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EFFECT OF ORGANIC & INORGANIC SOURCES OF NUTRIENTS ON SOIL PHYSICAL PROPERTIES, CHEMICAL PROPERTIES AND DIFFERENT NUTRIENT STATUS AT HARVEST OF THE MAIZE CROP

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ABSTRACT

The experiment was conducted in plot No. 126 of E block, Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad during *kharif*, 2011. The geographical co-ordinates of the experimental site are $15^0$26' N latitude and $75^0$07'E longitude and an altitude of 678 m above mean sea level (MSL).The uptake of nutrients by maize increased significantly with incorporation of organic manures with RDF and the highest uptake was recorded in the treatment with PM. Similarly, uptake of nutrients in the treatments with organics and fertilizers each at 50 per cent level with recommended FYM also recorded higher uptake of these nutrients than RDF and the treatments with 100 per cent organics. Water holding capacity, organic carbon, available N, P, K, S and DTPA-extractable Cu, Fe, and Mn in soil improved due to substitution of fertilizer N with organics and the extent of improvement was higher at 100 per cent level . The pH of soil in the treatment receiving only chemical fertilizers was 7.68 which decreased significantly due to substitution of RDN with organics namely FYM, vermicompost and poultry manure at 50 and 100 per cent levels. Maximum water holding capacity of soil varied from 55.0 to 63.7 per cent. Significantly higher water holding capacity of soil was recorded in the treatment with 100 per cent RDN through organics (50% FYM + 50% VC) + recommend FYM (63.7%) and it was on par with other similar treatments with 100 per cent organics along with recommended FYM (T_5, T_7, and T_8).

INTRODUCTION

Maize (*Zea mays* L.) is known as "Queen of cereals" because of its high production potential and wider adaptability. In the world, maize with a production of 854.67 million tonnes and productivity of 5081 kg ha^{-1} occupies an area of 168.2 million ha. In India, maize ranks third position among the important cereal crops next to rice and wheat with 51.87 million tonnes production grown on an area of 21million ha with productivity of 2470 kg ha^{-1} (Anon., 2011). Karnataka is one of the major maize producing states in the country and ranks second in production. It is grown over an area of 11.37 lakh ha with a production of 33.67 lakh tonnes and an average productivity of 2961 kg ha^{-1}. The productivity of maize is largely dependent on its nutrient management and is known to be a heavy feeder of nutrients. Excessive use of agrochemicals with reduced use of organic source of nutrients for the last several decades resulted in multinutrient deficiencies and decline in fertility and productivity of soil.

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Therefore, even with the application of recommended dose of chemical fertilizers, yield of most of the crops is either static or declining. Moreover, increase in the cost of chemical fertilizers, worldwide energy crisis, rapid exhaustion of non renewable energy sources and low purchasing power of farmers restrict the use of fertilizers alone as an input for increasing crop production. Further, a key factor in maintaining sustainable production in the tropical soils is protection and/or improvement in the soil organic matter content. Farmyard manure application to the crop is an age old practice. Well decomposed FYM in addition to supply of plant nutrients, binds soil particles and improves soil physical properties. Beneficial effects of earthworms and their cast were known as early as in Darwin's era. But the potential of vermicompost to supply nutrients and to support beneficial microbes is being recognized recently. Vermicompost is rich in nitrogen fixers and other beneficial microbial population. Hence, these characters recognized the vermicompost as biofertilizer (Kale *et al.,* 1988). The average nitrogen, phosphorous and potassium contents of poultry litter is reported to be approximately two, one and two per cent, respectively. It also contains higher amount of micronutrients and has higher dehydrogenase, urease and phosphatase enzyme activity (Rout *et al*., 2012). Therefore, this manure is of great value in soil fertility maintenance if it is added to soil in areas of its abundance. Continuous use of crop residues and organics help to build up soil humus and beneficial microflora besides improvement in soil physical properties. Therefore, the present investigation was undertaken to evaluate the effect of different organic manures *vis-à-vis* chemical fertilizers and their combinations on soil fertility and productivity of maize (*Zea mays* L.) at Main Agriculture Research Station, University of Agricultural Sciences, Dharwad during *kharif* 2011.

MATERIALS AND METHODS

The experiment was conducted in plot No. 126 of E block, Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad during *kharif*, 2011. The geographical co-ordinates of the experimental site are $15^0$26' N latitude and $75^0$07'E longitude and an altitude of 678 m above mean sea level (MSL). It is located in Northern Transition Zone (Zone8) of Karnataka which lies between Hilly Zone (Zone-9) towards West and Northern Dry Zone (Zone-3) towards East. The experiment was conducted on Typic Haplustert with clay texture. Composite soil sample was collected from the experimental site at a depth of 0-20 cm before sowing and was analyzed for various physical and chemical properties. The field experiment was laid out in Randomized Complete Block Design (RCBD). There were twelve treatments and three replications. The treatment details are presented in below.

T_1: Recommended dose of fertilizer (RDF) 150:75:37.5 N, P_2O_5, K_2O kg ha^{-1} + FYM (10 t ha^{-1}).
T_2: Recommended dose of fertilizer (RDF) + vermicompost (VC) 2.5 t ha^{-1}.
T_3: Recommended dose of fertilizer (RDF) + Poultre Manure (PM) 1.0 t ha^{-1}.
T_4: Recommended dose of fertilizer (RDF) 150:75:37.5 N, P_2O_5, K_2O kg ha^{-1}(chemical fertilizers only).
T_5: 100% Recommended dose of Nitrogen through organics (50% Farm Yard Manure + 50% Vermicompost).
T_6: 100% Recommended dose of Nitrogen through organics (50% Farm Yard Manure + 50% Vermicompost) + recommended Farm Yard Manure.
T_7: 100% Recommended dose of Nitrogen through organics (50% Poultre Manure + 50% Vermicompost) + recommended Farm Yard Manure.
T_8: 100% Recommended dose of Nitrogen through organics (50% Farm Yard Manure + 50% Poultre Manure) + recommended Farm Yard Manure.
T_9: 50% Recommended dose of Nitrogen through organics (50% Farm Yard Manure + 50% Vermicompost) + 50% Recommended dose of Nitrogen through inorganic fertilizers.
T_{10}: 50% Recommended dose of Nitrogen through organics (50% Farm Yard Manure + 50% Vermi compost) + 50% Recommended dose of Nitrogen through inorganic fertilizer + recommended Farm Yard Manure.
T_{11}: 50% Recommended dose of Nitrogen through organics (50% Poultry Manure + 50% Vermi compost) + 50% Recommended dose of Nitrogen through inorganic fertilizer + recommended Farm Yard Manure.
T_{12}: 50% Recommended dose of Nitrogen through organics (50% Farm Yard Manure + 50% Poultry Manure) + 50% Recommended dose of Nitrogen through inorganic fertilizer + recommended Farm Yard Manure.

PHYSICAL ANALYSIS OF SOIL

Particle size distribution (soil texture)

Particle size distribution of soil was done by adopting the International pipette method (Piper, 2002).

Bulk density

Bulk density of the soil samples was determined by using a core sampler method at initial and after harvest of crop (Black, 1965).

Chemical analysis of soil samples

Composite soil sample (0-20 cm depth) from the experimental site were collected, processed to pass through 2 mm sieve and preserved for further analysis. Similarly, representative soil samples from each plot were collected after the harvest of chilli crop. The soil samples were dried in shade, processed to pass through 2 mm sieve and used for further analysis for nitrogen, phosphorus, potassium, organic carbon, EC, pH, zinc, copper, manganese and iron.

Available Nitrogen (kgha^{-1})

Available soil nitrogen was estimated by alkaline permanganate oxidation method as outlined by Subbiah and Asija (1956).

Available Phosphorus (kgha^{-1})

Available soil phosphorus was estimated by Olsen's method as outlined by Jackson (1973) using spectrophotometer (660 nm wave length).

Available Potassium (kgha^{-1})

Available soil potassium was extracted using neutral normal ammonium acetate and the content of K in the solution was estimated by flame photometer (Jackson, 1973).

Avaialble Sulphur

Sulphate – S (SO_4-S) in the soil was extracted using 0.15% $CaCl_2$. The SO_4-S in the extract was estimated by trubidometric method using $Bacl_2$ (Chesnin and Yien, 1951). The turbidity was measured using spectrophotometer at 420 nm.

Organic carbon (g kg^{-1})

Soil organic carbon was determined by wet oxidation method as outlined by Jackson (1973).

pH and electrical conductivity

Soil pH was measured in 1:2.5 soil: water suspension by using pH meter. The clear supernatant solution of the above soil water suspension was taken and EC was measured using conductivity meter (Jackson, 1973).

DTPA-extractable micronutrients

Ten gram of air dried soil sample was shaken with 20 ml of extracting solution (0.005 M DTPA + 0.01 M calcium chloride + 0.1 M TEA, pH 7.3) for two hours. The soil suspension was filtered and the contents of zinc, iron, manganese and copper were measured by atomic absorption spectrophotometer (Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

Soil bulk density values in different treatments ranged from 1.12 to 1.20 Mg m^{-3}. Bulk density of soil was not significantly influenced due to the application of organic and inorganic sources of nutrients either individually or in combination. The maximum water holding capacity of soil varied from 55.0 to 63.7 per cent. Significantly higher water holding capacity of soil was recorded in the treatment with 100 per cent RDN through organics (50% FYM + 50% VC) + recommend FYM (63.7%) and it was on par with other similar treatments with 100 per cent organics along with recommended FYM (T_5, T_7, and T_8). Among the treatments which received combined application of organic and inorganic sources of nutrients each at 50 per cent level, T_{10} recorded higher maximum water holding capacity (59.3%) and was on par with other similar treatments (T_9, T_{11} and T_{12}). The treatments with RDF and RDF along with organic manures (T_1, T_2, T_3 and T_4) did not differ significantly among themselves with respect to maximum water holding capacity of soil.

The pH of soil in the treatment receiving only chemical fertilizers was 7.68 which decreased significantly due to substitution of RDN with organics namely FYM, vermicompost and poultry manure at 50 and 100 per cent levels. The extent of reduction in pH was higher in the treatments with 100 per cent organics along with recommended FYM when compared to the treatments receiving 50 per cent recommended N through organics and remaining N through chemical fertilizers along with recommended FYM. The total soluble salts content in soil ranged from 0.17 to 0.23 dSm^{-1} and it was not affected significantly due to application of different organic manures at 50 and 100 per cent level. However, there was slight decrease in electrical conductivity values due to addition of organic manures. The organic carbon content of soil after harvest of maize in the treatment receiving only recommended dose of chemical fertilizers was 5.00 g/kg and it increased significantly due to application of organic manures at 50 and 100 per cent substitution levels. The difference between the treatments with 50 and 100 per cent substitution levels along with recommended FYM was significant and results are presented in Table 1. The available nitrogen status of soil at harvest of the crop was significantly influenced by various treatments. It ranged from 164.9 to 207.7 kg ha^{-1}. The highest available nitrogen content of soil was recorded in the treatment receiving 100 per cent RDN through PM and VC each at 50 per cent level (207.7 kg/ha) and was found to be on par with rest of the treatments supplying 100 per cent RDN through organics but differed significantly to the rest of the treatments. Among the set of treatments supplying recommended N through organics and chemical fertilizers each at 50 per cent level along with recommended FYM, T_{10} recorded higher available N in soil (193.2 kg/ha) but however it was on par with the treatment T_{11} and T_{12}.

The available N status of soil in the treatments receiving RDF plus organics namely FYM, VC and PM ranged from 182.7 to 186.3 kg/ha and the difference between these three treatments was non-significant. Comparatively the treatments receiving 100 per cent organics with FYM, VC and PM along with recommended dose of organic manure i.e., FYM @ 10 t/ha, recorded higher available nitrogen content in soil than the treatments receiving organic and inorganic sources of nutrients in 1:1 ratio along with recommended FYM.The effect of different treatments on available nitrogen status of soil at grand growth was also similar (Table 2). The available phosphorus content in soil ranged from 22.2 to 30.7 kg/ha due to application of various treatments. The treatments supplying 100 per cent RDN through organics along with recommended FYM recorded relatively higher available phosphorus in soil in T_6, T_7 and T_8 treatments (28.9. 30.7 and 29.1 respectively). In a set of treatments supplying 50 per cent RDN each through organic and inorganic sources of nutrients, in addition to recommended FYM, the available phosphorus status in soil

Table 1. Effect of organic and inorganic sources of nutrients on soil physical and chemical properties

Treatments	Bulk density (Mg m^{-3})	MWHC (%)	pH (1:2.5)	EC (dSm^{-1})	Organic carbon (g kg^{-1})
			1:2.5		
T_1 – RPP (RDF + FYM)	1.18	57.0	7.60	0.18	5.29
T_2 – RPP (RDF + VC)	1.19	56.9	7.58	0.19	5.30
T_3 – RPP (RDF + PM)	1.20	56.3	7.52	0.17	5.31
T_4– RDF (chemical fertilizers only)	1.22	55.0	7.68	0.23	5.00
T_5 – 100% RDN through Organics (50 % FYM + 50 % VC)	1.15	60.1	7.43	0.18	5.86
T_6– 100% RDN through Organics (50 % FYM + 50 % VC) +Recommended FYM	1.12	63.7	7.45	0.19	6.21
T_7– 100% RDN through Organics (50 % PM + 50 % VC) + Recommended FYM	1.13	62.0	7.39	0.17	6.20
T_8– 100% RDN through Organics (50 % FYM + 50 % PM) + Recommended FYM	1.14	61.4	7.41	0.18	6.18
T_9– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDF through inorganic fertilizers	1.17	57.8	7.61	0.19	5.31
T_{10}– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	1.15	59.3	7.51	0.17	5.84
T_{11}– 50% RDN through Organics (50 % PM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	1.16	58.7	7.49	0.18	5.79
T_{12}– 50% RDN through Organics (50% FYM + 50 % PM) +50%RDN through inorganic fertilizer + Recommended FYM	1.16	58.2	7.50	0.18	5.80
S. Em.±	0.02	1.2	0.02	**0.003**	**0.048**
CD (0.05)	NS	3.6	0.06	**NS**	**0.12**

NS – Non significant

varied from 27.7 to 28.6 kg/ha and the difference between these treatments (T_{10}, T_{11} and T_{12}) was not significant. The treatments supplying RDF with organic manures namely FYM, VC and PM @ 10.0, 2.5 and 1.0 t/ha, respectively were on par with each other (26.6, 24.9 and 24.2 kg/ha, respectively). Similar results were also recorded at grand stage of the crop (Table 2).

The available potassium content of soil was significantly influenced by the application of organic and inorganic sources of nutrients and it ranged from 240.2 to 278.4 kg/ha due to application of different treatments. The treatments receiving 100 per cent RDN through organics along with recommended FYM (T_6, T_7 and T_8) recorded higher available potassium status in soil (265.0, 269.3 and 263.1 kg/ha, respectively) and

Table 2. Effect of organic and inorganic sources on the available nutrients status of soil (kg/ha) at harvest of the crop

Treatments	Nitrogen	Phosphorous	Potassium	Sulphur
T_1 – RPP (RDF + FYM)	182.7	26.6	257.3	21.7
T_2 – RPP (RDF + VC)	184.1	24.9	245.2	22.4
T_3 – RPP (RDF + PM)	186.3	24.2	240.2	23.4
T_4– RDF (chemical fertilizers only)	164.9	26.8	264.2	18.1
T_5 – 100% RDN through Organics (50 % FYM + 50 % VC)	173.4	22.3	215.4	21.4
T_6– 100% RDN through Organics (50 % FYM + 50 % VC) +Recommended FYM	199.1	28.9	265.0	23.8
T_7– 100% RDN through Organics (50 % PM + 50 % VC) + Recommended FYM	207.7	30.7	269.3	25.6
T_8– 100% RDN through Organics (50 % FYM + 50 % PM) + Recommended FYM	195.8	29.1	263.1	24.8
T_9– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDF through inorganic fertilizers	178.0	21.1	262.0	22.2
T_{10}– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	193.2	27.7	273.2	23.2
T_{11}– 50% RDN through Organics (50 % PM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	190.0	28.6	278.4	24.7
T_{12}– 50% RDN through Organics (50% FYM + 50 % PM) +50%RDN through inorganic fertilizer + Recommended FYM	188.7	27.1	275.3	23.6
S. Em.±	4.40	1.20	11.8	1.1
CD (0.05)	12.7	3.62	34.5	3.2

Table 3: Effect of organic and inorganic sources on the available nutrients status of soil (kg/ha) at grand growth stage

Treatments	Nitrogen	Phosphorus	Potassium	Sulphur
T_1 – RPP (RDF + FYM)	198.6	32.1	274.0	23.6
T_2 – RPP (RDF + VC)	201.8	32.4	284.1	24.1
T_3 – RPP (RDF + PM)	203.5	31.3	280.5	24.8
T_4– RDF (chemical fertilizers only)	181.4	33.8	273.1	21.3
T_5 – 100% RDN through Organics (50 % FYM + 50 % VC)	188.3	29.0	253.8	24.1
T_6– 100% RDN through Organics (50 % FYM + 50 % VC) +Recommended FYM	214.4	30.8	304.4	26.8
T_7– 100% RDN through Organics (50 % PM + 50 % VC) + Recommended FYM	221.5	31.4	310.5	28.2
T_8– 100% RDN through Organics (50 % FYM + 50 % PM) + Recommended FYM	213.1	29.8	303.8	26.5
T_9– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDF through inorganic fertilizers	195.4	20.6	300.5	27.2
T_{10}– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	208.1	25.4	307.8	28.1
T_{11}– 50% RDN through Organics (50 % PM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	204.4	26.1	310.6	29.3
T_{12}– 50% RDN through Organics (50% FYM + 50 % PM) +50%RDN through inorganic fertilizer + Recommended FYM	201.5	25.2	309.1	28.3
S. Em.±	7.46	4.12	16.10	3.45
CD (0.05)	21.5	12.9	48.8	10.30

Table 4. Effect of organic and inorganic sources of nutrients on DTPA-extractable micronutrients status of soil (mg/kg) at harvest of the crop

Treatments	Cu	Fe	Mn	Zn
T_1 – RPP (RDF + FYM)	1.53	4.46	6.26	0.62
T_2 – RPP (RDF + VC)	1.61	4.51	6.54	0.64
T_3 – RPP (RDF + PM)	1.77	4.53	6.95	0.67
T_4– RDF (chemical fertilizers only)	1.20	3.91	6.01	0.56
T_5 – 100% RDN through Organics (50 % FYM + 50 % VC)	1.42	4.21	6.39	0.63
T_6– 100% RDN through Organics (50 % FYM + 50 % VC) +Recommended FYM	1.77	4.61	6.66	0.67
T_7– 100% RDN through Organics (50 % PM + 50 % VC) + Recommended FYM	1.81	4.82	6.98	0.69
T_8– 100% RDN through Organics (50 % FYM + 50 % PM) + Recommended FYM	1.78	4.71	6.62	0.66
T_9– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDF through inorganic fertilizers	1.56	4.42	6.36	0.60
T_{10}– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	1.61	4.52	6.51	0.64
T_{11}– 50% RDN through Organics (50 % PM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	1.72	4.63	6.90	0.65
T_{12}– 50% RDN through Organics (50% FYM + 50 % PM) +50%RDN through inorganic fertilizer + Recommended FYM	1.69	4.51	6.53	0.60
S. Em.±	0.12	0.15	0.24	0.06
CD (0.05)	0.34	0.45	0.69	NS

NS – Non-significant

Table 5. Effect of organic and inorganic sources of nutrients on DTPA-extractable micronutrients status of soil at grand growth stage (mg/kg)

Treatments	Cu	Fe	Mn	Zn
T_1 – RPP (RDF + FYM)	2.22	4.66	6.36	0.63
T_2 – RPP (RDF + VC)	2.34	4.72	6.95	0.64
T_3 – RPP (RDF + PM)	2.48	4.74	7.20	0.68
T_4– RDF (chemical fertilizers only)	1.98	4.00	5.80	0.57
T_5 – 100% RDN through Organics (50 % FYM + 50 % VC)	1.43	4.18	6.41	0.64
T_6– 100% RDN through Organics (50 % FYM + 50 % VC) +Recommended FYM	1.59	4.30	6.71	0.68
T_7– 100% RDN through Organics (50 % PM + 50 % VC) + Recommended FYM	1.78	4.52	7.00	0.68
T_8– 100% RDN through Organics (50 % FYM + 50 % PM) + Recommended FYM	1.82	4.93	6.72	0.68
T_9– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDF through inorganic fertilizers	1.61	4.61	6.41	0.62
T_{10}– 50% RDN through Organics (50 % FYM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	1.67	4.68	6.63	0.66
T_{11}– 50% RDN through Organics (50 % PM + 50 % VC) + 50 % RDN through inorganic fertilizer + Recommended FYM	1.73	4.73	7.02	0.67
T_{12}– 50% RDN through Organics (50% FYM + 50 % PM) +50%RDN through inorganic fertilizer + Recommended FYM	1.71	4.62	6.81	0.62
S. Em.±	0.14	0.38	0.29	0.03
CD (0.05)	0.36	1.12	0.72	NS

NS – Non-significant

were on par with the treatments receiving RDF plus organics (FYM, VC and PM) and treatments receiving 50 per cent RDN through organics plus 50 per cent RDN through chemical fertilizers along with recommended FYM (T_{10}, T_{11} and T_{12}).The trend of the results at grand growth stage of the soil was also similar (Table 2). The available sulphur content of soil ranged from 18.1 to 25.6 kg/ha due to application of various treatments. The available sulphur content of soil in the treatment receiving only RDF was 18.1 kg/ha and it increased significantly 23.4, 22.4 and 21.7 kg/ha due to application of recommended doses of fertilizers along with poultry manure (T_3), vermicompost (T_2) and FYM (T_1). Similarly all other treatments receiving organic manures either at 50 per cent level (with chemical fertilizers) or at 100 per cent level recorded significantly higher available sulphur content in soil. The highest available sulphur content of 25.6 kg/ha was recorded in the treatment receiving 100 per cent RDN through poultry manure and vermicompost along with recommended FYM and this treatment was significantly superior to T_1 and T_9 along with T_4 but on pat with rest of the treatments. Similar results were recorded at grand growth stage of maize crop and results are presented in Table 3.

The DTPA extractable copper content in soil at harvest of the crop was significantly influenced due to application of different treatments and it ranged from 1.20 to 1.81 kg/ha. The highest DTPA extractable copper content in soil was recorded in the treatment receiving 100 per cent organic with poultry manure and vermicompost along with recommended FYM and this treatment was on par with all the treatments except the treatment receiving 100 per cent organics through FYM and vermicompost without recommended FYM (T_5). Different treatments had similar effects on DTPA-extractable (Table 4) copper content of soil at grand growth stages of the crop. The DTPA-extractable iron content in soil was 3.91 mg/kg in the treatment which received only RDF. Application of organic manures namely FYM, VC and PM either along with RDF or to substitute 50 and 100 per cent recommended 'N' either with or without recommended significantly increased the DTPA-extractable iron content in soil when compared to the treatments receiving only RDF (T_4). Further, the difference between the treatments receiving organic manures in different doses was not significant; however the highest DTPA-extractable iron content of 4.82 mg/kg was recorded in the treatments receiving 100 per cent organics with poultry manure and vermicompost along with recommended FYM. Effect of different treatments on DTPA extractable iron content of soil was similar to that recorded at harvest (Table 4). Application of two sources of nutrients namely organic and chemical to supply the recommended doses of fertilizers to maize crop significantly influenced the DTPA-extractable Mn content in soil. The highest DTPA-extractable Mn content of 6.98 mg/kg was recorded in the treatment receiving 100 per cent organics through FYM and VC along with recommended FYM and it was significantly superior to treatment with RDF + FYM (T_1) and only RDF (T_4) but at par with rest of the treatments. The DTPA-extractable manganese content of soil at grand growth stage of crop ranged from 5.80 to 7.20 mg/kg and the effect of different treatments on DTPA-extractable manganese content of soil was similar to that recorded at harvest (Table 4). The DTPA-extractable zinc content in soil ranged from 0.56 to 0.69 mg/kg and effect of organic and inorganic sources of nutrients on DTPA extractable zinc content in soil was non-significant. The results were also non-significant at grand growth stage of the crop (Table 5).

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