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A mixture of inorganic nitrogenous fertilizers and farmyard manure has an effect on the soil's pH, EC organic carbon, BD, and porosity after rice (*Oryza sativa* L.) is harvested

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Abstract
During the kharif Season 2018–2019 period, a pot culture experiment with the title "A mixture of inorganic nitrogenous fertilizers and farmyard manure has an effect on the soil's pH, EC, organic carbon, BD, and porosity after rice is harvested". Was conducted at Institute of Agricultural Sciences farm, Siksha 'O' Anusandhan University, Bhubaneswar Odisha. On Sandy loam soil. The experiment consisted of eight treatments *viz.* T_1-Control, T_2- 50% RDF, T_3-50% RDF + FYM @ 5t ha^{-1}, T_4-75% RDF, T_5-75% RDF + FYM @ 5t ha-1, T_6- 100% RDF (NPK 80:40:40), T_7-100% RDF + FYM @ 5t ha^{-1} and T_8-150% RDF. The experiment was laid out in a Randomized Block Design with three replications. The results on organic carbon content showed that T_7 (100% RDF + FYM @ 5 t ha^{-1}) had the greatest organic carbon content (7.43 g kg^{-1}) and T_1 had the lowest (5.43 g kg^{-1}). When compared quantitatively to inorganic and control treatments, use of organics (FYM) was determined to be better. Once the crop was harvested, the bulk density of the soil varied between 1.45 and 1.57 g cm^3 depending on the treatment. Under all treatments, the bulk density of soil was discovered to be lower than the initial (1.58 g cm^3) value, although there was no difference. Non-significant differences were seen across all treatments. After the crop was harvested, the EC of the soil varied from 0.48 to 0.56 dSm^{-1}. All treatments resulted in a reduction in electrical conductivity from the starting point. The combined application of organic (FYM) and inorganic fertilizers in this study had significant effect on total porosity. The highest total porosity (45.28%) was obtained from the application of 5 t FYM ha^{-1} in combination with 100% RDF inorganic fertilizer followed by treatment T_5 (75% RDF +5 t FYM ha^{-1}) with 44.15% porosity.

Keywords: FYM, NPK, INF, RDF

1. Introduction

The most vital cereal crop rice is an essential food for greater than 70% of the population of the world. In India rice is the most important staple food, contributing 45% to the total food grain production. The improved physical properties like water holding capacity and moisture retention provided a desirable soil condition for the root development, enhanced nutrient uptake, crop growth and yield was reported by Naphade *et al.* (1993) [15]. Bhaidas *et al.* 1999 [29] reported that addition of organic manures significantly increased the organic carbon content of the soils while, Sharma *et al.*, 2000 [30] observed a significant reduction in the bulk density in residues and FYM incorporated soils and this was attributed to the build-up of soil organic matter and better soil structure. The decrease in bulk density with the addition of FYM and vermi-compost attributed to the fixing of the low density materials with the dense mineral fraction of the soil resulted in good soil aggregation and increased pore space was reported by Srikanth *et al.*, (2000) [25]. Organic manures (*viz.* dhaincha, sunhemp and FYM) improved the soil fertility status like organic carbon, available N, P and K content in soil at post-harvest stage (Hemlatha *et al.*, 2000) [31]. Swarup and Yaduvanshi 2000 [26] reported that soil organic carbon, available P, K, Zn and Mn under inorganic fertilizer treatments were significantly lower compared to the treatments involving organic source such as FYM and green manure.

Farm yard manure occupies an important position among bulky organic manures. Application of composted coir pith and FYM reduced the bulk density appreciably over control and their effects were found to be comparable (Rajkannan *et al*., 2001) [17]. Sharma *et al*., 2003 [32] reported that there was a significant reduction in bulk density with significant improvement in water holding capacity, CEC and available N, P and K status of soil with addition of crop residues and FYM. A study to know the effect of FYM on soil pH showed that there was decrease in pH from 7.99 to 7.65 and each increment of FYM reduced the soil pH significantly due to organic acid production during its decomposition (Patil *et al.* 2003) [33].

2. Materials and Methods

The study was taken in earthen pots at Research farmhouse, Campus-4, Institute of Agricultural Science, Siksha 'O' Anusandhan University, Bhubaneswar**.** Odisha during Kharif 2018-2019. The experimental location experiences tropical climate with a maximum temperature ranged from 31.5 to 28.5 ˚C and a minimum temperature ranged from 18.7 to 13.0 ˚C. Besides, the experimental site received an average rainfall of 3.7 mm. The relative humidity varied from 48 to 38 percent. The composite surface (0-15 cm) soil samples were collected from the Campus-4 farm field for pot culture experiment. The soil type belongs to order *Alfisol,* with sandy loam texture. The soil samples thus collected were air dried, sieved through 2 mm sieve and stored in polythene bags for initial analysis of physico-chemical properties using standard analytical procedure, for the experimental set up, 10 kg of soil was filled in 12 kg capacity earthen pots with eight treatments and three replications.

2.1 Treatment details

The experiment was laid out in randomized block design (RBD) with three replications, and it consisted of the following eight treatments

Table 1: Treatment Details

Notation	Treatment details
T_1	Control
T_2	50% RDF
T_3	50% RDF + FYM 5 t ha^{-1}
T_4	75% RDF
T_5	75% RDF + FYM 5 t ha^{-1}
T_6	100% RDF
T_7	100% RDF + FYM 5 t ha^{-1}
T_8	150% RDF

2.2 Details of analytical methods for soil analysis

Table 2: Details of analytical methods for soil analysis

Sl. No	Parameter	Method adopted	References
1.	Textural analysis	Bouyoucos Hydrometer Method	Piper (1966) [35]
2.	Bulk and Particle density	Core Method	Jackson (1973) [34]
3.	Moisture	Oven dried at 105^0 C for 8 hours	Jackson (1973) [34]
4.	Soil reaction (pH)	Soil water suspension 1.2.5 ratio using PH meter (Potentiometry)	Jackson (1973) [34]
5.	Electrical Conductivity (EC)	Soil water suspension 1:2.5 ratio using EC meter. (Conductometry)	Jackson (1973) [34]
6.	Organic Carbon	Wet digestion of Walkley and Black	Jackson (1973) [34]
7.	Cation exchange capacity (CEC)	Ammonium acetate Method	Jackson (1973) [34]
8.	Available phosphorus	0.5 M $NaHCO_3$ (PH 8.5)	Jackson (1973) [34]
9.	Available potassium	1 N NH_4OAc (PH 7.0)	Jackson (1973) [34]
10.	Total nitrogen	Macro Kjeldahl Method	Jackson (1973) [34]

Fig 1: Experimental location

3. Results and Discussion

The data of the results on soil analysis, plant analysis, yield, nutrient content and N, P, K content in rice were subjected to analysis of variance ANOVA and correlation statistics as suggested by Sukhatme (1985) [36]. For statistical analysis of data, Microsoft Excel (Microsoft Corporation, USA) and AGRES window version 7.0 software was used. A pot culture experiment was conducted during kharif 2018-19 to study the "A mixture of inorganic nitrogenous fertilizers and farmyard manure has an effect on the soil's pH, EC organic carbon, BD, and porosity after rice (*Oryza sativa* L.) Is harvested." The results of the experiment were analyzed statistically and discussed with cause, effects and corroborative research findings of the scientists.

3.1. Physico - Chemical Properties

The data pertaining to the organic carbon, pH, EC and bulk density of the soils collected at the time of harvest are presented in the table 3.

3.1.1. Soil pH

The results on pH (Table 3) revealed non-significant impact of various treatments on soil pH in this study. The highest soil pH was observed in treatment T_7 (6.52) and lowest in control (5.76). As compared to initial pH (5.65), its value increased slightly 0.87 units in T_7 (100% RDF + 5 t ha^{-1}FYM). Organic matter produces different acids, which slightly decreased the soil pH. But this rise in soil pH is attributed to decrease in organic carbon content of the soil due to cropping. In inorganic treatment, soil pH has reduced than initial due to use of more quantum of chemical fertilizers mainly urea. Similar results were reported by (Grewal *et al*., 1981) [4]. Soil pH was slight high in treatments where integrated use of fertilizers and manures was made. Laxaminarayana (2006) [37] also reported that use of inorganic and organic manure to gather significantly increased soil pH. This marginal increase in soil pH in integrated treatments might be due to the moderating effect of organics as it decreases the activity of exchangeable Al^{3+} ions in soil solution due to chelating effect of organic molecules similar results observed by Prasad *et al*., (2010) [16], Tyagi (1989) [27], Goyal and Singh (1987) [3].

3.1.2. Electrical Conductivity

All the treatments showed non-significant difference. The EC of soil ranged between 0.48 to 0.56 dSm^{-1} at harvest of the crop (Table 3). The electrical conductivity decreased from the initial value in all treatments. The highest value of electrical conductivity was recorded in T_8 treatment (0.56 dSm^{-1}) where 150% RDF was applied followed by T_6 (0.55 dSm^{-1}) treatment where 100% RDF was applied while, the lowest value of EC was found in control T_1 (0.48 dSm^{-1}). The T_1 (control) treatment showed 17% declined in EC over initial value. The highest value of electrical conductivity as observed in T_8 treatment where 150% RDF was applied. This might be due to the effect of inorganic fertilizers on electrical conductivity which was increased with increase in inorganic fertilizers levels. The increase in the EC of the soil with application of fertilizers was due to the addition of salts through fertilizers and solubilization of native minerals due to the reduction in the pH (Hemalatha *et al*., 2013) [6] Aziz *et al*., (2012) [1] also found similar results.

3.1.3 Organic Carbon

The data on organic carbon content (Table 3) revealed that highest organic carbon (7.43 g kg^{-1}) obtained in T_7 (100% RDF + FYM @ 5 t ha^{-1}) and lowest (5.43 g kg^{-1}) in T_1 (control). Use of organics (FYM) was found numerically superior than inorganic and control treatments. Increased in organic carbon content in FYM treated pots with 50, 75, and 100% RDF might be due to less mineralization of nutrients in comparison to inorganic treatments which might have resulted in the high carbon content. This increase might be due to direct addition of organic source of nutrient and less mineralization due to wide C: N ratio. Results are corroborated with the findings of Bedi and Dubey (2009). However under control treatment less organic carbon might be due nutrient mining. Amongst inorganic sources of nutrients i.e. 50, 75, 100, and 150% RDF recorded higher organic carbon content than control but all are at par with each other. Treatment T_7 (gave highest organic carbon (7.43 g kg^{-1}) which is 6.14% and 17.93% higher than T_5 (75% RDF + FYM @ 5 t ha^{-1}) and T_3(%0% RDF + FYM @ 5 t ha^{-1}) respectively. Increased in organic carbon content in integrated nutrient management from organic and inorganic source of nutrient might be due to more mineralization and immobilization together by the involvement of proper C:N/C:P ratio along with the involvement of microorganisms. Similar results were reported by Walia *et al.,* (2010) [28].

3.1.4 Bulk Density

The bulk density of soil ranged from 1.45 to 1.57 g cm^3among various treatments after harvest of the crop (Table 3). The bulk density of soil was found less than the initial (1.58 g cm^3) value under all treatments but did not show much difference. This showed that bulk density of soil altered slightly among treatments. The highest bulk density was found in T_1 control plot (1.57 g cm^3) followed by T_2 treatment (1.56 g cm^3). While, the lowest bulk density i.e. 1.45 g cm^3 was found under T_7 (where 100% RDF was applied with FYM @ 5 t ha^-1and it was significantly lower than all the treatments. The decrease in bulk density could be due to that the organic matter resulted in considerable increase in polysaccharides and microbial gum synthesis in the soil. The microbial decomposition product being resistance to further decomposition and act as binding agent. This might help in soil aggregation resulting lower bulk density of soil. Similar result has also been reported by Sarkar *et al*. (1997) [19], Mishra *et al*. (1998) [38], Sharma and Gupta (1998) [23] and Kumar *et al*. (2011) [39]. Application of fertilizers alone also decreased the soil bulk density as compared to control. This might be due to increased soil organic carbon as a result of higher root biomass with application of fertilizers. Similar result was reported by Selvi *et al*. (2005) [21] under the effect of inorganic alone and in combination with farmyard manure on physical properties and productivity of Vertic Haplustepts under long-term fertilization.

3.1.5. Porosity

Results on BD and porosity (Table 3) showed that under various inorganic fertilizers sources alone or with FYM @ 5 t ha^{-1} treatments, recorded significant improvement in the soil physical properties including bulk density. The combined application of organic (FYM) and inorganic fertilizers in this study had significant effect on total porosity. The highest total porosity (45.28%) was obtained from the application of 5 t FYM ha^{-1}in combination with 100% RDF inorganic fertilizer followed by treatment T_5 (75% RDF +5 t FYM ha^{-1}) with 44.15% porosity. On the other hand, the lowest total porosity, 40.75%, was obtained from the control. This increased porosity with the application of FYM may increase root growth leading to accumulation of more organic residues in the soil. This more organic residue in the soil can increase the productivity of the crop as soil organic matter is not only a pool of plant nutrients but also affects soil physical, chemical and biological properties and plays a key role in establishing and maintaining soil fertility. Similar results reported by Kannan *et al.* 2005 [40], Singh *et al.* 2011 [24], Kannan *et al.* 2013 [7], Sahu, Poornima 2017 [18].

3.1.6. Impact of inorganic nitrogenous fertilizers and farmyard manure combinations on pH, EC organic carbon, BD and porosity of soil after harvest of rice

Table 3: INF and FYM on pH, EC organic carbon, BD, and soil porosity following rice harvest

Treatment	pH	EC (dSm^{-1})	OC (g kg^{-1})	BD g/cm^2	Porosity (%)
T_1 - Control	5.76	0.48	5.43	1.57	40.75
T_2 - 50% RDF	5.77	0.52	5.70	1.56	41.13
T_3 -50% RDF + FYM @5t/ha^{-1}	6.28	0.49	6.3	1.50	43.52
T_4 -75% NRD	5.82	0.54	6.77	1.53	42.26
T_5 -75% RDF + FYM @ 5t/ha^{-1}	6.42	0.52	7.00	1.48	44.15
T_6 -100% RDF	5.78	0.55	6.93	1.54	41.88
T_7-100% RDF + FYM @ 5t/ha^{-1}	6.52	0.51	7.43	1.45	45.28
T_8 -150% RDF	5.76	0.56	6.87	1.55	41.5
Initial status	5.65	0.58	5.80	1.58	40.37
S.Em±	0.16	0.01	0.15	0.02	0.66
CD (P=0.05)	NS	NS	0.45	0.05	1.99

4. Conclusion

Significantly high amount of nitrogen in rice grain and straw was recorded in both the levels of RDF (50, 75% RDF) alone as well as with their combination with 5t ha^{-1} FYM from control but they registered significantly low values of nitrogen as compared to application of 100% RDF + FYM @ 5t ha^{-1}. Protein content of grain also increased significantly with application of 100% RDF together with FYM @ 5t ha^{-1}. The phosphorus content of grain and straw of rice with the addition of FYM (5t ha^-1) with 100% RDF unlike in nitrogen recorded significantly high amount of P over the recommended dose of chemical fertiliser. Potassium content with 100% RDF + FYM 5 t ha^{-1} showed slight variations between the grain and straw, followed the same trend as that of phosphorus and was significantly superior to the recommended dose of chemical fertiliser (100% RDF) Significant improvement in physico chemical properties like organic carbon, bulk density and porosity was observed with the application of 100% RDF + FYM 5 t ha^{-1}. pH and EC showed non-significant results.

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