Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

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Influence of nutrient levels on pearl millet (*Pennisetum glaucum* L.) growth, yield and economics under dryland condition of Northern Karnataka

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DOI: https://doi.org/10.22271/phyto.2021.v10.i1e.13329

Abstract
The present study was conducted at Regional Agricultural Research Station, Vijayapur during *kharif* 2018 and 2019 in medium black soil. The experiment was designed in a split plot design comprising four pearl millet hybrids as main plots (VPMH 7, VPMH 8, GHB 558 and 86M88) and three nutrient levels (100% RDF, 125% RDF and 150% RDF) in sub plots, replicated thrice. Pearl millet hybrids VPMH 8, 86M88 and VPMH 7 were better in growth compared to GHB 558. Growth parameters were statistically superior in 150% and 125% RDF compared to 100% RDF. Grain and dry fodder yield were higher in 86M88 (2285 and 5210 kg ha^{-1}, respectively) and VPMH 8 (2255 and 4772 kg ha^{-1}, respectively) than GHB 558. Nutrient level at 150% RDF has recorded higher grain and dry fodder yield, respectively (2367 and 5143 kg ha^{-1}) and was on par with 125% RDF (2186 and 4931 kg ha^{-1}). Higher gross and net returns were recorded by 86M88 (Rs. 34,275.00 and 21,488.00, respectively). RDF at 150% and 125% have recorded higher net returns and B:C ratio.

Keywords: Pearl millet, nitrogen, phosphorus, yield, economics

Introduction

Pearl millet [*Pennisetum glaucum* (L.)] is the fourth most important cereal staple food crop in India next to rice, wheat and sorghum. It is popularly known as Bajra and being drought tolerant generally grown as rainfed crop on marginal lands under low input management conditions. Pearl millet grains are not only nutritionally comparable but are also superior to major cereals with respect to protein, energy, vitamins and minerals (Parthasarathy Rao *et al.*, 2006) [13]. Besides they are rich source of dietary fibre, phytochemicals, micronutrients, neutraceuticals and hence, now a days they are rightly termed as "nutricereal". It occupies an area of 6.93 million ha with an average production of 8.61 million tones and productivity of 1243 kg ha^{-1} during 2018-19 (Anon., 2020) [1]. The major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana which account for more than 90% of pearl millet acreage in the country. The main causes of low productivity are prevailing abiotic stresses like drought, poor soil fertility, high soil pH and high temperature. These factors limit the uptake of applied nutrients by roots and also do not able to turn over the nutrients commensurate with crop nutritional requirement at different growth stages.

Poor soil fertility and erratic rains are the most important constraints to crop production in arid and semi arid region. Soil fertility management i.e., nutrient management particularly nitrogen (N) and Phosphorus (P) plays a major role in increasing production and productivity of pearl millet. Nitrogen is an essential major nutrient for plant growth, which is closely associated with vegetative growth and development of plants; it plays an important role in plant metabolism by virtue of being an essential constituent of structural component of the cell wall and many metabolically active compounds. It is also a constituent of chlorophyll and amino acids, which is important for harvest of solar energy (Bray, 1983) [4]. It helps in early establishment of leaf area capable of photosynthesis. It promotes leaf and stem growth rapidly which consequently increase the yield and its quality. Nitrogen to some extent enhances the utilization of phosphorus and potassium. Nitrogen is most commonly deficient nutrient in Indian soil and gives considerable response in pearl millet crop (Jadhav *et al.*, 2011) [9]. Pearl millet is an exhaustive crop, nitrogen is the major nutrient required by pearl millet and has shown variable growth and yield response to N application (Gascho *et al.,* 1995) [6]. Generally, pearl millet has been known for growing under low N management (Gascho *et al.,* 1995) [6]

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but, several studies showed that N application can increase millet production efficiency (Singh *et al.*, 2010) [18]. Prasad *et al.* (2014) [14] found that the tallest plant (159.86 cm) of pearl millet was obtained with application of 60 kg N ha^{-1} compared to lower N levels.

Phosphorus is import constituents of protein and phospholipds. Phosphorus not only enhances the root growth but also promotes early plant maturity. Phosphorus is the key element in the process of conversion of solar energy into chemical energy. It influences the vigour of plants, root growth and improves quality of the produce. It is backbone of balanced fertilizer use and it occupies a key place in intensive agriculture. Pearl millet crop responds well to applied phosphorus (Malik *et al.*, 1990) [12]. Beerbhadra Tripathi *et al.* (2020) [2] reported that, the application of phosphorus at 80 kg ha^{-1} produced significantly higher all observed growth attributes, yield attributes and yield of pea. The present investigation was planned to study the effect of different N and P levels on grain, yield and economics of pearl millet.

Materials and Methods
The field experiment was conducted during two consecutive *kharif* season of 2018-19 and 2019-20 under AICRP on Pearl millet at Regional Agricultural Research Station, Vijayapur situated in the Northern Dry Zone (Zone-3) of Agro-climatic region-II of Karnataka. The field is located at 16^0 49' N latitude and 75^0 43' E longitude and 593 m above mean sea level with annual rainfall ranging from 550 to 680 mm. Soil of the experimental plot was clay loam in texture, alkaline in reaction (pH 8.3) with low organic carbon (0.61%). The available soil N, P and K were 191.00, 18.9 and 378.0 kg ha^{-1}, respectively (Table 1). The experiment was laid out in Split plot design with four main and three sub plot treatments replicated thrice. Each plot was 4 m in length and 3.6 m in width. There were twelve treatment combinations comprising four pearl millet hybrids i.e. M1: VPMH 7, M2: VPMH 8, M3: GHB-558, M4: 86M88 and three levels of N and P application N1: 100% RDF (50:25:0 kg NPK ha^{-1}), S2: 125% RDF, S3: 150% RDF. Urea and diammonium phosphate (DAP) were used as source of nitrogen and phosphorus. Recommended dose of fertilizers i.e. state recommendation was taken. After land preparation farm yard manure at 2.5 t ha^{-1} was applied and fertilizers were applied at the time of sowing. The seed rate used was 4 kg ha^{-1} with plant geometry at 45 x 15 cm in each experimental plot. Sowing was done plot wise, 45 cm marker was used for marking the rows and seeds were placed manually to maintain plant to plant spacing at 15 cm.

Table 1: Initial properties of the soil samples of experimental field

Soil Properties	Texture	pH	OM (g kg^{-1})	Ca	Mg	N	P	K	S	Fe	Zn	Cu
				meq 100g-1		(kg ha^{-1})				(mg g^{-1})		
Result	Medium black soil	8.3	0.65	6.2	0.6	191	18.9	378	21.1	9.8	0.75	0.51
Critical level	-	Alkaline	0.5	2.0	0.5	-	10	120	10	4.0	0.6	0.2

Five plants from each plot were sampled randomly for collection of different plant characters and yield attributes. Data on growth parameters like plant height (cm), total and effective number of tillers plant^{-1}, earhead length (cm), earhead girth (cm) and on yield contributing characters such as seed weight plant^{-1}, 1000 grain weight, grain and dry fodder yield (kg ha^{-1}) were recorded. For seed weight per plant the ear heads of sampled plants were threshed separately and grain weight recorded. The net plot and gross plots were harvested one by one, taking care that there will not be mixture. The produce of each net plot was threshed separately, cleaned and the grain yield was recorded in kg per net plot and then converted into kg ha^{-1}. Straw yield was obtained by subtracting the grain yield of each net plot from their respective total dry matter (above ground) yield and computed in terms of kg ha^{-1} and converted it on hectare basis. Experimental data recorded was statistically analyzed with the help of statistical package MSTAT-C.

Weather data during the crop growth period for two years 2018 and 2019 is presented in Fig 1. The rainfall received during the growing period (July to October) was 157.1 and 299.5 mm in the year 2018 and 2019, respectively. The rainfall received during July, August and first week of September is useful for the crop growth. The maximum, minimum temperature and relative humidity (RH) data presented in graph is average of 2018 and 2019. The mean weekly minimum and maximum temperature during the crop season fluctuated from 20.3 to 32.3°C and relative humidity from 45.6 to 94.4%. One or two irrigations with sprinkler were applied during the dry spells observed at early stage of crop establishment.
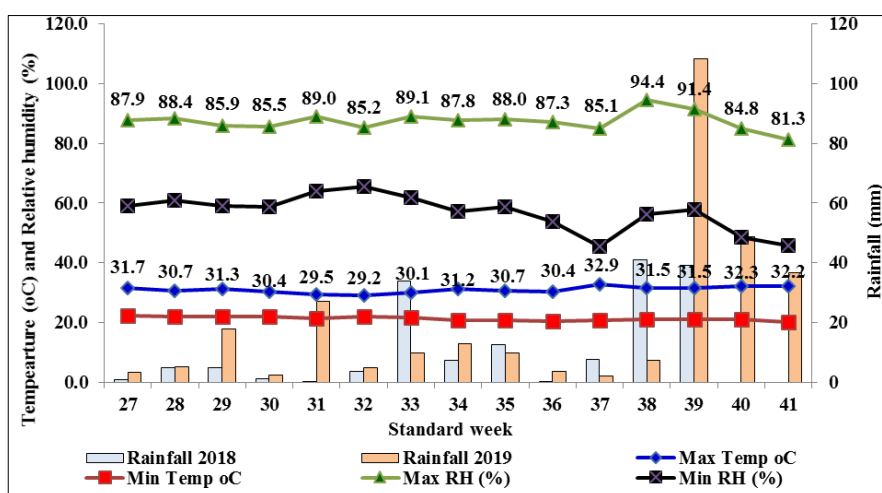

Fig 1: Climatic data during the cropping period (1st week of July to 2nd week of Oct)

Results and Discussion
Growth parameters
The pooled data of two years shows that, pearl millet hybrids VPMH 8 (132.1cm and 3.1), 86M88 (130.7 cm and 3.1) and VPMH 7 (127.9 cm and 3.1) have recorded statistically higher plant height and effective tillers plant[-1], respectively compared to GHB 558. Ear head length and girth was higher in VPMH 8 (30.81 and 38.5 mm, respectively) and VPMH 7 (29.76 cm and 36.9 mm, respectively) compared to 86M88 and GHB 558 (Table 2). Among the nutrient management practices plant height, effective no of tillers plant[-1], ear head length and girth was statistically superior in 150% (131.1 cm, 3.3, 26.56 cm and 36.1 mm, respectively) and 125% RDF compared to 100% RDF (119.8 cm, 2.6, 21.87 cm and 29.9 mm, respectively). Increased availability of nitrogen and phosphorus on poor soil might have increased cell number, cell size leading to better growth in terms of plant height and number of effective tillers plant[-1]. Similar results were reported by Reddy et al. (2016) [15] and Bhuva et al. (2018) [3]. Total dry matter production (TDM) per plant[-1] at harvest was higher in 86M88 (260.1 g) and VPMH 8 (252.3 g) hybrids compared to VPMH 7 and GHB 558. Nitrogen and phosphorus levels at 150% (253.3 g) and 125% (242.6 g) have recorded higher total dry weight plant[-1] compared to 100% RDF. Since, the major nutrients (nitrogen, phosphorus and potassium) are known as important constituents for cell division and cell elongation and their optimum availability led to higher plant growth. Higher availability of nutrients might improve photosynthetic area of plants that cumulatively contribute to higher dry matter accumulation. The results of study are in close agreement with the results reported by Fliessbach et al., 2007 [5], Leifeld et al., 2009 [11] and Joergensen et al., 2010 [10].

Table 2: Effect of different genotypes and fertilizer levels on plant height, tillers plant[-1], ear head length, girth and TDM plant[-1] (Pooled mean of two years, *Kharif* 2018 and 2019)

Treatment details	Plant height (cm)	Total no of tiller plant[-1]	Effective tillers plant[-1]	Ear head length (cm)	Ear head girth (mm)	TDM plant[-1] (g)
Main plot treatments						
M1: VPMH-7	127.9	3.5	3.1	29.76	36.9	248.7
M2: VPMH-8	132.1	3.5	3.1	30.81	38.5	252.3
M3: GHB-558	115.4	3.0	2.7	21.21	30.8	210.1
M4: 86M88	130.7	3.5	3.1	23.08	32.6	260.1
S.Em ±	2.38	0.11	0.13	0.66	0.79	2.09
C.D.(0.05)	7.11	0.30	0.37	1.98	2.35	6.20
Sub plot treatments						
S1: 100% RDF	119.8	2.9	2.6	21.87	29.9	219.5
S2: 125 % RDF	128.7	3.5	3.2	24.56	34.5	242.6
S3: 150 % RDF	131.1	3.7	3.3	26.56	36.1	253.3
S.Em ±	2.40	0.15	0.22	0.71	0.81	2.83
C.D.(0.05)	7.21	0.46	0.67	2.14	2.48	8.50

Yield parameter and yield
Hybrid like 86M88 (34.89 g) has recorded highest seed weight plant[-1] followed by VPMH 8 (33.57 g) and VPMH 7 (32.54 g). GHB 558 has resulted in lowest seed weight plant[-1] (28.78 g). Recommended dose of fertilizers at 150% (34.90 g) has recorded higher seed weight and was on par with 125% RDF. Control plot i.e. 100% RDF has resulted in lower seed weight plant[-1] (27.23 g). Grain and dry fodder yield were higher in 86M88 (2285 and 5210 kg ha^{-1}, respectively) and VPMH 8 (2255 and 4772 kg ha^{-1}, respectively) hybrids (Table 3). GHB 558 has reported lesser grain and dry fodder yield. Among the nutrient levels, 150% RDF has recorded higher grain and dry fodder yield (2367 and 5143 kg ha^{-1}, respectively) and was on par with 125% RDF (2186 and 4931 kg ha^{-1}, respectively). The increased supply of nitrogen and their higher uptake by plants might have stimulated the rate of various physiological processes in plant which led to increased growth and yield parameters and resulted in increased seed and stover yields and a better supply of phosphorus has been associated with prolific root growth resulting in enhanced water, nutrient absorption and higher yield. Similar results were reported by Guggari and Kalaghatagi (2001) [7], Shahin et al. (2013) [16], Ibrahim et al. (2014) [8], Sheoran et al. (2016) [17] and Beerbhadra Tripathi et al. (2020) [2].

Higher gross and net returns were recorded by the 86M88 hybrid (Rs. 34,275.00 and 21,488.00, respectively) compared to GHB 558 (Rs. 24,996.00 and 13,208.00, respectively). VPMH 7 and VPMH 8 were on par with 86M88. B:C ratio was highest in VPMH 8 (2.87). Among the nutrient levels, RDF at 150% has recorded higher gross and net returns (Rs. 35,508.00 and 23,033.00, respectively) and was on par with 125% RDF. Lesser nutrients application level (100% RDF) has resulted in statistically lower gross and net returns (Rs. 25,613.00 and 14,013.00, respectively). B:C ratio was higher at higher nutrient application level i.e. 150% (2.85) and 125% RDF (2.73).

Table 3: Effect of different genotypes and fertilizer levels on yield parameter, yield and economics in pearl millet (Pooled mean of two years, *Kharif* 2018 and 2019)

Treatment details	Seed weight plant^{-1}	Grain yield (kg ha^{-1})	Dry fodder yield (kg ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
Main plot treatments						
M1: VPMH-7	32.54	2142	4464	32,129	20,341	2.72
M2: VPMH-8	33.57	2255	4772	33,820	22,032	2.87
M3: GHB-558	28.78	1666	4331	24,996	13,208	2.11
M4: 86M88	34.89	2285	5210	34,275	21,488	2.67
S.Em ±	0.82	130.46	155.84	1189.8	1189.8	0.19
C.D.(0.05)	2.47	319.23	381.31	3567.9	3567.9	0.52
Sub plot treatments						
S1: 100% RDF	27.23	1708	4008	25,613	14,013	2.21
S2: 125 % RDF	33.23	2186	4931	32,793	20,756	2.73
S3: 150 % RDF	34.90	2367	5143	35,508	23,033	2.85
S.Em ±	0.91	164.69	459.94	1572.3	1572.3	0.15
C.D.(0.05)	2.73	493.73	1378.89	4717.1	4717.1	0.46

Conclusion

The present investigation showed that, under dryland condition application of 125% of recommended dose of fertilizers in pearl millet has improved plant height, no of effective tillers plant^{-1}, total dry matter production plant^{-1}, seed weight plant^{-1} and was useful in achieving higher grain and dry fodder yield. RDF at 125% and 150% were on par. Net returns and B:C ratio were higher in 125% RDF compared to 100% RDF.

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