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# Effect of Soil and Foliar Applications on Growth and Productivity of Pearl Millet (*Pennisetum glaucum* L.)

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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 field experiment was conducted during the *Rabi* season (Nov - Jan) of 2023-2024 in the experimental farm of Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu, India. To study "Effect of soil and foliar applications on growth and productivity of Pearl Millet (*Pennisetum glaucum* L)." Factorial Randomized Block Design was used with two factors and 3 replications. The treatment combination consists of 10 treatments *viz*., $T_1$- 100 percent RDF+ Nano-DAP, $T_2$ - 100 percent RDF + Nano-Urea foliar sprays at 30 and 45 DAS, $T_3$ – 100 percent RDF + FYM at 10 t $ha^{-1}$ + Nano-DAP foliar sprays at 30 and 45 DAS, $T_4$ – 100 percent RDF + FYM at 10 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS, $T_5$ – 100 percent RDF + VC at 5 t $ha^{-1}$ + Nano-DAP foliar sprays at

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30 and 45 DAS, $T_6$ - 100 percent RDF + VC at 5 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS, $T_7$ – 75 percent RDF + FYM at 10 t $ha^{-1}$ + Nano-DAP foliar sprays at 30 and 45 DAS, $T_8$ - 75 percent RDF + FYM at 10 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS, $T_9$ - 75 percent RDF + VC at 5 t $ha^{-1}$ + Nano-DAP foliar sprays at 30 and 45 DAS, $T_{10}$- 75 percent RDF + VC at 5 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS.The results indicated that the application of 75 percent RDF + Vermicompost at 5 t $ha^{-1}$ + Nano-Urea increased the growth parameters (plant height and Leaf Area Index), physiological parameters (Crop Growth Rate and Chlorophyll Index) and yield (grain and stover yield) of pearl millet.

*Keywords: Pearl millet; vermicompost; nano-urea; nano- DAP; crop growth rate; SPAD; leaf area index.*

## 1. INTRODUCTION

Pearl millet is India's fifth most important multipurpose grain next to rice, wheat, maize and sorghum, and is a staple diet for millions of people in dry land areas. More than 95percent of bajra production is used as food and rest is being used as cattle feed and other uses (seed, bakery products and snacks etc.). Pearl millet outperforms all other cereals, allowing it to survive even at a temperature as high as 42°C during the reproductive stage and making it a climate-resilient crop. Pearl millet is also referred as bajra, bulrush millet, spiked millet and poor man's crop. Because the grain is used for human consumption and the fodder is used for livestock feeding, and it is proved to be an important component of the agricultural and animal husbandry-dominated rural economy of India's dryland areas [1]. Farmers are using excess and imbalance chemical fertilizer, which leads to nutrient deficiency other than applied and declined organic carbon levels [2]. At present nutrient mining is a major threat to agricultural productivity as there is a wide gap between the quantum of nutrient applied and nutrient utilized by crop, one of the major reasons for lower production is blanket use of fertilizers by the farmers and improper nutrient management.

The basic concept determining the principles of integrated nutrient management (INM) is the maintenance and improvement of sustaining crop productivity on long term basis. This may be achieved through combined use of all possible sources of nutrients and their scientific management for optimum growth, yield and quality of different crops and cropping systems. But the appropriate combination of different sources of nutrients varies according to the system; land use, ecological, social and economic condition at the local level. The application of nitrogen helps in better vegetative growth of plants, phosphorous is used for better proliferation, which extracts moisture from the deep layers of the soil, particularly during moisture stress conditions. Potassium increases the potential and improving the quality of grains. The gap created between the removal and addition of nutrient will not be bridged by fertilizer alone. This can be achieved by integrated nutrient management. The soil physical properties can be improved by FYM application. Vermicompost is a rich mixture of macro and micro plant nutrients which increases microbial availability of nitrogen and phosphorus and improves microbial action in the soil. It improves not only the soil fertility but also increases efficiency of chemical fertilizer. The soil application of nutrient in the form of chemical fertilizer might be subjected to various losses like fixation, leaching and volatilization, etc. The foliar application of fertilizers reduces the usage as compared to soil application. Nitrogen is the most limiting macro-nutrient that determines the crop productivity. Phosphorus (P) is also a limiting macronutrient that regulates plant growth and development. The reduced particle size and increased specific surface area makes Nano-DAP physically more available than chemical DAP, and is preferred for agricultural sustainability [3].

In most of the Indian soils, Nitrogen is lacking which is the most important constituent for plant growth. Nitrogen application is important for synthesis of proteins, nucleic acids, growth hormones. Foliar application of Nano-Urea is a well-known technique to reduce acute deficiency at any crop growth stage [4]. The application of 500 ml of Nano-Urea is equal to 45 kg of urea, which can reduce the import of urea [5]. The Nano-Urea application can be used as an alternative for urea granules. Hence, it helps in better utilization of nitrogen and reduce the chemical residue in soil. Therefore, the present research has been undertaken to evaluate the effects of soil and foliar application on growth and yield of pearl millet.

## 2. MATERIALS AND METHODS

In the *Rabi* season (Nov - Jan) of 2023-2024, field study utilizing pearl millet was carried out at the Karunya Institute of Technology and Sciences' instructional farm in the northern region of Coimbatore, Tamil Nadu, India. The experimental site's geographic coordinates are 10◦56'N latitude, 76◦44'E longitude, and 474 m above sea level. (At 474 meters above mean sea level; latitude 10056' N, longitude 76044' E). *Rabi* 2023–2024 saw 91 rainy days with a total rainfall of 58.2 mm during the growth period. At the experimental site, the soil (0–15 cm) had a clay loam texture, pH 8.42, EC 0.52 dS $m^{-1}$, organic carbon 1.78percent, and accessible N, P, and K 305.2, 16.9, and 42.56 kg $ha^{-1}$, in that order. The study area is located in Tamil Nadu's Western Agro-Climatic Zone. The experiment was conducted using Factorial Randomised Block Design with 3 replications and 10 treatments. The treatment combinations were, $T_1$ - 100 percent RDF + Nano-DAP foliar sprays at 30 and 45 DAS, $T_2$ - 100 percent RDF + Nano-Urea foliar sprays at 30 and 45 DAS, $T_3$ – 100 percent RDF + FYM at 10 t $ha^{-1}$ + Nano-DAP foliar sprays at 30 and 45 DAS, $T_4$ – 100 percent RDF + FYM at 10 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS, $T_5$ – 100 percent RDF + VC at 5 t $ha^{-1}$ + Nano-DAP foliar sprays at 30 and 45 DAS, $T_6$ - 100 percent RDF + VC at 5 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS, $T_7$ – 75 percent RDF + FYM at 10 t $ha^{-1}$ + Nano-DAP foliar sprays at 30 and 45 DAS, $T_8$ - 75 percent RDF + FYM at 10 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS, $T_9$ - 75 percent RDF + VC at 5 t $ha^{-1}$ + Nano-DAP foliar sprays at 30 and 45 DAS, $T_{10}$- 75 percent RDF + VC at 5 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS. Three divided doses of nitrogen were administered at 0, 15, and 30 DAS. Every time a significant result from the "F" test was obtained at the five percent level, critical difference (CD) values were computed.

## 3. RESULTS AND DISCUSSION

### 3.1 Growth Attributes

#### 3.1.1 Plant height

The maximum plant height was recorded under the application of 75 percent RDF + VC at 5 t $ha^{-1}$ + Nano-Urea at 45 and 60 DAS than all the other treatments. The data (Table 1) showed that the application of 75 percent RDF + VC at 5 t $ha^{-1}$ + Nano-Urea foliar ($T_{10}$) sprays at 30 and 45 DAS increased the plant height by 139.78 and 146.43 cm, on $45^{th}$ and $60^{th}$ DAS. The lowest plant height was recorded under 100 percent RDF + Nano-DAP ($T_1$). The application of Nano fertilizers was easily absorbed by the leaf epidermis and moved to the stems, where they promoted the uptake of active molecules and improved growth in little millet Rajput et al. [6]. Amino acids, proteins, vitamins, hormones, and enzymes all are based on nitrogen, which impact cell division and growth of plant Udapudi et al. [7]. According to Abdel-Aziz et al. [8], Nano fertilizers promote the uptake of active molecules and improve the growth attributes. Similar findings were reported by Khan et al. [4].

#### 3.1.2 Leaf area index

The application of $T_{10}$- 75 percent RDF + VC at 5 t $ha^{-1}$ + Nano-Urea foliar sprays at 30 and 45 DAS increased the leaf area index by 3.57 and 4.34 at 45 and 60 DAS in pearl millet (Table 1). This was due to the direct application of nitrogen to the leaves which made a significant impact on cell multiplication, cell expansion and cell metabolism which increased the number of leaves Jadav et al. [9]. The lowest leaf area index of 2.8 and 3.4 at 45 and 60 DAS was recorded under 100 percent RDF +Nano-DAP ($T_1$).

### 3.2 Physiological Attributes

#### 3.2.1 Crop growth rate

The data showed that the treatment ($T_{10}$) shows higher Crop Growth Rate of 5.98 $g^{-1}m^2$ $d^{-1}$up to 60 DAS afterwards it got declined (Table 1). The lowest crop growth rate was recorded under 100 percent RDF +Nano-DAP ($T_1$). Application of nano- fertilizers increased the plant height, leaf area, no. of leaves $plant^{-1}$, dry matter production, chlorophyll content, photosynthetic rate which induces the transformation of photosynthetic materials to various parts of the plant. This increased the Crop Growth Rate of the plant Rajput et al. [6].

#### 3.2.2 Chlorophyll index

The chlorophyll Index was recorded at various stages of crop growth 45 and 60 DAS across various fertilizer treatments (Table 1). The treatment combination of 75 percent RDF +

**Table 1. Effect of soil and foliar applications on growth, physiological attributes and yield of pearl millet**

| | | Plant height (cm) | | Leaf area index (LAI) | | Chlorophyll index | | CGR ($g^{-1}m^2 d^{-1}$) | Yield | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Treatment** | **45 DAS** | **60 DAS** | **45 DAS** | **60 DAS** | **45 DAS** | **60 DAS** | **45 - 60 DAS** | **Grain yield ($q ha^{-1}$)** | **Stover yield ($q ha^{-1}$)** |
| **A.** | **Soil Application** | | | | | | | | | |
| S1 | 100 percent RDF | 80.02 | 80.99 | 2.04 | 2.51 | 29.42 | 31.23 | 3.90 | 16.03 | 45.02 |
| S2 | 100 percent RDF + FYM at 10 t $ha^{-1}$ | 80.6 | 82.35 | 2.07 | 2.55 | 29.48 | 31.64 | 3.92 | 16.43 | 45.68 |
| S3 | 100 percent RDF + VC at 5 t $ha^{-1}$ | 81.36 | 83.59 | 2.08 | 2.59 | 29.58 | 31.85 | 3.96 | 16.68 | 45.97 |
| S4 | 75 percent RDF + FYM at 10 t $ha^{-1}$ | 82.88 | 85.17 | 2.11 | 2.59 | 29.66 | 32.10 | 3.98 | 16.76 | 46.59 |
| S5 | 75 percent RDF + VC at 5 t $ha^{-1}$ | 85.69 | 89.24 | 2.17 | 2.66 | 30.31 | 33.05 | 4.05 | 17.69 | 48.12 |
| | S.E (d) ± | 1.54 | 1.33 | 0.04 | 0.04 | 0.26 | 0.31 | 0.05 | 51.54 | 92.49 |
| | **CD at 5percent** | **3.24** | **2.8** | **0.08** | **0.07** | **0.55** | **0.65** | **0.11** | **108.29** | **194.32** |
| **B.** | **Foliar Application** | | | | | | | | | |
| F1 | Nano- DAP | 115.59 | 116.21 | 2.9 | 3.59 | 41.92 | 45.15 | 5.53 | 22.97 | 65.71 |
| F2 | Nano- Urea | 130.74 | 136.6 | 3.38 | 4.15 | 47.15 | 50.78 | 6.36 | 27.17 | 73.11 |
| | S.E.(d) ± | 1.54 | 1.33 | 0.04 | 0.04 | 0.26 | 0.31 | 0.05 | 51.54 | 92.49 |
| | **CD at 5percent** | **3.24** | **2.8** | **0.08** | **0.07** | **0.55** | **0.65** | **0.11** | **108.29** | **194.32** |
| **C.** | **Interaction (A×B)** | | | | | | | | | |
| | S.E. ± | 2.18 | 1.89 | 0.05 | 0.05 | 0.37 | 0.44 | 0.07 | 72.89 | 130.81 |
| | **CD at 5percent** | **4.58** | **3.96** | **0.11** | **0.10** | **0.78** | **0.92** | **0.16** | **153.14** | **274.81** |

Vermicompost at 5 t $ha^{-1}$ + Nano-Urea showed the higher chlorophyll index of 48.70 and 53.2 at 45 and 60 DAS. The higher amount of nitrogen was supplied to pearl millet through Nano-Urea which resulted in higher amount of chlorophyll content in plants Benzon et al. [10]. The Nano-Urea has larger surface area and the particle size is less than the pores of root and leaves of plant which increased the quick absorption of nutrients and led to the increased rate of photosynthesis in pearl millet Sharma et al. [11]. The Nano-Urea increased the plant metabolic activities such as chlorophyll synthesis and photosynthetic activity Sudha et al. [12]. The vermicompost enhanced the availability of nitrogen in soil which led to higher photosynthetic rate of the plants through slow mineralization. The vermicompost contains higher amount of Nitrogen, Phosphorous and Potassium Thakare and Wake [13]. The combined application of RDF, Vermicompost and Nano-Urea increased the chlorophyll index in pearl millet. Similar results were found by Rundan et al. [14]. The lowest Chlorophyll index of 41.6 and 44.14 at 45 and 60 DAS was recorded under 100 percent RDF +Nano-DAP ($T_1$).

## 3.3 Yield

### 3.3.1 Grain yield

The treatment combination of 75 percent RDF + Vermicompost at 5 t $ha^{-1}$ + Nano-Urea showed the higher grain yield of 29.75 q $ha^{-1}$. The lowest grain yield was recorded under 100 percent RDF +Nano-DAP ($T_1$- 22.46 q $ha^{-1}$) (Table 1). The increased yield was due to the higher accumulation of photosynthates which were transferred to the economic parts of pearl millet Arya et al. [15]. The similar increase in yield was noted in little millet due to the application of Nano-Urea Chavan et al. [16]. Increased productivity was due to the Nano-Urea application by increasing the absorption in little millet Rajput et al. [6]. Similar findings were reported by Khan et al. [4].

### 3.3.2 Stover yield

The treatment combination of 75 percent RDF + Vermicompost @ 5 t $ha^{-1}$ + Nano-Urea showed the higher stover yield of 77.71 q $ha^{-1}$ (Table 1). The lowest stover yield of 65.11 q $ha^{-1}$was recorded under 100 percent RDF +Nano-DAP ($T_1$). The Nano-Urea was easily absorbed and rapidly translocated which caused the higher photosynthetic rate and higher dry matter production which leads to increased stover yield Arya et al. [15]. The increased stover yield was due to the efficient nitrogen utilization in finger millet Samanta et al. [17]. The application of Nano-Urea increased the growth parameters which led to increased stover yield of pearl millet Khan et al. [4,18].

## 4. CONCLUSION

Based on the above findings, the application of 75 percent RDF + VC at 5 t ha-1 + Nano- Urea sprays at 30 and 45 DAS significantly improved the growth, physiological and yield attributes of pearl millet than the other treatments. It was found that the application of Nano-Urea along with RDF and vermicompost had positive effect on growth and productivity of pearl millet. This treatment can be recommended to farmers to reduce the usage of granular urea in soil. These findings are based on the one season crop; further research findings should be done under this field of study.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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