Volume: 5, Issue: 5
Page: 139-149
2021

International Journal of
Science and Business
Journal homepage: ijsab.com/ijsb

IJSAB International

Growth and Yield performance of selected Wheat Genotypes at Variable Irrigation Management

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Abstract:

The experiment was conducted in the Agronomy Field, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 during the period of November 17, 2016 to March 29, 2017 on growth and yield performance of selected wheat genotypes at variable irrigation. In this experiment, the treatment consisted of three varieties viz. V_1 = BARI Gom 26, V_2 = BARI Gom 28, V_3 = BARI Gom 30, and four different irrigations viz. I_0 = No Irrigation throughout the growing season, I_1 = One irrigation (Irrigate at CRI stage), I_2= Two irrigation (Irrigate at CRI and grain filling), I_3= Three irrigation (irrigate at CRI, booting and grain filling stages). The experiment was laid out in two factors split plot with three replications. The collected data were statistically analyzed for evaluation of the treatment effect. Results showed that a significant variation among the treatments in respect majority of the observed parameters. Results showed significant variation in almost every parameter of treatments. The highest Plant height, number of effective tillers hill^{-1}, spike length, number of grain spike^{-1} was obtained from BARI Gom-30. The highest grain weight hectare^{-1} (3.44 ton) was found from wheat variety BARI Gom-30. All parameters of wheat showed statistically significant variation due to variation of irrigation. The maximum value of growth, yield contributing characters, seed yield was observed with three irrigation (irrigate at CRI, booting and grain filling stages). The interaction between different levels of variety and irrigation was significantly influenced on almost all growth and yield contributing characters, seed yield. The highest yield (3.99 t ha^{-1}) was obtained from BARI Gom-30 with three irrigation (irrigate at CRI, booting and grain filling stages). The optimum growth and higher yield of wheat cv. BARI Gom-30 could be obtained by applying three irrigations at CRI, booting and grain filling stages.

IJSB
Accepted 05 April 2021
Published 12 April 2021
DOI: 10.5281/zenodo.4680431

Keywords: *Growth and yield performance, Wheat, BARI Gom-30 treatment effect, Irrigation Management.*

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1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops cultivated all over the world. Wheat production was increased from 585,691 thousand tons in 2000 to 713,183 thousand tons in 2013 which was ranked below rice and maize in case of production (FAO, 2015). In the developing world, need for wheat will be increased 60 % by 2050 (Rosegrant and Agcaoili, 2010). The International Food Policy Research Institute projections revealed that world demand for wheat will increase from 552 million tons in 1993 to 775 million tons by 2020 (Rosegrant *et al.*,1997). Wheat grain is the main staple food for about two third of the total population of the world. (Hanson *et al.,* 1982). It supplies more nutrients compared with other food crops. Wheat grain is rich in food value containing 12% protein, 1.72% fat, 69.60% carbohydrate and 27.20% minerals (BARI, 2006). It is the second most important cereal crop after rice in Bangladesh. So, it is imperative to increase the production of wheat to meet the food requirement of vast population of Bangladesh that will secure food security. During 2013-14 the cultivated area of wheat was 429607 ha having a total production of 1302998 metric tons with an average yield of 3.033 metric tons ha^{-1}whereas during 2012-13 the cultivated area of wheat was 416522 ha having a total production of 1254778 metric tons with an average yield of 3.013 tons ha^{-1} (BBS, 2014).

Current demand of wheat in the country is 3.0-3.5 million tons. Increasing rate of consumption of wheat is 3% per year (BBS, 2013). Wheat production is about 1.0 milllion from 0.40 million hectares of land. Bangladesh has to import about 2.0-2.5-million-ton wheat every year. Wheat is grown all over Bangladesh but wheat grows more in Dhaka, Faridpur, Mymensingh, Rangpur, Dinajpur, Comilla districts. Wheat has the umpteen potentialities in yield among other crops grown in Bangladesh. However, yield per hectare of wheat in Bangladesh is lower than other wheat growing countries in the world due to various problems. Increasing food production of the country in the next 20 years to much population growth is a big challenge in Bangladesh. It is more difficult because, land area devoted to agriculture will decline and better-quality land and water resources will be divided to the other sector of national economy. In order to grow more food from marginal and good quality lands, the quality of natural resources like seed, water, varieties and fuel must be improved and sustained. Variety plays an important role in producing high yield of wheat because different varieties responded differently for their genotypic characters, input requirement, growth process and the prevailing environment during growing season.

In Bangladesh the wheat growing season (November-March) is in the driest period of the year. Wheat yield was declined by 50% owing to soil moisture stress. Irrigation water should be applied in different critical stages of wheat for successful wheat production. Shoot dry weight, number of grains, grain yield, biological yield and harvest index decreased to a greater extent when water stress was imposed at the anthesis stage while water stress was imposed at booting stage caused a greater reduction in plant height and number of tillers (Gupta *et al.*, 2001). Determination of accurate amount of water reduces irrigation cost as well as checks ground water waste. Water requirements vary depending on the stages of development. The pick requirement is at crown root initiation stage (CRI). In wheat, irrigation has been recommended at CRI, flowering and grain filling stages. However, the amount of irrigation water is shrinking day by day in Bangladesh which may be attributed to filling of pond river bottom. Moreover, global climate change scenarios are also responsible for their scarcity of irrigation water. So, it is essential to estimate water saving technique to have an economic estimate of irrigation water. Information on the amount of irrigation water as well as the precise sowing time of wheat with change in climate to expedite wheat production within the farmer's limited resources is inadequate in Bangladesh. The need of water requirement also varies with sowing times as the soil moisture depletes with the days after sowing in Bangladesh as there is scanty rainfall after sowing season of wheat in general in the month of November. With above considerations, the present research work was conducted with the following objectives:

1.1 To evaluate yield performance of selected wheat genotypes*(s)* at variable irrigation management.

1.2 To identify the suitable genotype (s) of wheat giving higher yield under moisture stress condition.

2. MATERIALS AND METHODS

2.1 Description of the experimental site

The experiment was conducted in the Research Field, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 during the period of November, 2016 to March, 2017 to observe the growth and yield performance of selected wheat genotypes at variable irrigation management. The experimental field is located at 23041´ N latitude and 90º 22´ E longitude at a height of 8.6 m above the sea level belonging to the Agro-ecological Zone "AEZ-28" of Madhupur Tract (BBS, 2013).

2.2 Soil characteristics

The soil of the research field is slightly acidic in reaction with low organic matter content. The selected plot was above flood level and sufficient sunshine was available having available irrigation and drainage system during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The experimental plot was also high land, having pH 5.56.

2.3 Climate condition

The experimental field was situated under sub-tropical climate; usually the rainfall is heavy during *Kharif* season, (April to September) and scanty in *Rabi* season (October to March). In *Rabi* season temperature is generally low and there is plenty of sunshine. The temperature tends to increase from February as the season proceeds towards *kharif*. Rainfall was almost nil during the period from November 2016 to March 2017 and scanty from February to September.

2.4 Planting material

The test crop was wheat (*Triticum aestivum*). Three wheat varieties BARI Gom-26, BARI Gom-28 and BARI Gom-30 were used as test crop and were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

2.5 Treatments

The experiment consisted of two factors and those were the wheat genotypes and irrigation. Three wheat genotypes and four irrigations were used under the present study. Factor A: three wheat varieties- V_1 = BARI Gom-26, V_2 = BARI Gom-28 and V_3 = BARI Gom-30. Factor B: four irrigations- I_0 = No Irrigation throughout the growing season, I_1 = One irrigation (Irrigate at CRI stage), I_2= Two irrigation (Irrigate at CRI and grain filling) and I_3= Three irrigation (Irrigate at CRI, booting and grain filling stages). The experiment was laid out in a split plot design with three replications having irrigation application in the main plots, verities in the sub plots. There were 12 treatments combinations. The total numbers of unit plots were 36. The size of unit plot was 2 m x 2 m = 4.00 m^2. The distances between sub-plot to sub-plot, main plot to main plot and replication to replication were, 0.75, 0.75 and 1.5 m, respectively.

2.6 Statistical analysis

The collected data on each plot were statistically analyzed to obtain the level of significance using the computer-based software MSTAT-C developed by Gomez and Gomez, 1984. Mean difference among the treatments were tested with the least significant difference (LSD) test at 5 % level of significance.

3. RESULTS AND DISCUSSION

3.1 Plant height

Plant height varied significantly among the tested three varieties (Table 1). At, 75 DAS, BARI Gom 30 showed the tallest plant height (34.72 cm) and BARI Gom 26 recorded the shortest plant height (32.32 cm). At, 90 DAS, BARI Gom 30 recorded the highest plant height (76.13 cm) was observed from BARI Gom 26. However, BARI Gom 26 recorded the shortest plant height (75.01 cm) which was also statistically similar with BARI Gom 28. Islam and Jahiruddin (2008) also concluded that plant height varied significantly due to various wheat varieties. Plant height of wheat showed statistically significant variation due to amount of irrigation at 75, 90 DAS under the present trial (Table 2). At 75 DAS, the tallest plant (34.78 cm) was recorded from I_3 (Three irrigation) while the shortest plant (32.02 cm) was observed from I_0 (No Irrigation throughout the growing season) treatment. At 60 DAS, the tallest plant (77.51 cm) was found from I_3, which was statistically similar with I_2 (Two irrigation) and I_1 (One irrigation). The shortest plant (71.29 cm) was observed from I_0. Plant height was likely increased due to applying higher amount of irrigation compared to less amount of irrigation. Sultana (2013) stated that increasing water stress declined the plant height. Interaction effect of variety and different amount of irrigation showed significant differences on plant height of wheat at 75 and 90 DAS (Table 3). The highest plant height at 30 was 38.00 cm obtained from V_3I_3 treatment combination. The shortest plant height at 30 was 30.67 cm obtained from V_1I_0 treatment combination. At 60 DAS, plant height was 78.50 cm obtained from V_3I_3 and lowest was 69.83 cm obtained from V_1I_0 treatment combination, which was statistically similar with V_2I_0 and $_3I_0$ treatment combination.

Table 1. Effect of variety on plant height of wheat at different days after sowing

Treatments	Plant height (cm)	
	75 DAT	90 DAT
V_1	32.32 a	75.1 a
V_2	33.21 b	75.2 a
V_3	34.72 c	76.13 b
LSD (0.05)	2.21	2.16
CV (%)	3.71	5.00

V_1 = BARI Gom 26, V_2 = BARI Gom 28, V_3 = BARI Gom 30
(**Source:** Field experiment, 2016-2017)

Table 2. Effect of irrigation on plant height of wheat at different days after sowing

Treatments	Plant height (cm)	
	75 DAT	90 DAT
I_0	32.02 a	71.29 a
I_1	33.23 a	76.27 b
I_2	33.63 b	76.83 b
I_3	34.78 c	77.51 c
LSD (0.05)	2.21	2.16
CV (%)	3.71	5.00

I_0 = No Irrigation throughout the growing season, I_1 = One irrigation (Irrigate at CRI stage), I_2= Two irrigation (Irrigate at CRI and grain filling), I_3= Three irrigation (irrigate at CRI, booting and grain filling stages) (**Source**: Field experiment, 2016-2017)

Table 3. Interaction effect of variety and irrigation on plant height of wheat

Treatment	Plant height (cm)	
	75 DAS	90 DAS
V_1I_0	30.67 e	69.83 c
V_1I_1	33.50 bcd	76.67 ab
V_1I_2	34.00 bcd	77.00 ab
V_1I_3	34.67 bc	76.90 ab
V_2I_0	32.50 cde	71.83 c
V_2I_1	33.27 bcd	75.40 b
V_2I_2	31.83 de	76.43 ab
V_2I_3	31.67 de	77.13 ab
V_3I_0	32.90 bcde	72.20 c
V_3I_1	32.93 bcde	76.73 ab
V_3I_2	35.07 b	77.07 ab
V_3I_3	38.00 a	78.50 a
$LSD_{(0.05)}$	2.11	2.26
CV (%)	3.73	5.00

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.
V_1 = BARI Gom 26, V_2 = BARI Gom 28, V_3 = BARI Gom 30
I_0 = No Irrigation throughout the growing season, I_1 = One irrigation (Irrigate at CRI stage), I_2= Two irrigation (Irrigate at CRI and grain filling), I_3= Three irrigation (irrigate at CRI, booting and grain filling stages) (**Source:** Field experiment, 2016-2017)

3.2 Number of effective tiller hill^{-1}

Number of effective tillers hill^{-1} of wheat was not varied significantly due to varieties (Table 4). BARI Gom 30 produced the highest number of effective tillers hill^{-1} **(**9.33) and the lowest number of effective tillers hill^{-1} (8.58) was observed in BARI Gom 26. Different levels of irrigation varied significantly in terms of number of effective tillers hill^{-1} of wheat at harvest under the present trial (Table 5). The highest number of effective tillers hill^{-1} 9.89 was recorded from I_3 treatment, while the corresponding lowest number of effective tillers hill^{-1} were 7.89 observed in I_0 treatment. Sultana (2013) stated that increasing water stress reduced the number of tillers per hill. Variety and irrigation showed significant differences on number of effective tillers hill^{-1} of wheat due to interaction effect (Table 6). The highest number of effective tillers hill^{-1} 10.33 were observed from V_3I_3 treatment combination, while the corresponding lowest number of effective tillers hill^{-1} as 7.33 were recorded from V_1I_0 treatment combination.

3.3 Number of non-effective tiller hill^{-1}

Number of non-effective tillers hill^{-1} of wheat was not varied significantly due to varieties (Table 4). BARI Gom 26 produced the highest number of non-effective tillers hill^{-1} **(**1.33) and the lowest number of non-effective tillers hill^{-1} (1.00) was observed in BARI Gom 30. Different levels of irrigation varied significantly in terms of number of non-effective tillers hill^{-1} of wheat at harvest under the present trial (Table 5). The highest number of non-effective tillers hill^{-1} (2.00) was recorded from I_0, while the corresponding lowest number of non-effective tillers hill^{-1} (0.67) was observed in I_3. Variety and irrigation showed significant differences on number of non-effective tillers hill^{-1} of wheat due to interaction effect (Table 6). The highest number of non-effective tillers hill^{-1} (2.33) were observed from V_1I_0 treatment combination, while the corresponding lowest number of non-effective tillers hill^{-1} (0.33) were recorded from V_3I_2 treatment combination.

Table 4. Effect of variety on yield and yield contributing characters of wheat

Treatment	Number of effective tiller per plant	Number of non-effective tiller per plant	Length of spike (cm)	Number of grain per spike
V_1	8.58	1.33	8.08	36.92 b
V_2	8.83	1.08	8.13	37.25 b
V_3	9.33	1.00	8.46	37.75 a
LSD (0.05)	NS	NS	NS	0.50
CV (%)	9.81	5.22	8.66	5.73

V_1 = BARI Gom 26, V_2 = BARI Gom 28, V_3 = BARI Gom 30

(**Source**: Field experiment, 2016-2017)

Table 5. Effect of irrigation on yield and yield contributing characters of wheat

Treatment	Number of effective tiller per plant	Number of non-effective tiller per plant	Length of spike (cm)	Number of grain per spike
I_0	7.89 b	2.00 a	7.17 c	34.56 c
I_1	8.67 ab	1.11 b	8.11 b	36.33 b
I_2	9.22 ab	0.89 bc	8.44 ab	39.00 a
I_3	9.89 a	0.67 c	9.17 a	39.33 a
LSD (0.05)	1.68	0.40	0.85	0.90
CV (%)	9.81	5.22	8.66	5.73

I_0 = No Irrigation throughout the growing season, I_1 = One irrigation (Irrigate at CRI stage), I_2= Two irrigation (Irrigate at CRI and grain filling), I_3= Three irrigation (irrigate at CRI, booting and grain filling stages)

(**Source:** Field experiment, 2016-2017)

Table 6. Interaction effect of variety and irrigation on yield and yield contributing characters of wheat

Treatment	Number of effective tiller per plant	Number of non effective tiller per plant	Length of spike (cm)	Number of grain per spike
V_1I_0	7.33 d	2.33 a	6.50 c	34.00 e
V_1I_1	8.67 abcd	0.67 cd	8.33 b	36.00 cde
V_1I_2	8.67 abcd	1.33 abcd	8.83 b	38.00 abcd
V_1I_3	9.67 abc	1.00 bcd	8.67 b	39.00 abc
V_2I_0	8.33 bcd	2.00 ab	7.50 bc	35.00 de
V_2I_1	8.33 bcd	0.67 cd	8.00 b	37.00 bcde
V_2I_2	9.00 abcd	0.67 cd	8.50 b	40.00 ab
V_2I_3	9.67 abc	1.00 bcd	8.50 b	37.00 bcde
V_3I_0	8.00 cd	1.67 abc	7.50 bc	34.67 de
V_3I_1	9.00 abcd	1.00 bcd	8.00 b	36.00 cde
V_3I_2	10.00 ab	0.33 d	8.00 b	40.00 ab
V_3I_3	10.33 a	1.33 abcd	10.33 a	41.00 a
LSD (0.05)	1.48	1.03	1.21	3.43
CV(%)	9.81	5.22	8.66	5.73

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability. V_1 = BARI Gom 26, V_2 = BARI Gom 28, V_3 = BARI Gom 30

I_0 = No Irrigation throughout the growing season, I_1 = One irrigation (Irrigate at CRI stage), I_2= Two irrigation (Irrigate at CRI and grain filling), I_3= Three irrigation (irrigate at CRI, booting and grain filling stages)

(**Source:** Field experiment, 2016-2017)

3.4. Spike length (cm)

Insignificant variation was observed on spike length (cm) at applied three types of modern wheat variety as BARI Gom-26 (V_1), BARI Gom-28 (V_2), and BARI Gom-30 (V_3). From the experiment with that three types of varieties BARI Gom-30 (V_3) (8.46 cm) given the largest spike length and BARI Gom-26 (V_1) (8.08 cm) was given the lowest spike length (Table 4). Similar result was found using with different type varieties by Hefni *et al*. (2000). Different irrigation application has a statistically significant variation on spike length as irrigated condition (I_3) was given the maximum result (9.17 cm) and non-irrigated condition (I_0) given the lowest spike length (7.17 cm) (Table 5). Interaction effect of improved wheat variety and irrigation showed significant differences on spike length. Results showed that the highest spike length was obtained from V_3I_3 (10.33 cm). On the other hand, the lowest spike length was observed at V_1I_0 (6.50cm) treatment combination (Table 6).

3.5. Grain spike^{-1}

Significant variation was observed on grain spike^{-1} at these applied three types of modern wheat variety. The BARI Gom-30 (V_3) (37.75) given the maximum number of grain spike^{-1} and BARI Gom-26 (V_1) (36.92) was given the lowest number of grain spike^{-1}, which was statistically similar with V_2 treatment (Table 4). Different wheat genotypes have significant effect on grain spike^{-1} observed also by Rahman *et al.* (2009). Different irrigation application has a statistically significant variation on grain spike^{-1} as the irrigation condition (I_3) was given the maximum result (39.33), which was statistically similar with I_2 and non-irrigated condition (I_0) given the lowest grain spike^{-1} (34.56) (Table 5). Sarkar *et al.* (2010) also observed that irrigation have a significant effect on grain spike^{-1}. Interaction effect of improved wheat variety and irrigation showed significant differences on grain spike^{-1}. Results showed that the highest grain spike^{-1} was obtained from V_3I_3 (41.0). On the other hand, the lowest grain spike^{-1} was observed at V_1I_o (34.00) which were also statistically similar with V_3Io (34.67) (Table 6).

3.6. Thousand Seed weight

There was significant variation was observed on thousand seed weight due to different types of modern wheat variety. The wheat variety of BARI Gom-30 (V_3) (50.40 g) given the maximum thousand seed weight and statistically different from BARI Gom-28 (V_2) (46.74 g). BARI Gom-26 (V_1) (46.22 g) was given the lowest thousand seed weight (Table 7). Rahman *et al.* (2009), Islam *et al*. (2015) also conducted experiment with different variety and observed have effect of varieties on yield. Different irrigation application has a statistically significant variation on thousand seed weight. The I_3 was given the maximum thousand seed weight (48.91) and non-irrigated condition (I_0) given the lowest yield (46.13 g) (Table 8). Sarkar *et al.* (2010), Baser *et al*. (2004) reported that grain yield under non-irrigated conditions was reduced by approximately 40%. Bazza *et al.* (1999) reported that one water application during the tillering stage allowed the yield to be lower only than that of the treatment with three irrigations but Meena *et al.* (1998) reported that wheat grain yield was the highest with 2 irrigations (2.57 ton/ha in 1993 and 2.64 ton/ha) at flowering and/or crown root initiation stages. Wheat is sown in November to ensure optimal crop growth and avoid high temperature and after that if wheat is sown in the field it faces high range of temperature for its growth and development as well as yield potential. Islam *et al*. (2015) reported that late planted wheat plants faced a period of high temperature stress during reproductive stages causing reduced kernel number spike^{-1} as well as the reduction of grain yield. Interaction effect of improved wheat variety and irrigation showed significant differences on thousand seed weight (Table 9). Results showed that the highest thousand seed weight (52.33 g) was obtained from V_3I_3 which was statistically similar with V_3I_2 (52.06 g). On the other hand, the lowest yield (45.36 g) was observed at V_1I_1.

Table 7. Effect of variety on yield and yield of wheat

Treatment	Thousand seed weight (g)	Yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)
V_1	46.22 c	3.21 b	1.87 b	5.08 b
V_2	46.74 b	3.43 a	1.90 b	5.33 ab
V_3	50.40 a	3.44 a	1.95 a	5.39 a
LSD $_{(0.05)}$	0.5091	0.1571	0.0497	0.2721
CV (%)	6.27	6.34	7.39	11.00

V_1 = BARI Gom 26, V_2 = BARI Gom 28, V_3 = BARI Gom 30
(**Source:** Field experiment, 2016-2017)

Table 8. Effect of irrigation on yield and yield of wheat

Treatment	Thousand seed weight (g)	Yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)
I_0	46.13 d	2.97 b	1.80 c	4.77 d
I_1	47.49 c	3.16 b	1.88 bc	5.03 c
I_2	48.60 b	3.56 a	1.94 ab	5.50 b
I_3	48.91 a	3.74 a	2.01 a	5.76 a
LSD $_{(0.05)}$	0.27	0.28	0.12	0.23
CV (%)	6.27	6.34	7.39	11.00

I_0 = No Irrigation throughout the growing season, I_1 = One irrigation (Irrigate at CRI stage), I_2= Two irrigation (Irrigate at CRI and grain filling), I_3= Three irrigation (irrigate at CRI, booting and grain filling stages)
(**Source**: Field experiment, 2016-2017)

Table 9. Interaction effect of variety and irrigation on yield and yield of wheat

Treatment	Thousand seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)
V_1I_0	45.65 fg	2.93 d	1.78 e	4.72 f
V_1I_1	45.36 g	3.21cd	1.89 cd	5.09 def
V_1I_2	46.70 cde	3.33 bcd	1.83de	5.16 cde
V_1I_3	47.15 cd	3.38 bc	1.96 bc	5.34 cd
V_2I_0	46.10 ef	2.99 cd	1.79 e	4.77 ef
V_2I_1	46.55 de	3.26 bcd	1.91 cd	5.17 cde
V_2I_2	47.04 cd	3.60 ab	1.91 cd	5.51 bc
V_2I_3	47.25 c	3.86a	2.00 ab	5.86 ab
V_3I_0	46.64 cde	3.00 cd	1.83 de	4.84 ef
V_3I_1	50.54 b	3.00 cd	1.83de	4.83 ef
V_3I_2	52.06 a	3.75 a	2.07 a	5.82 ab
V_3I_3	52.33 a	3.99 a	2.08 a	6.07 a
Lsd $_{(0.05)}$	0.56	0.36	0.08	0.36
CV(%)	6.27	6.34	7.39	11.00

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly by LSD at 0.05 level of probability.
V_1 = BARI Gom 26, V_2 = BARI Gom 28, V_3 = BARI Gom 30
I_0 = No Irrigation throughout the growing season, I_1 = One irrigation (Irrigate at CRI stage), I_2= Two irrigation (Irrigate at CRI and grain filling), I_3= Three irrigation (irrigate at CRI, booting and grain filling stages)
(**Source**: Field experiment, 2016-2017)

3.7. Grain yield (t ha^{-1})

Different wheat varieties showed significant difference for grain weight hectare^{-1} (Table 7). The highest grain yield hectare^{-1} (3.44 ton) was found from wheat variety BARI Gom-30 (V_3), which was statistically similar with V_2, whereas the lowest (3.21 ton) was observed from wheat variety BARI gom 26. Rahman *et al.* (2009), Islam *et al*. (2015) also conducted experiment with different variety and observed have effect of varieties on yield. Significant difference was observed for yield for different irrigation application. The three irrigation (I_3) was given the maximum yield (3.74 t ha^{-1}), which was statistically similar with I_2 treatment and non-irrigated condition (I_0) given the lowest yield (2.97 t ha^{-1}) (Table 8). Sarkar *et al.* (2010), Baser *et al*. (2004) reported that grain yield under non-irrigated conditions was reduced by approximately 40%. Bazza *et al.* (1999) reported that one water application during the tillering stage allowed the yield to be lower only than that of the treatment with three irrigations but Meena *et al.* (1998) reported that wheat grain yield was the highest with 2 irrigations (2.57 ton/ha in 1993 and 2.64 ton/ha) at flowering and/or crown root initiation stages. Wheat is sown in November to ensure optimal crop growth and avoid high temperature and after that if wheat is sown in the field it faces high range of temperature for its growth and development as well as yield potential. Islam *et al*. (2015) reported that late planted wheat plants faced a period of high temperature stress during reproductive stages causing reduced kernel number spike^{-1} as well as the reduction of grain yield. Interaction effect of improved wheat variety and irrigation showed significant differences on yield (t ha^{-1}). Results showed that the highest yield (3.99 t ha^{-1}) was obtained from V_3I_3, which was statistically similar with V_2I_3 and V_3I_2. On the other hand, the lowest yield (2.93 t ha^{-1}) was observed at V_1I_0 (Table 7).

3.8. Straw yield (t ha^{-1})

Applied three types of wheat variety have a statistically significant variation on straw yield (t ha^{-1}). The maximum straw yield (1.95 t ha^{-1}) was obtained from BARI Gom-30 and BARI Gom-26 (V_1) was given the lowest straw yield (1.87 t ha^{-1}), which was statistically similar with V_2 treatment. Different irrigation application has a statistically significant variation on straw yield (t ha^{-1}) of wheat. The I_3 treatment for straw yield (2.01 t ha^{-1}) was given the maximum result and non-irrigated condition (I_0) given the lowest (1.80 t ha^{-1}). Similar results were found by Ali and Amin (2004) through his experiment. Interaction effect of improved wheat variety and irrigation showed significant differences on straw yield (t ha^{-1}). The highest straw yield (2.08 t ha^{-1}) was obtained from V_3I_3 which was statistically similar with V_3I_2 (2.07 t ha^{-1}) treatment combination. On the other hand, the lowest straw yield (1.78 t ha^{-1}) was observed at V_1Io, which was statistically similar with V_2I_0 (2.07 t ha^{-1}) treatment combination.

3.9. Biological yield

Significant variation was attained for biological yield for different wheat varieties. The variety BARI Gom-30 given the maximum biological yield (5.39 t ha^{-1}) and BARI Gom-26 (V_1) was given the lowest biological yield (5.078 t ha^{-1}). Different irrigation application has a statistically significant variation biological yield (t ha^{-1}) of wheat. The I_3 treatment for biological yield (5.76 t ha^{-1}) was given the maximum result and non-irrigated condition (I_0) given the lowest (4.77 t ha^{-1}). Similar results were found by Ali and Amin (2004) through his experiment. At the time of biological yield (t ha^{-1}) consideration with variety and irrigation statistically significance variation was observed as maximum biological yield (t ha^{-1}) at V_3I_3 (6.07 t ha^{-1}). On the other hand, the lowest result was given at V_1Io (4.72 tha^{-1}).

4. SUMMARY AND CONCLUSION

From the backdrop of the above all out of the present study it may be concluded that the optimum growth and higher yield of wheat cv. BARI Gom-30 could be obtained by applying three irrigations at irrigate at CRI, booting and grain filling stages. BARI Gom-30 showed better performance due to the application of three irrigations as compared to the conventional irrigation. However, further studies are necessary to arrive at a definite conclusion.

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Cite this article:

Md. Abdur Rahman, Shamima Akter Baly, Mst. Afrose Jahan, A. T. Shamsuddoha, Sonia Nusrin, Sifat Jahan & Md. Saiful Islam (2021). Growth and Yield performance of selected Wheat Genotypes at Variable Irrigation Management. *International Journal of Science and Business, 5*(5), 139-149. doi: https://doi.org/10.5281/zenodo.4680431

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