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Influence of Irrigation and Nitrogen Level on the Yield of Wheat

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Abstract: An experiment was conducted during the period from November 2001 to April 2002 to determine the optimum irrigation time and nitrogen level of wheat. Highest grain yield (3.71 t ha^{-1}) was obtained with three irrigations at crown-root initiations (CRI)+maximum tillering (MT)+grain filling (GF) stages which was identical with two irrigations at crown-root initiations (CRI)+maximum tillering (MT) stages and at crown-root initiations (CRI)+grain filling stages. The highest grain yield (3.61 t ha^{-1}) was obtained from 120 kg N ha^{-1} which was followed by 100 kg N ha^{-1} treatment and the lowest grain yield (2.81 t ha^{-1}) was recorded under 40 kg N ha^{-1} treatment. No significant effect was observed on yield due to interaction of irrigation and nitrogen level. The highest grain yield (4.33 t ha^{-1}) was found by three irrigation at crown-root initiations (CRI)+maximum tillering (MT)+grain filling (GF) with 120 kg N ha^{-1}. However, grain yield of wheat was significantly influenced by irrigation and nitrogen level but not due to interaction of irrigation and nitrogen level.

Key words: Irrigation, nitrogen level, yield, wheat

INTRODUCTION

Wheat is the second major cereal crop of Bangladesh but first both in area and production among the grain crops of the world[1].Wheat grain is used as food for men and feed for animals. Bangladesh facing acute food shortage for long time due to high population pressure. It is necessary to produce more and more food to achieve the goal of self sufficiency in food. Increasing production per unit area is the only way to minimize the food deficit by applying modern cultivation knowledge and technology in Bangladesh. Wheat yield and production are less than other countries due to proper water and nitrogen fertilizer management. Specially the farmers have no attention to the irrigation schedule and nitrogen application rates. Wheat yield was reduced by 50% due to soil moisture stress[2]. Number of irrigation also influences on the yield of wheat[3]. It has been observed that water requirement of a crop varies with the stage of its growth. Under limited water supply the critical growth stages are taken into account for irrigation schedule. The critical growth stages are most sensitive to shortage of water and the yield of the crop is reduced drastically of the crop is not irrigated at these stages. The application of irrigation at all the critical stages significantly increased the grain yield of wheat over control[4]. The critical growth stages are different for different crops[5]. The importance of available soil nitrogen to wheat crop has been recognised. Rate of N application has a influence on growth, development and yield of wheat[6]. Not only may the acre yield be greatly influenced but also the protein content of the grain. The wheat best for flour milling are high in protein. The yield grain due to irrigation was confounded by increased nitrogen usages[7]. High availability of nitrogen during the reproductive stages of growth are necessary for a high protein grain. Therefore the present experiment was conducted to find out the influence of irrigation and different levels of nitrogen on the yield of wheat.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Farm, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh during the period from November 2001 to April 2002 to find out the optimum time of irrigation and nitrogen level of wheat. The soil of the experimental site was sandy loam with pH value of 6.5 to 7.5. Organic matter content was moderate and general fertility was low[8]. The experiment was laid out in split-plot design with three replication. Keeping four irrigation treatments in main plots and five nitrogen levels in sub-plots. The irrigations schedules treatments were as follows: I_1 = crown-root initiations (CRI), I_2 = crown-root

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initiations (CRI)+maximum tillering (MT), I_3 = crown-root initiations (CRI)+ grain filling (GF) stages and I_4 = crown-root initiations (CRI)+maximum tillering (MT)+grain filling (GF) stages. The five nitrogen levels were N_1, N_2, N_3, N_4 and N_5 application of nitrogen @ 40, 60, 80, 100 and 120 kg N ha^{-1}, respectively. The unit plot size was 4.0x2.5 m. Kanchon cultivar of wheat was used as materials for the study. Seed was sown on 20 November in 20 cm apart rows using a seed rate of 120 kg ha^{-1}. The crop was fertilized with half of nitrogen as per schedule of the experiment along with 60 kg P_2O_5, 40 kg K_2O ha^{-1} through urea, TSP and MP, respectively were at the time of sowing. Remaining half of nitrogen was top dressed at the time of first irrigation at Critical Root Initiation (CRI) stage. Before harvesting 10 sample plants were selected randomly from each plot and data were recorded on plant height, tiller per plant, fertile tiller per plant, spikelets per spike, grain per spike, 1000 grain weight, grain yield and straw yield. The collected data were analyzed statistically and the significance of the mean differences was adjusted by the Duncan's New Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effect of irrigation: Number of total tiller and fertile tiller per plant significantly increased by variation in irrigation time. Maximum number of fertile tiller per plant (4.93) was obtained in three irrigation at crown-root initiations (CRI)+maximum tillering (MT)+grain filling (GF) stages (Table 1). Similar result was found by Rahman[9]. Number of spikelets per spike (30.94) and number of filled grain (30.24) per spike were maximum with three irrigations at crown-root initiations (CRI)+maximum tillering (MT)+grain filling (GF) stages (Table 1). Kushta and Raghu[10] also reported similar result in wheat. The maximum plant height (99.98 cm) was observed by I_4 and the lowest plant height (93.78 cm) was found from I_1 irrigation. This result is in consistent with that of Shahidullh[11]. Highest 1000 grain weight (53.17 g) was found under I_4 treatment which followed by I_2, I_3 treatment and the lowest 1000 grain weight (51.90 g) was obtained from I_1. Highest grain yield (3.71 t ha^{-1}) was obtained with three irrigations at crown-root initiations (CRI)+maximum tillering (MT)+grain filling (GF) stages followed by two irrigations at crown-root initiations (CRI)+maximum tillering (MT) and crown-root initiations (CRI)+ grain filling (GF) stages (Table 1). Similar response was found by Pal *et al.*[12] and Eunus *et al.*[13]. This best yield was supported by the yield contributing characters such as number of effective tillers per plant, number of grains per spike and 1000 grain weight.

Straw yield increased with increasing irrigation. Maximum straw yield (7.24 t ha^{-1}) was obtained from I_4 irrigation and lowest straw yield (5.13 t ha^{-1}) from I_1. Similar findings were also reported by Shamsuddin *et al.*[14]. The response of straw yield showed similar trend as in grain yield due to the better response of plant height and total number of tiller per plant.

Effect of nitrogen level: Plant height increased gradually with the increased level of nitrogen from 0-120 kg ha^{-1}. Highest plant height (97.88 cm) was obtained from 100 kg N ha^{-1} (Table 1). Similar result was found by Gami *et al.*[15]. The highest number of tiller per plant (5.80), spikelet per spike (31.94), filled grain per spike (32.22) were obtained from 120 kg N ha^{-1} (N_5) treatment. The results are agree with the Malik *et al.*[6] and Singh *et al.*[16]. Highest 1000 grain weight (52.00 g) in 120 kg N ha^{-1} treatment which statistically similar to 60, 80 and 100 kg N ha^{-1}, respectively. Similar result was showed by Malik *et al.*[6]. Minimum 1000 grain weight (50.46 g) was obtained from 40 kg N ha^{-1} (N_3). The highest grain yield (3.61 t ha^{-1}) was found from 120 kg N ha^{-1} which was statistically similar to 100 kg N ha^{-1}. This result was supported by Malik *et al.*[6] The lowest grain yield (2.81 t ha^{-1}) was recorded under 40 kg N ha^{-1} (N_1) treatment.

Table 1: Effect of irrigation and nitrogen level on the yield and yield contributing characteristics of wheat

Treatments	Plant height (cm)	Tiller/plant	Effective tiller/plant	Spikelet/spike	Grain/spike	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Irrigation								
I_1	93.78b	4.62c	3.54c	25.52c	24.56	51.90b	2.60b	5.13c
I_2	96.43ab	5.02b	4.16b	28.16b	27.23	52.2ab	3.07ab	6.75ab
I_3	97.59ab	5.50a	4.88a	30.36a	30.07	53.01a	3.36a	6.93b
I_4	99.98a	5.58a	4.93a	30.94a	30.24	53.17a	3.71a	7.24a
CV (%)	4.59	6.36	9.34	21.22	22.11	2.59	21.89	8.97
Nitrogen level								
N_1	95.18c	4.53d	3.81d	25.37c	25.57c	50.46b	2.81c	6.23
N_2	96.50b	4.72d	4.17c	28.28b	28.39b	52.17a	2.97bc	6.55
N_3	97.68a	5.16c	4.42bc	18.44b	28.45b	51.71a	3.14b	6.31
N_4	97.88a	5.51b	4.63ab	29.69ab	30.60ab	51.59a	3.43a	6.56
N_5	97.45a	5.80a	4.77a	31.94a	32.22a	52.00a	3.61a	6.12
CV (%)	3.78	5.51	6.34	10.50	9.41	2.51	9.65	8.19

In a column, means having similar letter(s) do not differ significantly at 5% level of probability

Table 2: Interaction effect of irrigation and nitrogen level on the yield and yield contributing characteristics of wheat

Treatments	Plant height (cm)	Tiller/plant	Effective tiller/plant	Spikelet/spike	Grain/spike	1000 grain weight (g)	Grain yield (t ha $^{-1}$)	Straw yield (t ha $^{-1}$)
I_1N_1	92.62	4.26h	3.41i	25.02	24.16	50.40	2.21	4.91
I_1N_2	96.23	4.39gh	3.42i	25.82	24.59	52.12	2.41	5.23
I_1N_3	93.32	4.52f-h	3.53hi	27.12	26.17	52.38	2.65	4.91
I_1N_4	94.06	4.89efg	3.61g-I	27.58	26.63	52.88	3.02	5.42
I_1N_5	92.80	4.94f-h	3.81e-I	27.11	26.28	51.78	2.79	5.13
I_2N_1	98.46	4.56f-h	3.74f-I	26.81	25.90	52.53	2.57	6.35
I_2N_2	98.69	4.54ef	4.11d-g	29.68	29.03	52.72	2.92	7.08
I_2N_3	100.21	5.02c-e	4.11d-g	28.67	27.61	52.13	3.09	6.63
I_2N_4	100.01	5.22b-d	4.40d	28.03	27.06	51.79	3.44	6.96
I_2N_5	96.18	5.71ef-h	4.51cd	32.66	31.62	52.39	3.41	6.67
I_3N_1	92.65	4.73de	4.17d-f	27.64	26.89	52.01	3.12	6.88
I_3N_2	97.43	5.24de	4.93bc	30.34	29.50	53.69	3.12	6.43
I_3N_3	98.89	5.24de	5.01bc	31.78	31.31	53.27	3.30	5.95
I_3N_4	100.29	6.73a	5.12b	32.43	34.58	52.32	3.47	6.70
I_3N_5	97.67	5.52b	5.71a	34.68	34.13	53.84	3.89	5.67
I_4N_1	96.66	4.7e-h	4.01d-g	26.02	25.27	51.02	3.41	6.83
I_4N_2	93.61	6.76a	4.26de	31.34	30.40	54.27	3.48	7.48
I_4N_3	98.42	6.41ab	5.00bc	30.24	29.67	53.16	3.55	7.67
I_4N_4	102.11	6.21b	5.32ab	24.78	34.10	53.43	3.82	7.27
I_4N_5	102.03	6.01b	5.11b	37.38	36.83	54.03	4.33	6.97
CV (%)	3.78	5.51	6.34	10.50	9.41	2.51	9.65	8.19

In a column, means having similar letter(s) do not differ significantly at 5% level of probability

Interactoin effect of irrigation and nitrogen level: The interaction effect of irrigation and nitrogen level had a significant influence on the number of tiller per plant and the number of effective tiller per plant but on plant height, number of spikelet per spike, filled grain per spike, 1000 grain weight, grain yield and straw yield were not statistically significant (Table 2). The highest grain yield (4.33 t ha^{-1}) was produced by I_4N_5 and the lowest yield (2.21 t ha^{-1}) obtained from I_1N_1. Grain yield was not significantly affected by the interaction of irrigation and nitrogen level. Similar result was found by Malik *et al.*[6].

It was concluded that grain yield of wheat was significantly influenced by irrigation and nitrogen level but not due to interaction of irrigation and nitrogen level. Maximum grain yield was obtained from three irrigation at crown root initiations (CSI)+Maximum tillering (MT)+ Grain filling (GF) stages with 120 kg N ha $^{-1}$.

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