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NUTRIENT CONTENT, QUALITY AND WATER PRODUCTIVITY OF PEARL MILLET IN RESPONSE TO INTEGRATED NUTRIENT MANAGEMENT

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Abstract

A field experiment to study the effect of cultivars and integrated nutrient management on nutrient content, quality and water productivity was conducted at experimental farm, Annamalai University. On the basis of experimental data significant improvements were recorded in the nutrient content, quality and water productivity. Highest nutrient content, protein content, protein yield and water productivity were observed with PHB-3 among the cultivars. With respect to integrated nutrient management, 75% RDF + Biofertilizers @ 5 kg ha^{-1} incubated with vermicompost @ 500 kg ha-1 recorded highest nutrient content, protein content, protein yield and water productivity over the rest of the treatments.

***Keywords*:** Nutrient content, Pearl millet, Protein content, Protein yield, Water productivity and cultivars.

Introduction

Pearl millet (*Pennisetum glaucum* (L.) is an indispensible arid and semi-arid crop of India cultivated as dual purpose (food and fodder) crop in over 7.89 million hectares producing 9.18 million tonnes with productivity of 1164 kg ha^{-1} and covers about 8.5% of irrigated area (GOI, 2014. Ministry of Agriculture and Cooperation). In Telangana it is grown on 0.05 lakh hectares with 0.04 lakh tonnes of production and productivity of 824 Kg ha^{-1} (Department of Agriculture, Telangana, 2016-2017). It is nutritionally better than many cereals, it is a good source of protein having higher digestibility (12.1%), fat (5%), carbohydrate (69.4%) and minerals (2.3%). The main reason for low productivity is that the crop is raised under rainfed conditions on low fertility soils. Selection of a proper hybrid/variety is an important consideration that affects pearl millet production and productivity levels. Now a days, use of chemical fertilizer is increasing to boost up crop production. Simultaneously, cost of chemical fertilizer is increased constantly, besides these, only use of inorganic fertilizers is injurious to soil health and soil productivity. INM involving chemical fertilizers, biofertilizers and organic manures is the key to the sustained productivity as it reduces dependence on chemical fertilizers and not only improves fertilizer use efficiency, but also improves soil productivity by improving physical,/chemical and biological properties of soil (Patel *et al.,* 2016).

Nitrogen fixers and phosphate solubilizers contribute through biological fixation of nitrogen, solubilization of fixed nutrients and enhanced uptake of plant nutrients (Kanzaria *et al.,* 2010. Efficiencies of organic manures like vermin compost are not only for improving and buildup of soil fertility but also increases efficiency of applied chemical fertilizers.

Materials and Methods

The present investigation was carried out during *summer* season, 2017. The soil of experimental site was sandy loam in texture with 7.7 pH, EC (0.84 ds m^1), organic carbon (0.65%), available nitrogen, phosphorus and potassium (180, 85 and 360 kg ha^{-1}). The experiment was conducted in a Randomized block design with factorial concept, consisting of nine treatments replicated thrice. The first factor was ICMV-221, Dhanashakti and PHB-3, second factor consisted of three integrated nutrient management practices *i.e* 100% RDF, 75% RDF + 25% N through vermicompost and 75% RDF + Biofertilizers @ 5 kg ha^{-1} incubated with vermicompost @ 500 kg ha^{-1}. Protein content of pearl millet seeds were estimated as per the procedure outlined by Johan Kjeldahl in 1883 (Piper, 1950) Total nitrogen in the grain samples was estimated by conventional Micro-Kjeldahl's method. Generally 16% nitrogen is present in proteins. So, 100/16 = 6.25 factor may be used to convert nitrogen content to protein. Thus nitrogen content was multiplied with 6.25 factor to calculate protein content. Protein yield was obtained by multiplying protein content and grain yield of the respective treatment. After digesting the powdered plant samples by H_2S0_4 and H_20_2, nitrogen content in plant samples was estimated by modified Micro Kjeldahl method (Piper, 1950). The phosphorus content in the digested plant samples was determined by vanadomolybdo- phosphoric acid yellow color method using spectrophotometer at 470 nm wave length (Tandon, 1998).

The potassium content in the digested plant samples was determined by flame photometer after making proper dilutions (Tandon, 1998). The amount of water applied under each irrigation treatment was measured through water meter. The effective rainfall received in the crop growth period was added to this and expressed as total depth of water applied in m^3. A total amount 381.6 mm of water was consumed by crop consisting 373.4 mm applied water and effective rainfall was 8.2 mm received during crop growth period. Water productivity is the ratio of economic yield (grain) that can be produced to the unit quantity of water. Data gathered on each observation were subjected to analysis of variance procedures as outlined for Randomized block design factorial concept (Gomez and Gomez, 1984). Statistically significance was tested by F-value at 0.05% level of probability and critical difference was worked out where ever the effect were significant.

Results and Discussion

Nutrient content in grain and straw

Nitrogen content (%)

Cultivars and integrated nutrient management (INM) had significant effect on nitrogen content (Table 1). The highest nitrogen content in grain (2.06%) and straw (1.43%)were noticed with PHB-3.When compared to INM treatments, 75% RDF + Biofertilizers incubated with vermicompost@500 kg ha^{-1} recorded highest nitrogen content in grain (1.86%) and straw (1.39%) whereas, the lowest was found with 100% RDF. Similar findings were reported by Pallavi *et al.* (2016). This may be due to the more availability of this nutrient because of increased levels of nitrogen application and their favourable effects on the growth and yield.

Phosphorus content (%)

Phosphorus content in grain and straw increased significantly with cultivars and integrated nutrient management. Maximum P content in grain and straw (0.34 and 0.30 %) was observed with PHB-3 and the minimum P content in grain and straw (0.30 and 0.24%) was observed with ICMV-221 (table 1). Among the integrated nutrient management treatments, 75%RDF + Biofertilizers incubated with vermicompost@ 500 kg ha^{-1} recorded highest phosphorus content in grain and straw respectively (0.33 and 0.29%) followed by 75% RDF + 25% N through vermicompost (0.31 and 0.26%). These findings are reported by Pallavi *et al* (2016).

Table 1 : N,P and K content (%) of pearl millet in grain and straw as influenced by cultivars and INM at harvest

Treatments	N (%)		P (%)		K (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Cultivars						
C_1 : ICMV-221	1.54	1.09	0.30	0.24	0.61	2.26
C_2 : Dhanashakti	1.66	1.22	0.32	0.26	0.69	2.41
C_3 : PHB-3	2.06	1.43	0.34	0.30	0.78	2.61
SEm+	0.04	0.04	0.01	0.01	0.02	0.05
CD (P=0.05)	0.11	0.12	0.02	0.02	0.07	0.14
Integrated nutrient management						
F_1 : 100% RDF	1.66	1.14	0.30	0.25	0.64	2.32
F_2 : 75% RDF + 25% N through vermicompost	1.74	1.21	0.31	0.26	0.68	2.40
F_3 : 75% RDF + Biofertilizers incubated with vermicompost @ 500 kg ha^{-1}	1.86	1.39	0.33	0.29	0.76	2.57
SEm+	0.04	0.04	0.01	0.01	0.02	0.05
CD (P=0.05)	0.11	0.12	0.02	0.02	0.07	0.14
Interaction						
SEm+	0.06	0.06	0.01	0.01	0.04	0.08
CD (P=0.05)	NS	NS	NS	NS	NS	NS

RDF = 80.40:30 kg ha^{-1} N:P_2O_5: K_2O, 25% N tonnes of vermicopost. NS = Non-Significant
Biofertilizers = (*Azospirillum* + PSB) each @ 5 kg ha^{-1}

Potassium content (%)

The maximum K content in grain (0.78) and straw (2.61) were recorded with PHB-3, however, minimum was recorded with ICMV-221 (0.61 and 2.26).Application of 75% RDF + Biofertilizers incubated with vermicompost@ 500 kg ha-1 increased the potassium content in grain (0.76) and straw (2.57) compared to 75% RDF + 25% N through vermicompost (0.68 and 2.4%) and 100 % RDF (0.64 and 2.32%) (table 1). These findings are inline with the results of Pallavi *et al.* (2016):

Protein content (%)

Scrutiny of data (Table 2) revealed that protein content in grain was significantly influenced by cultivars and INM. The significantly maximum protein content in grain (12.9%) was recorded with PHB-3 followed by Dhanashakti (10.39%) and ICMV-221 (9.62%).

In relation to INM treatments, significantly maximum protein content in grain (11.65%) was recorded with 75% RDF + Biofertilizers @ 5 kg ha^{-1} incubated with Vermicompost @ 500 kg ha^{-1}compared to 75% RDF + 25% N through Vermicompost (10.89%).100% RDF registered minimum protein percentage of 10.37% which was on par with 75% RDF + 25% N through vermicompost Interaction effect between cultivars and INM was found to be non-significant. The difference in the protein percentage among the cultivars might be attributed to the better growth and development of the cultivars, especially PHB-3 and also higher nitrogen content resulting in higher protein content. Differences in the genetic makeup between cultivars can also be one of the reason. These results are in line with the findings of Prakash *et al.* (2014) and Makarana *et al.* (2017). With regard to INM increased protein content might be due to the better availability of applied nitrogen through the combination of organic and inorganic sources along with biofertilizers might be one $_x$ of the reasons for increased protein synthesis. These findings are in conformity with the findings of Patil *et al.* (2014).

Table 2 : Protein content, protein yield and water productivity of pearl millet as influenced by cultivars and INM

Treatments	Protein content (%)	Grain yield (kg ha^{-1})	Protein yield (kg ha^{-1})	Water productivity (kg m^3)
Cultivars				
C_1	9.62	2389.00	230.44	0.63
C_2	10.39	2605.00	270.78	0.68
C_3	12.90	3239.00	417.05	0.85
SEm+	0.23	58.30	7.54	0.01
CD (P=0.05)	0.68	174.80	22.60	0.04
Integrated nutrient management				
F_1	10.37	2572.00	278.09	0.69
F_2	10.89	2693.00	299.40	0.71
F_3	11.65	3001.00	340.78	0.76
SEm+	0.23	58.30	7.54	0.01
CD (P=0.05)	0.68	174.80	22.60	0.04
Interaction				
SEm+	0.40	100.90	13.05	0.02
CD (P=0.05)	NS	NS	NS	NS

Grain yield (kg ha^{-1})

The higher grain yield (3239 kg ha^{-1}) was obtained with PHB-3 which was significantly superior over Dhanashakti and ICMV-221. Difference in yields among the cultivars might be attributed due to better response of hybrid over the two composites resulting in increased number of effective tillers, better ear head length, girth and more no. of filled grains with higher test weight. Among the INM treatments 75 % RDF + Biofertilizers @ 5 kg ha^{-1} incubated with vermicompost @ 500 kg ha^{-1} yielded maximum grain yield of 3001 kg ha^{-1} and straw yield of 5240 kg ha^{-1}compared to 75% RDF + 25% N through vermicompost and 100% RDF (table 2). Similar results were confirmed by Patil and Shete (2008) and Patil *et al* (2014).

Protein yield (kg ha^{-1})

Among the cultivars it was noticed that maximum protein yield was recorded with PHB-3 (417.05 kg ha^{-1}) which was superior over Dhanashakti (270.78 kg ha^{-1}) and ICMV-221 (230.44 kg ha^{-1}). Higher protein yield of 340.78 kg ha^{-1} was noticed with 75 % RDF + Biofertilizers @ 5 kg ha^{-1} incubated with vermicompost @ 500 kg ha^{-1} compared to 75% RDF + 25% N through vermicompost (299.40 kg ha^{-1}). 100% RDF registered lower protein yield of 278.09 kg ha^{-1} which was on par with 75% RDF + 25% N through vermicompost. Since protein yield is a function of grain yield and protein content, the cultivar PHB-3which recorded higher grain yield, also recorded higher protein yield. The higher protein yield due to combined application of chemical fertilizers with biofertilizers incubated with vermicompost might be due to higher N content, mineralization effect on native N and higher grain

Water productivity (kg m^3)

Significantly higher water productivity of 0.85 kg m^{-3} was observed with PHB-3 followed by Dhanashakti (0.68 kg rrr) and ICMV-221 (0.63 kg m^{-3}) (Table 2). Among the integrated nutrient management treatments, significantly higher water productivity (0.76 kg m^{-3}) was recorded with 75% RDF + Biofertilizers @ 5 kg ha^{-1} incubated with vermicompost @ 500 kg ha^{-1} compared to 75% RDF + 25% N through vermicompost (0.71 kg m^{-3}). 100% RDF registered lowest water productivity of 0.69 kg m^3 which was on par with 75% RDF + 25% N through vermicompost. It might be due to the fact that increase in yield was of higher magnitude than the corresponding increase in water used that evenly resulted in higher water productivity. Similar findings were also reported by Chowdary *et al.* (2016).

Experimental results revealed that interaction effect of cultivars and INM was found to be non-significant in relation to nutrient content, protein content, protein yield, grain yield and water productivity.

Soil properties

The data presented in Table 3 indicates that the pH, EC, organic carbon, available nitrogen, available P_2O_5 and available K_20 was not significantly altered by cultivars and integrated nutrient management practices.

Table 3. Soil OC (%), pH, EC (dSm^{-1}), available N, P_2O_5 and K_2O (kg ha^{-1}) after harvest of pearl millet as influenced by cultivars and INM

Treatment	OC	PH	EC	N	P_2O_5	K_2O
Cultivars						
C_1	0.56	7.55	0.78	161.20	76.8	326.00
C_2	0.58	7.58	0.82	154.40	75.5	317.30
C_3	0.57	7.58	0.79	147.00	71.8	312.10
SEm+	0.01	0.16	0.02	5.23	2.41	8.01
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Integrated nutrient management						
F_1	0.53	7.65	0.82	148.70	71.6	309.64
F_2	0.57	7.61	0.79	153.40	74.4	314.30
F_3	0.61	7.59	0.81	160.50	78.0	329.60
SEm +	0.01	0.16	0.02	5.23	2.41	8.01
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Interaction						
SEm +	0.02	0.28	0.03	9.06	4.17	13.89
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Initial	0.65	7.7	0.84	180.00	85.00	360.00

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