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EFFECT OF IRRIGATION LEVELS ON GROWTH AND YIELD OF BARLEY (*Hordeum vulgare* L.)

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ABSTRACT

An experiment was conducted to find out the effect of soil moisture regimes on growth and grain yield of barley at the experimental field laboratory of Department of Crop Physiology and Ecology, Hajee Mohammad Danesh Science and Technology University, Dinajpur to study the performance of two barley varieties namely, BARI Barley 5 and BARI Barley 6 during the rabi season of 2006-2007. Four levels of irrigations were applied, viz., control or no irrigation (I_0), one irrigation at the tillering stage, when only 30 mm water was applied (I_1), two irrigations, one at the tillering and one at the booting stages, 60 mm water was applied during these two stages (I_2) and three irrigations, one at the tillering, one at the booting and one at the grain filling stages, 90 mm water was applied during these three stages (I_3). Three irrigations produced the highest TDM, CGR, LAI, and NAR while, LAR was the highest in rainfed crops (I_0). In irrigated crops, the highest grain yield (3.40 t ha^{-1}) was produced by three irrigations applied at 25, 45 and 65 DAS (I_3) followed by two irrigations (3.22 t ha^{-1}). The lowest grain yield (1.96 t ha^{-1}) was recorded in the non-irrigated (I_0) barley varieties. Between two barley varieties, BARI Barley 5 produced significantly higher grain yield (3.11 t ha^{-1}) than BARI Barley 6 (2.87 t ha^{-1}).

Key words: Barley, growth, irrigation level, variety, yield

INTRODUCTION

Barley (*Hordeum vulgare* L.) is the world's 4th most important cereal crop (FAO 2009) and it has the potential to become one of the important crops in Bangladesh. It is a long day plant and can cultivate usually during winter in our country. Barley though a minor crop of the country, can play an important role in enhancing the food security of the country and in drainage of foreign currency. Proper land preparation, optimum time of sowing, recommended fertilizer doses, proper irrigation schedule and seed rates are not usually practiced to raise this crop. As a result, the productivity of this crop is very poor than that of other countries of the world. Barley is an important crop for direct human consumption and for animal feed. The most important uses of barley are as grain feed to livestock and poultry, as malt for manufacture of beverages. Foods prepared from barley are useful for diabetic and high blood pressure patients. Efficient water management is most effective means of increasing crop production. Water being extremely limited in most of the barley growing seasons and areas, essentially demands high efficacy in water use that can be achieved by supplementing proper irrigation water at different growth stages. Crop productions in our country are hampered due to shortage of sufficient soil moisture during winter season. Yield loss of the crop can be minimize by using optimum irrigating in time. Water deficit barley plants fail to develop properly on account of retardation in photosynthetic and metabolic activities resulting in decreased number of tiller and spike production, decreased number of seeds/spike and reduced seed size (Chaudhary and Sharma 2003). Inadequate water supply, often result in disruption of physiological process (Hanson and Hitz 1982). Tillering, booting and heading are adversely affected by water stress at the early growth stage and dry matter partition, leaf area indices, crop growth rate also affected with water deficit condition (Baheri *et al*. 2005 and Rafiq *et al*. 2005). The present study was set up to find out a suitable irrigation level for better growth and yield of barley under field condition.

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MATERIALS AND METHODS

The experiment was conducted at the Crop Physiology and Ecology Field Laboratory, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during the period from November, 2006 to April, 2007. Seeds of two barley varieties were collected from BARI, Gazipur. These are BARI Barley 5 (Hulled) and BARI Barley 6 (Hull-less). Seeds were sown continuously by hand in 25 cm apart rows. The seed to seed distance was 4 cm. The experiment was laid out in a split-split plot design with 3 replications. The irrigations were assigned in the main plots and the barley variety was assigned in the sub-plots. The unit plot size was 2.5 m X 2 m having a plot to plot distance of o.5 m. Barley was sown in November 16, 2006. Four levels of irrigations were applied, viz., control or no irrigation (I_0), one irrigation at the tillering stage, 30 mm water was applied in total lifespan (I_1), two irrigations, one at the tillering and one at the booting stages, 60 mm water was applied in total lifespan (I_2) and three irrigations, one at the tillering, one at the booting and one at the grain filling stages, 90 mm water was applied in total lifespan (I_3) were given. Growth analysis has been established followed by standard technique for the study of plant growth and development (Radford, 1967 and Hunt, 1978).

RESULTS AND DISCUSSION

Growth parameters: Influence of irrigation level on total dry matter (TDM) of two barley varieties namely, BARI Barley 5 and BARI Barley 6 are shown in Figure 1. Starting from 40 days after sowing (DAS), the highest TDM was recorded in three irrigations (I_3) which was at par with I_2. The lowest TDM was observed in no irrigation (I_0) treatment. TDM varied significantly due to varieties at all the samplings. Between the two varieties, BARI Barley 6 produced higher TDM than BARI Barley 5. Similar results were reported in barley by Rashid *et al.*, 2007. Figure 2 indicated the results of soil moisture regimes on leaf area index (LAI) of two barley varieties at different growth stages. Irrigation levels had significant effect on LAI at all the growth stages except at 20 DAS. LAI increased with increasing levels of irrigation. The highest LAI was observed in three irrigations (I_3) in both the varieties. The lowest LAI was found in rainfed barley crop (I_0). The highest LAI was observed at 60 DAS and continued till 70 DAS and then declined sharply. Soil moisture shortage greatly reduces the leaf area index, which was also supported by Nahar and Paul, 1998. Figure 3 indicated the effects of irrigation level on crop growth rate (CGR) of two barley varieties at different stages of growth. Irrigation levels had significant effects on CGR at all the growth stages except at maturity (90-100 DAS). CGR increased significantly with increasing number of irrigations. The highest CGR was observed in I_3 and the lowest CGR was observed in the rainfed condition (I_0). Irrigated plants extended their luxurious growth up to 70-80 DAS having the highest peak at 60-70 DAS. Similar trend of the effect of irrigation on CGR was also observed by Nahar and Paul (1998) in wheat and Rashid *et al.* (2007) in barley. The patterns of irrigation effects on net assimilation rate (NAR) at different stages of growth are presented in Figures 4. Irrigation levels showed significant effects on NAR at the early stages of plant growth. During these periods, the highest NAR was in two and three irrigations and the lowest was in the control (I_0). At the early and at the later stages of growth, NAR did not differ significantly in both the varieties. Higher NAR was observed in BARI Barley 6 than BARI Barley 5. Increasing soil moisture produced higher NAR in beans (Nerkar *et al.* 1981). The influence of irrigation levels on leaf area ratio (LAR) are presented in Figure 5. Starting from higher values, LAR declined steadily with increasing plant age. It might be due to the abscission of mature and older leaves at the later growing stages. There was a decreasing trend of LAR with increasing irrigation frequencies. With a few exceptions, at every stages of plant growth the highest LAR was observed in the rainfed condition (I_0). Statistically similar LAR was observed in I_2 and I_3. With a few exceptions, BARI Barley 5 produced higher LAR than BARI Barley 6 at most of the growth stages. Nahar and Paul (1998) also observed higher LAR in the rainfed plants. In contrast, Haider *et al.* (2007) observed higher LAR in the irrigated wheat plants. The influences of irrigation level on specific leaf area (SLA) are presented in Figure 6. Starting with higher values, SLA declined gradually with fluctuations. Irrigation level showed significant effects on SLA at most of the growth periods except at 20-30 DAS. Significantly higher SLA was observed in the irrigated crops at the early ages but lower values of SLA were observed in the irrigated plants at the later stages of growth. No clear pattern of varietals effects was found in SLA. Both the cultivars, had generally higher SLA at the early stages of growth but it was lower at the middle stages and had increasing tendency at the later stages in most cases. Rashid *et al.* (2007) observed higher SLA in barley varieties in the irrigated condition. Similar result was observed by Haider *et al.* (2007) in wheat. The decline of SLA with age was reported by Sarker and Paul (1998) in wheat.

Yield and yield components: Most of the yield components such as plant height, number of fertile tillers/plant, number of infertile tillers/plant, number of fertile spikelets/spike, number of infertile spikelets/spike, spike length, extrusion length, 1000-grain weight, straw yield and grain yield varied significantly due to irrigation level (Table 1). The tallest plant was produced by three irrigations (I_3)

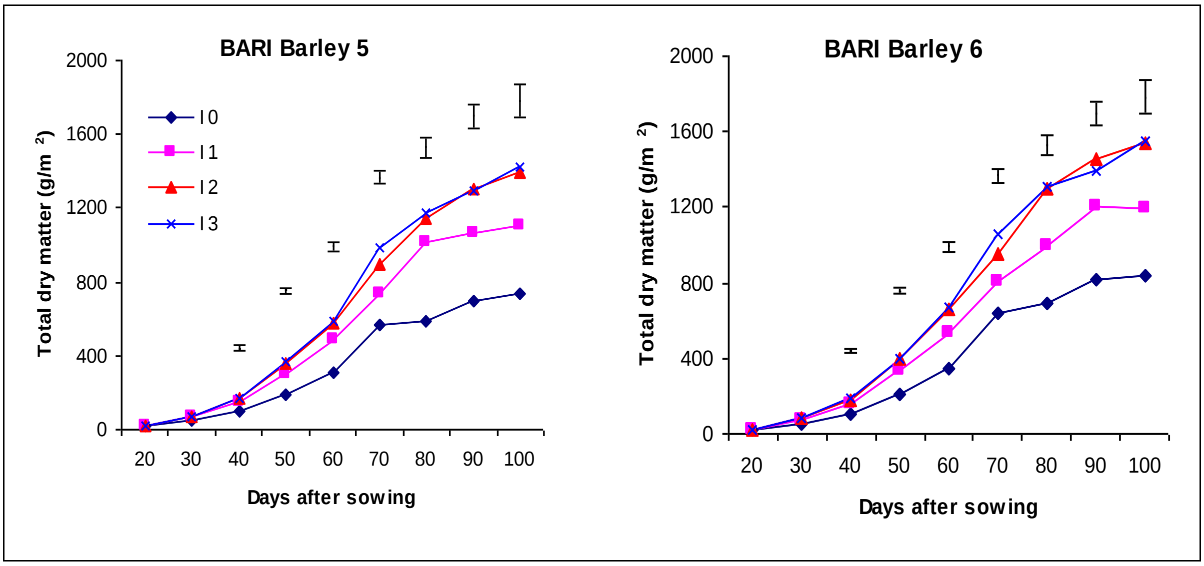

Figure 1. Effect of different irrigation levels on total dry matter (TDM) of two barley varieties at different days after sowing. Vertical bars indicate LSD at 5% level of significance. In figure I 0, I 1, I 2 and I 3 indicated number and frequency of irrigations.

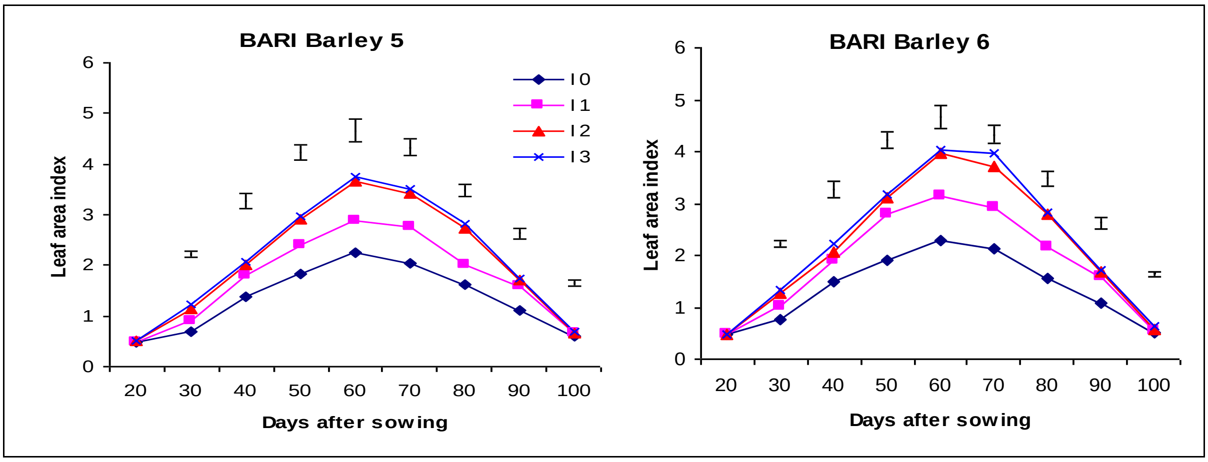

Figure 2. Effect of different irrigation levels on leaf area index (LAI) of two barley varieties at different days after sowing. Vertical bars indicate LSD at 5% level of significance. In figure I 0, I 1, I 2 and I 3 indicated number and frequency of irrigations.

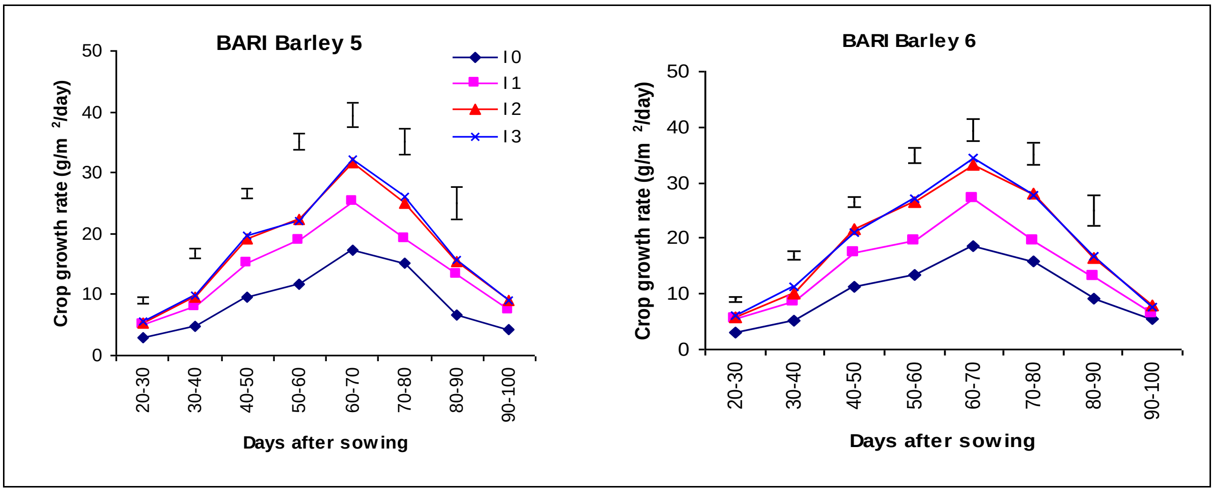

Figure 3. Effect of different irrigation levels on crop growth rate (CGR) of two barley varieties at different days after sowing. Vertical bars indicate LSD at 5% level of significance. In figure I 0, I 1, I 2 and I 3 indicated number and frequency of irrigations.

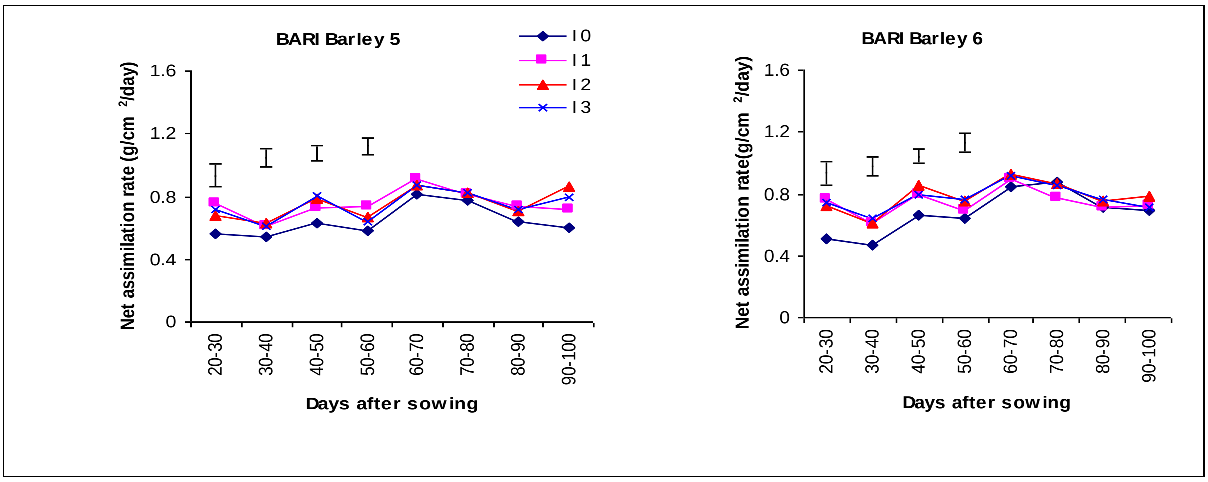

Figure 4. Effect of different irrigation levels on net assimilation rate (NAR) of two barley varieties at different days after sowing. Vertical bars indicate LSD at 5% level of significance. In figure I 0, I 1, I 2 and I 3 indicated number and frequency of irrigations.

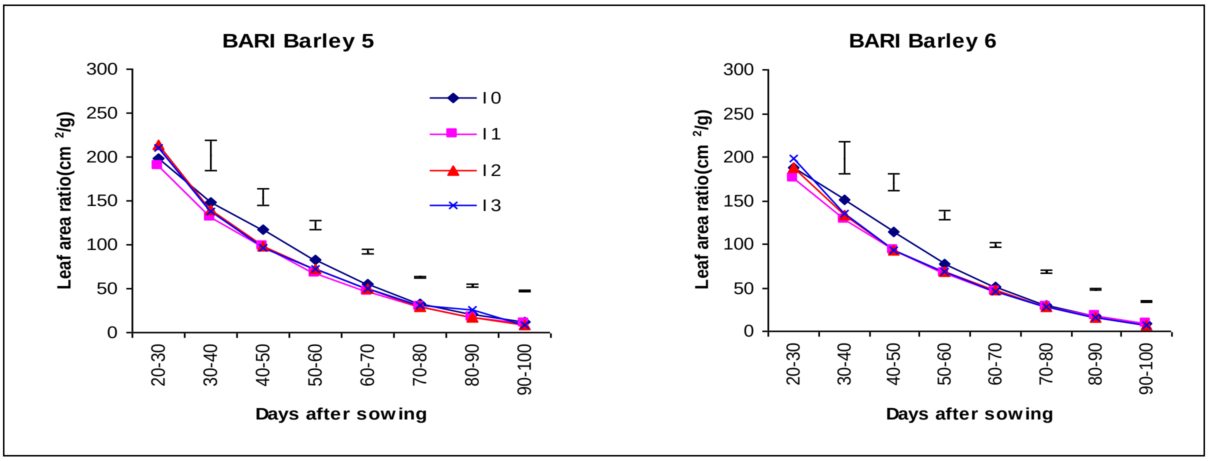

Figure 5. Effect of different irrigation levels on leaf area ratio (LAR) of two barley varieties at different days after sowing.. Vertical bars indicate LSD at 5% level of significance. In figure I 0, I 1, I 2 and I 3 indicated number and frequency of irrigations.

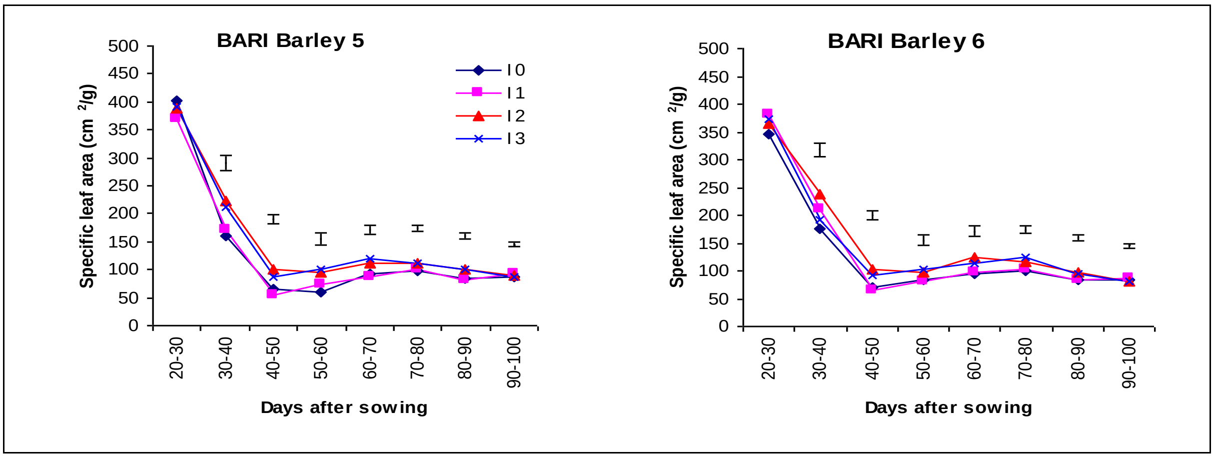

Figure 6. Effect of different irrigation levels on specific leaf area (SLA) of two barley varieties at different days after sowing. Vertical bars indicate LSD at 5% level of significance. In figure I 0, I 1, I 2 and I 3 indicated number and frequency of irrigations.

Table 1. Effect of irrigation level and variety on yield components and grain yield of barley

Treatment	Plant height (cm)	No. of fertile tillers/ plant	No. of infertile tillers/ plant	No. of fertile spikelets/ spike	No. of infertile spikelets/ spike	Spike length (cm)	Extrusion length (cm)	1000-grain wt (g)	Straw yield (kg ha^{-1})	Grain yield (t ha^{-1})
a) Irrigation										
I_0	81.07c	3.33d	1.30a	36.37c	4.24a	16.40c	1.94d	35.34d	6576.57d	1.96d
I_1	89.50b	4.16c	1.19b	40.17b	3.75b	17.86b	2.30c	37.45c	7989.53c	2.69c
I_2	96.01a	4.82b	1.13c	42.88a	3.62b	18.35ab	2.63b	38.68b	9285.03b	3.22b
I_3	98.12a	5.08a	0.93d	44.35a	3.16c	18.79a	3.00a	40.04a	9529.10a	3.40a
b) Variety										
BARI Barley 5	103.09a	3.98b	1.210a	40.81b	3.245b	19.63a	2.81a	41.84a	8280.90b	3.11a
BARI Barley 6	88.37b	5.15a	1.177a	45.167a	4.505a	17.87b	2.37b	37.71b	8736.41a	2.87b
CV (%)	6.99	7.59	7.03	6.97	6.72	6.22	6.44	4.30	12.38	9.05

In a column, values followed by a common letter(s) are not significantly different at 5% level of probability by DMRT.

which was statistically identical to two irrigations (I_2) and the lowest plant height was found in no irrigation (I_0). Between the two varieties, BARI Barley 5 produced taller plant than BARI Barley 6. Significantly higher number of fertile tillers/plant, number of fertile spikelets/spike, spike length, extrusion length,1000-grain weight, straw yield, and grain yield were observed in I_3 followed by I_2 and I_1 and the lowest values were found in the rainfed crops (I_0). Similar results were also found by Hassan *et al.* (1987), Haider (2002), Chaudhury and Sharma (2003), Hamdy *et al.* (2005) and Afzal *et al.* (2006). Only number of infertile tillers/plant and number of infertile spikelets/spike were higher in rainfed crops (I_0). BARI Barley 5 produced significantly higher grain yield than BARI Barley 6 but some yield contributing characters were higher in BARI Barley 6. Higher grain yield in BARI Barley 5 were due to higher individual grain weight (hulled).

CONCLUSION

In the present study, among different irrigation treatments, the three times irrigations (1_3) where 90 mm water was applied at 25, 45 and 65 DAS, exhibited /treated/ as a suitable water management technique for the cultivation of barley during rabi season. Between the two varieties, BARI Barley 5 showed better performance in their growth and yield attributes.

REFERENCES

Afzal A, Ahmad S, Khan A and Amin M. 2006. Comparison of wheat and barley for yield and yield components under different irrigation patterns. Sarhad J. Agric. 22(1): 7-11.

Baheri SF, Javanshir A, Kazemi H and Aharizad S. 2005. The effects of irrigation at different phenological stages on some traits in spring barley genotypes. Iranian J. Agril. Sci. 36(1): 169-176.

Chaudhary T and Sharma DD. 2003. Response of barley (*Hordeum vulgare* L.) to different varieties and irrigation levels. Current Agric. 27(1/2): 139-141.

FAO 2009. Food and Agriculture Organization of the United Nations. pp 5-18.

Haider SA. 2002. Effect of water stress on the physiology and grain yield of four bread wheat (*Triticum aestivum* L.) cultivars. Ph.D. Thesis. Crop Physiology Laboratory, Department of Botany, Rajshahi University. Rajshahi. pp. 71-342.

Haider SA, Alam MZ and Paul NK. 2007. Growth analysis using functional techniques in relation to irrigation in four bread wheat varieties. Plant Environ. Dev. 1(1):37-44.

Hamdy A, Sardo V and Ghanem KAF. 2005. Saline water in supplemental irrigation of wheat and barley under rainfed agriculture. Agril. Water Management. 78 (1/2): 122-127.

Hanson AD and Hitz WD. 1982. Metabolic responses of mesophytes to plant water deficits. Ann. Rev. Plant Physiol. 33:163-203.

Hassan UA, Ogunlela VB and Sinha TD. 1987. Agronomic performance of wheat (*Triticum aestivum* L.) as influenced by moisture stress at various growth stages and seeding rate. J. Agron. & Crop Sci. 3: 172-180.

Hunt RR. 1978. Plant Growth Analysis Studies. *In*: Biology Series No. 96. Edward Arnold Ltd. Bedford Square London. pp. 1-67.

Nahar N and Paul NK. 1998. Growth analysis of wheat genotypes under differing soil moisture regimes. Bangladesh J. Agric. 23: 57-64.

Nerkar YS, Wilson D and Lawes DA. 1981. Genetic variation in stomatal characteristics and behaviour, water use and growth of five *Vicia faba* L. genotypes under contrasting soil moisture regimes. Euphytica. 30: 335-345.

Radford PJ. 1967. Growth analysis formulae-their use and abuse. Crop Sci. 7: 171-175.

Rashid MH, Khalekuzzaman M, Hossain M S, Paul NK and Mollah MSI. 2007. Effect of soil moisture on growth of two varieties of barley *(Hordeum vulgare* L.*)*. Bangladesh J. Environ. Sci. 13(2): 341 – 344.

Rafiq, M, Hussain A, Ahmad A , Basra S, Shah M A and Javed A W. 2005. Effect of irrigation on agronomic traits of wheat (*Triticum aestivum* L.). Int. J. Biol. Biotec. 2(3): 751-759.