

Yield Maximization of Wheat (*Triticum aestivum* L.) Cultivars through Improved Water Management Strategy

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ABSTRACT

A field experiment was carried out in alluvial agro-climate of zone of West Bengal during *rabi*, 2014-15 and 2015-16 under the aegis of Bidhan Chandra Krishi Viswavidyalaya at AB block farm, Kalyani. The experimental work was conducted in split-plot design with three replications. Five different levels of irrigation based on crop growth stages *viz.*, one irrigation at CRI stage (I_1), two irrigation at CRI and tillering stage (I_2), three irrigations at CRI, tillering and jointing (I_3), four irrigations at CRI, tillering, jointing and booting stage (I_4), and five irrigations at CRI, tillering, jointing, booting and milking (I_5) were randomly allotted to main-plots, while four timely sown advance wheat genotypes *viz.*, DBW 39, PBW 343, K 0307 and HD 2967 were allocated randomly to sub-plots. More number of ear head/ m^2 registered with the I_4 and showed parity with the I_5 and I_3 and statistically better to other main plots treatments. Amongst various genotypes HD 2967 registered higher number of ear head/ m^2 , and was significantly better to other set of treatments. Grain/ear head with various main plots treatments revealed that, I_5 has more number compared to other allotted treatments, and showed parity with the I_4 and I_3 and better to all other treatments. Application of irrigation water at four different growths stages (CRI, tillering, jointing and booting stage (I_4)), gave significantly more grain (35.65 q/ha) and straw (51.03 q/ha) yield compared to other allotted subplots treatments, except I_5 . Observation related to various genotypes revealed that, HD 2967 recorded significantly more grain (34.95 q/ha) and straw (61.05 q/ha) yield, and was at par only with K0307. Economics revealed that, more net return observed with I_4 (₹ 47,087), but highest benefit cost ratio found with the I_3 (2.06) and followed by I_4 (2.02). Amongst various genotypes, highest net return observed with HD 2967, and this give equal B:C ratio with K0307 (1.89). Despite higher yield and good return under five irrigations, the maximum benefit-cost ratio was recorded with thrice irrigated treatment indicating the cost incurred towards extra two irrigations did not result in proportionate yield increase. So it is concluded that under new alluvial zone of West Bengal cultivation of HD 2967 and K0307 with three to four irrigation found to be economical to the farmers.

Keywords: Economics, genotype, irrigation level, yield, wheat

Wheat is one of the most important cereal crops, occupying the prime position among food crops in the world. Importance of wheat (*Triticum aestivum* L.) crop may be understood from the fact that it covers about one-fifth of total area under food grains and accounts for about one-third of the total food grain production in India (Bhattacharyya *et al.*, 2008). Wheat occupies a prominent place as an important crop contributing more than 40% in the total foodgrain production in the country. After introduction of high yielding varieties wheat became an important crop in West Bengal. Generally

the sowing of wheat gets delayed in the Gangetic plains of this state due to delay in harvesting of *kharif* rice. Even after harvesting of paddy, the soil gets saturated with moisture due to receipt of late monsoon rainfall in high intensity and the farmers of this region have to wait for another 15-20 days so that the soil moisture recedes to optimum one. Among the various factors influencing grain yield, availability of water and genotypes are of supreme importance. In India, the demand for water resources is exceeding the supply and the competition for this scarce water among the various

sector like domestic, industrial and agricultural use is becoming intense. Water is the key input for all recommended agronomic practices and therefore efficient utilization of irrigation water is essential for wheat and other crops (Rathore *et al.*, 2014). Technological advances are needed to reduce excess nutrient application by improving use efficiency and reducing losses (Mukherjee, 2014). In alluvial region of West Bengal, the monsoon shower starts with high intensity in the end of June and continues upto August. During these three months period, the zone receives high rainfall of 1200-2200 mm. This huge rainfall is effective in ground water recharge and there remains a scope to grow *rabi* crops utilizing the residual moisture. Even wheat crop can be raised successfully in this region under rainfed condition with the receipt of a winter rain. However, there is a need to quantify the irrigation need of the crop. Number and time of irrigation play crucial role in crop productivity and farmer's net return as a whole (Mukherjee, 2013). The present study was undertaken to assess the performance of wheat genotypes under restricted irrigation.

MATERIALS AND METHODS

The field experiment was conducted at District Seed Farm (AB Block), Kalyani under Bidhan Chandra Krishi Viswavidyalaya during winter season of 2014-15 and 2015-16 in upland situation. The farm is situated at approximately 22° 56' N latitude and 88° 32' E longitude with an average altitude of 9.75 m above mean sea level (MSL). The soil of the experimental field was loamy in texture and almost neutral in reaction having pH 7.2, organic carbon 0.44%, available nitrogen 241.63 kg, available phosphorus 23.53 and available potassium 256.93 kg/ha. The experimental work was conducted in split-plot design with three replications. Five different levels of irrigation based on crop growth stages *viz.*, one irrigation at CRI stage (I_1), two irrigation at CRI and tillering stage (I_2), three irrigations at CRI, tillering and jointing (I_3), four irrigations at CRI, tillering, jointing and booting stage (I_4), and five irrigations at CRI, tillering, jointing, booting and milking (I_5) were randomly allotted to main-plots, while four timely sown advance wheat genotypes *viz.*, DBW 39, PBW 343, K 0307 and HD 2967 were allocated randomly to sub-plots. The gross size of the plots was 2.07 m ×

8 m or 16.56 sq. m (9 rows at 23 cm spacing). The crop was uniformly fertilized with 150 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare. One third of N, full P_2O_5 and K_2O were applied as basal and remaining dose of N was top-dressed in two equal splits at 21 (CRI stage) and 42 (maximum tillering stage) days after sowing. A seed rate of 100 kg/ha was used. The irrigation was applied as per treatment on different growth stages and other management practices were adopted as per recommendations. The growth and yield parameters as well as yield were recorded at harvest and production economics were calculated based on prevailing market price of inputs like seeds, fertilizers, etc and sale price of wheat grain.

RESULTS AND DISCUSSION

The plant height of wheat increased significantly with increase in number of irrigations except five irrigation levels. Maximum plant height registered with I_4 and showed parity with the I_5 and I_3 . Amongst various main plot treatments, more plant height registered with the HD 2967, however it's failed to produce any significant response (Table 1). Further with various main plot treatments, highest LAI received with I_5 and was at par with the I_3 and I_4 . Increased number of irrigation resulted in higher vegetative growth of the plant thereby increasing the plant height and LAI production (Table 1). Amongst various genotypes more LAI registered with the K0307 and was at par with the DBW 39. With various levels of irrigation, plots receiving five irrigations recorded maximum number of tillers and were at par with the four level of irrigation. With various genotypes highest number of tiller/m² was registered with the HD 2967, and was at par with the K0307. With various yield attributing parameter, more number of ear head/m² registered with the I_4 and showed parity with the I_5 and I_3 and statistically better to other main plots treatments.

Amongst various genotypes HD 2967 registered more number of ear head/m² and was significantly better to other set of treatments (Table 1). Grain/ ear head with various main plots treatments revealed that, I_5 has more number compared to other allotted treatments, and showed parity with the I_4 and I_3 and better to all other treatments. The lesser competition and greater availability of water and nutrients with I_5 resulted in more number of spike bearing tillers as well as number of grains/ear (Das

Table 1: Growth parameters and yield attributes of wheat genotypes under various levels of irrigation (pooled data of two years)

Treatments	Plant height (cm)	LAI (60 DAS)	Tillers (No. /m ²)	Ear head (No. /m ²)	Grain/ear head (No.)	Test wt (g)	Days to 50% heading	Days to physiological maturity
<i>Irrigation levels</i>								
I ₁	70.51	2.45	156.06	107.33	32.01	31.11	66.11	108.11
I ₂	83.71	2.41	211.66	154.32	36.33	34.68	69.06	110.73
I ₃	89.73	3.14	325.73	286.63	41.36	38.01	71.11	114.53
I ₄	95.06	3.21	351.33	311.23	41.67	38.33	71.04	114.37
I ₅	94.65	3.27	365.25	298.92	42.66	38.98	69.52	112.53
S.Em±	1.67	0.13	11.36	8.32	1.36	0.97	2.02	1.21
C.D. (P=0.05)	5.26	0.39	35.11	25.16	3.89	2.91	NS	3.65
<i>Genotypes</i>								
DBW 39	91.34	3.49	369.11	279.66	39.46	38.04	73.25	111.41
PBW 343	94.11	2.87	312.33	243.11	37.17	37.80	67.66	113.87
K 0307	93.83	3.71	396.45	319.36	40.11	39.64	68.17	112.39
HD 2967	97.16	3.12	412.36	361.02	38.66	38.31	70.35	114.41
S.Em±	2.11	0.11	11.23	8.12	0.76	2.3	0.39	0.23
C.D. (P=0.05)	NS	0.36	35.23	23.82	2.12	NS	1.12	0.58

NS = Non significant

and Yaduraju, 1999). With different cultivars, K0307 gave maximum number of grain/ear head and was at par with the HD 2967, and statistically superior to other assignments. Highest thousand grain weight registered with the I₅ and at par with the all other main plot treatments except I₁ and I₂.

However, test weight failed to produce any statistical response with various genotypes, moreover more test weight registered with the K0307 and significantly better to all other allotted subplots treatments. With various growth parameters, days to 50% heading failed to produce any significant response with various irrigation levels. However, least days to 50% heading record with the I₁ and maximum with the I₃. Various subplots treatments revealed that, least days to 50% heading found with PBW 343, and was at par with the K0307, and significantly better to other treatments. Days to physiological maturity highest observed with three levels of irrigation (I₃) and was at par with the I₅ and I₄. However, least number of days registered with the I₃. Further, table 1 revealed that, HD 2967 took (114.41) more number of days to physiological maturity and was at par with the PBW 343. However least days to physiological maturity observed with the DBW 39.

Irrigation had a significant influence on seed and straw yields of wheat (Table 2). Application of irrigation water at four different growths stages (CRL, tillering, jointing and booting stage (I₄)), gave significantly more grain yield (35.65 q/ha) compared to other allotted subplots treatments, except I₅ (34.15 q/ha). This treatment gave 92.49, 35.08 and 15.67 % more grain yield over one (I₁), two (I₂) and three irrigation (I₃), respectively.

From the table 2 it is crystal clear that increase in irrigation frequency drastically improves wheat yield and productivity. The increased growth along with better expression of yield attributes might have lead to increase in grain yield. Higher irrigation frequency increased the availability of nutrients and thus enhanced the meristematic activities and size of cell and formation and functioning of protoplasm which consistently improved the crop growth and yield.

Further, increase in number of irrigation i.e. from I₄ to I₅ no significant response found among themselves. Observation related to various genotypes revealed that, HD 2967 (34.95 q/ha) recorded significantly more grain yield, and was at par only with K0307 (32.75 q/ha). However, least grain yield observed with PBW 343 (28.11 q/ha). More straw yield

Table 2: Economic yield, nutrient uptake and economics of wheat genotypes under various levels of irrigation (pooled data of two years)

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)	Nutrient uptake by crop (kg/ha)			Economics		
				N	P	K	Cost of cultivation (₹/ha)	Net return (₹/ha)	B:C ratio
Irrigation levels									
I ₁	18.52	38.30	32.59	56.91	10.32	51.02	31,989	19,397	1.61
I ₂	26.39	40.98	39.17	67.34	14.13	61.39	37,123	23,456	1.63
I ₃	30.82	49.81	38.61	81.72	17.13	65.32	41,958	44,589	2.06
I ₄	35.65	51.03	41.13	87.65	19.87	74.33	46,312	47,087	2.02
I ₅	34.15	52.96	39.20	85.36	18.82	70.11	50,897	42,397	1.83
S.Em±	0.72	1.23	0.67	1.86	0.38	1.58	—	—	—
CD (P=0.05)	2.18	3.17	2.01	6.04	1.21	4.61	—	—	—
Genotypes									
DBW 39	29.73	42.33	41.26	69.91	17.05	53.36	44,981	38,356	1.85
PBW 343	28.11	50.13	35.93	63.12	15.95	49.32	45,099	37,568	1.83
K 0307	32.75	57.34	36.35	74.11	18.77	67.35	46,087	40,897	1.89
HD 2967	34.95	61.05	36.41	78.96	19.36	74.11	46,389	41,125	1.89
S.Em±	0.99	2.56	0.45	1.01	0.41	1.23	—	—	—
C.D. (P=0.05)	3.04	7.11	1.36	3.05	1.18	3.75	—	—	—

observed with I₅ and was at par with the I₄ and I₅. Least number of irrigation (I₁), reduced straw yield by the tune of 38.27, 32.23 and 30.05% less with respect to I₅, I₄ and I₃. This corroborate with the findings of Jain *et al.* (2014). Amongst various cultivars, least straw yield resulted from DBW 39. Highest straw yield produced by HD 2967 and was at par with K0307, and statistically superior to all other subplots treatments. More harvest index resulted from I₄ and was at par with the I₅ and I₂. Amongst various genotypes more HI registered with the DBW 39 and statistically better to all other treatments. Nutrient uptakes by crop vary significantly improves with number of irrigations. Maximum NPK uptake observed with I₄ and was at par with I₅ and I₃ for nitrogen, and only with I₅ for P and K.

Moreover, utilization of nutrient elements was better under adequate moisture achieved through increasing number of irrigation (Mukherjee, 2016). Observation related to various genotypes, revealed that, more NPK uptake found with HD 2967, and was at par with K0307 only for P uptake and significantly better to all other treatments. This might be due to more biomass production by

cultivars. Economics revealed that, more net return observed with I₄ (₹ 47,087), but highest benefit cost ratio found with the I₃ (2.06) and followed by I₄ (2.02). Amongst various genotypes, highest net return observed with HD 2967 (₹ 41125), and this give equal B:C ratio with K0307 (1.89).

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