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Full Length Research Paper

Effect of sowing dates, fertility levels and cutting managements on growth, yield and quality of oats (*Avena sativa* L.)

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A two year study was conducted during *rabi* seasons of 2009-10 and 2010-11 at Research Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir to find out the influence of sowing dates, fertility levels and cutting management on growth, yield and quality of oats. The results revealed that September 30 sowing recorded significant improvement in green fodder yield over October 10 sowing. Crude protein content was highest in October 10 sown crop, whereas crude fibre was highest in September 20 sown crop. The fertility level of 150:70:40 ($N:P_2O_5:K_2O$ kg ha^{-1}) significantly increased both green and dry fodder yield as well as crude protein content over 125:60:30 and 100:50:20 ($N:P_2O_5:K_2O$ kg ha^{-1}), however crude fibre content significantly decreased with increase in fertility level. Double cut crop recorded 14.75 and 16.24% increase in green fodder yield and 3.70 and 1.36% in dry fodder yield over single cut crop during 2009-10 and 2010-11, respectively. Moreover, double cut crop recorded higher crude protein content but lower crude fibre content.

Key words: Sowing dates, fertility levels, cutting management, green and dry fodder yield, crude protein, crude fibre, oats.

INTRODUCTION

Oats (*Avena sativa* L.) rank fifth in terms of world production of cereals and is widely used as a companion crop for under-seeding of forage legumes (Dost, 1997). It is the most important winter cereal fodder which is rich source of energy, protein, vitamin B_1, phosphorus, iron and other minerals and is mainly grown in temperate and cool sub-tropical environments. A chronic fodder shortage, most serious in winter, is a major limiting factor for livestock production. There are two traditional fodder deficit periods especially in temperate regions including, December to March, when traditional winter fodder crops like berseem (*Trifolium alexandrinum*), oats (*A. sativa*) and lucerne (*Medicago sativa*) are dormant and May to June (when the main summer season fodder crops such as maize (*Zea mays*), pearl millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) have just begun growth and the winter fodder season is over. As a result of deficit periods, fodder becomes available for livestock feeding in late April thereby resulting in drastic reduction in milk and meat production. Sharma and Bhunia (2000) reported that higher fodder yield was recorded with increasing levels of nitrogen and when cutting was taken at 85 days after sowing. Similarly, Demetrio et al. (2012) obtained higher fodder yield by using up to two cuts in the vegetative stage, or a single one in the flowering stage. In view of this, an effort was made to adjust sowing date of oats in such a way that some green fodder becomes available to the livestock just at onset of winter without

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Table 1. Growth characters of oats as affected by sowing dates, fertility levels and cutting management.

Treatments	Plant height (cm)				Tillers m^{-2}				Leaf area index			
	2009-10		2010-11		2009-10		2010-11		2009-10		2010-11	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Sowing dates												
September, 20	77.05	83.56	75.50	74.23	377.11	324.28	355.20	316.77	2.50	4.02	2.48	3.93
September, 30	68.01	108.48	67.14	106.78	333.83	331.14	330.98	326.46	2.33	5.47	2.32	5.39
October, 10	20.17	110.56	20.00	108.68	259.30	334.10	254.44	336.04	0.48	5.33	0.45	5.11
SE(m)±	1.42	2.00	1.74	1.82	3.88	1.94	3.75	2.25	0.10	0.16	0.10	0.13
CD (p=0.05)	4.10	5.78	4.25	5.26	11.22	5.60	10.82	10.82	0.28	0.47	0.29	0.39
Fertility levels ($N:P_2O_5:K_2O$ kg ha^{-1})												
150:70:40	59.96	108.01	59.38	103.32	353.55	363.27	347.35	359.01	2.08	5.60	2.04	5.28
125:60:30	55.21	102.10	54.43	97.16	332.22	331.87	322.47	329.26	1.84	5.18	1.80	4.98
100:50:20	50.40	92.50	49.40	89.15	284.46	294.96	270.74	290.99	1.42	4.14	1.40	4.17
SE(m)±	1.42	2.00	1.74	1.82	3.88	1.94	3.75	2.25	0.10	0.16	0.10	0.13
CD (p=0.05)	4.10	5.78	4.25	5.26	11.22	5.60	10.82	6.51	0.28	0.47	0.29	0.39
Cutting levels												
Single cut (Cut at 50% flowering)	58.04	113.29	57.00	108.44	328.48	390.75	320.30	384.28	1.83	5.66	1.83	5.51
Double cut (Cut on 15th Dec. and 50% flowering)	58.01	88.45	57.03	84.64	330.34	269.25	318.74	268.56	1.83	4.28	1.79	4.44
SE(m)±	0.94	1.63	0.96	1.40	3.17	1.29	3.06	1.495.30	0.06	0.10	0.06	0.09
CD (p=0.05)	NS	4.71	NS	4.29	NS	4.57	NS		NS	0.38	NS	0.32

reduction in the total yield.

MATERIALS AND METHODS

A field experiment was undertaken during *rabi* seasons of 2009-10 and 2010-11 at Research Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir on silty clay loam soil low in available nitrogen (261.48 kg ha^{-1}), medium in available phosphorus (20.83 kg ha^{-1}) and potassium (165.0 kg ha^{-1}) with neutral pH (6.8). The treatments consisting of three sowing dates (September 20, September 30 and October 10), three fertility levels (150:70:40, 125:60:30,100:50:20 kg $N:P_2O_5:K_2O$ ha^{-1}) and two cuttings managements (Single cut - cut at 50% flowering and double cut - cut on 15th December and 50% flowering) were laid out in randomized block design replicated thrice. Oat variety "*Sabzar*" was sown as per treatment in rows 23 cm apart with a seed rate of 100 kg ha^{-1} in the plots of 13.8 m^2 area with 15 rows per plot. The fertilizers were applied as per treatment with half dose of nitrogen and full dose of phosphorus and potassium in the form of urea, diamonuum phosphate (DAP) and muriate of potash (MOP) as basal, and the remaining half of nitrogen was top dressed in two equal splits one each at 30 DAS and 1st week of March. All other operations were carried as per recommended package and practices. The observations on the plant height (cm), number of tillers m^{-2}, leaf area index, green fodder yield and dry fodder yield (sundried) in q ha^{-1} were recorded both at 1st and 2nd cut. Plant samples from green fodder yield of each treatment were sun dried followed by oven drying at 60 to 65°C to a constant weight and were finely ground for analysing of nitrogen content by microKjeldal method (Jackson, 1967), which was multiplied with 6.25 to represent protein content and calculate protein productivity. Crude fibre was determined by the method given by AOAC (1995). The data were analysed by the methods given by Cochran and Cox (1963).

RESULTS AND DISCUSSION

Sowing dates

Data (Table 1) revealed that crop sown on September 20th recorded significantly higher plant height, tillers m^{-2} and leaf area index at 1st cutting, whereas at 2nd cutting (September 30th and October 10th) they were statistically similar but significantly higher than September 20th during both the years of experimentation. The data presented in Table 2 revealed that September 30th and September 20th sown crops, at par with one

Table 2. Green fodder and dry matter yield of oats (q ha^{-1}) as affected by sowing dates, fertility levels and cutting management.

Treatments	Green fodder yield				Dry matter yield			
	2009-10		2010-11		2009-10		2010-11	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Sowing dates								
September, 20	150.29	229.18	148.09	211.31	27.26	70.05	25.31	65.22
September, 30	146.49	236.31	146.03	218.27	25.50	71.99	24.80	67.10
October, 10	25.61	244.02	25.09	228.91	5.10	74.06	5.06	69.95
SE(m)±	-	3.86	-	3.71	-	1.04	-	1.16
CD (p=0.05)	-	11.45	-	10.73	-	3.01	-	3.35
Fertility levels ($N:P_2O_5:K_2O$ kg ha^{-1})								
150:70:40	122.23	248.31	118.48	236.10	21.60	75.22	20.32	71.92
125:60:30	107.59	236.84	110.56	223.15	19.18	72.12	19.00	68.42
100:50:20	92.47	224.46	90.37	199.10	16.66	68.76	15.85	61.92
SE(m)±	-	3.86	-	3.71		1.04	-	
CD (p=0.05)	-	11.45	-	10.73		3.01	-	
Cutting levels								
Single cut (Cut at 50% flowering)	-	320.32	106.47	301.44	-	81.17	-	76.06
Double cut (Cut on 15th Dec. and 50% flowering)	107.44	260.15		243.94	19.25	62.89	18.32	58.78
SE(m)±	-	3.24		3.03		0.69	-	0.77
CD (p=0.05)	-	9.34		8.76	0.43	2.45	-	2.73

another recorded increase in the total green fodder yield to the tune of 41.97 and 40.73%, respectively, in 2009-10 and 43.56 and 41.55% in 2010-11 and dry matter yield by 23.45 and 22.92% in 2009-10 and 22.51 and 20.69% in 2010-11, respectively over October 10th sown crop. The higher temperatures available to the early sown crop resulted in the better growth of crop in terms of plant height and tiller production thereby producing more tonnage at 1st cut on December 15th. Sood et al. (1992) also reported higher yield in early sown oat crop compared to delayed sowing. Khalil et al. (2011) reported that forage dry matter production in wheat cut at 90 DAS was significantly higher than cut at 75 DAS. October 10th sown crop recorded higher crude protein but lower fibre content than September 20th and September 30th sown crop (Table 3). Higher protein content in October 10th sown crop could be attributed to higher nitrogen content in the plant at 1st cut and 2nd cutting. Protein content is inversely proportional to fibre content, hence lower fibre content in October 10th sown crop (Dost, 2004).

Fertility levels

The plant height and number of tillers m^{-2} showed significant and consistent increase with increase in fertility level from 100:50:20 to 150:70:40 kg $N:P_2O_5:K_2O$ ha^{-1}, however, leaf area index recorded with fertility level 125:60:30 and 150:70:40 kg $N:P_2O_5:K_2O$ ha^{-1} remained at par but significantly higher than 100:50:20 kg $N:P_2O_5:K_2O$ ha^{-1} during both the years of experimentation (Table 1). The highest fertility level 150+70+40 kg $N:P_2O_5:K_2O$ ha^{-1} significantly improved the oats yield with superiority of 7.58 and 16.% and 6.25 and 22.48% in total green fodder yield and 5.63 and 13.38% and 5.51 and 18.60% in total dry matter yield over 125+60+30 and 100+50+20 kg $N:P_2O_5:K_2O$ ha^{-1} during 2009-10 and 2010-11, respectively (Table 2). The abundant supply of nitrogen may have increased protoplasmic constituents and accelerated the process of cell division and elongation which has resulted in luxuriant vegetative growth in terms of plant height there by higher biomass and dry matter yield. Besides, phosphorus is involved in energy transfer and phosphorus dose at 70 kg P_2O_5 ha^{-1} may have significantly increased the tiller number especially at early crop growth stage thereby resulting in higher tonnage. These results corroborate the findings of Singh et al. (1997), Bali et al. *(*2003) and Malik and Paynter (2010).

The crude protein content showed significant improvement with increasing levels of fertility but crude fibre content remained unaffected (Table 3). Application of higher doses of nitrogen may have increased the nitrogen concentration in the plant and hence the crude protein content. Similar findings have also been made by Pandey et al. (1998).

Cutting management

The double cut crop recorded higher fodder yield with an increase of 14.75 and 16.24% in total green fodder yield and 3.70 and 1.26% in total dry matter yield over single cut crop during 2009-10 and 20110-11, respectively (Table 2). Double cut crop harvested on December 15th

Table 3. Crude protein and crude fibre content (%) of oats as affected by sowing dates, fertility levels and cutting management.

Treatments	Crude protein				Crude fibre			
	2009-10		2010-11		2009-10		2010-11	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Sowing dates								
September, 20	17.37	8.56	17.31	8.43	19.33	22.77	19.10	22.66
September, 30	19.06	8.62	19.00	8.50	19.26	22.59	19.02	22.51
October, 10	19.62	8.87	19.56	8.75	18.86	22.05	18.74	21.95
SE(m)±	-	0.07	-	0.05	-	0.18	-	0.17
CD (p=0.05)	-	0.21	-	0.14	-	0.53	-	0.48
Fertility levels (N:P_2O_5:K_2O kg ha^{-1})								
150:70:40	19.56	8.93	19.43	8.87	19.01	22.38	18.89	22.24
125:60:30	19.12	8.68	19.06	8.50	19.19	22.45	19.92	22.35
100:50:20	17.43	8.43	17.43	8.31	19.26	22.58	19.04	22.52
SE(m)±	-	0.07	-	0.05	-	0.18	-	0.17
CD (p=0.05)	-	0.21	-	0.14	-	NS	-	NS
Cutting levels								
Single cut	-	8.50	-	8.43	-	23.10	-	22.94
Double cut	18.68	8.87	18.56	8.68	19.15	21.84	18.95	21.80
SE(m)±	-	0.06	-	0.04	-	0.15	-	0.13
CD (p=0.05)	-	0.17	-	0.11	-	0.43	-	0.39

for 1st cut before arrest of growth due to chilling temperatures and snowfall damage provide good quantity of green fodder especially early sown crop thereby total fodder yield in two cuts was significantly higher than in single cut crop. Previously, Shah and Hasan (1999) and Singh and Dubey (2007) also recorded higher green fodder and dry matter yield in double cut compared to single cut crop. It was found that double cut crop recorded significantly higher crude protein and lower crude fibre content than single cut crop (Table 3). Higher nitrogen concentration in double cut crop might have resulted in higher crude protein content. Lower lignin concentration in the oat stems of double cut crop due to more softness of stem restricted the crop to become more fibrous.

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