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Yield and quality improvement in fodder oats (*Avena sativa* L.) through split application of fertilizer and cutting management

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Green fodder is an important component of livestock feed and nutrition. In West Bengal chronic shortage of fodder particularly in winter season (Nov to March) is a major limiting factor for livestock production. Generally fodder become available for livestock feeding in late April as a result of which both milk and meat production has been reduced. Winter forage plants can be growth in cool sub-tropical environment for increased fodder availability during traditional fodder deficit period Jehangir *et al*. (2013). Oats (*Avena sative* L.) has severed advantages are other fodder species because of its high yield potential, nutrition and high regeneration capacity particularly during early winter month.

Fertilization and various cuts (defoliation) are two most important factors in which influence both productivity and quality in forage species Bassegio *et al*. (2013). Like any other arable crops, nutrients are fundamentally important in production process of fodder crops, and N is considered to be most limiting one Lavres and Monteiro (2003). Forage yield will be affected to a great extent depending on the number and timing of defoliation Bortolinii *et al*. (2004). Demetrio *et al.* (2012) obtained higher fodder yield by using single cut in the flowering stage or two cut in the vegetative stage. Sharma and Bhunia (2000) have also reported interaction effect between N level and cutting management, and higher fodder yield was recorded with increasing levels of N and single cut at 85 DAS. In view of this, an effort was made to adjust nutrient level and cutting management in such a way that some green fodder becomes available to the livestock during winter months.

The field experiment was carried out during the *rabi* (winter) seasons of 2008-09 and 2009-2010 at Central Research Farm, Gayeshpur, under Bidhan Chandra Krishi Viswavidyalaya, West Bengal (23^o N latitude and 89^o E longitude and 9.75 m above mean sea level). The experimental site, having subtropical humid climate, is situated just south of Tropic of Cancer. During the experimental period, the maximum and minimum temperature varied from 21.4 to 36.6^{o}C and 8.3 to 25.4^{o}C, respectively. Maximum and minimum relative humidity (RH) ranged from 97.0 to 88.0% and 33.7 to 57.6%, respectively. The experimental soil was Gangetic alluvial (*Inceptisol*), sandy loam in texture and had neutral pH (6.90), 0.045% total N, available P_2O_5 45.0 kg ha^{-1} and available K_2O 240.0 kg ha^{-1}. The experiment was laid out in factorial randomized block design with 18 treatment combinations replicated thrice. The experiment, consisting of three factors; cutting management at two levels (C_1 : single cutting at 80 DAS and C_2 : double cutting at 60 DAS and at 105 DAS) and nitrogen (@90 kg ha^{-1}) scheduling at 3 levels (N_1 : ½ dose as basal + ½ dose at 20 DAS; N_2 : ½ dose as basal + ¼ dose at 20 DAS + ¼ dose at 40 DAS; N_3: 1/3 dose as basal + 1/3 dose at 20 DAS + 1/3 dose at 40 DAS) and K_2O (@ 60kg ha^{-1}) scheduling at 3 levels (K_1 : Full dose as basal; K_2 : ½ as basal + ½ at 20 DAS; K_3 : ½ as basal + ¼ at 20 DAS + ¼ at 40 DAS).

Seeds (JHO-822) were sown 25 cm apart in lines, @ 100kg ha^{-1} on 19.11.2009 during both the years. The total amount of P_2O_5 was applied as basal to all the plots but scheduling of N and K_2O were done as per the treatment details. Under single cut management practice, harvesting was done by cutting the plant with sickle at the ground level at 80 DAS whereas in case of double cut management practice, the 1st cut was taken at 60 DAS by cutting the plant leaving 10cm above the soil for further regeneration and the final cut was taken at 40 days after 1st cut. A dose of 30 kg N ha^{-1} was applied after the 1st cut at 60 DAS in the plots under double cutting system. The other intercultural operations were done as per the recommended package of practices. Statistical analyses of data were carried out by two factor randomized complete block design combined over years using MSTATC. Fischer and Yates tables were consulted for comparison of 'F' values and't' values for determination of critical differences at 5% level of significance.

Different growth attributes of oat, namely, plant height, root dry weight were recorded at the time of cutting to analyse the performance and progress of crop growth. The data revealed that all the growth attributes of fodder oats were significantly influenced

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by different scheduling of fertilizer application (Table 1). The highest plant height, root dry weight, leaf: stem ratio were obtained with the application of nitrogen @ 90kg ha^{-1} in three splits (½ dose as basal + ¼ dose at 20 DAS + ¼ dose at 40 DAS) along with potassium @ 60kg ha^{-1} in two splits (½ as basal + ½ at 20 DAS) closely followed by the treatment combination of nitrogen (½ dose as basal + ¼ dose at 20 DAS + ¼ dose at 40 DAS) in three splits along with potassium in three splits (½ as basal + ¼ at 20 DAS + ¼ at 40 DAS) which were statistically higher than all other treatments except N_2K_3 treatment for root dry weight and leaf: stem ratio. The lowest plant height, root dry weight and leaf: stem ratio were obtained with the basal application of nitrogen in two splits (½ dose as basal + ½ dose at 20 DAS) along with full dose of potassium. Split application of fertilizers especially nitrogen was reported to be associated with the better use efficiency of nitrogen leading to better growth and development of forage oat (Kumar *et al*., 1997). In other study, growth parameter like plant height was found to be improved with the split application nitrogen and potassium along with different cutting regimes (Bhagat *et al.*, 1994).

Table1: Effect of different treatments on growth attributes of fodder oats (Pooled)

Treatments	Plant height (cm)		Root dry weight		Leaf: stem ratio	
	Single cut	Double cut	Single cut	Double cut	Single cut	Double cut
N_1K_1	106.9	165.6	3.2	5.6	0.5	0.6
N_1K_2	120.3	181.0	3.4	5.8	0.6	0.7
N_1K_3	115.9	172.3	3.4	5.8	0.6	0.7
N_2K_1	137.9	190.6	4.0	6.4	0.6	0.8
N_2K_2	148.5	201.3	4.1	6.6	0.7	0.9
N_2K_3	140.8	193.6	4.1	6.5	0.7	0.9
N_3K_1	124.6	181.5	3.7	6.0	0.6	0.7
N_3K_2	135.7	189.9	3.8	6.2	0.7	0.8
N_3K_3	129.4	182.5	3.8	6.2	0.6	0.7
SEm (±)	**0.907**		**0.014**		**0.006**	
LSD (0.05)	**3.561**		**0.053**		**0.024**	

Table 2: Effect of different treatments on yield of fodder oats (Pooled)

Treatments	Green forage yield (t ha^{-1})		Yield (q $ha^{-1}day^{-1}$)	
	Single cut	Double cut	Single cut	Double cut
N_1K_1	30.4	52.8	3.8	5.0
N_1K_2	31.8	54.4	4.0	5.2
N_1K_3	31.9	54.2	3.9	5.2
N_2K_1	34.5	57.8	4.3	5.6
N_2K_2	36.1	58.5	4.5	5.6
N_2K_3	35.9	58.5	4.5	5.6
N_3K_1	32.7	55.5	4.1	5.3
N_3K_2	34.4	56.	4.3	5.4
N_3K_3	34.1	56.7	4.3	5.4
SEm(±)	**0.799**		**0.011**	
LSD(0.05)	**3.135**		**0.043**	

The highest green forage yield and per day yield were obtained with the application of nitrogen in three splits (½ dose as basal + ¼ dose at 20 DAS + ¼ dose at 40 DAS) along with the application of potassium in two splits (½ as basal + ½ at 20 DAS)(Table 2). The next best treatment combination was application of nitrogen (½ dose as basal + ¼ dose at 20 DAS + ¼ dose at 40 DAS) in three splits along with potassium in three splits (½ as basal + ¼ at 20 DAS + ¼ at 40 DAS) under double cut management practice which were statistically *at per* N_2K_3 treatment in single cut and double cut managements. Lowest green forage yield and per day yield were obtained with the application of nitrogen in two splits (½ dose as basal + ½ dose at 20 DAS) along with full dose of potassium as basal under single cut management practice. The difference in yield may be due to better utilization of fertilizers through split application. These results are in conformity with the findings reported by Rathi and Vaishya (1983). But under double cut management the yields of forage oats were higher than that of single cut management practice. Similar trend of result was also reported by Primavesi and Primavesi (1996). Mahale *et al*. (2004) also found that both green and dry forage productions of oats were influenced by the interaction between nitrogen level and cutting management.

Quality of fodder oats were mainly assessed by crude protein yield (CPY) and neutral detergent fiber (NDF). Both the quality parameters were significantly influenced by the timings of fertilizer application (Table 3). The highest crude protein yield and neutral detergent fiber yield were obtained with the application of nitrogen in three splits (½ doses as basal + ¼ dose at 20 DAS + ¼ dose at 40 DAS) along with potassium in two splits (½ as basal + ½ at 20 DAS).

Table 3: Effect of different treatments on fodder quality of oats (Pooled)

Treatments	Crude protein yield (q ha^{-1})		Neutral detergent fiber (NDF) (%)	
	Single cut	Double cut	Single cut	Double cut
N_1K_1	4.4	6.2	26.1	50.9
N_1K_2	4.5	6.4	29.9	55.5
N_1K_3	4.5	6.4	28.7	54.3
N_2K_1	4.7	6.4	30.8	58.8
N_2K_2	4.8	6.6	34.4	62.9
N_2K_3	4.8	6.5	33.3	61.5
N_3K_1	4.7	6.4	28.4	55.2
N_3K_2	4.8	6.6	31.0	58.2
N_3K_3	4.8	6.5	30.2	56.9
SEm (±)	**0.007**		**0.358**	
LSD (0.05)	**0.025**		**1.406**	

The second best treatment combination was nitrogen application in three splits (½ dose as basal + ¼ dose at 20 DAS + ¼ dose at 40 DAS) plus potassium in three splits (½ as basal + ¼ at 20 DAS + ¼ at 40 DAS) under double cut management practice. The lowest crude protein yield and neutral detergent fibre were obtained with application of nitrogen in two splits (½ doses as basal + ½ dose at 20 DAS) along with the application of full dose of potassium as basal under single cut management. Kumar *et al*. (2001) also opined that under double cut management system, different scheduling of nitrogenous fertilizer increased the crude protein yield.

It is concluded from the study that application of nitrogen @ 90kg ha^{-1} in three splits (½ dose as basal + ¼ dose at 20 DAS + ¼ dose at 40 DAS) along with potassium @ 60kg ha^{-1} in two splits (½ as basal + ½ at 20 DAS) improved yield and quality of fodder oat (Var. JHO 822) under double cut management practice. This approach of scheduling for nitrogen and potassium fertilizer finally helps towards realization of sustainable fodder oats production with higher economic return on a long-term basis under new alluvial zone of West Bengal.

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