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Growth and Yield of Finger Millet as Influenced by Organic Nutrient Management

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *rabi*2023-24 at Agricultural College Farm, Naira, Acharya N.G. Ranga Agricultural University, Andhra Pradesh. The experiment was laid out in a split-plot design and replicated thrice. The finger millet variety Indravathi (CFMV 1) was tested in the present experiment.At all the crop growth stages, significantly the tallest plants**,** more number of tillers plant^{-1}, highest dry matter production and higher leaf area index were recorded with application of 100% RDF (60:30:30 NPK kg ha^{-1}) (M_1) followed by application of 50% Recommed dose of fertilizer (NPK

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kg ha^{-1}) + 50% RDN through Poultry manure was comparable with treatment (M_1). Application of 100% RDN through Poultry manure (M_3) recorded the lowest growth parameters. Regarding the yield attributes, significantly the higher number of ears m^{-2}, earhead length, earheadweight, number of fingers $earhead^{-1}$ and test weight were obtained with application of 100% RDF (60:30:30 NPK kg ha^{-1}) (M_1) followed by application of 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure, which was in parity with (M_1). While the lowest values of yield attributes were obtained with application of 100 % RDN through poultry manure (M_3). Among the foliar sprays, significantly higher values of the yield attributes were obtained with application of Panchagavya@ 3% over rest of the treatments.

Keywords: Recommended dose of nitrogen; poultry manure; finger millet; vermiwash and panchagavya; drymatter production.

1. INTRODUCTION

Finger millet is a key small millet crop, predominantly cultivated in regions with erratic rainfall and marginal soils.In India, finger milletis the third most important millet, next to sorghum and pearl millet, grown over an area of 10.37 lakh hectares with an annual production of 13.86 lakhtonnes and productivity of 1336 kg ha^{-1}. Karnataka is the leading Finger millet producer in India followed by Tamilnadu and Maharashtra states. In Andhra Pradesh, it is cultivated in an area of 27,000 hectares with a production of 33,000 tonnes having productivity of 1222 kg ha^{-1} (Directorate of Agriculture and Farmers' Welfare, 2023-24).

Organic farming, which prohibits the use of synthetic fertilizers and chemicals, offers an alternative approach. In organic systems, crop nutrient requirements are met through organic inputs and biological processes. This method prioritizes the restoration and maintenance of soil fertility and health, promoting sustainability over the long term. Farmers are increasingly recognizing the benefits of organic farming in terms of improved soil quality, enhanced sustainability and long-term productivity.By diversifying and making better use of these resources, farmers can improve soil fertility, reduce dependence on external inputs and move towards more sustainable farming systems.

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).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).

2. 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 inreaction, 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 7.2soil pH with EC 0.25 dSm^{-1}. Gross plot size is 5.4 m x 4.5 m (24.3 m^2), Net plot size is 4.2 m x 3.6 m (15.12 m^2) and spacing adopted is 15 cm x 10 cm. The healthy seeds of finger millet were sown uniformly on a well-prepared fine seed bed @ 5 kg ha^{-1}

Application of nutrients was done as per the recommended dosage in the form of Urea, DAP and Muriate of potash in respective treatments. Nitrogen was applied in two splits *i.e.,*50 % at the time of transplanting and 50% at active tillering stage in the plots, the entire quantity of phosphorus was applied at the time of transplanting and potassium was applied in two splits, ½ at the time of transplanting and the remaining ½ at panicle initiation. The manures were analysed for its nutrient (NPK) content and applied on nitrogen equivalent basis to

supply 60 kg N ha^{-1}. It was thoroughly incorporated into the soil 15 days prior to transplanting of crop.

The experiment was laid out in a split-plot design and replicated thrice. The treatments consisted of three (inorganic and organic) nutrient sources *viz*M_1: 100% Recommended dose of fertilizer (60:30:30 NPK kg ha^{-1}), M_2: 50% RDF (NPK kg ha^{-1}) + 50% Recommended dose of nutrient through Poultry manure and M_3: 100% RDN through Poultry manure assigned to main plots, four foliar sprays *viz.,* S_1: Liquid *Azospirillum*+Phosphate solubulising bacteria+ Potassium releasing bacteria +Zinc solubulising bacteria @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: Panchagavyaspraying twice @ 3% at tillering and flowering stages andS_4: Jeevamruthamspraying twice @ 10% at tillering and PI stages were allotted to sub plots. The finger millet variety Indravathi (CFMV 1) was tested in the present experiment.

Plant height of five tagged plants was measured from the base of the plant to the tip of top most leaf at 20 and 50 DAT, whereas up to the fingers at maturity and the mean plant height was expressed in cm. The number of tillers were counted from each tagged plant at 20, 50 DAT and at harvest in each net plot and the mean value was expressed as number of tillers $plant^{-1}$. Five plants were collected at random from the border rows leaving the extreme row at 20, 50 DAT and at maturity for estimation of dry matter production of crop. Plants were sundried and latter oven dried at 60°C, to a constant weight. The oven dry weight of all the five plants was taken and dry matter production for hectare was worked out and expressed in kg ha^{-1}. Leaf area from the five destructively sampled plants was measured at 20, 50 DAT and at maturity using LI-COR Model, LI-3100 C leaf area meter with transparent conveyer belt having electronic digital display and expressed in cm^2. Leaf area index was calculated by the following formula (Watson, 1952).

$$\text{Leaf Area Index} = \frac{\text{Total Leaf area}}{\text{Unit Land area } (m^2)}$$

3. RESULTS AND DISCUSSION

The biometric observations with regard to plant height, leaf area index, dry matterproduction and number of tillers $plant^{-1}$ were recorded at periodical intervals *viz*., 20, 50DAT and at harvest. Plant height of the finger millet tends to increase progressively with advance in the age of the crop up to the harvest. Plant heightsrecorded at different growth stages i.e., 20, 50 DAT and at harvest varied significantly due to the application of organic, inorganic sources and foliar sprays but the interaction between organic manures and foliar sprays were not statistically traceable.

Among the organic and inorganic sources of fertilizers, soil application of 100 % RDF (60:30:30 NPK kg ha^{-1}) recorded significantly the highest plant height which was statistically at par with 50% RDF (60:30:30 NPK kg ha^{-1}) + 50% RDN through Poultry manure. The plant height of finger millet was lowest with soil application of 100 % N through Poultry manure at 20 DAT, 50 DAT and at maturity.Among the organic foliar sprays significantly higher plant height at 20DAT recorded with the application of Liquid *Azospirillum*+PSB+KRB+ZnSB@1.25 L ha^{-1} biofertilizer consortium by root dipping at transplanting and the lowest was observed with Jeevamrutham spraying @ 10%.At 50 DAT and at maturity significantly the tallest plants were observed with the application of Panchagavya @ 3% (S_3) statistically at par with the application of Liquid *Azospirillum*+PSB+KRB+ZnSB@1.25 L ha^{-1} bio fertilizer consortium by root dipping at transplanting (S_1) which was however, comparable with jeevamrutha @ 10 % (S_4), while the shortest plants were noticed with Vermiwash spraying twice @ 5% (S_4).Applying organic liquid manures, particularly Panchagavya might help the plants to absorb nutrients and move them around for longer shoots and synthesis of new leaves. Plant height and leaf number $plant^{-1}$ may have increased as a result of cell division and multiplication aided by an adequate nitrogen supply. Additionally, it is possiblethat these mixtures produced a variety of micronutrients that helped finger millet to flourish Biswas and Das (2024) and Aravind et al., (2020).

At 20 DAT and 50 DAT leaf area index does not show any significant variation with soil application of organic and inorganic sources of fertilizers. However at maturity significant higher values were recorded with100% RDF (60:30:30 NPK kg ha^{-1}) (M_1) is at par with50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure (M_2). The lowest values were observed with 100% RDN through Poultry manure (M_3).

Table 1. Plant height, Leaf area index, Drymatter production and yield of finger millet as influenced by different organic, inorganic sources and foliar sprays

Treatments	Plant height (cm) at			Leaf area index			Drymatter production (Kg/ha)			Yield (Kg/ha)
	20 DAT	50 DAT	Maturity	20 DAT	50 DAT	Maturity	20 DAT	50 DAT	Maturity	
Fertilizer levels (RDF:60:30:30 kg ha^{-1})										
M_1: 100% RDF (60:30:30 NPK kg ha^{-1})	26.41	58.50	88.78	1.90	3.97	3.33	1556	3398	5594	1889
M_2: 50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure	25.04	55.22	85.09	1.80	3.94	3.04	1486	3233	5455	1757
M_3: 100% RDN through Poultry manure	23.64	50.84	75.03	1.78	3.76	2.93	1420	3043	4930	1607
SEm (±)	0.51	1.25	1.67	0.06	0.11	0.08	26	67	114	36
CD *(p=0.05)*	2.01	4.90	6.58	NS	NS	0.31	101	264	447	143
CV (%)	7.10	7.91	6.99	11.14	9.52	9.34	6.00	7.23	7.40	7.20
Four liquid organic manures										
S_1: Liquid *Azospirillum*+PSB+KRB+ZnSB@1.25 L ha^{-1}biofertilizer consortium by root dipping at transplanting	28.15	55.82	78.42	1.94	3.85	2.90	1605	3121	4855	1570
S_2: Vermiwash spraying twice @ 5% at tillering and flowering stages	24.27	54.74	85.05	1.83	3.88	3.15	1443	3153	5389	1747
S_3: Panchagavyaspraying twice @ 3% at tillering and flowering stages	24.60	56.50	88.43	1.84	3.98	3.29	1496	3480	5869	1983
S_4: Jeevamruthamspraying twice @ 10% at tillering and PI stages	23.11	51.69	79.96	1.71	3.86	3.07	1405	3145	5191	1705
SEm (±)	0.66	0.98	1.67	0.08	0.08	0.10	26	95	184	46
CD *(p=0.05)*	1.96	2.91	4.97	0.25	NS	NS	101	282	545	137
CV (%)	7.90	5.38	6.05	13.53	6.05	9.21	6.00	8.82	10.34	7.92
Interaction										
S at M										
SEm (±)	1.14	1.70	2.90	0.14	0.14	0.16	60	164	318	80
CD *(p=0.05)*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
M at S										
SEm (±)	1.11	1.93	3.02	0.14	0.16	0.17	58	157	298	78
CD *(p=0.05)*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Significantly higher values of leaf area index wasnoticed with application of Liquid *Azospirillum*+PSB+KRB+ZnSB@1.25 L ha^{-1}biofertilizer consortium by root dipping at transplanting(S_1) at 20 DAT, while the lowest was registered with Vermiwash spraying twice @ 5% at tillering and flowering stages(S_2). At 50 DAT and at maturity there was no significant difference among the liquid organic manures on leaf area index.

Drymatter production has significant difference among the organic and inorganic sources, at 20 DAT, 50 DAT and at maturity application of 100% RDF (60:30:30 NPK kg ha^{-1}) (M_1) recorded significantly the highest Drymatter production and grain yield which were at par with50% RDF (NPK kg ha^{-1}) + 50% RDN through Poultry manure(M_2).The lowest Drymatter production and grain yield of finger millet was recorded with soil application of 100% RDN through Poultry manure (M_3)may be attributed to superiority of nutrient status and better response of finger millet.These resultsare in conformity with those of Govindappa *et al*., (2009).

Among the organic foliar sprays, Panchagavya spraying twice @ 3% at tillering and flowering stages (S_3) recorded significantly the highest Drymatter production and grain yield, followed by Vermiwash spraying twice @ 5% at tillering and flowering stages (S_2), which was however comparable with Jeevamrutham spraying twice @ 10% at tillering and PI stages (S_4). The lowest grain yield recorded with Liquid *Azospirillum*+PSB+KRB+ZnSB@1.25 L ha^{-1} biofertilizer consortium by root dipping at transplanting (S_1) might be due to poor source sink relationship owing to inadequate supply of nutrients. It may have increased nutrient translocation and absorption throughout the plant and into the soil. These results are in line with Dholaria et al., (2022). Increased root development and nutrient intake, particularly of nitrogen, may enhance chlorophyll content for increased photosynthetic efficiency as opined by Choudhary et al., (2024). Panchagavya contains plant growth promoting substances and the micro organisms are responsible for the production of enzymes, which will result in a larger production of dry matter and the transfer of dry matter from vegetative to reproductive portions. These results are in line with the results of Biswas *et al.,(*2020.) and Choudhary et al., (2017).

4. CONCLUSIONS

Application of 100% RDF (60:30:30 NPK kg ha^{-1}) recorded significantly higher growth parameters and yield over the rest of the nutrient treatments.Among the organic nutrient foliar sprays, foliar application of Panchagavya spraying twice @ 3% at tillering and flowering stages was found to be the best over other three organic foliar sprays tried under organic finger millet cultivation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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