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Productivity and Quality of Fodder Oats (*Avena sativa* L.) as influenced by Sowing Time, Cutting Schedules and Nitrogen Levels

S.S. Kadam[1], N.S. Solanki[2], Mohd. Arif[*3], L.N. Dashora[2], S.L. Mundra[2] and B. Upadhyay[4]
Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur-313 001, Rajasthan, India

ABSTRACT

A field experiment was conducted at Agronomy Farm, Rajasthan College of Agriculture, Udaipur, (Rajasthan) during *rabi* seasons of 2016-17 and 2017-18 to study the effect of sowing time (25th October and 25th November), cutting schedules (cut at 50 DAS, cut at 60 DAS and cut at 70 DAS) and nitrogen levels (80, 100 and 120 kg ha^{-1}) on productivity and quality of fodder oats. It was revealed that early sown crop on 25th October recorded significantly higher green (36.4 t ha^{-1}) and dry (8.0 t ha^{-1}) fodder yield as well as green (611 kg ha^{-1} day^{-1}) and dry (134 kg ha^{-1} day^{-1}) fodder production efficiency and quality parameters *viz.* ether extract (2.52%). Among different cutting schedules, cutting at 70 DAS recorded significantly higher green (37.8 t ha^{-1}) and dry (8.3 t ha^{-1}) fodder yield. However, cut at 50 DAS proved significantly better in terms of green (628.7kg ha^{-1} day^{-1}) and dry (137.0 kg ha^{-1} day^{-1}) fodder production efficiency as well as quality parameters *viz.* crude protein (12.3%) and ether extract (2.56%). Application of 120kg N ha^{-1} gave significantly higher green (36.5 t ha^{-1}), dry (8.0 t ha^{-1}) fodderyield and green (613.5 t ha^{-1}), dry (34.4 t ha^{-1}) fodder production efficiency and quality parameters *viz.* crude protein (12.1 %) and ether extract (2.53 %).It is concluded that among sowing times 25th October, among cutting schedule 50 DAS and among nitrogen levels 120 kg N ha^{-1} is the best treatment for recoding maximum value of green and dry fodder production efficiency and ether extract.

Keywords: Cutting and nitrogen, Oats, Productivity, Quality, Sowing

INTRODUCTION

In India the livestock is an integral component of agriculture economy which contributes about 4.11 % to total GDP and posses 15% of world's livestock population of 512.05 million constituting 37.3% cattle, 21.2% buffaloes, 12.7% sheep and 26.4% goats (DAHD & F 2017-18). The success of animal husbandry and dairy farming largely depends on regular supply of good quality fodder in sufficient quantities. Unfortunately, there is acute shortage of green as well as dry fodder in tune of 35.6 and 11.0 per cent, respectively (IGFRI Vision 2050) due to less acreage of green fodder crops (4.9 per cent) and more emphasis on food grain production (Kumar *et al.,* 2018; Pandey and Roy, 2011) that drastically affects the productivity of animals in comparison with other countries.

The mismatch in demand and supply of fodders as per projected scenario requires urgent attention to develop suitable strategies to bridge this gap. Oats (*Avena sativa* L.), is the most important *rabi* season crops grown for animal food under irrigated conditions of northern and north-western regions of India because of its excellent growth habit, quick regeneration capacity, better palatability with more protein and minerals content. Besides, it is also used for making silage for animals (Chakraborty *et al.,* 2016; Kumari *et al.,* 2014). Productivity and quality of oats depend upon various inputs like sowing time and cutting schedules besides fertilizer application. It has been proved that timely sowing (Shekara and Lohithaswa, 2012) and cutting of oats (Demetrio *et al.,* 2012) enhanced forage productivity as well as quality. Nitrogenous fertilizer is also the key factor which influences both yield and quality oat forage (Singh and Dubey, 2007; Subrahmanya *et al.,* 2017; and Yadav *et al.,* 2017). Hence, the present investigation was undertaken to ascertain the productivity and quality of fodder oats as influenced by sowing time, cutting schedules and nitrogen levels.

MATERIALS AND METHODS

A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Maharana

[1]Fodder Development Officer, BVC, Mumbai and Ph.D. Scholar, RCA, MPUAT, Udaipur-313 001, Rajasthan, India; [2]Professor Agronomyand [4]Professor Agril. Statistics RCA, MPUAT, Udaipur-313 001, Rajasthan, India; [3*]Scientist ICAR-Central Institute for Research on Goats, Makhdoom; [*]Corresponding author (E-mail: arifkhan.ag782@gmail.com)

Pratap University of Agriculture and Technology, Udaipur, (Rajasthan) during two consecutive *rabi* seasons of 2016-17 and 2017-18. The soil of experimental field was clay loam in texture that was low in available nitrogen and organic carbon, medium in available phosphorous and high in potassium status with slightly alkaline in reaction. The treatments consisting two sowing dates (25th October and 25th November), four cutting schedules (no cut, cut at 50 DAS, cut at 60 DAS and cut at 70 DAS) in main plots and three levels of nitrogen (80, 100 and 120 kg ha^{-1}) in subplots were laid out in Split Plot Design with three replications in plot size of 5.0 × 3.0 m^2. Dual purpose oats variety UPO-212 was sown by drilling method at 25 cm row spacing @ 100 kg ha^{-1}. Among fertilizer dose,1/3rd nitrogen and full dose of phosphorous and potassium (each 40 hg ha^{-1}) was supplied as basal dose through urea, DAP and MOP fertilizers. 1/3rd N as per treatment applied after first irrigation and remaining 1/3rd N was given after cutting treatment and for no cut treatment applied at 60 DAS through urea. Irrigations and spraying of 2,4-D weedicide were carried out as per recommendations. Cutting for green fodder was taken at 10 cm above ground level from net plot, then weighed and converted into tonnes ha $^{-1}$ to obtain green fodder yield. After harvesting green fodder, the crop was left for grain purpose. Simultaneously, a random sample of 500 g was taken from each net plot, chopped well and first dried in sun and then oven dried at 65-70°C till constant weight. On the basis of these samples, the green fodder yields were converted into dry fodder yields and were expressed as t ha^{-1}. Green as well as dry fodder production efficiency day^{-1} was calculated by dividing respective green and dry fodder yield by number of days for cutting and expressed in kg ha day^{-1}. The oven dried sample of oats were then ground and used for proximate analysis as per AOAC (1995).

RESULTS AND DISCUSSION

Sowing time had significant influence on green and dry fodder yield of oats during both *rabi* seasons and in pooled values (Table 1). It was observed that significantly higher green (36.4 t ha^{-1}) and dry (8.0 t ha^{-1}) fodder yield could be obtained with crop sown on 25th October as compared to 25th November sown crop (32.9 and 7.1 t ha^{-1}, respectively). The corresponding increment in green and dry fodder yield was in tune of 10.5 and 11.9 per cent, respectively. Further, significantly higher green (611.0 kg ha^{-1} day^{-1}) and dry (134.0 kg ha^{-1} day^{-1}) fodder production efficiency was registered with early sown crop on 25th October as compared to late sown crop on 25th November (552.7 and 120.4 kg ha^{-1} day^{-1}). Delay in sowing decreased the green and dry fodder yield, and fodder production efficiency of oats. The higher fodder yield as well as fodder production efficiency in early sown crop might be due to favourable climatic situations that might have led into luxuriant vegetative growth in the forms of plant height, number of tillers, dry matter accumulation and leaf stem ratio. Our findings are in conformity with Jehangir *et al.* (2012); Kumar (2012); Shekara and Lohithaswa (2012); Dar *et al.* (2014) and Sheoran *et al.* (2017).

The results showed that green and dry fodder yield of oats were remarkably influenced by different cutting schedules during both *rabi* seasons. Cut at 70 DAS gave significantly higher green fodder yield (37.8 t ha^{-1}) over cut at 60 DAS (34.6 t ha^{-1}) and cut at 50 DAS (31.4 t ha^{-1}) by 9.3 and 20.3 per cent, respectively. Similarly, cut at 70 DAS recorded significantly higher dry fodder yield (8.3 t ha^{-1}) over cut at 60 DAS (7.6 t ha^{-1}) and cut at 50 DAS (6.9 t ha^{-1}) by 9.0 and 20.6 per cent, respectively (Table-1). Increment in green and dry fodder yield because of delayed cutting might be due to longer vegetative growth period availed that increased growth as well as yield attributes and accumulated more photosynthates and dry matter, resulting in higher forage production of oats as compared to earlier cutting.The higher green and dry fodder yield may be due to higher plant height (r = 0.968 and r =0.908), number of tillers (r = 0.913 and r = 0.826), dry matter resulting in (r = 0.985 and r = 0.950) and leaf stem ratio (r = 0.881 and r = 0.796), respectively at this stage.Other reports (Hussain *et al.* 2004; Hedayetullah and Barik,

Table 1. Effect of sowing time, cutting schedules and nitrogen levels on green, dry fodder yield and fodder production efficiency of oats

Treatments	Green fodder yield (t ha^{-1})			Dry fodder yield (t ha^{-1})			Green fodder production efficiency (kg ha^{-1} day^{-1})			Dry fodder production efficiency (kg ha^{-1} day^{-1})		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
Sowing time												
D_1 - 25th October	36.1	36.6	36.4	7.9	8.1	8.0	607.1	615.0	611.0	132.4	135.7	134.0
D_2 - 25th November	32.7	33.1	32.9	7.0	7.2	7.1	548.7	556.6	552.7	118.5	122.3	120.4
SEm±	0.67	0.67	0.47	0.15	0.17	0.11	6.87	7.92	5.24	2.69	1.51	1.54
CD at 5 %	2.12	2.10	1.40	0.48	0.54	0.34	21.64	24.94	15.46	8.47	4.76	4.55
Cutting schedules												
C_1 - Cut at 50 DAS	31.2	31.7	31.4	6.8	7.0	6.9	623.9	633.5	628.7	135.0	139.0	137.0
C_2 - Cut at 60 DAS	34.4	34.8	34.6	7.5	7.7	7.6	572.8	580.3	576.6	124.6	128.0	126.3
C_3 - Cut at 70 DAS	37.6	38.1	37.8	8.2	8.4	8.3	537.0	543.5	540.3	116.5	120.2	118.4
SEm±	0.83	0.81	0.58	0.19	0.21	0.14	8.41	9.70	6.42	3.29	1.85	1.89
CD at 5 %	2.60	2.57	1.71	0.59	0.66	0.41	26.50	30.55	18.93	10.37	5.83	5.57
Nitrogen levels												
N_1 - 80 kg ha^{-1}	32.2	32.7	32.5	7.0	7.2	7.1	541.2	549.0	545.1	117.9	121.3	119.6
N_2 - 100 kg ha^{-1}	34.7	35.2	34.9	7.5	7.7	7.6	583.0	591.0	587.0	125.7	129.8	127.7
N_3 - 120 kg ha^{-1}	36.2	36.7	36.5	7.9	8.1	8.0	609.6	617.3	613.5	132.7	136.1	134.4
SEm±	0.46	0.33	0.28	0.13	0.19	0.12	5.85	5.39	3.98	2.08	1.28	1.22
CD at 5%	1.33	0.97	0.79	0.38	0.57	0.33	17.08	15.74	11.17	6.08	3.72	3.43

2012; Patel *et al.* 2013; Malik, 2014; Kumar *et al.* 2017) also reported that cutting management had remarkable effect on green and dry fodder yield of oats. Further; it was also observed (Table-1) that green and dry fodder production efficiency ha^{-1} day^{-1} of oats was significantly influenced by different cutting schedules. It was found that cut at 50 DAS registered higher green fodder production efficiency (628.7 kg ha^{-1} day^{-1}) over cut at 60 DAS and cut at 70 DAS by 9.0 and 16.4 per cent, respectively. Similarly, cut at 50 DAS obtained significantly higher dry fodder production efficiency (137.0 kg ha^{-1} day^{-1}) over cut at 60 DAS and cut at 70 DAS by 8.5 and 15.8 per cent, respectively.The higher fodder production efficiency associated with early cutting might be due to less duration required for cutting. The fodder production efficiency is always inversely proportional to number of days required for harvesting. The green fodder production efficiency had negative correlation with plant height (r = - 0.897), number of tillers (r = - 0.812), dry matter accumulation (r = - 0.950) and leaf stem ratio (r = - 0.802) under different cutting schedules. Alipatra *et al.* (2013) also reported that fodder production efficiency was significantly influenced due to cutting management.

Dry fodder yield and fodder production efficiency day^{-1} of oats were remarkably influenced by various nitrogen levels during two *rabi* seasons and in pooled values. It was interpreted that application of 120 kg N ha^{-1} recorded maximum green fodder yield (36.5 t ha^{-1}) followed by 100 kg N ha^{-1} and 80 kg N ha $^{-1}$ which was significantly higher by 4.4 and 12.3 per cent, respectively. Similarly, application of 120 kg N ha^{-1} gave significantly higher dry fodder yield (8.0 t ha^{-1}) over 100 kg N ha^{-1} and 80 kg N ha $^{-1}$ by 5.5 and 12.5 per cent, respectively (Table-1). Further, application of 120 kg N ha^{-1} obtained significantly higher green fodder production efficiency (613.5 kg ha^{-1} day^{-1}) than 100 and 80 kg N ha $^{-1}$ by 4.5 and 12.5 per cent, respectively and higher dry fodder production efficiency (134.4 kg ha^{-1} day^{-1}) by 5.2 and 12.4 per cent, respectively. The increment in green, dry fodder yield and production efficiency due to higher dose of nitrogen may be due to luxuriant vegetative growth achieved in form of plant height, number of tillers, dry matter accumulation and leaf stem ratio which enhanced the photosynthetic activities and hence forage production as well as production efficiency. Results coincide with the findings of Luikham *et al.* (2012); Malik (2014); AICRP-FCU, (2016); Ratan *et al.* (2016) and Kumar *et al.* (2017).

Sowing time had no significant influence with respect to crude protein content in fodder oats (Table 2). This might be due to non-significance of nitrogen content in fodder oats due to sowing time as nitrogen being main constituent that play important role in formation of amino acids as well as protein in plants. Similar findings were reported by Mutti (1995). Kumar (2012) also reported that sowing time had no significant influence on crude protein content during second cut of oats. Further, crude fibre and ether extract content in fodder oats were significantly affected due to sowing time during both *rabi* seasons. Oat crop sown on 25th October recorded significantly lower crude fibre (23.1 per cent) and higher ether extract (2.52 per cent) in comparison with crop sown on 25th November (24.0 and 2.34 per cent, respectively). The lower crude fibre associated with early sown crop might be due to more leaf stem ratio. Higher ether extract with early sown crop may be due to availability of favourable environments for rapid metabolic activities and better biomass production as compared to late sown crop. The results are in conformity with Kumar (2012); Dar *et al.* (2014) and Jehangir *et al.* (2017). As per data (Table 2) it is evident that significantly higher ash content (13.3 per cent) was noticed with 25th October sown crop in comparison with 25th November sown crop (12.5 per cent). The higher ash content due to early sown crop may be due to higher dry matter content as compared to delayed sown crop. Kumar (2012) and Jehangir *et al.* (2017) also reported similar findings. Nitrogen Free Extract (NFE) in fodder oats was not significantly influenced due to sowing time during both *rabi*

Table 2. Effect of sowing time, cutting schedules and nitrogen levels on crude protein, crude fibre, ether extract, ash and NFE content in fodder oats

Treatments	Crude protein (%)			Crude fibre (%)			Ether extract (%)			Ash content (%)			NFE(%)		
	20116	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Sowing time															
D_1 - 25th October	12.0	12.0	12.0	23.1	23.1	23.1	2.52	2.53	2.52	13.3	13.3	13.3	49.1	48.7	48.9
D_2 - 25th November	11.8	11.8	11.8	24.0	24.0	24.0	2.34	2.33	2.34	12.5	12.5	12.5	49.3	49.1	49.2
SEm±	0.09	0.07	0.06	0.10	0.09	0.07	0.02	0.01	0.01	0.05	0.05	0.04	0.18	0.17	0.12
CD at 5 %	NS	NS	NS	0.31	0.29	0.20	0.06	0.03	0.03	0.15	0.16	0.10	NS	NS	NS
Cutting schedules															
C_1 - Cut at 50 DAS	12.2	12.3	12.3	23.3	23.4	23.3	2.57	2.56	2.56	12.7	12.8	12.8	49.0	49.0	49.0
C_2 - Cut at 60 DAS	12.2	12.3	12.2	23.5	23.5	23.5	2.45	2.44	2.44	12.8	12.9	12.8	49.0	49.0	49.0
C_3 - Cut at 70 DAS	11.2	11.2	11.2	23.8	23.8	23.8	2.27	2.29	2.28	13.2	13.2	13.2	49.6	48.8	49.2
SEm±	0.11	0.09	0.07	0.12	0.11	0.08	0.02	0.01	0.01	0.06	0.06	0.04	0.21	0.21	0.15
CD at 5 %	0.36	0.29	0.21	0.39	0.35	0.23	0.08	0.04	0.04	0.19	0.20	0.13	NS	NS	NS
Nitrogen levels															
N_1 - 80 kg ha^{-1}	11.7	11.7	11.7	23.6	23.6	23.6	2.29	2.29	2.29	12.8	12.8	12.8	49.6	49.3	49.4
N_2 - 100 kg ha^{-1}	11.8	11.9	11.9	23.6	23.6	23.6	2.47	2.48	2.47	12.8	12.9	12.9	49.2	48.9	49.1
N_3 - 120 kg ha^{-1}	12.1	12.1	12.1	23.5	23.5	23.5	2.53	2.53	2.53	13.1	13.1	13.1	48.8	48.6	48.7
SEm±	0.08	0.06	0.05	0.12	0.11	0.08	0.02	0.01	0.01	0.05	0.06	0.04	0.16	0.20	0.13
CD at 5%	0.23	0.17	0.14	NS	NS	NS	0.05	0.03	0.03	0.16	0.18	0.11	0.46	0.60	0.36

NS - Non significant

seasons. Similar findings were reported by Kumar (2012).

The results (Table 2) indicate that crude protein, crude fibre, ether extract and ash content in fodder oats were significantly affected due to various cutting schedules during both the years and in pooled data. However, nitrogen free extract content was not influenced because of different cutting schedules. Cut at 50 DAS recorded significantly higher crude protein (12.3 per cent) and ether extract content (2.56 per cent) over cut at 70 DAS. However, cut at 70 DAS registered significantly higher ash (13.2 per cent) and crude fibre content (23.8 per cent) over rest of cutting schedules. Various cutting schedules did not affect Nitrogen Free extract of fodder oats. The higher crude protein content at early cutting might be due to more nitrogen content in fodder at this stage which is a main constituent that plays major role in synthesis of protein.The dilution effect where photosynthates get dissolved in higher biomass produced during later stage might have resulted in declined protein content due to delayed cutting. Results are in conformity with results of Hussain *et al.* (2004); Bhilare and Joshi (2007); Jehangir *et al.* (2012); Malik *et al.* (2015) and AICRP-FCU, (2016). Similarly, ether extract or crude fat declined due to delayed cutting might be due to plants were at late vegetative growth stage and ether extract get declined with advancement of cutting. Similar results was reported by Kumar (2012). Crude fibre content increases with maturity of crop and more fibrous nature of stem than that of leaf. These results are in conformity with the results of Hussain *et al.,* (2004); Jehangir *et al.* (2012) and Kumar (2012). The higher ash content at later stage of crop may be due to less moisture and more dry matter content. Similarly, Kumar (2012) reported that cutting management had significant influence on ash content.

Data (Table 2) demonstrate that different nitrogen levels caused significant variation in crude protein, ether extract, ash and nitrogen free extract content in fodder oats during both *rabi* seasons and also in pooled samples. Application of 120 kg N ha^{-1} registered more crude protein (12.1 per cent), ether extract (2.53 per cent) and ash content (13.1 per cent) which was significantly superior over 100 and 80 kg N ha^{-1}. Application of 80 kg N ha^{-1} recorded significantly higher nitrogen free extract (49.4 per cent) over 120 kg N ha^{-1} (48.7 per cent). The various nitrogen levels had no any significant influence on crude fibre content of fodder oats. The higher dose of nitrogen might have increased the protein content as nitrogen being the major constituent for synthesis of protein as well as amino acid. Patel *et al.* (2011and Sheoran *et al.* (2017) also reported that crude protein content in fodder oats was significantly influenced by nitrogen application. The increase in ether extract content because of high dose of nitrogen may be due to the fact that nitrogen accelerates the respiration process that converts the most of carbohydrate into crude fat. However, crude fibre content in fodder oats was not influenced by nitrogen levels during entire investigation period. The application of nitrogen might have failed to produce fibroid components such as lignin and cellulose in plants. The more ash content with high dose of nitrogen may be due to rapid respiration caused because of acceleration of meristemetic activities that converts carbohydrate into ash. Bhilare and Joshi (2007) also reported that ash content in fodder oats differed significantly due to nitrogen application.

CONCLUSIONS

Early sown (25th October) dual purpose oats recorded significantly higher values of green and dry fodder yield as well as fodder production efficiency. Further, cutting at 50 DAS recorded higher green and dry fodder production efficiency, and crude protein and ether extract content. Application of 120 kg N ha^{-1}resulted in higher green and dry fodder yield as well as fodder production efficiency, and crude protein, ether extract and ash content. Thus, it is concluded that among sowing times 25th October, among cutting schedule 50 DAS and among nitrogen levels 120 kg N ha^{-1} is the best treatment for recoding maximum value of green and dry fodder production efficiency and ether extract content.

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