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EFFECTS OF SOWING TIME AND NITROGEN FERTILIZER ON BARLEY (*HORDEUM VULGARE* L.)

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Abstract

Field experiments were carried out to study the effects of sowing dates (November to December) and nitrogen fertilizers on nitrogen utilization and some related characters of barley cultivars (*Hordeum vulgare* L.). Results indicated that sowing in the 1st and 2nd week of November resulted higher grain yield and total dry matter compared to other times. Delay in sowing, i.e. after 17 November decreased dry matter accumulation and nitrogen utilization. Accumulation of dry matter increased with higher doses of nitrogen but nitrogen use efficiency increased upto 90 kg/ha and nitrogen harvest index was more or less similar except in control.

Introduction

Barley ranks third after rice and wheat and used as supplementary food and fodder crops in Bangladesh. Seeding of barley is generally done in early November to late December. Late harvesting of preceding crops, excessive soil moisture after rainy season and increasing cropping intensity have pushed a sizable barley area under morderately late to late sown condition. Late sown plants experience low temperature at the vegetative stage, which decrease the physiological processes particularly, root growth and nutrient and water uptake. On the contrary, reproductive stages of late sown plants experience high temperature, which reduces grain growth and ultimately crop productivity. Farmers of Bangladesh use nitrogen fertilizer indiscriminately without adequate information concerning actual soil requirements and this results in over or under application. There are few options regarding fertilizer requirement of late planted barley. Some argue for higher level of nutrient to the crop to compensate yield loss owing to delayed seeding (Kotrba *et al*. 1984; Noworolnik 1987), others advocate lower level of nutrient as the crop is unable to absorb higher level of nutrient owing to its reduced growth duration (Kahnt and Kubler 1981). So, to avoid indiscriminate use of nitrogen, a clear understanding on nitrogen removal and its utilization efficiency is pre-requisite for recommending the nitrogen level at different seeding time.

Materials and Methods

The experiment was conducted in the research field of the Department of Botany, University of Rajshahi in 2002-2003 with four barley cultivars viz. BB 1, Karan 19, Karan 163 and Karan 351. The soil of the experimental field was silty loam with pH 6.6. The total nitrogen was 0.06%, organic matter 1.04%, phosphorus 13.9 ppm, potassium 0.12 milliequivalent/100 g soil, zinc 0.40 ppm and sulphur 8.1 ppm. The experiment was conducted in a split plot design with four sowing times (S_1, S_2, S_3 and S_4 indicate 5th, 17th and 29th November and 11th December respectively) five N treatments (N_0, N_1, N_2, N_3 and N_4 indicate 0, 30, 60, 90 and 120 kg/h N respectively) in each sowing and cultivars with three replications. Row to row distance was 20 cm and plant-to-plant distance was 5 cm in all the plots, thus 100 plants were counted per square meter avoiding border row. Nitrogen content of grain and straw was determined by the micro Kjeldahl method (Jayaraman 1985). Statistical Analysis was carried out according to Gomez and Gomez (1984).

Nitrogen utilization was calculated using the formula (Nyborg *et al.* 1995) given below:

$$\text{(i) } \textit{Nitrogen uptake} = \frac{\%\ \textit{nitrogen obtained}}{100} \text{ x } \textit{Dry weight}$$

$$\text{(ii) } \textit{Nitrogen use efficiency (NUE)} = \frac{Fn - Fo}{\text{N added}}$$

[*Fn* = N uptake at given fertilizer, *Fo* = N uptake at control]

$$\text{(iii) } \textit{Nitrogen harvest index (NHI)} = \frac{\textit{Grain nitrogen uptake}}{\textit{Total nitrogen uptake}}$$

Results and Discussion

Sowing times significantly influenced straw dry matter and total dry matter in barley, as such the maximum dry matter was obtained in S_1, followed by S_2, S_3 and S_4 (Table 1). This difference in dry matter yield was attributed to thrifty vegetative growth due to optimum environmental condition such as optimum temperature, available soil moisture in that particular time. Abdel-Raouf *et al.* (1983) observed similar results in barley. Straw dry matter and total dry matter were also found to increase with increased nitrogen levels. Similar results were reported by Natr (1997) and Sonmez (2000) from Turkey.

Table 1. Straw dry matter, total dry matter and grain yield as affected by different nitrogen levels at various sowing dates.

Treatment	Straw dry matter (g/plan)					Total dry matter (g/plan)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
N_0	6.63 d	5.31 d	4.08 d	3.18 d	4.80 e	8.29 e	7.04 e	5.32 e	3.90 d	6.14 e
N_1	7.90 c	6.84 c	5.29 c	3.90 c	5.98 d	10.23 d	9.25 d	7.05 d	4.90 c	7.85 d
N_2	9.68 b	8.57 b	7.03 b	6.01 b	7.82 c	12.85 c	11.79 c	9.48 c	7.59 b	10.43 c
N_3	1002 ab	9.49 a	8.17 a	7.21 a	8.72 b	13.83 b	13.37 b	11.25 b	9.27 a	11.93 b
N_4	10.23 a	9.84 a	8.48 a	7.33 a	8.97 a	14.41 a	14.06 a	11.91 a	9.68 a	12.51 a
Mean	8.89 a	8.01 b	6.6 c	5.53 d	7.26 f	11.92 a	11.10 a	9.00b	7.07 c	9.77
LSD at 5%	S = 0.60		T = 0.19			S = 1.14		T = 0.22		

Contd. Table 1.

Treatment	Grain yield (kg/ha)				
	S_1	S_2	S_3	S_4	Mean
N_0	1664.3 e	1726.8 e	1239.3 e	708.8 e	1334.8 e
N_1	2340.9 d	2403.1 d	1750.0 d	998.2 d	1873.0 d
N_2	3148.8 c	3213.7 c	2447.0 c	1596.7 c	2601.5 c
N_3	3803.3 b	3880.7 b	3076.0 b	2067.5 b	3206.9 b
N_4	4179.3 a	4210.0 a	3433.6 a	2326.6 a	35374 a
Mean	3027.3 a	3086.9 ab	2389.2 b	1539.5 c	2510.7
LSD at 5%	S= 715.0		T = 78.3		

In a column, values followed by a common letter do not differ significantly at 5% level.

Sowing times significantly influenced the grain yield of barley. The maximum grain yield was obtained in S_2 plants and it was followed by S_1, S_3 and S_4 (Table 1). This difference in grain yield was attributed to significant reduction of fertile tiller/plant, number of spikelets/spike and 1000-grain weight. Delayed sowing resulted in reduced grain yield were also reported by Noworolnik and Leszczynska (1997). Increased nitrogen levels increased grain yield in the present study as well. Similar results were reported in barley by Clancy et al. (1991).

S_2 sown barley grain uptook significantly more nitrogen (46.72 kg/ha) than the crop planted at later dates. It might be due to higher grain yield and moderate % of grain nitrogen. But straw nitrogen uptake was found higher in S_1 (Table 2). It might be due to cummulative effect of straw dry weight and % of straw nitrogen. Generally delayed sowing beyond mid-November reduced grain, straw and total nitrogen uptake. It might be due to lower dry matter accumulation though % of N was higher at the delayed sowings. Increased nitrogen levels were also found to increase straw nitrogen uptake and grain nitrogen uptake in the present study as well. This is in agreement with findings of Gouis *et al.* (1999).

Table 2. Straw nitrogen uptake and grain nitrogen uptake as affected by different nitrogen levels and sowing dates.

Treatment	Straw nitrogen uptake (kg/ha)					Grain nitrogen uptake (kg/ha)				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
N_0	22.37e	23.89 e	17.46 e	10.22 e	18.48 e	22.39 e	8.08 e	15.71 e	12.49 d	17.17 e
N_1	32.38d	34.23 d	25.33 d	14.77 d	26.68 d	27.19 d	23.97 d	21.25 d	15.85 d	22.07 d
N_2	45.70c	47.89 c	37.04 c	24.74 c	38.84 c	37.39 c	33.46 c	30.72 c	27.63 c	32.30 c
N_3	5801b	60.80 b	48.98 b	33.64 b	50.36 b	44.34 b	42.43 b	42.94 b	38.20 b	41.98 b
N_4	64.53a	66.77 a	55.47 a	38.39 a	56.29 a	51.33 a	49.73 a	49.54 a	45.18 a	48.95 a
Mean	44.60 ab	46.72 a	36.86 b	24.35 c	38.13	36.53 a	33.54 ab	3203 b	27.87 c	32.49
LSD at 5%	S = 9.85		T=1.47			S = 3.99			T = 2.01	

In a column, values followed by a common letter do not differ significantly at 5% level.

Nitrogen use efficiency gradually decreased with subsequent delay in sowing after S_2 (Table 3). It might be due to lower dry matter accumulation and shorter growth period. Influence of nitrogen fertilizer on nitrogen use efficiency was found to increase significantly upto N_2 in the present study.

Table 3. Nitrogen use efficiency and nitrogen harvest index as affected by different nitrogen levels and sowing dates.

Treatment	Nitrogen use efficiency (kg N/kg N)					Nitrogen harvest index				
	S_1	S_2	S_3	S_4	Mean	S_1	S_2	S_3	S_4	Mean
N_0	-	-	-	-	0.495 b	0.569 a	0.513 a	0.443 a	0.505 b	
N_1	0.493 b	0.541 b	0.446 b	0.265 b	0.436 c	0.541 a	0.588 a	0.535 a	0.476 a	0.535 a
N_2	0.638 a	0.657 a	0.576 a	0.493 a	0.591 b	0.553 a	0.590 a	0.539 a	0.470 a	0.538 a
N_3	0.639 a	0.682 a	0.652 a	0.546 a	0.630 a	0.572 a	0.593 a	0.531 a	0.468 a	0.541a
N_4	0.594 a	0.620 a	0.598 a	0.506 a	0.580 b	0.564 a	0.575 a	0.526 a	0.458 a	0.531 a
Mean	0.591 a	0.625 a	0.568 a	0.453 b	0.559	0.545 a	0.583a	0.529 a	0.463 b	0.530
LSD at 5%	S = 0.081		T = 0.038			S = 0.077		T = 0.016		

In a column, values followed by a common letter do not differ significantly at 5% level.

Nitrogen harvest index was found to be higher in S_2 followed by S_1, S_3, and S_4 (Table 3). It might be due to cummulative effect of grain weight and grain nitrogen content. It was also observed that the effects of nitrogen fertilizer levels were more or less similar for NHI except control in the present study. Similar results were reported by Pettersson (1989) and Boonchoo *et al.* (1998).

The overall results indicated that sowing after 17^{th} November decreased dry matter accumulation and nitrogen utilization. Accumulation of dry matter increased with higher doses of nitrogen but nitrogen use efficiency increased upto 90 kg N/ha and nitrogen harvest index was more or less similar except control. In fact, number of days from seeding to emergence is linearly related to temperature and consequently delayed emergence of late planted barley under low temperature adversely affects rate of physiological processes particularly root growth, root : shoot ratio and nutrient uptake proportionately. Later on rise in post-January atmospheric temperature accelarates rates of growth and development leading to shortening of different phenophases and pre-mature ripening which further reduces nutrient recovery in the late planted crops.

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