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# Effect of nitrogen management on growth and yield of finger millet (*Eleusine coracana* L.) in *Entisol* of Chhattisgarh

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## Abstract
A field experiment was conducted during *kharif* season of 2023 to study "Effect of nitrogen management on growth and yield of Finger millet (*Eleusine coracana* L.) in *Entisol* of Chhattisgarh" in sandy clay loam soil of Dry land Horticulture Research Cum Instructional Farm Pt. Shiv Kumar Shastri College of Agriculture & Research Station, Rajnandgaon (C.G.). The soil of experimental site was medium in Organic Carbon (0.60%), low in available Nitrogen (163.2 kg $ha^{-1}$) and Phosphorous (12.82 kg $ha^{-1}$) and medium in available Potassium (302.5 kg $ha^{-1}$). The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and replicated thrice. Among the different nitrogen management treatments application of 75% N through fertilizer + 25% N through Vermicompost ($T_5$) recorded significantly higher finger millet grain yield (2068.33 kg $ha^{-1}$) and straw yield 6670.62 kg $ha^{-1}$). Similarly, higher plant height (130.35 cm), total dry matter accumulation $plant^{-1}$ (39.05 g), number of effective tillers $m^{-2}$ (160.95), ear head length (9.08 cm) and ear head weight (9.12 g) were also recorded with same treatment and which was at par with $T_1$- Control (100% RDN through fertilizer) and $T_8$- 50% N through fertilizer + 50% N through Vermicompost + Azospirillum.

**Keywords:** Finger millet, nitrogen, RDN, FYM, vermicompost, *Azospirillum*, fertilizer, growth, yield

## Introduction
Finger millet (*Eleusine coracana* L.) is an important small millet crop grown in India and it is considered to be originate 5000 years ago in Africa and subsequently spread via Western Uganda and Ethiopian highlands of Eastern Africa (Dida *et al.*, 2007) [8]. Soon after it was domesticated in India which became its secondary Centre of diversity. The genus *Eleusine* is a member of tribe *Eragrosteae* and contains about 12 species (Bisht and Mukai, 2001) [4]. Finger millet (*Eleusine coracana* L. Gaertn) is a self-pollinated cereal crop and one of the most important crop belonging to the family poaceae and sub family Cloridoideae. It is also known as bird's foot millet, coracana, African millet, Ragi, and Kurukkan. Finger millet is nutritionally comparable to rice and wheat and ranks 4th among millets in the world. It was first native & domesticated in Ethiopian highlands and Western Uganda (Mirza and Marla, 2020) [16]. Finger millet is highly nutritious with good quality protein, rich in minerals. highest content of calcium, fiber and energy as compared to other traditional crops like paddy, wheat, oat and sorghum. Calcium content in finger millet is 8 to 10 times more than wheat or rice. In addition to this, lower glycemic index makes it highly suitable for diabetic patients. Finger millet, one of the minor cereals, is known for several health benefits and some of the health benefits are attributed to its polyphenol and dietary fibre contents. They are also recognized for their health beneficial effects, such as anti-diabetic, anti-tumorigenic, atherosclerogenic effects, anti-oxidant and antimicrobial properties. The dietary fibre, minerals, phenolics and vitamins concentrated in the outer layer of the seed coat form the part of the food and offer their nutritional and health benefits (Chandra *et al*., 2016) [5]. It is mainly cultivated in Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Odisha, Madhya Pradesh, Rajasthan and Uttarakhand states. Finger millet is mostly grown in resource poor conditions with minimum agronomic management.

But researches indicated that the crop responds well to added nutrients (Maitra *et al*. 2020 and Harika *et al.* 2019) [14, 11]. The cultivation of small millets in India, form an important component of the traditional cropping systems and contribute significantly to the regional food and nutritional security and diversity in the national food basket. They are important in the areas of their production as dry land crops, as extraction of soil moisture, efficient photo- synthetic mechanism and rapid transfer of nutrient from source to sink. Nitrogen is considered to be one of the most essential nutrients for the growth and development of all crops including finger millet. It played an essential role in the synthesis of chlorophyll, proteins, enzymes and other metabolic activities (Bhatt *et al.*, 2001) [3]. Insufficient supply of nitrogen to finger millet results in stunted growth, chlorosis of leaves and low grain yield. On the other hand, excessive use of nitrogenous fertilizers does not always translate into proportional increase in yield and may even reduce the yields in some situations. Therefore, judicious and balanced use of nitrogen is essential for maximizing the growth and yield of finger millet. Nitrogen management by integrated application of nitrogen from inorganic and organic source may be a sustainable option for finger millet farmers in these regions. The main objectives of nitrogen management are advancement in plant performance and resource use efficiency while reduce negative environmental impacts (Chen *et al*., 2011) [7]. These can be achieved through use of all possible sources of nitrogen such as use of chemical fertilizers along with organic manures *viz*; - FYM and Vermicompost and biofertilizers to meet crop demand, matching soil nitrogen availability with crop demand (spatially and temporally), and minimizing nitrogen losses (Wu and Ma, 2015) [20]. The major advantages of nitrogen management are increases in yield, nitrogen use efficiency, grain quality, economic return, and sustainability. Keeping the above points in view the present investigation was initiated to study the effect of nitrogen management on growth and yield of finger millet (*Eleusine coracana* L.).

## Materials and Methods

The field experiment conducted at Dry Land Horticulture Research Cum Instructional Farm, Pt. Shiv Kumar Shastri College of Agriculture & Research Station, Rajnandgaon (C.G.) during *kharif* season in the year 2023. The soil of the experimental site was sandy clay loam in texture. The variety “C.G. Ragi-2” was used. An experiment was laid out in randomized block design (RBD) with eight treatments and three replications. The treatment consisted of eight nitrogen management practices *viz*., ($T_1$)- Control (100% RDN through fertilizer), ($T_2$)- 75% N through fertilizer + 25% N through FYM, ($T_3$)- 50% N through fertilizer + 50% N through FYM, ($T_4$)- 25% N through fertilizer + 75% N through FYM, ($T_5$)- 75% N through fertilizer + 25% N through Vermicompost, ($T_6$)- 50% N through fertilizer + 50% N through Vermicompost, ($T_7$)- 25% N through fertilizer + 75% N through Vermicompost and ($T_8$)- 50% N through fertilizer + 50% N through Vermicompost + Azospirillum. The gross plot size was 5m × 4m, which equals 20 $m^2$, while the net plot size, where the actual experimentation occurred, was slightly smaller at 4 m × 3.68 m, equivalent to 14.72 $m^2$. To maintain separation between replications, a gap of 1 m was left between them, and a gap of 0.50 m separated each individual plot. Finger millet was sown on 15th July 2023 with a spacing of 25 cm × 8 cm using seed rate of 12 kg $ha^{-1}$ and harvested on 8th November 2023. The required quantities of (25%, 50% and 75% N through) FYM and vermicompost were applied in respective plots as per the treatments and incorporated into soil two weeks before sowing of crop. Half of nitrogen as per the N level (100%, 75%, 50% and 25% RDN), full dose of phosphorous and full dose recommended doses of potassium were applied in the form of urea, SSP and MOP as basal dose before the sowing. Another half dose of nitrogen required was applied at 2 splits at 25 and 45 DAS.

Five plants were selected at random from net plot area and labelled with tags for recording growth attributes throughout the crop growth period. Those five plants were sampled from net plot of each plot to observe the growth parameters and yield attributing characters as well as grain and straw yield were recorded at harvest to evaluate the treatment effects. Cost of cultivation was calculated and studies on economics were carried out with the help of prevailing market price and MSP of finger millet. The data was prevailing market price of finger millet. The data was statistically analyzed with standard method outlined for randomized block design (Gomez and Gomez, 1984) [10]. Statistically significance was tested by F-value at 0.05% level of probability and critical difference was worked out where ever the effect was significant.

## Results and Discussion

### Growth parameters

The growth parameters (Table. 1) *viz*., plant height and dry matter accumulation $plant^{-1}$ were significantly influenced by nitrogen management at harvest. Application of 75% RDN through fertilizer + 25% RDN through Vermicompost ($T_5$) had shown significantly higher plant height (130.35 cm) and dry matter accumulation $plant^{-1}$ (39.05 g) compared to all other treatments, except Control [100% RDN through fertilizer] ($T_1$) and 50% N through fertilizer + 50% N through Vermicompost + Azospirillum ($T_8$) which was at par with it. This might be due to the combined application of 75% nitrogen through inorganic source and 25% nitrogen through vermicompost, which provide sufficient amount inorganic N coupled with prolonged availability of nitrogen during the crop growth period, promoting superior plant growth at all stages. Nitrogen was associated with increase in protoplasm, cell division and cell enlargement resulting in taller plant’s (Tisdale *et al.*, 1985) [19]. These results were in conformity with the findings of Patel *et al.* (2014) [17], Teja *et al.* (2016) [18], Aparna *et al.* (2020) [1] and Chaudhari *et al.* (2024) [6].

### Yield attributes

In nitrogen management treatments, application of 75% RDN through fertilizer + 25% RDN through Vermicompost ($T_5$) had resulted in significantly highest number of effective tillers $m^{-2}$ (160.95), ear head length (9.08 cm), ear head weight (9.12) and number of grain ear $head^{-1}$ (1734.54) over other combination of treatments and it was statistically at par with Control [100% RDN through fertilizer] ($T_1$) and 50% N through fertilizer + 50% N through Vermicompost + Azospirillum ($T_8$). This might be due to the integrated application of nitrogen through inorganic source which is provide to a higher availability of nutrient to the plant, while vermicompost improves the soil-physical properties, supplied essential micro-nutrients and also the availability of NPK which promote vigorous plant growth and development and resulting in increased yield attributes of finger millet. This result is agreement with the finding of Kumar *et al.* (2014) [13], Manivannan *et al.* (2016) [15], Divya *et al.* (2017) [9] and Himanshi and Shroff (2020) [12].

### Yield

The significantly higher grain yield (2068.33 kg $ha^{-1}$) and straw yield (6670.62 kg ha$^{-1}$) were produced by the application of 75% N through fertilizer + 25% N through Vermicompost ($T_5$) compared to all other combination of nitrogen management treatments and it was at par with Control [100% RDN through fertilizer] ($T_1$) and 50% N through fertilizer + 50% N through Vermicompost + Azospirillum ($T_8$). Grain and straw yield were directly related with the growth and yield attributes. The results indicate that the combined application of 75% of the recommended nitrogen dose (RDN) from (inorganic sources) and 25% nitrogen from vermicompost produced the higher grain and straw yield. This might be due to the optimal dose of inorganic nitrogen and the continuous nutrient availability from vermicompost throughout the crop's growth period, which enhanced both growth and yield attributes and ultimately boosting grain and straw yield as evidenced through higher productive tillers, filled grains and maximum yield compared to other treatment. The data also suggest that supply of nitrogen to line sown brown seeded finger millet could be substituted up to 25% level with vermicompost as it was on par with 100% RDN through fertilizer. These results were in conformity with the findings of Basavaraju and Purushotham (2009) [2], Teja *et.al.* (2016) [18] and Aparna *et al.* (2020) [1]. The harvest index was non-significantly differ due to the nitrogen management practices. However, higher harvest index (23.66%) was found with the application of 75% RDN through fertilizer + 25% RDN through vermicompost ($T_5$).

**Table 1:** Growth and yield attributes of finger millet at harvest as influenced by various nitrogen management treatments

| Treatment | Plant height (cm) | Dry matter accumulation g plant$^{-1}$ | No. of effective tillers m$^{-2}$ | Ear head length (cm) | Ear head weight (g) | Number of grains ear head$^{-1}$ |
|---|---|---|---|---|---|---|
| $T_1$: Control (100% RDN through fertilizer) | 126.02 | 37.58 | 157.25 | 8.96 | 8.87 | 1701.77 |
| $T_2$: 75% N through fertilizer + 25% N through FYM | 122.34 | 33.58 | 134.60 | 8.54 | 8.25 | 1635.20 |
| $T_3$: 50% N through fertilizer + 50% N through FYM | 119.71 | 29.17 | 107.73 | 8.12 | 7.68 | 1553.59 |
| $T_4$: 25% N through fertilizer + 75% N through FYM | 116.58 | 23.84 | 91.96 | 7.32 | 7.16 | 1431.11 |
| $T_5$: 75% N through fertilizer + 25% N through Vermicompost | 130.35 | 39.05 | 160.95 | 9.08 | 9.12 | 1734.54 |
| $T_6$: 50% N through fertilizer + 50% N through Vermicompost | 121.02 | 31.90 | 123.50 | 8.37 | 8.03 | 1596.00 |
| $T_7$: 25% N through fertilizer + 75% N through Vermicompost | 118.23 | 25.74 | 96.92 | 7.49 | 7.39 | 1511.36 |
| $T_8$: 50% N through fertilizer + 50% N through Vermicompost + Azospirillum | 125.42 | 36.58 | 154.24 | 8.85 | 8.53 | 1669.72 |
| S.Em± | 1.70 | 1.11 | 2.42 | 0.14 | 0.26 | 24.35 |
| CD= (0.5%) | 5.14 | 3.36 | 7.35 | 0.42 | 0.79 | 73.86 |

**Table 2:** Yield of finger millet as influenced by various nitrogen management treatments

| Treatment | Grain yield (kg ha$^{-1}$) | Straw yield (kg ha$^{-1}$) | H.I. (%) |
|---|---|---|---|
| $T_1$: Control (100% RDN through fertilizer) | 2005.33 | 6558.60 | 23.42 |
| $T_2$: 75% N through fertilizer + 25% N through FYM | 1913.52 | 6229.54 | 23.50 |
| $T_3$: 50% N through fertilizer + 50% N through FYM | 1827.22 | 6042.18 | 23.21 |
| $T_4$: 25% N through fertilizer + 75% N through FYM | 1756.26 | 5922.66 | 22.87 |
| $T_5$: 75% N through fertilizer + 25% N through Vermicompost | 2068.33 | 6670.62 | 23.66 |
| $T_6$: 50% N through fertilizer + 50% N through Vermicompost | 1852.53 | 6070.12 | 23.39 |
| $T_7$: 25% N through fertilizer + 75% N through Vermicompost | 1812.16 | 6034.85 | 23.10 |
| $T_8$: 50% N through fertilizer + 50% N through Vermicompost + Azospirillum | 1963.28 | 6322.29 | 23.70 |
| S.Em± | 45.14 | 60.26 | 0.48 |
| CD= (0.5%) | 136.93 | 182.77 | NS |

## Conclusion

On the basis of experimental results, Application of 75% N through fertilizer + 25% N through Vermicompost ($T_5$) attain significantly higher growth parameters, yield contributing characters and yield i.e., Plant height, total dry matter accumulation plant$^{-1}$, Number of effective tillers m$^{-2}$, ear head length, ear head weight, number of grains ear head$^{-1}$, grain yield and straw yield. and it was at par with Control [100% RDN through fertilizer] ($T_1$) and 50% N through fertilizer + 50% N through Vermicompost + Azospirillum ($T_8$). In conclusion, the study indicated that the Nitrogen management practice of applying 75% N through fertilizer + 25% N through Vermicompost helped in increasing nutrient pool of the soil by maintaining positive balance of NPK status in the soil and to provide sustainable yield of the crops.

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