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Effect of cutting management and nitrogen levels on biomass production and proximate quality of barley (*Hordeum vulgare*) in saline soil

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ABSTRACT

A field experiment was conducted during the winter (*rabi*) seasons of 1997–1998 to 1999–2000 on an alluvial loamy sand saline soil at Hisar, to find out the effect of cutting management and nitrogen levels on biomass production and proximate quality of barley (*Hordeum vulgare* L.). Dry forage yield of barley was 6.3% higher when harvested once at 50% heading compared with 2 cuttings at 60 days of growth and 50% heading. The total biomass was 3.8% higher when harvested for grain purpose compared to the treatment in which the crop was first harvested for forage at 60 days and subsequently left for grain purpose. However, no significant differences were observed in the yield equivalents of barley grown for grain purpose or green forage and grain. Application of N significantly increased the yield from 22.5 q/ha with 60 kg N/ha to 29.3 q/ha with 80 kg N/ha. The protein and mineral matter contents were higher in grains (9.2 and 4.7%) and fodder (5.3 and 10.3%) harvested at the early stages than 9.0 and 4.6% in grain; and 4.9 and 9.8% in fodder at the late stage. However, the fibre and lignin contents were more in fodder harvested at later stages. With increasing levels of N application, the mineral matter remained unaffected, while the crude protein and lignin contents increased and fibre decreased in both fodder as well as grain.

Key words : Barley, Biomass production, Cutting management, Forage/Grain yield, Nitrogen, Proximate quality

Barley is a valuable crop because it is grown for several purposes such as primary feed and fodder crop, malt and beer making and also as a staple food for human consumption. Its grain provides an excellent feed for cattle and horses, and straw is fed to cattle. The crop is generally grown in areas where irrigation facilities are limited, as it can tolerate moisture and salt stress to a great extent. Barley is more tolerant to saline and alkali conditions than other winter cereals (Mas and Hoffman, 1977). Taneja *et al.* (1981) and Rawat (1998) reported that barley can be grown for forage first and subsequently left for grain in normal soils. However, there is lack of specific information whether barley could be grown on saline soil as a dual-purpose crop. There is also little information available as to how the nitrogen fertilization will compensate the effect of first cut on the successive forage and grain yield at final harvest and its proximate quality. Hence the present investigation was conducted to study the response of cutting management and nitrogen application on biomass production and proximate quality of barley grown as a dual-purpose crop on a saline soil.

MATERIALS AND METHODS

A field experiment was conducted for 3 years during the winter seasons of 1997–98 to 1999–2000 on an alluvial loamy sand saline (4.8 d/Sm) soil at Central Institute for Research on Buffaloes, Hisar. Initial soil samples were taken from 0–15 and 15–30 cm soil depths at the commencement of the experiment in winter season of 1997–98. Soil samples were collected with 5-cm diameter auger, air-dried, ground, passed through a 2-mm sieve and their physico-chemical properties were analysed using standard methods (Page *et al.*, 1982). Soil physical analysis showed that the soil was loamy sand with 75% sand, 16.5% silt and 8.5% clay. Soil had ECe 4.8 dS/m, pH 7.8, organic matter 0.45%, available N 68 kg/ha, available P 23.6 kg/ha and available K 247 kg/ha in the surface layer. The experiment was laid out in split-plot design with 4 replications. The main plot treatments consisted of 4 cutting management, viz. cutting the barley crop for forage purpose at 50% heading (F); cutting the crop for forage purpose 60 days after sowing (DAS) and subsequently for forage at 50% heading (F+F); cutting the crop for forage

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purpose at 60 DAS and subsequently for grain purpose at maturity (F+G); and crop grown only for grain purpose (G); and 3 nitrogen levels, viz. 60, 80 an 100 kg N/ha, in the subplots.

The crop was sown in the second week of October during all the years. A seed rate of 100 kg/ha was used with inter-row spacing of 25 cm. In the treatments where barley was grown only for forage or grain, nitrogen as per treatment was given in 3 equal splits, viz. at sowing, and with first and second irrigation respectively. However, in the treatments where it was first harvested for forage and subsequently left for forage or grain, one-half of N was applied at the sowing time and the rest after taking the first cut. Canal water was used for irrigation and 5 irrigations of about 7 cm depth were applied in addition to 8-cm pre-sowing irrigation. The crop received 9.3, 11.8 and 2.6 cm rainfall during the growth period in 1997–98, 1998–99 and 1999–2000 respectively. Plant samples for dry-matter yield were dried in oven at 70°C ± 2 for 48 hr. The dried samples were ground and sieved through 1-mm sieve. Proximate parameters like mineral matter, crude protein and cell wall constituents (crude fibre and lignin) were determined following the standard procedures (Gupta *et al.*, 1988; AOAC, 1990; Van Soest *et al.*, 1991). The grain-yield equivalent of barley for each treatments was computed considering the prevailing market prices of the respective components. The crop was harvested for seed in the first fortnight of April. Statistical analysis for biomass yield was not performed because the treatments involved different plant components and thus the mean biomass production of the 3 years was worked out.

RESULTS AND DISCUSSION

Biomass production

As the treatment involved different plant components, their statistical analysis was not feasible, but the statistical analysis for total biomass production (average of 3 years) was done (Table 1). Dry forage yield was about 6.3% higher when barley was harvested once at 50% heading, compared with 2 cuttings at 60 days after sowing (DAS) and 50% heading. Similarly, when the treatments involving grain yield were compared, total biomass was slightly higher when harvested for grain purpose compared with the first harvesting for forage at 60 DAS and subsequently for grain purpose. Higher biomass in the latter 2 treatments (harvesting for fodder at 60 DAS and for grain at maturity, and harvesting for grain only) was largely due to higher straw yield. Taneja *et al.* (1981) observed that from barley and oat 1 cut can be taken for green fodder without much reduction in seed yield. Application of 80 and 100 kg N/ha increased the biomass production significantly over 60 kg N level. The rate of increase in biomass due to N application was more at 80 kg N/ha (first level impact) than at 100 kg N/ha, followed the law of diminishing returns. Rawat (1998) also found that the dose of 80 kg N/ha was optimum for barley and oat. Taneja *et al.* (1981) mentioned that for seed yield of barley and oat the response was significant up to 80 kg N/ha.

Yield equivalent

Yield equivalent of barley was not significant between treatments involving 1 and 2 cuts for green fodder alone as well as between treatments involving harvesting of barley for grain (Table 2). The yield equivalents were almost 2 times more in treatments involving raising of crop for grain than in those involving raising for green fodder

Table 2. Grain-equivalent yield of barley (q/ha) as affected by cutting management and nitrogen levels

Treatment	1997–98	1998–99	1999–2000	Mean
Cutting management				
Forage	21.6	19.4	19.6	20.2
Forage + forage	19.5	18.5	18.8	18.9
Forage + grain	36.8	36.4	38.2	37.1
Grain	38.5	37.0	36.4	37.3
CD (P=0.05)	5.8	7.4	6.7	
Nitrogen (kg/ha)				
60	23.4	21.6	22.4	22.5
80	29.7	28.9	29.2	29.3
100	34.3	33.0	33.1	33.5
CD (P=0.05)	3.7	4.3	4.5	

Price (Rs/q) : Straw 80; grain, 500; green fodder, 40

Table 1. Biomass production (q/ha) of barley as affected by cutting management and nitrogen levels

Purpose	N 60 kg/ha				N 80 kg/ha				N 100 kg/ha			
	F	G	S	Total	F	G	S	Total	F	G	S	Total
Forage	35.7	0	0	35.7	43.7	0	0	43.7	49.7	0	0	49.7
Forage + forage	30.3	0	0	30.3	42.4	0	0	42.4	48.3	0	0	48.3
Forage + grain	8.3	19.4	31.3	59.0	11.7	25.4	46.3	83.4	13.3	29.3	55.0	97.6
Grain	0	24.0	40.6	64.6	0	29.2	56.0	85.2	0	32.8	66.3	99.1
CD (P=0.05)				4.6				3.9				4.3

F, Forage, G, grain; S, straw

Table 3. Mean proximate quality (%) of barley as affected by cutting management and nitrogen levels

se	Consituent	60 kg N/ha			80 kg N/ha			100 kg N/ha		
		F	G	S	F	G	S	F	G	S
age	CP	4.6			4.9			5.2		
(50% heading)	MM	9.7			9.8			9.8		
	CF	30.8			28.8			29.0		
	Lignin	6.1			6.5			6.7		
Forage + forage	CP	4.9			5.4			5.6		
(60 DAS +	MM	10.5			10.5			10.3		
50% heading)	CF	23.9*			22.4*			22.2*		
	Lignin	29.9			29.4			28.7		
	Lignin	5.0*			5.2*			5.2*		
		7.3			7.3			7.3		
Forage + grain	CP	5.0	9.1	3.2	5.5	9.3	3.0	5.7	9.2	3.3
(60 DAS +	MM	10.1	4.7	10.7	10.0	4.8	10.6	10.2	4.6	10.5
maturity)	CF	23.3			23.5			23.5		
	Lignin	4.7			5.0			5.0		
Grain	CP		9.1	2.9		9.0	2.9		9.1	3.2
(at maturity)	MM		4.6	9.7		4.5	11.1		4.8	10.6
	CF			36.6			35.9			35.9
	Lignin			8.5			9.0			8.8

CP, Crude protein; MM, mineral matter; C.F, crude fibre; F, forage; G, grain; S, straw
*Values for forage were taken 60 days after sowing

alone. The straw yield (dry-matter residue at harvest) was the major contributor to equivalent yield (Table 2). Similar results were obtained by Sharma and Bhunia (2001). The 2 grain production treatments were significantly superior to forage production treatments. There was also steady increase in the yield equivalents up to 100 kg N/ha and the increase was significant at each successive N level except during 1999–2000, when the differences between 80 and 100 kg N/ha levels were not significant. Sharma and Bhunia (2001) recorded the highest yield of forage, grain, net return and benefit : cost ratio with 80 kg N/ha but in the present study application of 100 kg N/ha was found optimum.

Proximate composition

Crude protein content in green forage of barley was higher in the first harvest at 60 DAS than that harvested at 50% heading (Table 3). This was owing to dilution effect with ageing. Application of N steadily increased the crude protein content. Shah and Hassan (1999) also observed higher crude protein content in oat fodder with increasing levels of N. Grain contained appreciably higher crude protein than forage. There was, however, no effect of N on protein content of grain and straw in the treatments where barley was harvested for grain.

Mineral matter was also higher in the first cut compared with that at 50% heading. However, the mineral matter content was not influenced due to N application. On the other hand, crude fibre and lignin were lower in the first harvest compared with that at 50% heading. Crude fibre was not affected but the lignin content increased with N levels. The increase in fibre and lignin and decrease in crude protein content with age of crop could be due to synthesis of more structural carbohydrates at the later stages (Panwar *et al.*, 1999).

Thus barley can be grown as dual-purpose crop on saline soils successfully. The crop can be first harvested for forage at 60 days after sowing and subsequently for grain purpose without much grain yield reduction. Application of N increases its yield significanlty up to 80 kg N/ha. Forage contains greater protein and mineral matter but lower fibre and lignin contents when harvested at the early stages.

REFERENCES

AOAC. 1990. *Official Methods of Analysis*, edn 12. Association of Analytical Chemists, Washington DC.

Gupta, P.C., Khatta, V.K. and Mandal, A.B. 1988. *Analytical Techniques in Animal Nutrition*. Directorate of Publications, Haryana Agricultural University, Hisar, p. 98.

Maas, E.V. and Hoffman, G.L. 1977. Crop salt tolerance–current assessment. *Journal of Irrigation and Drainage Division. American Society of Civil Engineers* 113 : (IR2) : 115–134.

Page, A.L., Miller, R.H. and Kenny, D.R. 1982. *Methods of Soil Analysis*. Part I and II. American Society of Agronomy, Madison, Wisconsin, USA.

Panwar, V.S., Tewatia, B.S. and Lodhi, G.P. 1999. Chemical composition and dry matter digestibility of some varieties of sorghum harvested at different stages. *Forage Research* 24 : 209–211.

Rawat, C.R. 1998. Nitrogen requirement of barley and oat for feed and fodder. *Forage Research* 23 : 135–140.

Shah, W.A. and Hassan, B. 1999. Grain and fodder yield of oats as influenced by nitrogen levels and cutting schedules. *Forage Research* 24 : 185–190.

Sharma, S.K. and Bhunia, S.R. 2001. Response of oat (*Avena sativa*) to cutting management, method of sowing and nitrogen. *Indian Journal of Agronomy* 46 : 563–567.

Taneja, K.D., Gill, P.S. and Solanki, K.R. 1981. Possibility of taking fodder in addition to seed from barley (*Hordeum vulgare* L.) and oats (*Avena sativa*) under different levels of nitrogen. *Forage Research* 7 : 31–38.

Van Soest, P.J., Robertson, H.B. and Lewis, B.A. 1991. Method of dietary fibre, NDF and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* 74 : 3,583–3,597.