Environment and Ecology 38 (2) : 123—127, April—June 2020
ISSN 0970-0420

Direct and Residual Effect of Inorganic and Organic Sources on Soil Health in Eastern Uttar Pradesh

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Received 18 January 2020; Accepted 12 March 2020; Published on 3 April 2020

ABSTRACT

A field experiment was conducted during pre-*kharif* and *kharif* seasons of 2014 and 2015 at Varanasi to study the direct and residual effect of fertility, nitrogen levels and organic sources on soil health. Application of fertility levels did not show any significant direct and residual effect on soil health during 2014 and 2015. However, higher values were recorded with the application of 100% RDF. Whereas , application of 50 kg nitrogen ha^{-1} through organic sources recorded significantly higher available N, P, K and S after baby corn harvest. Likewise, maximum values of available NPKS after baby corn harvest were observed with the application of FYM as compared to vermicompost and sewage sludge the course of study. Nonetheless, nitrogen levels and organic sources failed to touch the level of significance on soil health parameters after rice harvest.

Keywords Fertility levels, Nitrogen, Organic sources, Available NPKS.

INTRODUCTION

The food grain production in India has reached to the plateau and factor productivity is declining particularly in high productive zone of North India. Therefore, now it has become essential to ponder how crop cultivation itself can excel the economic condition of the farming community. Maize (*Zea mays* L.) is a versatile cereal crop grown all over world and due to its photo and thermo insensitivity has wide adaptability. In the recent years, baby corn maize has gained popularity as a valued vegetable through out the world including India as well. Being a short duration as photo and thermo insensitivity crop, it fits easily in an intensive cropping systems, more particularly as a pre-*kharif* crop and ensures best utilization of land which otherwise remain fallow during this period (Kumar and Bohra 2014). Baby corn is a short duration crop occupying about 60-65 days in the field but very high doses of nutrients are applied to soil in its cultivation. Therefore, sizable

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amount available nutrients are expected to left in the soil, particularly when the organic manures are applied along with the chemical fertilizers. Residual effects of organic manures on chemical peroperties of soil was studied by Tabibian et al. (2012) and they found significant increase in organic matter, electrical conductivity. Organic amendments play a residual role in their on going maintenance. Residual amendment effects on total nitrogen and phosphorus were apparent even after 11.5 year of application (Larney et al. 2011). This residual effect of nutrients if exploited can reduce the cost on nutrient application of succeeding crop. In view of these facts, an experiment was undertaken at Agricultural Research Farm, Banaras Hindu University, Varanasi during pre-*kharif* and *kharif* seasons of 2014 and 2015 to determine the direct and residual effect of fertility levels, nitrogen levels and organic sources on the soil health under irrigated conditions.

MATERIALS AND METHODS

Experimental site and treatment combination

A field experiment was conducted during pre-*kharif* and *kharif* seasons of 2014 and 2015 at Agricultural Research Farm, Varanasi, under irrigated condition. The experimental location is situated at 25°18´ N latitude, 83°03´ E longitude and at an altitude of 128.93 m above mean sea level. The experimental soil was sandy loam in texture having a pH of 7.43 (1 : 2.5 soil : Water) and neutral in reaction. It was moderately fertile, being low in organic carbon (0.33%). The experimental soil contents (0-30 cm) low in available N and K were 192.81 and 182.04 kg ha^{-1}. The available phosphorus (0.5 M $NaHCO_3$ extractable) and sulfur were medium (18.78 and 17.60 kg ha^{-1}). The experiment was carried out at the same site during both the years in the split plot design and replicated thrice with NPKS (100%, 75% and 50% RDF (recommended dose of fertilizer) in the main plots and nitrogen application through organic sources (25 and 50 kg N ha^{-1}) and organic sources (FYM, vermicompost and sewage sludge) in the subplots. Each replication was divided into three main plots and every main plot into six subplots. Thus, in all there were 18 (3 main plots×6 subplots) treatment combinations and 54 experimental units in the experiment . Baby corn hybrid HM-4 was sown in summer season as a main crop and rice (HUR-105) was taken as residual crop after baby corn harvest during 2014 and 2015, respectively. In baby corn, nitrogen was applied in three splits per treatment, i.e. half of basal, 25% at knee high and 25% at tassel emergence stages. The entire doses of P, K and S were applied as di-ammonium phosphate (DAP), muriate of potash (MOP) and elemental sulfur at the time of last ploughing. Organic manures were incorporated in plots 10 days before the sowing of baby corn. The quantities of organic manures were calculated on the basis of nitrogen present in them. Sewage sludge was air dried and grounded before applied in the field. FYM and vermicompost were applied as fresh in the plots. The moisture content of all three manures was calculated and all were applied on dry weight basis. The recommended dose of NPK (100% RDF) represents 150-75-60-40 kg NPKS ha^{-1}. After the harvesting of baby corn rice was taken as residual crop and individual plots were prepared and puddle by using power tiller without disturbing the layout. In all the plots nutrients were applied at 50% RDF (60, 30, 30 kg NPK ha^{-1}). Half of the N and full dose of P and K were applied as basal and rest 50% N was top dressed in two equal splits at critical tillering and panicle initiation stages.

Soil analysis

Soil samples from 0–15 cm depth were collected just before sowing for determining the initial physico-chemical properties and after harvesting of baby corn and rice for analyzing their organic carbon, available N, P, K and S. The samples were oven dried, grounded and sieved through a 2 mm mesh. Organic carbon , available N, P,K,S and Zn were estimated by the following rapid titration methods (Walkley and Black1934), Modified Kjeldahl methods (Jackson 1973), Olsen's method (Olsen et al. 1954), Flame photometer method (Jackson 1973) and Turbidimetric method (Chesnin and Yien 1950), respectively.

Statistical analysis

The data pertaining to each characters of the experimental crops were sorted out, tabulated and finally analyzed statistically by applying the standard tech-

Table 1. Effect of fertility, nitrogen levels and organic sources on soil health after baby corn harvest.

Treatments	Soil parameters													
	pH		EC (dSm)		OC (%)		Avl N (kg ha^{-1})		Avl P_2O_5 (kg ha^{-1})		Avl K_2O (kg ha^{-1})		Avl S (kg ha^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Fertility levels														
100% RDF	7.40	7.41	0.348	0.362	0.345	0.365	206.7	209.0	16.25	16.85	185.4	188.6	17.07	17.99
75% RDF	7.38	7.39	0.341	0.347	0.339	0.353	199.0	200.0	15.59	16.14	178.5	180.1	16.41	16.77
50% RDF	7.27	7.28	0.330	0.337	0.330	0.342	194.8	196.4	15.31	15.86	174.6	175.6	15.79	16.46
SEm ±	0.11	0.08	0.005	0.005	0.005	0.005	3.31	3.06	0.24	0.25	2.37	2.59	0.24	0.46
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen levels (kg ha^{-1} through organic sources)														
N_{25}	7.33	7.34	0.336	0.345	0.335	0.349	193.0	194.6	15.47	16.03	175.7	177.6	16.12	16.38
N_{50}	7.37	7.38	0.343	0.352	0.340	0.357	207.3	209.0	15.96	16.53	183.3	185.3	16.73	17.77
SEm ±	0.05	0.06	0.003	0.003	0.003	0.003	3.38	3.11	0.10	0.12	1.45	1.71	0.13	0.24
CD (p=0.05)	NS	NS	NS	NS	NS	NS	9.8	9.0	0.28	0.33	4.2	4.9	0.39	0.68
Organic sources														
FYM	7.35	7.36	0.345	0.354	0.345	0.358	212.6	214.4	16.07	16.72	184.7	187.7	17.02	17.93
Vermicompost	7.31	7.33	0.339	0.349	0.336	0.355	200.1	201.4	15.71	16.28	179.5	181.5	16.47	17.08
Sewage sludge	7.39	7.40	0.334	0.342	0.332	0.346	187.8	189.7	15.36	15.84	174.3	175.1	15.77	16.21
SEm ±	0.07	0.07	0.004	0.004	0.004	0.004	4.14	3.81	0.12	0.14	1.78	2.10	0.16	0.29
CD (p=0.05)	NS	NS	NS	NS	NS	NS	12.0	11.0	0.34	0.41	5.1	6.1	0.47	0.84

niques to draw a valid conclusion. The significance of treatment differences were judged by F-test as outlines by (Cochran and Cox1992). To evaluate the significant difference between two treatment means, critical difference CD at 5% level was worked out (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Soil pH, EC (dS m^{-1}) and organic carbon (%)

Direct effect of treatments

It is evident from the data that fertility levels failed to show considerable direct effect on soil pH, electric conductivity(dS m^{-1}) and organic carbon content in both the years. However, it was found maximum with the application of 100% RDF compared to 75% and 50% RDF, respectively (Table 1). A perusal of the data clearly indicated that direct effect of nitrogen application through organic sources slightly improved the soil pH, electric conductivity (dS m^{-1}) and organic carbon content with the application of 50kg N ha^{-1} over 25 kg N ha^{-1}, but the differences due to different nitrogen levels were not significant in both the years of trial (Table 1). Study of the data revealed that the application of three organic sources also failed to show direct impact on the soil pH, electric conductivity (dS m^{-1}) and organic carbon content after harvest of baby corn in either of the two years experimentation (Table 1). However, application of FYM proved to be better over remaining sources.

Residual effect of treatments

The applied treatments in baby corn have been concerned for their residual effect on soil health of succeeding rice. The application of fertility levels did not bring any residual effect on soil pH, electric conductivity (dS m^{-1}) and organic carbon content in both the years (Table 2). Nevertheless, it was found maximum with the application of 100% RDF over 75% and 50% RDF, respectively,. Similarly, application of nitrogen through organic sources also failed to show residual effect on soil pH, electric conductivity

Table 2. Residual effect of fertility, nitrogen levels and organic sources on soil health after rice harvest.

Treat-ments	Soil parameters													
	pH		EC (dS m^{-1})		OC (%)		Avl N (kg ha^{-1})		Avl P_2O_5 (kg ha^{-1})		Avl K_2O (kg ha^{-1})		Avl S (kg ha^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Fertility levels														
100% RDF	7.39	7.41	0.340	0.351	0.332	0.341	194.6	196.3	15.24	15.81	175.3	177.0	15.74	15.97
75% RDF	7.37	7.38	0.332	0.343	0.328	0.337	189.8	190.8	14.97	15.24	171.0	173.0	14.62	15.21
50% RDF	7.26	7.29	0.321	0.335	0.318	0.324	182.3	184.1	14.16	14.67	164.5	166.1	14.40	14.63
SEm ±	0.14	0.14	0.004	0.005	0.004	0.005	3.61	4.63	0.28	0.37	3.68	3.80	0.28	0.30
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen levels (kg ha^{-1}) through organic sources														
N_{25}	7.33	7.35	0.329	0.339	0.324	0.331	187.6	188.9	14.57	14.96	167.8	169.9	14.61	15.05
N_{50}	7.35	7.37	0.333	0.347	0.328	0.337	190.1	191.9	15.01	15.52	172.7	174.2	15.23	15.49
SEm ±	0.11	0.09	0.003	0.003	0.003	0.004	2.81	2.18	0.22	0.17	2.64	2.74	0.22	0.19
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Organic sources														
FYM	7.35	7.37	0.336	0.349	0.331	0.341	190.2	192.3	15.12	15.62	173.7	174.0	15.18	15.61
Vermicompost	7.30	7.33	0.333	0.344	0.328	0.335	189.1	190.5	14.91	15.19	170.0	172.3	14.95	15.41
Sewage sludge	7.37	7.38	0.324	0.336	0.319	0.326	187.4	188.4	14.34	14.91	167.1	169.9	14.63	14.79
SEm ±	0.13	0.11	0.004	0.004	0.003	0.005	3.44	2.67	0.27	0.21	3.23	3.36	0.27	0.24
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

(dS m^{-1}) and organic carbon content and the maximum values were obtained with the application of 50 kg N ha^{-1} over 25 kg N ha^{-1} in both the years of trial (Table 2). Application of organic sources also failed to show residual impact on the soil pH, electric conductivity (dS m^{-1}) and organic carbon content in either of the two years experimentation. Though, application of FYM proved to be better over vermicompost and sewage sludge during course of the study (Table 2).

Available nitrogen, phosphorus, potassium and sulfur (kg ha^{-1})

Direct effect of treatments

Application of fertility levels failed to bring significant difference on available nitrogen, phosphorus, potassium and sulfur content in soil after harvesting of baby corn during both the years of study. Nonetheless, the highest values were observed with the application of 100% RDF over 75% and 50% RDF, respectively (Table 1).

Whereas, application of 50 kg N ha^{-1} through organic sources recorded significantly highest available nitrogen (207.3 and 209.0 kg ha^{-1}), phosphorus (15.96 and 16.53 kg ha^{-1}), potassium (183.3 and 185.3 kg ha^{-1}) and sulfur (16.73 and 17.77 kg ha^{-1}) content after harvesting of baby corn over application of 25 kg N ha^{-1} during 2014 and 2015 (Table 1), respectively. Application of higher levels of organic manures might have improved the activity of beneficial micro-organisms due to increase in the fast decomposing organic matter fraction as consequence there was higher availability of N, P, K and S in soil.

Similarly, marked variation on available nutrient content in soil was noticed with the application of organic sources during the trial. Application of FYM resulted in significantly highest available nitrogen (212.6 and 214.4 kg ha^{-1}), phosphorus (16.07 and 16.72 kg ha^{-1}), potassium (184.7 and 187.7 kg ha^{-1}) and sulfur (17.02 and 17.93 kg ha^{-1}) content in soil after harvesting of baby corn as compared to vermicompost and sewage sludge during both the years, respectively (Table 1). It might be due to direct addition of N through FYM and greater multiplication of soil microbes, which convert organically bound

N to inorganic form. The increase in P content may be ascribed to the capacity of FYM to form a cover of sesquioxide which reduces the phosphate fixation. The availability of K might be due to addition of K to the available pool of the soil (Panwar 2008). Another reason may be short duration baby corn crop, could not fully utilize the applied nutrients and remained left in the soil. More availability of nutrients in soil can be attributed to the efficiency of FYM resulting in slow release of nutrients. This might be attributed to increased population of beneficial micro-organisms like N-fixers, P-solubilizers and higher nitrogenase and urease enzyme activity in soil. This led to increased concentration of nutrients and improved the soil chemical parameters. Similar results have also been reported by (Ram et al. 2009, Singh et al. 2010, Barod and Dhar 2015).

Residual effect of treatments

The application of fertility levels did not bring any significant difference on soil nitrogen, phosphorus, potassium and sulfur content of soil during the study and the maximum values were observed with the application of 100% RDF (Table 2). Likewise, application of nitrogen through organic sources also failed to touch the level of significance during the trial (Table 2). However, maximum available N, P, K and S content in soil was noted with the application of 50 kg N ha^{-1} over 25 kg N ha^{-1}. Application of FYM recorded highest available nitrogen, phosphorus, potassium and sulfur content in soil. However, the difference between the sources did not reach the level of significance (Table 2).

CONCLUSION

The direct effect of fertility levels failed to bring significant difference on soil health. similarly, application of nitrogen level through organic sources and application of organic sources did not show any direct effect on soil pH, electric conductivity and organic carbon content in 2014 and 2015. Whereas, application of 50 kg N ha^{-1} through FYM showed significant direct effect on available N, P, K and S content in soil during the trial. However, all the treatments failed to exhibit residual effect on soil health during course of the study. Therefore, combined application of 100% RDF along with 50 kg N ha^{-1} through FYM to maintain soil health in eastern Uttar Pradesh.

ACKNOWLEDGEMENT

The authors are grateful to the referees and editor for the valuable suggestions and advice, which greatly enhanced the quality of this manuscript.

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