Pak. J. Agri. Sci., Vol. 47(3), 231-234; 2010
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
http://www.pakjas.com.pk

EFFECT OF NITROGEN FERTILIZATION AND HARVESTING INTERVALS ON THE YIELD AND FORAGE QUALITY OF ELEPHANT GRASS (*PENNISETUM PURPUREUM)* UNDER MESIC CLIMATE OF POTHOWAR PLATEAU

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The study was conducted at National Agricultural Research Centre (NARC) Islamabad during 2002-03 to asses the effect of nitrogen fertilizer and harvesting intervals on the forage yield and nutritional value of elephant grass. Four nitrogen levels i.e. 0, 40, 80 and 120 kg N ha^{-1} in the form of Urea were applied with three harvesting intervals i.e. 30, 45 and 60 days. The study revealed that the highest Dry Matter yield was obtained by harvesting elephant grass at 60 days interval with 80 or 120 Kg N ha^{-1} fertilizer level while the lowest Dry Matter was obtained at 30 days harvesting interval. The results showed that crude protein decreased with longer harvesting intervals in elephant grass. The higher crude fiber was noted in plants harvested after longer interval of cutting, 45 or 60 days interval contained CF as 30.0 and 32.7, respectively. The plants harvested at 45 days interval gave good total ash than other intervals while nitrogen fertilizer had slight effect.
Key words: Elephant grass, harvesting interval, nitrogen fertilization, dry matter yield, crude protein, crude fiber.

INTRODUCTION

Elephant grass (*Pennisetum purpureum*) is valued for its high forage yield, vigour palatability and quality in the tropical grass lands of the world. Substantial increase in the forage production of elephant grass has been obtained with application of nitrogen fertilizer at the rate of 600 kg ha^{-1}. However, increase in the yield of elephant grass diminished as the level of nitrogen was further increased. In a similar study in West Indies, rates of N above 170 kg ha^{-1} did not affect forage yield of elephant grass significantly (Walsmsley *et al.*, 1978).
Nitrogen fertilizer significantly affects the nutritional quality of grasses. Walmsley *et al.,* (1978) reported increase in crude protein of brome grass (*Bromus inermis*) from 8.9 to 14.8% by adding 160 kg N ha^{-1}. Crude protein was higher in plants receiving higher N fertilizer inputs. Walmsley *et al.* (1978) did not note any effect of nitrogen fertilizer (170-340 kg N/ha) on the crude protein in elephant grass. Nitrogen fertilizer reduced fibre (CF) in orchard grass (*Dactylis glomerala*) and Sudan grass (*Sorghum sudanese*) but did not affect coastal *Bermuda* grass (Russeli *et al.,* 2004).
Harvesting interval affects the quantity as well as quality of forage (Elessesser, 2004). It is reported that dry matter yield of elephant grass was increased by extending the intervals of cutting from four to seven weeks. In another study, Rushland *et. al*. (1993) obtained the highest dry matter yield of 45 t ha^{-1} from elephant grass clipped at 10 week interval. In Puerto Rico, significant increase in forage yield and crude protein in elephant grass was noted when harvesting interval was increased from 30 to 60 days. Several studies indicated that with longer cutting intervals, crude protein in elephant grass was decreased but CF was substantially increased (Berdahl *et al.*, 2004).
The introduction trials conducted at the National Agricultural Research Centre (NARC), Islamabad during 1998-2003 indicated that elephant grass variety 'A-146' of Taiwan origin was the most suitable for cultivating in the sub-tropical and sub-humid Pothwar tract of Pakistan. This study was conducted to determine the combined effects of N fertilizer levels and clipping intervals on the forage yield and chemical composition of elephant grass cv. 'A-146'.

MATERIALS AND METHOIDS

The study was carried out at the National Agriculture Research Centre (NARC), Islamabad, in the sub-tropical sub-humid Pothowar tract of Pakistan. Average annual rainfall during the last six years recorded was 944mm most of which was received during monsoon. Rainfall received during six months of study period (June-November 2003) was 722.64 mm. Summer were very hot (40°C) while winters were very cold occasionally reaching below freezing point (Nizami *et al.*, 2004). The soil of the experimental site was sandy loam, deep and slightly acidic (Table 1).

Table 1. Physio-chemical soil properties of experimental site

Characteristics	Unit	Values	
		Sowing	Harvesting
ECe	dS m^{-1}	0.53	0.51
pH	-	8.4	8.3
Total Nitrogen	%	0.037	0.049
Available Phosphorus	ppm	4.70	3.99
Extractable Potash	ppm	74.60	69.10
Organic Matter	%	0.53	0.75
Texture Class	-	Sandy loam	

During July 2002, root shoot stock of elephant grass cv 'A-146'was transplanted manually in the field at 50cm x 50cm spacing. Weeding of the plots was done in early September 2002 and April 2003. The plots were never irrigated. In the fourth week of May, 2003, 36 plots of 4m x 5m were laid out using two way factorial experimental designs with three replications. One meter on each side of plot was left untreated to reduce boundary effect (Qamar and Arshad, 2002). All the plots were clipped at 7 cm stubble height before application of treatments for nitrogen application.

Treatments included four nitrogen levels i.e., 0, 40, 80 and 120 kg N ha^{-1} with three harvesting intervals (30, 45 and 60 days). Nitrogen fertilizer in the form of urea was applied after receipt of first showers of monsoon rain. Plants were clipped at 7 cm stubble height on prescribed harvest intervals. After the application of different levels of nitrogen, the plots were harvested in three intervals 30, 45 and 60 days and only one cut for each harvest interval was taken. The clipped material was oven dried at 65°C for 24 h to determine the dry matter yield. The dried material was ground and passed through a 40- mesh screen. For determining total dry matter yield and chemical analysis, oven dried ground material clipped at different dates was pooled together for each experimental unit separately. Crude protein was estimated by multiplying N parentage by 6.25**.** N contents were determined by modified Kjeldahal's method (AOAC, 1994). Crude fiber and total ash contents were determined by using methods of Harris (1970).

All data were subjected to analysis of variance for F value determination. Treatment means of dry matter yield, crude protein, crude fiber and ash contents were compared by LSD test (Steel and Torrie, 1997).

RESULTS AND DISCUSSION

Dry matter yield is the basic component related to the forage production. The dry matter yield of elephant grass increased as well as the nitrogen level increased (Table 2). The dry matter yield was at par with 80 and 120 kg N ha^{-1}. Nitrogen element is basically related with the growth of crop or grass. This showed that nitrogen level significantly affected the dry matter yield.

Dry matter yield (DM) was more as the harvest interval (days) was increased, hence, it significantly affected the dry matter yield (Table 2). This increasing trend was due to better establishment of elephant grass with time.

Dry Matter (DM) yield of elephant grass was influenced markedly by nitrogen application up to 80 kg N ha^{-1} and by lengthening the harvest interval from 30 to 60 days. The highest DM (3.2 to 3.3 t. ha^{-1}) was obtained by harvesting elephant grass at 60 days interval with 80 or 120 kg N ha^{-1} fertilizer level. The lowest DM was recorded from the plants harvested at 30 days interval (Table 2).

Plants fertilized at 40kg N ha^{-1} when clipped at 60 days interval, produced more DM than harvested at 30 or 45 days interval of the plants fertilized up to 120 kg Nha^{-1} (Table 2). Heavily fertilized (80-120 kg N ha^{-1}) plants probably did not utilize total available N during one growing season. These results are agreed with the findings of Sengul (2003).

Several studies showed that DM produced per kg of applied nitrogen sharply declined with increasing N rates (Malhi *et al*., 2004). At doses from 200 to 600 kg Nha^{-1}, 30 to 50% increase was recorded in the harvested foliage. Above these levels, the recovery dropped from 10% to 20%. It was, therefore, inferred that as far as DM is concerned nitrogen requirement of elephant grass in the growing season could be reduced to half by 60 days (Burle *et al.,* 2003).

The forage quality is very important for human nutrition because the forage eaten by the livestock is the ultimate end of human feed. Crude protein is the basic component of forage quality. The crude protein below 6% disturbs the animal health as well as reproduction. Crude protein was statistically significant among different nitrogen levels (Table 2). This showed the increasing trend as the nitrogen quantity increased up to 120 kg N ha^{-1} because nitrogen is the basic constituent of crude protein.

The crude protein was also statistically significant with harvest interval. As the harvesting interval increased, crude protein percentage decreased due to the maturation of grass (Table 2). Crude protein showed the decreasing trend as the harvesting interval

Table 2: Treatments means comparison of dry matter yield, crude protein, crude fiber and total ash of elephant grass at four nitrogen levels and three harvest intervals at NARC

Nitrogen fertilizer levels (kg ha^{-1})	DM yield (t. ha^{-1})	Crude protein (% DM)	Crude fiber (% DM)	Total Ash (% DM)
120	2. 0	10. 2	29. 6	14. 3
80	2. 0	9. 7	31. 2	15. 3
40	1. 7	7. 0	28. 9	15. 2
0	1. 2	5. 6	27. 3	13. 1
L.S.D 5%	0. 18	0. 72	N.S.	0. 62
Harvest intervals (days)				
60	2. 8	6. 4	32. 7	14. 6
45	1. 5	8. 1	30. 0	15. 3
30	0. 8	9. 8	25. 1	13. 4
L.S.D 5%	0. 12	0. 38	2. 32	0. 57
Nitrogen levels x harvest intervals				
120 x 60	3. 2	7. 8	33. 1	14. 1
120 x 45	1. 8	10. 3	30. 6	14. 8
120 x 30	0. 9	12. 6	25. 1	13. 9
80 x 60	3. 3	7. 4	34. 7	14. 1
80 x 45	1. 7	9. 5	32. 0	17. 7
80 x 30	1. 0	12. 2	27. 1	14. 0
40 x 60	2. 8	6. 2	32. 1	15. 7
40 x 45	1. 5	7. 0	30. 2	16. 2
40 x 30	0. 7	8. 0	24. 4	13. 7
0 x 60	2. 0	4. 4	31. 2	14. 7
0 x 45	1. 0	5. 6	27. 2	12. 4
0 x 30	0. 5	6. 7	23. 7	12. 1
L.S.D. 5%	0. 24	0. 76	4. 63	1. 14

increased. This trend may be due to more maturation and ultimately more utilization of nitrogen by the grass.

Quality is the main criteria in the production of forage crops and it has been determined by the nutrient they supply. Among these nutrients, crude protein is of great importance and it is commonly stated that forage with higher crude protein have superior feeding (Qureshi, 1992). Crude protein (CP) in elephant grass increased significantly with nitrogen fertilizer up to 80 kg N ha^{-1} (Table 2). The increase in CP% can be attributed to the luxurious consumption of N by grasses.

When average across all treatments, CP% was significantly higher in plants harvested at 30 days interval than the plants subjected to 45 or 60 days harvesting interval. The treatments 120 kg N ha^{-1} x 30 days and 80kg N/ha x 30days gave 12.6 to 12.2 CP in elephant grass while unfertilized plants harvested at 45 to 60 days interval produced only 5.6 and 4.4 CP, respectively (Table 2). The optimum DM yielding treatment (40 kg N ha^{-1} x 60 days) contained 6. 2% CP which was statistically equal to the combination of 0 kg N ha^{-1} x 30 day, 40 kg N/ha x 45 day, 80 kg N ha^{-1} x 60 day and 120 kg N ha^{-1} x 60 day. All these results concluded that longer harvesting interval decreases CP% in elephant grass which may probably be due to severe etiolating and drying of plants.

Crude fiber is also an important constituent of forage quality. More percentage of crude fiber reduces the forage quality. The results showed non-significant trend in this regard (Table 2). Digestibility of livestock feed is dependant on the crude fiber.

Crude fiber was statistically significant by the harvest interval. Crude fiber increased as the harvesting interval increased. This might be due to more maturation that produced more fiber whit ultimately deteriorates the forage quality.

Nitrogen fertilizer (0 to 120 kg N ha^{-1}) did not decrease crude fiber (CF) contents in elephant grass (Table 2). Plants harvested at 45 or 60 days interval contained statistically equal CF as 30.0 and 32.7, respectively (Li *et al.*, 2003). CF from plants harvested at 30 days interval was lowest irrespective of nitrogen levels. Higher CF% in plants harvested after longer interval of cutting was probably due to maturation of the grass.

Total ash is another important criterion in determining quality of forage. The effect of total ash was statistically significant by nitrogen levels. As the nitrogen level increased, the percentage of total ash was decreased. Harvesting interval of 45 days increased the ash more than the other two intervals i.e. 60 days and 30 days.

Nitrogen fertilizer showed a slight influence on total ash in elephant grass (Table 2). When averaged across all treatments, plants harvested at 30 days interval contained lower total ash than the plants harvested at 60 to 45 days interval. The decrease in ash content with the length of harvest interval is probably a normal result of maturity and may have been caused partly by the dilution effect of higher yields in the presence of a constant amount of available minerals in the soil (Rao *et al.*, 2007).

CONCLUSION

Elephant grass cv ‘A-146’ was used for the study which was transplanted in 36 plots of 4m x 5m each. Four nitrogen levels i.e. 0, 40, 80 and 120 kg N ha^{-1} in the form of Urea were applied with three harvesting intervals i.e. 30, 45 and 60 days. Plants were clipped on prescribed harvest intervals, oven dried at 65°C for 24 h to determine the dry matter yield. Dry matter was grounded and used for chemical analysis to determine Crude protein Crude fiber and total ash for different level of fertilization and harvesting intervals. This study concluded that 60 days harvesting interval along with 80 or 120 kg N ha^{-1} fertilizer level was the best for attaining maximum dry matter yield of elephant grass. Crude protein decreased at longer harvesting interval and crude fiber increased due to more stem hardness. Thirty or 45 days harvesting intervals produced better ash than other treatments while nitrogen fertilizer had no effect on its production.

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