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## Effect of nano-fertilizers and spacing on growth and yield of pearl millet (*Pennisetum glaucum* L.)

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**Abstract**

A field experiment was conducted during *Kharif* season of 2025 at Crop Research Farm (CRF), of Agronomy, SHUATS, Prayagraj (U.P.) to investigate the “Effect of Nano- fertilizers and Spacing on Growth and Yield of Pearl millet (*Pennisetum glaucum* L.).” The experiment was laid out in Randomized Block Design with 10 treatments replicated thrice. The experiment consists of 3 different sources of Nano-fertilizer viz. Nano urea 4%, Nano DAP 4%, and Nano urea 4% + Nano DAP 4%, and different plant spacing viz. 25 cm×20 cm, 35 cm×15 cm, and 45 cm × 10 cm. The results revealed that growth parameters were significantly influenced by treatments. Application of nano urea 4% with spacing of 25 cm × 20 cm recorded significantly highest plant height (213.4 cm), dry weight (84.05 g/plant). The treatment nano urea 4% + 25 cm × 20 cm spacing recorded significantly maximum ear head length (31.3 cm), girth (5.5 cm), ear head weight (31.7 g), and number of grains per ear head (2346.27). Consequently, this treatment also produced significantly highest grain yield (2.31 t/ha), stover yield (5.31 t/ha), and test weight (12.33 g). Economic analysis indicated that the highest gross return (INR. 116,658.33/ha), net return (INR. 85,708.33/ha), and B:C ratio (2.77) were obtained with nano urea 4% applied at 25 cm × 20 cm spacing, demonstrating its economic viability over other treatments and the control.

**Keywords:** Pearl millet, Nano-fertilizers, Nano urea, crop growth rate, yield attributes.

**Introduction**

Pearl millet stands as the predominant staple crop cultivated by numerous impoverished and small-scale landowners in Asia and Africa. Additionally, it serves as a source of feed and fodder for livestock. This crop represents nearly fifty percent of the worldwide millet output. Pearl millet ranks as the sixth most significant cereal crop globally, following maize, rice, wheat, barley, and sorghum. The nutritional composition of pearl millet is quite favorable when assessed alongside other cereals and millets. It boasts a high level of protein with a marginally enhanced amino acid profile. The grain of pearl millet comprises 13-14 percent protein, 5-6 percent fat, 74 percent carbohydrate, and 1-2 percent minerals. Additionally, it contains greater quantities of carotene, riboflavin (Vitamin B2), and niacin (Vitamin B4).

It encompasses an area of 70. 08 lakh hectares, yielding an average output of 95. 31 lakh tonnes and a productivity rate of 1360 kg/ha in India for the year 2023-24 (Anon., 2023a) <sup>[1]</sup>. The primary states cultivating pearl millet include Rajasthan, Maharashtra, Uttar Pradesh, Gujarat, and Haryana, which collectively account for 90% of the national production.

Nano fertilizers comprise nanomaterials, which are characterized as substances with dimensions ranging from 1 to 100 nm in at least one direction. Their higher surface area to volume ratio significantly enhances their availability and absorption. Moreover, they exhibit dynamic physical and chemical properties compared to traditional fertilizers. The inaugural “Nano Urea” was launched by IFFCO in the year 2021-22. The dimensions of a single urea nanoparticle are approximately 55,000 times smaller than those of a typical urea granule. Nano urea contains 4. 0% total nitrogen (w/v) and these particles are uniformly suspended in water. Due to their diminutive size (20-50 nm) and elevated utilization efficiency (greater than 80%), when applied to plant leaves (2-4 ml/liter) during critical growth phases, nano urea enhances the immediate availability of nutrients to the developing plant tissues, promotes chlorophyll synthesis, increases the rate of photosynthesis, augments dry matter production, and consequently fosters the overall growth of plants. Nano urea particles (30-40 nm) can seamlessly infiltrate stomata and easily enter through plasmodesmata (40 nm),

subsequently participating in metabolic processes by associating with various carrier proteins. The unused nitrogen is sequestered within the plant vacuole and released gradually to support optimal plant growth and development. (Anon., 2023b) [2].

Nano DAP, developed by IFFCO's Nano Biotechnology Research Centre in Gujarat, presents an innovative method for nutrient delivery (Kantwa and Yadav, 2022) [5]. This formulation contains 8 percent nitrogen and 16 percent phosphorus, offering an effective remedy for soil nutrient deficiencies. The application of nanotechnology in fertilizers facilitates improved nutrient absorption, thereby fostering more sustainable and productive agricultural practices. The primary objective of utilizing fertilizers in agriculture is to provide essential macro and micronutrients that are frequently deficient in the soil. Fertilizers account for approximately 35 to 40 percent of agricultural productivity; however, some can have a direct effect on plant growth. (Kantwa and Yadav, 2022) [5].

Crop spacing serves as a critical element influencing agricultural output. An appropriate crop geometry will augment production by facilitating the optimal use of nutrients and moisture, both from subterranean sources and from the crop canopy above, via the absorption of photo synthetically active radiation (PAR), ultimately leading to the generation of a greater quantity of photosynthates. In terms of yielding increased straw and grain, wider spacing proves to be more effective than narrower spacing. Additionally, the correct crop geometry can guarantee heightened productivity, a decrease in seed rate, and a healthier crop stand in the field (Minz *et al.*, 2021) [6].

Consequently, it is imperative to enhance fertility management alongside the ideal plant density of contemporary hybrids to ensure sustainable productivity (Rana *et al.*, 2009) [9]. In addition to enhancing planting densities, the utilization of irrigation and nitrogen fertilizers can assist smallholder farmers in generating greater quantities of grain and fodder for their households and livestock in regions where families practice subsistence agriculture. The yield of grain and biomass in pearl millet is limited by insufficient plant population densities as well as nutrient and water stress, which adversely affect radiation and water use efficiencies.

## Materials and Methods

The experiment was laid out during *Kharif* season of 2025 at Crop Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). The crop research farm is located at 25.570° N latitude, 87.190° E longitude, and 98 m altitude above mean sea level (MSL). This area is situated on the right side of river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj (U.P) city. The soil of experimental field was sandy loam in texture with 7.2 soil pH.

The experiment was laid out in Randomized Block Design (RBD) with 10 treatments replicated three times. The experiment consists of 3 different sources of Nano-fertilizer viz. Nano urea 4%, Nano DAP 4%, and Nano urea 4% + Nano DAP 4%, and different plant spacing viz. 25 cm×20 cm, 35 cm×15 cm, and 45 cm × 10 cm. The treatment combinations are, Nano urea 4% + 25 cm×20 cm, T2 (Nano urea 4% + 35 cm×15 cm), T3 (Nano urea 4% + 45 cm×10 cm), T4 (Nano DAP 4% + 25 cm×20 cm), T5 (Nano DAP 4% + 35 cm×15 cm), T6 (Nano DAP 4% + 45 cm×10 cm),

T7 (Nano Urea 4% + Nano DAP 4% + 25 cm×20 cm), T8 (Nano Urea 4% + Nano DAP 4% + 35 cm×15 cm), T9 (Nano Urea 4% + Nano DAP 4% + 45 cm×10 cm), T10 (80 - 40 - 40 kg/ha N-P-K (Control)). Before sowing, the field was ploughed with harrow and rotavator. Adequate amount of fertilizers were applied during sowing, proper seed rate was followed. The seed was sown in line and covered with the soil. After sowing proper moisture, weed management was managed. Pre harvest observations such as plant height, dry weight were recorded properly at given time intervals. After harvesting the post-harvest observations such as ear head length, ear head girth, weight of ear head, number of grains per ear head, weight of grains per ear head, test weight, grain yield stover yield were recorded properly and statistical analysis performed.

## Result and Discussion

### 1. Growth Parameters

#### 1.1 Plant Height

At 100 DAS, significantly maximum plant height 213.4 cm was recorded in treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 210.7 cm and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 208.2 cm was recorded statistically at par with treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest plant height 180.3 cm was recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control).

The superior plant height under Nano Urea treatments could be attributed to enhanced nitrogen availability, improved chlorophyll synthesis, and increased cell division and elongation. Efficient nitrogen utilization promotes vigorous vegetative growth and greater canopy development. Similar findings were reported by Arya *et al.* (2022) [3] and Sharma *et al.* (2022) [10], who observed significantly greater plant height in pearl millet under nano-nitrogen fertilization compared to conventional fertilizer application.

#### 1.2 Plant Dry Weight (g)

At harvest 100 DAS, significantly maximum dry weight 84.05 g was recorded in Treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 83.37 g and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 81.30 g, was recorded statistically at par with treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest dry weight 63.07 g was recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control).

Higher dry matter accumulation under Nano Urea treatments may be due to increased photosynthetic activity, better nutrient uptake, and enhanced assimilate production. Improved nitrogen availability throughout the crop growth period results in greater biomass accumulation. These findings corroborate the results of Meena *et al.* (2024) [8], who reported significant increases in dry matter production of pearl millet with nano-fertilizer application.

## 2. Yield and Yield Attributes

### 2.1 Ear head length (cm)

Significantly maximum ear head length 31.3cm was recorded in treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 29.4 cm and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 29.0 cm, was recorded statistically at par with treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest ear head length 24.8 cm was

recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control). The improvement in ear head length with nano urea application may be attributed to enhanced nitrogen availability and improved vegetative growth, resulting in better assimilate translocation towards reproductive organs. Similar findings were reported by Chavan *et al.* (2025)<sup>[4]</sup> and Sharma *et al.* (2022)<sup>[10]</sup> in pearl millet.

## 2.2 Ear head girth (cm)

Significantly maximum ear head girth 5.5 cm was recorded in treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 4.7 cm and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 4.4 cm, was recorded statistically at par with treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest ear head girth 2.1 cm was recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control).

Increased ear head girth under nano urea treatments could be due to improved nutrient uptake and photosynthetic efficiency, leading to better ear development. Similar observations were reported by Chavan *et al.* (2025)<sup>[4]</sup> in pearl millet.

## 2.3 Weight of ear head (g)

Significantly maximum ear head weight 31.7 g was recorded in treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 30.8 g and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 29.4 g, was recorded statistically at par with treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest ear head weight 23.0 g was recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control).

Enhanced ear head weight under nano urea application may be attributed to improved nitrogen use efficiency and increased dry matter accumulation. Similar results were reported by Sharma *et al.* (2022) and Vegda *et al.* (2024)<sup>[10, 11]</sup>.

## 2.4 Number of grains per ear head

Significantly maximum number of grains per ear head 2346.27 was recorded in treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 2209.80 and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 2134.00, was recorded statistically at par with

Treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest number of grains per ear head

1809.20 was recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control).

The increase in grain number may be due to enhanced nutrient availability during flowering and grain formation stages, resulting in better fertilization and grain setting. Similar findings were reported by Sharma *et al.* (2022)<sup>[10]</sup> in pearl millet

## 2.5 Weight of grains per ear head (g)

Significantly maximum weight of grains per ear head 27.11 g was recorded in

Treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm)

25.24 g and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 25.03 g, was recorded statistically at par with treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest weight of grains per ear head

20.18 g was recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control).

The improvement under nano urea application may be attributed to enhanced nitrogen availability, increased photosynthetic activity, and better translocation of assimilates towards reproductive organs. Similar findings were reported by Arya *et al.* (2022)<sup>[3]</sup> who observed increased ear head weight with foliar application of nano nitrogen fertilizers.

## 2.6 Test weight (g)

Significantly maximum test weight 12.33 g was recorded in treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 11.67 g and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 9.67 g, was recorded statistically at par with treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest test weight 9.33 g was recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control).

Higher test weight under nano urea treatment may be due to improved nutrient uptake and efficient grain filling during the reproductive stage. These results are in agreement with findings of Arya *et al.* (2022)<sup>[3]</sup>, who reported enhanced seed weight in cereals with nano- fertilizer application.

## 2.7 Grain yield (t/ha)

Significantly maximum grain yield 2.31 t/ha was recorded in treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 2.15 t/ha and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 2.08 t/ha, was recorded statistically at par with treatment T<sub>1</sub>

(Nano urea 4% + 25 × 20 cm). The lowest grain yield 1.63 t/ha was recorded in treatment T<sub>10</sub> (0 - 40 - 40 kg/ha N-P-K Control).

The increased grain yield under nano urea application may be attributed to improved nitrogen use efficiency, better crop growth, and higher yield attributes. Similar results were reported by Manjunath *et al.* (2025)<sup>[7]</sup>, who found significant yield enhancement due to nano nitrogen fertilization.

## 2.8 Stover yield (t/ha)

Significantly maximum stover yield 5.31 t/ha was recorded in treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). And treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm) 4.96 t/ha and treatment T<sub>3</sub> (Nano urea 4% + 45 × 10 cm) 4.74 t/ha, was recorded statistically at par with treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm). The lowest stover yield 3.19 t/ha was recorded in treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control).

Increased stover production under nano urea treatment may be due to enhanced vegetative growth resulting from improved nutrient absorption and photosynthetic efficiency. These findings corroborate the observations of Manjunath *et al.* (2025)<sup>[7]</sup>, who reported higher biomass production with efficient nitrogen management practices.

## 2.9 Harvest index (%)

Harvest Index was recorded non-significant. Treatment T<sub>10</sub> (80 - 40 - 40 kg/ha N-P-K Control) was recorded maximum harvest index 33.9%. And lowest harvest index 30.3% was observed in Treatment T<sub>1</sub> (Nano urea 4% + 25 × 20 cm) and Treatment T<sub>2</sub> (Nano urea 4% + 35 × 15 cm).

The non-significant variation indicates that nano-fertilizer treatments affected grain and biological yield

proportionately without markedly altering assimilate partitioning.

### 3. Economic Analysis

#### 3.1 Cost of cultivation (INR)

The cost of cultivation varied across treatments depending on the type of nano-fertilizer used. The lowest cost of cultivation (INR 29,150/ha) was recorded under the control (80:40:40

kg/ha N:P:K), whereas the highest cost (INR 35,750/ h) was observed in combined applications of Nano urea 4% + Nano DAP 4%. Treatments involving Nano urea alone incurred relatively lower costs (INR 30,950/ha) compared to Nano DAP and combined treatments due to differences in input prices and application requirements.

The increased cultivation cost under combined nano-fertilizer application was due to the additional expenditure on both foliar nutrient sources.

#### 3.2 Gross return (INR)

Gross return ranged from INR 76,725.00 to INR 116,658.33/ha. The maximum gross return (INR116,658.33/ha) was recorded under Nano urea 4% + 25 cm × 20 cm spacing, followed by Nano urea 4% + 35 cm × 15 cm (INR108,783.33/ha). The lowest gross return (INR76,725.00/ha) was observed under the control. Higher gross returns under nano urea treatments can be attributed to increased grain and stover yield, which enhanced overall productivity and market value.

The higher gross returns under Nano Urea treatments may be attributed to enhanced nutrient availability, improved crop growth, and higher grain and stover yields. Closer spacing (25 cm

× 20 cm) further contributed to greater productivity per unit area, resulting in maximum economic returns.

#### 3.3 Net return (INR)

Net return followed a similar trend as gross return, varying from INR47, 575.00 to INR85, 708.33/ha. The highest net return (INR85,708.33/ha) was recorded under Nano urea 4% + 25 cm × 20 cm, which was substantially higher than all other treatments. The lowest net return (INR47, 575.00/ha) was recorded in the control. The higher profitability under nano urea treatments is due to the combined effect of increased yield and relatively lower input costs.

The superior net returns under Nano Urea treatments indicate that the additional income generated from higher yields outweighed the increase in cultivation costs. In contrast, the combined application of Nano Urea and Nano DAP resulted in comparatively lower net returns due to higher input costs and relatively lower yield advantages.

#### 3.4 Benefit cost ratio

The BC ratio ranged from 1.42 to 2.77. The highest BC ratio (2.77) was recorded under Nano urea 4% + 25 cm × 20 cm, followed by Nano urea 4% + 35 cm × 15 cm (2.51) and Nano urea 4% + 45 cm × 10 cm (2.38). The lowest BC ratio (1.42) was observed under Nano urea 4% + Nano DAP 4% + 45 cm × 10 cm.

The higher BC ratio under Nano Urea treatments suggests better utilization of resources and greater economic returns per rupee invested. The lower BC ratio under combined nano- fertilizer treatments was mainly due to increased cultivation costs without a proportional increase in returns.

**Table 1:** Effect of Nano- Fertilizers and Spacing on Growth Attributes of Pearl millet

| Treatment Code  | Treatment Description                        |
|-----------------|----------------------------------------------|
| T <sub>1</sub>  | Nano Urea 4% + 25 cm × 20 cm                 |
| T <sub>2</sub>  | Nano Urea 4% + 35 cm × 15 cm                 |
| T <sub>3</sub>  | Nano Urea 4% + 45 cm × 10 cm                 |
| T <sub>4</sub>  | Nano DAP 4% + 25 cm × 20 cm                  |
| T <sub>5</sub>  | Nano DAP 4% + 35 cm × 15 cm                  |
| T <sub>6</sub>  | Nano DAP 4% + 45 cm × 10 cm                  |
| T <sub>7</sub>  | Nano Urea 4% + Nano DAP 4% + 25 cm × 20 cm   |
| T <sub>8</sub>  | Nano Urea 4% + Nano DAP 4% + 35 cm × 15 cm   |
| T <sub>9</sub>  | Nano Urea 4% + Nano DAP 4% + 45 cm × 10 cm   |
| T <sub>10</sub> | 80:40:40 kg ha <sup>-1</sup> N:P:K (Control) |

**Table 2:** Effect of nano- fertilizers and spacing on yield and yield attributes of pearl millet

| Treatment                                                      | Ear Head Length (cm) | Ear Head Girth (cm) | Weight of Ear Head (g) | No. of Grains per Ear Head |
|----------------------------------------------------------------|----------------------|---------------------|------------------------|----------------------------|
| T <sub>1</sub> . Nano Urea 4% + 25 cm × 20 cm                  | 31.3                 | 5.5                 | 31.7                   | 2346.27                    |
| T <sub>2</sub> . Nano Urea 4% + 35 cm × 15 cm                  | 29.4                 | 4.7                 | 30.8                   | 2209.80                    |
| T <sub>3</sub> . Nano Urea 4% + 45 cm × 10 cm                  | 29.0                 | 4.4                 | 29.4                   | 2134.00                    |
| T <sub>4</sub> . Nano DAP 4% + 25 cm × 20 cm                   | 28.7                 | 3.5                 | 27.9                   | 2041.53                    |
| T <sub>5</sub> . Nano DAP 4% + 35 cm × 15 cm                   | 26.8                 | 3.7                 | 26.9                   | 2051.27                    |
| T <sub>6</sub> . Nano DAP 4% + 45 cm × 10 cm                   | 26.9                 | 3.1                 | 25.7                   | 2031.00                    |
| T <sub>7</sub> . Nano Urea 4% + Nano DAP 4% + 25 cm × 20 cm    | 27.9                 | 3.6                 | 27.2                   | 2048.27                    |
| T <sub>8</sub> . Nano Urea 4% + Nano DAP 4% + 35 cm × 15 cm    | 27.2                 | 3.1                 | 26.9                   | 1985.93                    |
| T <sub>9</sub> . Nano Urea 4% + Nano DAP 4% + 45 cm × 10 cm    | 27.3                 | 3.5                 | 27.1                   | 1934.47                    |
| T <sub>10</sub> . 80:40:40 kg ha <sup>-1</sup> N:P:K (Control) | 24.8                 | 2.1                 | 23.0                   | 1809.20                    |
| F-test                                                         | S                    | S                   | S                      | S                          |
| SEm (±)                                                        | 1.07                 | 0.31                | 1.28                   | 86.05                      |
| CD (P = 0.05)                                                  | 3.20                 | 0.94                | 3.81                   | 255.67                     |

**Table 3:** Effect of nano- fertilizers and spacing on yield and yield attributes of pearl millet

| Treatments                                  | Weight of Grains per Ear Head (g) | Test Weight (g) | Grain Yield (t/ha) | Stover Yield (t/ha) | Harvest Index (%) |
|---------------------------------------------|-----------------------------------|-----------------|--------------------|---------------------|-------------------|
| T1. Nano Urea 4% + 25 × 20 cm               | 27.11                             | 12.33           | 2.31               | 5.31                | 30.3              |
| T2. Nano Urea 4% + 35 × 15 cm               | 25.24                             | 11.67           | 2.15               | 4.96                | 30.3              |
| T3. Nano Urea 4% + 45 × 10 cm               | 25.03                             | 9.67            | 2.08               | 4.74                | 30.5              |
| T4. Nano DAP 4% + 25 × 20 cm                | 23.54                             | 8.67            | 1.91               | 4.23                | 31.2              |
| T5. Nano DAP 4% + 35 × 15 cm                | 22.71                             | 9.00            | 1.85               | 3.85                | 32.5              |
| T6. Nano DAP 4% + 45 × 10 cm                | 21.92                             | 9.33            | 1.76               | 3.72                | 32.1              |
| T7. Nano Urea 4% + Nano DAP 4% + 25 × 20 cm | 23.02                             | 9.67            | 1.92               | 4.27                | 31.1              |
| T8. Nano Urea 4% + Nano DAP 4% + 35 × 15 cm | 22.43                             | 9.67            | 1.83               | 3.85                | 32.3              |
| T9. Nano Urea 4% + Nano DAP 4% + 45 × 10 cm | 22.63                             | 9.00            | 1.79               | 3.74                | 32.3              |
| T10. 80-40-40 kg/ha N-P-K (Control)         | 20.18                             | 9.33            | 1.63               | 3.19                | 33.9              |
| F-test                                      | S                                 | S               | S                  | S                   | NS                |
| SEm (±)                                     | 0.91                              | 0.75            | 0.06               | 0.13                | 1.20              |
| CD (P = 0.05)                               | 2.71                              | 2.23            | 0.20               | 0.40                | -                 |

**Table 4:** Effect of nano- fertilizers and spacing n economics of pearl millet

| Treatments                                        | Cost of Cultivation (INR) | Gross Return (INR) | Net Return (INR) | B:C Ratio |
|---------------------------------------------------|---------------------------|--------------------|------------------|-----------|
| T1. Nano urea 4% + 25 cm × 20 cm                  | 30,950                    | 116,658.33         | 85,708.33        | 2.77      |
| T2. Nano urea 4% + 35 cm × 15 cm                  | 30,950                    | 108,783.33         | 77,833.33        | 2.51      |
| T3. Nano urea 4% + 45 cm × 10 cm                  | 30,950                    | 104,541.67         | 73,591.67        | 2.38      |
| T4. Nano DAP 4% + 25 cm × 20 cm                   | 33,950                    | 94,791.67          | 60,841.67        | 1.79      |
| T5. Nano DAP 4% + 35 cm × 15 cm                   | 33,950                    | 89,341.67          | 55,391.67        | 1.63      |
| T6. Nano DAP 4% + 45 cm × 10 cm                   | 33,950                    | 85,600.00          | 51,650.00        | 1.52      |
| T7. Nano Urea 4% + Nano DAP 4% + 25 cm × 20 cm    | 35,750                    | 95,466.67          | 59,716.67        | 1.67      |
| T8. Nano Urea 4% + Nano DAP 4% + 35 cm × 15 cm    | 35,750                    | 88,916.67          | 53,166.67        | 1.49      |
| T9. Nano Urea 4% + Nano DAP 4% + 45 cm × 10 cm    | 35,750                    | 86,658.33          | 50,908.33        | 1.42      |
| T10. 80-40-40 kg ha <sup>-1</sup> N-P-K (Control) | 29,150                    | 76,725.00          | 47,575.00        | 1.63      |

## Conclusion

It is concluded that Application of Treatment T1 [Nano urea 4% + 25cm×20cm] has recorded highest growth attributes, yield, gross return, net return and maximum BC Ratio in Pearl millet.

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