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Effect of levels and mode of nitrogen application on dual purpose barley (*Hordeum vulgare*) under semi-arid condition

L.R. MEENA[1], J.S. MANN[2] AND S.L. MEENA[3]

Central Sheep and Wool Research Institute, Avikanagar, Rajasthan 304 051

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ABSTRACT

A field experiment was conducted during *rabi* 2005-06 and 2006-07 at Avikanagar, Rajasthan to study the response of multi cut barley (*Hordeum vulgare* L.) to 3 levels of N (30, 60 and 90 kg N/ha) and 3 modes of its application. Significantly higher green fodder (32.0 t/ha), total dry fodder (8.22 t/ha) and grain yield (3.57 t/ha) was obtained with 90 kg N application. Application of 90 kg N/ha increased the green fodder, total dry fodder and grain yield by 5.8, 0.95 and 0.93 t/ha over 30 kg N/ha, respectively. Nitrogen content and uptake, protein content and yield increased progressively as nitrogen application increased from 30 to 90 kg/ha. The highest gross return (₹49,096 /ha) and net return (₹41,785 /ha) were obtained with the use of 90 kg N/ha. However, the partial factor productivity (PFPn) for green fodder at first cut decreased from 848 kg/ha N to 306 kg/ha N as the level of N was increased from 30 to 90 kg N/ha. Nitrogen x mode of N application interaction was significant and showed that application in 3 split doses was better than its application in 2 split doses only at 90 kg N/ha.

Key words: Dual purpose barley, Green fodder, Protein, N concentration, N uptake

Barley has the widest ecological range of adaptation among the cereals and it is widely grown in Rajasthan and other temperate and sub-tropical regions of the country. Because of its lower cost of cultivation and low input demand, it is preferred by the resource poor farmers in the area. Barley grain is considered as an important raw material for food industry in addition to its consumption for chapati making. Its straw is a good quality fodder for cattle. Development of dual-purpose (grain and fodder) varieties is considered the most limiting factor for realizing higher yields in barley (Yadav *et al*.2003). Farmers of arid and semi-arid regions of the country prefer this crop as it requires less water and does well even with saline water. In Rajasthan, it is grown both as irrigated as well as a rainfed crop on light textured soils. The major constraints for production in the state are poor nitrogen status of these soils. Little information is available on N requirement of barley in coarse Rajasthan soils. The present investigation was planned to study the effect of nitrogen levels and its mode of application on the production and economics of barley production.

MATERIALS AND METHODS

A field experiment was carried out during the *rabi* seasons of 2005-06 and 2006-07 at Avikanagar, Rajasthan. The soil of the experimental site was sandy loam in texture, having pH 8.4 and organic carbon 0.22 %. The soil of the experimental site was low in available N (134 kg/ha), and medium in available P (16.4 kg/ha) and available K (268 kg/ha). The treatments comprised of 3 levels of nitrogen (30, 60 and 90 kg/ha) through urea in main plots and 3 schedules of nitrogen applied at varying growth stages of barley *viz*., ½ at sowing and ½ at CRI, ½ at sowing and ½ at tillering and $^1/_3$ each at sowing, CRI and tillering stages of barley in sub plots. Treatments were replicated thrice in a split plot design. A common basal dose of 30 kg P_2O_5 and 20 kg K_2O and N as per the treatments was applied. Dual purpose (fodder and grain) variety of barley 'RD 2618' was sown on 15th October in 2006 and 20th October in 2007 at a spacing of 22.5cm with a seed rate of 80 kg/ha. The seeds were treated with fungicide prior to sowing. The crop was cut for fodder at 50 days after sowing (boot stage) and therefore it was left for grain formation. Green and dry weights of fodder were recorded. Partial factor productivity (PFPn) in green fodder production was calculated using the expression (Prasad, 2011).

$$\text{PFPn for green fodder} = \frac{\text{kg green fodder}}{\text{kg N applied.}}$$

[1]Corresponding author E mail: lrmeena63@yahoo.com
[1&3]Senior Scientist, [2]Principal Scientist, CSWRI, Avikanagar

Growth attributing parameters were recorded at the time of harvest. Ten plants were selected randomly from each treatment to record the observations on growth parameters. Nitrogen content was determined and uptake was calculated by multiplying the content with the dry matter yield of fodder. Protein content in dry matter was estimated by multiplying the N content with 6.25 (AOAC, 1990). The cost of production and the net profit was worked out on the basis of actual production cost and yield of barley. The crop was harvested for grain production on 25th April in 2006 and 30th April in 2007, respectively. The data were analyzed using appropriate analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Effect of nitrogen level

Nitrogen application significantly influenced the plant height, dry matter accumulation/plant, dry matter accumulation (g/m^2) at 50 days after sowing, leaf area index (LAI), and crop growth rate (g/m^2/day) of barley and for most characters studied the increase due to successive levels of N was significant (Table1). Values for the growth attributes were the highest at 90 kg N /ha and were significantly higher as compared to other levels of N (30 and 60 kg N/ha). The highest green fodder (32.0 t/ha), total dry forage (8.22 t/ha) and grain yield (3.57 t/ha) were realized under 90 kg N /ha application. These results are in close conformity with the findings of Ramos *et al*. (1995). Singh and Singh (2005) also recommended an application of 80 kg N/ha for dual purpose barley. The increase in green and dry matter yields were due to taller plants having more effective tillers/m^2 due to increased nitrogen application. Effect of N application on yield attributes was also reflected on grain production. Partial factor productivity of

Table 1. Effect of N levels and mode of nitrogen application on growth attributes, green fodder, dry matter and grain yield of multi cut barley (data pooled over two years)

Treatment	Plant height (cm)	DM (g/plant) at harvest	Effective tillers/m^2	DM (g/m^2) at 50 DAS	LAI at 50 DAS	CGR (g/m^2/day)	Green fodder yield at I cut (t/ha)	Dry matter yield at I cut (t/ha)	Straw yield at II cut (t/ha)	Total dry fodder yield (t/ha)	Grain yield (t/ha)
Nitrogen levels (kg/ha)											
30	95.2	11.6	218.2	99.6	2.1	7.2	26.2	3.36	3.91	7.27	2.64
60	102.7	13.7	225.2	111.6	2.6	7.8	29.2	3.78	4.04	7.82	3.06
90	111.6	15.7	235.1	119.7	2.8	8.3	32.0	4.07	4.15	8.22	3.57
SEm±	0.84	0.47	1.28	1.18	0.03	0.16	0.56	0.07	0.22	0.12	0.11
CD (P=0.05)	2.43	1.01	NS	4.28	0.09	0.51	1.88	0.21	0.65	0.38	0.32
Mode of N application											
½ as basal and ½ at CRI	98.5	12.8	228.2	106.6	2.6	7.4	27.2	3.64	3.85	7.49	2.84
½ as basal and ½ at active tillering	102.6	14.0	233.5	110.7	2.9	7.6	29.2	3.76	4.02	7.78	3.05
$^1/_3$ each as basal, at CRI and tillering	107.6	14.8	238.4	113.1	3.5	8.0	30.1	3.84	4.47	8.31	3.36
SEm±	0.84	0.47	1.28	1.18	0.03	0.16	0.56	0.07	0.22	0.12	0.11
CD (P=0.05)	2.43	1.01	NS	4.28	0.09	0.51	1.88	0.21	0.65	0.38	0.32

Table 2. Effect of N levels and mode of nitrogen application on nutrient uptake, protein, nitrogen use efficiency and economic returns of multi cut barley (data pooled over two years)

Treatment	PFPn (kg green fodder/kg N)	N content (%)		N uptake(kg/ha)			Protein content (%)	Protein yield (kg/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
		Straw	Grain*	Straw	Grain	Total					
Nitrogen levels (kg/ha)											
30	848	0.62	1.50	42.0	47.3	89.3	5.4	424	38,652	32,148	2.88
60	439	0.68	1.83	51.6	63.2	114.8	6.0	454	43,505	36,858	3.21
90	306	0.77	2.11	61.3	92.6	153.9	7.0	475	49,096	41,785	3.35
SEm±	7.2	0.02	0.07	2.05	4.62	5.37	0.1	13.0	-	-	-
CD (P=0.05)	23.7	0.06	0.21	6.93	13.20	15.35	0.3	40.1	-	-	-
Mode of N application											
½ as basal and ½ at CRI	527	0.63	1.72	47.8	58.8	106.6	5.3	368	42,106	35,308	3.06
½ as basal and ½ at active tillering	531	0.66	1.79	51.7	62.2	113.9	6.3	448	43,879	37,049	3.14
$^1/_3$ each as basal, at CRI and tillering	536	0.71	1,93	55.0	71.4	126.4	7.1	545	45,268	38,433	3.24
SEm±	7.2	0.02	0.07	2.05	4.62	5.37	0.1	13.0	-	-	-
CD (P=0.05)	23.7	0.06	0.21	6.93	13.20	15.37	0.3	40.1	-	-	-

Table 3. Interaction effect of nitrogen levels and mode of its application on grain and straw yields of multi cut barley (data pooled of 2005-06 and 2006-07)

Mode of N application*	Nitrogen levels (kg/ha)		
	30	60	90
½ as basal and ½ at CRI	Grain yield (t/ha)2.65	3.11	3.52
½ as basal and ½ at active tillering	2.74	3.25	3.84
$^1/_3$ each as basal, at CRI and tillering	2.84	3.28	4.14
SEm±		0.08	
CD (P=0.05)		0.26	
	Dry fodder yield (t/ha)		
½ as basal and ½ at CRI	6.66	7.43	7.90
½ as basal and ½ at active tillering	6.95	7.56	8.07
$^1/_3$ each as basal, at CRI and tillering	7.21	7.62	8.20
SEm±		0.09	
CD (P=0.05)		0.27	

nitrogen (PFPn) in green fodder production decreased as the level of nitrogen increased from 30 to 90 kg N /ha (Table 2). Nitrogen content in grain and straw, crude protein content in grain and nitrogen uptake by grain and straw increased successively with each level of N as it was increased from 30 to 90 kg N/ha. The maximum profit in terms of gross return (₹49,096 /ha), net return (₹41,785 /ha) and B: C ratio (3.35) were recorded with 90 kg N/ha.

Mode of N application

The mode of N application significantly increased most growth attributes (Table 1 and 2). The maximum plant height (107.6 cm), dry matter accumulation (14.8 g /plant), effective tillers /m^2 (238.4) and dry matter production (113.1 g/m^2) was obtained when N was applied in three equal splits i.e., one third each at sowing, CRI and tillering stage as compared to N applied in two equal splits. These results are in corroboration with the findings made by Patel *et al*. (2004) and Dhukia *et al*. (1998). Mode of N application had same effect on green fodder yield at first cut (Table 1), which although highest with 3 split application was at par with ½ basal + ½ at active tillering, but significantly superior to ½ basal + ½ CRI. Mode of N application had no significant effect on PFPn in respect of green fodder yield at first cut. A significant increase in N content in straw, N uptake by straw and total N uptake by barley was recorded with three split applications, which was at par with ½ basal + ½ at active tillering, but significantly superior to ½ basal + ½ CRI. These results show the advantage of N application at active tillering in barley as compared to that at CRI. If two split applications are to be made, the second dose should be delayed till active tillering. Highest gross return (₹45,268 /ha), net return (₹38,433 /ha) and B: C ratio (3.24) were also obtained when nitrogen applied in three equal splits. However, the interaction effect between nitrogen level and mode of application was significant in respect of grain and total dry fodder yield of barley (Table 3) and showed that application in 3 split doses was advantageous only at 90 kg N/ha but not at 30 or 60 kg N/ha.

It was concluded that multi cut barley should be fertilized with 90 kg N/ha in three equal splits at sowing, CRI and tillering stages to obtain higher green fodder, straw and grain yield and higher net return under semi-arid conditions.

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