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Response Of Fingermillet (Eleusine Coracana L.) Under Organics And Inorganics On Soil Physico-Chemical Properties In Entisols

Aravinthkumar. P[1]*, S. Srinivasan[2], A. Vijai Ananth[3], M. Venkatraman[4], K. Manikandan[5], P. Pavithra[6]
[1*]Assistant Professor, Department of Soil Science and Agricultural Chemistry, School of Agricultural Sciences, Dhanalakshmi Srinivasan University, Samayapuram, Trichy.
[2]Associate Professor, Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram.
[3, 4]Assistant Professor, Department of Horticulture, School of Agricultural Sciences, Dhanalakshmi Srinivasan University, Samayapuram, Trichy.
[5]Assistant Professor, Department of Plant Pathology, School of Agricultural Sciences, Dhanalakshmi Srinivasan University, Samayapuram, Trichy
[6]Programme Assistant- Lab Technician, ICAR, KVK, Coimbatore

Abstract
Soil health is an appropriate function of soil within ecosystem boundaries. Soil health is assessed in terms of soil physico-chemical properties of soil. The Field experiment was conducted during, 2022 at Valiyampattu Village, Sankarapuram Taluk, Kallakurichi District, Tamil Nadu. Soil of the experimental field was sandy loam in texture. The soil belonged to the Pachol (Phl) series, Entisol in order. The taxonomic classification of the soil was Paralithic Ustorthent. The bulk density, particle density, pore space and water holding capacity of the initial soil were 1.47 Mg m^{-3}, 2.21 Mg m^{-3}, 33.48 and 23.27 per cent, respectively. The experiment consists of twelve treatments which were replicated thrice. The design of the experiment was randomized block design (RBD). The twelve treatments included in the study were T_1 - Absolute Control, T_2 - 100% RDF ($N;P_2O_5:K_2O$) (60:30:30 kg ha^{-1}), T_3 - 75% RN(C.F) + 25% RN(GLMC), T_4 - 75% RN(C.F) + 25% RN (GOC), T_5 - 75% RN(C.F) +25% RN (PMC), T_6 - 75% RN(C.F) +25% RN(CPC), T_7 - 50 % RN(C.F) + 25% RN (GLMC) + 25% RN(GOC) , T_8 - 50 % RN(C.F) + 25% RN(PMC) + 25% RN(CPC), T_9 - 50 % RN(C.F) + 25% RN(GLMC) + 25% RN(PMC), T_{10} – 50 % RN(C.F) + 25% RN(GLMC) + 25% CPC, T_{11} - 50% RN(C.F) + 25% RN(GOC) + 25% RN(PMC) and T_{12} - 50% RN(C.F) + 25%RN (GOC) + 25% RN(CPC). The results revealed that the combined application of 50% RN through chemical fertilizer + 25% RN through GLMC + 25% RN through GOC (T_7) recorded bulk density (1.30 Mg m^{-3}), Pore space (42.73%), maximum water holding capacity (30.69%), pH soil reaction was noticed of (6.45), Electrical conductivity (0.16 dSm^{-1}) and at post – harvest soil over control (T_1).
Key Words: *Finger millet; Nutrient Management; plant uptake; productivity.*

1. INTRODUCTION

Finger millet is a traditional food crop that holds immense significance due to its versatility, climate resilience, and higher nutritional value. Finger millet growers face challenges due to poor soil properties and environmental conditions. To meet the growing demand, finger millet production must be substantially increased through suitable organic nutrient management practices [1]. The major finger millet growing states in India are Karnataka, Tamilnadu, Andhra Pradesh, Orissa, Jharkhand, Maharashtra and Uttaranchal. In India, it is grown in an area of 1.19 million hectares with a production of 1.98 million tonnes and the productivity is 1661 kg ha^{-1} [2]. Organic manures not only supply the plant nutrients but also improve soil health. Moreover, the amount of micronutrients present in organic manures may be sufficient to meet the requirement of crop production. But, it is also the fact that optimum yield level of maize production can't be achieved by using only organic manures because of their low nutrient content. Efficacy of organic sources to meet the nutrient requirement of crop is not as assured as mineral fertilizers. Under such situation, integrated plant nutrient system (IPNS) has assumed a great importance and has vital significance for the maintenance of soil productivity. Hence, joint use of chemical fertilizers along with various organic sources is capable of improving soil quality and higher crop productivity on long-term basis [3]. The present investigation was conducted to find out best combination of organic and inorganic fertilizers to attain maximum production of fingermillet in sustainable manner without affecting the soil health.

2. MATERIALS AND METHODS

The field investigation was carried out "Studies on IPNS strategy on soil health and crop productivity in finger millet – horsegram cropping sequence under Entisols soil" was carried out during *kharif* 2022 at Farmer's Field, Valiyampattu Village, Sankarapuram Taluk in Kallakurichi District of Tamilnadu, India. The experimental site is geographically situated at a

Table 1. Initial Soil physico-chemical properties of the experimental site

S. No	PROPERTIES	CONTENT
A. PHYSICAL PROPERTIES		
	MECHANICAL PROPERTIES	
1	Coarse sand (%)	33.22
2	Fine sand (%)	26.19
3	Silt (%)	22.25
4	Clay (%)	17.67
5	Texture	Sandy loam
6	Soil colour	Reddish brown 5YR 5/4
7	Taxonomical classification	*ParalithicUstorthent*
8	Soil series	Pachol (Phl)
9	Bulk density (Mg m^{-3})	1.47
10	Particle density(Mg m^{-3})	2.21
11	Pore space (%)	33.48
12	Water holding capacity	23.27
B. PHYSICO –CHEMICAL PROPERTIES		
13	pH (1:2.5) Soil water suspension	7.27
14	EC (1:2.5) (dSm^{-1}) Soil water suspension	0.33
15	Organic carbon (g kg^{-1})	2.86

latitude of 11.85°'N and longitude of 78.97°'E and at an altitude of 152 meters above mean sea level (MSL). Test crop finger millet CO14 variety. The experiment was laid out in RBD with twelve treatments replicated thrice using different composts (GLMC, GOC, PMC and CPC) and NPK fertilizers. The twelve treatments were T_1 - Absolute Control, T_2 - 100% RDF ($N:P_2O_5:K_2O$) (60:30:30 kg ha^{-1}), T_3 - 75% RN(C.F) + 25% RN (GLMC), T_4 - 75% RN (C.F) + 25% RN (GOC), T_5 - 75% RN(C.F) + 25% RN (PMC), T_6 - 75% RN(C.F)+ 25% RN(CPC), T_7 - 50 % RN (C.F) + 25% RN (GLMC) + 25% RN(GOC), T_8 - 50 % RN(C.F) + 25% RN(PMC) + 25% RN(CPC), T_9-50 % RN(C.F)+25% RN(GLMC) + 25% RN(PMC), T_{10} - 50 % RN(C.F) + 25% RN(GLMC) + 25% RN(CPC), T_{11} - 50% RN(C.F) + 25% RN(GOC) + 25% RN(PMC) and T_{12} - 50% RN(C.F) + 25% RN (GOC) + 25% RN(CPC). The recommended dose of fertilizers ($N:P_2O_5:K_2O$) (60:30:30 kg ha^{-1}) were applied to the field through Urea, SSP and MOP, respectively. The composts *viz*., GLMC, GOC, PMC and CPC were applied as basal on N equivalent basis. The experimental field was having slope geography. A representative soil samples were drawn from 0-22.5 cm depth before and after sowing of the finger millet crop. The samples were miscellaneous thoroughly and a composite sample was obtained. These samples were analysed for various physico-chemical properties.

2.1. Statistical analysis

The data on the observations made was analyzed statistically by applying the technique of analysis of variance for randomized block design suggested by [4]. The statistical significance was tested by F-test at 5 per cent level of probability and wherever the 'F' value was found significant, critical difference (CD) was worked out to test the significance.

3. RESULTS AND DISCUSSION

3.1. Physico-chemical properties of the initial soil sample

The information in respect of soil physical properties like pH, EC, BD, PD and Water holding capacity were prejudiced by different treatments after harvest of finger millet are presented in Table 1. The initial soil of the experiment of 33.22 per cent coarse sand, 26.19 per cent fine sand, 22.25 per cent silt and 17.67 per cent clay. Hence it was classified as sandy loam texture. The soil belonged to the Pachol (Phl) series, Entisol in order. The taxonomic classification of the soil was *Paralithic Ustorthent*. The bulk density, particle density, pore space and water holding capacity of the initial soil were 1.47 Mg m^{-3}, 2.21 Mg m^{-3}, 33.48 and 23.27 per cent, respectively. The soil color was 5YR 5/4 based on Munsell color chart. The soil registered a pH, electrical conductivity and organic carbon content of 7.27, 0.33 dSm^{-1} and 2.86 g kg^{-1}, respectively.

3.2. Bulk density

Application of 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) was significantly recorded the highest bulk density (1.46 Mg m^{-3}) and the lowest bulk density of 1.30 Mg m^{-3} was observed in T_7-50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) was recorded with over control (T_1) *kharif* 2022 (table.2) and application of 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) (T_7) registered lowest bulk density (1.32 Mg m^{-3}) and control recorded highest bulk density (1.47 Mg m^{-3}), respectively. Organics might have caused better aggregation thereby increasing soil aeration [5]. Application of 50% RN(C.F) + 25% RN(GOC) + 25% RN(PMC) also decreased soil bulk density in *kharif* 2022. Might be lead to production of polysaccharides which improved soil aggregation and decreased bulk density [6].

3.3. Pore space

Among the different treatments tried, application of 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) (T_7) registered the highest pore space of 42.73% over control (33.94%) (Table.2). The treatment T_2- 100% RDF recorded pore space of 36.32% .The treatment T_5 and T_6 recorded the pore space were 37.50 and 37.05%, respectively. The treatment T_5 was on par with T_6. Similarly, the treatment T_9 (41.15%) and T_{10} (40.71%) were also on par. Incorporation of 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) was significantly increased the pore space over control during *kharif* 2022 was 42.73%, respectively. This was due to maximum capillary and non capillary porosity improved by the addition organic and inorganic fertilizers [7].

3.4. Water holding capacity (%)

The maximum value with respect to water holding capacity (30.69%) was registered in (T_7) which was received 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) (Table.2). This was on par with T_{11} (30.40%). Application of 50% RN(C.F) + 25% RN(GLMC) + 25% RN(PMC) (T_9) and 50% RN(C.F) + 25% RN(GLMC) + 25% RN(CPC) registered water holding capacity of 28.98 and 28.79%, respectively. These treatments were also on par. However, lowest water holding capacity of 22.24% was found to be with control (T_1), which was received no organic and inorganic sources of nutrient. The maximum water holding capacity values during *kharif*, 2022 were 30.69%, respectively found to be with 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) (T_7). This successive increase due to better aggregation and improvement in micro pore content of the soil [8, 9, 10, 11].

3.5. pH soil reaction

The highest pH (7.26) noticed in control treatment (T_1), which was followed by T_2 (7.13) was received 100% RDF. This was followed by 6.94, 6.81, 6.78 and 6.69 were noticed in T_4, T_6, T_5 and T_3, respectively (Table.2). The treatment T_5 was on par with T_6. The highest pH (7.26) noticed in control treatment (T_1) and lowest pH during *kharif*, 2022 were 6.57 observed

Table 2. Effect of inorganic fertilizers and composts on physico-chemical properties of finger millet cv.CO14 in finger millet during *kharif* (2022)

Treatments	Bulk density (Mg m-3)	Pore space (%)	Water holding capacity (%)	pH	EC (dSm^{-1})
T_1	1.46	33.94	22.24	7.26	0.32
T_2	1.42	36.32	25.11	7.13	0.30
T_3	1.38	38.40	27.25	6.69	0.24
T_4	1.44	35.43	24.02	6.94	0.29
T_5	1.40	37.50	26.28	6.78	0.27

T_6	1.41	37.05	26.34	6.81	0.28
T_7	1.30	42.73	30.69	6.45	0.16
T_8	1.36	39.55	27.60	6.66	0.22
T_9	1.33	41.15	28.98	6.56	0.20
T_{10}	1.34	40.71	28.79	6.57	0.19
T_{11}	1.31	42.29	30.40	6.47	0.17
T_{12}	1.37	39.11	27.41	6.68	0.23
S.Ed	0.005	0.34	0.35	0.04	0.01
CD(p=0.05)	0.010	0.69	0.72	0.08	0.02

Table 3. Effect of inorganic fertilizers and composts on soil organic carbon (g kg^{-1}) at different stages of finger millet cv.CO14 during *kharif* (2022)

T. No.	**Treatments Details**	**Organic Carbon (g kg^{-1})**		
		30 DAT	**60 DAT**	**Harvest**
T_1	Absolute control	2.85	2.82	2.76
T_2	100% RDF (N:P2O5:K2O) (60:30:30 kg ha^{-1})	2.96	2.95	2.85
T_3	75% RN(C.F) + 25% RN(GLMC)	3.05	2.99	2.92
T_4	75% RN(C.F) + 25% RN(GOC)	2.92	2.89	2.81
T_5	75% RN(C.F) + 25% RN(PMC)	3.03	2.97	2.90
T_6	75% RN(C.F) +25% RN(CPC)	3.01	2.96	2.89
T_7	50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC)	3.29	3.20	3.11
T_8	50% RN(C.F) + 25% RN(PMC) + 25% RN(CPC)	3.11	3.06	2.98
T_9	50% RN(C.F) + 25% RN(GLMC) + 25% RN(PMC)	3.18	3.12	3.04
T_{10}	50% RN(C.F) + 25% RN(GLMC) + 25% RN(CPC)	3.16	3.11	3.03
T_{11}	50% RN(C.F) + 25% RN(GOC) + 25% RN(PMC)	3.24	3.16	3.09
T_{12}	50% RN(C.F) + 25% RN(GOC) + 25% RN(CPC)	3.10	3.04	2.97
S.Ed		0.02	0.01	0.01
CD(p=0.05)		0.04	0.03	0.03

with 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) (T_7). This might be due to the production of CO_2, which react with H_2O produced carbonic acid, further due to organic acids that are produced during the decomposition of organic materials [12].This was also due to decomposition and release of organic acids and carbon dioxide, soil pH turn to decrease. Application of 100% RDF was decreased to the oxidation of nitrogen fertilizers such as the conversion of urea to ammonia ion released H^+ (potential sources of soil fertility) that decreased the soil pH during the reduction reaction [13].

3.6. Electrical conductivity (dSm^{-1})

The electrical conductivity was high (0.32 dSm^{-1}) with control (T_1) treatment. The treatments T_2, T_3 and T_4 recorded the electrical conductivity of 0.30, 0.24 and 0.29 dSm^{-1},
respectively in the table. 2. These treatment T_5 (0.27 dSm^{-1}) was found to be on par with T_6 (0.28 dSm^{-1}). However, application of 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) (T_7) significantly reduced soil EC of 0.16 dSm^{-1}. The electrical conductivity was high (0.32 dSm^{-1}) with control (T_1) and decreased to 0.16 dSm^{-1} during *kharif*, 2022 with 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) (T_7). This might be due to the presence of more soluble salts and more exchangeable calcium, magnesium and potassium in organics than the soil [14]. The soil EC showed a negative trend in this study with crop growth progress reported by [15]. Irrespective of 100% RDF application recorded higher EC value. This result has been confirmed by [16]. The variation in EC due to different organics might be due to the variation in its content of soluble salts.

3.7. Organic carbon content

The highest soil organic carbon contents at 30 DAT, 60 DAT and at post- harvest stages were 3.29, 3.20 and 3.11kg ha^{-1}, respectively recorded with 50% RN (C.F) + 25% RN(GLMC) + 25% RN(PMC) (T_7) (Table. 3).

Soil organic carbon content increased with combined addition of inorganic fertilizers and composts over control during, *kharif* 2022. This was due to integrated application of green leaf manure compost, groundnut oilcake and inorganic fertilizers increased higher soil organic carbon content over control. The addition of organic manure along with chemical fertilizers helps in maintaining organic matter status in soil. The combined application of compost and fertilizers beneficial effect of balanced nutrition through IPNS over control treatment on soil organic carbon content was attributed to better crop growth with concomitant greater root biomass generation and greater return of leftover surface plant residues. [17]. The integrated application of compost along with fertilizer showed higher SOC compared to their sole application [18]. The combined use of organic manures along with chemical fertilizers resulted in an improvement in the organic carbon content of soil over the initial content. These results line up with [19] also supported the present findings. This was also due to highest C biomass and N contents in the soil treated with compost showed changes in soil organic matter content caused by microbial enzymatic activities [20].

4. CONCLUSION

From the study, the results clearly revealed that application of either 50% RN(C.F) + 25% RN(GLMC) + 25% RN(GOC) (T_7) registered maximum bulk density, particle density, pore space and water holding capacity, pH, electrical conductivity and organic carbon content respectively. Hence, it is inferred from the present study that integrated application of 50% RN through inorganic fertilizers + 25% RN through green leaf manure compost + 25% RN through groundnut oilcake under IPNS technology would greatly benefit for the farmers to realize higher productivity, profitability and soil sustainability in finger millet.

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