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Sompalli Gowthami
M. Sc. Scholar,
Department of Agronomy,
Naini Agricultural Institute,
SHUATS, Prayagraj,
Uttar Pradesh, India

Bodapati Keerthi
M. Sc. Scholar,
Department of Agronomy,
Naini Agricultural Institute,
SHUATS, Prayagraj,
Uttar Pradesh, India

Gowriraja Gayethri
M. Sc. Scholar,
Department of Agronomy,
Naini Agricultural Institute,
SHUATS, Prayagraj,
Uttar Pradesh, India

Seelam Raghavender Reddy
M. Sc. Scholar,
Department of Agronomy,
Naini Agricultural Institute,
SHUATS, Prayagraj,
Uttar Pradesh, India

Dr. Shikha Singh
Assistant Professor, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Sompalli Gowthami
M. Sc. Scholar,
Department of Agronomy,
Naini Agricultural Institute,
SHUATS, Prayagraj, Uttar Pradesh, India

Effect of organic manures and zinc levels on growth and yield of finger millet (*Eleusine coracana* L.)

Sompalli Gowthami, Bodapati Keerthi, Gowriraja Gayethri, Seelam Raghavender Reddy and Dr. Shikha Singh

Abstract
A field experiment was conducted during Kharif 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with Nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T1:Poultry manure 2t/ha + Zn 25 kg/ha, T2:Poultry manure 2t/ha + Zn 0.5%, T3:Poultry manure 2t/ha + Zn 1%, T4:FYM 12t/ha + Zn 25 kg/ha, T5:FYM 12t/ha + Zn 0.5%, T6:FYM 12t/ha + Zn 1%, T7: Vermicompost 3t/ha + Zn 25 kg/ha, T8:Vermicompost 3t/ha + Zn 0.5%, T9: Vermicompost 3t/ha + Zn 1% are used. The results showed that application of Poultry manure 2t/ha + Zn 1% was recorded significantly higher plant height (89.21 cm), Number of tillers/plant (13.70), Plant dry weight (15.64 g/plant), Number of tillers/hill (5.47), Test weight (3.20 g),Grain yield (3.04 t/ha),Straw yield (5.65 t/ha), gross returns (Rs.114000.00/ha), net return (Rs.76958.2/ha) and benefit cost ratio (2.07)as compared to other treatments.

Keywords: Poultry manure, FYM, vermicompost, zinc, soil, foliar, yield

Introduction
Finger millet is the third most important millet in India (locally called as Ragi) next to sorghum and pearl millet. Finger millet grown on marginal land provides a valuable resource in times of famine. It contains high levels of calcium, iron and manganese. The millet straw is also an important livestock feed, building material and fuel. The finger millet contains a low glycaemic index and has no gluten, which makes it suitable for diabetics and people with digestive problems (Apoorva *et al.* 2010) [1]. Hence, finger millet considered as 'poor man' and also 'rich man crop'.

Finger millet is cultivated in more than 25 countries in the world. In India, finger millet is primarily grown in the states of Karnataka, Uttarakhand, Maharashtra and Tamil Nadu. Millets is known to be "crops of the future" as it well adapted and cultivated under harsh environment of arid and semi-arid region (Resmisa, 2012) [14]. The grain content 9.2% proteins, 1.29% fats, 76.32% carbohydrates, 2.2% mineral, 3.90% ash, 0.33% calcium. Vitamin A, B and phosphorus are also present in smaller quantity, iodine content in finger millet is reported to be the highest among food grain (Upadhyaya, 2011) [17].

Micronutrient deficiency, including Zn, is increasing in most of the annual crops due to intensive cropping systems, use of modern high yielding cultivars, loss of organic matter in top soils by erosion, burning crop residues, liming acid soils, and use of inadequate rates in most cropping systems (Fageria *et al.* 2002) [5]. Zinc deficiency in crop plants is reported worldwide. Micronutrient deficiencies have been reported to be one of the main causes for yield plateau or even yield decline in intensified cropping systems (Katyal and Rattan, 2003) [9]. Organic farming practices are gaining importance as farmers realized benefits in terms of soil fertility, soil health and sustainable productivity. Most of the research on organic production of finger millet was applied with utilization of FYM, green manures, compost, neem cake, poultry manure, etc. The application of FYM in the soil helps in increasing the fertility of the soil as physical condition including its water holding capacity. Organic manures, which were perhaps the major sources of plant nutrients in traditional agriculture, receive less emphasis with the advent of high analysis chemical fertilizers. FYM not only supply macronutrients but also meet the requirement of micronutrients besides improving soil health. Organic manure influence both yield and plant micronutrients need and thus help to sustain crop productivity (Montaghian *et al.* 2008).

Materials and Methods

The present examination was carried out during the *Kharif* season 2021, at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.) which is located at 25^0 30' 42''N latitude, 81^0 60' 56" E longitude and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the Yamuna river by the side of Prayagraj - Rewa road about 12 km from the city. The experiment laid out in Randomized Block Design which consisting of nine treatments with T1:Poultry manure 2t/ha + Zn 25 kg/ha, T2:Poultry manure 2t/ha + Zn 0.5%, T3:Poultry manure 2t/ha + Zn 1%, T4:FYM 12t/ha + Zn 25 kg/ha, T5:FYM 12t/ha + Zn 0.5%, T6:FYM 12t/ha + Zn 1%, T7: Vermicompost 3t/ha + Zn 25 kg/ha, T8:Vermicompost 3t/ha + Zn 0.5%, T9: Vermicompost 3t/ha + Zn 1% are used. Nine treatments were replicated thrice in Randomized Block Design. The recommended dose of fertilizer (N;P;K) is 60:30:30 kg/ha.

Chemical analysis of soil

Composite soil samples are collected before layout of the experiment to determine the initial soil properties. The soil samples are collected from 0-15 cm depth and were dried under shade, powdered with wooden pestle and mortar, passed through 2 mm sieve and were analyzed for organic carbon by rapid titration method by Nelson (1975) [12]. Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956) [15], available phophorus by Olsen's method as outlined by Jackson (1967) [8], available potassium was determined by using the flame photometer normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973) [8] and available $ZnSO_4$ was estimated by Atomic Absorption Spectrophotometer method as outlined by Lindsay and Norvell (1978).

Statistical analysis

The data recorded were different characteristics were subjected to statistical analysis by adopting Fishers the method of analysis of variance (ANOVA) as described by Gomez and Gomez (2010). Critical difference (CD) values were calculated the 'F' test was found significant at 5% level.

Results and Discussion

Plant height

Data in table 1 tabulated that significantly highest plant height (89.21cm) was recorded in the treatment with Poultry manure 2t/ha + Zinc 1% over all the other treatments. However, the treatments with application of Vermicompost 3t/ha + Zinc 1% (88.75 cm) and FYM 12t/ha + Zinc 1% (88.54 cm) which were found to be at par with treatment Poultry manure 2t/ha + Zinc 1% as compared to all the treatments.

Increase in plant height might be the involvement of micronutrient Zinc in different physiological processes like enzyme activation, electron transport, chlorophyll formation, stomatal regulation, etc. With the increase in levels of zinc the plant height gradually increased, which might be attributable to greater photosynthetic activity and chlorophyll synthesis due to zinc fertilization resulting into better vegetative growth. The results were in accordance to Chand *et al.*, (2017) [4].

The application of Poultry manure might have favoured better root proliferation, more solubility of phosphorous which consequently favoured higher biological nitrogen fixation and uptake of nutrients and availability of all plant nutrients during the crop growth period. Which resulted in the higher plant height. These results are in close in close conformity with the findings of Togas *et al.,* (2017) [16].

Tillers/plant

Treatment with Poultry manure 2t/ha + Zinc 1% was recorded with significantly highest tillers/plant (13.70) over all the treatments. However, the treatments with Vermicompost 3t/ha + Zinc 1% (13.53) which were found to be statistically at par with Poultry manure 2t/ha + Zinc 1%.

The beneficial response of poultry manure to yield attributes might also be attributed to the availability of sufficient amounts of easily utilizable from of plant nutrients throughout the growth period and especially at critical growth periods of crop resulting in better uptake, plant vigour and superior yield attributes. The results were found to be similar with the Fazily and Hanshul (2019) [6].

Application of Zinc to generally improves fruit growth by synthesizing tryptophan and auxin. The enhancement effect on tillers/plant attributed to the favourable influence of the Zn application to crops on nutrient metabolism, biological activity and growth parameters and hence, applied zinc resulted in taller and higher enzyme activity which in turn encourage more tillers/plant. Similar findings have been reported earlier by Naik *et al.,* (2020) [11].

Plant dry weight (g/plant)

Treatment with Poultry manure 2t/ha + Zinc 1% was recorded with significantly maximum dry weight (15.64 g/plant) over all the treatments. However, the treatments Vermicompost 3t/ha + Zinc 1% (15.51 g/plant) and FYM 12t/ha + Zinc 1% (15.18 g/plant) which were found to be statistically at par with Poultry manure 2t/ha + Zinc 1%.

The increase in the total dry matter production may be due to better source and sink capacity developed due to better dry matter production and its accumulation in assimilatory surface area and increase in the photosynthetic efficiency and thus increased the production of photosynthesis reflected in better growth and ultimately in higher dry accumulation. The result. The results were found to be similar with Bhattacharya *et al.*, (2003) [3].

Table 1: Effect of Organic manures and Zinc levels on Growth parameters of Finger millet

Treatments	Plant height (cm)	No. of Tillers/plant	Dry weight (g)
1. Poultry manure 2t/ha + Zn 25 kg/ha	88.22	13.20	14.94
2. Poultry manure 2t/ha + Zn 0.5%	87.00	12.77	14.37
3. Poultry manure 2t/ha + Zn 1%	89.21	13.70	15.64
4. FYM 12t/ha + Zn 25 kg/ha	87.32	12.90	14.57
5. FYM 12t/ha + Zn 0.5%	86.52	12.47	13.96
6. FYM 12t/ha + Zn 1%	88.54	13.37	15.18

7. Vermicompost 3t/ha + Zn 25 kg/ha	87.83	13.07	14.71
8. Vermicompost 3t/ha + Zn 0.5%	86.73	12.67	14.12
9. Vermicompost 3t/ha + Zn 1%	88.75	13.53	15.51
S. EM (±)	0.23	0.06	0.11
CD (P = 0.05)	0.68	0.19	0.33

Yield attributes and Yield

Significantly Maximum Number of tillers/hill (5.47) was recorded with the treatment of application of Poultry manure 2t/ha + Zinc 1% over all the treatments. However, the treatments Vermicompost 3t/ha + Zinc 1% (5.37) and FYM 12t/ha + Zinc 1% (5.29) which were found to be statistically at par with Poultry manure 2t/ha + Zinc 1%.

The higher number of branches due to the application of poultry manure might be due to the availability of desired and required quantity of nutrients for longer period in root zone of growing plants which helped plant cells to divide. The results were found to in correspondence with Upendranaik *et al.*, (2018) [18].

Significantly highest Test weight (3.20 g) was recorded with the treatment of application of Poultry manure 2t/ha + Zinc1% over all the treatments. However, the treatments Vermicompost 3t/ha + Zinc 1% (3.12 g) and FYM 12t/ha + Zinc 1% (2.97 g) which were found to be statistically at par with Poultry manure 2t/ha + Zinc 1%.

Significantly highest Grain yield (3.04 t/ha) was recorded with the treatment application of Poultry manure 2t/ha + Zinc 1%over all the treatments. However, the treatments with (2.88 t/ha) in Vermicompost 3t/ha + Zinc 1% and with (2.79 t/ha) in FYM 12t/ha + Zinc 1% which were found to be statistically at par with Poultry manure 2t/ha + Zinc 1%.

The higher increase in the yield has been reported to be associated with the release of macro and micro nutrients during the course of microbial decomposition. Organic matter also functions as source of energy for soil micro flora which brings about the transformation of other nutrients held in soil or applied through other means, in a form that is readily utilized by growing plants which helped in increase of seed yield. The results were in accordance with Aravind *et al.* (2020) [2].

Significantly highest Straw yield (5.65 t/ha) was recorded with the treatment application of Poultry manure 2t/ha + Zinc 1% overall the treatments. However, the treatments with (5.55 t/ha) in Vermicompost 3t/ha + Zinc 1% and (5.39 t/ha) in FYM 12t/ha + Zinc 1% which were found to be statistically at par with Poultry manure 2t/ha + Zinc 1%.

Zinc plays a vital role in increasing straw yield because zinc takes place in many physiological process of plant such as chlorophyll formation, stomatal regulation, starch utilization and biomass accumulation which enhanced haulm yield. Zinc also converts ammonia to nitrate in crops which contribute to yield. The similar findings were reported by Pradhan *et al.* (2016) [13].

The harvest index is found to be non-significant. Whereas, There was no significant difference among the treatments. However, highest harvest index (34.99%) was recorded with the treatment Poultry manure 2t/ha + Zinc 1%, whereas minimum harvest index (32.87%) was recorded with the treatment FYM 12t/ha + Zinc 0.5%

Table 2: Effect of Organic manures and Zinc levels on Yield attributes and Yield of Finger millet

Treatments	No. of tillers/hill	Test Weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
Poultry manure 2t/ha + Zn 25 kg/ha	5.17	2.90	2.77	5.32	34.42
Poultry manure 2t/ha + Zn 0.5%	4.86	2.68	2.50	4.96	33.55
Poultry manure 2t/ha + Zn 1%	5.47	3.20	3.04	5.65	34.99
FYM 12t/ha + Zn 25 kg/ha	4.98	2.75	2.61	5.06	33.98
FYM 12t/ha + Zn 0.5%	4.66	2.48	2.30	4.69	32.87
FYM 12t/ha + Zn 1%	5.29	2.97	2.79	5.39	34.12
Vermicompost 3t/ha + Zn 25 kg/ha	5.10	2.85	2.68	5.20	33.99
Vermicompost 3t/ha + Zn 0.5%	4.76	2.60	2.47	4.82	33.84
Vermicompost 3t/ha + Zn 1%	5.37	3.12	2.88	5.55	34.14
F test	S	S	S	S	NS
S. EM (±)	0.06	0.03	0.06	0.05	0.57
CD (P = 0.05)	0.19	0.10	0.18	0.15	-

Conclusion

It is concluded that application of treatment Poultry manure 2t/ha + Zinc 1% performed exceptionally in obtaining maximum seed yield of Finger millet. Hence, Poultry manure 2t/ha + Zinc 1% is beneficial under eastern Uttar Pradesh Conditions.

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