



Nutritional evaluation of dual purpose barley as fodder

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ABSTRACT

The present study was taken up to assess the effect of N scheduling on the fodder and grain yield and on the nutritional worth of green fodder obtained from grain (RD-2552) and dual purpose (RD-2035) barley (*Hordeum vulgare* L.) varieties. The crop of both the cultivars was harvested 55 days after sowing (DAS) and was used as fodder. Nitrogen fertilizer (urea) was applied @ 87q/ha, either 50% at the time of sowing and 50% after 55 DAS (T₁); 50% at the time of sowing, 25% after 55 DAS and 25% after next irrigation i.e. 80 DAS (T₂); 33% at the time of sowing, 33% after 55 DAS and 33% after 80 DAS (T₃); 33% at the time of sowing and 67% after 55 DAS (T₄) or 67% at the time of sowing and 33% after 55 DAS (T₅). Both the varieties of barley were cultivated in 1.15 m × 7.0 m plots in triplicate at the Ludhiana campus of Punjab Agricultural University for 2 consecutive years. The data were analyzed statistically by using 2 × 5 factorial design. The dual purpose variety, irrespective of N-scheduling, gave significantly higher fodder and significantly lower grain yield as compared to grain variety. The N-scheduling, irrespective of the genotype, did not have any significant effect on the fodder yield in 2008–09, but during 2009–10 significantly higher fodder yield was observed in T₅ as compared to T₃ and T₄ N-scheduling. While reverse trend was observed in grain yield i.e. it was highest in T₄ followed by T₃, but lowest in T₁ N-scheduling in both the years of cultivation. The grain variety had significantly higher total ash, CP and hemicellulose content, while the dual purpose variety had significantly higher ADF and cellulose content. The T₂ N-scheduling resulted in the highest CP and EE content and lowest cell wall constituents. The net gas production, digestibility of nutrients, VFA production and ME availability were significantly higher in the fodder of grain variety as compared to dual purpose barley variety. The N-scheduling showed no significant effect on above parameters. It was concluded that grain variety (RD-2552) had high grain and straw yield but low green fodder yield with better nutritional quality as compared to dual purpose barley variety (RD-2035).

Key words: Dual purpose barley, Fodder, *In-vitro* evaluation, Nutrient digestibility, VFA production, Yield

The availability of green fodder/animal/d in Punjab state of India has increased remarkably from 10 kg (1974–75) to 21 kg (2009–10). But to boost the milk production in the state and in turn at national level, strenuous but consistent efforts will have to be made for increasing quality fodder production and its per capita availability to the livestock. The gap in the demand and supply of green fodder can be covered up to a certain extent by developing high yielding fodder varieties as well as dual purpose cereal varieties. A few reports are available on the fodder and grain yield of dual purpose crops like wheat, barley, oats, triticale and canola (Al-Doss *et al.* 2000, Kaur *et al.* 2009, GRDC 2009, Vishwakarma *et al.* 2011, Hari Ram *et al.* 2012), but little

information is available on the chemical composition and the nutritional worth of the fodder from dual purpose barley. The present study was therefore, taken up to assess the effect of nitrogen scheduling on the fodder and grain yield and on the nutritional worth of green fodder obtained from grain (RD-2552) and dual purpose (RD-2035) varieties of barley.

MATERIALS AND METHODS

Fodder and grain yield: The grain (RD-2552) and dual purpose (RD-2035) varieties of barley were cultivated in 1.15 m × 7.0 m plots in triplicate at the Research Farms of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana for 2 consecutive years (2008–09 and 2009–10) and supplied for nutritional evaluation. The barley crop was sown using seed rate of 87.5 kg/ha between 10–16 November and harvested on 25–30 March in both the years of the study. The crop of both the cultivars was harvested 55 days after sowing (DAS) and was used as fodder. Phosphorus fertilizer (P₂O₅) was applied @ 30 kg/ha at the time of sowing. Nitrogen fertilizer (urea) was applied @ 80 kg/ha either 50% at the time of sowing and 50% after 55 DAS (T₁); 50% at the time of

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sowing, 25% after 55 DAS and 25% after next irrigation i.e. 80 DAS (T_2); 33% at the time of sowing, 33% after 55 DAS and 33% after 80 DAS (T_3); 33% at the time of sowing and 67% after 55 DAS (T_4) or 67% at the time of sowing and 33% after 55 DAS (T_5).

In-vitro gas production studies: The nutritional value of fodder obtained from RD-2552 and that of RD-2035 cultivars of barley was evaluated by *in vitro* gas production technique (Menke *et al.* 1979, Menke and Steingass 1988). About 375 mg of the barley fodder (on DM basis) was incubated at 39°C for 24 h in triplicate in 100 ml calibrated glass syringes with buffered rumen fluid (Menke *et al.* 1979). Blank and sample of standard hay were run in triplicate with each set. Rumen contents were collected from 3 rumen fistulated buffalo calves, maintained on 2.0 kg conventional concentrate mixture (maize 25, mustard cake 10, de-oiled mustard cake 20, rice bran 15, de-oiled rice bran 27, mineral mixture 2 and common salt 1 part each) supplemented with 5.0 kg green fodder and 6.0 kg rice straw.

Chemical and statistical analysis: The finely ground (1 mm sieve) samples were analyzed in duplicate for nitrogen and total ash (AOAC 1995), cellulose (Crampton and Maynard 1938) and other cell wall constituents (Robertson and Van Soest 1981). The volatile fatty acids were estimated using Netchrom 9100 gas chromatograph equipped with glass column (packed with chromosorb 101) and flame ionization detector as per method described by Cottyn and Boucque (1968). The data were analyzed by 5×2 factorial design (Snedecor and Cochran 1994) by using the software package SPSS (2007) version 16 and differences in mean were assessed by using Tukey's b.

RESULTS AND DISCUSSION

Fodder and grain yield: The effect of genotype of barley, irrespective of N-scheduling, on the fodder and grain yield revealed that dual purpose variety (RD-2035) gave higher ($P<0.01$) fodder and lower ($P<0.01$) grain yield as compared to grain (RD-2552) variety (Table 1). The straw production was higher ($P<0.01$) in RD-2552 as compared to RD-2035. Kaur *et al.* (2009) have also reported almost similar fodder,

grain and straw yield from RD-2552 variety of barley. The differential response of varieties to forage and grain yield were also reported earlier (Singh *et al.* 2009). The N-scheduling, irrespective of the genotype, did not have any significant effect on the fodder yield in 2008–09, but during 2009–10 higher ($P<0.05$) fodder yield was observed in T_5 as compared to T_3 and T_4 N-scheduling. However, the fodder yield was comparable between T_1 and T_4 . While reverse trend was observed in grain yield i.e. it was highest ($P<0.01$) in T_4 followed by T_3 , but lowest in T_1 N-scheduling in both the years of cultivation. The interaction between N scheduling and the barley varieties was not significant. The fodder as well as grain yield was much higher during 2009–10 as compared in 2008–09, which may be due to favorable ambient temperature and other environmental conditions.

Chemical composition of barley fodder: The effect of genotype of barley, irrespective of the N scheduling, on the chemical composition of barley fodder revealed that grain variety (RD-2552) had higher ($P<0.05$) total ash, CP and hemicelluloses content as compared to dual purpose variety (RD-2035), but reverse ($P<0.01$) trend was observed with respect to OM, ADF and cellulose contents (Table 2). The effect of N-scheduling, irrespective of the barley genotype, on chemical composition of barley fodder revealed that T_2 N-scheduling resulted in the higher ($P<0.01$) CP and EE content, but lower ($P<0.05$) fiber fractions (NDF, ADF and hemicellulose) as compared to other N-scheduling. However, cellulose content was highest in T_1 scheduling. The N scheduling did not have any significant effect on total ash and OM content of barley fodder.

In-vitro digestibility: The effect of barley genotypes, irrespective of the N scheduling, on the digestibility and other parameters revealed that fodder of grain variety RD-2552 had higher ($P<0.01$) net gas production, digestibility of NDF and true OM, and ME availability as compared to dual purpose variety RD-2035 (Table 3). The partitioning factor was higher ($P<0.01$) in RD-2035 as compared to RD-2552. The barley genotypes did not have any significant impact on the *in vitro* release of ammonia. The effect of N-

Table 1. Effect of barley genotypes and N-scheduling on the fodder, grain and straw yield (q/ha)

	Variety (V)		PSE	Treatment (T)					PSE	Effects		
	RD-2552	RD-2035		T ₁	T ₂	T ₃	T ₄	T ₅		V	T	VxT
2008–09												
Fodder yield	149.48 ^A	177.74 ^B	5.94	170.29	173.98	148.62	152.69	172.94	9.4	**	NS	NS
Biomass yield	96.39 ^B	89.49 ^A	1.89	90.87	92.60	91.44	97.20	92.59	2.99	NS	*	NS
Grain yield	45.76 ^B	40.65 ^A	0.77	40.55 ^a	41.75 ^a	45.26 ^{ab}	47.16 ^b	41.29 ^a	1.21	**	**	NS
Straw yield	50.63	48.84	1.95	50.32	50.84	46.18	50.04	51.30	3.09	NS	NS	NS
2009–10												
Fodder yield	166.07 ^A	189.67 ^B	5.22	183.33 ^{ab}	187.50 ^{ab}	159.67 ^a	162.50 ^a	200.33 ^b	8.25	**	*	NS
Biomass yield	123.00 ^B	114.00 ^A	0.96	112.67 ^a	124.17 ^b	123.67 ^b	116.50 ^a	115.5 ^a	1.51	**	**	*
Grain yield	53.36 ^B	48.45 ^A	0.71	45.40 ^a	52.35 ^b	53.39 ^b	53.98 ^b	49.40 ^{ab}	1.12	**	**	NS
Straw yield	69.64 ^B	65.55 ^A	1.09	67.26 ^{ab}	71.82 ^b	70.28 ^b	62.52 ^a	66.10 ^{ab}	1.73	*	*	NS

Figures with different superscripts^{A,B} for different barley genotypes and superscripts^{a,b} for N-scheduling within a row differ significantly * $P<0.05$; ** $P<0.01$; NS, nonsignificant; PSE, pooled SE.

Table 2. Effect of barley genotypes and N-scheduling on the chemical composition of barley fodder (% DM basis)

	Variety (V)		PSE	Treatment (T)					PSE	Effects		
	RD-2552	RD-2035		T ₁	T ₂	T ₃	T ₄	T ₅		V	T	V×T
Total ash	16.14 ^B	15.33 ^A	0.16	15.58	15.87	15.59	15.73	15.91	0.26	*	NS	NS
OM	83.86 ^A	84.67 ^B	0.16	84.42	84.13	84.41	84.27	84.09	0.26	*	NS	NS
CP	14.05 ^B	13.66 ^A	0.11	13.82 ^{ab}	14.31 ^b	13.83 ^{ab}	13.45 ^a	13.87 ^{ab}	0.18	*	*	*
EE	2.34 ^A	2.45 ^B	0.21	2.33 ^a	2.49 ^b	2.43 ^{ab}	2.35 ^{ab}	2.37 ^{ab}	0.034	**	*	**
NDF	58.77	58.68	0.21	58.18 ^a	58.40 ^a	59.25 ^{ab}	59.88 ^b	57.92 ^a	0.34	NS	**	NS
ADF	38.92 ^A	40.36 ^B	0.23	39.08 ^{ab}	38.85 ^a	40.12 ^b	40.28 ^c	39.89 ^{ab}	0.37	**	*	*
Cellulose	31.87 ^A	34.54 ^B	0.18	33.85	33.12	32.70	32.92	33.42	0.28	**	NS	**
HC	19.84 ^B	18.72 ^A	0.19	19.10 ^{ab}	19.55 ^b	19.12 ^{ab}	19.61 ^b	18.04 ^a	0.30	**	**	**

HC, Hemicellulose; Figures with different superscripts^{A,B} for different barley genotypes and superscripts^{a,b} for N-scheduling within a row differ significantly *P<0.05; **P<0.01; NS, nonsignificant; PSE, pooled SE.

Table 3. Effect of barley genotypes and N-scheduling on the net gas production (NGP), digestibility, fermentability and ME availability from barley fodder

Variety (V)	PSE			Treatment (T)					PSE	Effects		
	RD-2552	RD-2035		T ₁	T ₂	T ₃	T ₄	T ₅		V	T	V×T
NGP, ml/g DM/24 h	145.12 ^B	137.13 ^A	1.56	144.22	139.31	142.05	140.64	139.41	2.47	**	NS	*
NDFD%	71.32 ^B	69.60 ^A	0.33	70.79	69.08	70.95	70.81	70.44	0.54	**	NS	*
TOMD%	80.71 ^B	79.60 ^A	0.22	80.82	79.46	80.47	80.08	79.92	0.34	**	NS	*
PF	2.46 ^A	2.63 ^B	0.03	2.46	2.54	2.54	2.58	2.60	0.05	**	NS	*
Ammonia-N	0.029	0.030	-	0.028 ^a	0.028 ^a	0.028 ^a	0.031 ^b	0.031 ^b	-	NS	**	**
ME availability, MJ/kg DM	7.13 ^B	6.92 ^A	0.043	7.07	7.06	7.03	6.95	7.02	0.07	**	NS	NS

NGP, Net gas production; NDFD, neutral detergent fiber digestibility; TOMD, true OM digestibility; PF, partitioning factor; ME, metabolizable energy; Figures with different superscripts^{A,B} for different barley genotypes and superscripts^{a,b} for N-scheduling within a row differ significantly *P<0.05; **P<0.01; NS, nonsignificant; PSE, pooled SE.

Table 4. Effect of barley genotypes and N-scheduling on the *in-vitro* volatile fatty acid production (mM/dl) from barley fodder

Variety (V)	PSE			Treatment (T)					PSE	Effects		
	RD-2552	RD-2035		T ₁	T ₂	T ₃	T ₄	T ₅		V	T	V×T
TVFA	7.60 ^B	7.45 ^A	0.01	7.56 ^b	7.53 ^{ab}	7.55 ^b	7.51 ^{ab}	7.48 ^a	0.016	**	*	*
Acetate (A)	5.51 ^B	5.47 ^A	0.007	5.48	5.50	5.51	5.49	5.47	0.01	**	NS	**
Propionate (P)	1.45 ^B	1.42 ^A	0.003	1.44	1.43	1.43	1.43	1.42	0.005	**	NS	*
Iso-butyrate	0.059	0.056	0.001	0.061 ^b	0.058 ^{ab}	0.054 ^a	0.059 ^{ab}	0.056 ^{ab}	0.002	NS	*	**
Butyrate	0.49 ^B	0.43 ^A	0.004	0.49 ^b	0.46 ^a	0.46 ^a	0.44 ^a	0.46 ^a	0.007	**	**	**
Iso-valerate	0.058	0.052	.002	0.056	0.050	0.060	0.056	0.053	0.003	NS	NS	*
Valerate	0.033	0.030	0.001	0.034 ^b	0.030 ^{ab}	0.036 ^b	0.033 ^b	0.024 ^a	0.002	NS	**	NS
A: P	3.81 ^A	3.86 ^B	0.012	3.81	3.85	3.84	3.83	3.84	0.018	**	NS	NS
<i>Relative proportion (%)</i>												
Acetate (A)	72.54 ^A	73.36 ^B	0.054	72.48 ^a	73.08 ^b	72.93 ^b	73.15 ^b	73.08 ^b	0.12	**	**	NS
Propionate (P)	19.04	19.01	0.05	19.04	18.99	18.99	19.08	19.03	0.07	NS	NS	*
Iso-butyrate	0.77	0.76	0.01	0.80	0.77	0.72	0.78	0.74	0.02	NS	NS	*
Butyrate	6.46 ^B	5.78 ^A	0.05	6.48 ^b	6.10 ^a	6.09 ^a	5.79 ^a	6.12 ^a	0.08	**	**	**
Iso-valerate	0.76	0.70	0.02	0.74	0.66	0.80	0.75	0.71	0.04	NS	NS	*
Valerate	0.44	0.40	0.02	0.45 ^a	0.40 ^a	0.47 ^b	0.44 ^b	0.32 ^a	0.03	NS	**	NS

TVFA- Total volatile fatty acids; Figures with different superscripts^{A,B} for different barley genotypes and superscripts^{a,b} for N-scheduling within a row differ significantly *P<0.05; **P<0.01; NS, nonsignificant; PSE, pooled SE.

scheduling, irrespective of the barley genotypes, had no significant effect on any of the above parameters except that ammoniacal-N was higher (P<0.01) in T₄ and T₅ as compared to other N schedules. The ME availability from

the barley fodder was also not affected by N-scheduling.

Effect on VFA production: The effect of barley genotypes, irrespective of N-scheduling, on the total and individual VFA revealed that total VFAs, acetate, propionate and

butyrate production was higher ($P<0.01$) in the fodder of grain variety RD-2552 as compared to dual purpose barley variety RD-2035 (Table 4). The barley genotypes did not show any significant effect on the iso-butyrate, iso-valerate and valerate production. However the relative proportion of acetate was higher ($P<0.01$) in grain variety RD-2552 as compared to the dual purpose variety RD-2035, reverse trend ($P<0.01$) was observed in butyrate. The concentration of other VFAs was not affected by the barley genotypes. The effect of N-scheduling, irrespective of barley genotypes, on total and individual VFA production revealed that total VFAs in T_1 and T_3 N-scheduling were higher ($P<0.05$) than T_5 , but comparable with remaining N-schedules. The acetate, propionate and iso-valerate production was not affected by N-scheduling. The butyrate production was higher ($P<0.01$) in T_1 scheduling as compared to the rest of scheduling patterns. The valerate production in T_3 and T_4 was comparable but higher ($P<0.01$) than the remaining scheduling patterns. The relative proportion of acetate was lowest ($P<0.01$) in T_1 while that of butyrate was highest ($P<0.01$) in T_1 as compared to the rest of scheduling patterns.

It was concluded that grain variety (RD-2552) had high grain and straw yield but low green fodder yield with better nutritional quality as compared to dual purpose barley variety (RD-2035).

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