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Effect of nitrogen and cutting management on growth, yield and quality of fodder pearl millet (*Pennisetum glaucum* L.) cultivars

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Abstract
A field experiment was conducted for three consecutive years on fodder pearl millet during *kharif* season of 2012, 2013 and 2014 at Bikaner to find out the Effect of nitrogen and cutting management on growth, yield and quality of fodder pearl millet cultivars. The treatment consists of three pearl millet cultivars *viz.,* BAIF Bajra 1, AVKB 19 and GFB 1; three cutting management practices *viz.* no cut, one cutting at 40 DAS and two cuttings at 40 and 80 DAS; and two levels of nitrogen *viz.*,100% RDN (60 kg/ha) and 150% RDN (90 kg/ha). The results showed that maximum plant height (182.07 cm) and yield attributes *viz.,* tillers/m row length (35.11) and leaf stem ratio (2.66) of fodder pearl millet was recorded by 'cultivar, AVKB 19' whereas maximum yield *viz*., green fodder (211.68 q/ha), grain (15.16 q/ha) and dry matter (44.56 q/ha) yield were recorded with pearl millet cultivar GFB-1. The study on cutting management indicated that plant height (165.83 cm), tillers/m row length (45.57), and after two cut for fodder gave the highest green fodder (311.77 q/ha), dry matter (68.82 q/ha) and crude protein (10.54 q/ha) yield, nitrogen uptake (224.09 kg/ha) and net return (Rs. 78380 /ha). Further, higher plant height (165.67 cm); yield attributes *viz.,* tillers/m row length (30.89) and leaf: stem ratio (2.31); yield *viz*., green fodder (200.17 q/ha), stover (63.14 q/ha), grain (12.92 q/ha) and dry matter (41.69 q/ha) yield; quality parameters *viz*., crude protein per cent (7.76 %) and yield (7.06 q/ha); nitrogen uptake (193.22 kg/ha) and economics *viz*., net return (Rs. 74772 /ha) and B:C ratio (4.22) were recorded with 150% RDN (recommended dose of nitrogen). Similarly, interaction effect of variety and cutting and nitrogen and cutting management had significant effect on green fodder, dry matter and crude protein yield. Pearl millet variety GFB-1 with two cuts for green fodder was superior in respect of dry matter production, crude protein yield, and nitrogen up take as well as net returns to all other varieties along with different cutting management.

Keywords: Crude protein, Cutting management, Fodder production, Nitrogen levels, Pearl millet

Introduction

Pearl millet (*Pennisetum galucum* L.) is an important coarse grain cereal generally grown as rainfed crop on marginal lands under low input management conditions. It is adapted under drought condition and poor soil fertility, but responds well to good management and higher fertility levels. It is generally cultivated in area where rainfall ranges from 150 to 600 mm. This crop is not only cultivated for grain, but is also valued for its stover as fodder purpose. Even some of the varieties are grown exclusively for fodder production. The dual-purpose nature of pearl millet ensures both food and fodder security in the arid and semi-arid regions of the country (Ramesh *et al.,* 2006). Pearl millet as fodder crop has some additional advantages over sorghum and maize because of, firstly the green fodder of pearl millet has high crude protein content (9.9 to 14%) and secondly, its green fodder can be safely fed to cattle at all stages of growth because of absence of hydrocyanic acid.

Nitrogen is an essential primary nutrient for profuse plant growth and plays a pivotal role in productivity of forage. Application of nitrogen to fodder crops is the most important way to increase forage production. Although the optimization of nitrogen fertilization is an important aspect in making pearl millet fodder production cost effective, use of nitrogen in excess leads to deterioration of soil health and accumulation of nitrate-N in fodder which is toxic to animals. The other important factor affecting the yield and quality of forage crops is their stage of cutting. The effects of harvesting time on yield and chemical composition of forage attained much importance than that of cultivars. The fresh fodder yield of pearl millet goes on increasing up to certain growth stage and there after starts decreasing (Keshawa and Yadav, 1989). Delay in harvest increases dry matter yield but decreases crude

protein content (Malai *et al.*, 1980). Bukhari (2009) observed a decrease in crude protein and ash contents with delayed harvest, whereas, crude fibre and dry matter percentage increased with advanced maturity. The present study was, therefore, designed to evaluate the effects of cutting management and levels of nitrogen on yield and quality of fodder pearl millet.

Materials and Methods

Experimental site: A field experiment was conducted on fodder pearl millet during *kharif* season of 2012, 2013 and 2014 at Agricultural Research Station, SK Rajasthan Agricultural University, Bikaner situated in western hyper arid zone of Rajasthan. The soil was sandy loam in nature, having field capacity 6.50%, PWP 1.52%, bulk density 1.51 g/cc, pH (1:2) 8.09, electrical conductivity (1:2) 0.9 dS/m. The soil was very low in organic carbon (0.15%), available nitrogen (111 kg/ha) medium in available P (15.6 kg/ha) and medium in available K (245.7 kg/ha). Total rain fall during crop growing period was 209, 198 and 417 mm received in 15, 16 and 11 rainy days in 2012, 2013 and 2014, respectively.

Experimental design: The experiment was laid out in randomized block design with three replications. The treatments consist of three pearl millet released varieties *viz*., BAIF Bajra-1, AVKB-19 and GFB-1; three cutting management practices *viz.,* no cut, one cutting at 40 DAS and there after left for grain production and two cuttings at 40 and 80 DAS and the crop was left for grain production; and two levels of nitrogen *viz.*,100% RDN (60 kg/ha) and 150% RDN (90 kg/ha). In no cut treatment nitrogen was applied in two equal splits at sowing and 35 DAS. Whereas, in one and two cut treatments nitrogen was applied in three equal splits (at sowing, 25 DAS and after cutting) and four equal splits (at sowing, 25 DAS and after 1st cut and 2nd cut) respectively. The crop was sown on 19th July, 28th June and 18th July in 2012, 2013 and 2014, respectively with the onset of monsoon or pre-sowing irrigation using recommended seed rate of 10 kg/ha with row to row 25 cm and plant to plant 3-5 cm spacing and harvested for green forage as per the treatment. Final harvesting for stover and grain was done at 90-105, 120-130 and 135-145 DAS for no cut, one cut and two cuts treatments, respectively. All the cultural operations *viz*., hoeing and weeding, irrigation, fertilization (P) were carried out as per recommendations. Two irrigations, one as lifesaving during long gap in between rains during growth period as and when required, and second at grain formation stage was given in every year.

Observations and methods of analysis: The observations on the plant height (cm), tiller per meter row length, leaf stem ratio, green fodder and dry matter (sun dried) yield in q/ha were recorded at each cutting stages and harvest. Total nitrogen in fodder was determined by the method of sulphuric acid digestion and distillation was made with micro-Kjeldahl apparatus (Jackson, 1962). The nitrogen percentage was then multiplied with dry matter yield to obtain nitrogen uptake. For the determination of crude protein percentage, nitrogen percentage was multiplied with 6.25 and for obtaining crude protein yield crude protein percentage, multiplied by dry matter yield. The pooled data were subjected to analysis of variance (ANOVA) for randomized block design following Snedecor and Cochran (1994).

Results and Discussion

Pearl millet cultivars: Pearl millet cultivars had significant effect on growth, yield, quality and economics. Maximum yield attributes viz., plant height (182.07 cm), tillers/m row length (35.11) and leaf stem ratio (2.66) of fodder pearl millet was recorded by the pearl millet cultivar, AVKB 19 (Table 1). The variation in plant height and leaf: stem ratio in different pearl millet cultivars may be due to their adaptability to the environmental conditions in the region and disparity in genetic makeup of these varieties. Significant difference in pearl millet varieties in respect of plant height was also reported by Ayub *et al.* (2012). However, highest yield *viz*., green fodder (211.68 q/ha), grain (15.16 q/ha) and dry matter (44.56 q/ha) yields were recorded with pearl millet cultivar, 'GFB 1' which were significantly higher by 8.2, 30.7 and 5.6 percent, respectively over AVKB-19 and 30.5, 49.5 and 38.2 per cent, respectively over BAIF Bajra 1. This might have happened due to higher genetic yield potential of pearl millet cultivar GFB 1 governed by better adaptability to adoption in low soil fertility as compared to AVKB 19 and BAIF Bajra-1. Further, pearl millet cultivar GFB-1 recorded better quality parameters *viz.,* crude protein (8.07%) and crude protein yield (7.54 q/ha); nitrogen uptake (205.57 kg/ha) and economics *viz*., net return (Rs. 78242/ha) and B:C ratio (4.48) as compared to AVKB 19 and BAIF Bajra 1 (Table 3). This might be due to the fact that the pearl millet cultivars GFB 1 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 behaviour of these genotypes could also be explained solely by the variation in their genetic

Table 1. Effect of nitrogen and cutting management on yield attributes and yields of fodder pearl millet cultivars (pooled over data of three years)

Treatment	Plant height (cm)	Tillers / m row length	Leaf: Stem ratio	Green fodder yield (q/ha)	Stover yield (q/ha)	Grain yield (q/ha)
Pearl millet cultivars						
BAIF Bajra-1	135.98	23.17	1.55	162.25	62.87	10.14
AVKB-19	182.07	35.11	2.66	195.72	54.48	11.60
GFB-1	170.39	31.31	2.49	211.68	59.99	15.16
SEm±	2.33	0.74	0.07	2.61	1.37	0.35
CD (P ≤ 0.05)	5.47	1.75	0.17	6.12	3.22	0.83
Cutting management						
C_0	160.00	-	-	-	103.02	22.40
C_1	162.61	44.02	3.37	257.88	44.91	14.50
C_2	165.83	45.57	3.34	311.77	29.41	0.00
SEm ±	2.33	0.74	0.07	2.61	1.37	0.35
CD (P ≤ 0.05)	5.47	1.75	0.17	6.12	3.22	0.83
Nitrogen levels						
100% RDN	159.96	28.84	2.16	179.59	55.09	11.68
150% RDN	165.67	30.89	2.31	200.17	63.14	12.92
SEm ±	1.90	0.61	0.06	2.13	1.12	0.27
CD (P ≤ 0.05)	4.47	1.43	0.14	5.00	2.63	0.67

C_0: No cut; C_1: Cutting at 40 DAS and left for grain; C_2: Two cuttings at 40 and 80 DAS and left for grain; RDN : Recommended dose of nitrogen (60 kg/ha)

constituent. Meena and Mann (2007) opined that dry matter production efficiency of genotype determines its potential to produce economic yield. The genotype variation in behaviour *viz*., growth parameters and yields were also reported by other researcher as in perennial ryegrass (Solomon *et al*., 2016) and in pearl millet (Blummel *et al*., 2003).

Cutting management: The study on cutting management indicated that total plant height (165.83 cm), tillers/m row length (45.57), green fodder (311.77 q/ha), dry matter (68.82 q/ha) and crude protein yield (10.54 q/ha), nitrogen uptake (224.09 kg/ha) and net return (Rs. 78380/ha) were recorded higher with two cuts for green fodder at 40 and 80 DAS and left for grain (C_2), whereas, higher stover (103.02 q/ha) and grain (22. 40 q/ha) yields were recorded with uncut (C_0) fodder pearl millet, which was possibly due to more time period available for sufficient vegetative growth resulting higher grain yield also in uncut treatment. Yadav *et al*. (2015) reported similar findings i.e, maximum seed in tetraploid berseem in January last cutting and reduced seed yield under delay in date of cutting. Further higher leaf: stem ratio (3.37), crude protein percentage (11.40 %) and B:C ratio (4.12) were recorded with one cut at 40 DAS and left for grain (C_1). However, all these were at par with two cuts for green fodder at 40 and 80 DAS and left for grain (C_2), with the corresponding values of 3.34, 11.38 and 4.07, respectively (Table 1 & 3). Double cut crop recorded higher green fodder and dry matter yield and also recorded significantly higher crude protein yield as compared to uncut and single cut crop. Higher nitrogen concentration in double cut crop might have resulted in higher crude protein content (Intikhab *et al*., 2013).

Nitrogen levels: Plant height, yield and yield attributes, quality parameters, nitrogen uptake and economics of fodder pearl millet was significantly influenced by the nitrogen levels. Maximum plant height (165.67 cm); yield attributes *viz.,* tillers/m row length (30.89) and leaf: stem ratio (2.31); yield *viz*., green fodder (200.17 q/ha), stover (63.14 q/ha), grain (12.92 q/ha) and dry matter (41.69 q/ha) yield; quality parameters *viz*., crude protein per cent (7.76) and yield (7.06 q/ha); nitrogen uptake (193.22 kg/

ha) and economics *viz*., net return (Rs. 74772 / ha) and B:C ratio (4.22) were recorded with 150% RDN (Table 1 & 3). This may be mainly attributed to improved growth and yield parameters *viz*., plant height, number of tillers/m row length, leaf: stem ratio and the beneficial effects of nitrogen on cell division and elongation, formation of nucleotides and co-enzymes which resulted in increased meristematic activity and photosynthetic area and hence more production and accumulation of photosynthates, yielding higher green fodder and dry matter. The improvement in grain yield with increasing nitrogen level (40 kg/ha) under rainfed condition and upto 90 kg/ha under irrigated situation was observed by Rathore *et al*. (2002). Further these results were in conformity with the findings of earlier workers (Dudhat *et al*., 2004; Sharma and Verma, 2005; Sheoran and Rana, 2006; Yadav and Singh, 2012).

Interaction effects: Variety x cutting management interaction was found statistically significant for yield attributes *viz.,* tillers/m row length and leaf: stem ratio; yield *viz*., green fodder, stover, grain and dry matter yield; quality parameters *viz*., crude protein per cent and yield; nitrogen uptake and economics *viz*., net return and B:C ratio of fodder pearl millet (Table 2 & 4). Highest leaf: stem ratio (4.01) and tillers/m row length (54.11) was recorded with pearl millet cultivar AVKB-19 with one cut at 40 DAS and left for grain (V_2C_1). Further, pearl millet cultivars GFB-1 with two cuts for green fodder at 40 & 80 DAS and left for grain (V_3C_2) recorded maximum green fodder (341.28 q/ha), dry matter (78.22 q/ha) and crude protein (12.43 q/ha) yield, nitrogen uptake (294.44 kg/ha) and net return (Rs. 86914/ha). Whereas, maximum crude protein percentage (12.21) and B:C ratio (4.67) was recorded with GFB 1 with 40 DAS and left for grain (V_3C_1). Although, maximum grain (27.45 q/ha) and stover (110.78 q/ha) yields were recorded with pearl millet cultivars, 'GFB 1' and BAIF Bajra 1, respectively when no cutting was done. Thus pearl millet cultivars GFB-1 with two cuttings

Table 2. Interaction effect of cultivars x cutting management and nitrogen x cutting management on growth, yield and yield attributes of fodder pearl millet (pooled over data of three years)

Treatment	Leaf: Stem ratio	Tillers / m row length	Green fodder yield (q/ha)	Stover yield (q/ha)	Grain yield (q/ha)
Variety x Cutting management					
V_1C_0	-	-	-	110.78	18.72
V_2C_0	-	-	-	97.55	21.03
V_3C_0	-	-	-	100.74	27.45
V_1C_1	2.29	33.44	210.38	52.31	11.71
V_2C_1	4.01	54.11	269.52	37.81	13.77
V_3C_1	3.81	44.50	293.74	44.61	18.02
V_1C_2	2.36	36.06	276.38	25.52	0.00
V_2C_2	3.98	51.22	317.65	28.08	0.00
V_3C_2	3.66	49.44	341.28	34.63	0.00
SEm $\pm$	0.13	1.33	4.68	2.46	0.63
CD ($P \leq 0.05$)	0.30	3.13	10.99	5.77	1.48
Nitrogen x Cutting management					
N_1C_0	-	-	-	96.20	21.80
N_2C_0	-	-	-	109.85	23.00
N_1C_1	-	-	246.76	42.35	13.25
N_2C_1	-	-	269.01	47.47	15.75
N_1C_2	-	-	292.03	26.73	0.00
N_2C_2	-	-	331.52	32.10	0.00
SEm $\pm$	-	-	3.82	2.01	0.52
CD ($P \leq 0.05$)	-	-	8.97	4.71	1.21

V_1: BAIF Bajra 1; V_2: AVKB 19; V_3: GFB 1; C_0: No cut; C_1: Cutting at 40 DAS and left for grain; C_2: Two cuttings at 40 and 80 DAS and left for grain; N_1: 100% RDN; N_2: 150% RDN

Table 3. Effect of nitrogen and cutting management on dry matter yield, quality, nutrient uptake and economics of fodder pearl millet (pooled over data of three years)

Treatment	Dry matter yield (q/ha)	Crude protein (%)	CP yield (q/ha)	N uptake (kg/ ha)	Net returns (Rs / ha)	B : C ratio
Pearl millet varieties						
BAIF Bajra-1	32.25	7.27	5.91	164.44	63206	3.63
AVKB-19	42.20	7.42	6.22	156.63	69099	3.94
GFB-1	44.56	8.07	7.54	205.57	78242	4.48
SEm ±	0.46	0.03	0.08	2.39	1016	0.06
CD (P ≤ 0.05)	1.07	0.06	0.19	5.60	2385	0.14
Cutting management practices						
C_0	0.00	0.00	0.00	101.35	59037	3.87
C_1	50.20	11.40	9.14	201.21	73130	4.12
C_2	68.82	11.38	10.54	224.09	78380	4.07
SEm ±	0.46	0.03	0.08	2.39	1016	0.06
CD (P ≤ 0.05)	1.07	0.06	0.19	5.60	2385	0.14
Nitrogen levels						
RDN100%	37.66	7.42	6.06	157.88	65593	3.82
RDN150%	41.69	7.76	7.06	193.22	74772	4.22
SEm ±	0.37	0.02	0.07	1.95	830.00	0.05
CD (P ≤ 0.05)	0.88	0.05	0.16	4.57	1948	0.12

C_0: No cut; C_1: Cutting at 40 DAS and left for grain; C_2: Two cuttings at 40 and 80 DAS and left for grain; RDN : Recommended dose of nitrogen (60 kg/ha)

Table 4. Interaction effect of cultivars x cutting management and nitrogen x cutting management on dry matter yield, quality, nutrient uptake and economics of fodder pearl millet (pooled over data of three years)

Treatment	Dry matter yield (q/ha)	Crude protein (%)	Crude protein yield (q/ha)	N uptake (kg/ ha)	Net returns (Rs / ha)	B : C ratio
Variety x Cutting management						
V_1C_0	-	-	-	125.89	57194	3.75
V_2C_0	-	-	-	84.23	55005	3.60
V_3C_0	-	-	-	93.92	64913	4.25
V_1C_1	40.34	10.85	8.78	188.48	63087	3.55
V_2C_1	54.79	11.12	8.43	186.79	73403	4.13
V_3C_1	55.47	12.21	10.20	228.35	82900	4.67
V_1C_2	56.40	10.97	8.96	178.96	69336	3.60
V_2C_2	71.82	11.15	10.23	198.87	78890	4.09
V_3C_2	78.22	12.01	12.43	294.44	86914	4.51
SEm ±	0.82	0.04	0.15	4.28	1823	0.11
CD (P ≤ 0.05)	1.93	0.10	0.35	10.04	4279	0.26
Nitrogen x Cutting management						
N_1C_0	-	-	-	-	-	-
N_2C_0	-	-	-	-	-	-
N_1C_1	48.70	-	8.64	-	-	-
N_2C_1	51.70	-	9.63	-	-	-
N_1C_2	64.28	-	9.54	-	-	-
N_2C_2	73.35	-	11.54	-	-	-
SEm ±	0.67		0.12			
CD (P ≤ 0.05)	1.57	-	0.28	-	-	-

V_1: BAIF Bajra 1; V_2: AVKB 19; V_3: GFB 1

for green fodder at first 40 and 80 DAS and left for grain (V_3C_2) recorded maximum green fodder, dry matter and crude protein yield, nitrogen uptake and net return.

Pearl millet green fodder, dry matter, stover, grain and crude protein yields were significantly influenced by nitrogen x cutting management practices (Table 2 & 4). Maximum green fodder (331.52 q/ha), dry matter (73.35 q/ha) and crude protein (11.54 q/ha) yield were recorded in 150% of RDN (90 kg/ha) with two cuts at 40 and 80 DAS and left for grain (N_2C_2). Further highest grain (23.00 q/ha) and stover (109.85 q/ha) yields of fodder pearl millet were recorded in 150% of RDN with uncut crop (N_2C_0).

Conclusion

Variety and cutting management significantly affected yield attributes, yields, economics and quality parameters in dual purpose fodder pearl millet. Pearl millet cultivar, 'GFB 1' with two cuts for green fodder at 40 and 80 DAS and left for grain (V_3C_2) recorded maximum green fodder (341.28 q/ha), dry matter (78.22 q/ha), crude protein (12.43 q/ha) yield, net return (Rs. 86914 / ha) and nitrogen uptake (294.4 kg/ha). Similarly 150% of RDN with two cuts for green fodder at 40 and 80 DAS and then left for grain (N_2C_2) gave the maximum green fodder (331.52 q/ha), dry matter (73.35 q/ha) and crude protein yield (11.54 q/ha), though the highest grain and stover yields (23.0 & 109.9 q/ha) were recorded with uncut pearl millet at the same nitrogen level.

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