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Response of barley to nitrogen management at varying growth stages under semi-arid conditions of Rajasthan

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Abstract

A field experiment was conducted during winter (*rabi*) seasons of 2005-06 and 2006-07 at Avikanagar (Rajasthan) on malt variety of barley *cv*. RD 2618 to find out the economic rate and optimal time of nitrogen application for better quality and higher yield of irrigated barley (*Hordeum vulgare* L.). Application of 90 kg N/ha gave the highest grain (38.35 q/ha), straw (50.44 q/ha) yield and crude protein content in grain and straw (13.21 and 7.26 %). The efficiency of N application was also higher when it was applied in 3 equal splits, *i.e.* at sowing, crown root initiation (CRI) and first node (FN) stage with respect to grain and straw yields. Results of pooled data showed that application of nitrogen in 3 equal splits gave 1.15 and 3.16 q/ha higher grain yield and 1.91 and 4.96 q/ha straw yield over other split combinations (½ at sowing and ½ at CRI stage and ½ each at sowing and FN stage). Application of 90 kg N /ha in three equal splits each at sowing, CRI and first node stage was found better in obtaining higher gross return (Rs. 33570 /ha), net return (Rs.19307/ha) and benefit: cost ratio (2.35) as compared to other modes of split application.

Key words: Barley, Economics, Mode of N application, Nitrogen, Protein, Yield

Introduction

Barley (*Hordeum vulgare* L.) is an important cereal crop of arid and semi-arid regions of the country. It is highly preferred as a staple food for human being and its grain provides an excellent feed for cattle and horses. Barley is generally grown in areas where irrigation facilities are limited, as it can tolerate moisture and salt stress to a great extent than parallel winter cereal crops (Mass and Hoffman, 1977). Its performance is commendable, as this crop continues to be grown on marginal lands with low levels of inputs. Adequate nitrogen fertilizer may enhance its productivity. Coarse texture soils of Rajasthan are deficient in available N (Kumawat and Jat, 2005). Awasti and Surajbhan (1993) reported that adequate supply of nitrogen to barley crop is associated with efficient source to sink relationship leading to higher productivity. Therefore, an attempt was made to develop a suitable N fertilization practice for recently released high yielding variety of barley ‘RD 2618’ in order to obtain higher grain production and more economic return.

Materials and Methods

A field experiment was conducted during winter (*rabi*) seasons of 2005-06 and 2006-07 at CSWRI, Avikanagar, Rajasthan. The soil was sandy loam in texture with pH 7.8, low in available N (158.4 kg/ha) and available P (16.8 kg/ha) and medium in available K (258.2 kg /ha). The experiment was conducted in split plot design with three replications. Keeping N levels (30, 60 and 90 kg/ha) as main plots and 3 modes of application of each level as [T_1, ½ each at sowing and crown root initiation (CRI) stage; T_2, ½ each at sowing and first node (FN) stage and T_3, ? each at sowing, CRI and first node stage as sub plots treatment]. In addition, a uniform dose of 30 kg P_2O_5 /ha through single super phosphate (SSP) and 20 kg/ha K_2O through murate of potash (MOP) was drilled 10 cm deep at sowing. Barley *cv*. RD 2618 was sown with a seed rate of 80 kg /ha. All other operations were performed as per recommendations for raising a good crop.The sowing was done on 18 and 22 November and harvested on 15 and 21 March 2006 and 2007, respectively during 2006 and 2007. The sowing of seeds was done in lines at a distance of 22cm and depth was kept at about 5 cm. The seeds were treated with Bavistin @ 2 g /kg of seed and soil was dressed with 2% *Endosulfan* dust @ 20 kg /ha. First weeding was done at 25 DAS (days after sowing) and second weeding was done at 45 DAS. Five plants were selected randomly for recording growth parameters under each treatment. The crop was harvested with the help of sickle. The grain and straw yields were recorded on the basis of per square metre area.

Results and Discussion

Nitrogen levels had significant effects on all the growth and yield attributes *viz*. plant height, dry matter/plant, tillers/plant, spike length, number of grains/spike, 1,000-grain weight (Table 1). However, application of 60 and 90 kg N /ha was found statistically at par in respect of number of grains/spike and 1,000-grain weight. The favourable effects of N application on growth and yield parameters led to significant increase in grain and straw yields. The results corroborate the finding of Saini and Thakur (1999). Physiological role of N in enhancing dry matter accumulation might have led to increase in yield attributes and thereby yield of crop at the higher N rates (Dhukia *et al*., 1998). Successive increase in N levels upto 90 kg N / ha significantly increased grain and straw yields of barley (Table 2). Similar trends were also seen in case of harvest index, nitrogen content and uptake at harvest. These characters increased with increasing levels of N. Total uptake of N in grain and straw, crude protein content in grain and straw were also increased remarkably with increasing levels of N application. However, grain

Table 1: Growth and yield attributes of barley as affected by nitrogen levels and its mode of application (Pooled over two years)

Treatment	Plant height (cm)	Dry matter /plant (g)	Tillers /plant	Spike length (cm)	1,000-grain weight (g)	Number of grains /spike
Nitrogen level (kg /ha)						
30	99.00	13.07	3.27	8.40	38.56	40.94
60	107.07	15.24	4.41	9.02	39.71	43.79
90	112.22	18.33	5.17	10.07	40.11	45.60
SEm ±	0.84	0.35	0.13	0.12	0.32	0.86
CD (P=0.05)	2.50	1.05	0.39	0.37	0.96	2.58
Mode of N application						
1/2 each at sowing and crown root initiation (CRI) stage	104.00	14.39	3.81	8.09	36.83	37.22
1/2 each at sowing and first node stage	105.33	16.08	4.03	9.05	39.18	45.67
1/3 each at sowing, CRI and first node stage	109.06	16.37	4.36	10.35	42.35	47.44
SEm ±	0.84	0.35	0.13	0.12	0.32	0.86
CD (P=0.05)	2.50	1.05	0.39	0.37	0.96	2.58

Table 2 : Grain and straw yield, harvest index, nitrogen uptake and crude protein content of barley as influenced by nitrogen levels and its mode of application (Pooled over 2 years)

Treatment	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Uptake of nitrogen (kg /ha)			Crude protein (%)	
				Grain	Straw	Total	Grain	Straw
Nitrogen level (kg /ha)								
30	27.42	37.22	38.74	41.28	30.88	72.16	10.21	4.99
60	32.12	43.07	40.57	59.62	46.70	106.33	11.97	6.39
90	38.35	50.44	42.08	80.44	55.59	136.03	13.21	7.26
SEm±	0.50	0.86	0.08	1.82	1.15	2.96	0.15	0.12
CD (P=0.05)	1.51	2.58	0.22	5.19	3.30	8.47	0.45	0.36
Mode of N application								
1/2 each at sowing and crown root initiation (CRI) stage	31.04	41.04	39.67	54.13	39.62	93.75	11.37	5.681
1/2 each at sowing and first node stage	33.05	44.09	40.54	59.41	45.24	104.65	11.71	6.18
1/3 each at sowing, (CRI and first node stage	34.20	46.00	41.19	67.81	48.31	116.12	12.31	6.78
SEm±	0.50	0.86	0.08	1.82	1.15	2.96	0.15	0.12
CD (P=0.05)	1.51	2.58	0.22	5.19	3.30	8.47	0.45	0.36

contained appreciably higher crude protein content than straw. Shah and Hassan (1999) also observed higher crude protein content in parallel cereal *i.e.* oat straw with increasing levels of N. The marginal increase in crude protein content of grain and straw (10.21 and 4.99%) were noticed with the application of 30 kg N /ha. This might be due to less response of the crop at the lower level of N in comparison to higher level of N application.

Significant variations were observed in growth and yield attributes *viz.* plant height, dry matter/plant, tillers/plant, spike length, 1,000-grain weight and number of grains/ spike due to mode of N application Table 1& 2. These values were maximum with N application in three equal splits *i.e.* at sowing, CRI and first node growth stage of barley. However, the difference between two other modes of nitrogen application ½ each at sowing and CRI and ½ each at sowing and first node stage was at par with each other for plant height, tillers/plant, nitrogen content in grain and crude protein content. Application of N in two equal splits half at sowing and rest half at first node showed significant improvement in dry matter/plant, spike length, test weight, grains/spike and thereby grain, straw yields and harvest index in comparison to N application half at sowing and half at CRI stage. Similar results were observed for N content in straw, uptake of N by grain, straw and total N uptake. Crude protein of straw also showed similar results. Further, N application in three equal splits resulted in significant increase in plant height, spike length, test weight, harvest index, N-content in grain and straw and total N uptake as well as crude protein in grain and straw compared to two equal splits of N application at sowing and first node. These results are in confirmation with the findings of Ranwa and Singh (1999) and Singh *et al.* (2003).

Interaction effect of N levels and mode of its application was significant in respect of grain and straw yield (Table 3).The highest grain yield (41.43 q/ha) and straw yield (51.09 q/ha) was recorded with the application of 90 kg N /ha applied in three equal splits which was significantly higher for grain yield to rest of the treatment combinations. In general, with all the mode of N application 90 kg N application significantly registered higher grain and straw yields as compared to 60 kg N application.

Table 3 : Interaction effect of nitrogen levels and its mode of application on grain and straw yields in barley

Mode of N application*	*Nitrogen level (kg /ha)*		
	30	60	90
Grain yield (q/ha)			
1/2 each at sowing and crown root initiation(CRI) stage	26.51	31.12	35.20
1/2 each at sowing and first node stage	27.37	32.48	38.40
1/3 each at sowing, CRI and first node stage	28.40	32.76	41.43
SEm±	0.87		
CD (P=0.05)	2.62		
Straw yield (q/ha)			
1/2 each at sowing and crown root initiation(CRI) stage	32.30	42.09	48.41
1/2 each at sowing and first node stage	38.00	44.08	49.40
1/3 each at sowing, CRI and first node stage	41.36	45.25	51.09
SEm±	1.49		
CD (P=0.05)	4.47		

* Treatment details given in materials and methods

Table 4 : Effect of nitrogen levels and its mode of application on economic returns (mean over two years)

Treatment	Cost of cultivation (Rs. / ha)	Gross return (Rs./ha)	Net return (Rs./ha)	Benefit : cost ratio
Nitrogen level (kg /ha)				
30	13164	26779	13615	2.03
60	13553	31768	18215	2.34
90	13942	35863	21921	2.57
Mode of N application				
1/2 each at sowing and crown root initiation (CRI) stage	13271	29881	16610	2.25
1/2 each at sowing and first node stage	13767	31996	18229	2.32
1/3 each at sowing, CRI and first node stage	14263	33570	19307	2.35

The economic analysis of various treatments indicated that the highest gross return, net returns (Rs. 35, 863 and Rs. 21, 921/ha) and benefit: cost ratio (2.57) were accrued to application of 90 kg N /ha (Table 4). Among mode of N application, three equal split application resulted in the highest gross return (Rs. 33570), net return (Rs. 19, 307 /ha and B: C ratio (2.35).

It was concluded that the highest grain and straw yield of malt variety of barley *cv*. RD 2618 and net profit was obtained when 90 kg N/ha was applied in three equal splits at sowing, CRI and first node stage in semi-arid regions of Rajasthan.

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