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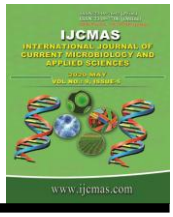

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Effect of Organic and Inorganic Sources of Nutrients on Soil Chemical Properties and Nutrient Availabilities under Direct Seeded Rice in *Inceptisols* of Bastar Plateau Zone

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A B S T R A C T

A field experiment was carried out at S.G. College of Agriculture and Research Station, Jagdalpur, Chhattisgarh during *Kharif* 2016 to study the effect of organic and inorganic sources of nutrients on soil chemical properties and nutrient availabilities under direct seeded rice in *Inceptisols* of Bastar plateau zone. The experiment was conducted in randomized block design with twelve treatments and four replications. The 100% NPK i.e. recommended dose of fertilizers were 100:60:40 kg N: P_2O_5: K_2O/ ha for rice crop. Soil samples were collected from the top soil surface (0-15 cm) of all the four replications before and after *Kharif* 2016 and analyzed for chemical properties and nutrients availabilities. The highest pH (6.70) was recorded in 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_{12}) whereas the lowest pH (6.1) was recorded in 100% NPK. A slight increase in soil pH was observed in all the treatments which received FYM and lime and decrease was recorded in treatments which received inorganic nutrient sources as compared to the initial. The continuous application of organic materials along with fertilizers significantly increased the soil organic carbon as compared to the application of fertilizers alone. The use of organic manure like FYM with chemical fertilizers increased the availability of macro (N, P, K, S, Ca, and Mg) and micro (Zn) nutrients in soil over chemical fertilizer alone.

Introduction

Rice (*Oryza sativa* L.) occupies a pride place among the food crops cultivated in India which has the largest area among rice growing countries and stands second in the production. In India, during the past three decades, intensive agriculture involving high yielding varieties of rice has led to heavy withdrawal of nutrients from the soil.

Use of organic manures in present agriculture is decreasing day by day. Its utility has not only improved the physical, chemical and biological properties of soil but also maintained the good soil health.

Long-term experiment has shown that crop residues incorporation, farm yard manures and green manures increased soil +organic carbon and nutrient availability as compared

to the nitrogenous fertilizers alone (Lado *et al.*, 2004). The advantage of combining organic and inorganic sources of nutrients in integrated nutrient management has been proved superior to the use of each component separately (Palaniappan and Annadurai, 2007). The use of organics plays a major role in maintaining soil health due to buildup of soil organic matter, beneficial microbes. The conjunctive application of organics with inorganic sources of nutrient reduces the dependence on chemical inputs and it not only acts as a source of nutrient but also provides micronutrient as well as modifies the soil physical behaviour and increases the efficiency of applied nutrients (Pandey *et al.*, 2007). Integrated application of inorganic fertilizers and organic manures with micronutrients helped in increasing the availability of nutrients and in sustaining and restoring soil fertility in its available nutrients and major physical and chemical characteristics of the soil. Utilization of indigenous organic sources, *viz*. farmyard manure (FYM), obnoxious weeds and green leaf manures may serve as alternatives or supplements to chemical fertilizers, and help in increasing the productivity of the rice-based cropping system in all zones of the country.

Materials and Methods

The field experiment was conducted in midland field under long term fertilizer experiment, AICRIP-Dryland Agriculture at SG College of Agriculture and Research Station, Kumhrawand, Jagdalpur (C.G.) during *Kharif* 2016. The experimental soils was sandy loam having pH 6.3 and EC 0.02 dSm^{1}, organic carbon status 0.56%, 186 kg ha^{1} of alkaline $KMnO_4$ N, 21.4 kg ha^{-1} P, 178 kg ha^{1} of NH_4OAC- K, 33 kg ha^{1} of Turbidimetric- S, 92 and 58 kg ha^{-1} of EDTA titrated- Ca & Mg, respectively and 1.03 ppm DTPA extractable zinc. The experiment was conducted with twelve treatments namely T_1(control), T_2(100% NPK i.e. 100:60:40 kg/ha N: P_2O_5: K_2O), T_3(100% PK), T_4(100% NK), T_5(100% NP), T_6(100% NPK+5 t FYM), T_7(100% NPK+5 t FYM+ $ZnSO_4$@25kg ha^{-1}), T_8(100% NPK+5 t FYM+ $ZnSO_4$@25kg ha^{-1} + Lime 3 q ha^{-1}), T_9 (50% NPK), T_{10}(50% NPK + 5 t FYM), T_{11} (50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}) and T_{12} (50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}+ Lime 3 q ha^{-1}). The experiment was laid out in randomized block design (RBD) with four replications. Soil samples were collected from the top soil surface (0-15 cm) of all the four replications before and after *Kharif* 2016 and analyzed for chemical properties and nutrients availabilities using standard procedures.

Results and Discussion

pH

The pH of the soil was statistically influenced by different treatments (Table 1). The pH of the soil ranged from 6.11 to 6.70. The highest (6.70) value was recorded in 50% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_{12}) whereas the lowest (6.1) value was recorded in 100% NPK. A slight increase in soil pH was observed in all the treatments as compared to the initial (6.59) soil pH studied during the starting of the experiment. This was ascribed to the neutralizing effect of lime in the field. This was supported by the findings of Parvathi *et al.*, (2013).

Organic carbon

The continuous application of organic materials along with fertilizers significantly increased the soil organic carbon as compared to the application of fertilizers alone (Table 1). The highest (0.83 %) value was observed in 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (T_7) followed (0.82) by % NPK +5 t FYM

+ $ZnSO_4$ @ 25 kg/ ha+ Lime 3q/ha (T_8) (0.82) where as the lowest (0.52) was observed in 100% PK (T_3). Organic carbon plays an important role in maintaining soil health and its increase during the period of experimentation shows that use of fertilizers has contributed in improving the soil health. The highest value of organic content *i.e.* 0.83% in 100% NPK+5 t FYM + $ZnSO_4$ @ 25 kg/ ha treatment can be assigned to the annual use of FYM @ 5 ton ha^{-1} during the period of experimentation. This also indicates that if fertilizer use is integrated with manure, substantial improvement in soil health can be expected. The similar results were also found by Sharma and Sharma (2002), Kumar *et al.*, (2001) and Antil *et al.*, (2011).

Available nitrogen

The combine application of manure and fertilizer exhibited a significant effect on available nitrogen in the soil. The 100% NPK + 5 t FYM (T_6) treated plot had significantly greater available Nitrogen (264.2 kg/ha) followed by 100% NPK + 5 t FYM + $ZnSO_4$@25kg/ha (T_7) treated plot as compared to control and other treatments plots. The 100% NPK + 5 t FYM (T_6) and 100% NPK + 5 t FYM + $ZnSO_4$@25kg/ha (T_7) treatments registered 56.4% and 47.3% higher available nitrogen than the control. A perusal of the data (Table 1) revealed that available nitrogen varied from 150.1 kg/ ha under control (T_1) to 275.6 kg/ ha under 100% NPK + 5 t FYM (T_6). Application of chemical fertilizers with organic manures increased available nitrogen over other treatments as well as control.

Application of 50 and 100% NPK (T_9 & T_2), 100% NP (T_5) and 100% NK (T_4) and 100% PK (T_3)significantly increased the available nitrogen content in soil over control. Similarly, incorporation of organic manures along with chemical fertilizers also increased available nitrogen content over control. The highest available nitrogen (264.2 kg ha^{-1}) was found in the plots which received 100% NPK + 5 t FYM followed by 100% NPK + 5 t FYM + $ZnSO_4$@25kg/ha (T_7) (248.8 Kg ha^{-1}). Amongst sources of nutrients, FYM with inorganics fertilizer proved best as compare to inorganics alone.

The lower available nitrogen in control plot (168.9 kg ha^{-1}) is a result of mining of available nitrogen with continuous cropping without fertilization over a long period of time. Increase in available nitrogen with organics is attributed to its direct addition through organics as FYM contained 264.2 kg ha^{-1}available nitrogen. The favorable soil conditions viz. organic carbon, porosity, water holding capacity etc. might have helped in the mineralization of soil nitrogen leading to buildup of higher available nitrogen. The results are in conformity with the findings of Singh *et al.*, (2007) and Urkurkar *et al.*, (2010).

Available phosphorus

The available phosphorus was significantly influenced by the fertilizer and organic manure applied over the cropping years. The 50% NPK + 5 t FYM + $ZnSO_4$@25kg ha^{-1} (T_{11}) recorded significantly higher available phosphorus as compared to its value in other treatments. Available Phosphorus content of soil was increased as compared to its initial status. The 100% NPK+ 5 t FYM (T_6) also recorded significantly higher available phosphorus than control and other treatments. The 50% NPK + 5 t FYM + $ZnSO_4$@25kg ha^{-1} (T_{11}) and 100% NPK+ 5 t FYM (T_6) registered 118.6% and 107.4% higher available phosphorus than the control, respectively. The data given in table 1 revealed that the available phosphorus content of soil during *Kharif* 2016 varied from 9.4 to 31.3 kg ha^{-1}amongst different treatments.

Graded doses of chemical fertilizers also increased the available phosphorus contents in soil over control. Among the plots treated with FYM, zinc sulphate, lime and RDF recorded highest available phosphorus content followed by FYM plus RDF.

The organic matter forms a cover on sesquioxides and makes them inactive and thus reduces the phosphate fixing capacity of the soil, which ultimately, helps in release of ample quantity of phosphorus. Similar result was found by Tolanur and Badanur (2003).

Available potassium

The available potassium was significantly affected by long-term application of inorganic fertilizer and manure. The available K in 100% NPK + 5 t FYM were significantly higher than other treatments. Fertilizer plus manure application (100% NPK + 5 t FYM) increased available potassium by 43.5% followed by100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha + lime 3 q/ha (T_8) 37.3% as compared to the control.

The data tabulated in Table 1 revealed that during *Kharif* 2016,available K content of soil varied from a minimum of 139.8 kg ha^{-1}under control to a maximum of 214.2 kg ha^{-1} under 100% NPK + FYM. Application of organic manures along with chemical fertilizers increased the available K content of soil significantly over control. Increase in available potassium due to addition of organic manures may be ascribed to the reduction of potassium fixation and release of potassium due to interaction of organic matter with clay, besides the direct potassium addition to the pool of soil (Urkurkar *et al.,* 2010). Such increase in the content of available potassium with the use of organics with chemical fertilizers has also been reported by Singh *et al.,* (2007).

Available sulphur

The data on available sulphur content in soil after harvest of rice crop was arranged in Table 1. The range of available sulphur was vary from 17.3 to 51.2 kg/ha in various treatments. Highest available sulphur 45.7 kg ha^{-1} was obtained with T_{11} (50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}) followed by T_{12} (50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}+ Lime 3 q ha^{-1}) (44.1 kg ha^{-1}) and lowest (23.9 kg ha^{-1}) in control. Continuous use of organic and inorganic sources of nutrients since 2014-15 is conducive for maintaining the soil available sulphur. The results of the present study revealed that higher available sulphur content were recorded in integrated nutrient management treatments which were relatively half does of nutrient as compared to absolute inorganics and control.

Available calcium

The available calcium was not significantly influenced by the fertilizer and organic manure applied over the cropping years. The 100% NPK + 5 t FYM treatment recorded higher (94.5 kg/ha) available calcium as compared to its value in other treatments.

The 100% NPK + 5 t FYM(T_6) and50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}+ Lime 3 q ha^{-1}(T_{12}) treatments registered 4.21% and 3.74% higher available calcium than the control. The data given in table 1 revealed that the available calcium content of soil during *Kharif* 2016 varied from 88.4 to 96.2 kg ha^{-1}amongst different treatments.

Graded doses of chemical fertilizers also increased the available calcium contents in soil over control. Among the plots treated with FYM, zinc sulphate, lime and RDF recorded highest available calcium content followed by FYM plus RDF. Similar result was found by Chukwu *et al.,* (2012).

Table.1 Effect of organic and inorganic sources of nutrients on soil properties after *Kharif* rice harvest

Treatment	pH	OC %	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)	Available S (kg/ha)	Available Ca (kg/ha)	Available Mg (kg/ha)	Available Zn (ppm)
Control	6.28	0.57	168.9	13.4	145.6	23.9	90.7	57.3	1.00
100% NPK	6.11	0.75	200.5	22	174.7	30.7	92.2	55.3	0.98
100% PK	6.33	0.52	159.0	26.8	194.5	28.6	91.0	55.9	0.99
100% NK	6.19	0.57	197.7	16.0	190.4	23.6	91.4	55.5	0.98
100% NP	6.26	0.57	214.6	24.9	140	26.0	89.7	54.8	0.98
100% NPK+5 t FYM	6.44	0.82	264.2	27.8	209	35.4	94.5	58.4	1.04
100% NPK+5 t FYM+ $ZnSO_4$@25kg ha^{-1}	6.46	0.86	248.8	24.6	200	41.7	93.8	58.8	1.09
100% NPK+5 t FYM+ $ZnSO_4$@25kg ha^{-1} + Lime 3q ha^{-1}	6.62	0.87	229.9	26.7	189.8	37.9	94.3	58.8	1.10
50% NPK	6.19	0.71	189.3	19.6	162.6	32.8	90.0	56.6	0.99
50% NPK + 5 t FYM	6.45	0.76	233.3	25.5	196.3	41.3	93.2	58.5	1.04
50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}	6.51	0.81	231.8	29.3	190.4	45.7	92.8	59.2	1.10
50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}+ Lime 3 q ha^{-1}	6.70	0.84	242.6	26.0	189.3	44.1	94.1	59.3	1.10
CV %	1.11	7.75	5.3	12.0	4.0	14.6	1.5	2.5	2.86
CD (5%)	0.10	0.08	16.5	4.0	10.5	7.2	2.0	2.0	0.04
CD (1%)	0.13	0.10	22.2	5.4	14.1	9.7	2.7	2.8	

Available magnesium

The data on available Mg content in soil after harvest of rice crop was arranged in Table 1. The range of available Mg was vary from 53 to 61.2 kg/ha in various treatments.

Highest available Mg 59.3 kg ha^{-1} was obtained with T_{12}(50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1} + Lime 3 q ha^{-1}) followed by (59.2 kg ha^{-1}) T_{11}(50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}) treatment and lowest (57.3 kg ha^{-1}) in control.

Continuous use of balanced fertilizer i.e. organic and inorganic since 2014-15 is conducive for maintaining the soil available Mg. The results of the present study revealed that higher available Mg content were recorded in integrated nutrient management treatments which was relatively half does of nutrient as compared to absolute inorganics and control. Similar result was found by Hemalatha and Chellamuthu (2013).

DTPA extractable zinc

The DTPA extractable zinc was not significantly influenced by the fertilizer and organic manure applied over the cropping years. The treatment T_8(100% NPK+5 t FYM+ $ZnSO_4$@25kg ha^{-1} + Lime 3 q ha^{-1}), T_{11}(50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}) and T_{12}(50% NPK + 5 t FYM+ $ZnSO_4$@25kg ha^{-1}+ Lime 3 q ha^{-1}) were recorded the highest (1.10 ppm) availability of zinc. Followed by treatment 100% NPK +5 t FYM + $ZnSO_4$ @ 25 kg/ ha (1.09 ppm).

The combine use of RDF, FYM, lime, and zinc sulphate increase the availability of zinc in the soil as compare to RDF alone. Even though half does of RDF also increased the zinc availability when that is applied with organics nutrient. Similar result was found by Vidyavathi (2012).

Continuous application of chemical fertilizers with integration of the organics influence pH of soil significantly. However, the organic carbon content was higher in 100% NPK+5 t FYM+ $ZnSO_4$@25kg ha^{-1} treatments. The inorganic fertilizer and organic manure maintained and/or sustained highest levels of available N, P, K, S, Ca, Mg, and Zn due to its long-term application. Higher response was observed in integrated use of organic along with inorganic fertilizer for the nutrient supply of rice crop and further it improves the organic carbon and available nitrogen and potassium content of soil.

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