J. Soils and Crops 29 (1) 63-67, June 2019

ISSN 0971-2836
NAAS Rating - 4.46
Scientific Journal Impact Factor - 6.736

EFFECT OF DIFFERENT ORGANICS AND INORGANICS ON AVAILABLE NUTRIENTS OF SOIL IN A VERTISOL UNDER MAIZE (*Zea mays* L.) CROP

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ABSTRACT

A field experiment was undertaken during *kharif* 2016 in order to study the "Effect of different organics and inorganics on available nutrients of soil in a Vertisol under maize crop". The experiment was laid in a randomized block design with thirteen treatments and three replications. Application of 100 per cent RDF + poultry manure recorded highest available major nutrients (N, 356.01; P_2O_5, 61.81; K_2O, 496.71 ; and S, 26.11 kg ha^{-1}) and micronutrients (Zn, 0.97; Fe, 7.91; Mn; 6.90 and Cu, 1.70 mg kg^{-1}) in post harvest soil followed by application of 100 per cent RDF+ sheep manure. The treatments which received organics alone recorded lowest nutrients content in the post harvest soil. The field trial thus, revealed that an integrated supply of organic manures with chemical fertilizers significantly increased the all available major, secondary and micronutrients in both surface and subsurface post harvest soil.

(Key words: Maize, manures, primary and micronutrients)

INTRODUCTION

Maize (*Zea mays* L.) has high genetic yield potential than other cereal crops. Hence, it is called as 'miracle crop' and also as 'queen of cereals'. As heavy feeder of nutrients, maize productivity is largely dependent on nutrient management. Low soil fertility is one of the bottlenecks to sustain agricultural production and productivity. Intensive cultivation, growing of exhaustive crops, use of unbalanced and inadequate fertilizers accompanied by restricted use of organic manures have made the soils not only deficient in the nutrients, but also deteriorated the soil health resulting in decline in crop response to recommended dose of fertilizers. Under such situation, integrated plant nutrient system (IPNS) has assumed a great importance and has vital significance for the maintenance of soil productivity. Organic manures, particularly FYM, vermicompost, sheep manure and poultry manure, not only supply macronutrients but also meet the requirements of micronutrients, besides improving soil health. To sustain the soil fertility and crop productivity the role of organic manures and fermented organic nutrients are very important.

The field trial thus, revealed that an integrated supply of organic manures with chemical fertilizers significantly increased the all available major, secondary and micronutrients in both surface and subsurface post harvest soil.The organic manures in addition to nutrients contain microbial load and growth promoting substances which helps in improving the plant growth, metabolic activity and resistance to pest and diseases. Boosting yield, reducing production cost and improving soil health are three inter -linked components of the sustainable triangle.

MATERIALS AND METHODS

The study was conducted in the long term maize experimental field at main agricultural research station (MARS), Dharwad, Karnataka during *kharif,* 2016. The experiment was laid out in randomized complete block design with 13 treatments, replicated thrice. The treatments included, 100 per cent RDF+ FYM (T_1), 100 per cent RDF + Vermicompost (T_2), 100 per cent RDF + Poultry manure (T_3), 100 per cent RDF + Sheep manure (T_4), FYM alone (T_5), Vermicompost alone (T_6), Poultry manure alone (T_7), Sheep manure alone (T_8), 50 per cent RDF +FYM (T_9), 50 per cent RDF + Vermicompost (T_{10}), 50 per cent RDF + Poultry manure (T_{11}), 50 per cent RDF + Sheep manure (T_{12}) and RDF alone (T_{13}). The quantity of Farm yard manure (FYM), Vermicompost (VC), Poultry manure (PM) and Sheep manure (SM) applied was based on their N content to meet RDN in organic alone treatment and on equivalent basis of N in FYM in all other INM treatments. Recommended dose of nitrogen, phosphorus and potassium were applied in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively at the time of sowing of maize.

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After the harvest of crop, the soil samples were collected from a depth of 0-22.5cm and 22.5- 45.0 cm from each treatment and the soil samples were analyzed for the available nitrogen by modified alkaline potassium permanganate method (Sharawat and Buford,1982), phosphorus by chlorostannous reduced blue colour method (Jackson, 1973), potassium by flame photometer method (Sparks,1996), sulphur by turbidimetric method using Spectrophotometer (Sparks,1996) and DTPA-extractable micronutrients(zinc, iron, copper and Manganese) were measured by atomic absorption spectrophotometer (Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

The data regarding available N, P, K and S status in post harvest soil are given in table 1.

Available nitrogen

In surface soil, significantly highest available nitrogen (356.01 kg N ha^{-1}) was recorded in treatment receiving 100 per cent RDF + poultry manure (T_3) followed by T_4 (100 % RDF + sheep manure). Available nitrogen content in sub surface soil (173.01 to 223.82 kg N ha^{-1}) was much lower than surface soil in all the treatments and it did not differ significantly. The higher available nitrogen content of soil due to addition of poultry manure was due to the fact that the C:N ratio of poultry manure is narrow than FYM, vermicompost and sheep manure which accentuates the release of nitrogen in soil and thus contributing to the available pool of nitrogen in soil (Chadwick *et al.,* 2000).

Available phosphorus

In surface soil, the highest available phosphorus (61.81 kg P_2O_5 ha^{-1}) was recorded in treatment T_3 (100 % RDF + poultry manure) followed by T_4 (100 % RDF + sheep manure). Among the treatments with organics alone, poultry manure applied soil (T_7) accounted for significantly higher phosphorus (36.22 kg P_2O_5 ha^{-1}) than other organics. In the subsurface soil, the availability of phosphorus was highest (40.01 kg P_2O_5 ha^{-1}) in 100 per cent RDF + poultry manure (T_3) followed by 100 per cent RDF + vermicompost (T_2). This is attributable to the solubilisation of P by the organic acids released by the organic manures during their decomposition, reduction of P fixation in the soil due to chelation of P with organic ligands and also to the enhanced microbial activity (Sathya, 2010). In addition, phosphorus is relatively immobile nutrient which moves in soil by diffusion and is regulated by soil moisture. Addition of organic manure increases soil moisture content thereby improving the P availability in soil (Boateng *et al*., 2006).

Available potassium

Available potassium content in surface soil ranged from 450.03 to 496.71 kg K_2O ha^{-1} and all the treatments were on par with each other. But, however, the treatments differed significantly for potassium availability in the subsurface soil. The highest available potassium in the surface soil (496.71 kg K_2O ha^{-1}) was recorded in T_3 treatment which received 100 per cent RDF + poultry manure, whereas in the subsurface soil, the highest available potassium was found in treatment which received 100 per cent RDF + sheep manure (T_4). Application of different organic manures alone or in combination with fertilizers did not significantly influence the available potassium status of the surface soil. This might be due to high potassium status of experimental soil (475.13 kg K_2O ha^{-1}) and excess K after crop utilization might have been fixed in the soil in non exchangeable form. The available K status in sub soil was also high but lower than surface soil. Although the treatments influenced its availability in sub soil, all the treatments except those with 100 per cent RDF + organics (T_1 to T_4) were on par with each other.

Available sulphur

The highest available sulphur (26.11 kg S ha^{-1}) was recorded in T_3 which received 100 per cent RDF + poultry manure. Increase in available sulphur due to organic manures application might be due to its direct addition and mineralization of sulphur due to decomposition of organic matter. Similar findings were also observed by Channal (2012). Available sulphur content in sub surface soil was lower than surface soil in all the treatments (13.52 to 21.00 kg S ha^{-1}). The available sulphur content in sub surface soil did not differ significantly.

Micronutrients

The data regarding amount of DTPA- extractable micronutrients in the post harvest soil are given in table 2.

DTPA-extractable micronutrients in the post harvest soil were also maximum in the treatment which received 100 per cent RDF + poultry manure (Zn, 0.97; Fe, 7.91; Mn, 6.90 and Cu, 1.70 mg kg^{-1}) followed by other similar INM treatments. The treatments which received 50 per cent RDF + organics recorded lower values than 100 per cent RDF+ organics except T_{11} but significantly higher than the organic manures alone. The treatment which received only organics recorded lowest available micronutrients in the soil. The RDF treatment T_{13} contained Zn, 0.70; Fe, 7.11; Mn, 6.03 and Cu, 1.20 mg kg^{-1} and was on par with most of the INM treatments. Significantly increased availability of DTPA extractable micronutrients might be due to their direct addition of micronutrients to soil and release of chelating agents which might have prevent micronutrients from precipitation, oxidation and leaching (Sharma *et al.,* 2001). The application of organics alone resulted in significantly lower contents than rest of the treatments. Similar results were reported by Kumar *et al.* (2012) and it was attributed to non-replenishment of micronutrients through chemical fertilizers. The contents of DTPA extractable Cu, Fe, Mn and Zn at the harvest of the crop increased when compared to their initial value due to incorporation of organic manures and the extent of increase was 16.44, 8.37, 10.31 and 11.66 per cent due to poultry manure, 3.87, 7.89, 3.80 and 6.66 per cent due to vermicompost. Vidyavathi *et al*. (2012) reported that the DTPA extractable micronutrients viz., Zn; 1.40, Fe; 7.27, Mn; 8.90 and Cu; 0.86 mg kg^{-1} increased in INM treatment.

Table 1. Effect of different organics and inorganics on available major nutrients at harvest soil

Treatments	N (kg ha^{-1})		P_2O_5 (kg ha^{-1})		K_2O (kg ha^{-1})		S (kg ha^{-1})	
	Soil depth (cm)							
	0 - 22.5	22.5 - 45.0	0 - 22.5	22.5-45.0	0 - 22.5	22.5- 45.0	0 - 22.5	22.5 - 45.0
T_1: 100 % RDF + FYM	348.31^{ab}	216.82^{a}	55.01^{b}	30.01^{b}	478.01^{a}	353.51^{ab}	21.01^{b-d}	17.01^{a}
T_2 : 100 % RDF + VC	352.00^{ab}	217.01^{a}	56.52^{b}	34.31^{ab}	481.02^{a}	356.52^{ab}	22.22^{a-c}	18.72^{a}
T_3: 100 % RDF + PM	356.01^{a}	223.82^{a}	61.81^{a}	40.01^{a}	496.71^{a}	388.71^{a}	26.11^{a}	21.00^{a}
T_4: 100 % RDF + SM	353.31^{ab}	220.02^{a}	59.81^{ab}	32.71^{b}	486.22^{a}	391.02^{a}	23.10^{ab}	18.42^{a}
T_5 : FYM alone	301.31^{d}	191.73^{a}	28.62^{g}	20.62^{c}	451.71^{a}	329.61^{bc}	15.21^{e}	13.52^{a}
T_6: VC alone	304.42^{cd}	206.91^{a}	30.01^{g}	21.71^{c}	450.03^{a}	320.32^{bc}	17.22^{de}	16.52^{a}
T_7 : PM alone	308.70^{cd}	207.31^{a}	36.22^{ef}	22.01^{c}	457.02^{a}	331.81^{bc}	17.91^{c-e}	17.13^{a}
T_8 : SM alone	306.90^{cd}	201.71^{a}	32.51^{fg}	21.32^{c}	455.31^{a}	323.71^{bc}	17.62^{de}	16.50^{a}
T_9 : 50 % RDF + FYM	325.01^{a-d}	192.30^{a}	41.42^{de}	29.22^{b}	463.01^{a}	333.72^{bc}	18.80^{b-e}	13.61^{a}
T_{10} : 50 % RDF + VC	326.72^{a-d}	195.10^{a}	39.31^{e}	30.41^{b}	470.62^{a}	336.01^{b}	19.61^{b-e}	14.02^{a}
T_{11}: 50 % RDF + PM	335.71^{a-c}	211.01^{a}	45.52^{cd}	32.32^{b}	477.31^{a}	352.50^{ab}	20.71^{b-d}	17.41^{a}
T_{12}: 50 % RDF + SM	327.01^{a-d}	208.12^{a}	39.61^{e}	31.80^{b}	478.41^{a}	341.31^{b}	19.80^{b-d}	14.42^{a}
T_{13} : 100 % RDF	322.72^{b-d}	173.01^{a}	49.32^{c}	29.11^{b}	470.42^{a}	292.22^{c}	19.00^{b-e}	15.30^{a}
LSD	27.79	-	4.84	6.78	-	36.36	3.07	-

Note: Initial value of available N = 300.15 kg ha^{-1}, P_2O_5 = 40.16 kg ha^{-1}, K_2O = 475.13 kg ha^{-1} and S = 21.6 kg ha^{-1}Means followed by same latter (s) within a column are not significantly different (DMRT P = 0.05)

Table 2. Effect of different organics and inorganics on DTPA extractable nutrients at harvest soil

Treatments	Zn (mg kg^{-1})		Fe (mg kg^{-1})		Mn (mg kg^{-1})		Cu (mg kg^{-1})	
	Soil depth (cm)							
	0 - 22.5	22.5 - 45.0	0 - 22.5	22.5 - 45.0	0 - 22.5	22.5 - 45.0	0 - 22.5	22.5 - 45.0
T_1: 100 % RDF + FYM	0.84^{a-d}	0.31^{a}	7.30^{a-c}	3.30^{a-d}	6.11^{b-d}	3.10^{a}	1.30^{c-e}	0.58^{a-d}
T_2 : 100 % RDF + VC	0.87^{a-c}	0.40^{a}	7.51^{ab}	3.53^{a-c}	6.37^{a-c}	3.23^{a}	1.43^{bc}	0.61^{abc}
T_3: 100 % RDF + PM	0.97^{a}	0.40^{a}	7.91^{a}	3.70^{a}	6.90^{a}	3.63^{a}	1.70^{a}	0.63^{a}
T_4: 100 % RDF + SM	0.92^{ab}	0.42^{a}	7.63^{ab}	3.63^{ab}	6.51^{ab}	3.10^{a}	1.60^{ab}	0.62^{ab}
T_5 : FYM alone	0.57^{f}	0.21^{a}	5.11^{e}	2.67^{e}	4.70^{f}	2.30^{a}	0.52^{f}	0.32^{d}
T_6: VC alone	0.62^{ef}	0.21^{a}	5.51^{e}	2.87^{de}	4.83^{f}	2.50^{a}	0.60^{f}	0.34^{cd}
T_7 : PM alone	0.64^{ef}	0.31^{a}	5.92^{de}	3.10^{cde}	5.20^{ef}	2.70^{a}	0.72^{f}	0.36^{a-d}
T_8 : SM alone	0.63^{ef}	0.30^{a}	5.41^{e}	2.90^{de}	4.83^{f}	2.63^{a}	0.70^{f}	0.35^{b-d}
T_9 : 50 % RDF + FYM	0.75^{c-e}	0.31^{a}	6.12^{c-e}	3.20^{b-d}	5.57^{de}	2.73^{a}	1.10^{e}	0.52^{a-d}
T_{10} : 50 % RDF + VC	0.78^{b-e}	0.32^{a}	6.23^{c-e}	3.30^{a-d}	5.83^{cd}	2.82^{a}	1.14^{de}	0.54^{a-d}
T_{11}: 50 % RDF + PM	0.87^{a-c}	0.41^{a}	6.40^{b-e}	3.57^{a-c}	6.30^{bc}	3.04^{a}	1.38^{b-d}	0.56^{a-d}
T_{12}: 50 % RDF + SM	0.82^{a-d}	0.32^{a}	6.20^{c-e}	3.43^{a-c}	5.87^{cd}	2.89^{a}	1.23^{c-e}	0.55^{a-d}
T_{13} : 100 % RDF	0.70^{d-f}	0.31^{a}	7.11^{a-d}	3.20^{b-d}	6.03^{b-d}	2.76^{a}	1.20^{c-e}	0.58^{a-d}
LSD	0.14	-	1.10	0.42	0.53	-	0.23	0.23

Note: Initial value of DTP extractable Zn = 0.68 mg kg^{-1}, Fe = 5.13 mg kg^{-1}, Mn = 4.00 mg kg^{-1} and Cu = 1.28 mg kg^{-1}Means followed by same latter (s) within a column are not significantly different (DMRT P = 0.05)

The field trial thus, revealed that an integrated supply of organic manures with chemical fertilizers significantly increased the all available major, secondary and micronutrients in both surface and subsurface post harvest soil.

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Rec. on 30.08.2018 & Acc. on 23.09.2018