



# Influence of Different Fertility Levels on Growth and Quality of Pearl millet in Mid Hills of Himachal Pradesh, India

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## 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

The present study was conducted at Shoolini University, Solan during the *kharif* season 2022 to evaluate the influence of Different Fertility Levels on Growth and Quality of Pearl millet in Mid Hills of Himachal Pradesh. The soil of the experimental site was fertile with uniform sandy loam texture, medium in N and K but high in phosphorus availability. The experiment was laid out in RBD comprising of ten treatments (T<sub>1</sub>) Control, (T<sub>2</sub>) 100% RDF, (T<sub>3</sub>) 120% RDF, (T<sub>4</sub>) 50% RDF + FYM @ 10 t ha<sup>-1</sup>, (T<sub>5</sub>) 75% RDF + FYM @ 5 t ha<sup>-1</sup>, (T<sub>6</sub>) 100% RDF + FYM @ 5 t ha<sup>-1</sup>, (T<sub>7</sub>) 50% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup>, (T<sub>8</sub>) 75% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup>, (T<sub>9</sub>) 100% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup> and (T<sub>10</sub>) 75% RDF + FYM @ 5 t ha<sup>-1</sup> + Vermicompost @ 2.5 t ha<sup>-1</sup> and replicated thrice. Pearl millet cultivar PHB-2884 was sown at spacing of 45 × 15 cm with the seed rate of 4 Kg ha<sup>-1</sup>. Plant population, plant height, nitrogen content & uptake and protein yield were recorded significantly higher with application of (T<sub>3</sub>) 120% RDF which was statistically at par

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with (T<sub>9</sub>) 100% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup>, (T<sub>6</sub>) 100% RDF + FYM @ 5 t ha<sup>-1</sup> and (T<sub>2</sub>) 100% RDF. However, least values of these characters were recorded under (T<sub>1</sub>) control treatment. Findings can be concluded as the significantly higher Growth, and quality produce by pearl millet were observed with application of (T<sub>3</sub>) 120% RDF and was at par with (T<sub>2</sub>) 100% RDF, (T<sub>9</sub>) 100% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup> and (T<sub>6</sub>) 100% RDF + FYM @ 5 t ha<sup>-1</sup> over rest of the treatments. Thus, application of (T<sub>3</sub>) 120% RDF was found to be most promising treatment in enhancing the growth and quality of pearl millet.

**Keywords:** Fertility levels; yield; growth; pearl millet.

## 1. INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.), is the world's hardiest warm season cereal crop [1]. It is largely grown for fodder and grain purposes. It is also known as Bajra, Bajri, Sajja, combo or Kambam [2]. "It is an erect annual grass, reaching up to 3 m in height with a profuse root system. Culms are slender, 1-3 cm wide. Leaves are alternate, simple, blade linear, minutely serrated. The inflorescence is a panicle which is 12-30 cm long. The nutritional richness of this crop provides ample opportunity for the creation of value-added goods in new market sectors with a focus on health as due to its higher fiber content and benefits for diabetics and heart patients" [3]. The grain is more nutrient-dense and has a considerable quantity of phosphorus and iron in addition to 11 to 19 per cent protein, 60 to 78 per cent carbs, and 3.0 percent to 4.6 per cent fat [4]. Additionally, it includes more beta-carotene, riboflavin (vitamin B<sub>2</sub>), and niacin (vitamin B<sub>4</sub>). It is an important crop in India and parts of Africa and India ranked first in the world in terms of area (7.55 m ha), production of 9.22 million Tones, productivity (1,374 kg ha<sup>-1</sup>) during 2021-22 [5].

In the Himachal area under pearl millet production is 5 ha and production is 4.5 tons and productivity is 900 kg ha<sup>-1</sup> [5]. "Nitrogen is an important nutrient for the growth and development of plants. It is a very important constituent composed of cellular parts. Numerous additional cellular molecules, including alkaloids, amides, amino acids, proteins, DNA, RNA, enzymes, vitamins, and hormones, include nitrogen as one of its constituent parts. It is the constituent of several enzyme systems which regulate various metabolic reactions in the plant" [6]. "Phosphorus plays key roles in many plant processes such as energy metabolism, the synthesis of nucleic acids and membranes, photosynthesis, respiration, nitrogen fixation and enzyme regulation. Adequate phosphorus nutrition

enhances many aspects of plant growth development including flowering, fruiting, roots growth and yield components of different crops. Phosphorus is essential for all living organisms. Potassium is responsible for opening and closing of stomata and also plays a major role in translocation of nutrients and water throughout the plant parts. Potassium increase the potential and improving the quality of grains" [7]. "Efficiencies of organic manures like vermicompost not only improve or build up soil fertility but also increase the efficiency of chemical fertilizers. Vermicompost is a potent source of both macro and micro nutrients for plants. Additionally, it boosts soil microbial activities and increases the microbiological availability of nitrogen and phosphorus. It has been suggested that vermicompost is an excellent source of organic manure. Farm yard manure refers to the decomposition of farm animals waste such as mixture of dung and urine along with litter and leftover roughage or fodder material fed to the cattle. There is 0.5 per cent N, 0.2 per cent P<sub>2</sub>O<sub>5</sub> and 0.5 per cent K<sub>2</sub>O in the decomposed farmyard manure. It transforms inaccessible soil nutrients into usable form and thus the nutrient requirement can be reduced to medium to high levels of available nutrient status. FYM boost the soil's ability to absorb cations and anions, especially phosphates and nitrates. For the advantage of the current crop as well as following crops, these adsorbed ions are slowly released" [8]. Therefore, in view of the above considerations the present investigation was conducted to study the effect of different fertility levels on growth and productivity of Pearl millet in Mid Hills of Himachal Pradesh.

## 2. MATERIALS AND METHODS

The investigation reported here was carried out during *kharif* season of 2022 at Chamelti Agriculture Farm, Shoolini University, Solan, Himachal Pradesh which is situated 30 km away from Solan city at an elevation of 1,270 meters

above mean sea level lying between latitude 30° 85'67.30 N and longitude 77° 13'20.38E. This region falls under moist sub humid zone of Himachal Pradesh. Climate of this region is generally categorized as sub-humid, sub temperate with cool winters. Generally, December and January months are the coldest while, May and June are the hottest. The average annual rainfall of this is 1039.5 mm. The meteorological data with respect to rainfall, temperature and relative humidity acquired from Automatic Weather Station, Shoolini University of Biotechnology and Management Sciences, Solan.

The experiment was laid out in randomized block design, comprising of ten treatments (T<sub>1</sub>) Control, (T<sub>2</sub>) 100% RDF, (T<sub>3</sub>) 120% RDF, (T<sub>4</sub>) 50% RDF + FYM @ 10 t ha<sup>-1</sup>, (T<sub>5</sub>) 75% RDF + FYM @ 5 t ha<sup>-1</sup>, (T<sub>6</sub>) 100% RDF + FYM @ 5 t ha<sup>-1</sup>, (T<sub>7</sub>) 50% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup>, (T<sub>8</sub>) 75% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup>, (T<sub>9</sub>) 100% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup> and (T<sub>10</sub>) 75% RDF + FYM @ 5 t ha<sup>-1</sup> + Vermicompost @ 2.5 t ha<sup>-1</sup> and replicate thrice. Pearl millet cultivar PHB-2884 was sown at spacing of 45 × 15 cm with the seed rate of 4 Kg ha<sup>-1</sup>. Soil of experimental field was fertile with uniform texture. Soil was medium in N and K but high in phosphorus availability. The initial plant stand was recorded at 20 DAS and final stand at harvest of crop, this was done by counting the number of plants m<sup>-2</sup> area in line sown plot. To record plant height, height of the five tagged plants in net plot was recorded from the base to the tip of the main shoot at 30, 60, 90 DAS and at harvest stage. To record dry matter accumulation, ten plants randomly selected from each plot and were pulled out at 30, 60, 90 DAS and at harvest stage. The plants were washed out and were allowed to sun dried first and finally oven dried at 65° C for 24 hours up to dry and constant weight and recorded accordingly. Nitrogen content (%) in grain was estimated by Micro-kjeldahl method [9] and multiplied by conversion factor *i.e.* 6.25 suggested by A.O.A.C [10] to obtain protein content (%) in grain. Protein yield in grain (kg ha<sup>-1</sup>) was calculated by multiplying the protein content (%) in grain with their respective yields. In order to test the significance of result, standard statistical method based on the analysis of variance technique as suggested by Gomez and Gomez [11] were employed. The treatments differences were compared with the critical difference (CD) at 5% level of significance to ascertain their significance.

### 3. RESULTS AND DISCUSSION

#### 3.1 Growth Parameters

**Plant Population (m<sup>-2</sup>):** Plant population was recorded at 20 DAS and at harvest, the data indicated that numbers of plants per net plot at initial stage and at were found to be non-significant, during the course of investigation where maximum plant population was recorded under (T<sub>3</sub>) and minimum was under (T<sub>1</sub>) control treatments.

**Plant Height (cm):** The data on plant height at different stages of observations under different fertility indicates that irrespective of treatments, height of pearl millet plant increased with the advancement of the crop age. Tallest plants was recorded with application of (T<sub>3</sub>) 120% RDF at 30 DAS which was statistically at par with application of (T<sub>9</sub>) 100% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup>, (T<sub>6</sub>) 100% RDF + FYM @ 5 t ha<sup>-1</sup> and (T<sub>2</sub>) 100% RDF. Moreover, treatments (T<sub>10</sub>), (T<sub>8</sub>) and (T<sub>5</sub>) were found statistically at par with (T<sub>2</sub>) 100% RDF. Similar trend was observed at 60, 90 DAS and at harvest. However, the lowest plant height was recorded under control treatment. It might be due to the positive effect of nutrients on plant height throughout the crop growth period. "Nitrogen has essential functions in plant life *viz.*, its role in rapid multiplication and expansion of plant cells and increase in amount of growth substances such as naturally occurring Phytohormones, photosynthesis rate and increase level of auxin supply, Phosphorus stimulates root development and increase stalk and stem strength and potassium regulates the opening and closing of stomata and also plays a major role in the regulation of water and nutrients in plants, with higher level of nitrogen, phosphorus and potassium might have brought about a significant increase in plant height. It was also reported that increase in plant height with nitrogen fertilizer was due to the fact that nitrogen promotes number of internodes and increase length of the internodes which results in progressive increase in plant height" Kumawat et al. [12]; Kumar et al. [13] and Khinchi et al. [6].

**Dry matter accumulation (g m<sup>-2</sup>):** Application of 120% RDF resulted in significantly higher dry matter accumulation was statistically at par with application of (T<sub>9</sub>) 100% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup>, (T<sub>6</sub>) 100% RDF + FYM @ 5 t ha<sup>-1</sup> and (T<sub>2</sub>) 100% RDF. Moreover, treatments (T<sub>10</sub>), (T<sub>8</sub>) and (T<sub>5</sub>) were found statistically at par with (T<sub>2</sub>)

100% RDF. Similar trend was observed at 60, 90 DAS and at harvest. However, the lowest dry matter accumulation was recorded under control treatment during the course of study.

**Table 1. Plant population (m<sup>-2</sup>) of pearl millet as influenced by different fertility levels**

Treatments	Plant population (m <sup>-2</sup> )	
	20 DAS	At harvest
T <sub>1</sub> : Control	14.51	14.16
T <sub>2</sub> : 100% RDF	14.69	14.34
T <sub>3</sub> : 120% RDF	14.73	14.38
T <sub>4</sub> : 50% RDF + FYM (10 t ha <sup>-1</sup> )	14.52	14.17
T <sub>5</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> )	14.57	14.22
T <sub>6</sub> : 100% RDF + FYM (5 t ha <sup>-1</sup> )	14.69	14.35
T <sub>7</sub> : 50% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	14.56	14.21
T <sub>8</sub> : 75% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	14.59	14.25
T <sub>9</sub> : 100% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	14.70	14.36
T <sub>10</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> ) + Vermicompost (2.5 t ha <sup>-1</sup> )	14.63	14.28
SEm (±)	0.05	0.05
CD (p=0.5)	NS	NS

**Table 2. Plant height (cm) of pearl millet as influenced by different fertility levels at periodic intervals**

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
T <sub>1</sub> : Control	30.47	84.60	180.82	181.63
T <sub>2</sub> : 100% RDF	41.80	129.67	209.70	216.90
T <sub>3</sub> : 120% RDF	44.50	136.86	223.18	226.00
T <sub>4</sub> : 50% RDF + FYM (10 t ha <sup>-1</sup> )	37.51	119.79	191.47	196.45
T <sub>5</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> )	38.42	123.52	198.56	201.90
T <sub>6</sub> : 100% RDF + FYM (5 t ha <sup>-1</sup> )	43.97	134.30	219.21	220.25
T <sub>7</sub> : 50% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	39.17	121.10	195.42	198.69
T <sub>8</sub> : 75% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	38.78	123.60	200.80	202.39
T <sub>9</sub> : 100% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	43.98	134.49	221.99	223.20
T <sub>10</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> ) + Vermicompost (2.5 t ha <sup>-1</sup> )	39.37	124.36	201.88	203.90
SEm (±)	1.38	3.51	6.83	7.03
CD (p=0.5)	4.11	10.42	20.29	20.91

**Table 3. Dry matter accumulation (g m<sup>-2</sup>) of pearl millet as influenced by different fertility levels at periodic intervals**

Treatments	Dry matter accumulation (g m <sup>-2</sup> )			
	30 DAS	60 DAS	90 DAS	At harvest
T <sub>1</sub> : Control	27.54	173.82	259.50	288.10
T <sub>2</sub> : 100% RDF	61.08	282.20	455.30	510.56
T <sub>3</sub> : 120% RDF	70.00	308.28	515.60	579.18
T <sub>4</sub> : 50% RDF + FYM (10 t ha <sup>-1</sup> )	35.86	210.76	310.10	345.50
T <sub>5</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> )	56.51	253.23	425.73	478.61
T <sub>6</sub> : 100% RDF + FYM (5 t ha <sup>-1</sup> )	66.58	297.54	492.14	550.15
T <sub>7</sub> : 50% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	39.87	212.60	337.78	373.24
T <sub>8</sub> : 75% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	57.67	256.65	426.26	479.95
T <sub>9</sub> : 100% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	68.50	304.21	508.50	571.10
T <sub>10</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> ) + Vermicompost (2.5 t ha <sup>-1</sup> )	58.68	261.85	431.90	483.72
SEm (±)	3.01	8.78	10.75	13.11
CD (p=0.5)	8.95	26.10	31.95	38.95

**Table 4. Nitrogen content (%) and their uptake (kg ha<sup>-1</sup>) of pearl millet as influenced by different fertility levels**

Treatments	Nitrogen content (%)		Nitrogen uptake (kg ha <sup>-1</sup> )		
	Grain	Stover	Grain	Stover	Total
T <sub>1</sub> : Control	1.43	0.99	8.88	30.44	39.32
T <sub>2</sub> : 100% RDF	2.03	1.28	31.20	66.54	97.74
T <sub>3</sub> : 120% RDF	2.08	1.32	35.20	71.40	106.60
T <sub>4</sub> : 50% RDF + FYM (10 t ha <sup>-1</sup> )	1.77	1.02	16.28	38.69	54.98
T <sub>5</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> )	1.98	1.23	26.52	61.53	88.05
T <sub>6</sub> : 100% RDF + FYM (5 t ha <sup>-1</sup> )	2.04	1.29	32.75	68.55	101.30
T <sub>7</sub> : 50% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	1.84	1.05	18.37	42.80	61.17
T <sub>8</sub> : 75% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	1.99	1.24	26.96	61.81	88.76
T <sub>9</sub> : 100% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	2.06	1.31	33.45	70.30	103.75
T <sub>10</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> ) + Vermicompost (2.5 t ha <sup>-1</sup> )	2.00	1.25	27.71	61.82	89.54
SEm (±)	0.02	0.01	1.35	2.35	3.12
CD (p=0.5)	0.07	0.05	4.02	7.01	9.29

**Table 5. Qualitative characters of pearl millet as influenced by different fertility levels**

Treatments	Qualitative characters	
	Protein content (%)	Protein yield (kg ha <sup>-1</sup> )
T <sub>1</sub> : Control	8.92	55.50
T <sub>2</sub> : 100% RDF	12.69	195.01
T <sub>3</sub> : 120% RDF	13.00	220.00
T <sub>4</sub> : 50% RDF + FYM (10 t ha <sup>-1</sup> )	11.06	101.78
T <sub>5</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> )	12.38	165.74
T <sub>6</sub> : 100% RDF + FYM (5 t ha <sup>-1</sup> )	12.75	204.68
T <sub>7</sub> : 50% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	11.50	114.81
T <sub>8</sub> : 75% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	12.44	168.47
T <sub>9</sub> : 100% RDF + Vermicompost (2.5 t ha <sup>-1</sup> )	12.85	209.06
T <sub>10</sub> : 75% RDF + FYM (5 t ha <sup>-1</sup> ) + Vermicompost (2.5 t ha <sup>-1</sup> )	12.50	173.21
SEm (±)	0.15	8.45
CD (p=0.5)	0.46	25.13

Nitrogen, phosphorus and potassium might have helped the crop for maximum utilization of available nutrients which enhanced the vegetative growth of pearl millet leading to maximum utilization of solar radiation contributing to the higher rate of photosynthesis which had favourable influence on higher accumulation of photosynthates and finally dry matter accumulation. The results are in close conformity with the findings of Ayub et al. [14] and Ganapati and Guggari [15] who reported that, forage and dry matter yields of pearl millet were increased significantly with each increased rate of nitrogen.

### 3.2 Qualitative Characters

**Nutrient Content (%) and their Uptake (kg ha<sup>-1</sup>):** Nitrogen content in grain and stover were affected significantly by various fertility levels.

Application of (T<sub>3</sub>) treatment 120% RDF gained maximum nitrogen content in grain (2.08%) and stover (1.32%) which was statistically at par with treatment T<sub>9</sub>, T<sub>6</sub> and T<sub>2</sub>. However, the lowest nitrogen content in grain and straw (1.43 and 0.99%, respectively) was recorded with control treatment (T<sub>1</sub>). Nitrogen content in grain and stover were affected significantly by various fertility levels. Application of (T<sub>3</sub>) treatment 120% RDF gained maximum nitrogen content in grain (2.08%) and stover (1.32%) which was statistically at par with treatment (T<sub>9</sub>), (T<sub>6</sub>) and (T<sub>2</sub>). However, the lowest nitrogen content in grain and straw (1.43 and 0.99%, respectively) was recorded with control treatment (T<sub>1</sub>). "This could be due to the fact that the nitrogen fertilization increases the cation exchange capacity of plant roots and makes them more efficient to absorb the nutrients and exert favorable effects of nitrogen on growth

parameters and yield attributes, which resulted in higher grain and stover yields and consequently more nitrogen uptake by the crop. Also, application of higher dose of Nitrogen and Phosphorus is responsible for better root and shoots development, which in turn increased potash uptake". Chaudhary and Gautam (2007); Rao et al. (2007); Choudhary and Prabhu (2014); and Khinchi et al. [6].

**Protein Content (%) and Protein Yield (kg ha<sup>-2</sup>):** Protein content in grain and protein yield was influenced by different fertility levels during both the year of study. Highest protein content in grain (13%) and protein yield was recorded with the application of (T<sub>3</sub>) 120% RDF and it was found statistically at par with (T<sub>9</sub>), (T<sub>6</sub>) and (T<sub>2</sub>). However, the control treatment recorded lowest value of protein content in grain (8.92%) and protein yield. Protein content in grain and protein yield was influenced by different fertility levels, higher protein content in grain (13%) was recorded with the application of (T<sub>3</sub>) 120% RDF and was statistically at par with (T<sub>2</sub>) 100% RDF. Higher protein yield (220 Kg ha<sup>-1</sup>) was recorded with the application of (T<sub>3</sub>) 120% RDF and was statistically at par with (T<sub>9</sub>) 100% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup>. However, the control treatment recorded lowest value of protein content in grain (8.92%) and protein yield (55.50 Kg ha<sup>-1</sup>). Nitrogen had positive effect on protein content of grain. "Nitrogen is an important constituent of protein, which always gives a marked promoting influence on protein synthesis by way of promoting synthesis of amino acid, which are constituent building blocks of protein" Ayub et al. [16]; Rathore et al. [17] Jadhav et al. [18] and Prasad et al. [19-29].

#### 4. CONCLUSION

The following conclusion may be formed on the basis of findings of the current investigation. The best treatment in the field experiment was (T<sub>3</sub>) 120% RDF that produced the best results in terms of plant growth parameters [plant height and dry matter accumulation (at 30, 60, 90 and at harvest)] and quality produced (Protein content and protein yield) which was found at par with (T<sub>2</sub>) 100% RDF, (T<sub>9</sub>) 100% RDF + Vermicompost @ 2.5 t ha<sup>-1</sup> and (T<sub>6</sub>) 100% RDF + FYM @ 5 t ha<sup>-1</sup> over rest of the treatments.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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