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# Effect of nano fertilizer in relation to growth, yield and economics of little millet (*panicum sumatrense* roth) under rainfed conditions

**Jaydeep Singh Rajput, AK Thakur, NK Nag, T Chandrakar and DP Singh**

**Abstract**
Experiment was conducted during *Kharif* season 2021 in the *Entisols* of New Upland Research cum Instructional Farm, Lamker under S. G. College of Agriculture and Research Station, Jagdalpur, Chhattisgarh, India. The experiment was laid out in randomized complete block design (RCBD) with three replication and consisted of twelve treatments. The experimental results revealed that among all the treatments, treatment $T_{12}$ (75% RDF+ Seed treatment with nano fertilizer + Foliar spray of nano fertilizer at active tillering stage and 7-10 days before flowering) recorded significantly higher plant height, number of tillers hill$^{-1}$, panicle length, panicle weight, number of grains panicle$^{-1}$, 1000 seeds weight, grain yield) and straw yield. The highest net returns were recorded in treatment $T_{12}$ (75% RDF+ Seed treatment with nano fertilizer + Foliar spray of nano fertilizer at active tillering stage and 7-10 days before flowering) over rest of the treatments and was followed by treatment $T_{11}$ (75% RDF+ Foliar spray of nano fertilizer at active tillering stage and 7-10 days before flowering). However, highest B: C ratio was recorded in treatment $T_{12}$ followed by treatment $T_1$ (100% Recommended dose of fertilizer).

**Keywords:** Nano fertilizer, little millet, rainfed conditions

## Introduction
Millets are in the family of cereals (Poaceae) grown in different parts of the world for human consumption and as feed and fodder for animals. Millets are known as ancient nutritional grain and important staple food, particularly, in poor peoples of semi-arid tropics of Asia and Africa (Mahendra, 2012 and Narloch *et al*., 2009) [16, 20]. Millets are cultivated in diverse and adverse environments, mostly in the dry, semi-arid to sub-humid drought-prone agro ecosystems. The nutritive value of millets is comparable to other staple cereals like wheat and rice. Some of the millets are nutritionally better than common cereals in protein, fat and mineral contents (Kamatar *et al.*, 2013) [9]. The major millet growing region in India is mostly found in the rain-fed states of Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh, Telangana, and the red lateritic tract of Eastern India. Millet is grown over a total area of over 25.17 million hectares in India, with a gross production of 42.86 million tonnes (Anonymous, 2016).

Little millet belongs to the family Poaceae, sub-family Panicoideae and the tribe Paniceae (Rachie, 1975) [22]. Globally it is grown indigenously in the tropics and sub tropics, it is a drought tolerant crop and requires less amount of water to complete its life cycle. Hence, it can provide us with food security in unfavourable climatic conditions. In addition, it is rich in vitamin B, minerals like potassium, phosphorus, iron, zinc and magnesium. Therefore, it can address nutritional sensitive agriculture, which aims at nutritional enhancement to combat the present scenario of micronutrient malnutrition (Arunachalam *et al*., 2005; Kundgol *et al*., 2014 and Selvi *et al.*, 2015) [3, 13, 23]. The cultivation of little millet is mainly observed in the states of Karnataka, Madhya Pradesh, Andhra Pradesh, Odisha, Tamil Nadu, Gujarat, Chhattisgarh and Maharashtra. Like other small millets, little millet is also rich in nutrients (Maitra and Shankar, 2019) [17].

Nano-materials are defined as the materials with a single unit between 1 and 100 nm in size in at least one dimension (Liu and Lal, 2015) [14]. Some studies already proved the significance of nano-fertilizers. Some beneficial effects include increased nutrient use efficiency, better yield and reduced soil pollution (Naderi and Danesh-Sharaki, 2013) [19]. Nanostructured formulations with altered physicochemical properties can be probable solution to the current problems through mechanisms such as targeted delivery or slow/controlled release mechanisms

and trigger controlled-conditional release (Guru *et al*., 2015) [6]. The use of nanofertilizers is reported to increase fertilizer use efficiency minimizing the potential negative effects associated with over dosage which reduces the frequency of the application (Kottegoda *et al.,* 2011) [11]. Nano fertilizers are advantageous over conventional fertilizers as they increase soil fertility yield and quality parameters of the crop, they are nontoxic and less harmful to environment and humans, they minimize cost and maximize profit. Nano particles increase nutrients use efficiency and minimizing the costs of environment protection. (Naderi and Abedi, 2012) [18].

## Material and Methods

The experiment was conducted during *Kharif* season 2021 in the *Entisols* ofNew Upland Researchcum Instructional Farm, Lamker under S.G. College of Agriculture and Research Station, Jagdalpur, Chhattisgarh, India.The experiment was consisting of three replications with twelve treatments that were laid out in Randomized Block Design (RBD). The treatment details are as follows,$T_1$: 100% Recommended dose of fertilizer, $T_2$: 100% RDF without Nitrogen application, $T_3$: 50% RDF + Seed treatment with nano fertilizer, $T_4$: 50% RDF+ Foliar spray of nano fertilizer at active tillering stage, $T_5$: 50% RDF+ Foliar spray of nano fertilizer at 7-10 days before flowering, $T_6$: 50% RDF+ Foliar spray of nano fertilizer at active tillering stage and 7-10 days before flowering, $T_7$: 50% RDF + Seed treatment with nano fertilizer + Foliar spray of nano fertilizer at active tillering stage and 7-10 days before flowering, $T_8$: 75% RDF+ Seed treatment with nano fertilizer, $T_9$: 75% RDF+ Foliar spray of nano fertilizer at active tillering stage, $T_{10}$: 75% RDF+ Foliar spray of nano fertilizer at 7-10 days before flowering, $T_{11}$: 75% RDF+ Foliar spray of nano fertilizer at active tillering stage and 7-10 days before flowering, $T_{12}$: 75% RDF+ Seed treatment with nano fertilizer + Foliar spray of nano fertilizer at active tillering stage and 7-10 days before flowering. The recommended dose of fertilizer 40:20:10 kg N: P: K $ha^{-1}$ for little millet field, urea, single super phosphate and muriate of potash respectively was applied to all plots. 50% of nitrogen, 100% phosphorus and potash were applied during sowing of crop and remaining half dose of nitrogen was applied in two split doses at active tillering stage and at panicle initiation stage.

## Result and Discussion

It was observed that yield as well as yield attributing characters like plant height, number of tillers $hill^{-1}$, panicle length, panicle weight, total number of grains $panicle^{-1,}$ test weight and yield were significantly influenced by different nano fertilizer treatments in Table 1.

The plant height recorded significantly highest in treatment $T_{12}$among the all the treatment which was found on par with treatment $T_{11}$, $T_1$, $T_9$, $T_7$ and $T_6$ while the lowest plant height was found in treatment $T_2$. Effect of nano fertilizer on plant height of little millet observed significant increase due to use of nano urea with chemical fertilizers. Application of nano urea at different growth stages (seed treatment and foliar spray at active tillering stage and 7 to 10 before flowering) promoted growth of the plants. Nano fertilizer provides nutrients for the plant or aid in the transport or absorption of available nutrients resulting in better crop growth (Benzon *et al*., 2015; Jyothi and Hebsur, 2017) [4, 8]. Nano fertilizers are readily taken up by the epidermis of leaves and translocated to stems, facilitating active molecule uptake and enhancing growth (Abdel-Aziz *et al.,* 2018) [1]. The maximum number of tillers $hill^{-1}$produced in treatment $T_{12}$ among the all the treatment which was found at par with treatment $T_{11}$, $T_1$, $T_6$ and $T_7$. It was observed that spraying of nano urea at active tillering stage significant increase in the number of active tillers due to provide balance nitrogen to crop.

**Table 1:** Effect of nano fertilizer on growth and yield attributes of little millet

| Treatments | Plant height (cm) | No. of tillers $hill^{-1}$ | Panicle length (cm) | Panicle weight (g) | No. of grains $Panicle^{-1}$ | 1000 seed weight (g) |
|---|---|---|---|---|---|---|
| T1 | 127.87 | 3.20 | 24.80 | 1.52 | 343.33 | 2.39 |
| T2 | 99.07 | 2.23 | 18.40 | 1.17 | 278.67 | 2.24 |
| T3 | 108.73 | 2.47 | 19.45 | 1.24 | 300.67 | 2.27 |
| T4 | 116.77 | 3.07 | 20.67 | 1.33 | 335.00 | 2.30 |
| T5 | 111.67 | 2.93 | 21.07 | 1.24 | 314.00 | 2.29 |
| T6 | 120.33 | 3.20 | 22.20 | 1.39 | 336.33 | 2.34 |
| T7 | 121.50 | 3.13 | 22.40 | 1.47 | 342.33 | 2.37 |
| T8 | 110.73 | 3.00 | 21.40 | 1.29 | 313.67 | 2.31 |
| T9 | 124.47 | 3.07 | 23.00 | 1.51 | 345.00 | 2.38 |
| T10 | 114.70 | 3.00 | 23.67 | 1.31 | 323.00 | 2.33 |
| T11 | 130.77 | 3.27 | 24.77 | 1.61 | 356.33 | 2.39 |
| T12 | 135.13 | 3.47 | 25.85 | 1.71 | 364.00 | 2.41 |
| S.Em± | 5.06 | 0.15 | 1.05 | 0.06 | 13.01 | 0.09 |
| CD at 5% | 14.95 | 0.45 | 3.10 | 0.19 | 38.41 | NS |
| CV% | 7.40 | 8.71 | 8.17 | 7.90 | 6.84 | 6.55 |

The significant increment in number of tillers was induced by nano fertilizers, which increased the activity of chloroplast (Hong *et al*., 2005) [7], rubisco enzyme (Gao *et al*., 2006) [5], antioxidant enzyme system (Nekrasova *et al*., 2011) [21] and nitrate reductase (Lu *et al*., 2002) [15] that could be underlying mechanism for increased growth and number of tillers.

## Yield attributes and Yield

The highest panicle length observed in the treatment $T_{12}$ followed by treatment $T_1$, $T_{11}$, $T_{10}$ and $T_9$, and highest panicle weight was recorded under the treatment $T_{12}$. It was observed that application of nano fertilizer at the time of panicle initiation significantly enhanced panicle length and panicle weight. Nano-fertilizer application increased the panicle

weight, total grain weight, total shoot dry weight and harvest index and they may have a synergistic impact with conventional fertiliser to improve nutrient absorption by plant cells, resulting in optimal growth (Jyothi and Hebsur, 2017) [8]. Maximum number of grains panicle$^{-1}$ recorded in treatment $T_{12}$which was found at par with treatment $T_{11}$, $T_1$, $T_9$ and $T_7$.Nano fertilizers offer a higher surface area due to the tiny particle size, which provides more surface area to facilitate different metabolic functions in the plant system as a result of more photosynthates being produced (Kumar *et al.*, 2020) [12]. Maximum weight of 1000 seeds observed in treatment $T_{12}$while the minimum weight was recorded in treatment $T_2$. The increase in yield attributes *viz*. number of effective tillers, length of ear, number of grains per ear, 1000-grain weight may be due to the reason that nano fertilizers promote the plant to absorb the water of soil and nutrients, then the photosynthesis is improved (Wu, 2013) [26].

Treatment $T_{12}$ recorded significantly higher grain yield which was produced at par with treatment $T_{11}$. However, lowest yield was recorded in treatment $T_2$. Treatment $T_{12}$ recorded significantly maximum straw yield, but lowest straw yield was recorded in treatment $T_2$. Treatment $T_{10}$ recorded numerically higher harvest index while, lowest harvest index was recorded in treatment $T_2$.There was a significant increase recorded in all yield attributes and yield of little millet under nano fertilizer treatment (seed treatment and foliar spray at active tillering stage and 7- 10 days before flowering) used with chemical fertilizer. Nano fertilizers offer a higher surface area due to the tiny particle size, which provides more surface area to facilitate different metabolic functions in the plant system as a result of more photosynthates being produced (Kumar *et al.*, 2020) [12]. Foliar fertilization has the potential to increase the efficiency and frequency by which a nutrient is utilised by the plant in order to maximise growth and yield (Kandil and Eman, 2017) [10]. Foliar application of Nano fertilizers significantly improves the crop yield (Tarafdar *et al*., 2012) [25]. The synergistic effect of nano fertilizers on the efficiency of chemical fertilizer for greater absorption of nutrients by plant cells, resulting in maximum growth of plant parts and metabolic activities such as photosynthesis, which leads to higher photosynthates accumulation and translocation to the plant's economic parts, thus resulting in high yield which attributed to increased source and sink strength (Benzon *et al*., 2015; Taiz and Zeiger 2006) [4, 24]. Nano fertilizer application increased the harvest index and they may have a synergistic impact with conventional fertiliser to improve nutrient absorption by plant cells, resulting in optimal growth (Jyothi and Hebsur, 2017) [8].

Economics: Maximum cost of cultivation of recorded in treatment T12 (22614 Rs ha-1) among all the treatments followed treatment T7 (22188 Rs ha-1) and T11 (21534 Rs ha-1). Minimum cost of cultivation was found in treatment T2 (18225 Rs ha-1). The highest gross income was found in treatment $T_{12}$ (51504 Rs ha$^{-1}$) among all the treatments followed by treatment $T_{11}$ (47064 Ra ha$^{-1}$) and $T_1$ (44683 Rs ha$^{-1}$) while, the lowest gross income was obtained in treatment $T_2$ (23918 Rs ha$^{-1}$). The highest net income obtained in treatment $T_{12}$ (28890Rs ha$^{-1}$) followed by treatment $T_{11}$ (25530 Rs ha$^{-1}$) and $T_1$ (25012 Rs ha$^{-1}$) while, the lowest net income was noted in treatment $T_2$ (5693 Rs ha$^{-1}$). Among the all treatments, treatment $T_{12}$ (2.28) recorded maximum B: C ratio followed by treatment $T_1$ and $T_{11}$. Whereas, treatment $T_2$ (1.31) recorded minimum B: C ratio. Nano fertilizers boost growth, yield and quality parameters of the crops; nutrient use efficiency, reducing fertilizers wastage and minimize cost of cultivation (Kumar *et al*., 2020) [12].

**Table 2:** Effect of nano fertilizer on grain and straw yield, and harvest index of little millet

| Treatments | Grains yield (Kg ha$^{-1}$) | Straw yield (Kg ha$^{-1}$) | Harvest Index (%) |
|---|---|---|---|
| T1 | 1319.77 | 2261.20 | 36.88 |
| T2 | 704.30 | 1350.61 | 34.24 |
| T3 | 906.95 | 1527.29 | 37.23 |
| T4 | 1171.84 | 1985.76 | 37.07 |
| T5 | 1038.27 | 1896.48 | 35.40 |
| T6 | 1253.68 | 2203.02 | 36.28 |
| T7 | 1274.40 | 2357.99 | 35.05 |
| T8 | 1056.29 | 1944.31 | 35.14 |
| T9 | 1257.34 | 2233.54 | 35.89 |
| T10 | 1113.88 | 1818.02 | 38.06 |
| T11 | 1390.98 | 2322.20 | 37.43 |
| T12 | 1520.30 | 2668.46 | 36.30 |
| S.Em± | 56.36 | 84.66 | 1.74 |
| CD at 5% | 166.36 | 249.89 | NS |
| CV | 8.36 | 7.16 | 8.33 |

**Table 3:** Effect of nano fertilizer on economics of little millet

| Treatments | Cost of cultivation (Rs ha$^{-1}$) | Gross income (Rs ha$^{-1}$) | Net income (Rs ha$^{-1}$) | B:C ratio |
|---|---|---|---|---|
| T1 | 19671 | 44683 | 25012 | 2.27 |
| T2 | 18225 | 23918 | 5693 | 1.31 |
| T3 | 20028 | 30693 | 10665 | 1.53 |
| T4 | 20028 | 39664 | 19636 | 1.98 |
| T5 | 20028 | 35211 | 15183 | 1.76 |
| T6 | 21108 | 42473 | 21365 | 2.01 |
| T7 | 22188 | 43234 | 21046 | 1.95 |
| T8 | 20454 | 35830 | 15376 | 1.75 |
| T9 | 20454 | 42609 | 22155 | 2.08 |
| T10 | 20454 | 37667 | 17213 | 1.84 |

| | | | | |
|---|---|---|---|---|
| T11 | 21534 | 47064 | 25530 | 2.18 |
| T12 | 22614 | 51504 | 28890 | 2.28 |
| S.Em± | - | - | - | 0.09 |
| CD at 5% | - | - | - | 0.27 |
| CV% | - | - | - | 8.40 |

## Conclusion

Based on the experiment, it is concluded that treatment $T_{12}$ (75% RDF+ Seed treatment with nano fertilizer + Foliar spray of nano fertilizer at active tillering stage and 7-10 days before flowering) was found the best treatment in increasing the crop growth and grain yield of little millet as well treatment $T_{12}$ was found the mosteconomical treatment as it gave highest net return and benefit: cost ratio of little millet

## References


1. Abdel-Aziz HMM, Mohammed NAH, Aya MO. Effect of Foliar Application of Nano Chitosan NPK Fertilizer on the Chemical Composition of Wheat Grains. Egypt. J Bot. 2018;58(1):87-95.
2. Annonymous. Government of India, Ministry of Finance, Department of Economic Affairs, E.D. Economic Survey 2016-17; Delhi, 2016.
3. Arunachalam V, Rengalakshmi R, Kubera Raj MS. Ecological stability of genetic diversity among landraces of little millet (*Panicum sumatrense*) in south India. Genetic Resources and Crop Evolution. 2005;52(1):15-19.
4. Benzon H, Rubenecia M, Ultra V, Lee S. Nano-fertilizer affects the growth, development and chemical properties of rice. International Journal of Agronomy and Agricultural Research. 2015;7(1):105-117.
5. Gao F, Hong F, Liu C, Zheng L, Su M, Wu X. Mechanism of nano anatase TiO2 on promoting photosynthetic carbon reaction of spinach. Biological Trace Element Research. 2006;111(1-3):239-253.
6. Guru T, Veronica N, Thatikunta R, Reddy SN. Crop Nutrition Management with Nano fertilizers. International Journal of Environmental Science and Technology. 2015;1(1):4-6.
7. Hong F, Zhou J, Liu C, Yang F, Wu C, Zheng L. Effect of nano titanium oxide on phytochemical reaction of chloroplast of spinach. Biological Trace Element Research. 2005;105(1-3):269-279.
8. Jyothi TV, Hebsur NS. Effect of nano fertilizers on growth and yield of selected cereals: A review. Agricultural Reviews. 2017;38(2):112-120.
9. Kamatar MY, Hemalatha S, Meghana, Talawar S, Naik RK. Evaluation of Little Millet (*Panicum sumatrense*) Land Races for Cooking and Nutritional Composition. Current Research in Biological and Pharmaceutical Sciences. 2013;2(1):07-11.
10. Kandil EE, Eman AOM. Response of some wheat cultivars to nano mineral fertilizers and amino acids foliar application. Alexandria science exchange journal. 2017;38(1):53-68.
11. Kottegoda N, Munaweera I, Madusanka N, Karunaratne V. A green slow-release fertilizer composition based on urea-modified hydroxyapatite nanoparticles encapsulated wood. Current Science. 2011;101(1):73-78.
12. Kumar Y, Tiwari KN, Nayak RK, Rai A, Singh SP, Singh AN, *et al*. Nano Fertilizers for Increasing Nutrient Use Efficiency, Yield and Economic Returns in important Winter Season Crops of Uttar Pradesh. Indian Journal of Fertilizers. 2020;16(6):772-786.
13. Kundgol NG, Kasturiba B, Math KK, Kamatar MY. Screening of little millet landraces for chemical composition. International Journal of Farm Sciences. 2014;4(2):33-38.
14. Liu R, Lal R. Potentials of engineered nanoparticles as fertilizers for increasing agronomic productions. Science of The Total Environment. 2015;514(1):131-139.
15. Lu CM, Zhang CY, Wen JQ, Wu GR, Tao MX. Research of the effect of nanometer materials on germination and growth enhancement of *Glycine max* and its mechanism. Soybean Science. 2002;21(3):168-171.
16. Mahendra Dev S. Small farmers in India: challenges and opportunities. Emerging Economies Research Dialogue, Beijing, China, 2012, 14-15pp.
17. Maitra S, Shankar T. Agronomic Management of Little Millet (*Panicum sumatrense* L.) for Enhancement of Productivity and Sustainability. International Journal of Bioresource Science. 2019;6(2):91-96.
18. Naderi MR, Abedi A. Application of nanotechnology in agriculture and refinement of environmental pollutants. Journal of Nanotechnology. 2012;11(1):18-26.
19. Naderi MR, Danesh-Sharaki A. Nanofertilizers and their Role in Sustainable Agriculture. International Journal of Agriculture and Crop Sciences. 2013;5:2229-2232.
20. Narloch U, Unai P, Adam G, Drucker. Payments for agrobiodiversity conservation services (PACS): Creating incentive mechanisms for the sustained on-farm utilization of plant and animal genetic resources, Proceedings of 11th Annual Bio Econ Conference, September 21-22, Venice, Italy, 2009.
21. Nekrasova GF, Ushakova OS, Ermakov AE, Uimin MA, Byzov IV. Effects of copper (II) ions and copper oxide nanoparticles on Elodea densa planch. Russian Journal of Ecology. 2011;42(6):458-463.
22. Rachie KO. The millets. Importance, utilization and outlook. Int. Crops Res. Inst. Semi-Arid Tropics (ICRISAT publication). Hyderabad, India, 1975.
23. Selvi MV, Nirmalakumari A, Senthil N. Genetic diversity for zinc, calcium and iron content of selected little Millet Genotypes. Journal of Nutrition & Food Sciences. 2015;5(6):1.
24. Taiz L, Zeiger E. Plant physiology, 4th Edition. Sinauer Associates, Inc. Sunderland, Massaschusetts, USA, 2006.
25. Tarafdar JC, Sharma S, Raliya R. Nano-technology: Interdisciplinary science of applications. African Journal of Biotechnology. 2012;12(3):219-226.
26. Wu M. Effects of incorporation of nano-carbon into slow-released fertilizer on rice yield and nitrogen loss in surface water of paddy soil. Advance Journal of Food Science and Technology. 2013;5:398-403.