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Yield parameters, yield and economics of Finger millet as influenced by organic nutrient management

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Abstract
A field experimental trail was carried out during *rabi* 2023-24 at Agricultural College Farm, Naira, Acharya N.G. Ranga Agricultural University, Andhra Pradesh. This experiment was conducted three times using a split-plot design. The finger millet variety Indravathi (CFMV 1) was tested in the present experiment. Significantly the higher number of ear heads m^{-2}, fingers ear head^{-1}, ear length and ear weight were obtained with application of 100% RDF (60-30-30 NPK kg ha^{-1}) (M_1) which performed better than the other treatments, which greatly increased grain and straw yields by 17.5%. The next best treatment was application of 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure (M_2). Application of 100% RDN- Poultry manure (M_3) is recorded the lowest stature of yield parameters. Among the foliar sprays, Panchagavya spraying twice at 3% during the tillering and flowering stages (S3) produced greater values of the aforementioned yield qualities than the remaining treatments. Compared to the other treatments, the application of 100% RDF (60-30-30 NPK kg ha-1) (M1) produced notably higher gross returns, net returns, and BC ratio. Among the foliar treatments, higher yields were noted when Panchagavya was sprayed twice at a rate of 3% throughout the tillering and flowering stages (S3).

Keywords: Poultry manure, finger millet, vermiwash and Panchagavya, drymatter production

Introduction
Millet cultivation has gained significant attention in present years due to its high nutritional value, documented health benefits, adaptability to various environments, sustainability in low-input agriculture, and suitability for organic farming. Most millet crops are indigenous to India and are often referred to as "Nutri-Cereals" because they provide essential nutrients vital for proper bodily function. India, particularly the semi-arid regions including Andhra Pradesh, has long been a hub for millet production. Finger millet, also known as ragi, holds particular importance as a staple food and a dryland crop. It has been consumed in India for thousands of years, and its production still sustains agricultural systems, particularly in regions where other crops can suffer from a lack of water and unfavourable soil conditions. (Tripathi *et al.*, 2023) [11].
The one of the most important small millet crop that is mostly grown in areas with variable rainfall and marginal soils is finger millet. Finger millet, which is cultivated on 10.37 lakh hectares and produces 13.86 lakh tons annually with a productivity of 1336 kg ha-1, is the third most significant millet in India, behind sorghum and pearl millet. The two states that produce the most finger millet in India are Karnataka, Tamil Nadu, and Maharashtra.
With a productivity of 1222 kg ha-1 and a production of 33,000 tons, it is cultivated on 27,000 hectares in Andhra Pradesh (Directorate of Agriculture and Farmers' Welfare, 2023-24) [1]. There is a growing demand for the mandatory use of organic manures in agricultural production due to the recent energy crisis, which has resulted in rising prices for inorganic fertilizer and diminishing soil productivity and health (Jagadeesha *et al.*, 2010) [3]. Crop yields and produce quality are significantly increased by organic manures, such as chicken manure (Rasool *et al.*, 2023) [6].
To address the slow release of nutrients from bulky organic manures, foliar nutrition offers an effective solution by providing nutrients directly to the site of metabolism. This allows for the translocation of nutrients during peak periods of crop growth, promoting more efficient absorption through the leaves, where plants are often able to absorb nutrients more effectively

than through their roots. As a result, organic foliar supplementation is considered safe for crops (Sujatha *et al.*, 2016) [9]. Various types of foliar sprays, such as vermiwash, panchagavya and jeevamrutham have proven to be excellent means of addressing micronutrient deficiencies in organic farming. Additionally, they contain a diverse range of micro-organisms that not only support plant growth but also help restore soil fertility by activating biological reactions. This microbial diversity in the foliar sprays acts as a plant growth stimulant, enhancing crop productivity and resilience (Swaminathan, 2005 & Sreenivasa *et al.*, 2011) [10].

Materials and Methods

A field experiment was conducted during *rabi* 2023-24 at Agricultural College Farm, Naira, Acharya N.G. Ranga Agricultural University, Andhra Pradesh. The soils of the experimental site were sandy clay loam in texture, neutral in reaction, low in organic carbon (0.49%) and available nitrogen (221 kg ha^{-1}), medium in phosphorus (22.7 kg ha^{-1}) and potassium (245 kg ha^{-1}) having 7.2 soil pH with EC 0.25 dS m^{-1}.

The study was conducted using a split-plot design and was triple-replicated. The treatments consisted of three (inorganic and organic) nutrient sources *viz* M_1: 100% RDF (60:30:30 NPK kg ha^{-1}), M_2: 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure and M_3: 100% RDN through Poultry manure assigned to main plots, four foliar sprays *viz.*, S_1: Liquid *Azospirillum*+PSB+KRB+ZnSB@1.25 L ha^{-1} biofertilizer consortium by root dipping at transplanting, S_2: Vermiwash spraying twice @ 5% at tillering and flowering stages, S_3: Panchagavya spraying twice @ 3% at tillering and flowering stages and S_4: Jeevamrutham spraying twice @ 10% at tillering and PI stages were allotted to sub plots. The finger millet variety Indravathi (CFMV 1) was tested in the current experiment. The total cost of cultivation of finger millet (Rs ha^{-1}) was calculated for treatment on the basis of inputs used. Gross returns (Rs ha^{-1}) were computed by considering the prevailing market price of the output. Net returns (Rs ha^{-1}) were arrived at by deducting the cost of cultivation of respective treatments from gross returns for the corresponding treatments.

As recommended by Panse and Sukhatme (1985) [4], the analysis of variance for split-plot design was used to statistically examine the data collected on various finger millet properties. The "F" test was used to test for statistical significance at the 5% level of probability. If the "F" value was deemed significant, the treatment means were compared with the crucial difference (CD), which was calculated at the 5% level of probability.

Results and Discussion

The number of ear m^{-2} differed significantly due to application of organic, inorganic sources and foliar. The interaction effect between organic, inorganic sources and foliar sprays was not statistically traceable. Significantly the highest number of ear heads $m^{-2,}$ number of fingers ear $head^{-1,}$ ear head length and ear head weight in finger millet was recorded with application of 100% RDF (60:30:30 NPK kg ha^{-1}) (M_1), which was followed by 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure(M_2) and significantly the lowest number of ear heads m^{-2} was noticed with 100% RDN through Poultry manure (M_3).

Maximum number of ear m^{-2} were observed with application of Panchagavya spraying twice @ 3% at tillering and flowering stages (S_3), which was significantly superior over rest of the treatments tried. The next best treatments were Vermiwash spraying twice @ 5% at tillering and flowering stages (S_2) and Jeevamrutham spraying twice @ 10% at tillering and PI stages (S_4) with no significant disparity between them. The lowest number of ear heads m^{-2} were significantly observed with Liquid *Azospirillum* +PSB +KRB +ZnSB @1.25 L ha^{-1}biofertilizer consortium by root dipping at transplanting(S_1). A higher proportion of earhead hills-1 were observed in the foliar spray of Panchagavya at 3% spray. When applied topically, Panchagavya increases the plants' capacity for photosynthetic activity and encourages the growth of a widespread root system. This enhanced the plants' ability to draw nutrients from the soil, leading to higher yield components (Vimalendran and Wahab 2013 and Sivagamy *et al*., 2024) [12, 7].

Significantly highest grain yield and straw yield in finger millet was recorded with application of 100% RDF (60:30:30 NPK kg ha^{-1}) (M_1), which was followed by 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure(M_2) and significantly the lowest number of ear heads m^{-2} was noticed with 100% RDN through Poultry manure (M_3). Maximum number of ear m^{-2} were observed with application of Panchagavya spraying twice @ 3% at tillering and flowering stages (S_3), which was significantly superior over rest of the treatments tried. It may have increased nutrient translocation and absorption throughout the plant and into the soil. Increased root development and nutrient intake, particularly of nitrogen, may enhance chlorophyll content for increased photosynthetic efficiency, which will result in a larger production of dry matter and the transfer of dry matter from vegetative to reproductive portions. The present study was in line with Biswas *et al.*, 2024 [2] and Sonawane *et al*. 2024 [8].

Gross returns and net returns differed significantly due to application of organic, inorganic sources and foliar application. Gross returns (Rs 60582 ha^{-1}) net returns (Rs 15670 ha^{-1}) were realized with application of100% RDF (60:30:30 NPK kg ha^{-1}) (M_1) over the rest of the treatments. It is clear that the achievement of higher gross returns was due to the higher yield. The next best treatment was application of 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure (Rs.56246ha^{-1}) (Rs.11442ha^{-1}). Significantly, the lowest gross returns (Rs51499ha^{-1}) were noticed with 100% N through poultry manure due to lower yields. The above results are in collaborated with Vimalendran and Wahab, (2013) [12]. Among different foliar sprays, the maximum gross returns (Rs 63545 ha^{-1}) were observed with application of Panchagavya spraying twice @ 3% at tillering and flowering stages (S_3).

Number of ears $m^{-2,}$ Number of fingers ear $head^{-1}$, Ear head length (cm), Ear head weight (g), Grain yield (kg ha^{-1}) and Straw yield (kg ha^{-1}) of finger millet as influenced by different organic, inorganic sources and foliar sprays

Treatments	Number of ears m^{-2}	Number of fingers ear $head^{-1}$	Ear head length (cm)	Ear head weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Fertilizer levels (RDF:60:30:30 kg ha^{-1})						
M_1: 100% RDF (60:30:30 NPK kg ha^{-1})	70.15	6.31	5.79	8.89	1889	3912
M_2: 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure	62.86	5.72	5.14	8.24	1757	3536
M_3:100% RDN through Poultry manure	60.15	5.42	4.63	7.69	1607	3289
S.Em (±)	1.96	0.12	0.18	0.18	36	108

CD *(p=0.05)*	7.71	0.49	0.71	0.72	143	423
CV (%)	10.56	7.44	12.13	7.65	7.20	10.44
Four liquid organic manures						
S_1: Liquid *Azospirillum*+PSB+KRB+ZnSB@1.25 L ha^{-1}biofertilizer consortium by root dipping at transplanting	58.34	5.18	4.42	7.60	1570	3057
S_2: Vermiwash spraying twice @ 5% at tillering and flowering stages	66.35	6.01	5.35	8.30	1747	3858
S_3: Panchagavya spraying twice @ 3% at tillering and flowering stages	69.90	6.36	6.11	9.05	1983	4055
S_4: Jeevamrutham spraying twice @ 10% at tillering and PI stages	62.96	5.72	4.87	8.15	1705	3345
S.Em (±)	1.86	0.14	0.20	0.19	46	99
CD *(p=0.05)*	5.52	0.42	0.58	0.55	137	294
CV (%)	8.65	7.34	11.36	6.71	7.92	8.29
Interaction						
S at M						
S.Em (±)	3.22	0.25	0.34	0.32	80	171
CD *(p=0.05)*	NS	NS	NS	NS	NS	NS
M at S						
S.Em (±)	3.41	0.25	0.35	0.33	78	183
CD *(p=0.05)*	NS	NS	NS	NS	NS	NS

Gross returns (Rs.) and Net returns (Rs.) of finger millet as influenced by different organic, in-organic sources and foliar sprays

Treatments	Gross returns (Rs.)	Net returns (Rs.)
Fertilizer levels (RDF:60:30:30 kg ha^{-1})		
M_1: 100% RDF (60:30:30 NPK kg ha^{-1})	60582	15670
M_2: 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure	56246	11442
M_3: 100% RDN through Poultry manure	51499	6802
Four liquid organic manures		
S_1: Liquid *Azospirillum*+PSB+KRB+ZnSB@1.25 L ha^{-1}biofertilizer consortium by root dipping at transplanting	50157	6165
S_2: Vermiwash spraying twice @ 5% at tillering and flowering stages	56268	11026
S_3: Panchagavyaspraying twice @ 3% at tillering and flowering stages	63545	17803
S_4: Jeevamruthamspraying twice @ 10% at tillering and PI stages	54495	10253

Conclusion

Application of 100% RDF (60:30:30 NPK kg ha^{-1}) recorded significantly maximum yield parameters and yield over the other nutrient treatments. The Panchagavya foliar application, which was applied twice at a rate of 3% throughout the tillering and flowering stages, was determined to be the most effective of the three organic foliar sprays tested under organic finger millet farming. Because 100% prescribed fertilizer doses are less expensive to cultivate than alternative treatments, gross returns and net returns were also noticeably higher. The nutrient availability through inorganic sources will be more immediately after application. Organic nutrient sources 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure is next best to the M1. Organic sources will increase the physio-chemical properties of the soil and helpful in maintaining sustainability.

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