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INFLUENCE OF IRRIGATION, FERTILIZER AND VARIETY ON GRAIN GROWTH OF BARLEY (*HORDEUM VULGARE* L.)

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Abstract

An experiment was conducted in the experimental field of Rajshahi University Campus (AEZ-11) to study the influence of soil moisture and NPK fertilizers on grain growth of four varieties of barley (*Hordeum velgare* L.). Spikelet number (SN), spike dry weight (SDW), grain number (GN), grain dry weight (GDW), spike relative growth rate (spike RGR) and grain relative growth rate (grain RGR) were observed highest in the highest level of irrigation (40 mm) . The highest amount of fertilizer (120N 75P 45K) produced the highest SN, SDW, GN, GDW, spike RGR and grain RGR. BHL-3 produced the highest SN, BARI Barley-2 produced the highest spike RGR, BARI Barley-1 produced the highest grain RGR and BL-1 produced the highest SDW, GN, and GDW.

Key words: *Irrigation, soil moisture, fertilizers, barley, grain growth.*

Introduction

As an important cereal crop, barley is cultivated successfully in a wider range of climate of all over the world. In Bangladesh, it is grown in some areas, mainly in the northern parts, as a rabi crop. It ranks third after rice and wheat as supplementary food and fodder crops of Bangladesh (FAO 2002). Barley is used for direct human consumption, animal feed, poultry feed, malt extract for manufacture of beverages, human food in the form of parched grain, pearled grain for soap, flour for bread, and partly ground grain as porridge. People from Bangladesh and India prefer barley as flour with molasses, milk or ripe mango as well as chapati made by mixing barley and wheat flour. It is a staple food in the mountainous areas of Afganistan, India and Nepal. The area and production of barley for the fiscal year 1991-92 were 40000 acres and 10000 tons, respectively whereas it was 3000 acres and 1000 tons in 2004-2005, respectively (BBS 2005). Barley though a minor crop, can play an important role in enhancing the food security of the country. But the productivity of this crop is very low compared to that of many other countries. Lack of irrigation facilities, increased cost of irrigation and fertilizers, lack of stress tolerant high yielding varieties are responsible for this. Moreover, farmers of this country use different fertilizers indiscriminately without adequate information concerning actual soil requirements and these results in over or under application. A clear understanding on use of different doses of NPK fertilizers and their utilization efficiency are pre-requisite to avoid indiscriminate use of fertilizers.

Very little work has been done in Bangladesh to develop a package of improved management practices required to achieve higher yield of this cereal crop. Thus, the present experiment was undertaken to find out the effect of soil moisture and NPK fertilizers on grain growth of four varieties of barley.

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Materials and Methods

The experiment was conducted in the experimental field of Rajshahi University campus (AEZ-11) during from November 2004 to March 2005 with four barley varieties, BARI Barley-1, BARI Barley-2, BHL-3 and BL-1. The soil of the field was silty loam, having pH 7.5 as well as 35% of field capacity. The experiment was arranged in split-split plot design with three replications. Each replicated field was divided into three main plots for irrigation treatment. Each main plot divided into four sub-plots for varieties of barley. Three levels of irrigation treatments (0, 20, and 40 mm as I_0, I_1 and I_2 respectively) were adopted at every 30 day's interval for three times during the growing period. Four levels of NPK used (kg /ha) for N as urea were 0, 40, 80 and 120; for P as TSP were 0, 25, 50 and 75 and lastly for K as MP were 0, 15, 30 and 45. These basal doses of fertilizers were applied as F_0, F_1, F_2 and F_3 at each split plot before sowing. Each split plot size was 4 m? 1.8 m, i.e., 7.2 m? having a plot to plot distance 1m to the North-South, 2 m to East –West, replication to replication distance 2 m, row to row 20 cm, and plant to plant 5 cm. Necessary intercultural operations were adopted, but no fungicides or insecticides were used. At equal intervals of seven days after anthesis (DAA), five grain harvests were done for grain growth analysis. For this, main spike plant^{-1} treatment^{-1} variety^{-1} replication^{-1} was selected, tagged with identifying marks to collect them at 7, 14, 21, 28 and 35 DAA. At each harvest, the spikes were packed separately in labelled paper bags and were oven dried for 72 hours at 85°C. Various components of grain growth analysis were spikelet number (SN), spike dry weight (SDW), grain number (GN) and grain dry weight (GDW). Grain growth parameters were spike relative growth rate (spike RGR) and grain relative growth rate (grain RGR) determined from between two successive harvests of spike and grain growth stages by using the following formulae according to the classical technique of growth analysis (Radford 1967).

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

where, W_2 and W_1 are the spike or grain dry weights per spike (main tiller) at the later (t_2) and the former (t_1) grain growth harvest, respectively. Statistical analysis was done according to Gomez and Gomez (1984).

Results and Discussion

Irrigation increased the number of spikelets spike^{-1}, thus the I_2 treatment produced the highest spikelet number (Table 1). The lowest spikelet number was produced by the non-irrigated plants. This result is corroborated with Okuyama and Igarashi (1990), Rahman *et al*.(2001), Haider (2002) and Rahman (2004) in wheat. Irrigated plants had higher SDW than the rainfed plants. Rahman and Paul (1998) noticed similar findings in wheat. The highest GN spike^{-1} was in the irrigated plants (I_2 treatment). Similar results were reported by Labuschagne and Van-Deventer (1992) and Rahman (2004) in wheat. The highest GDW was in the I_2 treatment and the lowest was in the control. Similar results were also stated by Machodo and Paulsen (2001), Haider (2002) and Rahman (2004) in wheat. Rainfed condition resulted in the lowest RGR of spike. I_2 treatment had the highest RGR of spike at the first harvest interval. Higher grain RGR was in the irrigated plants than in the rainfed plants. The highest grain RGR was in the I_2 treatment. This result is in agreement with Haider (2002) in wheat.

Table 1. Influence of irrigation on mean values of spikelet number,spike dry weight (g), grain number, grain dry weight (g), spike RGR (gg^{-1} day^{-1}) and grain RGR (gg^{-1} day^{-1}) at different days after anthesis.

Days After Anthesis (DAA)							Days After Anthesis (DAA)				
	07	14	21	28	35		07	14	21	28	35
Spikelet number							Spike dry weight (g)				
I_0	45.438	45.531	45.531	45.531	45.531		0.593	0.888	1.071	1.288	1.514
	48.156	48.156	48.156	48.156	48.156		0.649	1.072	1.357	1.775	2.195
I_2	48.156	48.156	50.219	50.219	50.219		0.649	1.072	1.455	2.268	2.712
SD (5%)	0.124	0.188	0.459	0.124	0.124		0.001	0.006	0.052	0.008	0.061
Grain number							Grain dry weight (g)				
I_0	29.719	28.344	25.563	24.063	24.063		0.335	0.459	0.549	0.637	0.799
I_1	35.063	33.188	30.406	28.750	28.750		0.422	0.526	0.616	0.764	0.986
I_2	35.063	32.813	34.406	32.938	32.938		0.422	0.526	0.800	0.984	1.199
SD (5%)	0.617	0.524	0.585	0.810	0.810		0.003	0.002	0.016	0.018	0.004
	07-14	14-21	21-28	28-35			07-14	14-21	21-28	28-35	
Spike RGR (gg^{-1} day^{-1})							Grain RGR (gg^{-1} day^{-1})				
I_0	0.056	0.029	0.028	0.025			0.044	0.026	0.020	0.030	
I_1	0.068	0.035	0.043	0.033			0.031	0.025	0.027	0.039	
I_2	0.068	0.045	0.068	0.028			0.031	0.064	0.025	0.030	
SD (5%)	0.0031	0.0051	0.0031	0.0031			0.0003	0.0004	0.0021	0.0026	

Fertilized plants produced higher number of spikelets $spike^{-1}$ than that of non-fertilized plants (Table 2). F_3 treatment produced the highest SN as SN $spike^{-1}$ increased with the increase of NPK fertilization. Similar trend of the influence of fertilizer (N) was noticed in barley by Malesevic *et al.* (1981), Bianchi and Ciriciofolo (1982), Basso (1983), Shim *et al*., (1998) and Alam (2003) and in wheat by Singh *et al*., (1992), Patel *et al*. (1995), Tarique (2003), Rahman (2004), and Khaleque (2005). Higher SDW was produced by the fertilized plants than that of the control. This result is also corroborated with Rahman (2004) and Khaleque (2005) in wheat. F_3 fertilized plants produced the highest GN $spike^{-1}$ and Ellen (1990), Rahman *et al*.(1999), Tarique (2003), Rahman (2004) and Khaleque (2005) noticed similar findings in wheat. Higher GDW was in the fertilized plants than in the control. Increased GDW was produced by increasing the fertilizer level. F_3 treatment had the highest GDW. Haque (2000), Rahman (2004) and Khaleque (2005) reported similar findings in wheat. The highest spike RGR was in the F_3 treatment. The lowest grain RGR was in the non-fertilized plants at all the days after anthesis. Fertilized plants had higher grain RGR than the control. The highest grain RGR was in the F_3 treatment. Rahman (2004) and Khaleque (2005) noticed similar findings in wheat.

Table 2. Effect of fertilizer on mean values of spikelet number, spike dry weight (g), grain number, grain dry weight (g), spike RGR (gg^{-1} day^{-1}) and grain RGR (gg^{-1} day^{-1}) at different days after anthesis.

Days After Anthesis (DAA)							Days After Anthesis (DAA)				
	07	07	14	21	28		07	14	21	28	35
Spikelet number							Spike dry weight (g)				
F_0	39.750	39.750	40.125	40.125	40.125		0.325	0.455	0.651	1.038	1.461
F_1	44.625	44.625	45.375	45.375	45.375		0.575	0.971	1.180	1.638	1.906
F_2	49.875	49.875	50.750	50.750	50.750		0.760	1.156	1.397	2.003	2.349
F_3	54.750	54.750	55.500	55.500	55.500		0.862	1.465	1.954	2.445	2.839
LSD (5%)	0.801	0.796	0.902	0.962	0.962		0.011	0.034	0.062	0.075	0.130
Grain number							Grain dry weight (g)				
F0	22.917	22.083	20.500	19.083	19.083		0.181	0.241	0.355	0.399	0.534
F1	27.750	26.125	25.042	23.833	23.833		0.370	0.412	0.543	0.594	0.742
F2	39.375	37.000	36.042	34.083	34.083		0.495	0.632	0.776	0.995	1.230
F3	43.083	40.750	39.083	37.500	37.500		0.526	0.732	0.947	1.191	1.479
LSD (5%)	0.501	0.991	1.183	1.260	1.260		0.009	0.004	0.016	0.038	0.047
	07-14	14-21	21-28	28-35			07-14	14-21	21-28	28-35	
Spike RGR (gg^{-1} day^{-1})							Grain RGR (gg^{-1} day^{-1})				
F0	0.048	0.051	0.064	0.047			0.041	0.052	0.017	0.040	
F1	0.074	0.027	0.045	0.021			0.016	0.037	0.014	0.031	
F2	0.060	0.026	0.048	0.024			0.035	0.029	0.034	0.031	
F3	0.075	0.040	0.030	0.021			0.048	0.035	0.032	0.032	
LSD (5%)	0.006	0.006	0.006	0.008			0.0034	0.0007	0.0038	0.0052	

Table 3. Mean values of spikelet number,spike dry weight (g), grain number, grain dry weight (g), spike RGR (gg^{-1} day^{-1}) and grain RGR (gg^{-1} day^{-1}) at different days after anthesis as affected by variety.

Days After Anthesis (DAA)							Days After Anthesis (DAA)				
	07	07	14	21	28		07	07	14	21	28
Spikelet number							Spike dry weight (g)				
BARI Barley -1	45.875	45.875	46.750	46.750	46.750		0.612	0.992	1.281	1.761	2.109
BARI Barley -2	47.250	47.250	47.625	47.625	47.625		0.633	1.038	1.272	1.769	2.231
BHL-3	50.875	50.875	51.250	51.250	51.250		0.631	0.988	1.300	1.775	2.070
BL-1	45.000	45.000	46.125	46.125	46.125		0.646	1.030	1.328	1.818	2.145
LSD (5%)	0.516	0.535	0.765	0.693	0.693		0.018	0.041	0.007	0.091	0.076
Grain number							Grain dry weight (g)				
BARI Barley -1	31.500	29.542	28.125	26.042	26.042		0.373	0.494	0.645	0.751	0.865
BARI Barley -2	33.667	31.333	29.958	28.625	28.625		0.398	0.504	0.654	0.777	1.010
BHL-3	32.875	31.917	30.417	29.167	29.167		0.393	0.506	0.658	0.815	1.037
BL-1	35.083	33.167	32.167	30.667	30.667		0.408	0.513	0.664	0.837	1.072
LSD (5%)	0.456	1.159	0.762	0.468	0.468		0.009	0.008	0.024	0.045	0.028
	07-14	14-21	21-28	28-35			07-14	14-21	21-28	28-35	
Spike RGR (gg^{-1} day^{-1})							Grain RGR (gg^{-1} day^{-1})				
BARI Barley -1	0.064	0.038	0.047	0.029			0.041	0.039	0.020	0.020	
BARI Barley -2	0.066	0.030	0.049	0.036			0.033	0.038	0.022	0.038	
BHL-3	0.062	0.040	0.044	0.022			0.035	0.038	0.026	0.036	
BL-1	0.064	0.037	0.047	0.026			0.032	0.038	0.028	0.039	
LSD (5%)	0.0056	0.0060	0.0071	0.0050			0.0024	0.0047	0.0049	0.0047	

Although the varietal differences were significant for all the characters studied, but the ranking of the varieties was different for different characters (Table 3). BHL-3 had the highest SN $spike^{-1}$, BL-1 produced the highest SDW, GN and GDW. The highest spike RGR was produced by BARI Barley-2. BARI Barley-1 had the highest grain RGR.

In this study, grain growth of the four barley varieties was observed highest in the highest level of irrigation and fertilizer than the control. So, proper grain growth is very much dependent on the availability of adequate amount of soil moisture and adequate quantity of fertilizer.

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