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Productivity and quality of oat (*Avena sativa*) in relation to cutting management and nitrogen levels

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ABSTRACT

A field experiment was conducted during two consecutive winter (*rabi*) seasons of 2003-04 and 2004-05 to study the effect of cutting management and nitrogen levels on quality of oat (*Avena sativa* L.) at Pantnagar. Pooled results revealed that single cut at 50% flowering recorded significantly higher dry-matter (8.05 t/ha) and digestible dry-matter yields (5.0 t/ha), dry-matter content (20.85%), acid-detergent fibre (48.14%), neutral detergent fibre (59.56%) and hemicellulose content (23.02%) than double-cutting system. But total crude-protein yield (805 kg/ha), crude-protein content at both the cuts (18.70 and 10.55% respectively), digestibility (76.31%), ash (10.44%) and cell contents (56.79%) at the first cut were significantly higher when the first cut was taken at 50 days after sowing and the second cut at 50% flowering. However, at second cut, digestibility (66.72%), ash (10.34%) and cell contents (43.47%) were statistically more when the first cut was taken at 60 days after sowing and the second cut at 50% flowering. Application of 120 kg N/ha recorded significantly higher dry-matter and digestible dry-matter yields; however, significant increase in crude-protein yield was observed up to 160 kg N/ha. The dry-matter content, digestibility and cell content decreased with successive increase in N level from 0 to 160 kg/ha, whereas the reverse trend was noticed for crude-protein content, acid-detergent fibre, neutral detergent fibre and hemicellulose content.

Key words : Cutting management, Nitrogen level, Oat, Quality

Oat (*Avena sativa* L.) is an important winter forage crop, grown under irrigated condition of northern and north-western regions of India because of its excellent growth character, quick regrowth and economic source of dietary energy. Like other multicut fodders, it provides succulent and highly palatable fodder in two to three cuttings extending from January to April. To maintain good health and potential of animals in terms of draught, milk, meat and wool, feeding of good-quality fodder is highly important. Cutting management plays an important role in the quality of oat. Nitrogen, because of its consumption by the crop in large quantity, plays a vital role in fodder production. Besides increasing the quantity of fodder, it improves the quality of herbage also. Keeping these points in view, the present experiment was undertaken.

MATERIALS AND METHODS

The field experiment was conducted at Instructional Dairy Farm, G.B. Pant University of Agriculture and Technology, Pantnagar during the winter (*rabi*) seasons of 2003-04 and 2004-05. The treatments comprised three cutting managements [C_1, single cut at 50% flowering; C_2, the first cut at 50 days after sowing (DAS) and the second cut at 50% flowering and C_3 the first cut at 60 DAS and the second cut at 50% flowering and five N levels (0, 40, 80, 120 and 160 kg/ha). The experiment was laid out in factorial randomized block design with four replications. The soil was silty loam with pH 7.1, having 1.23 per cent organic C, 0.14% total N, 46.25 kg/ha available P and 279.8 kg/ha available K. The crop was fertilized with 60 kg P/ha and N as per the treatments. Oat 'UPO 212' was sown in rows 25 cm apart on 21 November 2003 and 9 November 2004. Half the quantity of N and full dose of P were applied as basal dressing in each plot. The remaining half dose of N in C_2 was top-dressed just after first cut (50 DAS) and in C_3 and C_1 at 60 DAS. The first irrigation was given a week after sowing and subsequent irrigations at 20-25 days interval. A total of three irrigations were given to meet the water requirement of crop. To keep the experimental plots weed free, 2,4-D was applied to all plots @ 1.0 kg/ha at 25 days after sowing. One supplementary hand-weeding was also done just after the first

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cut. Rainfall during the crop period was 48.2 and 106.6 mm in 2003-04 and 2004-05 respectively. The crop was harvested as per the treatments. Fresh sample (500 g) at each cut from each plot was taken and dried in oven at 70°C for 48 hr to determine the dry-matter content and estimation of quality parameters. The dried samples were ground in Willey mill using 2 mm sieve to estimate crude protein, digestibility and ash content, and 1 mm sieve to determine acid-detergent fibre and neutral detergent fibre. Nitrogen was determined by the method of microKjeldahl (Jackson, 1973), nylon-bag dry-matter digestibility by that of Mehrez and Orskov (1977) and acid detergent fibre (ADF) and neutral detergent fibre (NDF) by those of Goering and Van Soest (1970). Crude-protein content was worked out by multiplying with a factor of 6.25. Hemicellulose content was determined by subtracting ADF content from NDF content, and cell content was determined by subtracting NDF content from 100.

RESULTS AND DISCUSSION

Cutting management

Pooled data of Table 1 revealed that delay in taking the first cut from 50-60 days after sowing (C_2 to C_3) significantly increased the dry matter, crude protein and digestible dry-matter yield by 47.60, 13.18 and 42.96% respectively over C_2, i.e. first cut at 50 days. Among the cutting-management practices, single cut at 50% flowering (C_1) produced significantly higher dry matter and digestible dry-matter yields than double-cutting management. However, at the second cut and in total yields, C_2 (first cut at 50 days after sowing) proved significantly superior to C_3 (first cut at 60 days after sowing). The higher dry-matter yield in single-cut system might be owing to greater biomass synthesis caused by uninterrupted photosynthetic activity beyond 50-60 days of growth and resultant increase in plant height, number of shoots and leaves and dry-matter accumulation per unit area (Singh *et al.*, 2005). The significantly higher crude protein and digestible dry-matter yield were due to more dry-matter yield. These results are in conformity with the findings of Joshi *et al.* (1997).

Cutting management interacted with N levels (Table 2), showing that during the first cut at C_2 and C_3 an increase in N levels from 0 to 120 kg/ha significantly increased the dry-matter yield and thereafter with application of 160 kg N/ha the differentces were found non-significant. Under all N levels, C_3 gave significantly more dry-matter yield than C_2. The data presented in Table 3 reveal that one-cutting management (C_1) gave significantly more dry-matter yield than double-cutting managements (C_2 and C_3) at all levels of N. The dry-matter yield increased significantly up to 120 kg N/ha under all cutting managements.

In general, dry-matter content, ADF, NDF and hemicellulose content in plant progressively increased with advancement of crop age; however, a reverse trend was noticed for crude-protein content, digestibility and cell content. The delay in first cutting from 50-60 days after sowing statistically increased the dry-matter content, ADF, NDF and hemicellulose content; but a reverse trend was noticed for crude-protein content, cell content and ash content (Tables 4, 5). The crop harvested once at 50% flowering (C_1) recorded significantly higher dry matter content, ADF, NDF and hemicellulose content tan double-cutting managements (C_2 and C_3). The first cut at 50 days after sowing and the second cut at 50% flowering

Table 1. Effet of cutting management and N levels on dry-matter yield, crude-protein yield and digestible dry-matter yield of oat (pooled data of 2003-04 to 2004-05)

Treatment	Dry -matter yield (t/ha)			Crude-protein yield (kg/ha)			Digestible dry-matter yield (t/ha)		
	I cut	II cut	Total	I cut	II cut	Total	I cut	II cut	Total
Cutting management									
C_1, Single cut at 50% flowering		8.05	8.05		788	788		5.00	5.00
C_2, I cut at 50 DAS and II cut at 50% flowering	1.31	4.99	6.31	258	547	805	0.99	3.29	4.28
C_3, I cut at 60 DAS and II cut at 50% flowering	1.94	3.69	5.63	292	383	674	1.41	2.45	3.86
SEm±	0.02	0.09	0.09	4	11	11	0.02	0.06	0.07
CD (P=0.05)	0.07	0.25	0.26	12	30	32	0.05	0.17	0.19
N (kg/ha)									
0	0.86	3.54	4.11	111	257	330	0.66	2.36	2.80
40	1.35	4.82	5.32	207	448	586	1.02	3.14	3.82
80	1.73	5.85	7.01	283	59	778	1.28	3.78	4.63
120	2.05	6.75	8.11	370	448	995	1.49	4.28	5.28
160	2.13	6.95	8.37	403	822	1,091	1.53	4.36	5.38
SEm±	0.04	0.11	0.12	7	14	15	0.03	0.08	0.09
CD (P=0.05)	0.11	0.32	0.33	19	39	42	0.08	0.22	0.24

Table 2. Interaction effect of cutting management and nitrogen level on dry-matter yield (t/ha) at I cut (pooled data of 2003-04 to 2004-05)

Treatment	N_0	N_{40}	N_{80}	N_{120}	N_{160}
C_2	0.31	1.13	1.41	1.61	1.70
C_3	1.01	1.57	2.06	2.49	2.56
SEm±			0.05		
CD (P=0.05)			0.15		

Table 3. Interaction effect of cutting management and nitrogen level on dry matter yield (t/ha) at II cut (pooled data of 2003-04 to 2004-05)

Treatment	N_0	N_{40}	N_{80}	N_{120}	N_{160}
C_1	5.63	7.20	8.36	9.44	9.60
C_2	2.73	4.33	5.30	6.20	6.43
C_3	2.26	2.93	3.89	4.60	4.81
SEm±			0.16		
CD (P=0.05)			0.45		

(C_2) gave significantly more crude-protein contents at both the cuts (18.70 and 10.55% respectively), and digestibility (76.31%), ash (10.44%) and cell contents (56.79%) at first cut. However, the second-cut stage, the first cut at 60 days after sowing and the second at 50% flowering (C_3) registered statistically higher values of digestibility (66.72%), ash (10.34%) and cell contents (43.47%). Higher crude-protein content in double-cut system was due to more crude-protein content at 50 days stage (at I cut) and the consequent loss of nitrogen by cutting, forcing the plant at later stage to absorb relatively more nitrogen than single-cut system. Significantly higher digestibility with two-cut system was due to lower dry matter, ADF, NDF and hemicellulose contents. Cherney and Marten (1982) reported that *in vitro* digestible dry matter decreased with increased time of cutting, and an increase in lignin concentration in stem accounted for reduced digestibility with increased maturity. Higher ADF and NDF content in the single cut might be due to lower leaf:stem ratio and the more fibrous nature of stem than of leaf (Verma and Singh, 1987). Kumar *et al.* (2001) also reported similar results.

Nitrogen level

At the first and second cuts and in total yields, an increase in nitrogen level from 0 to 120 kg/ha significantly increased the dry matter and digestible dry-matter yields; however, crude-protein yield increased significantly up to 160 kg N/ha (Table 1). It has been opined that N supply increased the formation of nucleotides and coenzyme to which nitrogen is a constituent and this facilitates cell elongation (Epstein, 1972). Moreover, acceleration of meristematic activity and encouragement of vegetative growth are some of the recognized effects of N fertilization. The significant increase in crude-protein yield with increase in N level was due to higher crude-protein content and dry-matter yield at higher levels of N (Verma and Singh, 1987; Aklilu, 2005).

The pooled data presented in Tables 4 and 5 show that at the first and second cuts dry-matter content, digestibility and cell content decreased with an increase in N level; but an increasing trend was noticed for crude protein content, ADF, NDF and hemicellulose contents. The crude-protein content, ADF, NDF and hemicellulose contents were significantly higher with increase in nitrogen level up

Table 4. Effet of cutting management and N levels on dry-matter, crude-protein, digestibility and ash content of oat (pooled data of 2003-04 to 2004-05)

Treatmetn	Dry matter (%)		Crude-protein (%)		Digestibility (%)		Ash (%)	
	I cut	II cut	I cut	II cut	I cut	II cut	I cut	II cut
Cutting management								
C_1, Single cut at 50% flowering		20.85		9.51		62.46		9.60
C_2, I cut at 50 DAS and II cut at 50% flowering	15.86	19.91	18.70	10.55	76.31	66.25	10.44	9.85
C_3, I cut at 60 DAS and II cut at 50% flowering	16.39	19.48	14.63	9.93	73.83	66.72	9.28	10.34
SEm±	0.09	0.16	0.17	0.10	0.31	0.33	0.09	0.08
CD (P=0.05)	0.27	0.44	0.48	0.28	0.87	0.92	0.25	0.22
N (kg/ha)								
0	17.45	20.99	12.99	7.39	77.69	67.65	9.85	10.33
40	16.57	20.33	15.49	9.35	76.20	65.99	9.57	9.67
80	15.86	19.95	16.71	10.17	74.97	65.06	9.80	9.78
120	15.44	19.65	18.62	11.17	73.70	63.88	9.95	9.89
160	15.31	19.50	19.51	11.91	72.79	63.16	10.14	9.99
SEm±	0.15	0.20	0.27	0.13	0.48	0.42	0.14	0.10
CD (P=0.05)	0.43	0.56	0.76	0.37	1.37	1.19	NS	0.28

Table 5. Effet of cutting management and nitrogen levels on acid detergent fibre, neutral detergent fibre, hemicellulose and cell content of oat (pooled data of 2003-04 to 2004-05)

Treatmetn	ADF (%)		NDF (%)		Hemicellulose (%)		Cell content	
	I cut	II cut	I cut	II cut	I cut	II cut	I cut	II cut
Cutting management								
C_1, Single cut at 50% flowering		48.14		59.56		23.02		40.44
C_2, I cut at 50 DAS and II cut at 50% flowering	24.56	46.82	43.21	57.62	18.65	22.13	56.79	42.38
C_3, I cut at 60 DAS and II cut at 50% flowering	25.95	45.80	45.02	56.52	19.08	21.76	54.99	43.47
SEm±	0.06	0.09	0.07	0.08	0.07	0.16	0.07	0.09
CD (P=0.05)	0.18	0.25	0.19	0.25	0.19	0.45	0.19	0.25
N (kg/ha)								
0	23.82	44.49	42.05	55.25	18.23	21.76	57.95	44.75
40	24.66	46.05	43.34	57.02	18.67	22.23	56.66	42.98
80	25.35	46.95	44.26	57.96	18.91	22.38	55.74	42.04
120	25.90	47.89	45.09	58.96	19.19	22.58	54.91	41.04
160	26.50	49.21	45.81	60.32	19.31	22.64	54.19	39.68
SEm±	0.10	0.11	0.11	0.12	0.10	0.20	0.11	0.12
CD (P=0.05)	0.29	0.33	0.30	0.33	0.30	0.58	0.30	0.33

to 160 kg N/ha at both the cuts. The increase in crude-protein content with increased N levels (Table 4) might be due to rapid synthesis of carbohydrates and their conversion to protein and protoplasm, leaving only a smaller portion for cell-wall synthesis because carbohydrates and nitrogen provide skeleton for protein synthesis (Russell, 1973). Aklilu (2005) reported that digestibility decreased with increased N supply, probably due to higher cellulose, hemicellulose and greater lignification of crop at higher N level. The ADF and lignin components of fibre increase with nitrogen level (Collins *et al.*, 1990). The decrease in cell content with increase in N level was due to higher NDF content at higher level of nitrogen (Table 5). These results are in conformity with the report of Kumar *et al.* (2001).

It was concluded that growing of oat crop under single-cut system (50% flowering) with application of 120 kg N/ha is a better proposition for achieving higher yield and good-quality fodder.

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