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GRAIN GROWTH AND YIELD OF WHEAT UNDER DIFFERENT IRRIGATION REGIMES

S. A. Haider*, M. Z. Alam and N. K. Paul

Crop Physiology Laboratory, Department of Botany
University of Rajshahi, Rajshahi 6205, Bangladesh

Abstract: A field experiment was carried out to study the influence of different irrigation regimes on the panicle and grain growth, relative growth rate of grain, grain abortion, yield and some yield components of four wheat varieties in two growing seasons. Irrigation regimes had significant effects on the aforesaid parameters and the varieties were found to be more efficient under well irrigated conditions. A drastic reduction in panicle and grain growth and yield and increase in grain abortion was noticed when the varieties were grown under rainfed condition. C 306 was found to be the most efficient to have higher values of panicle and grain growth, relative grain growth rate and yield under all the irrigation regimes in both the growing seasons.

Key words: Wheat, irrigation, relative growth rate, grain abortion

mvivsk: M‡gi PviwU f¨vivBwUi kxl Ges `vbvi e„w×, `vbvi Av‡cw¶K e„w× nvi, `vbvi AKvj öjb Ges dj‡bi Dci wewfbœ gvÎvi †mP Gi cfve wbY‡qi Rb¨ `ÕeQi e¨vcx GKwU gvV chv‡qi M‡elYv Kiv n‡qwQj| wewfbœ gvÎvi †m‡Pi cfv‡e Dc‡i DwjwLZ ˆewkó¨¸wji g‡a¨ ZvrchcY cv_K¨ cwijw¶Z n‡qwQj Ges D”P gvÎvi †m‡Pi d‡j f¨vivBwU¸wj AwaK `¶Zv c`kb K‡iwQj| †mPwenxb Ae¯vq f¨vivBwU¸wji kxl I `vbvi e„w×, `vbvi Av‡cw¶K e„w× nvi I djb gvivZ¥Kfv‡e K‡g wM‡qwQj| f¨vivBwU wm 306 Dfq eQ‡iB c‡Z¨K gvÎvi †m‡Pi †¶‡Î kxl I `vbvi e„w×‡Z, `vbvi e„w×i Av‡cw¶K nvi Ges dj‡bi †¶‡Î mewaK `¶Zv cgvb K‡iwQj|

Introduction

Wheat is largely grown in Bangladesh during the period of November-March when stored soil moisture soil moisture is depleted rapidly, especially in the later part of crop growth. As a consequence, the yield of wheat is depressed significantly. In low soil moisture condition, the growth rate of grains determines the grain yield. Yield can be related to the number of flowers produced (Dominguez and Hume 1978) or inversely related to the percentage of total flower and grain abortion (Hardman and Brun 1971). Various environmental factors including soil moisture influence grain abortion and growth of wheat. The present experiment was conducted to study the effects of soil moisture on panicle and grain growth, grain abortion and yield of four bread wheat varieties over two growing seasons.

Materials and Methods

The experiment was carried out in the Botanical Research field of Rajshahi University, Bangladesh with *Triticum aestivum* L. varieties, *e.g.*, Akbar, Opata, Protiva and C 306. The soil of the experimental field was silty loam having a pH of 7.5, low in organic carbon (0.44%), total N (0.43%), available P (15 ppm) and K (82 ppm). The field capacity of the soil was 34% at the beginning and end of the experiment. A basal dose of urea (80 kg ha^{-1}), TSP (60 kg ha^{-1}) and MP (30 kg ha^{-1}) were added to the soil before seeding. The experimental design was a split-split plot with three irrigation treatments (I_0= rainfed, I_1= 10 mm irrigation and I_2= 20 mm irrigation) and three replications in each treatment for every individual variety. The total experimental field was divided into three main plots (treatments). Each plot was again subdivided into three replication plots of 5×3.4 m^2 each containing all the four varieties assorted randomly. Seeds were sown on 15th November, first irrigation treatment was applied at 18 days after sowing and the later were at 15 days interval manually over the I_1 and the I_2 plots. The total amount of water received as irrigation was 0 mm, 50 mm and 100 mm for the I_0, I_1 and I_2 plots respectively.

At 50% anthesis, twenty five plants of each variety from each replication of each treatment were tagged. Two panicles of a variety from 7 days after anthesis (DAA) at an interval of 7 days up to the maturity at final harvest were collected. Weights of panicle and grain were taken after oven-drying at 85^{0}C for 48 hours when a constant weight was obtained. The selection of appropriate polynomial regression model was made by 'lack of fit' method and the functional techniques of growth analysis were followed to obtain the fitted values according to Nicholls and Calder (1973). The percentages of grain abortion for all the replications were also calculated. Six plants/ replication/ treatment/ variety were harvested finally at maturity to determine the yield and yield component characters, e.g., number of spikelet/panicle, grain yield/panicle, 100-seed weight and commercial yield. The total experiment was carried out during the growing seasons of 1998-1999 for the first year and 1999-2000 for the second year.

*Corresponding author: haider_rubd@yahoo.com

Table 1. Yield and yield components at maturity of four wheat varieties as influenced by different irrigation regimes in two seasons.

	First year			Second year		
	I_0	I_1	I_2	I_0	I_1	I_2
Akbar	16.22ab	18.50a	18.06a	17.82c	18.92bc	19.15b
Opata	17.50a	18.24a	18.81a	19.65a	20.78a	20.45a
Protiva	15.88b	16.94b	17.59a	17.73c	18.15c	19.50b
C 306	17.30a	18.96a	18.48a	18.65b	19.33b	19.82ab
Akbar	3.90b	5.94b	6.48a	5.39a	5.92b	6.43a
Opata	3.71b	5.47b	6.28a	4.61b	7.40a	5.37b
Protiva	3.96b	5.41b	6.26a	4.56b	4.15c	4.71c
C 306	5.47a	6.89a	7.13a	4.50b	5.72b	6.90a
Akbar	4.12a	4.17a	4.20a	4.39a	4.52a	4.31a
Opata	2.80c	3.05c	3.14b	3.41b	3.55b	3.38b
Protiva	3.66b	3.83ab	4.02a	4.31a	4.37a	4.31a
C 306	3.74ab	3.54b	3.91a	4.28a	4.36a	4.09ab
Commercial yield (kg ha^{-1})						
Akbar	3901b	5940b	6476a	5386a	5916a	6433b
Opata	3708b	5465b	6278a	4605b	5656b	5373c
Protiva	3960b	5415b	6263a	4560b	4146c	4705d
C 306	5473a	6886a	7133a	4498b	5720b	6895a

In a column, means followed by a common letter are not significantly different at 5% level by Duncan's Multiple Range Test.

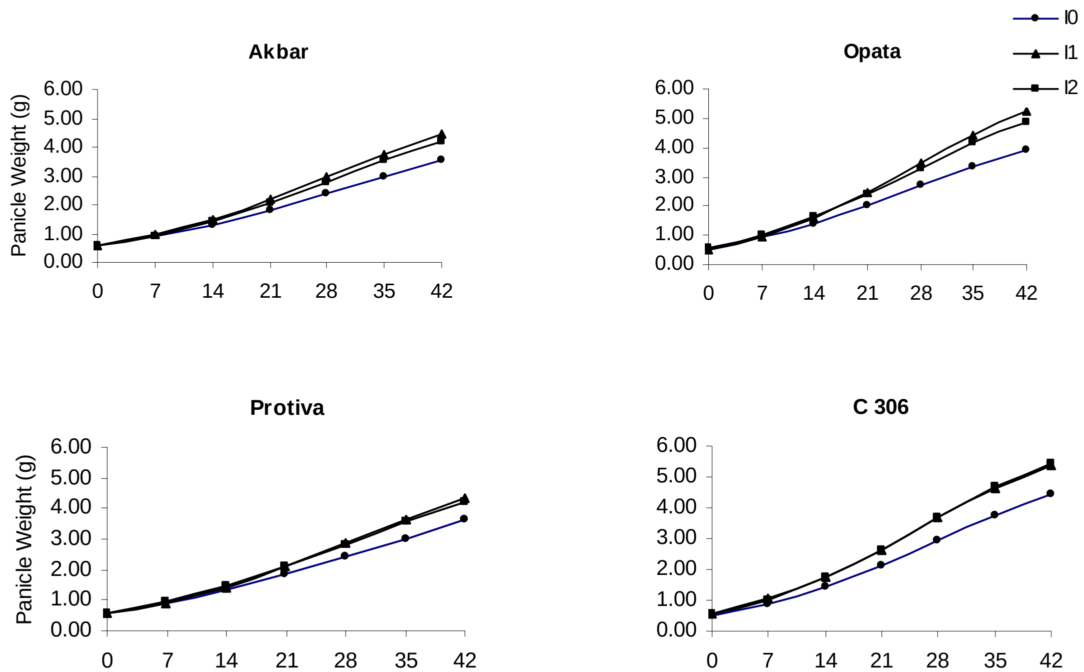
Results and Discussion

Influence of different irrigation regimes on panicle growth is shown in Figures 1a and 1b for the first and the second year, respectively. Starting from a lower value, panicle weight increased with time. Irrigation regimes had significant effect on panicle growth from 21 DAA onwards in almost all occasions and the rainfed treatment (I_0) resulted in the lowest panicle weight in all four varieties in both seasons. The I_2 plants had the highest value of panicle weight in all occasions except Akbar and Opata in the first year and Protiva in the second year. Significantly higher panicle weight was found in C 306 and lower in Akbar in both the growing seasons. Panicle weight was reduced under rainfed condition and this result was in agreement with that of Nicolas *et al.* (1985) and Rahman and Paul (1996).

Increase in grain weight per panicle of four wheat varieties at successive stages of growth is presented in Figures 2a and 2b for the first and the second year, respectively. Significant effect of irrigation on grain growth was noticed and the rainfed condition resulted in reduced grain growth in all the varieties. According to Evans and Wardlaw (1976), the number of grains that develop in a panicle of wheat is dependent on the number of florets and the effective fertilization of them after anthesis. It has been reported that grain weight per panicle is dependent on the number of grains and its size and shape (Amin *et al.* 1995). Water stress during grain filling has a detrimental effect on panicle weight and subsequently grain yield through a shortening of the grain filling duration (Bagga and Rawson 1977). Lalonde *et al.* (1997) reported that water stress during meiosis in microspore mother cells of wheat induced male sterility which resulted in reduced grain yield. The highest grain weight per panicle was found in the I_2 plants in all the varieties for both the growing seasons and it was followed by the I_1 and I_0 plants. The differences in grain weight per panicle between the varieties within the treatment and between treatments within variety were significant in all occasions in both the growing seasons. C 306 had the highest grain weight per panicle in each treatment for both the growing seasons.

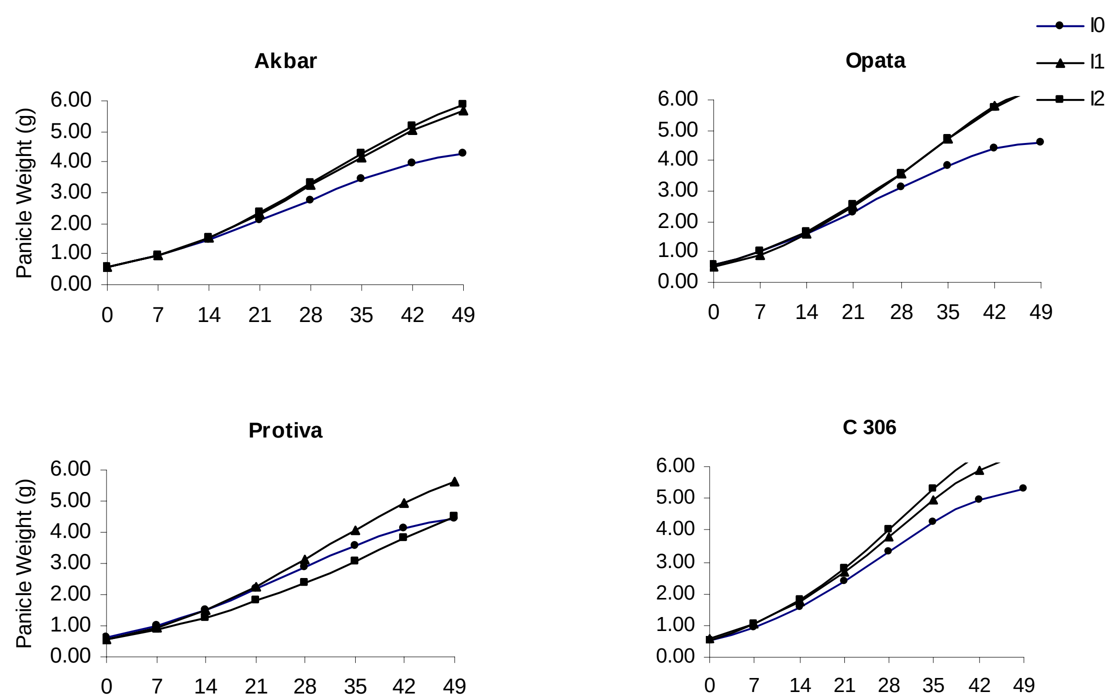
Irrigation effects on relative growth rate (RGR) of grain calculated from the quadratic fitted values are shown in Figs 3a and 3b. Higher RGR of all the varieties was noticed at the early stages and then declined with increasing plant age for all the irrigation regimes. Continuous reduction is a common response among the wheat varieties due to abiotic stresses (Ford 1976 and Kolderup 1979). The reason for higher prematurity of grains in the I_0 plants might be due to the water shortage during the three or four weeks after flowering and water stress along with high temperature at the grain developing stages resulted in decreasing RGR of grain and this result is similar to Nass *et al.* (1975) and Sairam *et al.* (1992).

Higher grain abortion was noticed at the early stages of the reproductive phase and decreased at the later stages of grain growth with moderate fluctuations (Figs 4a and 4b). Irrigation regimes had significant effect on grain abortion and the I_0 plants had the highest rate, followed by I_1 and I_2 plants for all the varieties in both years. Grain abortion remained higher up to 28 DAA. The highest rate of grain abortion was found in Akbar at 21 DAA over all irrigation regimes and C 306 had the least effect of irrigation on grain abortion. Higher grain abortion percentage due to water stress was also reported by Rahman and Paul (1996) in wheat.



Days after anthesis

Fig. 1a. Panicle growth of four wheat varieties as affected by different irrigation regimes (First year)



Days after anthesis

Fig. 1b. Panicle growth of four wheat varieties as affected by different irrigation regimes (Second year).

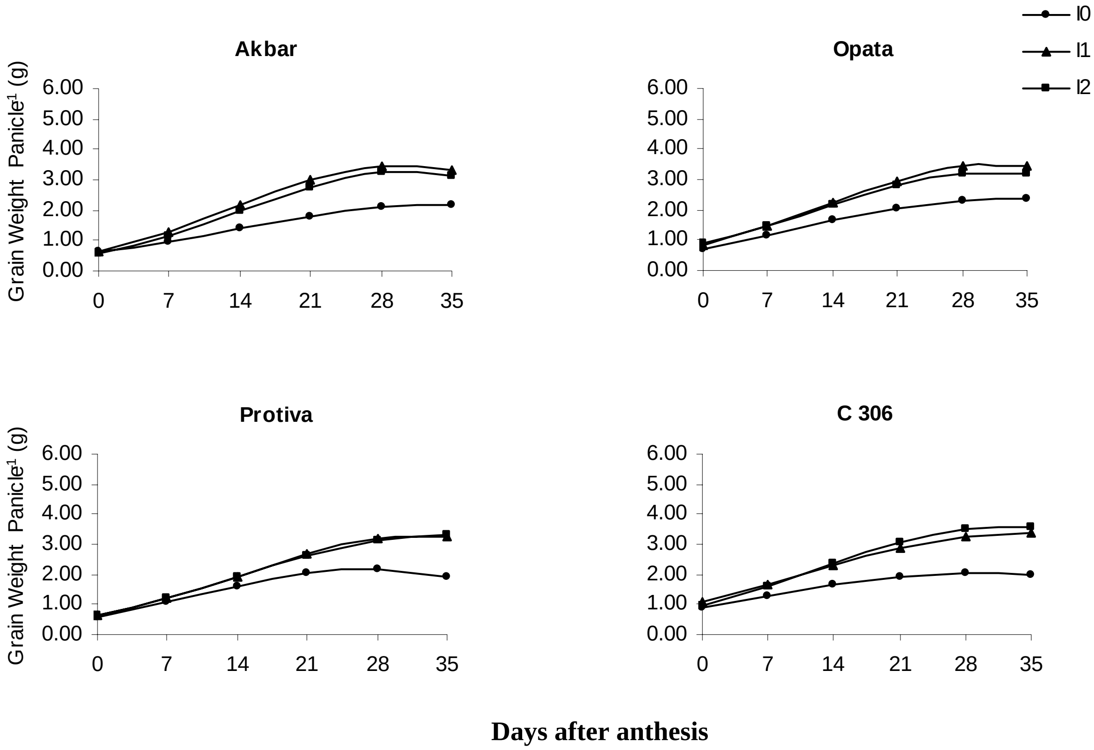


Fig. 2a. Grain growth of four wheat varieties as affected by different irrigation regimes (First year).

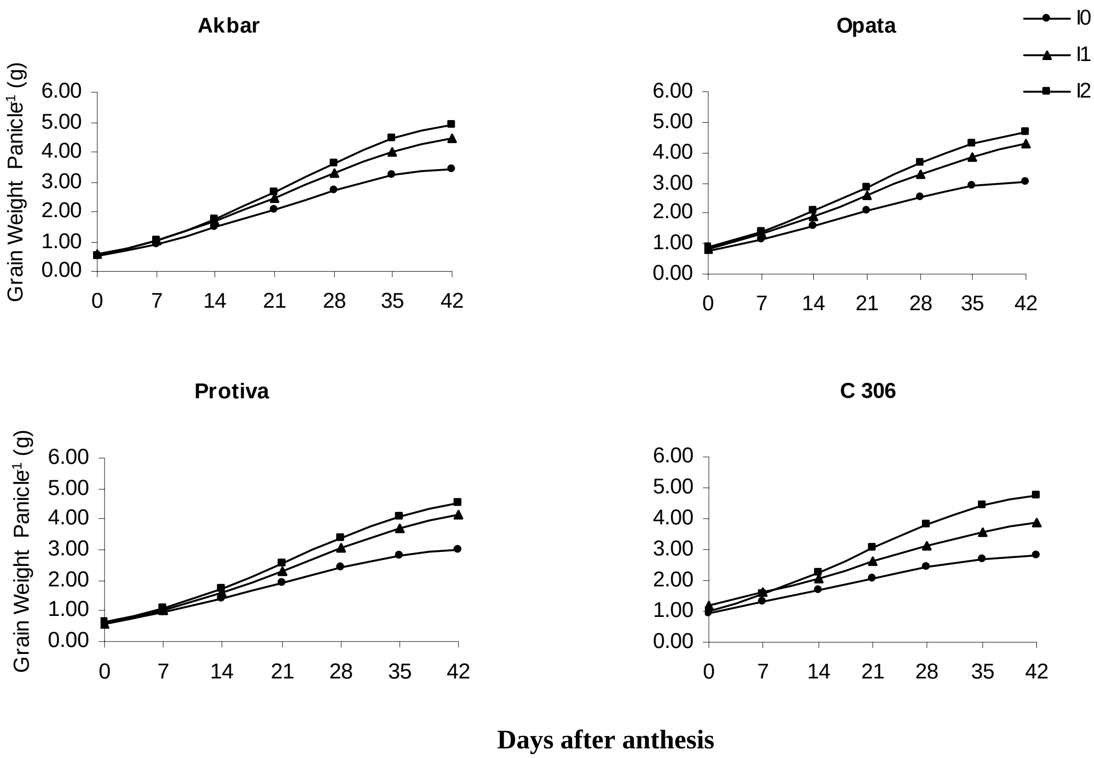
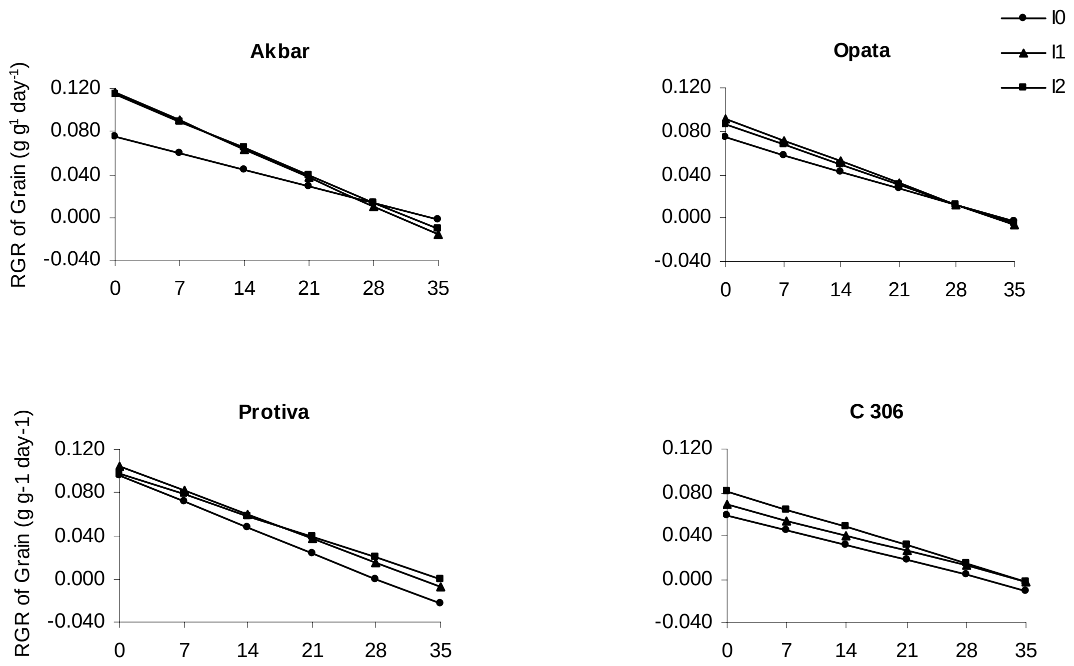
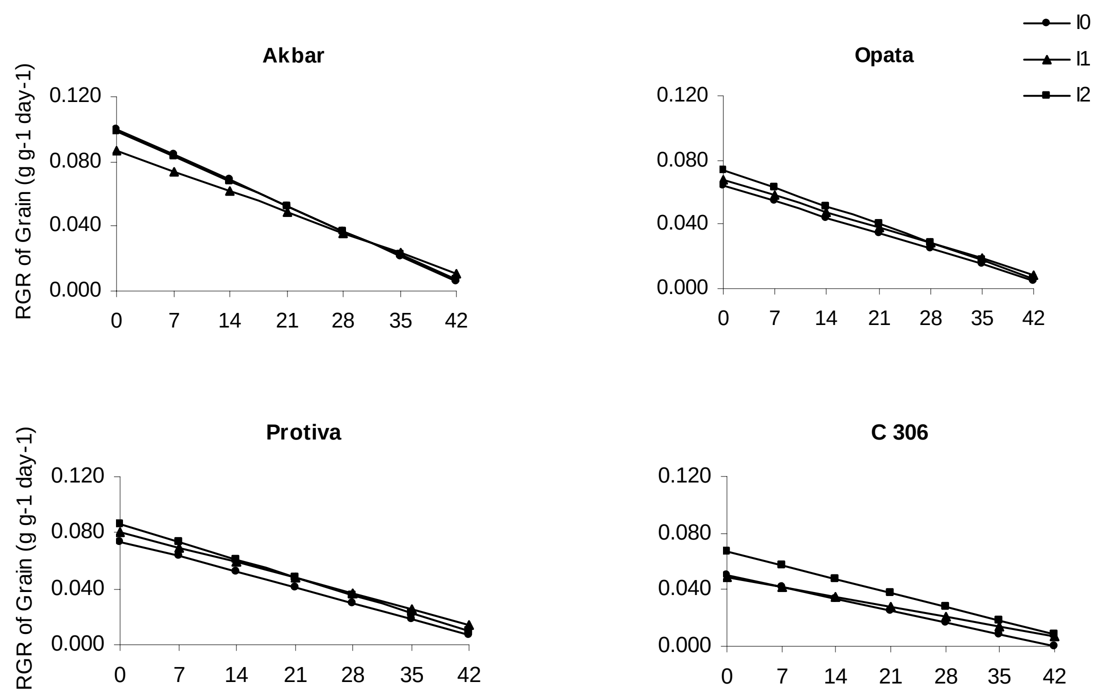


Fig. 2b. Grain growth of four wheat varieties as affected by different irrigation regimes (Second year).



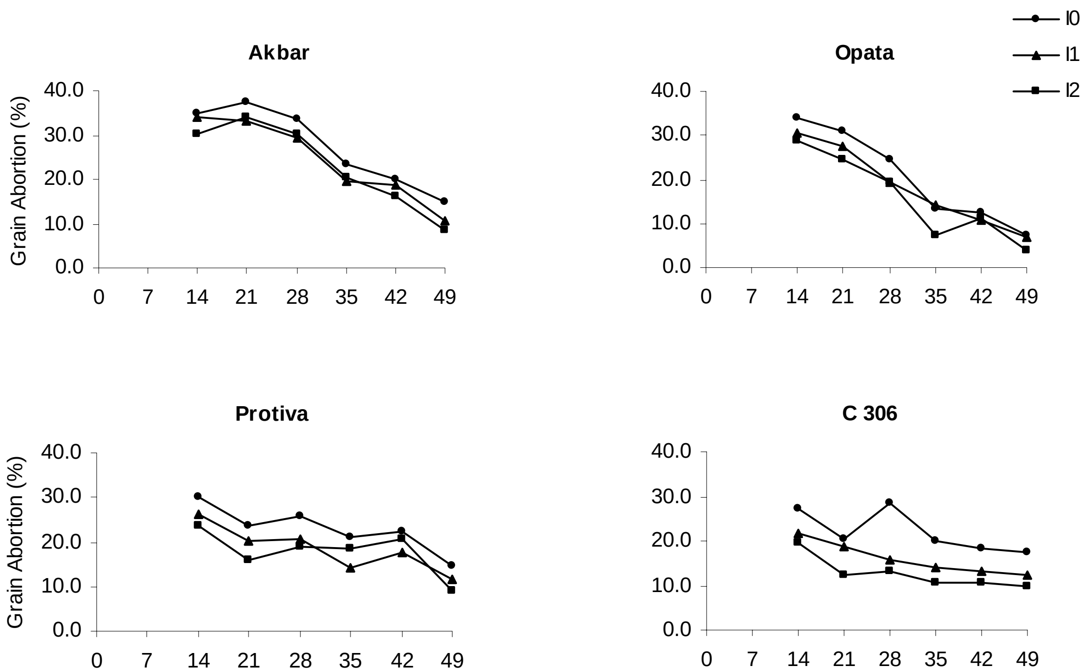
Days after anthesis

Fig. 3a. Relative growth rate of grain of four wheat varieties as affected by different irrigation regimes (First year).



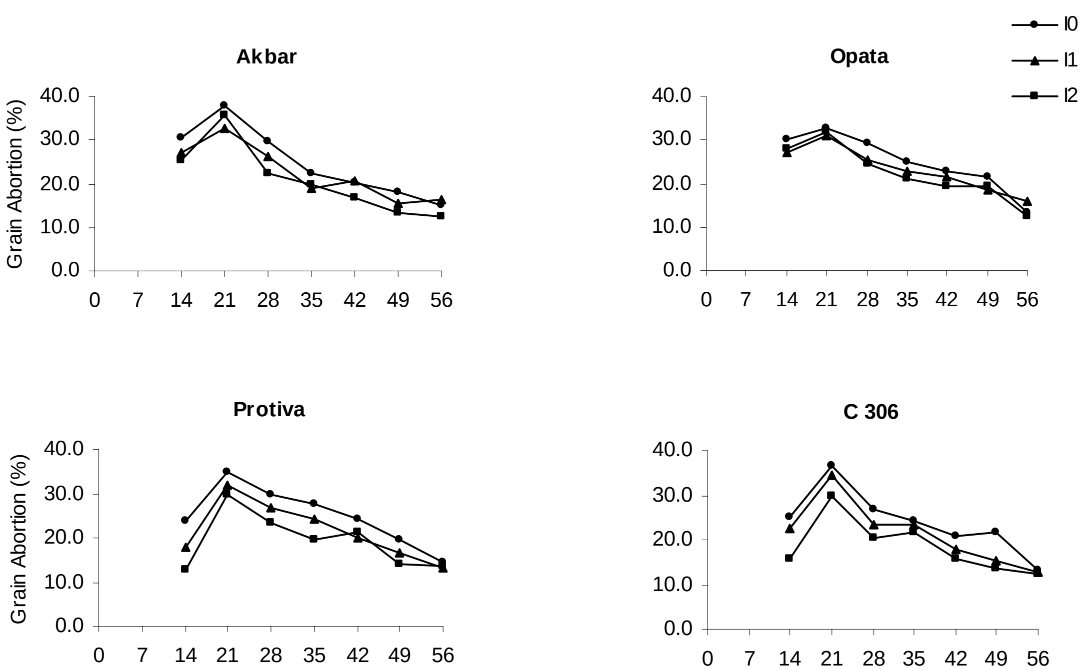
Days after anthesis

Fig. 3b. Relative growth rate of grain of four wheat varieties as affected by different irrigation regimes (Second year).



Days after anthesis

Fig. 4a. Grain abortion of four wheat varieties as affected by different irrigation regimes (First year).



Days after anthesis

Fig. 4b. Grain abortion of four wheat varieties as affected by different irrigation regimes (Second year).

Grain yield and some yield components were significantly affected by water stress in the present study (Table 1). Number of spikelets per panicle, grain yield per plant, 100-seed weight and commercial yield of all the four varieties were noticed to be higher in the well-irrigated I_2 plants. Reduction in yield and yield components due to water stress was also reported in wheat by many workers (Rahman and Paul 1998; Destro *et al.* 2001; Guttieri *et al.* 2001). Different varieties responded differently under each irrigation regimes and C 306 was found to have higher values of different yield components than the other three varieties. Significant differences in yield were noticed between varieties within treatment and the lowest yield was found in Protiva under each irrigation regimes in most cases.

Conclusion

Water stress may affect every stage of plant growth and physiology, especially the reproductive phase. The effect of water stress is mainly related to the hastening of reproductive development and shortening of the developmental phases during which the various components of yield are determined. Rainfed condition decreased panicle and grain growth and relative growth rate of grain along with yield and some yield components and increased grain abortion. C 306 was found to be an efficient wheat variety which may be grown in the areas where irrigation facilities are limited to obtain satisfactory growth and yield.

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