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Effect of nano fertilizer and nitrogen levels on growth characters and yield of little millet (*Panicum sumatrence* L.)

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Abstract
Experiment was carried out at the farm of Zonal Agriculture Research Station, Shendapark, Kolhapur (M.S.), India during *kharif*, 2021. The experiment was laid out in randomized block design with three replication and consist of twelve treatments. The treatments consist of different levels of RDN along with seed treatment and foliar sprays of nano nitrogen fertilizer. Variety Phule Ekadashi was used for experiment. The experiment findings show that among all the treatments, treatment T_{12} (75% RDN + Seed treatment with 1% nano fertilizer+ Foliar spray of nano fertilizer @ 0.4% at active tillering stage and at 7-10 days before flowering) recorded highest growth characters *viz.*, plant height at harvest (140 cm), dry matter accumulation plant^{-1} at harvest (7.03 gm), flag leaf blade length (25 cm) and width (1.06 cm). Also, same treatment recorded maximum grain yield (1466 kg/ha), straw yield (2458 kg/ha) and harvest index over rest of the treatments and was followed by treatment T_{11} (75% RDN + Foliar spray of nano fertilizer @ 0.4% at active tillering stage and at 7-10 days before flowering).Lowest findings as regards to all growth characters and yield of little millet were recorded by treatment T_2 (T_1 without nitrogen application).

Keywords: Growth and yield**,** little millet, nano fertilizer, nitrogen levels

Introduction
One of the earliest foods consumed by humans is millets, which may have been the first cereal grain used in residential settings. Small- seeded millets are resilient, rain-fed crops that thrive well in dry region and also grow well in low soil fertility and moisture. Millets are incredibly nutrient rich, non-glutenous and acid-free meals. They are regarded as the least allergic and most easily digestible grains available in the market. Millets are referred as "nutria-cereals" due to their higher nutritional content. They are also known as "famine reserves" due to their prolonged storability under circumstances (Michaelraj and Shanmugam, 2013) [6].

By taking into consideration importance of millets Government of India had proposed to united nations for declaring 2023 as International Year of Millets. The proposal of India was supported by 72 countries and declared 2023 as International Year of Millets (IYOM) on 5thMarch, 2021. Now, Government of India is celebrating 2023 as a IYOM with purpose of making peoples' movement towards Indian millets, recipes and value-added products which are helpful to accept at global level.

Little millet (*Panicum sumetranse* L.) is one of the minor millets, which belongs to family *Poaceae.* It is important catch crop as it withstands both drought and water logging conditions. It contains 67.0 g of carbohydrates, 7.7 g of proteins, 4.7 g of fats, 12.2 g of dietary fibers, 1.5 g of mineral matter, 17.0 g of calcium, 220.0 mg of phosphorous and 6.0 mg of iron (Divyashree *et al*., 2018) [1]. Even though it is nutritionally rich crop it got neglection because of lack of adoption of improved package of practices. And it is one of the reasons of less production and productivity of little millet.

Nutrient management is an approach for maintaining and enhancing soil fertility and improving productivity of the crop. Among all primary macronutrients, nitrogen is most important nutrient required by the plant. In all vegetative growth stages of plant nitrogen plays an important role as it is major constitute of chlorophyll which imparts green color to the plant and helps for the production of proteins (Iqbal, 2019) [3]. Nitrogen use efficiency (NUE) by crops is very low when comparison is done with the quantity of nitrogen applied to soil. Whatever amount of nitrogen as a conventional fertilizer applied out of this only 30-50 percent get utilized by plant, while remaining nitrogen lost by leaching and volatilization.

Now it's time to solve this problem by adopting nanotechnology (Maria *et al.,* 2010) [5]. The phrase 'Nanotechnology' comes from the Greek word 'nanos', which means dwarf having size of particles about 1-100 nm. Nanotechnology will be the blessing for contemporary agricultural farming as it enhances the efficiency of nutrient uptake by using nano-fertilizers (Manikandan *et al.*, 2018) [4]. Before being approved as a nano fertilizer, a substance or set of particles must pass tests to determine their size, stability, form and characterisation **(**Misra *et al.*, 2014) [7]. Several studies shows that nano fertilizers profoundly increase the crop yield over control which are without application of nano fertilizer, when applied as foliar spray. This because of nano fertilizer gets direct entry into leaves of plant through stomata and other openings. As they are utilized according to need of plant that encourages the growth of plant and increases the rate of metabolic processes like, photosynthesis which leads to higher accumulation of photosynthates and its translocation towards the economic parts of the plant. This foliar application of nano particles increases crop yield significantly. Nano fertilizer provide more surface area and more availability of nutrients to the crop (Singh *et al.*, 2017) [11]. Hence, through this trial major emphasis was given on nutrient management particularly nitrogen by making eminent use of nano fertilizers over conventional fertilizers.

Materials and Methods

Experiment was carried out at the farm of Zonal Agriculture Research Station, Shendapark, Kolhapur (M.S.), India during *kharif*, 2021. The variety *Phule Ekadashi* was used for research trial. The gross plot size was 3.80 m × 3.60 m and net plot size was 3.20 m × 2.70 m. 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:RDF (60:30:30 NPK kg ha^{-1}), T_2: T_1 without nitrogen application, T_3: 50% RDN + Seed treatment with 1% nano fertilizer, T_4: 50% RDN + Foliar spray of nano fertilizer @ 0.4% at active tillering stage, T_5: 50% RDN + Foliar spray of nano fertilizer @ 0.4% at 7-10 days before flowering, T_6: 50% RDN +Foliar spray of nano fertilizer @ 0.4% at active tillering stage and at 7-10 days before flowering, T_7: T_3+ Foliar spray of nano fertilizer @ 0.4% at active tillering stage and at 7-10 days before flowering, T_8: 75% RDN + Seed treatment with 1% nano fertilizer, T_9: 75% RDN + Foliar spray of nano fertilizer @ 0.4% at active tillering stage, T_{10}: 75% RDN + Foliar spray of nano fertilizer @ 0.4% at 7-10 days before flowering, T_{11}: 75% RDN + Foliar spray of nano fertilizer @ 0.4% at active tillering stage and at 7-10 days before flowering, T_{12}: T_8 + Foliar spray of nano fertilizer @ 0.4% at active tillering stage and at 7-10 days before flowering. The recommended dose of fertilizer 60:30:30 kg N: P: K Kg ha^{-1} for little millet. The source used to supply are urea, single super phosphate and muriate of potash and they are applied as per the treatment.Nitrogen was applied in two split doses at active tillering stage and at panicle initiation stage. Total phosphorous and potash were applied at the timeof sowing.IFFCO nano urea is used for seed treatment and foliar spraying in little millet and applied as per treatment. All observations are recorded by following standard methodology of research. Data is statistically analysed as per the method given by Panse and Sukhatme (1967) [8].

Result and Discussion

Growth Characters: It was observed that growth characters like plant height at harvest, dry matter accumulation $plant^{-1}$ at harvest, flag leaf blade length and width at the time of flowering were significantly influenced by effect of nano fertilizer and different nitrogen levels treatments which shows in Table 1.Treatment T_{12} recorded highest plant height at harvest (140 cm), which was at par with treatment ($T_{11,}$ $T_{7,}$ T_6 and T_9) and was significantly superior over treatments $T_{4,}$ T_5, T_{10}, T_1, T_8, T_3 and T_2. It is due to combined effect of foliar sprays of nano nitrogen along with seed treatment which enhances plant height by translocation of desired amount of nutrient to particular plant part which stimulate the plant height. Lowest plant height was recorded in treatment T_2 (109 cm) (Rajput *et al.,* 2022, and Samanta *et al.,* 2022) [9, 10]. The maximum amount of dry matter accumulation $plant^{-1}$ was recorded under treatment T_{12} (7.03 g) which was at par with treatment T_{11}. It's because of the site-specific absorption of nano nitrogen and which was utilized according to need of plant that leads towards good vegetative growth ultimately which improves biomass by increasing metabolic activities which increases the accumulation of dry matter. And the treatment T_2 recorded lowest dry matter accumulation $plant^{-1}$ (4.80 g) (Samanta *et al.*, 2022) [10]. Research findings also shows significant influence on flag leaf blade length of little millet while non-significant effect was found on flag leaf blade width. Maximum value of flag leaf blade length was recorded by treatment T_{12} (25 cm) which was significantly superior over rest of treatments except treatment T_{11}& T_7. It's because of appropriate utilization of applied foliar sprays of nano fertilizer along with different nitrogen levels which improves the growth of plant which enhance the flag leaf blade growth. In case of width of flag leaf blade treatment T_{12} observed highest (1.06 cm). Despite of that short flag leaf blade length (18 cm) and width (0.89 cm) was recorded by treatment T_2.

Yield of little millet

Table 2 is showing the results of experiment regarding the grain yield, straw yield and harvest index of little millet crop as influenced by the effect of nano fertilizer and nitrogen levels. Treatment T_{12} recorded the highest values for grain yield kg ha^{-1}. This treatment numerically at par with treatments T_{11}, T_7, T_6 and T_9, however treatment T_{12} significantly found superior over rest treatments T_4, T_{10}, T_5, T_1, T_8, T_3 and T_2 with highest grain yield of 1466kgha^{-1}. The reason behind it is the foliar application of nano nitrogen on leaves. As nano urea is in liquid form it easily gets entry into leaves infrastructure through stomata which is assimilated by plants and easily distributed through phloem from source to sink and utilized according to need of plant. Indicating that nano nitrogen fertilizer increases area for different metabolic processes such as photosynthesis. Its application leads to increase grain yield of little millet. Lowest grain yield was recorded by treatment T_2 with grain yield of 969kg ha^{-1}. (Rajput *et al.*, 2022 and Samanta *et al.,* 2022) [9, 10]. The maximum straw yield was noted under treatment T_{12} (2458 kg ha^{-1}) which was significantly at par with treatment T_{11}, T_7, T_6, T_9, T_4 and T_{10}. However, treatment T_{12} significantly superior over rest of the treatments T_5, T_1, T_8, T_3 and T_2. Lowest straw yield was noted in treatment T_2 (1892kg ha^{-1}) (Imam Sarvar MD 2021) [2]. Numerically, highest harvest index (37%) was noticed under treatment T_{12}. The treatment T_2 resulted in

lowest harvest index (34%) of little millet (Rajput *et al.*, 2022 and Samanta *et al.*, 2022) [9, 10].

Table 1: Effect of nano fertilizer (N) and nitrogen levels on growth characters of little millet

Treatments	Plant height at harvest (cm)	Dry matter plant^{-1}at harvest (g)	Flag leaf blade length (cm)	Flag leaf blade width (cm)
T_1	118	5.41	20	0.92
T_2	109	4.80	18	0.89
T_3	116	5.11	19	0.91
T_4	120	5.56	21	0.93
T_5	119	5.53	20	0.93
T_6	130	5.73	22	0.96
T_7	131	5.80	23	0.99
T_8	116	5.28	20	0.92
T_9	129	5.57	21	0.93
T_{10}	119	5.55	21	0.93
T_{11}	134	6.22	23	1.01
T_{12}	140	7.03	25	1.06
S. Em±	6.02	0.34	0.97	0.03
C. D. at 5%	17.67	1.01	2.87	NS

Table 2: Effect of nano fertilizer (N) and nitrogen levels on grain yield, straw yield and harvestindex of little millet

Treatments	Grain Yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Harvest Index (%)
T_1	1178	2192	35
T_2	969	1892	34
T_3	1169	2178	35
T_4	1262	2243	36
T_5	1227	2214	36
T_6	1299	2250	36
T_7	1333	2267	37
T_8	1177	2197	35
T_9	1292	2247	37
T_{10}	1248	2228	36
T_{11}	1337	2274	37
T_{12}	1466	2458	37
S. Em±	63.55	81.69	1.42
C. D. at 5%	186.41	239.61	NS

Conclusion

Based on the experiment, it is concluded that treatment T_{12} (75% RDN +Seed treatment with 1% nano fertilizer+ Foliar spray of nano fertilizer @ 0.4% at active tillering stage and at 7-10 days before flowering) was found the best treatment in increasing the crop growth characters as well as for obtaining higher yield of little milletin the sub-montane zone of Kolhapur.

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