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Growth, yield and economics of dual purpose oats (*Avena sativa* L.) as affected by sowing time, cutting schedules and nitrogen levels

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Abstract
A field experiment was conducted for two consecutive *Rabi* seasons of 2016-17 and 2017-18 to study the effect of sowing time, cutting schedules and nitrogen levels on growth, yield and economics of dual purpose oats. The experiment was laid out in split plot design with three replications. The treatments of two dates of sowing (25th October and 25th November) and four cutting schedules (no cut, cut at 50, 60 and 70 DAS) were kept in main plots whereas three nitrogen levels (80, 100 and 120 kg ha^{-1}) were kept in sub plots. Study indicated that early sown oats on 25th October recorded significantly higher values for all growth attributes at cutting and harvest, green fodder yield (36.4 t ha^{-1}), dry fodder yield (8.0 t ha^{-1}), grain yield (2.7 t ha^{-1}), straw yield (6.6 t ha^{-1}), nitrogen (154.6 kg ha^{-1}), phosphorus (16.3 kg ha^{-1}) and potassium (86.8 kg ha^{-1}) uptake, net returns (Rs. 84678 ha^{-1}) and B: C ratio (2.32) over late sown oats. Among different cutting schedules, cut at 70 DAS recorded significantly higher values for growth attributes of fodder at cutting, green fodder yield (37.8 t ha^{-1}), dry fodder yield (8.3 t ha^{-1}), nitrogen (154.1 kg ha^{-1}), phosphorus (15.9 kg ha^{-1}) and potassium (84.9 kg ha^{-1}) uptake over other cutting schedules in descending sequence of cut at 70, 60 and 50 DAS. However, cut at 50 DAS proved significantly better in terms of net returns (Rs 96260 ha^{-1}) and B: C ratio (2.58). No cut system registered significantly higher values for all growth parameters at harvest, grain yield (3.0 t ha^{-1}) and straw yield (7.3 t ha^{-1}) over rest of cutting schedules. In case of nitrogen levels, application of 120 kg N ha^{-1} showed significantly higher values for all growth attributes at cutting and harvest, green fodder yield (36.5 t ha^{-1}), dry fodder yield (8.0 t ha^{-1}), grain yield, (2.5 t ha^{-1}), straw yield (6.2 t ha^{-1}), nitrogen, phosphorus and potassium content and uptake, net returns (Rs. 86937 ha^{-1}) and B: C ratio (2.33). Therefore, dual purpose oats sown on 25th October, cut at 50 DAS and fertilized with 120 kg N ha^{-1} recorded optimum yield and benefit cost ratio.

Keywords: Cutting management, Dual purpose oats, Nitrogen levels, Sowing time, Yield

Introduction

Despite India is having the largest livestock population *i.e.* around 15% of world's livestock population (DAHDF, 2017-18), the average productivity of animals in comparison with other countries is very low due to acute deficit of feed as well as fodder resources. As per the recent survey there is shortage of green and dry fodder in tune of 35.6 and 11.0 per cent, respectively (IGFRI Vision, 2050) due to less area under cultivation of fodder crops and more emphasis on food grain and cash crops. To overcome the scarcity of fodder for animals and paucity of quality seed for forage production urgent attention is needed to introduce dual purpose crops like oats. Oats (*Avena sativa* L.) is the most important *Rabi* season crops grown for animal feed and fodder under irrigated conditions of northern and north-western regions of India because of its excellent growth habit and quick regeneration capacity. The growth, productivity and economics of oats mainly depend upon proper management of nonmonetary inputs like sowing time and cutting schedules as well as monetary inputs like nitrogen application. Time of sowing is one of the important yield contributing factors in oat production which is governed by soil moisture and temperature. Appropriate sowing date is, therefore, important to have the crop in the field, when environmental conditions are conducive for growth and development (Kumar and Faruqui, 2010). Regular supply of green fodder from oats can be manipulated by adjusting its capacity for regeneration through proper cutting management system. It was reported that too early cutting adversely affects the biomass yield and delayed cutting reduces the forage quality (Kumawat *et al*., 2016). Harvesting of dual purpose crops at optimum time produces higher fodder yield without much affecting grain yield. Nitrogen is an important constituent of protein and chlorophyll which impart dark green colour to the plants and promotes rapid early vegetative growth. Application of optimum dose of nitrogen enhances the forage as well as grain yield of oats. Hence, present investigation on effect of sowing time, cutting schedules and nitrogen levels on growth, productivity and economics of dual purpose oats (*Avena sativa* L.) was undertaken.

Materials and Methods

Study site: A field experiment was conducted at Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, India for two consecutive *Rabi* seasons of 2016-17 and 2017-18. The soil status of experimental sites during both the growing seasons was recorded and found to be moderate in organic carbon content and moderate to high in available N, P and K contents (Table 1).

Experimental design: The treatments consisted of two sowing dates (25th October and 25th November) and four cutting schedules (no cut, cut at 50, 60 and 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 with each plot size of 5 m x 3 m. Dual purpose oats variety UPO-212 was sown by drilling method at 25 cm row spacing as per treatment using seed rate of 100 kg ha^{-1}. Among fertilizer dose, 1/3rd nitrogen as per treatment and full doses of phosphorus and potassium (each 40 kg ha^{-1}) were applied as basal dose through urea (N), di-ammonium phosphate (N and P) and muriate of potash (K) fertilizers. 1/3rd N as per treatment was applied after first irrigation and remaining 1/3rd N as per treatment was given after cutting and for no cut it was applied after cut at 60 DAS. Irrigations and spraying of 2,4-Dichlorophenoxyacetic acid (30-35 DAS) was carried out as per recommendations.

Observations and analysis: The growth attributes *viz*., plant height, number of tillers and dry matter accumulation m^{-1} row length were measured at cutting and at harvest. Leaf stem ratio was calculated dividing the leaf weight by stem weight at cutting. As per treatment cutting for green fodder was taken at 10 cm above ground level from net plot then weighed and converted into t ha^{-1} to obtain green fodder yield. The randomly collected green fodder samples were first dried in the sun and then transferred in an hot air oven for drying at a temperature of 65 ^{0}C till constant weight. On the basis of these samples, the green fodder yields were converted into dry fodder yields and were expressed in t ha^{-1}. After recording the sun dried weight of biological yield obtained from each net plot, the grains were separated and weighted. Later on grain yield kg plot^{-1} was converted to t ha^{-1}. The straw yield was computed by subtracting the corresponding grain yield from their total dry matter (biological yield) and expressed in terms of t ha^{-1}. Nitrogen, phosphorus and potassium content were measured by Nesseler's reagent colorimetric method, vanadomolybdate phosphoric yellow colour method and by flame photometeric method, respectively. To find out the most profitable treatments, economics of different treatments was worked out as follow in terms of net return Rs. ha^{-1} and B: C ratio.

$$\text{Net return} = \text{Gross return} - \text{Cost of cultivation}$$

$$\text{B:C ratio} = \frac{\text{Net return (Rs. ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs. ha}^{-1}\text{)}}$$

All the data were then subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Gomez and Gomez (1984).

Results and Discussion

Growth attributes: Growth attributes like plant height, number of tillers m^{-1} row length, dry matter accumulation m^{-1} row length and leaf stem ratio of fodder oats at cutting were significantly affected due to sowing time (Table 2). The significantly higher plant height (76.0 cm) and number of tillers m^{-1} row length (104.2) at cutting were recorded with crop sown on 25th October as compared to 25th November sown crop (70.3 cm and 91.2, respectively). Further, higher dry matter accumulation m^{-1} row length (175.0 g) and leaf stem ratio (0.87) were recorded by crop sown on 25th October over 25th November sown crop (155.1 g and 0.79, respectively). These growth attributes *viz*., plant height, number of tillers, dry matter accumulation and leaf stem ratio of oats showed decline trend because of late sowing, might be due to exposure of late sown crop to non congenial climate such as low temperature and shorter day length that might have led into poor vegetative growth in comparison with early sown

Table 1. Soil conditions of trial sites

Year	pH	Organic carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
2016-17	8.1	0.65	271.40	19.60	286.61
2017-18	8.0	0.68	275.70	20.20	292.80

crop. Dar *et al*. (2014) also reported that growth parameters declined significantly due to late sowing. The data further indicated that plant height; dry matter accumulation and number of tillers m^{-1} row length of oats at harvest were significantly influenced due to sowing time. The higher plant height (137.6 cm), dry matter accumulation (271.6 g) and number of tillers (92.3) m^{-1} row length were recorded by 25th October sown crop. The higher values of growth attributes for early sown crop might be due to favorable environmental situation. Khattak *et al.* (2016) also reported that sowing time significantly influenced growth parameters at harvest.

Again growth attributes were significantly affected due to various cutting schedules (Table 2). Significantly higher plant height (78.9 cm) and number of tillers m^{-1} row length (101.3), dry matter accumulation m^{-1} row length (177.1 g) and leaf stem ratio (0.89) were obtained due to cut at 70 DAS over remaining cutting schedules. The growth attributes *viz.*, plant height, number of tillers, dry matter accumulation and leaf stem ratio showed increment due to late cutting, which might be due to advancement of crop age and longer period for development of luxuriant vegetative growth and accumulation of more photosynthates as compared to earlier cuttings. Hussain *et al*. (2004) reported that plant height and number of tillers of fodder oats significantly affected due to cutting management practices. The data further revealed that plant height, dry matter accumulation and number of tillers m^{-1} row length at harvest of oats were significantly influenced due to various cutting schedules (Table 2). The higher plant height (142.9 cm), dry matter accumulation (297.6 g) and number of tillers (102.2) m^{-1} row length were produced due to no cut (C_0) and lower values for these growth attributes were associated with cut at 70 DAS (C_3). The increment in these growth attributes associated with no cut treatment might be due to the crop at this stage was kept uncut, therefore, availability of longer vegetative period for growth as compared to other cutting treatments. Hussain *et al*. (2004) also reported that cutting systems significantly affected the growth parameters of grain oats.

Growth attributes of fodder oats at a cutting were also significantly influenced due to different nitrogen levels (Table 2). The significantly more plant height (75.6 cm) and number of tillers m^{-1} row length (102.0), dry matter accumulation (174.1g) and leaf stem ratio (0.89) were recorded due to application of 120 kg N ha^{-1} over remaining nitrogen levels. The increment in all growth

Table 2. Effect of sowing time, cutting schedules and nitrogen levels on growth attributes and yield of fodder and grain oats (pooled data of two years)

Treatments	Plant height (cm)		Number of tillers m^{-1} row length		Dry matter accumulation (g) m^{-1} row		Leaf stem ratio	Dry fodder yield (t ha^{-1})	Green fodder yield (t ha^{-1})
	At cutting	At harvest	At cutting	At harvest	At cutting	At harvest	At cutting		
Sowing time									
25th October	76.0	137.6	104.2	92.3	175.0	271.6	0.87	36.4	8.0
25th November	70.3	124.8	91.2	84.9	155.1	262.4	0.79	32.9	7.1
SEm±	0.77	1.38	0.90	0.70	2.11	2.09	0.008	0.47	0.11
CD (P=0.05)	2.26	4.07	2.65	2.07	6.24	6.16	0.024	1.40	0.34
Cutting schedules									
No cut	-	142.9	-	102.2	-	297.6	-	-	-
Cut at 50 DAS	67.4	129.4	94.1	86.2	151.4	265.4	0.75	31.4	6.9
Cut at 60 DAS	73.2	121.4	97.7	77.4	166.8	237.9	0.85	34.6	7.6
Cut at 70 DAS	78.9	115.1	101.3	75.4	177.1	231.7	0.89	37.8	8.3
SEm±	0.94	1.95	1.10	0.99	2.59	2.95	0.010	0.58	0.14
CD (P=0.05)	2.76	5.76	3.25	2.93	7.64	8.71	0.029	1.71	0.41
Nitrogen levels									
80 kg ha^{-1}	70.5	123.6	93.3	82.3	154.1	247.9	0.77	32.5	7.1
100 kg ha^{-1}	73.4	127.9	97.8	86.5	167.0	260.3	0.83	34.9	7.6
120 kg ha^{-1}	75.6	130.1	102.0	87.2	174.1	266.4	0.89	36.5	8.0
SEm±	0.44	0.91	0.72	0.60	1.16	2.30	0.009	0.28	0.12
CD (P=0.05)	1.24	2.55	2.01	1.68	3.25	6.46	0.026	0.79	0.33

attributes due to higher dose of nitrogen might be because of major role of nitrogen that facilitates the rapid vegetative growth through cell elongation in form of plant height, number of tillers, dry matter accumulation and leaf stem ratio. Similarly significant influence on growth attributes of fodder oats was reported with increasing level of nitrogen earlier (AICRPFCU, 2016). Khinchi *et al*. (2018) observed that plant height, number of tillers plant^{-1} and leaf: stem ratio of fodder pearl millet were significantly influenced with application of increasing doses of nitrogen. Plant height, dry matter accumulation and number of tillers m^{-1} row length at harvest of oats were significantly influenced due to various nitrogen levels (Table 2). The significantly higher plant height (130.1cm), dry matter accumulation (266.4 g) and number of tillers (87.2) m^{-1} row length were recorded due to application of 120 kg N ha^{-1} over 80 kg N ha^{-1}, but found at par with 100 kg N ha^{-1}. This might be due to nitrogen, being a constituent of protoplasm that plays major role in stimulation of cell, cell division and elongation which improved vegetative growth *viz*., plant height, number of tillers and dry matter accumulation.

Forage and grain yield: Sowing time had significant influence on green and dry fodder yield of oats (Table 2). Significantly higher green (36.4 t ha^{-1}) and dry (8.0 t ha^{-1}) fodder yield was obtained with crop sown on 25th October as compared to 25th November sown. The corresponding increment in green and dry fodder yield was in tune of 10.5 and 11.9%, respectively. Kumar (2012) reported that 11th October sown oats produced significantly higher green (30.3 t ha^{-1}) as well as dry (4.9 t ha^{-1}) fodder yield over rest of sowing dates. Jehangir *et al.* (2012) similarly found that early sown oats recorded significantly higher green and dry fodder yield over other late sowing dates under single cut system. Further significantly higher green (611.0 kg ha^{-1} day^{-1}) and dry (134.0 kg ha^{-1} day^{-1}) fodder production efficiency registered with early sown crop on 25th October as compared to late sown crop i.e. 25th November (552.7 and 120.4 kg ha^{-1} day^{-1}, respectively). Delay in sowing decreased the green, dry fodder yield and fodder production efficiency of oats. The higher fodder yield as well as fodder production efficiency day $^{-1}$ in early sown crop might be due to favourable climatic situations which led into luxuriant vegetative growth in the forms of plant height, number of tillers, dry matter accumulation and leaf stem ratio. The similar results were observed earlier (Jehangir *et al*., 2012; Dar *et al*., 2014; Kumar, 2012). Significantly higher grain (2.7 t ha^{-1}) and straw (6.6 t ha^{-1}) yields of oat crop were obtained with crop sown on 25th October as compared to crop sown on 25th November. The higher grain and straw yields of oats associated with early sown crop might be due to increment in yield attributes because of favorable environment that became available during the reproductive phase of crop over late sown crop. Khattak *et al.* (2016) also reported that early sown oats had significantly higher grain and straw yield as compared to late sown oats.

Fodder yields of oats also significantly varied due to different cutting schedules (Table 2). Cut at 70 DAS had significantly higher green fodder yield (37.8 t ha^{-1}) over cut at 60 and 50 DAS to the tune of 9.3 and 20.3%, 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 50 DAS (6.9 t ha^{-1}). Increase in green and dry fodder yields 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 accumulation required for higher forage production of oats as compared to earlier cutting. The higher green and dry fodder yield might 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 accumulation (r = 0.985 and r = 0.950) and leaf stem ratio (r = 0.881 and r = 0.796), respectively at this stage. Hussain *et al*. (2004) also reported that cutting management had remarkable effect on green and dry fodder yield of oats. Further; it was also observed (Table 3) that green and dry fodder production efficiency ha^{-1} day^{-1} of oats significantly influenced due to 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%, 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 70 DAS by 8.5 and 15.8%, 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 significantly influenced due to cutting management. The results revealed that different cutting schedules brought about significant variation with respect to grain as well as straw yield of dual purpose oats. The highest grain (3.0 t ha^{-1}), straw (7.3 t ha^{-1}) and biological yield (10.4 t ha^{-1}) of oats was registered due to no cut over other cutting schedules in ascending sequence of cut at 70, 60, 50 DAS and no cut. The higher grain yield might be due to positive correlation of yield attributes *viz*., number of effective tillers, panicle length, number of grains panicle^{-1}, and 1000-grain weight and weight of grains. The lowest straw yield from cut at 70 DAS might be due to poor regeneration resulted in poor straw production. Straw yield also had positive correlation with plant height (r = 0.963), dry matter accumulation (r = 0.980) and number of tillers (r = 0.952). It was also known that delayed cutting significantly reduced grain as well as straw yield of oats in comparison with early cuttings.

Fodder yields of oats were remarkably influenced due to various nitrogen levels. 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%, respectively. The corresponding increment in dry fodder yield was by 5.5 and 12.5%, respectively. The increment in green and dry fodder yield due to higher dose of nitrogen probably due to luxuriant vegetative growth achieved in form of plant height, number of tillers, dry matter accumulation and leaf stem ratio at cutting which enhanced the photosynthetic activities and hence, the forage production. Further application of 120 kg N ha^{-1} recorded significantly higher green fodder production efficiency (613.5 kg ha^{-1} day^{-1}) as well as dry fodder production efficiency (134.4 kg ha^{-1} day^{-1}) compared to others. The increment in green, dry fodder yield and production efficiency due to higher dose of nitrogen probably 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. Nitrogen application also significantly influenced forage production and efficiency of oats earlier (AICRPFCU, 2016). Different nitrogen levels also brought about significant variation with respect to grain and straw yield of dual purpose oats (Table 3). Significantly higher grain (2.5 t ha^{-1}) and straw yield (6.2 t ha^{-1}) of oats were registered due to application of 120 kg N ha^{-1} over 80 kg N ha^{-1}, but found statistically at par with 100 kg N ha^{-1}. Increased grain yield might be due to increased yield attributes. Similarly straw yield might have enhanced due to increase in plant height (r = 0.896), dry matter accumulation (r = 0.958) and number of tillers (r = 0.898) at harvest. A positive correlation with straw yield justified the fact. Similarly Devi *et al*. (2010) reported that nitrogen application had significant influence on grain and straw yield of oats.

Table 3. Effect of sowing time, cutting schedules and nitrogen levels on production efficiency, yield and economics of fodder and grain oats (pooled data of two years)

Treatments	Green fodder production efficiency (kg ha^{-1} day^{-1})	Dry fodder production efficiency (kg ha^{-1} day^{-1})	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)	Net returns (Rs. ha^{-1})	B:C ratio
Sowing time								
25th October	611.0	134.0	2.7	6.6	9.3	29.3	84678	2.32
25th November	552.7	120.4	2.5	6.2	8.7	28.7	74095	2.03
SEm±	5.24	1.54	0.03	0.07	0.09	0.25	908	0.03
CD (P=0.05)	15.46	4.55	0.09	0.22	0.27	NS	2678	0.07
Cutting schedules								
No cut	-	-	3.0	7.4	10.4	29.4	50722	1.56
Cut at 50 DAS	628.7	137.0	2.6	6.3	8.9	29.0	96260	2.58
Cut at 60 DAS	576.6	126.3	2.2	5.5	7.7	28.5	91177	2.40
Cut at 70 DAS	540.3	118.4	1.9	4.8	6.7	28.7	89751	2.33
SEm±	6.42	1.89	0.04	0.11	0.13	0.35	1284	0.04
CD (P=0.05)	18.93	5.57	0.12	0.31	0.39	NS	3787	0.10
Nitrogen levels								
80 kg ha^{-1}	545.1	119.6	2.3	5.6	7.9	28.8	74500	2.03
100 kg ha^{-1}	587.0	127.7	2.5	6.1	8.6	29.0	84495	2.28
120 kg ha^{-1}	613.5	134.4	2.5	6.2	8.7	29.0	86937	2.33
SEm±	3.98	1.22	0.02	0.07	0.07	0.28	500	0.01
CD (P=0.05)	11.17	3.43	0.04	0.20	0.21	NS	1404	0.04

Nutrient content and uptake: N, P and K contents in fodder oats did not influenced significantly due to different sowing times (Table 4). However, N, P and K uptake were influenced by sowing time. The crop sown on 25th October registered significantly higher nitrogen (154.6 kg ha^{-1}), phosphorus (16.3 kg ha^{-1}) and potassium (86.8 kg ha^{-1}) uptake over 25th November. Significantly higher nitrogen, phosphorus and potassium uptake by fodder with early sown crop might be due to higher dry fodder production. The positive correlation of dry fodder yield with nitrogen (r = 0.984), phosphorus (r = 0.977) and potassium (r = 0.998) uptakes confirmed this statement. Jehangir *et al*. (2017) also reported that nitrogen, phosphorus and potassium uptake by fodder significantly influenced due to sowing time.

Different cutting schedules under study resulted in significant variation with respect to nitrogen, phosphorus and potassium content and uptake in fodder oats (Table 4). Cut at 50 DAS produced significantly higher nitrogen, phosphorus and potassium content over cut at 70 DAS, but it was at par with cut at 60 DAS, whereas cut at 70 DAS produced significantly higher nitrogen, phosphorus and potassium uptake over cut at 50 DAS but it was at par with cut at 60 DAS. Meena *et al.* (2016) also reported that nitrogen, phosphorus and potassium content and uptake by barley fodder crop were significantly influenced due to various cutting schedules.

Application of 120 kg N ha^{-1} recorded significantly higher nitrogen, phosphorus and potassium content in fodder oats over 80 kg N ha^{-1} but it was at par with 100 kg N ha^{-1} (Table 4). However, in case of nutrient uptake application of 120 kg N ha^{-1} had significantly higher nitrogen, phosphorus and potassium uptake over 80 and 100 kg N ha^{-1}. Positive correlation between dry fodder yield and uptake of nitrogen, phosphorus and potassium (r = 0.990, r= 0.994 and r = 0.973, respectively) in fodder justified the above fact.

Economics: Net returns and B: C ratios of dual purpose oats were significantly varied due to sowing time (Table 3). The higher net returns (Rs. 84678 ha^{-1}) and B: C ratio (2.32) was obtained with the crop sown on 25th October. The early sown crop recorded higher net returns as well as B: C ratio because of favorable atmosphere during that period over late sown crop. Jehangir *et al*. (2012) also observed that net return and benefit cost ratio were significantly affected due to sowing time.

Different cutting schedules influenced significantly with respect to net return and B: C ratio of dual purpose oats (Table 3). The significantly higher net return (Rs. 96260 ha^{-1}) and B: C ratio (2.58) was recorded due to cut at 50 DAS (C_1) over rest of cutting schedules in descending order of cut at 50, 60, 70 DAS and no cut treatment. This might be due to moderate yields of grain, straw and fodder

Table 4. Effect of sowing time, cutting schedules and nitrogen levels on nitrogen, phosphorus and potassium content and uptake in fodder oats (pooled data of two years)

Treatments	Nitrogen		Phosphorus		Potassium	
	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})
Sowing time						
D_1 - 25th October	1.94	154.6	0.20	16.3	1.087	86.8
D_2 - 25th November	1.92	136.9	0.20	14.3	1.078	77.0
SEm±	0.01	2.26	0.00	0.18	0.004	1.20
CD (P=0.05)	NS	6.67	NS	0.52	NS	3.54
Cutting schedules						
C_1 - Cut at 50 DAS	1.96	134.5	0.22	15.0	1.122	76.6
C_2 - Cut at 60 DAS	1.96	148.7	0.21	15.1	1.112	84.0
C_3 - Cut at 70 DAS	1.86	154.1	0.18	15.9	1.014	84.9
SEm±	0.01	2.77	0.003	0.22	0.005	1.47
CD (P=0.05)	0.03	8.17	0.01	0.64	0.014	4.34
Nitrogen levels						
N_1 - 80 kg ha^{-1}	1.90	134.9	0.19	13.5	1.018	72.2
N_2 - 100 kg ha^{-1}	1.93	146.1	0.21	15.5	1.111	84.0
N_3 - 120 kg ha^{-1}	1.95	156.2	0.21	17.0	1.120	89.3
SEm±	0.01	2.37	0.003	0.15	0.004	1.33
CD (P=0.05)	0.02	6.66	0.01	0.42	0.010	3.73

NS: Non significant

obtained from cut at 50 DAS and left for grain production. From the report of it was observed that gross return, net return and B: C ratio of dual purpose oats were significantly influenced due to cutting management earlier (AICRPFCU, 2016).

Net return and B: C ratios were significantly influenced due to various nitrogen levels (Table 3). Higher net return (Rs. 86937 ha^{-1}) and B: C ratio (2.33) was recorded due to application of 120 kg N ha^{-1} in ascending sequence of 80, 100 and 120 kg ha^{-1}. Higher net return and benefit cost ratio might be due to high productivity (fodder, grain and straw yield) obtained with higher dose of nitrogen. Supply of nitrogen to oats significantly affected net return and B: C ratio earlier also (Devi *et al*., 2010; AICRPFCU, 2016).

Conclusion

It was concluded that dual purpose oats sown on 25th October, cut at 50 DAS and fertilized with 120 kg N ha^{-1} recorded optimum green fodder yield, grain yield, straw yield, nitrogen, phosphorus and potassium content with maximum net return and B: C ratio.

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