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Response of forage pearl millet genotypes to different nitrogen levels

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Abstract
A field experiment was conducted at Agricultural Research Institute, Professor Jayashankar Telangana State Agricultural University Hyderabad during Kharif 2018 to study the response of forage pearl millet genotypes to nitrogen levels for producing optimum fodder yield and quality. The treatments comprised four genotypes (TSFB 15-4, TSFB 15-4, Giant bajra, and Moti bajra) and four nitrogen levels (0, 30, 60, and 90 kg/ha) laid out in a randomized complete block design with three replications. Plant height, green fodder, dry matter, and crude protein yields of pearl millet genotypes were influenced significantly by different nitrogen levels. TSFB 15-8 outyielded other genotypes in green fodder (509.72 q/ha) and dry matter (116.56q/ha) yields. TSFB 15-4 produced the highest crude protein yield (10.00 q/ha) than the other three genotypes. All the genotypes responded significantly up to 60 kg N/ha in obtaining plant height, green fodder, dry matter, crude protein %, and crude protein yield (200.2 cm, 478.41 q/ha, 110.83 q/ha, 8.9%, and 10.30 q/ha, respectively). The interaction effect of genotypes and nitrogen levels was found nonsignificant.

Keywords: Forage pearl millet, genotypes, nitrogen levels, green fodder, dry matter, crude protein

1. Introduction
Pearl millet (*Pennisetum glaucum* L.) is a nutritious drought and heat tolerant cereal crop known as bajra in India. It is cultivated for both grain and fodder purposes. Originated in Africa, it is one of the oldest cultivated cereal crops in the world. Pearl millet is the sixth most important cereal crop in the world in area and mostly grown in arid and semi-arid tropical regions of the world. It occupies an area of 7.46 million ha with an average production of 9.63 million tones and productivity of 1305 kg/ha during 2016-17 (Directorate of Economics & Statistics, Department of Agriculture, Cooperation & Farmers Welfare, 2018) [1]. Hence there is a wide scope of using its stover for dry fodder purposes. Being a C4 crop it has high photosynthetic efficiency, high water use efficiency, and high dry matter production capacity. It can commonly be grown in the rainy and summer seasons in India for grain or fodder purposes. Pearl millet has a fast-growing and high tillering habit compared to other cereal fodders. It can be grown in marginal and low fertile soils under adverse agroclimatic conditions where other cereal forage crops such as maize and Sorghum produced economically. Pearl millet supplies palatable and high protein content (10-12%) fodder for livestock. Pearl millet doesn't possess the toxic HCN content in its early growth stages as Sorghum does; hence, its green forage can be supplied to animals safely at any stage of crop growth. Fodder shortage is acute for sustainable livestock production as arable land for forage production is becoming scarce. Under these circumstances, suitable genotypes with high fodder production efficiency are necessary to meet the demand. The growth and fodder yield of pearl millet were influenced significantly with genotypes. Giant bajra recorded significantly higher plant height, green fodder, dry matter, and crude protein yield over other 6 genotypes tested at CCS Haryana Agricultural University Hisar (Singh *et al*., 2012) [2]. Tiwana and Puri (2005) [3] also reported that Gian Bajra produced significantly higher green fodder and dry matter yields in Punjab.
Nitrogen is considered as an important factor among various agronomic factors that may affect fodder yield and quality (Ayub *et al*. 2007) [4]. Nitrogen is an essential element of all the amino acids in plant structures which are the building blocks of plant proteins, important in the growth and development of vital plant tissues and cells like the cell membranes and chlorophyll. Hence plant growth and yield (GFY and DMY) and crude protein yield also depends on N fertilizer application in forage crops.

Number of effective tillers, ear length and stover yield increased with increasing nitrogen rates (Sharma *et al*., 1999) [5], significant increase in plant height, leaf length, leaf width, stem diameter, dry matter and crude protein yield with nitrogen increase (Cho *et al*., 2001) [6]. Moreover, different genotypes respond differently to nitrogen rates. Pujarula *et al*. (2021) [7] identified top 25 N-insensitive and N-sensitive genotypes in their study at ICRISAT Hyderabad. The present study was therefore, designed to identify promising genotypes to Telangana region and to study the response of forage pearl millet genotypes to different nitrogen levels on fodder yield and quality.

2. Materials and Methods

The experiment was carried out in the fields of AICRP on Forage Crops & Utilization Scheme at the Agricultural Research Institute, Professor Jayashankar Telangana State Agricultural University, Hyderabad in kharif 2018. The experimental location is situated at 17°19' 18" N latitude, 78°24' 18" E longitude and at an altitude of 527m above mean sea level in the Southern Telangana Agroclimatic Zone in Telangana State India. The average annual rainfall of the area was 750 mm and maximum and minimum temperatures ranged between 24.6 to 34.1^{0}C and7.6 to 18.6 ^{0}C respectively during the crop growth period. Experimental site was well drained moderately deep sandy loam soil with pH of 7.8 and EC of 0.22 dS m^{-1}. Soil texture analysis was carried out with Bouyoucos hydrometer method and soil pH and EC were measured using pH meter and EC meter respectively. The experimental field was low in available N (152 kg ha^{-1}), medium in phosphorus (26.0 kg ha^{-1}) and high in potash (293.0 kg ha^{-1}). Available nitrogen, phosphorus, and potassium in soil were measured using Kjeldahl, Olsen, and Spectrophotometer methods respectively. The experiment was laid out with 8 treatments replicated thrice in a randomized complete block design having gross plot size of 4.0 m x 3.0 m =12 m^2. The treatments were composed of four genotypes/varieties (TSFB 15-4, TSFB 15-4, Giant bajra, and Moti bajra) and four nitrogen levels (0, 30, 60, and 90 kg/ha). The crop was sown with a spacing of 30 cm (row to row) x 10 cm (plant to plant). 40 kg phosphorous and 40 kg/ha potash were applied as basal application in the form of single super phosphate and muriate of potash fertilizers respectively. Nitrogen was applied twice in the form of urea as per the treatment dose (first half was applied as basal and second one was applied at 30 days after sowing).

Plant height and leaf to stem ratio were measured on 3 randomly selected plants per plot at 50% flowering stage. Leaf to stem ratio (LS ratio) was measured on a sample of 3 randomly selected plants harvested from each treatment plot. Leaves removed from the 3 plants collected and sun dried first and later oven-dried. Leaves removed stems of 3 plants were also dried in the similar fashion as leaves. LS ratio was calculated by dividing the dried leaf weight by dried stem weight. The crop was harvested plot-wise separately and fresh green forage yield was recorded in kg/plot and was converted into quintals per hectare. A fresh sample of 500 g taken from each treatment was sundried initially followed by oven dried at 60-65^{0}C to a constant weight and estimated dry matter yield, later dried plant samples were finely ground and subsequently used for quality analysis (crude protein content) in the biochemistry laboratory. Crude protein yield was estimated from crude protein content (%) of dried and powdered plant sample and multiplied with its dry matter in grams and converted into q/ha of crude protein yield. The collected data was statistically analysed by analysis of variance (ANOVA) for randomised complete block design. Critical differences were worked out at five percent probability level in LSD, if treatments were significantly differed and if not; NS was denoted (Gomez and Gomez, 1984) [8]. The data was statistically analysed using OPSTAT software for the interpretations of results (Sheron *et al*., 1998) [9].

3. Results and Discussion

3.1 Plant height

Genotypes/varieties didn't differ significantly in case of plant height. The genotype TSFB 15-8 recorded higher plant height of 198.7 cm followed by Moti bajra recorded plant height of 197.9 cm (Table 1). But Sheoran *et al*. (2016) [10] reported that genotypes significantly differed in plant height. Nitrogen application had significant influence on plant height of all the four genotypes. Nitrogen applied at the rate of 30 kg/ha had produced plant height of 195.6 cm which was significantly higher than the control (178.1 cm). Ausiku *et al*. (2020) [11] also reported that plant height increased with increasing the nitrogen dose up to 90 kg/ha. The plant height of forage pearl millet varieties has responded to the application of nitrogen up to 150 kg/ha (Bramhaiah *et al*., 2020) [12]. Sahin *et al*. (2013) [13] also found that plant height of pearl millet affected significantly with the application of nitrogen. However, the three nitrogen levels (30, 60, and 90 kg/ha) were not differed significantly in our study. The interaction between genotypes and N levels were found nonsignificant.

3.2 Leaf to stem ratio

Moti bajra recorded highest leaf to stem ratio (0.21) followed by TSFB 15-4 and Giant bajra with leaf to stem (LS) ratio of 0.20 (Table 1). The least LS ratio recorded by the genotype TS 15-8 (0.19). But LS ratio was not influenced significantly by genotypes. Nitrogen application also not influenced leaf to stem ratio significantly. Interaction between genotypes and nitrogen application was also non significant in our study. These results are in agreement with the results reported by Kumawat *et al*. (2017) [14] in fodder pearl millet and Choudhary *et al.* (2014) [15] in dual-purpose pearl millet. In contrast Bramhaiah *et al*. (2018) [12] reported both genotypes and nitrogen levels significantly affected the LS ratio in forage pearl millet. But they reported that interaction effect was nonsignificant.

3.3 Green fodder yield

Genotypes differed significantly under different levels of nitrogen in producing green fodder yield (Table1). The genotype TSFB 15-8 produced 509.72 quintals of green fodder per hectare, followed by genotype TSFB 15-4 with 471.72 q/ha. These two new genotypes were significantly superior over the other two varieties (Giant bajra and Moti bajra). This might be due to the superiority of these genotypes to produce more values of growth characteristics like plant height, leaf to stem ratio and number of tillers plant. The variety Giant bajra recorded the lower green forage yield of 400.16 q/ha. Salama *et al*. (2020) [16] and Shekara *et al*. (2020) [17] also reported green fodder yield was significantly affected by genotypes. The application of nitrogen increased the green fodder yield of all the genotypes up to 90 kg/ha; however, its influence was found significant up to 60 kg N/ha only (Table 1). The interaction between genotypes and nitrogen levels found nonsignificant. Nitrogen plays a vital role in cell division, cell elongation, and cell differentiation; therefore, better vegetative growth occurs with the application of nitrogen. Nitrogen application brings higher plant height, tiller number, and stem girth resulted in higher green forage yield. These results were in agreement with the findings of Rana *et al*. (2013) [18], Meena and Jain (2013) [19], Shekara *et al*. 2019 [20], and Midha *et al*. (2015) [21].

3.4 Dry matter yield
Dry matter yield was significantly affected by genotypes and nitrogen levels, but the interaction between genotypes and nitrogen levels was nonsignificant (Table 1). The genotype TSFB 15-8 produced highest dry matter of 116.56 q/ha. TSFB 15-4, Moti bajra, and Giant bajra produced 112.44, 107.29, and 97.60 q/ha of dry matter respectively. Similar results were also reported by Shekara *et al*. (2020) [17], Bramhaiah *et al*. (2018) [12], Sheoran *et al*. (2016) [10]. The genotypes TSFB 15-8 and TSFB showed higher values in vegetative growth parameters such as plant height and number of tillers per plant which ultimately resulted in higher dry matter yield. Dry matter production increased significantly to the N level of 60 kg per ha with 110.83 q/ha. Nitrogen at the rate of 30, 60, and 90 kg/ha had produced 101.39, 110.83, and 111.29 quintals of dry matter yield per hectare, respectively. The control treatment produced a 99.37 kg dry matter yield per ha. But the difference between 60 kg and 90 kg nitrogen in recording dry matter yield was nonsignificant (Table 1). Nitrogen has got significant influence in increasing the dry matter yield [Shekara *et al*. (2020) [17]; Bramhaiah *et al*. (2018) [12]; Sheoran *et al*. (2016) [10]].

3.5 Crude protein %
Genotypes differed significantly in crude protein %. The genotype TSFB 15-4 had the highest crude protein % (8.8), followed by TSFB 15-8 with crude protein % of 8.6. Giant bajra and Moti bajra had 8.2% and 7.8% crude protein, respectively (Table 1). Similar results also reported by Singh *et al*. (2012) [2], Kumawat *et al*. (2017) [14], and Shekara *et al*. (2020) [17]. Crude protein % in all the four genotypes increased up to the N level 60 kg/ha only. Kumawat (2017) [14] had also observed that crude protein % increased up to the level 60 kg N/ha. Crude protein % was 8.3, 8.9, and 8.5 with the application of nitrogen at the rates of 30, 60, and 90 kg/ha, respectively. The control treatment recorded 7.6% crude protein only. There was no significant interaction effect observed between genotypes and N levels in influencing crude protein %. The nonsignificant interaction effect between genotypes and nitrogen also reported by Kumawat (2017) [14] and Bramhaiah *et al*. (2018) [12].

3.6 Crude protein yield
Crude protein yield was significantly affected by genotypes (Table1). The genotype TSFB 15-4 produced the highest crude protein yield (10.0 q/ha), followed by TSFB 15-8 (9.9 q/ha). Giant bajra recorded the lowest crude protein yield of 8.1 q/ha, whereas Moti bajra recorded 8.6 q/ha of crude protein yield. Genotypes significantly differed in producing crude protein yields [Singh *et al*. (2012) [2], Kumawat (2017) [14] and Shekara *et al*. (2020) [17]]. Nitrogen application influenced crude protein yield significantly up to the N level of 60 kg/ha. Kumawat *et al*. (2017) [14] also reported similar results, but Shekara *et al*. (2020) [17] reported that crude protein yield increased up to the N level of 120 kg/ha and Singh *et al*. (2012) [2] reported up to N level of 90 kg/ha. Genotype and nitrogen interaction on crude protein yield was nonsignificant (Table 1).

Table 1: Effect of N levels on growth, fodder yield, and quality of forage pearl millet varieties

Particulars	Plant Height (cm)	Leaf to Stem ratio	Green fodder yield (Q/ha)	Dry matter yield Q/Ha)	Crude protein yield (Q/Ha)	Crude protein (%)
Varieties						
TSFB 15-4	189.8	0.20	471.72	112.44	10.0	8.80
TSFB 15-8	198.7	0.19	509.72	116.56	9.90	8.60
Giant Bajra	191.1	0.20	400.66	97.60	8.10	8.20
Moti Bajra	197.9	0.21	437.52	107.29	8.40	7.80
SE(m) ±	3.61	0.10	9.38	2.90	0.21	0.08
C.D. (P=0.05)	NS	NS	27.22	8.41	0.60	0.23
Nitrogen Levels (kg/ha)						
0	178.1	0.22	428.19	99.37	7.40	7.60
30	195.6	0.21	453.30	101.39	9.10	8.30
60	200.2	0.20	478.41	110.83	10.30	8.90
90	203.7	0.18	459.72	111.29	9.50	8.50
SE(m) ±	3.6	0.01	9.38	2.90	0.21	0.08
C.D. (P=0.05)	10.6	NS	27.22	8.41	0.60	0.23
Interaction (V x N)						
SE(m) ±	7.23	0.02	18.76	5.80	0.42	0.16
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

4. Conclusions
Our experiment revealed that among four genotypes/varieties were tested, TSFB 15-8 and TSFB 15-4 genotypes performed and found suitable for Telangana State in producing high green fodder, dry matter, and crude protein yields. Genotypes responded significantly up to the N level of 60 kg/ha in producing green fodder, dry matter, and crude protein yields in forage pearl millet. Therefore, forage pearl millet genotypes TSFB 15-8 and TSFB 15-4 can be cultivated economically with the application of 60 kg N/ha in Telangana.

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