity and sustainability are bound to suffer (Mann *et al.*, 2008). Water use optimization is fundamental to water resource use since water for irrigation is a scarce resource. This allows for better utilization of all other production factors and thus leads to increased yields per unit area and time. Selection of suitable crop and varieties is one of the ways for achieving higher yield and water use efficiency. So there is a need to identify wheat varieties which can give good response to limited irrigations.

In North Eastern Plain Zone attempts have been made for growing wheat under rainfed condition and it was found that some varieties like HD 3016 can successfully be grown

Department of Agronomy, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar-736 165, West Bengal, India.

**Corresponding Author:** Jince Mary M. Joy, Department of Agronomy, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar-736 165, West Bengal, India.

Email: jincymundonayil@gmail.com

**How to cite this article:** Joy, J.M.M., Mitra, B. and Roy, A.K.S. (2021). Growth and Yield Performances of Wheat Genotypes under Restricted Irrigation in Eastern Sub-Himalayan Plains. Indian Journal of Agricultural Research. 55(4): 505-508. DOI: 10.18805/IJARE.A-5545.

**Submitted:** 02-03-2020 **Accepted:** 07-12-2020 **Online:** 25-02-2021

under rainfed condition utilizing the residual moisture (Das and Mitra, 2011). As the cessation of monsoon rain is late in this part, soil holds a fair amount of moisture during November-December. So this residual moisture can be utilized and thus the number of irrigations given to the wheat crop can be reduced. Application of irrigation water at three major growth stages, viz., CRI, tillering and booting stages produced 26.24 percent higher grain yield compared with single irrigation at CRI stage in timely sown irrigated wheat genotypes under sub-Himalayan plains where it was also found that further increase in irrigation level from three did not increase the yield significantly (Mitra and Das, 2015).

In an experiment conducted in eastern sub-Himalayan plains, Singha *et al.* (2018) reported 3.5 t ha<sup>-1</sup> of yield with three irrigations in K 0307. As timely sown irrigated wheat genotypes responded well to three irrigations in this part of the country, attempts may be taken to grow wheat under restricted irrigations (maximum two irrigations) with some genotypes which were typically earmarked for restricted irrigations. Keeping these in backdrop, the experiment has been planned to evaluate the performance of certain new wheat genotypes under restricted irrigation.

## MATERIALS AND METHODS

The experiment was conducted during *Rabi* season, 2016-17 at the Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar located at 26°24'02.2"N latitude, 89°23'21.7"E longitude and at an elevation of 43 meters above mean sea level. The experimental soil was sandy loam in texture with pH-5.75, Organic C (%) - 0.92, mineralizable N-168.7 kg ha<sup>-1</sup>, available P-32.3 kg ha<sup>-1</sup> and available K-142.7 kg ha<sup>-1</sup>.

The experiment was laid out in a split-plot design having 18 treatment combinations. Three different levels of irrigation, viz., no irrigation, one irrigation at CRI stage, two irrigations at CRI and booting stage were randomly allotted in each main plot, while within each main plot, six genotypes comprising HI 1612, HD 2888, C 306, K 8027, HD 3171 and K 1317 were randomly allotted in sub plots. The treatments were replicated thrice. The sizes of each experimental plot were 8m × 1.8m.

After first ploughing, the land was kept exposed for 10-12 days for reducing the existing moisture level and then two cross ploughings with rotavator was given. Levelling was done with ladder. Seeds were sown in lines 22.5 cm apart manually with a seed rate of 100 kg ha<sup>-1</sup>. The fertilizers were applied @ 90-60-40 kg NPK ha<sup>-1</sup>. All the fertilizers were applied as basal in no-irrigated plots. However, in irrigated plots, full P and K along with one-third of N were applied as basal, while the rest two-third N was applied at 21 days after sowing (DAS) along with the first irrigation. Irrigation was applied based on treatments. Check basin method of irrigation was followed keeping the depth of irrigation at 5 cm. Thinning and manual weeding were done at 3-4 weeks after sowing. Broad-leaved weeds were further controlled with carfentrazone ethyl @ 20 g a.i ha<sup>-1</sup> at 5 weeks after sowing. Boron was applied twice @ 0.20% with Solubor (B 20%), once at 35-40 DAS and the next at 55-60 DAS. The periodical growth parameters were recorded accordingly, while yield was estimated on net plot basis excluding the border rows.

Analysis of variance method was used for statistical analyses. The significance of various sources of variation was tested by error mean square by Fisher-Snedecor's "F" Test at probability levels 0.05 (Cochran and Cox 1955; Panse and Sukhatme, 1967). For comparison of "F" tables and for computation of critical differences, Fisher and Yates table was consulted.

## RESULTS AND DISCUSSION

### Growth attributes

The overall biomass production was increased with increase in number of irrigations irrespective of genotypes. The highest biomass (8.18 t ha<sup>-1</sup>) was achieved with the plots in which two irrigations were given (Table 1). There was a 21.9% increase in total biomass when the number of irrigations was increased from one to two. Though the plant height didn't vary significantly with respect to various levels of irrigation, irrigation had a significant effect towards other growth attributes viz., number of tillers m<sup>-2</sup> as well as LAI and biomass production (Table 1). Rajesh *et al.* (2015) observed that frequent irrigation with small amount of water promotes faster plant growth and higher biomass. Maximum biomass production was recorded in the genotype C 306 (7.36 t ha<sup>-1</sup>), while K 8027 recorded the highest plant height (113.56 cm). Tiller number was significantly higher in treatments with two irrigation over one irrigation and no irrigation. Optimum moisture availability resulted from more number of irrigation had a positive effect towards increase in tiller number for wheat. The poor moisture status in the plots where irrigation was not given might be the cause for its poor tillering ability. Rajesh *et al.* (2015) observed that higher number of effective tillers was obtained in frequent irrigation with small quantities of water. The genotypes did not vary significantly with each other at same level of irrigation in all the stages of recording observations. The maximum number of tillers were recorded with the genotype K 8027 followed by K1317. Irrespective of irrigation levels, LAI was maximum at 90 DAS which coincided with the late flowering stage, the stage in which the crop showed highest LAI. The highest LAI (3.92) was recorded in twice irrigated treatments while lowest LAI (3.33) at 90 DAS was recorded under non-irrigated plots. LAI decreased sharply at harvest due to leaf senescence under all crop establishment techniques. Higher LAI at 90 DAS was probably due to higher rate of leaf emergence resulted from greater moisture availability. Nutrients as well as moisture led to the increased number of leaves per unit area and resulting in enlargement in leaf area also. Among the genotypes, LAI recorded at different stages of growth was found to differ significantly. The highest LAI at 90 DAS was recorded with C 306 (3.98) followed by K 8027 (3.96). The growth tendency of different varieties was not similar for which there was variation in LAI among the varieties.

### Yield attributes and yield

Number of spikes m<sup>-2</sup> was found to differ significantly under various levels of irrigation (Table 2). Maximum number of spikes m<sup>-2</sup> (214.56) was achieved in the plots in which two irrigations were given. It was followed by the treatment in which one irrigation was given (184.83). When the number of irrigations was increased from one to two, there was 16% increase in the number of spikes m<sup>-2</sup>. This increase was 28% in twice irrigated plots compared to plots without any

irrigation. It was noted that with increase in number of irrigation the number of spikes  $\text{m}^{-2}$  was increased irrespective of the varieties. Choudhury and Kumar (1980) reported that moderate and severe water stress to wheat crop resulted in decrease in the number of spikes  $\text{m}^{-2}$ . As far as genotypes were concerned, the maximum number of spikes  $\text{m}^{-2}$  was recorded in the genotype HI 1612(196.22) which were closely followed by K 1317(194.00). However, there was no significant difference in number of spikes  $\text{m}^{-2}$  between all the genotypes taken in the experiment. Perusal

of data in Table 2 also reflected the superiority of number of filled grains spike<sup>-1</sup> vis-à-vis spike length in twice irrigated plot. It was noted that increment in number of filled grains spikes<sup>-1</sup> was 24% in twice irrigated plots against the plot in which no irrigation was given. Ahmad and Kumar (2015) reported that with increasing the number of irrigations the percentage of filled grains per spike also increased. The genotype HI 1612 exhibited maximum number of filled grains spike<sup>-1</sup> (40.67) and it was significantly higher as compared to the other genotypes. This was followed by C 306 (37.56),

**Table 1:** Growth attributes of different wheat genotypes under varying levels of irrigation.

Treatments	Plant	Biomass	No. of tillers m <sup>-2</sup>			LAI			Harvest
	height (cm)	production at harvest ( t ha <sup>-1</sup> )	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	
<b>Irrigation levels</b>									
No irrigation	100.39	5.76	119.89	184.33	221.17	0.73	2.73	3.33	1.05
1 irrigation at CRI	103.93	6.71	143.56	193.00	234.67	0.77	2.89	3.72	1.32
2 irrigations at CRI and booting	108.11	8.18	135.89	204.61	262.89	0.85	3.01	3.92	1.43
SEm(±)	1.62	0.10	1.75	6.31	8.45	0.04	0.03	0.06	0.04
CD(P=0.05)	NS	0.40	6.89	NS	33.19	0.14	0.10	0.19	0.13
<b>Genotypes</b>									
HI 1612	95.11	7.28	143.22	189.22	232.56	0.93	2.95	3.89	1.14
HD 2888	110.39	7.16	138.89	207.89	243.56	0.70	2.80	3.76	1.13
C 306	111.58	7.36	126.67	193.11	237.67	0.81	2.95	3.98	1.28
K 8027	113.56	7.33	141.78	179.56	247.56	0.83	2.83	3.96	1.26
HD 3171	95.59	5.70	119.22	190.00	231.67	0.63	2.60	3.21	1.04
K 1317	98.64	6.46	128.89	204.11	244.44	0.80	2.76	3.28	1.06
SEm(±)	3.46	0.27	5.09	12.30	11.18	0.05	0.04	0.08	0.05
CD(P=0.05)	10.05	0.80	14.70	NS	NS	0.15	0.12	0.24	0.15

NS- Non-Significant; Treatments details are presented in materials and methods.

**Table 2:** Yield attributes and yields of different wheat genotypes under varying levels of irrigation.

Treatments	Spike length (cm)	No. of Spike $\text{m}^{-2}$	No. of grains spike <sup>-1</sup>	1000- grain weight (g)	Grain yield (t ha <sup>-1</sup> )	Straw yield (t ha <sup>-1</sup> )	Harvest index
<b>Irrigation levels</b>							
No irrigation	9.44	167.61	32.56	36.42	2.14	3.62	0.35
1 irrigation at CRI	9.70	184.83	35.50	38.64	2.54	4.17	0.38
2 irrigations at CRI and booting	10.15	214.56	40.39	39.72	3.02	5.16	0.39
SEm(±)	0.23	5.40	0.35	0.49	0.05	0.06	0.008
CD(P=0.05)	NS	21.77	1.37	1.99	0.22	0.25	0.03
<b>Genotypes</b>							
HI 1612	10.56	196.22	40.67	40.01	2.76	4.52	0.38
HD 2888	9.51	185.22	36.56	38.99	2.56	4.60	0.37
C 306	9.97	189.11	37.56	38.08	2.63	4.73	0.34
K 8027	9.86	186.67	36.89	37.76	2.62	4.71	0.38
HD 3171	9.14	182.78	32.78	37.14	2.24	3.46	0.38
K 1317	9.53	194.00	32.44	37.58	2.59	3.87	0.39
SEm(±)	0.16	5.21	1.10	0.58	0.10	0.18	0.01
CD(P=0.05)	0.47	NS	3.18	1.67	0.31	0.53	0.03

NS- Non-Significant; Treatments details are presented in materials and methods.

being at par with HI 1612. The 1000 grain weight varied significantly with respect to the levels of irrigation. Better moisture availability due to increased number of irrigation could be the reason for the increased 1000-grain weight under twice irrigated plots.

The plots receiving two irrigations exhibited higher yield performances ( $3.02 \text{ t ha}^{-1}$ ) as compared to the plots in which one irrigation was given. The yield increment was 18.90% in twice irrigated plot over single irrigated plot. When it was compared with no-irrigated plots, the yield increment was as high as 41.12%. With increase in number of irrigation the grain yield increased significantly. Application of more number of irrigation under restricted irrigation enhanced the productivity significantly by improving the soil moisture status. Though the soil moisture was sufficient in initial stages, but later on the crop was in need of irrigation for maintaining a favourable water balance in plants. That is why the crop showed better growth and yield attributing characters when it was substituted with two irrigations compared to one or no irrigation. Significant reduction in yield and yield attributes was observed under restricted irrigation when water stress occurred at reproductive and vegetative phase (Dhaka *et al.* 2006). Shirpurkar *et al.* (2008) found that two irrigations at CRI and late tillering stages gave significantly higher grain yield ( $35.45 \text{ q/ha}$ ) compared to no irrigation ( $14.33 \text{ q/ha}$ ) and one irrigation at CRI ( $21.64 \text{ q/ha}$ ). Higher biomass production with increased number of spikes  $\text{m}^{-2}$  and number of filled grains  $\text{spike}^{-1}$  reflected the superiority of twice irrigated plots over single irrigated plots or plots without any irrigation. The crop faced water stress when irrigation was not given. Sharma *et al.* (1990) suggested that the grain yield increased with increase in frequency of irrigation. Similar reports were given by Bandhyopadhyay and Mallick (2003). Among the genotypes, HI 1612 reflected the maximum grain yield ( $2.76 \text{ t ha}^{-1}$ ) which was followed by C 306 ( $2.63 \text{ t ha}^{-1}$ ), K 8027 ( $2.62 \text{ t ha}^{-1}$ ), K 1317 ( $2.59 \text{ t ha}^{-1}$ ) and HD 2888 ( $2.56 \text{ t ha}^{-1}$ ). Except HD 3171, the lowest yielder ( $2.24 \text{ t ha}^{-1}$ ), there was no significant difference in grain yield achieved with the other 5 genotypes taken in the experimentation. It was seen that the yielding ability of various wheat genotypes under restricted irrigation was quite similar, though the maximum grain yield was exhibited by HI 1612. However, the highest straw yield ( $4.73 \text{ t ha}^{-1}$ ) was found in the genotype C 306. Varying yield performance of different wheat genotypes under varying moisture condition was also reported previously by Arzani (2002) in various locations of Iran.

It can be concluded that among the genotypes, HI 1612 reflected the maximum grain yield ( $2.76 \text{ t ha}^{-1}$ ) under restricted irrigation. This genotype can be a good option for the wheat farmers of the NEPZ under restricted irrigation in terms of productivity as well as various growth parameters.

## REFERENCES

- Ahmad, A. and Kumar, R. (2015). Effect of irrigation scheduling on the growth and yield of wheat genotypes. *Agricultural Science Digest*. 35(3): 199-202.
- Arzani, A. (2002). Grain yield performance of durum wheat germplasm under Iranian dryland and irrigated field conditions. *SABRAO Journal of Breeding and Genetics*. 34(1): 9-18.
- Bandyopadhyay, P.K. and Mallick, S. (2003). Actual evapotranspiration and crop coefficients of wheat (*Triticum aestivum*) under varying moisture levels of humid tropical canal command area. *Agricultural Water Management*. 59(1): 33-47.
- Berry, P.M., Sterling, M., Spink, J.H., Baker, C.J., Sylvester-Bradley, R.S., Mooney, A.R., Tams, A.R., Ennos, A.R. (2004). Understanding and Reducing Lodging in Cereals. *Advances in Agronomy*. 84: 217-271.
- Choudhury, P.N. and Kumar, V. (1980). The sensitivity of growth and yield of dwarf wheat to water stress at three growth stages. *Irrigation Science*. 1(4): 223-231.
- Cochran, W.G. and Cox, G.M. (1955). *Experimental Designs*. 1963. New York.
- Das, S. and Mitra, B. (2011). Performance of different wheat genotypes under various levels of nitrogen in rainfed condition of terai region of West Bengal. *Journal of Crop and Weed*. 7(1): 23-25.
- Dhaka, A.K., Bangarwa, A.S., Pannu, R.K., Malik, R.K., Garg, R. (2006). Phenological development, yield and yield attributes of different wheat genotypes as influenced by sowing time and irrigation levels. *Agricultural Science Digest*. 26(3): 174-177.
- Mann, R.A., Ramzan, M., Munir, A. (2008). Improving the sustainability of wheat production in irrigated areas of Punjab, Pakistan through conservation tillage technology. *International Journal of Agriculture and Biology*. 10(3): 249-254.
- Mitra, B. and Das, S. (2015). Economization of irrigation schedule in wheat cultivation under sub-Himalayan plains of West Bengal. *Journal of Crop and Weed*. 11(2): 122-126.
- Panse, V.G. and Sukhatme (1967). *Statistical Methods for Agricultural Workers*. 100-174.
- Rajesh, K.M., Parihar, S.S., Singh, M., Khanna, M. (2015). Influence of date of sowing and irrigation regimes on crop growth and yield of wheat (*Triticum aestivum*) and its relationship with temperature in semi-arid region. *Indian Journal of Agronomy*. 60 (1): 72- 78.
- Sharma, B.D., Kar, S., Cheema, S.S. (1990). Yield, water use and nitrogen uptake for different water and N levels in winter wheat. *Fertilizer Research*. 22(2): 119-127.
- Shirpurkar, G.N., Sonawane, P.D., Wagh, M.P., Patil, D.T. (2008). Performance of wheat genotypes under restricted irrigation conditions. *Agricultural Science Digest*. 28(1): 57-58.
- Singha, P., Mondal, T., Patra, K. and Mitra, B. (2018). Straw mulch and restricted irrigation effect on productivity, profitability and water use in wheat (*Triticum aestivum* L.) under various crop establishment techniques in eastern sub-Himalayan plains of India. *International Journal of Current Microbiology and Applied Sciences*. 7(2): 1521-1533.