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Performance of Guinea Grass in Relation to Fertility and Cutting Management under Rainfed Conditions

S.N. Ram* and B.K Trivedi

ICAR-Indian Grassland and Fodder Research Institute, Jhansi 284 003, India

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Abstract: A field experiment was conducted during July 2007 to June 2010 on sandy loam soil at Central Research Farm of Indian Grassland and Fodder Research Institute, Jhansi, to find out the effect of nitrogen, farmyard manure and cutting intervals on growth, forage productivity and quality of Guinea grass (*Panicum maximum* Jacq.) under semi-arid rainfed conditions. Harvesting of Guinea grass at 60 day interval along with application of 80 kg N ha^{-1} in combination with 5 t FYM ha^{-1} recorded significantly higher dry forage yield (6.15, 11.30 and 7.82 t ha^{-1}) 40 and 60 day harvest intervals + lower levels of fertility and at par with 60 days harvest intervals + 40 kg N ha^{-1} + 10 t FYM ha^{-1} and 60 days harvest intervals + 80 kg N ha^{-1} + 10 t FYM ha^{-1}. Dry forage yield of Guinea grass recorded during first, second and third years were 4.25, 8.61 and 5.22 t ha^{-1}, respectively. Harvesting at 40 day interval recorded significantly higher crude protein at and lower NDF and ADF contents than at 60 days interval.

Key words: Cutting interval, farmyard manure, forage yield, nitrogen levels, *Panicum maximum*

Guinea grass (*Panicum maximum* Jacq.) is an important pasture species suitable for higher forage production from community lands, village grazing lands and marginal lands owned by the farmers. It performs well in 900 to 1500 mm annual rainfall, and even survive regions receiving when rainfall is less than 400 mm. It has profuse tillering, quick regeneration and high leaf-stem ratio providing highly nutritious, digestible and palatable forage (Skerman and Riveros, 1989). It can be easily established by seeds or vegetative means. It grows well under shade of trees and on saline sodic soils. The productivity of Guinea grass is often below desired level under semi-arid rainfed conditions. The main constraints for low productivity are poor soil fertility and lack of proper cutting management and moisture. Harvesting of grasses at an appropriate growth stage results in green forage with acceptable dry matter content and nutrient, particularly protein (Ramamurthy and Vinod Shankar, 1998). Under irrigated condition harvesting at 40 day interval and under rainfed conditions at 60 day interval is suitable. The first cut of Guinea grass should be taken 60-70 days after sowing or at flowering stage or at 50% flowering stage under rainfed conditions. Incorporation of farmyard manure in combination with inorganic fertilizer in grasses maintained the productivity and soil health (Rai and Pahwa, 1996). The present experiment was under taken to find out the effect of nitrogen, farmyard manure and cutting intervals on productivity and quality of Guinea grass forage under semi-arid rainfed conditions.

*E-mail: ramshivnath@yahoo.com

Materials and Methods

A field experiment was conducted from July 2007 to June 2010 at Central Research Farm (25° 27'N latitude, 78° 37'E longitude and 275 m above mean sea level) of Indian Grassland and Fodder Research Institute, Jhansi. The soil of the experimental field was sandy loam, low in organic carbon (0.470, 0.488, 0.513%) and available nitrogen (212.14, 217.45, 226.93 kg ha^{-1}) and medium in available phosphorus (10.16, 10.27, 10.41 kg ha^{-1}) and potash (157.42, 170.20, 176.48 kg ha^{-1}) during first, second and third year, respectively. Total 553.8, 1267.1 and 544.9 mm rainfall was received in 38, 52 and 33 rainy days in 2007, 2008 and 2009. Eighteen treatment combinations comprising two cutting intervals (40 and 60 days), three levels of farmyard manure (0, 5 and 10 t ha^{-1}) and three levels of nitrogen (0, 40 and 80 kg ha^{-1}) replicated thrice in split plot design. Net plot size was 9.5 x 4.5 m. The 2-3 seedlings of 5-6 week age of Guinea grass were transplanted at 50 x 50 cm spacing

in the month of July, 2007. N and FYM were applied in each year during rainy season. N was applied in two splits. In first year two-third N was applied as basal and one-third after 1st cut and from 2nd year onward two-third was applied just after monsoon rain and one-third applied after 1st cut. Total two cuts 15 cm from ground were taken at 40 and 60 day interval in each year under semi-arid rainfed conditions. In first year 40 and 60 days was counted from sowing and from second year onwards just after monsoon rain. Dry matter content was estimated by drying 500 g plant sample from each treatment in hot-air oven at 70°C till constant weight (about 24 hours). The plant samples were analyzed for crude protein content according to AOAC (1995), and neutral detergent fibre (NDF) and acid detergent fibre (ADF) by the methods of Georing and Vonsoest (1970).

Results and Discussion

Effect of harvest intervals

Harvesting of foliage at 60 day interval recorded significantly higher plant height (128.2, 174.4 and 162.6 cm), number of tillers plant^{-1} (19.0, 30.5 and 24.6) and tussock diameter (11.2, 19.4 and 17.2 cm) as compared to 40 days interval during first, second and third year, respectively. The higher growth parameters of Guinea grass at 60 day harvest interval might be due to increased photosynthates available for the synthesis of metabolites. While leaf stem ratio (0.93, 0.76 and 0.68) increased significantly by harvesting at 40 day interval as compared to 60 day interval (0.65, 0.58 and 0.52). Green fodder (19.11, 33.52 and 21.02 t ha^{-1}) and crude protein yields (353.9, 608.8 and 464.5 kg ha^{-1}) were also increased significantly with 60 day interval than 40 day interval. The higher yield with harvest at 60 day interval could be ascribed to optimum period available for the growth of Guinea grass under semi-arid rainfed condition. The higher dry matter yield with 60 day interval may be a valid reason of increased crude protein yield. Ramamurthy and Vinod Shankar (1998) reported higher forage yields of *Pennisetum* trispecific hybrid grass by harvesting at 75 day interval and Choubey *et al*. (1999) reported higher forage yields of *Brachiaria mutica* by harvesting at 60 day interval. During second year 90.84% increase in green forage yield was recorded as compared to 1st year (16.81 t ha^{-1}), while during 3rd year 43.61% decrease in yield was found due to low rainfall than second year (32.08 t ha^{-1}).

Harvesting at 40 day interval recorded significantly higher crude protein content and lower NDF and ADF contents as compared to 60 days harvest (Table 3). The higher crude protein content and lower fibre content with the harvesting at 40 day interval may be ascribed to succulent plants with higher nitrogen content. Sunil Kumar *et al*. (2007) also reported higher crude protein content at shorter harvest interval

Table 1. Effect of harvest intervals, farmyard manure and nitrogen on growth parameters of Guinea grass

Treatment	Height (cm)			Tillers plant^{-1}			Tussock diameter (cm)			Leaf-stem ratio		
	2007-08	2008-09	2009-10	2007-08	2008-09	2009-10	2007-08	2008-09	2009-10	2007-08	2008-09	2009-10
Cutting intervals (days)												
40	102.0	145.3	130.4	15.6	26.2	22.1	8.6	14.4	15.4	0.93	0.76	0.68
60	128.2	174.4	162.6	19.0	30.5	24.6	11.2	19.4	17.2	0.65	0.58	0.52
CD (P=0.05)	2.4	3.0	3.7	0.6	0.7	0.5	0.2	0.4	0.5	0.008	0.004	0.004
Farmyard manure (t ha^{-1})												
0 (control)	105.0	147.0	133.5	14.3	25.8	21.5	9.0	15.4	14.5	0.74	0.66	0.57
5	116.9	161.9	148.4	17.8	28.5	23.5	10.0	17.0	16.3	0.80	0.68	0.61
10	123.5	170.7	157.6	19.8	30.7	25.0	10.7	18.2	17.9	0.83	0.69	0.62
CD (P=0.05)	3.0	3.7	4.6	0.7	0.8	0.7	0.2	0.5	0.6	0.01	0.005	0.005
Nitrogen levels (kg ha^{-1})												
0 (control)	101.8	139.9	124.4	13.0	24.6	20.4	8.6	14.7	13.8	0.71	0.65	0.55
40	118.5	165.8	152.5	18.6	29.3	24.1	10.3	17.4	16.8	0.82	0.68	0.61
80	125.0	173.8	162.5	20.3	31.2	25.5	10.8	18.5	18.3	0.84	0.69	0.64
CD (P=0.05)	6.2	7.6	9.5	1.5	1.8	1.4	0.5	1.0	1.2	0.02	0.01	0.01

Table 2. Effect of harvest intervals, farmyard manure and nitrogen application on green forage and crude protein yield of Guinea grass

Treatment	Green forage yield (t ha^{-1})			Crude protein yield (kg ha^{-1})		
	2007-08	2008-09	2009-10	2007-08	2008-09	2009-10
Cutting intervals (days)						
40	14.50	30.64	15.15	230.2	525.03	274.35
60	19.11	33.52	21.02	353.9	608.78	464.47
CD (P=0.05)	0.48	1.01	0.53	8.5	18.4	12.3
Farmyard manure (t ha^{-1})						
0 (control)	14.05	28.39	16.07	248.4	490.40	271.78
5	17.48	32.57	18.23	303.4	579.37	336.71
10	18.90	35.28	19.97	324.2	630.95	378.68
CD (P=0.05)	0.59	1.25	0.65	10.4	22.7	15.1
Nitrogen levels (kg ha^{-1})						
0 (control)	13.33	26.18	15.04	237.9	439.77	230.01
40	17.82	33.81	18.75	306.7	601.02	355.93
80	19.28	36.25	20.54	331.6	659.94	401.22
CD (P=0.05)	1.24	2.60	1.35	21.7	47.3	31.5

(30 day) in *Sehima nervosum* than longer harvest interval (60 day).

Effect of farmyard manure

Height (123.5, 170.7 and 157.6 cm), number of tillers plant^{-1} (19.8, 30.7 and 25.0), tussock diameter (10.7, 18.2 and 17.9 cm) and leaf stem ratio (0.83, 0.69 and 0.62) of Guinea grass were increased significantly with the application of 10 t FYM ha^{-1} as compared to control treatment and 5 t FYM ha^{-1} during first, second and third years, respectively. Application of 5 t FYM ha^{-1} also recorded significantly higher growth parameters of Guinea grass as compared to control treatment (Table 1). The green forage and crude protein yields also increased significantly with successive increase in farmyard manure (Table 2). The application of 10 t FYM ha^{-1} gave 34.52 and 8.12, 24.27 and 8.32 and 24.27 and 9.54% higher green forage yield as compared to control and 5 t FYM ha^{-1} in first, second and third years, respectively. The beneficial effects of organic manure in terms of sustained production could be related to the enhanced biological activities in the rhizosphere, improved soil structure and increased nutrient availability. Green forage yield of Napier bajra hybrid also increased significantly with the application of 10 tons dung + urine ha^{-1} year^{-1} (Ramamurthy, 2002). Application of farmyard manure, at 10 t ha^{-1} also significantly increased crude protein content and lowered NDF and ADF as compared to control treatment during all the three years of study (Table 3). Sunil Kumar *et al*. (2004) also found improvement in crude protein content in forage crop with the use of farmyard manure.

Effect of nitrogen

Application of 80 kg nitrogen ha^{-1} recorded significantly taller plants (125.0, 173.8 and 162.5 cm), number of tillers plant^{-1} (20.3, 31.2 and 25.5), tussock diameter (10.8, 18.5 and 18.3 cm) and leaf stem ratio (0.84, 0.69 and 0.64) of Guinea grass as compared to control treatment during first, second and third year, respectively. The difference between 80 and 40 kg N ha^{-1} for growth parameters were also significant (Table 1). Patel *et al*. (2007) reported significantly higher growth parameters of *Dichanthium annulatum* with the application of 60 kg N ha^{-1}. The green forage and crude protein yields of Guinea grass were also significantly influenced by the application of different levels of nitrogen (Table 2). Increasing levels of nitrogen from control to 40 and further to 80 kg ha^{-1} significantly increased the green forage yield by 25.35 and 6.97, 31.12 and 7.47 and 48.29 and 8.85% during first, second and third year, respectively. The higher crude protein yield might be due to increase in protein content and dry matter yield with increasing levels of nitrogen. The significant increase in forage and

Table 3. Effect of harvest intervals, farmyard manure and nitrogen levels on forage quality of Guinea grass

Treatment	Crude protein content (%)			Neutral detergent fibre (%)			Acid detergent fibre (%)		
	2007-08	2008-09	2009-10	2007-08	2008-09	2009-10	2007-08	2008-09	2009-10
Cutting intervals (days)									
40	7.14	7.00	6.82	64.38	66.76	67.45	41.22	40.58	45.68
60	6.72	6.39	6.11	71.56	75.43	74.18	46.68	48.67	50.82
CD (P=0.05)	0.10	0.12	0.14	1.27	1.36	1.49	0.96	1.07	1.19
Farmyard manure (t ha^{-1})									
0 (control)	6.82	6.58	6.35	69.91	74.19	72.45	45.09	45.84	49.82
5	6.96	6.73	6.48	67.86	71.27	70.74	43.86	44.48	47.94
10	7.01	6.78	6.57	66.14	69.84	69.27	42.89	43.62	46.85
CD (P=0.05)	0.12	0.15	0.17	1.56	1.67	1.83	1.19	1.32	1.47
Nitrogen levels (kg ha^{-1})									
0 (control)	6.79	6.49	6.22	70.94	74.19	73.49	45.61	46.56	50.55
40	6.97	6.75	6.51	67.35	70.82	70.15	43.58	44.31	47.82
80	7.04	6.85	6.67	65.62	69.37	68.81	42.64	43.07	46.24
CD (P=0.05)	0.25	0.31	0.35	3.25	3.48	3.82	2.47	2.75	3.06

crude protein yield in *Dichanthium annulatum* was also reported by Patel *et al*. (2007).

Application of 80 kg N ha^{-1} also recorded significantly higher crude protein content and lower NDF and ADF as compared to control treatment during all three years (Table 3). The increase in crude protein content of Guinea grass with increasing levels of nitrogen may be attributed to the fact that nitrogen is the main constituent of protein and is involved in the synthesis of amino acids and accumulation of protein in plants. Increase in crude protein content of *Iseilema laxum* grass was also reported by Neel Ratan and Singh (2004).

Interaction effect

Harvesting of Guinea grass at 60 day interval along with application of 80 kg N ha^{-1} in combination with 5 t FYM ha^{-1} recorded significantly higher dry forage yield (6.15, 11.30 and 7.82 t ha^{-1}) under semi-arid rainfed condition as compared to 40 and 60 day harvest intervals + lower levels of fertility treatments and at par with 60 day harvest intervals + 40 kg N ha^{-1} + 10 t FYM ha^{-1} and 60 day harvest intervals + 80 kg N ha^{-1} + 10 t FYM ha^{-1} during first, second and third year, respectively (Table 4). Ramamurthy and Vinod Shankar (1998) also found higher forage yield of *Pennisetum* trispecific hybrid by harvesting at 75 day interval along with application of 75 kg N ha^{-1} under semi-arid rainfed condition. Dry forage yield of Guinea grass recorded during first, second and third year were 4.25, 8.61 and 5.22 t ha^{-1}, respectively. During second year 102.59% increase in dry forage yield was recorded as compared to first year. While during third year 39.37% decrease in yield was observed as compared to second year. During 3rd year rainfall was less than

Table 4. Effect of harvest intervals, farmyard manure and nitrogen levels on dry forage yield (t ha^{-1}) of Guinea grass

Treatments	2007-08			2008-09			2009-10		
	Nitrogen levels (kg ha^{-1})			Nitrogen levels (kg ha^{-1})			Nitrogen levels (kg ha^{-1})		
Cutting intervals (days) and FYM (t ha^{-1})	N_0	N_{40}	N_{80}	N_0	N_{40}	N_{80}	N_0	N_{40}	N_{80}
$C_{40}FYM_0$	2.33	2.77	3.29	5.58	6.75	7.55	2.33	3.63	4.22
$C_{40}FYM_5$	2.70	3.53	3.72	5.92	8.06	9.22	2.90	4.46	5.12
$C_{40}FYM_{10}$	2.99	3.82	3.92	6.30	9.37	9.47	3.39	5.20	5.32
$C_{60}FYM_0$	3.97	4.60	5.14	7.44	8.85	9.57	4.01	5.77	6.57
$C_{60}FYM_5$	4.49	5.81	6.15	7.86	10.12	11.30	4.77	6.88	7.82
$C_{60}FYM_{10}$	4.83	6.15	6.31	8.51	11.47	11.59	5.47	7.97	8.17
CD (P=0.05)	0.60			1.02			0.95		

average rainfall, therefore, the yield obtained with shorter harvest interval (40 days) was less than longer harvest interval (60 days).

Thus, it can be concluded that harvesting of Guinea grass at 60 day interval along with application of 80 kg N in combination with 5 tons FYM ha^{-1} in sandy loam low fertile soil was found adequate for higher growth, productivity and quality of forage under semi-arid rainfed conditions.

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