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Influence of Cutting and Fertilizer Management on Growth and Yield of Fodder Oats (*Avena sativa* L.)

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A field experiment was conducted during *rabi* season of 2006-2007 and 2007-2008 at Agriculture Research Farm of Palli Siksha Bhavana, Visva-Bharati to study the "Influence of cutting and fertilizer management on growth and yield of fodder oats (*Avena sativa* L.)". Various growth attributes (viz. dry matter accumulation and leaf area index) of fodder oats were influenced significantly with different levels of fertilizer management. An increasing trend was found in dry matter accumulation and leaf area index of oats with the advancement of growth of the crop up to 60 days when 1st cutting was taken. A significant response from cutting and fertilizer management was found on total green and dry fodder yields of oats. The highest green and dry fodder yields were achieved from fertilizer schedule of N_{120} P_{60} K_{60} kg ha^{-1} both at single cutting and two cuttings management. Significantly higher total green and dry fodder yields were obtained from two cut management (29.74 and 7.92 t ha^{-1}, green and dry fodder respectively) when compared with single cut management (14.68 and 3.37 t ha^{-1}, respectively), indicating the scope of getting two cuttings from fodder oats in red and lateritic belt of West Bengal.

Key words: Cutting, fertilizer, growth, nutritive value, fodder yield.

Oats (*Avena sativa* L.) is an important winter cereal food and forage crop all over the world (Wu 2007). It is becoming a promising good quality forage crop due to its excellent growth habit, better regeneration capacity, palatability and nutritive value. It contains 3.32 -6.90 % protein, 30-35 % dry matter, 9.33 % total ash, 0.47 % calcium, 0.22 % phosphorus and 2.43-4.38 % potassium. It is used as green fodder, straw, hay or silage. Fodder is the major input in livestock production. In value terms, it accounts for about 80-90 % of the variable cost of milk production. The feed and fodder in India mostly consists of crop by-residues that depend on the regional cropping pattern. Two essential sources of nutrients to realize the genetic potential of animals, viz. green fodder and concentrates, particularly in the form of balanced compound animal feed are in short supply. The area under fodder crops in India has stagnated at about 8.5-9.0 million hectares during the past decade and accounts for only about 4.6% of the total cultivated area. With the production of about 491 million tonnes of green fodder as against an estimated requirement of nearly 648 million tones, there is more than 27% deficit in green fodder. Also, there is a 35% shortfall in availability of concentrates in the country (GOI, 2007).

There is a large gap between demand and supply of fodder for the increasing livestock population. But there is least chance to further increase in the area under forage cultivation. The area under cultivation of fodder has always remained meager and it is so even now. With growing human population the demand for livestock products and principal grain and pulse crops are increasing. As such cultivation of green fodder in the cropping system becomes important (Aulakh, et al. 2012). It is therefore necessary to increase the productivity of fodder crops. With this background, the experiment was taken up to study the effect of cutting and different levels of fertilizer management on growth, productivity and quality of fodder oats.

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Materials and Methods

The experiment was carried out during winter season of 2006-2007 and 2007-2008 at agricultural research farm, Institute of Agriculture, Visva-Bharati, Sriniketan, to study the influence of cutting and fertilizer management on growth and yield of fodder oats in red and lateritic belt of West Bengal. The experimental soil was sandy loam in texture with slightly acidic in reaction (pH 5.8), low in available nitrogen (167.5 kg ha^{-1}), medium in available phosphorus (39.2 kg ha^{-1}) and low in available potassium (165.3kg ha^{-1}) . The experiment, consisting of eight treatment combinations having two levels of cutting (one cutting and two cuttings) and four levels of fertilizer management (N_0 P_0 K_0;

N_{40} P_{20} K_{20}; N_{80} P_{40} K_{40}; N_{120} P_{60} K_{60} kg ha^{-1}), was laid out in randomized block design with factorial arrangement where each treatment was replicated thrice. The NPK fertilizers were applied as per treatment. Half dose of nitrogen (urea) and full quantity of phosphorus (SSP) and potassium (MOP) were applied during the time of sowing as basal and rest half of nitrogen was top dressed in two splits :One after first irrigation and other after first cutting. The fodder oats variety OS-6 was sown on 04.12.2006 and 04.12.2007 during *rabi* (winter) season with row spacing of 30 cm and seed rate of 100 kg ha^{-1}. The experiment was repeated in 2007-2008 with same treatment combinations. The NPK fertilizers were applied as per treatment. Half dose of nitrogen (urea) and full quantity of phosphorus (SSP) and potassium (MOP) were applied during the time of sowing as basal and rest half of nitrogen was top dressed in two splits: One after first irrigation and other after first cutting. Biometric observations were recorded at regular interval. Oats fodder was raised under irrigated condition. For successful cultivation, four irrigations were applied to the crop at various stages of growth such as 21 DAS, 42 DAS, 64 DAS and 81 DAS in addition to rainfall received during the period of experiment. The first cutting was done plot wise by sickle at 60 days after sowing at a stubble height of 5 cm above the ground level and second cutting was done for obtaining satisfactory re-growth during second cutting at 90 days after sowing. The field data were analyzed statistically following the standard method.

Results and Discussion

Growth attributes

The growth attributes (viz. leaf area index and dry matter accumulation) were influenced significantly at different stages of growth by fertilizer management (Table 1). An increasing trend was found in all the growth attributes of oats upto first cutting (60 DAS) and these values were higher even during final cutting (90 DAS) except leaf area index. The highest leaf area index (4.45) was observed at first cutting (60 DAS) with the application of N_{120} P_{60} K_{60} whereas in final cutting (90 DAS) lower leaf area index (3.25) was recorded. This was in conformity with the findings of Zhanga *et al*. (1999). At first cutting highest dry matter accumulation (256.83 g m^{-2}) was noticed with the application of N_{120} P_{60} K_{60} followed by 227.85 g m^{-2} with the application of N_{80} P_{40} K_{40}. The highest dry matter accumulation (405.39 g m^{-2}) was found at final cut (90 DAS) with the application of N_{120} P_{60} K_{60} (Table 1) as compare to first cut. Malakar *et al*. (2009) reported similar results in oats.

Table 1. Effect of cutting and fertilizer management on leaf area index and dry matter accumulation of oats fodder at different crop growth stages in 2006-07 and 2007-08 (Pooled over two years)

Treatment	Leaf area index (LAI)			Dry matter accumulation (g m^{-2})		
	30 DAS	60 DAS	90 DAS (Final cut)	30 DAS	60 DAS	90 DAS (Final cut)
Cutting management(C)						
C_1	0.95	3.47		49.66	195.51	
C_2	0.94	3.41		49.40	181.37	
S. Em(±)	0.004	0.02		0.79	6.93	
C.D.(P=0.05)	NS	NS		NS	NS	
Fertilizer management (F)						
F_0	0.54	1.78	1.51	24.22	84.37	154.60
F_1	0.95	3.39	2.76	48.24	184.70	309.91
F_2	1.06	4.15	2.81	62.29	227.85	361.22
F_3	1.23	4.45	3.25	63.37	256.83	405.39
S. Em(±)	0.005	0.03		1.11	9.80	
C.D.(P=0.05)	0.016	0.09		3.37	29.72	
Interaction (C×F)						
C_1F_0	0.53	1.79		26.28	80.41	
C_1F_1	0.94	3.35		45.17	223.07	
C_1F_2	1.08	4.24		62.99	230.15	
C_1F_3	1.24	4.48		64.21	248.40	
C_2F_0	0.55	1.76		22.15	88.33	
C_2F_1	0.95	3.43		51.31	146.32	
C_2F_2	1.05	4.05		61.60	225.55	
C_2F_3	1.21	4.42		62.53	265.27	
S. Em(±)	0.08	0.04		1.57	13.86	
C.D.(P=0.05)	0.24	0.12		4.77	42.03	

C_1 = One cutting, C_2 = Two cuttings, F_0 = N_0 P_0 K_0, F_1= N40 P_{20} K_{20}, F_2= N_{80} P_{40} K_{40}, F_3= N_{120} P_{60} K_{60}

Yield and quality

A significant effect of cutting and fertilizer management was found on total (1_{st} cut + 2_{nd} cut) green and dry fodder yields of oats whereas cutting management had no positive effect on green and

dry fodder yields at 1st cutting (Table 2). Significantly higher green and dry fodder yields were achieved from two cut management of oats when compared with single cut system. The findings of the present study regarding significant effect of nitrogen on dry fodder yield were reported by Hasan and Shah (2000). This higher productivity might be attributed to cumulated yield of first and final cutting as well as higher production of different yield components during its life cycle. Fertilizer management exerted significant influence on green and dry fodder yields of oats both at 1st cutting and on total yields. With the increasing levels of NPK fertilizers, green and dry fodder yields increased significantly. The highest total green and dry fodder yields (29.74 and 7.92 t ha^{-1}, respectively) were obtained with the application of N_{120} P_{60} K_{60} which was significantly higher than other treatments (Table 2). Similar results were also reported by Sharma (2009). A significant interaction between cutting and fertilizer management was also found with respect to total green and dry fodder yields of oats. Wu *et al*. (2010) also reported similar results. At final cutting (90 DAS) green fodder yield was higher than first cutting and highest green fodder

Table 2. Effect of cutting and fertilizer management on green and dry fodder yield of oats fodder in 2006-07 and 2007-08 (Pooled over two years).

Treatment	Green fodder yield (t ha^{-1})		Total DFY (t ha^{-1})	Dry fodder yield (t ha^{-1})		Total GFY (t ha^{-1})
	60 DAS (1st cut)	90 DAS (Final cut)		60 DAS (1st cut)	90 DAS (Final cut)	
Cutting management (C)						
C_1	9.03		9.03	2.45		2.45
C_2	9.84		21.45	2.49		5.66
S. Em(±)	0.37		0.36	0.06		0.06
C.D.(P=0.05)	NS		1.08	NS		0.18
Fertilizer management (F)						
F_0	3.26	5.93	6.18	0.82	1.54	1.62
F_1	8.41	11.92	14.86	2.20	3.10	3.75
F_2	11.80	13.89	17.70	3.27	3.61	5.20
F_3	14.27	15.58	22.21	3.59	4.06	5.64
S. Em(±)	0.52		0.50	0.08		0.09
C.D.(P=0.05)	1.59		1.52	0.25		0.26
Interaction (C×F)						
C_1F_0	3.19		3.19	0.79		0.79
C_1F_1	8.34		8.34	2.21		2.21
C_1F_2	9.90		9.90	3.43		3.43
C_1F_3	14.68		14.68	3.37		3.37
C_2F_0	3.33		9.18	0.85		2.46
C_2F_1	8.47		21.38	2.20		5.29
C_2F_2	13.71		25.51	3.11		6.97
C_2F_3	13.86		29.74	3.81		7.92
S. Em(±)	0.74		0.71	0.12		0.12
C.D.(P=0.05)	2.24		2.15	0.35		0.36

C_1 = One cutting, C_2 = Two cuttings, F_0 = N_0 P_0 K_0, F_1= N40 P_{20} K_{20}, F_2= N_{80} P_{40} K_{40}, F_3= N_{120} P_{60} K_{60}, GFY= Green fodder yield, DFY= Dry fodder yield

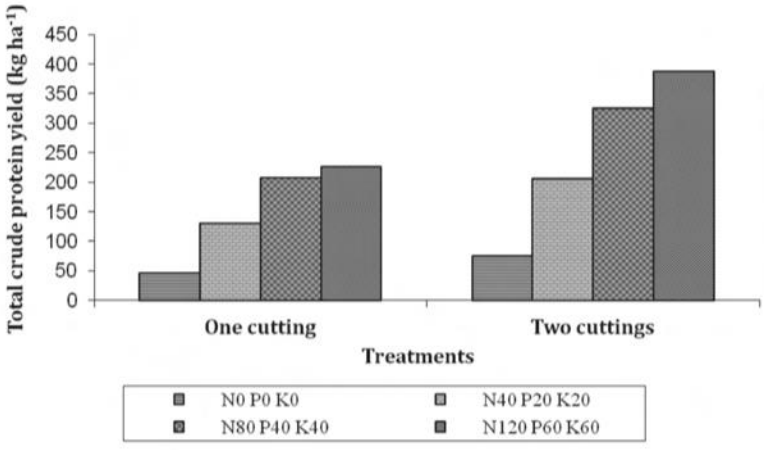

Fig.1. Effect of cutting and fertilizer management on total crude protein yield (kg ha^{-1}) of fodder oats in 2006-07 and 2007-08 (pooled over two years)

yield was achieved with N_{120} P $_{60}$ K_{60} (15.58 t ha $^{-1}$). The present findings regarding significant effect of nitrogen level are in agreement with the results reported by Mahale *et al.,* (2003) and Johnston *et al.* (2004). All levels of NPK fertilizers produced significantly higher total green fodder yield over control treatment. Supply of N_{120} P_{60} K_{60} under two cuts management produced the highest total green fodder yield (29.74 t ha_{-1}). This was significantly higher than the application of N_{80} P_{40} K_{40} (25.93 t $ha^{-}{}_{1}$). These results were in conformity with the findings of Singh *et al*. (1990), Pradhan and Mahapatra (1995) and Joshi *et al*. (1996). At first cutting, the highest dry fodder yield was obtained with the application of N_{120} P_{60} K_{60} (3.37 t ha^{-1}). The highest total dry fodder yield was achieved from the application of N_{120} P_{60} K_{60} kg ha^{-1} (7.92 t ha $^{-1}$) which was significantly higher than the use of N_{80} P_{40} K_{40} application (6.62 t ha $^{-1}$). Similar findings were also reported by Babalad *et al*. (1993). Application of fertilizers at 120:60:60 of N: P_2O_5: K_2O (kg ha^{-1}) along with two cuttings produced the highest yields of green and dry fodder in oats. Agarwal *et al*. (1995), Sing *et al*. (1996) and Singh *et al*. (1999) also reported similar results. Application of N_{120} P_{60} K_{60} kg ha^{-1} under two cuttings management exhibited highest total crude protein yield (388 kg ha^{-1}) which was higher than the application of N_{80} P_{40} K_{40} kg ha^{-1} (325 kg ha^{-1}) under same cutting management (Fig. 1). These results were in conformity with the findings of Ayub *et al*. (2011). Higher crude protein yield in oats might be attributed to higher application of nitrogen to the crop (Sharma, 2009).

Conclusion

From the findings of this field experiment, it may be concluded that in red and lateritic soil higher fodder production can be achieved from oats variety, OS-6 when two cuttings were taken successfully under irrigated condition. Application of N_{120} P_{60} K_{60} had significantly higher growth attributes, green and dry fodder yields as well as crude protein yield of fodder oats over N_{80} P_{40} K_{40}. The highest total green and dry fodder yields as well as total crude protein yield of oats were achieved from the application of N_{120} P_{60} K_{60} under two cuts management which was significantly higher than other treatment combinations.

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