

Physico-Chemical Properties of Soil as Influenced by Combined Application of Organic and Inorganic Sources to Fodder Oat and Succeeding Residual Fodder Maize

ABSTRACT

An experimental trial was carried out during 2018-19 and 2019-20 at Banaras Hindu University, Varanasi to assess the direct and residual effect of varying levels of fertility and organic sources on different soil chemical properties. Application of fertility levels had non-significant direct as well as residual effect on soil health in both the years, though maximum values were obtained with the application of 100% RDF. Maximum values of available NPK in soil after fodder oat harvest were observed with the application of vermicompost over poultry manure and FYM. Application of 50 kg nitrogen ha⁻¹ through organic sources recorded distinctly higher soil available N, P and K after the harvest of fodder oat. However, the residual effect of nitrogen levels and organic sources failed to touch the level of significance on soil health parameters after harvesting of fodder maize.

Key words- *Fertility, Organic, Residual, Soil Health and Vermicompost.*

1. INTRODUCTION

India supports about 17% human population and 15% livestock population from 2.3% geographical area and 4.2% water resources of the world's [1]. Livestock production is a major component of Indian farming system which contributes 7% to national GDP and provides employment and livelihood for 70% population in rural areas [2]. Recent reports clearly indicated that India faces a net deficit of green fodder by 61.1%, dry crop residues by 21.9% and for feeds as high as 64% [1]. To sustain the fodder production, oats is the prominent fodder crop due to its fast-growing nature, nutritive value grown in winter season while taking fodder maize in summer is one of the promising options. However, nutrients management in intensive cereals- cereals cropping system is a major challenge. Soil nutrients supplied through sole usage of mineral NPK fertilizers in a continuous intensive cropping system may deplete soil fertility, especially micronutrients [3] and organic carbon, because fertilizers have no direct effect on soil physical properties [4]. The strategic use of organic and inorganic sources showed positive impact on soil organic carbon, available nutrient status and soil quality indicators [5]. The higher soil available N, P, K and micronutrients status can be maintained with integrated use of vermicompost, compost and biofertilizers with inorganic fertilizers [6]. Supplementation of recommended dose of nutrients through vermicompost and compost enhances the total uptake of macro (N, P and K) and micronutrient (Zn, Cu, Fe and Mn) [7]. Organic source of nutrients enhances microbial proliferation leading to better nutrient mobilization for crop assimilation. Additionally, manure may directly enhance soil physical properties such as aggregate stability [8] and water retention [9]. Diacono and Montemurro (2010) [10] opined that addition of organic manure to cropland can lead to enhancement in soil biological functions for more than 15 years after using, but concluded that repeated applications or regular additions were needed in order to elicit effects. The use of organic sources in crop nutrition provides balance supply of mineral nutrients to the main crop and has some additional influence on the succeeding crop. Residual effects of organic sources on chemical properties of soil were studied by Tabibian *et al.* (2012) [11] and reported significant improvement in organic matter and soil health. Residual amendment effects on total nitrogen and phosphorus were apparent even after 11.5 year of application [12]. In view of the above facts, present study was conducted with the aim of comparing three organic sources, viz., farmyard manure, poultry manure and vermicompost, for their direct and residual effects on soil physico-chemical properties on fodder oat and succeeding fodder maize.

2. MATERIALS AND METHODS

2.1 Site and soil conditions

The field trial was conducted during summer season of 2019 and 2020 after the harvest of fodder oat to study the residual effect of varying fertility and organic sources on nutrient content and uptake of maize fodder. The experiment was laid out in the IFS block of Agricultural Research Farm, Banaras Hindu University, Varanasi under assured irrigation facility. The experimental site was located at 5° 18'N latitude and 88° 03'E longitude at an altitude of 128.93 meters above the mean sea level at the centre of North- alluvial Gangetic plain. Climatologically, Varanasi lies under subtropical zone having extreme climatic features such as scorching summer and chilling winter. The region falls under semi arid to sub humid climate having a mean annual rainfall and potential evapo-transpiration (PET) of 1102.4 mm and 1550 mm, respectively, with a moisture deficit index ranging between -20 to -40. The soil of the experimental site was Gangetic alluvial having uniform fertility and leveled topography. The initial physico-chemical properties of experimental site are presented in Table.1.

Table 1: Initial physico-chemical properties of experimental field

Particulars	Value		Method employed
	2015	2016	
Soil properties (%)	2015	2016	
Mechanical analysis			
Sand	48.74	48.47	Hydrometric method [13]
Silt	28.72	28.88	
Clay	22.54	22.65	
Textural class	Sandy clay loam		
Taxonomy	Ustochrept		
Physical analysis			
Bulk density (Mg/m ³)	1.39	1.35	Core sampler [14]
Chemical analysis			
Soil pH (1:2.5 soil: water suspension)	7.34	7.32	Glass electrode pH meter [15]
Electrical Conductivity (dS/m at 25°C)	0.221	0.223	Systronics electrical conductivity meter [15]
Organic Carbon (%)	0.41	0.42	Walkley and Black method (Jackson, 1973) [16]
Available Nitrogen (N kg/ha)	180.44	182.67	Alkaline permanganate method [17]
Available Phosphorus (P kg/ha)	17.12	18.85	0.5 M NaHCO ₃ Olsen's Colorimetric method [18]
Available Potassium (K kg/ha)	194.5	196.86	Flame Photometer method (Jackson,

2.2 Experimental Design, treatment details and crop management

During *rabi* (winter) season of both the experimental years fodder oat cv. Kent was grown in split plot design in plot size of 4.5cm×4.0cm comprising of eighteen treatment combinations. The main plot was allocated with three fertility levels (100%, 75% and 50% RDF) whereas the subplot was comprised of combinations of three organic sources (FYM, Poultry manure and Vermicompost) and two nitrogen levels (25 and 50 kg N ha⁻¹) applied through the above-mentioned organic sources. In fodder oat, nitrogen is applied in three splits *i.e.* 50% at basal, 25% at first irrigation and 25% after first cut in the form of urea. The entire doses of phosphorus and potassium were applied through Diammonium phosphate (DAP) and Muriate of potash (MOP) at the time of final land preparation. The recommended dose of NPK (100% RDF) represents 120-60-60 kg NPK ha⁻¹. Organic manures are incorporated fresh in each plot two weeks prior to sowing of fodder oat. The required quantities of organic manures were calculated on the basis of their nitrogen content. The moisture and nitrogen content of each organic manure was estimated on dry weight basis and required amount of fresh manure was worked out. After harvesting of fodder oat, fodder maize cv. African Tall was taken as residual crop on the same experimental set up after applying a light pre sowing irrigation without disturbing the lay out during summer season of both the years. A spacing of 30cm×10cm was maintained with a seed rate of 40 kg ha⁻¹. In all the plots nutrients were applied at 50% RDF (120-60-60 kg NPK ha⁻¹). Half of the nitrogen and full doses of P and K were applied as basal and rest 50% was top dressed at knee high stage of the crop. All other agronomic packages were kept normal and invariable for all the treatments. Plant protection measures were adopted to keep the crop free from insect-pests, weeds and diseases. The crop was harvested at 70 DAS before tassel emergence *i.e.* 7th and 4th of June in 2019 and 2020, respectively.

2.3 Soil analysis

The soil samples from 0-15 cm depth were collected prior to sowing to determine the initial physico-chemical properties and after the harvest of fodder oat and fodder maize to analyze various soil chemical properties. The samples were air dried, grounded and sieved through 2mm sieve and analyzed for pH, EC, available N, P and K in soil. The soil pH and EC was estimated with the help of pH meter and EC meter. The analysis for soil nutrient status was accomplished by following the standard alkaline permanganate (Subbiah and Asija, 1956) [17], Olsen's method [18] (Olsen *et al.*,

1954), flame photometer method (Jackson, 1973) [15] for nitrogen, phosphorus and potassium analysis, respectively.

2.4 Statistical data analysis

The data pertaining to each character of the test crop was sorted out, tabulated and finally analyzed statistically by using analysis of variance technique for split plot design as described by Gomez and Gomez (1984) [19]. Critical difference values at $P=0.05$ were used for determining the significance of differences between mean values of treatments.

3. RESULT AND DISCUSSION

3.1 Soil pH and EC

3.1.1 Direct effect of treatments

Results (Table. 2) revealed that direct effect of fertility levels on soil failed to show considerable effect on soil pH and EC after harvesting of fodder oat during both the years of investigation. However, it showed an increasing trend with increase in fertility levels from 50% to 100% RDF in soil pH as well as EC. A perusal of the data clearly indicated that none of the

Table 2. Residual effect of fertility levels, organic sources and nitrogen levels on soil health after harvesting of fodder oat

Treatment	pH		EC (dS/m)		Av. N (kg ha ⁻¹)		Av. P (kg ha ⁻¹)		Av. K (kg ha ⁻¹)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Fertility levels										
100% RDF	7.33	7.31	0.220	0.218	201.2	209.8	18.88	19.38	199.57	200.40
75% RDF	7.30	7.29	0.216	0.215	199.4	204.5	18.73	19.02	195.31	196.11
50% RDF	7.27	7.26	0.209	0.209	195.7	199.9	18.52	18.70	189.90	189.93
SE m±	0.19	0.21	0.007	0.010	2.9	3.4	0.34	0.47	3.62	2.72
CD 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Organic sources										
FYM	7.34	7.33	0.218	0.217	194.6	199.4	18.14	18.32	188.61	188.93
Poultry manure	7.30	7.29	0.215	0.214	198.6	205.5	18.72	19.00	195.51	197.33
Vermicompost	7.27	7.25	0.211	0.211	203.1	209.3	19.27	19.77	200.66	200.21
SE m±	0.14	0.17	0.007	0.009	2.1	2.5	0.30	0.40	2.91	2.19
CD 5%	N.S.	N.S.	N.S.	N.S.	6.1	7.1	0.85	1.14	8.42	6.32
Nitrogen levels										
25 kg N ha ⁻¹	7.32	7.31	0.217	0.216	196.1	201.7	18.28	18.42	191.41	192.35
50 kg N ha ⁻¹	7.28	7.27	0.213	0.212	201.4	207.7	19.14	19.65	198.44	198.62
SE m±	0.12	0.14	0.006	0.007	1.7	2.0	0.24	0.32	2.38	1.79
CD 5%	N.S.	N.S.	N.S.	N.S.	5.0	5.8	0.70	0.93	6.87	5.16

three organic sources able to influence significantly on soil pH and EC after the harvest of fodder oat (Table. 2). Notwithstanding, vermicompost proved to be better among the different sources as the values tend to near neutral. Similarly, direct effect of application of nitrogen through organic sources did not touch the level of significance with respect to soil pH and EC during both the years, though it was slightly decreased with the application 50 kg N ha⁻¹ compared to 25 kg N ha⁻¹(Table. 2). The results are in agreement with earlier work done by Kumar *et al.*, (2022) [20] and Kashyap *et al.*, (2017) [21].

3.1.2 Residual effect of treatments

The treatments applied to fodder oat have been concerned for their residual effect on succeeding fodder maize. Data presented in the Table.3 showed that the residual effect of fertility levels had non-significant effect on soil pH and EC after harvesting of fodder maize in both the years. Nevertheless, it was recorded maximum with the application of 100% RDF compared to 75% and 50% RDF, respectively. Application of organic sources failed to show appreciable residual effect on soil pH and EC (Table. 3). However, among the three organic sources, residual effect of vermicompost reported marginal decrease in soil pH and EC thus improving the soil health. Study of the data revealed that the soil pH as well as EC did not differ significantly due to the residual effect of application of nitrogen through organic sources in either of the two year experimentation (Table. 3). Application of 50 kg N ha⁻¹ through organic sources improved the soil health by bringing the soil reaction near neutral Sharma *et al.*, (2007) [22] also reported that there was decrease in pH in all the integrated nutrient management practices involving FYM @10 t ha⁻¹.

3.2 Available nitrogen, phosphorus and potassium in soil (kg ha⁻¹)

3.2.1 Direct effect of treatments

Data presented on (Table.2) revealed that application of 100% RDF resulted in improved availability of soil nutrients such as nitrogen, phosphorus and potassium as compared to lower levels of fertility though the differences among the fertility levels did not able to exert significant effect on soil available nitrogen, phosphorus and potassium after the harvest of fodder oat during both the years of study. The results corroborate the findings of Raghuveer and Bohra (2020) [23].

Application of organic sources resulted in lucid improvement in soil nutrient status after harvesting of fodder oat. Among different organic sources, vermicompost recorded significantly higher soil available nitrogen, phosphorus and potassium compared to FYM. However, the differences between application of vermicompost and poultry manure remained comparable during both the years of experimentation (Table. 2). This could be attributed to the addition of organic manures which slowly released the nutrients (NPK) to

the soil and produced organic acids during the faster decomposition of manures due to enhanced activity of beneficial soil microbes which helped in better mineralization and solubilization of nutrients thus improving soil NPK status. More availability of soil nutrients may be ascribed to the efficiency of vermicompost which increased soil porosity and water holding capacity thus allowing more nutrients to retain [24]. The findings are similar to the findings of Malik and Singh [25] (2016) who reported that available nitrogen, phosphorus and potassium content in soil was more when nutrients were supplied through FYM or vermicompost along with inorganic fertilizers to the preceding crops.

Increasing dose of nitrogen from 25 to 50 kg ha⁻¹ applied through organic sources resulted distinct enhancement in soil available nutrients. Application of 50 kg N ha⁻¹ significantly increased the soil available nitrogen, phosphorus and potassium when applied through organic manures during the course of study (Table. 2). The increase in soil nitrogen, phosphorus and potassium was 2.7%, 4.9% and 4.1%, respectively in 2018-19 and 3.0%, 7.2% and 3.56%, respectively in 2019-20. This might be due to application of higher doses of nitrogen through organic sources resulted in enhanced soil microbial population which converted the organically bound nitrogen to inorganic form through mineralization. Higher availability of phosphorus may be ascribed to the addition of nitrogen in the form of organic manures which not only improved solubilization of fixed soil phosphorus but also restricted its fixation. Similarly, greater availability of potassium might be due to addition of higher amount of potassium from exchangeable pool to available pool [26]. Similar results have also been reported by Pandey (2018) [27].

3.2.2 Residual effect of treatments

A close examination of the data revealed that the application of various fertility levels did not influence the available nitrogen, phosphorus and potassium content in soil. However, the highest values were obtained at 100% RDF over the lower levels of fertility (Table.3). Application of vermicompost recorded maximum soil available nitrogen, phosphorus and potassium, though the differences among the sources did not touch the level of significance

4. CONCLUSION

From the above experiment it was concluded that the direct effect of fertility levels did not show any significant difference on soil health. Similarly, various organic sources and application of nitrogen level through organic sources failed to bring any significant direct effect on soil pH and electric conductivity in 2018-19 and 2019-20. Whereas, application of 50 kg N ha⁻¹ through vermicompost recorded significant effect on soil available N, P and K after the harvest of fodder oat. However, all the treatments failed to exhibit residual effect on soil health during course of the study. Therefore, application of 100% RDF along with 50 kg N ha⁻¹ through vermicompost can be practiced to maintain soil health in eastern Uttar Pradesh.

5. REFERENCES

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