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Effect of Nitrogen Application and Harvesting Intervals on Forage Yield and Quality of Pearl Millet (*Pennisetum americanum* L.)

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Abstract

A field experiment to evaluate the effect of 0, 60,120 and 180 kg N ha^{-1} on forage yield and quality of pearl millet (*Pennisetum americanum* L.) harvested at 40, 50 and 60 days after sowing was conducted at Agronomic Research Area, University of Agriculture, Faisalabad during 2004. The experiment was laid out in randomized complete block design (factorial) with three replications, using net plot size 1.80m X 7m. Forage and dry matter yield were increased by nitrogen application and increase was significant at each increased nitrogen rate. The increase in yield was mainly due to increase in plant height, stem diameter, number of leaves and leaf area plant^{-1}. The quality parameters like crude protein and ash contents were increased with nitrogen application but dry matter and crude fibre contents remained unaffected. The parameters like dry matter and crude fibre contents, plant height, forage yield, stem diameter, number of leaves and leaf area plant^{-1} were consistently increased up to final harvest. Whereas, ash and crude protein contents were decreased with delaying the harvest. It can be concluded from the result that for obtaining higher yield of pearl millet it may be fertilized at the rate of 180 kg N ha^{-1} and harvest it 60 days after sowing.

Keywords: Pearl millet, nitrogen, harvesting intervals, forage yield

Introduction

Pearl millet (*Pennisetum americanum* L.) is an important forage crop of barani areas of Pakistan. It has the ability to grow successfully both under rainfed and irrigated conditions. It is also grown in mixture with maize and sorghum in irrigated areas. Although climatic condition of Pakistan are favorable for millet production but it's per hectare yield is very low. Low yield of millet is due to many constrains but fertilizer application is considered one of the major factor. Nitrogen is an essential nutrient for plant growth and development. To improve the yield and quality of forage it is much essential to determine the fertilizer requirement of crop. Judicious and appropriate use of fertilizer not only increases yield but also improves quality of forage especially protein contents (Ayub *et al.*, 2007). Huge differences exist in the use of nitrogen for getting higher forage yield of millet. The maximum dry matter yield of pearl millet was obtained when fertilized at the rate of 120kg N ha^{-1} (Mesquita and Pinto, 2000). While, Rajaram and Selvararaj (1986) observed non-significant difference among nitrogen levels of 25, 50 and 75 kg ha^{-1} on green forage yield of pearl millet, whereas, Ayub *et al.* (2007) reported that 100kg N ha^{-1} gave significantly higher forage yield than 50 and 150 kg N ha^{-1}.

Another important factor affecting the yield and quality of forage crops is their growth stage at harvest. The effects of harvesting time on yield and chemical composition of forage are greater than that of cultivars. The fresh fodder yield of pearl millet goes on increasing up to certain growth stage and after that starts decreasing (Keshawa and Yadav, 1989). Ayub, *et al*. (2002a) reported that sorghum green fodder and dry matter yield, neutral and acid detergents fibre were increased but crude protein, either extractable fat and total ash contents were decreased with delaying the harvest. Delay in harvest increased dry matter yield but decreased crude protein contents (Malai, *et al*., 1980). Bukhari (2009) observed a decrease in crude protein and ash contents with delaying harvest, whereas, crude fibre and dry matter percentage were increased with advanced maturity. Similarly Beck *et al.* (2007) also observed a linear decrease in crude protein and increase in acid detergents fibre. Ayub *et al.* (2003b) harvested maize 40, 50 and 60 days after sowing and reported that dry matter yield and dry matter and crude fibre contents were significantly increased with delaying the harvest whereas, crude protein and ash contents were decreased with delayed harvest. The information on interactive effects of harvesting time and nitrogen levels on pearl millet are lacking in Pakistan. The present study was, therefore designed to evaluate the effects of different levels of nitrogen and harvesting

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times on growth, forage yield and quality of pearl millet under Faisalabad conditions.

Materials and Methods

A field experiment to observe the effect of different nitrogen levels and harvesting intervals on growth, forage yield and quality of pearl millet was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during the year 2003.

The experiment was laid out in randomized complete design (factorial arrangement) having three replications, measuring a net plot size 1.8 X 7.0 m^2. The pearl millet cultivar 18-BY was sown in second week of July on well prepared seed bed with the help of a single row hand drill in 30cm apart rows. The P_2O_5 was applied at the rate of 60 kg ha^{-1} as single super phosphate at seed bed preparation. The nitrogen to appropriate plots was applied with first irrigation at the rate of 0, 60, 120 and 180 kg ha^{-1} and harvesting was done 40, 50 and 60 day after sowing. For determining dry matter percentage the samples were dried at 80^0 C until a constant weight was attained. Ten plants were selected at random for recording individual plant observation like plant height, stem diameter, number of leaves and leaf area per plant. Stem diameter was measured with help of verniar caliper from the base, middle and top portion and averages were recorded. Leaf area was recorded with the help of leaf area meter model L1-3000. Quality parameter like crude protein, crude fibre and ash contents were determined by using method recommend by AOAC (1984). All other agronomic practices were kept normal and uniform for all the treatments. The data collected was analyzed statistically by using Fisher's analysis of variance technique and difference among the treatment means were compared by using LSD test ay 5 % probability level (Steel *et al.,* 1997).

Results and Discussion

Growth Parameters and Yield

Plant height was influenced significantly by nitrogen application and harvesting intervals. Plots that received nitrogen at rate of 180kg ha^{-1} produced tallest plants (199.87cm) than other fertilizer treatments (Table-1). The minimum plant height (159.64cm) was observed in plots receiving no nitrogen fertilizer. Significant increased in plant height with nitrogen fertilizer have also been observed by Ayub *et al.* (2002a and 2003a) and Bukhari (2009). The plots harvested 60 days after sowing produced taller plants (205.29cm) as compared to plots harvested 40 and 50 days after sowing. An increase in plant height with delayed harvest has also been reported by Ayub *et al.* (2002a) and Bukhari (2009). All levels of nitrogen produced plants having significantly thicker stem than control and the differences among the nitrogen levels were also significant. The maximum stem diameter (1.16cm) was observed with the application of 180 kg N ha^{-1}. An increase in stem diameter with nitrogen application has also been reported by Ayub *et al.* (2002b and 2007). The plots harvested 60 days after sowing produced significantly thicker (1.19cm) stem than other treatments which confirm the findings of Ayub *et al.* (2002a) and Bukhari (2009). They reported that stem diameter was increased with delayed harvest.

Numbers of leaves per plant were increased significantly at each increased nitrogen level. Plot receiving nitrogen at rate of 180kg ha^{-1} produced the maximum number of leaves per plant (14.92) and plots given no nitrogen produced plants with minimum number of leaves. The results are in line with those of Bajwa *et al.* (1983) and Ayub *et al.* (2002b). Numbers of leaves $plant^{-1}$ were increased with delaying the harvest. Significant increase in number of leaves $plant^{-1}$ with delayed harvesting has also been reported by Ashraf *et al.* (1995) and Ayub *et al.* (2002a) and Bukhari (2009). The application of nitrogen significantly increased the leaf area $plant^{-1}$at each increased nitrogen rate. Plots receiving N at the rate of 180 kg ha^{-1} produced maximum leaf area $plant^{-1}$ (3844 cm^2). The minimum leaf area was observed in those plots where no nitrogen was applied. Similar results were observed by Ayub *et al.* (2002b). All harvesting intervals also differed significantly from one another. Plots harvested 60 days after sowing produced more leaf area (3377 cm^2) as compared to others. Increase in leaf area per plant with delayed harvesting has also been reported by Botha and Rethman (1994) and Bukhari (2009). It can concluded from these results that the millet continued its growth up to 60 day after sowing.

Both green forage and dry matter yield were influenced by the application of nitrogen fertilizer. A significant increase in yield was recorded at each increased nitrogen level. Significantly higher green forage (67.14t ha^{-1}) and dry matter yield (19.83t ha^{-1}) were recorded when nitrogen was applied at rate of 180 kg ha^{-1}. The increase in yield was mainly due to greater plant height, stem diameter, number of leaves and leaf area $plant^{-1}$. It can also be due to greater number of tillers per plant (data was not recorded). Increase in yield by nitrogen application has also been reported by Ayub *et al.* (2002a and 2007) and Keshwa and Yadav (1992). Harvesting time also influenced significantly green forage and dry matter yield and trend of both parameters was exactly similar. The yield was increased with delaying harvest. The minimum yield was recorded when crop

was harvested 60 days after sowing. The increase in yield with delaying harvest has been mainly due to increase in growth parameter i.e. plant height, stem diameter, number of leaves and leaf area plant^{-1}. These results confirm the findings of Ayub *et al.* (2002b and 2003a) and Bukhari (2009).

Quality parameters

The effect of nitrogen application on dry matter percentage was not significant and dry matter percentage ranged between 27.11% to 28.04%. The results are contradictory to those of Ayub *et al.* (2002b and 2007) who reported significant effect of nitrogen application on dry matter percentage of sorghum and millet forage, respectively. The contradictory results might have been due to difference in soil fertility status. The dry matter contents were increased significantly with advancement in maturity and all harvest intervals differed significantly from one another, being maximum 60 days after sowing which agree with the published work of Ayub *et al.* (2002a and 2003b) and Bukhari (2009). The application of nitrogen significantly affected the crude protein contents (Table-1). A significant increase was observed at each increased nitrogen rate. The maximum (8.67%) crude protein contents were noted in plots receiving nitrogen at the rate of 180 kg ha^{-1}, and it was followed by the plots fertilized with 120 and 60 kg N ha^{-1}, which gave 7.37% and 6.51% crude protein contents, respectively. Whereas, the minimum (5.60 %) crude protein contents were noted in plots received no nitrogen. These results confirm the findings of Ayub *et al.* (2002a&b and 2007). But these results are contradictory to those of Soni *et al.* (1991). These contradictory results may be due to variation in initial nitrogen status of soil. Zuber *et al.* (1954) concluded that when soils are deficient in nitrogen, small application of nitrogen will not necessarily increased nitrogen contents. Crude protein percentage was decreased as the period before harvest was extended, being maximum (7.93%) and minimum (6.19%) at 40 and 60 days after sowing, respectively. The decrease in protein contents may be due to dilution factor. A decrease in protein contents with delaying the harvest has also been reported by Ayub *et al.* (2002a and 2003b) and Amodu *et al.* (2007) and Bukhari (2009).

Although the crude fibre contents were not influenced significantly by nitrogen application but there has been decreasing trend with increased nitrogen application. The maximum (47.45%) and minimum (46.03%) crude fibre contents were noted at zero and 180kg N ha^{-1}, respectively. These results confirm the finding of Ayub *et al.* (2002b) who reported that acid and neutral detergents fiber were decreased with nitrogen application. The crude fibre contents were increased by delaying the harvest. The crop harvested 60 days after sowing gave significantly higher crude fibre contents than 40 and 50 days after sowing, which in turn did not differ significantly. Increase in crude fibre contents with delaying the harvest has also been reported by Ayub *et al.* (2002a) for sorghum and Bukhari (2009) for millet. The application of nitrogen at the rate of 180 kg ha^{-1} produced maximum ash contents (7.36%) but it was statistically similar to 120 kg ha^{-1}. The plot fertilized at the rate of 60 kg N ha^{-1} has statistically similar ash contents to control and 120 kg N ha^{-1}. The differences between control and 120 kg ha^{-1} were significant. It can be concluded from these results that nitrogen application might have synergistic effect on the up take of nutrients. These results are quite in line of with those of Ayub *et al.* (2002b and 2007). Ash percentage was decreased with delaying the harvest. The plot harvest 40 days after sowing gave maximum ash percentage (7.32 %). The plot harvest 50 and 60 days after sowing have statistically similar ash contents. Decrease in ash contents with delaying the harvesting has also been reported by Ashraf *et al.* (1995), Ayub *et al.* (2002a) and Bukhari (2009).

Conclusion

The nitrogen application improved the quality parameter and yield, whereas, delaying the harvest increased yield but decreased the forage quality. Keeping in view both quality and yield the millet cultivar 18-By may be fertilized at the rate of 180 kg ha^{-1} and harvesting is suggested 60 days after sowing.

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Table-1: Growth, forage yield and quality of pearl millet as influenced by nitrogen application and harvesting intervals.

Treatments	Plant height (cm)	Stem diameter (cm)	No. of leaves plant^{-1}	Leaf area plan^{-1}	Forage yield (t ha^{-1})	Dry Matter yield (t ha^{-1})	Dry Matter (%)	Crude Protein (%)	Crude Fibre (%)	Ash (%)
Nitrogen levels (kg ha^{-1})										
0	159.64 d	0.84 d	10.88d	2018d	41.30d	11.54d	27.11	5.6d	47.45	6.7c
60	170.26 c	0.98 c	11.54c	2852c	50.65c	14.66c	27.77	6.51c	46.91	6.93bc
120	185.26 b	1.07 b	13.49b	3593b	63.15b	18.50b	27.71	7.37b	46.43	7.08ab
180	199.87 a	1.16 a	14.92a	3844a	67.14a	19.83a	28.04	8.67a	46.03	7.36a
LSD	2.197	0.031	0.598	2.651	1.194	0.827	NS	0.235	NS	0.282
Harvesting intervals (Days after sowing)										
40	154.45c	0.86c	10.84c	2764c	39.56c	8.30c	20.96c	7.93a	45.74b	7.32a
50	176.62b	0.98b	12.55b	3090b	56.39b	15.21b	26.90b	7.01b	46.12b	6.99b
60	205.29a	1.19a	14.53a	3377a	70.73a	24.84a	35.16a	6.19c	48.25a	6.76b
LSD	1.902	0.027	0.518	2.29	1.034	0.716	1.353	0.204	1.08	0.244

Any two means not sharing a letter in common differ statistically at 5% probability level