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Exploring the Impact of Varying Nitrogen Levels and Cutting Management on Fodder Yield and Nutritional Quality in Fodder Pearlmillet (*Pennisetum glaucum* L.)

T. Shashikala [a++*], Rvt. Balazzii Naaiik [a#] and T. Sukruth Kumar [a†]

[a] *AICRP on Forage Crops and Utilization, Agricultural Research Institute, Rajendranagar, Hyderabad-030, Telangana, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A Field experiment was conducted at AICRP on Forage Crops and Utilization, ARI, Rajendranagar, Hyderabad during *kharif* 2021. The treatments consisted of four fodder pearl millet varieties (TSFB 15-4, TSFB 15-8 ,Moti bajra and Moti bajra), two nitrogen levels (80 and 120 kg N ha^{-1}) and two cutting management practices (C_1: Two cuts: 1st at 60 DAS, 2nd cut at 50% flowering) (C_2: Three cuts: 1st at 50 DAS, 2nd cut at 35 days after 1st cut and 3rd cut at 50% flowering) laid out in randomized block design with factorial concept, with Factor (A) as varieties, Factor (B) as nitrogen

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++ *Principal Scientist (Genetics and Plant breeding) & Head;*
# *Principal Scientist (Agronomy);*
† *Principal Scientist (SSAC);*
**Corresponding author: E-mail;*

levels and Factor (C) as cutting management with three replications. The soil was sandy loam in texture with pH of 7.0 low in available nitrogen, medium in available phosphorus and available potassium. The results revealed that TSFB 15-8 recorded significantly higher green fodder (769.8 q $ha^{-}1$) and dry fodder (191.7 q $ha^{-}1$) yields. The variety TSFB 15-8 was also shown highest crude protein content (6.0%), crude protein yield (13.8 q ha^{-1}) and higher nitrogen uptake (190.2 kg ha^{-1}). Application of nitrogen 120 kg N ha^{-1} significantly recorded maximum green fodder yield (716.1 q $ha^{-}1$),dry fodder yield,crude protein content (6.1%), crude protein yield (14.7 q ha^{-1}) and nitrogen uptake (207.1kg ha^{-1}). But as the nitrogen application increases the ADF and NDF contents decrease. The higher ADF and NDF contents recorded highest at 80 kg N ha^{-1} and lowest at 120 kg N ha^{-1}. Three cuts for green fodder recorded highest crude protein content (6.5%), crude protein yield (13.9 q ha^{-1}) and nitrogen uptake (228.0 kg ha^{-1}) over two cuts for green fodder. Variety TSFB 15-8 with nitrogen level of 120 kg N ha^{-1} at C_2 found suitable and economical for cultivation in southernTelangana zone.

Keywords: Varieties; nitrogen levels and cutting management.

1. INTRODUCTION

"In India, the requirement of green fodder was 611.99 Mt against the availability of only 224.08 Mt [1]. The availability of fodder resources is approximately 60% of the requirement, and the area under fodder crops in India is approximately 8.6 M ha. To meet the fodder shortage for the growing animal population, the fodder growing area should ideally be around 20 M ha by 2020, but this appears to be rather difficult to achieve Hazra and Tripathi" [2]. "The only way to increase productivity per unit area under irrigated or rainfed conditions is through balanced nutrition to fodder crops. Pearl millet (*Pennisetum glaucum* L.) is one of the most widely adapted cereal forage crops under rainfed conditions, and it is gaining popularity in Maharashtra due to its rapid growth, high quality forage, and improved palatability. Nitrogen is a necessary primary element. Although optimising nitrogen levels is an important aspect of cost-effective N fertilizer management, excessive nitrogen use degrades soil health and leads to nitrate-N accumulation in fodder, which is toxic to animals. The ruminant toxic effects of nitrate are well known" Bradley et al. [3]. "Nitrate is converted to highly toxic nitrite in the rumen by bacterial nitrate reductase" Lewis [4]. "Ruminants are primarily exposed to nitrates through the plants they consume Wright and Davison" [5]. "Nitrogen is an essential nutrient for fodder crop vegetative growth and plays a critical role in increasing forage productivity and quality. Therefore, the development of quality fodder cultivars and management to meet out the fodder requirements forever increasing livestock population is imperative, as the quality of fodder is very important issue with respect to livestock health status as well as to maximize the animal production" [6]. Many new improved genotypes of pearl millet are being developed as forage varieties, and it is necessary to standardize the nitrogen dose for improved forage yield and quality with nontoxic accumulation of nitrate-N. As a result, the current investigation was launched.

2. MATERIALS AND METHODS

A Field experiment was conducted during *kharif* season of 2021 at AICRP on Forage Crops and Utilization, ARI, PJTSAU, Rajendranagar, Hyderabad. The present research work is framed with an objective to identify high green fodder and nutritious fodder pearl millet varieties influenced by nitrogen levels and cutting management. The experiment was laid out with randomized block design with factorial concept. The soil was sandy loam in texture with pH of 7.0 low in available nitrogen, medium in available phosphorus and available potassium. The experiment consisted of 16 treatment combinations viz., four varieties (TSFB 15-4, TSFB 15-8, Moti bajra and BAIF bajra), two nitrogen levels (80 and 120 kg N ha^{-1}) and two cutting management practices (C_1: Two cuts: 1st at 60 DAS, 2nd cut at 50% flowering) (C_2: Three cuts: 1st at 50 DAS, 2nd cut at 35 days after 1st cut and 3rd cut at 50% flowering) with three replications. The phosphorus (40 kg P_2O_5 ha^{-1}) and potassium (20 kg K_2O ha^{-1}) were applied through Di-ammonium phosphate and Murate of potash respectively. Nitrogen was given in split dose, half as basal and other half dose was given after 30 DAS and after each cut as top dressing. Crop was sown at a row distance of 30 cm. "The crop was sown during 2nd week of July and harvested when crop attained 50% flowering. Five plants were randomly selected in each net plot area for taking observations on growth and yield attributing parameters. The crude protein content of forage was worked out by multiplying the nitrogen percentage with factor 6.25" [7]. "The crude protein yield was calculated by multiplying crude protein percentage with dry matter yield and expressed in quintal ha^{-1}. Data obtained were statistically analyzed" as mentioned by Gomez and Gomez, [8].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Varieties

The growth and fodder yield of pearl millet significantly varied among varieties (Table 1). The pearl millet variety TSFB 15-8 recorded significantly higher plant height (105.0 cm) over other varieties and also the maximum number of tillers was found in TSFB 15-8(4.0) and was at par with Motibajra . The TSFB 15-8 recorded highest green fodder yield of 769.8 q ha^{-1} which was followed by TSFB 15-4 (704.3 q ha^{-1}) and the same variety recorded higher dry matter yield of 191.7 q ha^{-1} followed by variety Moti bajra (182.1 q ha^{-1}). This was due to the superiority of the genotype to produce more values of growth characters like plant height and number of tillers.

3.1.2 Nitrogen levels

Application of nitrogen 120 kg N ha^{-1} recorded significantly higher green fodder yield (716.1 q ha^{-1}) and dry matter yield (182.7q ha^{-1}). Increase in green bio-mass yield was due to increased plant height (102.6 cm). Nitrogen is directly involved in cell division, cell elongation, formation of nucleotides and co-enzymes that increased meristematic activity, since nitrogen is an integral part of chlorophyll, plays an important role in photosynthesis and produce more of photosynthates, which helped in accumulation more dry matter yield. This is in conformity with the findings of Golada et al. and Damame et al.

3.1.3 Cutting management

Results with cutting management indicated that the increased plant height (96.0 cm) was reported with two cuts (C1) and number of tillers m^{-2} (4.6) was recorded with three cuts. Significantly higher green fodder yield (764.7 q ha^{-1}) and dry matter yield (188.2 q ha^{-1}) were recorded in three cuts (C2) as compared to two cuts of green fodder yield (615.0 q ha^{-1}) and dry matter yield (161.2 q ha^{-1}). This might be due to high production potential of all the varieties and higher number of tillers m^{-2} as evident from data (Table 1).

Table-1a. Effect of nitrogen and cutting management on performance of Forage Pearl Millet varieties (*Kharif*, 2021)

Treatment	Plant height (cm)	Number of shoots/tillers Per plant	GFY (q ha^{-1})	DMY (q ha^{-1})
V_1 : TSFB15-4	86.1	3.6	704.3	182.1
V_2 : TSFB15-8	105.0	4.0	769.8	191.7
V_3 : Moti Bajra	88.0	4.0	665.5	172.2
V_4 : BAIFBajra-1	95.5	3.7	619.9	152.8
S.Em$\pm$	2.9	0.1	19.39	6.8
C.D. at 5%	8.4	0.3	57.5	19.8
N_1 : 80 Kg ha^{-1}	84.7	3.9	663.6	166.7
N_2 : 120 Kg ha^{-1}	102.6	3.8	716.1	182.7
S.Em$\pm$	2.0	0.7	14.0	4.8
C.D. at 5%	5.9	NS	40.7	14
C_1 : Two Cuts	96.0	3.1	615.0	161.2
C_2 : Three Cuts	91.4	4.6	764.7	188.2
S.Em$\pm$	2.0	0.08	14.0	4.8
C.D. at 5%	NS	0.22	40.7	14.0
Interactions				
V × N : S.Em$\pm$	4.1	0.16	28.1	9.6
C.D. at 5%	NS	0.46	81.4	NS
V × C: S.Em$\pm$	4.1	0.15	28.1	9.6
C.D. at 5%	11.9	NS	NS	NS
N × C: S.Em$\pm$	2.9	0.10	19.9	6.8
C.D. at 5%	NS	NS	NS	NS
V × N × C: S.Em$\pm$	5.8	0.22	39.8	13.7
C.D. at 5%	16.9	0.64	NS	NS

Table 1b. Effect of Nitrogen and Cutting management on performance of Forage Pearl Millet varieties (*Kharif*, 2021)

Treatment	Green Fodder Yield (q ha^{-1})			Total green fodder yield (q ha^{-1})	Dry Matter Yield(q ha^{-1})			Total dry matter yield (q ha^{-1})
	1st cut	2nd cut	3rd cut		1st cut	2nd cut	3rd cut	
V_1 : TSFB15-4	454.7	306.9	62.8	704.3	96.9	69.8	15.4	182.1
V_2 : TSFB15-8	409.1	327.1	85.5	769.8	96.3	75.1	20.2	191.7
V_3 : Moti Bajra	365.4	291.9	64.7	665.5	86.8	67.3	18.0	172.2
V_4 : BAIFBajra-1	358.3	248.3	62.1	619.9	82.3	54.6	15.7	152.8
S.Em±	12.1	13.4	5.5	19.39	4.2	3.4	1.5	6.8
C.D. at 5%	35.0	38.9	16.0	57.5	NS	9.8	NS	19.8
N_1 :80 Kg ha^{-1}	380.9	272.7	71.9	663.6	86.5	62.2	17.9	166.7
N_2 : 120 Kg ha^{-1}	412.7	314.3	65.6	716.1	94.7	71.2	16.7	182.7
S.Em±	8.6	9.5	3.9	14.0	2.9	2.4	1.9	4.8
C.D. at 5%	24.7	27.5	NS	40.7	NS	6.9	NS	14
C_1 :Two Cuts	408.9	294.7	0	615.0	94.1	67.1	0	161.2
C_2 : Three Cuts	384.7	292.4	137.0	764.7	87.1	66.3	34.7	188.2
S.Em±	8.5	9.5	3.9	14.0	2.9	2.4	1.0	4.8
C.D. at 5%	NS	NS	11.3	40.7	NS	NS	3.0	14.0
Interactions								
V × N :S.Em±	17.16	19.0	7.8	28.1	5.9	4.8	2.1	9.6
C.D. at 5%	NS	55.0	NS	81.4	NS	NS	NS	NS
V ×C: S.Em±	17.16	19.0	7.8	28.1	5.9	4.8	2.1	9.6
C.D. at 5%	NS	NS	22.7	NS	NS	NS	NS	NS
N ×C: S.Em±	12.1	13.4	5.5	19.9	4.2	3.4	1.5	6.8
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
V × N × C: S.Em±	24.7	26.9	11.1	39.8	8.4	6.8	3.0	13.7
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS

3.1.4 Interaction effect

The interaction between different varieties and nitrogen levels was found to be significant, while for dry matter yield the interaction effects were non- significant.

3.2 Quality parameters

3.2.1 Varieties

TSFB 15-4 and TSFB 15-8 recorded at par significantly higher crude protein content (5.84% and 5.65 respectively) and crude protein yield (13.8% and 13.6 q ha^{-1}) as compared to Moti bajra (5.22% and 11.4 q ha^{-1}) and BAIF bajra (4.93% and 9.8 q ha^{-1}) Table 2. The increase may be due to increased nutrient uptake, assimilation and translocation to the biomass. Similar results has reported by Rana et al. [9]. The higher crude protein content and crude protein yield is due to higher dry matter yield of variety TSFB 15-8 as compared to other varieties. The highest nitrogen uptake has recorded in TSFB 15-4 (221.1kg ha^{-1}) at par with TSFB 15-8 (218.8 kg ha^{-1}). “This might be due to the fact that the pearl millet cultivar TSFB 15-4 and TSFB 15-8 had higher nitrogen uptake due to better adaptability in low soil fertility condition areas. Higher nitrogen uptake leads to higher crude protein percentage in leaves and stem of fodder pearl millet, which ultimately increased crude protein yield. The differential behavior of these varieties could also be explained solely by the variation in their genetic constituent. The genotype variation in behavior *viz.,* growth parameters and yields were also reported by other researcher in pearl millet” [6].

3.2.2 Nitrogen levels (kg ha^{-1})

“Application of nitrogen 120 kg N ha^{-1} recorded significantly higher crude protein content and crude protein yield (5.6% and 13.2 q ha^{-1}) compared to nitrogen 80 kg N ha^{-1} (5.2% and 11.2 q ha^{-1}) Table 2. This might be due to the application of nitrogen resulted in increased availability of nitrogen status in the soil, which in turn leads to significant improvement in nitrogen content in fodder and ultimately the crude protein content also increased. Crude protein yield may be due to increased crude protein and dry matter yield”. Damameet et al. [10] and Meena and Jain (2013). The nitrogen application increased the uptake of nitrogen which is the constituent of amino acids and protein Randhawa et al. [11] and decreased the pectin, cellulose and hemicellulose content which are major constituents of fiber Babu et al.

Table 2. Effect of Nitrogen and Cutting management on performance of Forage Pearl Millet varieties (*Kharif*, 2021)

Treatment	Crude Protein Content (%)	Crude Protein Yield (q ha^{-1})	N Uptake Kg ha^{-1}
V_1 : TSFB15-4	5.84	13.8	221.1
V_2 : TSFB15-8	5.65	13.6	218.8
V_3 : Moti Bajra	5.22	11.4	183.1
V_4 : BAIFBajra-1	4.93	9.8	156.6
S.Em±	0.06	0.52	8.4
C.D. at 5%	0.16	1.5	24.3
N_1 : 80 Kg ha^{-1}	5.23	11.17	178.8
N_2 : 120 Kg ha^{-1}	5.59	13.18	211.0
S.Em±	0.04	0.38	5.9
C.D. at 5%	0.12	1.1	17.2
C_1 : Two Cuts	4.67	11.7	187.1
C_2 : Three Cuts	6.15	12.6	202.7
S.Em±	0.04	0.3	5.9
C.D. at 5%	0.12	NS	NS
Interactions			
V × N : S.Em±	0.08	0.7	11.9
C.D. at 5%	NS	NS	NS
V × C: S.Em±	0.08	0.7	11.9
C.D. at 5%	NS	NS	NS
N × C: S.Em±	0.05	0.5	8.4
C.D. at 5%	NS	NS	NS
V × N × C: S.Em±	0.11	1.0	16.8
C.D. at 5%	NS	NS	NS

3.2.3 Cutting management

Three cuts for green fodder had recorded significantly higher crude protein content and crude protein yield (6.15% and 12.6 q ha^{-1}) as compared to two cuts for green fodder (4.67% and 11.7 q ha^{-1}) Table 2. This was attributed due to higher crude protein and dry matter yield finally resulted in higher crude protein yield. Higher nitrogen uptake (202.7 kg ha^{-1}) were also recorded with three cuts for green fodder, which was possibly due to more time period available for sufficient vegetative growth resulting higher fodder yield.

3.2.4 Interaction effect

The interaction effects were found to be non-significant.

4. CONCLUSION

Based on the research results it can be inferred that forage pearl millet variety TSFB 15-8 with nitrogen level of 120 kg N ha^{-1} at C_2(Three cuts) found suitable and economical for cultivation in Southern Telangana Zone. These results are in conformity with findings of Shekara et al. [12] and Shekara et al. [13].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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