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GREEN FODDER YIELD AND QUALITY OF BARLEY (*HORDEUM VULGARE* L.) AS AFFECTED BY LEVELS OF NITROGEN

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SUMMARY

A field study was conducted during **rabi** season of 2012-13 at Research Farm of College of Agriculture, S. K. Rajasthan Agricultural University, Bikaner. Treatments comprised six levels of nitrogen (20, 30, 40, 45, 60 and 80 kg/ha) with four replications in randomized block design. Response in terms of green fodder yield (GFY) obtained per kg of nitrogen applied (PFPn) sharply declined beyond 30 kg N/ha. In terms of GFY, significant response of basal application of nitrogen was noticed up to 40 kg N/ha (124.25 q/ha). In case of DMY, significant positive response was noticed only up to 30 kg N/ha. NDF, ADF and lignin content remained unaffected due to nitrogen application. The crude fat and mineral contents exhibited significant and positive response up to 30 kg N/ha. Crude protein content tended to increase up to 80 kg N/ha. Beyond 30 kg N/ha only 60 and 80 kg N/ha produced significant and positive effect on CP content.

Key words : Dual purpose barley, green fodder yield, nitrogen schedule

Indian rural economy with more than 90 per cent population of ruminants with small and marginal farmers (Devendra and Thomas, 2002) is strongly backed by livestock supported agriculture. We, with the largest livestock population of the world (530 millions) and only 2.4 per cent of world's geographical area are facing tremendous pressure on the availability of feed and fodder for the livestock. Only 4.4 per cent of the cultivated area in the country is under fodder crops. Estimates reveal that projected deficit of 63.5 per cent in green fodder and 23.56 per cent in dry fodder requirements by 2015 is unlikely to change in next decade indicating 64.21 and 64.87 per cent deficit in green fodder requirement and 24.8 and 24.9 per cent in dry fodder requirements, respectively, by 2020 and 2025. It is required, therefore, to make India a leading player in livestock product markets through sustained and all-round improvements in quality and efficiency by ensuring availability of fodder, so that small producers can gainfully participate in the process of growth and modernization of this sector.

Barley (*Hordeum vulgare* L.), one of the world's most important cereal crops, is being cultivated as a food and feed source from the beginning of settled agriculture and is widely adapted to a broader range of environments, especially low rainfall environments. Its water requirement per unit cereal grain production is lower than those for other cereals due to its relatively low transpiration rate (Poehlman, 1985). As far as grain crop is concerned, barley is next to wheat in acreage (2.78 lakh ha) and production (7.89 lakh tonnes) in Rajasthan. In India, area under barely crop was about 0.75 m ha during 2011 with a production of 1.5 million tonnes.

Barley has such morpho-physiological traits that make it suitable for dual purpose cultivation than other cereals. It is highly efficient in the utilization of water and nutrients in limiting conditions, has high capacity for tillering and re-growth after cutting; and additional capacity for large accumulation of biomass. It sets seed rapidly after re-growth, thus escaping terminal stress due to high temperature and warm winds often experienced in the region. Thus, as a dual purpose (green forage and feed/grain) crop it provides a welcome boost to the confidence of forage growers and fits well for crop diversification in the integrated crop-livestock

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production system of the state.

MATERIALS AND METHODS

The field experiment was conducted during **rabi** season of 2012-13 at Agronomy Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (Rajasthan). The experimental location is situated at an elevation of 234.70 m above mean sea level with latitude of 28.01^0 North and longitude of 73.22^0 East under Agro-Ecological region No. 2 (M9E1) under Arid Ecosystem (Hot Arid Ecoregion with Desert and Saline soils), which is characterized by deep, sandy and coarse loamy desert soils with low water holding capacity, hot arid climate and precipitation less than 300 mm. PET in this region ranges between 1500-2000 mm. As per NARP agro-climatic zone, the soils of the zone are mostly sandy in texture and aeolian in nature having high permeability at surface and are very low in fertility and organic matter content.

The region has arid climate characterized by moderate winters and harsh summers. Strong south-west winds during summer with frequent dust storms are regular phenomena. The mean daily maximum temperature goes up to 42^0C during summers and 24^0C during winters. The maximum temperature may go as high as 48^0C during summers. Similarly, mean daily minimum temperature reaches to 27^0C during summers and comes down to freezing point during winters. The average rainfall of Bikaner is 260 mm, most of which is received during the months of July and August.

During the course of the study, weather conditions were, in general, favourable for the growth and development of the crop. The maximum and minimum temperatures during crop growth period ranged between 17.5^0 to 33.5^0C and 0.6^0 to 17.0^0C, respectively. The soil analysis indicated that soils of the experimental field were sandy in texture and alkaline in nature. Soils were poor in organic matter, while low in available nitrogen and phosphorus and medium in potassium.

Treatments comprised six levels of nitrogen i. e., 20, 30, 40, 45, 60 and 80 kg N/ha applied as basal dose. Experiment was laid out in randomized block design with four replications. Barley variety ‘RD 2715’ was sown on 10 November 2012. Seeds were sown at 5-6 cm depth in furrows, 25 cm apart, using uniform seed rate of 100 kg/ha. Harvesting for green fodder was done at 55 days after sowing. In order to obtain better re-growth through growing point, cutting was taken leaving 5-7 cm stubble height so that growing point was not damaged. The harvested material from each net plot was weighed for recording green fodder yield. The standard procedures as suggested by Fisher and Yates (1963) were employed by applying the technique of analysis of variance for randomized block design to test the significance of results.

RESULTS AND DISCUSSION

The present study was carried out to understand the comparative effects of the levels of nitrogen on the growth parameters and subsequent forage production. It is pertinent to point out here that under the three levels of nitrogen (60, 90 and 120 kg/ha), 20, 30, 40, 45, 60 and 80 kg N/ha could be applied as basal up to the time when cutting for green forage was taken. Thus, it may be noted from the data on forage production that application of nitrogen under basal doses of 30, 40, 45, 60 and 80 kg/ha increased green fodder yield (GFY) by 81.0, 98.6, 101.9, 107.0 and 110.7 per cent, respectively, when compared with 20 kg N/ha (62.6 q/ha) (Table 1). However, when comparisons are made between two consecutive levels of nitrogen, it comes out that application of 30 kg N/ha increased green fodder yield by 81.0 per cent over 20 kg N/ha; application of 40 kg N/ha increased green fodder yield by 9.7 per cent over 30 kg N/ha; application of 45 kg N/ha increased green fodder yield by 1.8 per cent over 40 kg N/ha; application of 60 kg N/ha increased green fodder yield by 2.5 per cent over 45 kg N/ha and application of 80 kg N/ha increased green fodder yield by 1.7 per cent over 60 kg N/ha. Thus, the benefits in the GFY decreased sharply after 40 kg N/ha (Table 2A). All the growth parameters recorded also showed similar trends with regard to the effectiveness of different levels of nitrogen. Dry matter accumulation by crops was also not affected due to application of nitrogen beyond 30 kg/ha (Table 2B). The most plausible reason for this absence of nitrogen response beyond 40 kg/ha may be attributed to an important consideration of the fact that the extent to which the crop can take up from the applied fertilizer depends on amount of internal re-mobilization and assimilated soil nitrogen used by plants. It clearly means that all the applied nitrogen may not necessarily be utilized by the plants in early stage of development, which may

TABLE 1
Effect of doses of nitrogen on green fodder and dry matter yield (q/ha)

Treatment (Doses of nitrogen*)	Yield (q/ha) (Mean over uneven number of replications)	
	Green fodder yield	Dry matter yield
20 kg/ha (N_{20})	62.56	14.55
30 kg/ha (N_{30})	113.30	24.25
40 kg/ha (N_{40})	124.25	24.97
45 kg/ha (N_{45})	126.44	26.71
60 kg/ha (N_{60})	129.64	25.28
80 kg/ha (N_{80})	131.88	23.37
F test	S	S

S–Significant.

be due to lesser proliferation of root system at that stage. Data on N uptake, partial factor productivity and crop growth rates serve to illustrate differences in efficiency of nitrogen utilization, which further evidences the significant response of nitrogen only up to 30 kg N/ha in general way. Ram *et al.* (2012) also could not find significant variation in GFY of dual purpose barley due to basal application of 26.7, 40 and 53.3 kg N/ha. Kwabiah (2005) observed that forage yield of barley responded in a quadratic manner to increasing N rates and could not find encouraging response beyond 30 kg N/ha. Hedi *et al.* (2012) also reported that nitrogen application beyond 50 kg/ha was not effective in respect of various growth parameters of barley. Findings of this study are in close conformity with those of several reports from other parts of country pertaining to performance of dual purpose barley under varying nitrogen schedules tested in U. P., Hisar, Delhi, Rajasthan, (Anonymous, 2010).

Nitrogen application @ 40 to 80 kg/ha as basal caused significant increase in nitrogen content of plants as well as nitrogen uptake by the crop in comparison to 20 kg N/ha. Basal dose of 40, 45, 60 and 80 kg N/ha brought about consistently increasing trends in nitrogen content of dry fodder (Table 3B). Similar trends were noted in nitrogen uptake by the crop Table 6. In both these parameters, 40 kg N/ha was at par with 45, 60 and 80 kg N/ha. It was obvious that up to cutting for green fodder (at 55 DAS) nitrogen nutrition of the crop plants improved consistently with nitrogen supply up to 40 kg/ha. Thus, while dilution and concentration of nitrogen in cell sap may be the reason for a few non-significant variations in nitrogen contents of fodder at increasing nitrogen levels, slightly increased dry matter accumulation from 30 to 60 kg N/ha coupled with increasing concentrations of nitrogen is the obvious effect of nitrogen application on N uptake in the present study. This was again confirmed as the difference between 30 and 45 kg N/ha was significant in respect of dry matter yield (Table 2B). Kwabiah (2005) noticed that at low seeding rate (110 kg/ha), forage N yield increased by 20 per cent when N rate was increased from 0 to 30 kg/ha but remained unchanged when N rate was increased from 30 to 60 kg N/ha. However at high seeding rate (160 kg/ha) forage N yield increased by 51 per cent when N rate was increased from 0 to 30 kg/ha but reduced by 6 per cent when N rate was increased from 30 to 60 kg/ha. Results of present study are in accordance with the findings of Singh and Singh (2005), Rashid and Khan (2008) and Ram *et al.* (2012).

Nitrogen application brought about significant variations in crude protein content Table 3, crude fat, mineral matter content (Table 5) and crude protein yield (Table 6) of barley fodder. Crude protein (CP) content of fodder increased significantly with nitrogen applied up to 80 kg N/ha level as compared

TABLE 2A
Comparison between green fodder yield (q/ha) of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	50.74* (8.02)	61.69* (8.45)	63.88* (9.26)	67.08* (8.45)	69.32* (11.34)
N_{30}		0 (0)	10.95* (7.07)	13.14* (8.02)	16.34* (7.07)	18.58* (10.35)
N_{40}			0 (0)	2.19 (8.45)	5.39 (7.56)	7.63 (10.69)
N_{45}				0 (0)	3.2 (8.45)	5.44 (11.34)
N_{60}					0 (0)	2.24 (10.69)
N_{80}						0 (0)

The values in parentheses are LSD values. *Significant at P=0.05 level.

TABLE 2B

Comparison between dry matter yield (q/ha) of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	9.7* (2.03)	10.42* (2.14)	12.16* (2.35)	10.73* (2.14)	8.82* (2.87)
N_{30}		0 (0)	0.72 (1.79)	2.46* (2.03)	1.03 (1.79)	-0.88 (2.62)
N_{40}			0 (0)	1.74 (2.14)	0.31 (1.91)	-1.6 (2.71)
N_{45}				0 (0)	-1.43 (2.14)	-3.34* (2.87)
N_{60}					0 (0)	-1.91 (2.71)
N_{80}						0 (0)

The values in parentheses are LSD values. *Significant at P=0.05 level.

TABLE 3

Effect of doses of nitrogen on nitrogen, crude protein and neutral detergent fibre content (%) of fodder

Treatment (Doses of nitrogen*)	Content (%) (Mean over uneven number of replications)		
	Nitrogen	Crude protein	Neutral detergent fibre
20 kg/ha (N_{20})	1.50	9.36	40.03
30 kg/ha (N_{30})	1.53	9.57	40.29
40 kg/ha (N_{40})	1.54	9.61	40.63
45 kg/ha (N_{45})	1.55	9.66	41.20
60 kg/ha (N_{60})	1.57	9.79	41.46
80 kg/ha (N_{80})	1.58	9.89	41.13
F test	S	S	NS

S–Significant, NS–Not Significant.

to lower doses of nitrogen (20 and 30 kg/ha) but beyond 40 kg N/ha, response in terms of CP content was significant. Neutral detergent fibre (Table 3), acid detergent fibre (Table 4B) and lignin contents (Table 5), however, remained unaffected due to increased application of nitrogen. Increase in crude protein content of fodder due to nitrogen application was obvious as increased availability of nitrogen to crop plants led to more absorption and thus resulted in increased nitrogen accumulation in plants, which contributed to crude protein content. Several workers have reported similar effects of nitrogen application on crude protein content of barley (Zhang *et al.*, 2002; Singh *et al.*, 2009; Hedi *et al.*, 2012). Crude protein yield being a function of dry matter and crude protein content logically ascribes the significant increase so recorded here in the present study. Significant increase in crude fat and mineral matter contents due to nitrogen application was also noticed in the present study (Table 5). It is interesting to indicate that when plants remain more in meristematic activity, the respiration process becomes rapid and in rapid process of respiration, most of the carbohydrates are converted into fats (Meyer and Anderson, 1952). Thus, with the application of nitrogen not only protein content is improved but mineral salts and crude fats are also improved (Ayub *et al.*, 1999; Kumawat *et al.*, 1999; Yadava, 2000; Kawka *et al.*, 2009).

TABLE 4A

Comparison between nitrogen content (%) of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	0.03 (0.04)	0.04* (0.04)	0.05* (0.04)	0.07* (0.04)	0.08* (0.05)
N_{30}		0 (0)	0.01 (0.03)	0.02 (0.04)	0.04* (0.03)	0.05* (0.05)
N_{40}			0 (0)	0.01 (0.04)	0.03 (0.04)	0.04 (0.05)
N_{45}				0 (0)	0.02 (0.04)	0.04 (0.05)
N_{60}					0 (0)	0.02 (0.05)
N_{80}						0 (0)

*Significant at P=0.05 level.

TABLE 4B

Comparison between crude protein content (%) of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	0.21 (0.24)	0.25* (0.25)	0.31* (0.27)	0.44* (0.25)	0.53* (0.34)
N_{30}		0 (0)	0.05 (0.21)	0.1 (0.24)	0.22* (0.21)	0.32* (0.31)
N_{40}			0 (0)	0.05 (0.25)	0.18 (0.22)	0.28 (0.32)
N_{45}				0 (0)	0.13 (0.25)	0.22 (0.34)
N_{60}					0 (0)	0.1 (0.32)
N_{80}						0 (0)

*Significant at P=0.05 level.

TABLE 5

Effect of doses of nitrogen on acid detergent fibre, lignin, crude fat and mineral matter content (%) of fodder

Treatment	Content (%) (Mean over uneven number of replications)			
	Acid detergent fibre	Lignin	Crude fat	Mineral matter
20 kg/ha (N_{20})	27.36	2.16	1.86	9.02
30 kg/ha (N_{30})	27.63	2.09	1.93	9.71
40 kg/ha (N_{40})	27.89	2.11	1.99	9.74
45 kg/ha (N_{45})	28.05	2.17	1.99	9.82
60 kg/ha (N_{60})	28.26	2.13	1.98	9.80
80 kg/ha (N_{80})	28.83	2.18	2.01	9.79
F test	NS	NS	S	S

*Significant at P=0.05 level.

TABLE 5A

Comparison between crude fat content (%) of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	0.07* (0.07)	0.13* (0.08)	0.13* (0.08)	0.12* (0.08)	0.15* (0.103)
N_{30}		0 (0)	0.06 (0.06)	0.06 (0.07)	0.05 (0.06)	0.08 (0.094)
N_{40}			0 (0)	0.01 (0.08)	-0.01 (0.07)	0.02 (0.097)
N_{45}				0 (0)	-0.01 (0.08)	0.02 (0.103)
N_{60}					0 (0)	0.03 (0.097)
N_{80}						0 (0)

*Significant at P=0.05 level.

TABLE 5B

Comparison between mineral matter content (%) of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	0.69* (0.32)	0.72* (0.34)	0.8* (0.37)	0.78* (0.34)	0.77* (0.45)
N_{30}		0 (0)	0.03 (0.28)	0.11 (0.32)	0.09 (0.28)	0.08 (0.41)
N_{40}			0 (0)	0.08 (0.34)	0.06 (0.3)	0.05 (0.42)
N_{45}				0 (0)	-0.02 (0.34)	-0.03 (0.45)
N_{60}					0 (0)	-0.01 (0.42)
N_{80}						0 (0)

*Significant at P=0.05 level.

TABLE 6

Effect of N doses on crude protein yield (kg/ha), N uptake (kg/ha) by fodder and partial factor productivity in green fodder (PFPn)

Treatment	Mean over uneven number of replications		
	Crude protein yield	Nitrogen uptake	PFPn
20 kg/ha (N_{20})	136.34	21.81	312.81
30 kg/ha (N_{30})	232.04	37.13	377.67
40 kg/ha (N_{40})	239.88	38.38	310.63
45 kg/ha (N_{45})	257.91	41.27	280.97
60 kg/ha (N_{60})	247.65	39.62	216.07
80 kg/ha (N_{80})	231.07	36.97	164.84
F test	S	S	S

*Significant at P=0.05 level.

TABLE 6A

Comparison between crude yield (kg/ha) of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	95.7* (20.18)	103.54* (21.28)	121.57* (23.31)	111.31* (21.28)	94.73* (28.55)
N_{30}		0 (0)	7.84 (17.8)	25.87* (20.18)	15.61 (17.8)	-0.97 (26.06)
N_{40}			0 (0)	18.03 (21.28)	7.77 (19.03)	-8.81 (26.91)
N_{45}				0 (0)	-10.26 (21.28)	-26.84 (28.55)
N_{60}					0 (0)	-16.58 (26.91)
N_{80}						0 (0)

*Significant at P=0.05 level.

TABLE 6B

Comparison between nitrogen uptake (kg/ha) by fodder of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	15.32* (3.23)	16.57* (3.4)	19.46* (3.73)	17.81* (3.4)	15.16* (4.57)
N_{30}		0 (0)	1.25 (2.85)	4.14* (3.23)	2.49 (2.85)	-0.16 (4.17)
N_{40}			0 (0)	2.89 (3.4)	1.24 (3.04)	-1.41 (4.31)
N_{45}				0 (0)	-1.65 (3.4)	-4.3 (4.57)
N_{60}					0 (0)	-2.65 (4.31)
N_{80}						0 (0)

*Significant at P=0.05 level.

TABLE 6C

Comparison between PFPn (kg green fodder/kg N) of each pair of treatments using LSD test with unequal replications

	N_{20}	N_{30}	N_{40}	N_{45}	N_{60}	N_{80}
N_{20}	0 (0)	64.86* (21.01)	-2.18 (22.14)	-31.84* (24.26)	-96.74* (22.14)	-147.97* (29.71)
N_{30}		0 (0)	-67.04* (18.53)	-96.7* (21.01)	-161.6* (18.53)	-212.83* (27.12)
N_{40}			0 (0)	-29.66* (22.14)	-94.56* (19.81)	-145.79* (28.01)
N_{45}				0 (0)	-64.9* (22.14)	-116.13* (29.71)
N_{60}					0 (0)	-51.23* (28.01)
N_{80}						0 (0)

*Significant at P=0.05 level.

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