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Research Paper

Nitrogen and cutting management of dual-purpose barley (*Hordeum vulgare*) varieties for their production potential and profitability

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ABSTRACT

A field experiment was conducted during the winter (*rabi*) season of 2016–17 and 2017–18 at Research Farm, Rajasthan Agricultural Research Institute, Durgapura, Jaipur (Rajasthan), to study the effect of nitrogen and cutting management on production, potential and profitability of dual-purpose barley (*Hordeum vulgare* L.) varieties. The experiment consisted of 24 treatment combinations, comprising of 4 levels of cutting management, i.e. 0, 40, 50 and 60 days after sowing (DAS), 2 varieties, viz. 'RD 2552' and 'RD 2715', and 3 levels of nitrogen, i.e. 100, 125 and 150% recommended dose of nitrogen (RDN), laid out in a factorial randomized block design, replicated thrice. The maximum green fodder yield (26.30 t/ha) and protein content (8.34%) were noticed when cutting was done at 60 DAS, whereas the highest net returns (₹ 74,447/ha) and benefit: cost ratio (2.02) were recorded at 50 DAS. The highest fodder yield (16.55 t/ha) was recorded with 'RD 2715', while the highest net returns (₹ 68,002/ha) and benefit: cost ratio (1.92) were obtained in variety 'RD 2552'. Nitrogen fertilization of 125% RDN to barley recorded significantly higher grain and straw yields, crude protein and benefit: cost ratio.

***Key words*:** Cutting management, Dual purpose barley varieties, Economics, Nitrogen, Quality

In India, Rajasthan is the largest state having more than 50% of area and production of barley (*Hordeum vulgare* L.), followed by Uttar Pradesh (Gupta, 2013). Barley grain has prime place as animal feed alone or in combination owing to high amount of protein yield as well as digestibility than other cereals. The rising health consciousness and barley being a valuable source of beta-glucum, this crop offers better opportunity for popularizing it as a food crop for human consumption either as its direct use or through blends with other cereals like wheat (Kumar *et al*., 2014). Owing to hardy nature it is generally grown under low inputs in marginal lands. Nitrogen plays a vital role for obtaining higher yield in cereal crops, the amount of nitrogen absorption and partition mainly determined through demand and supply during different growth stages of crops. Nitrogen management in barley becomes difficult when it is grown for green fodder as well as grain purpose. Improper time of nitrogen fertilization and rates can reduce seed yield and quality of seed. Fodder is main source of protein in ration of milch animals and therefore cultivating more nutritious and higher-yielding fodder varieties are imperative. In addition, cutting schedule is more important for obtaining higher green fodder, grain yield, soft and palatable fodder.

When forage is removed during the vegetative and jointing stage of growth, the grain yield is generally limited by the plant potential to produce new leaf area rapidly and its ability to prevent tiller senescence during the period between jointing and anthesis (Dunphy *et al*., 1984). Several authors have agreed upon the importance of rapid regeneration of leaf area after forage removal to establish sufficient photosynthetic capacity to support maximum grain yield (Winter and Thompson, 1987). Fodder harvesting affects the tillering, stem enlargement, growth of shoot and root, and finally the crop yield. With the development of dual-purpose barley varieties, it has become possible to catch both the needs, namely green fodder and grain from the single crop raising.

When grown as a green fodder plus grain crop, the first cut of barley at proper vegetative growth stage provides

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fresh and nutritious green fodder to animal at minimal cost. The ratoon is maintained for grain. Harvesting at crop maturity gives satisfactory grain yield and straw yield. Barley straw is an important feed source for cattle and small ruminants during the dry season. Due to recent droughts in the drier parts of northern plains, acute shortage of green forage may occur during scarcity period (November to February). In such situations barley can be utilized as an alternative source of green forage. Considering these facts, an experiment was planned to study the effect of nitrogen and cutting management in dual-purpose barley varieties for their production potential and profitability.

MATERIALS AND METHODS

A field experiment was conducted during the winter (*rabi*) seasons of 2016–17 and 2017–18 at the Research Farm, Rajasthan Agricultural Research Institute, Sri Karan Narendra Agriculture University, Durgapura, Jaipur (75º 47" E, 26º 51" N, 390 m above mean sea-level). This region falls under Agro-climatic zone III-a (Semi-arid eastern plain zone) of Rajasthan. The climate of this region is a typically semi-arid, characterized by aridity of the atmosphere and extremity of temperature both in summer (45.5º C) and winter (4ºC). The average rainfall is in between 500 and 700 mm. The soil of the experimental field was loamy sand, slightly alkaline, poor in organic carbon with low available nitrogen (136.4 kg/ha), high available phosphorus (34 kg/ha) and potassium (195.4 kg/ha), status. The experiment comprised 4 levels of cutting management [0, 40, 50 and 60 days after sowing (DAS)], 2 varieties ('RD 2552' and 'RD 2715') and 3 levels of nitrogen [100, 125 and 150% recommended dose of nitrogen (RDN)], making 24 treatment combinations. There were laid out in a factorial randomized block design with 3 replications. The fertilizer 60 kg N + 40 P_2O_5 kg/ha was applied through urea and diammonium phosphate. Half dose of N and full dose of P were applied basal at the time of sowing and 25% N was applied at the time of 1st irrigation. However, remaining 25% N was applied through urea after green fodder cutting. Prior to sowing, the seeds were treated with bavistin @ 2.5 g/kg to protect from seed-and soil-borne diseases. The seeds were sown by *kera* method at about 5 cm depth in rows, 22.5 cm apart, using 100 kg seed/ha. Irrigation was given as per the requirement of crop using check-basin method. Three cutting schedules were done at 40, 50 and 60 DAS for green fodder.

The crude protein content in fodder was calculated by multiplying nitrogen concentration in fodder (%) on dry-matter basis with a factor of 6.25. The net plots, leaving the 2 border rows on and 0.5 m on opposite direction of the plots of barley were harvested manually with sickles. After threshing the bundles from each plot, the grains were cleaned, dried and weighed. The grain yield was expressed in t/ha. Straw yield was obtained by subtracting the grain yield from the weight of total biological yield for individual plots and was expressed in tonnes/ha. The net returns of each treatment were calculated by deducting the total cost of cultivation from gross returns of respective treatments and the benefit: cost ratio was calculated by dividing the net returns with total cost of cultivation. All data recorded were analyzed with the help of analysis of variance (ANOVA) technique (Gomez and Gomez, 1984) for split plot using SAS 9.3 software (SAS Institute, Cary, NC). The least significant test was used to decipher the main the interaction effects of treatments at 5% level of significance (P<0.05).

RESULTS AND DISCUSSION

Grain and straw yields

The highest grain yield was obtained from no cut treatment, followed by cutting at 40 DAS which was statistically superior to cutting at 50 DAS and 60 DAS with the magnitude of 9.65 and 71.70% respectively (Table 1). It is well known that, N plays important role for providing nutrient to the plants during vegetative and reproductive stage. Variety 'RD 2552' gave the maximum grain yield (3.56 t/ha) which was significantly higher than that of 'RD 2715' (3.23 t/ha). Grain yield of barley increased significantly with application of 125% RDN in comparison to 100% RDN. However, the highest grain yield was obtained with 150% RDN.

Straw yield of barley was influenced in similar trend as grain yield owing to various cutting schedules. Different stage of cutting differed the straw yield significantly with advancement of stage of cutting for green fodder. Barley variety 'RD 2552' gave the highest straw yield over 'RD 2715'. The maximum straw yield was obtained with application of 150% RDN over lower levels. Biological yield of barley indicated that, biological yield significantly decreased with advancement of stage of cutting for green fodder; biological yield was negatively affected. The maximum biological yield was given by variety 'RD 2552' as compared to 'RD 2715', indicating an increase of 13.19%. The highest biological yield (8.66 t/ha) of barley was observed with the fertilization of 150% RDN, being 19.94% higher than 100% RDN. Different cutting schedules as well as nitrogen management and varieties could not influence the harvest index of barley up to the level of significance. The profound impact of nitrogen application on each of these characters mediated by using improved photosynthetic performance and nutrient accumulation might have finally increased the biological yield. The findings of present experiments showed that, productivity of dual-purpose barley varieties increased with the increasing the level

Table 1. Effect of cutting and nitrogen management on yield, harvest index and seed viability of dual-purpose barley varieties (pooled data 2 years)

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Green fodder yield (t/ha)	Harvest index (%)	Seed viability (%)
Cutting-management					
No cutting	4.78	6.21	0.00	43.56	85.3
40 DAS	3.52	4.91	14.78	41.81	84.3
50 DAS	3.21	4.55	21.65	41.45	82.8
60 DAS	2.05	3.08	26.30	40.02	82.1
SEm±	0.07	0.08	0.29	0.59	0.95
CD (P=0.05)	0.18	0.23	0.81	NS	NS
Varieties					
RD 2552	3.56	5.03	14.81	41.14	84.2
RD 2715	3.23	4.35	16.55	42.28	83.0
SEm±	0.05	0.06	0.20	0.42	0.67
CD (P=0.05)	0.13	0.16	0.58	NS	NS
Nitrogen-management					
100% RDN	3.09	4.13	14.65	42.50	80.9
125% RDN	3.48	4.89	16.02	41.27	84.3
150% RDN	3.61	5.05	16.38	41.36	85.7
SEm±	0.06	0.07	0.25	0.51	0.82
CD (P=0.05)	0.16	0.19	0.71	NS	2.33

DAS, days after sowing; RDN, recommended dose of nitrogen

of nitrogen application. Our results confirm the findings of Sharma and Verma (2010); Rawat (2011); Tiwana *et al.,* (2012) and Raval *et al*., (2014).

Green fodder yield

Green fodder yield significantly increased with the delay in cutting schedule (Table 2). The highest green fodder yield was obtained when with cutting was done at 60 days after sowing. Green fodder yield at 60 DAS increased to 77.9 and 21.5% in comparison to cutting at 40 and 50 days after sowing. Barley variety 'RD 2715' gave significantly higher green fodder yield than 'RD 2552'. The highest green fodder yield of barley was recorded with the application of 150% RDN. Results also showed that, application of 150% RDN increased the green fodder yield with the margin of 2.24% over 125% RDN. However, they could not bring any significant variation with 125% RDN.

The improved growth and higher tillering because of nitrogen application matched with increasing photosynthesis on one side and higher mobilization of assimilates towards reproductive structure (sink) on the other side, may have been responsible for components of yield. Increasing the nitrogen levels significantly influenced total biomass production, crude protein content and fodder yield. This might be owing to higher supply of N increased the protoplasmic constituent and accelerated processes such as cell-division and cell elongation, thereby resulting luxuriant growth and higher green fodder yield. These results confirm the findings of Singh *et al*. (2010) and Jarial (2015).

Quality of seed and fodder

Data showed that among the cutting schedules, fodder harvest at 60 days after sowing produced maximum protein concentration in green fodder over cutting at 40 and 50 DAS (Table 2). The results showed that, no-cutting treatment recorded maximum content of protein in grain and straw and the values of protein content in grain (10.75%) and straw (3.25%). Protein content of grain and straw gradually increased with increasing dose of nitrogen up to 125% RDN. Cutting at 40 DAS produced significantly more palatable fodder as compared to cutting at 50 and 60 DAS. The same treatment registered remarkable increase in palatability of green fodder to the tune of 3.74 and 8.38% over 50 and 60 days after cutting respectively. Variety 'RD 2715' produced more palatable fodder than 'RD 2552'. Results further showed that, increasing dose of N resulted in more palatable fodder up to 125% RDN over lower RDN. The improvement in crude protein content in grain may be attributed to the application of extra dose of nitrogen. It is the fact that nitrogen is the essential component of protein synthesis as a part of basic structures of all amino acids, enzymes, and synthesis of chlorophyll and also play vital role in various biochemical processes for the metabolism of carbohydrates, lipids and proteins in plants mechanism. Singh and Singh (2005) also reported similar results in barley fertilization with nitrogen increased the supply of N to crops caused better extraction and as a result maximum accumulation of nitrogen in vegetation, which contributed to increased CP content in green fodder.

Table 2. Effect of cutting and nitrogen management on crude protein, palatability and economics of dual-purpose barley varieties (pooled data 2 years)

Treatment	Crude protein (%)	Palatability (%)	Net returns (₹/ha)	Benefit: Cost ratio
Cutting management				
No cutting	0.00	0.0	62,656	1.94
40 DAS	7.21	97.5	66,138	1.82
50 DAS	7.86	94.0	74,447	2.02
60 DAS	8.34	90.0	61,074	1.64
SEm±	0.08	1.26	1,813	0.03
CD (P=0.05)	0.22	3.56	5,128	0.08
Varieties				
'RD 2552'	7.90	92.0	68,002	1.92
'RD 2715'	7.71	95.6	64,156	1.80
SEm±	0.06	1.03	1,282	0.03
CD (P=0.05)	NS	2.91	3,626	0.09
Nitrogen management				
100% RDN	6.67	88.5	57,392	1.62
125% RDN	8.30	95.3	68,863	1.94
150% RDN	8.45	97.7	71,981	2.02
SEm±	0.08	1.26	1,570	0.04
CD (P=0.05)	0.22	3.56	44	0.12

DAS, days after sowing; RDN, recommended dose of nitrogen

Similar results were reported in barley by Hadi *et al.*, (2012) and Choudhary *et al.,* (2014).

Net returns and benefit: cost ratio

Among different cutting-management treatments, cutting at 50 DAS fetched the highest net returns of ₹ 74,447/ha and benefit: cost ratio 2.02. Variety 'RD 2552' showed the highest net return of ₹ 68,002/ha and benefit: cost ratio of 1.92. Among different nitrogen-management treatments, the highest net returns of ₹ 71,981/ha and benefit: cost ratio of 2.02 were obtained with 150% RDN. However, it could not bring any significant variation with 125% RDN.

It was concluded that cutting at 50 days after sowing and 125% recommended dose of nitrogen were found most suitable for obtaining maximum yields and good quality fodder of barley variety 'RD 2552'.

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