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Effect of long term application of inorganic and organic fertilizers on soil micronutrient status

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Abstract
Soil micronutrients were studied on Inceptisol with an 16-years old experiment at Regional Agricultural Research Station, Professor Jayashankar Telangana State Agricultural University, Jagtial in rice – rice cropping system. The present study was undertaken during kharif, 2016 and results indicated that continuous application of chemical fertilizers and manures increased the micronutrient availability in soil. Application of 100% NPK + Zn over a period of 16 years significantly increased the Zn content in soil by 37.8% as against 100% NPK treatment. Continuous application of FYM (100% FYM) recorded highest Mn content of 7.75 mg kg^{-1} in soil.

Keywords: inorganic and organic fertilizers, soil micronutrient

Introduction
Micronutrient does not mean that they are less important to plants than other nutrients. Each essential element only when can perform its role in plant nutrition properly that other necessary elements are available in balanced ratios for plant. Plant growth and development may be retarded if any of these elements is lacking in the soil or is not adequately balanced with other nutrients. Inorganic micronutrients occur naturally in soil minerals. The parent material from which the soil developed and soil forming processes determines what the micronutrient content of the soil will be. As minerals break down during soil formation, micronutrients are gradually released in a form that is available to plants. Two sources of readily available micronutrients exist in soil: nutrients that are adsorbed onto soil colloids (very small soil particles) and nutrients that are in the form of salts dissolved in the soil solution. Organic matter is an important secondary source of some micronutrients. Most micronutrients are held tightly in complex organic compounds and may not be readily available to plants. However, they can be an important source of micronutrients when they are slowly released into a plant available form as organic matter decomposes. Divalent manganese ions (Mn^{2+}) is converted to Mn^{3+} or Mn^{4+} easily, therefore in the plant manganese plays an important role on oxidation and reduction processes, as electron transport in photosynthesis. Manganese deficiency has very serious effects on non-structural carbohydrates, and roots carbohydrates especially. Zinc uptake of soil solution in divalent cations form (Zn^{2+}) ;in calcareous soils with high pH zinc uptake may be a valence ion form. In the xylem routes zinc is transmitted to divalent form or with organic acids bond. Zinc deficiency can be seen in eroded, calcareous and weathering acidic soils. Zinc deficiency is often accompanied with iron deficiency in calcareous soils. Iron in the soil is the fourth abundant element on earth, but its amount was low or not available for the plants and microorganisms needs, due to low solubility of minerals containing iron in many places the world, especially in arid region with alkaline soils. The aim of this study was to determine the effect of long-term fertilization on micronutrient contents in soil.

Materials and Methods
A field experiment was conducted during *rabi*, 2015 and *kharif*, 2016 at Regional Agricultural Research Station, Jagtial (India) on an ongoing long term (16 years) experiment which was initiated in *kharif*, 2000. The soil of the experimental site is a Typic Ustochrept. The soil was clay in texture, with a bulk density of 1.47 Mg m^{-3} and infiltration rate of 0.6 cm hr^{-1}, slightly saline in reaction (pH of 7.1) with a electrical conductivity of 0.47 d Sm^{-1}, high in organic carbon content (0.79%) and low in available N (107.6 kg ha^{-1}), medium in available P_2O_5 (44.2 kg ha^{-1}) and high in available K_2O (440 kg ha^{-1}). The experiment consisted of 12 treatments which were arranged in a randomised block design with four replications.

The dimensions of the experimental plot are 12 m x 9 m. The soil samples were collected from each plot after 16 cropping cycles and analysed for Soil available micronutrients were extracted by shaking the soil with 0.005 *M* DTPA (Diethylene –triamine penta acetic acid) solution and micronutrients in extract were estimated by atomic absorption spectrophotometer.

Table 1: Details of treatments and source of nutrient

Treatment No	Treatment	kg N-P_2O_5-K_2O ha^{-1}	
T_1	50%NPK	60-30-20	-
T_2	100%NPK	120-60-40	-
T_3	150%NPK	180-90-60	-
T_4	100% NPK +HW	120-60-40	Only hand weeding
T_5	100% NPK+ $ZnSO_4$	120-60-40	10 kg ha^{-1}(in *kharif*)
T_6	100% NP	120-60-0	-
T_7	100% N alone	120-0-0	-
T_8	100% NPK+FYM	120-60-40	10 t ha^{-1}(in each *kharif*)
T_9	100% NPK-S	120-60-40	P through DAP
T_{10}	FYM	-	10 t of FYM each in *kharif* and *rabi* per ha
T_{11}	Control	-	No fertilizers, No manures
T_{12}	Fallow	-	No crop, No fertilizers

Results and Discussion

The available iron content was not influenced by different treatments. The iron content ranged from 11.85 to 13.26 mg kg^{-1}. Application of organic manures alone or in combination with inorganic fertilizers increased the iron content of soil. Highest available Fe content of 13.26 mg kg^{-1} was recorded in fallow (T_{12}) treatment and the lowest was registered in control plot.

The available manganese content was significantly influenced by different treatments. Among the all treatments highest available manganese content of 7.75 mg kg^{-1} was recorded with FYM application (T_{10}) and it was statistically on par with 100% NPK + FYM (7.65 mg kg^{-1}) and 150% NPK (7.15 mg kg^{-1}) treatments. The lowest manganese content of 4.53 mg kg^{-1} was recorded under control (T_{11}) treatment and it was statistically on par with the treatments receiving 100% N (T_7) and 50% NPK (T_1) and the values were being 5.28 and 4.86 mg kg^{-1} respectively.

The available zinc content was significantly differed in different treatments. With respect to all treatments the highest available zinc content of 3.57 mg kg^{-1} was observed in 100% NPK+ Zn (T_5) and it was significantly superior over rest of the treatments. Application of FYM (T_{10}) increased the zinc content by 25.3 percent as against control. Among the all treatments the lowest zinc content of 1.86 mg kg^{-1} was recorded in control (T_{11}) treatment.

The available copper content was not significantly differed due to treatments under this experiment. However, available copper content of soil differed numerically. With respect to the treatments available manganese content varied between 1.66 to 2.44 mg kg^{-1}. The highest available copper content of 2.44 mg kg^{-1} was obtained with FYM application (T_{10}), whereas the lowest was observed in control and the value being 1.66 mg kg^{-1}

A perusal of the data presented in Tables 2 indicated that the trend of significant and non-significant variations with respect to micronutrients (Cu, Fe, Zn and Mn) among the treatments might be attributed to the accumulation of micronutrients due to application of fertilizers alone or in combination with different fertilizers and organic manure alone which contains micronutrients in traces to considerable amount and depletion of micronutrients over a period of time by the crop. Further, a critical examination of data revealed that available Fe, Mn, Zn and Cu content were sufficient in all the experimental plots as per the critical limits (Fe 4.00 mg kg^{-1}, Mn 2.00 mg kg^{-1}, Zn 0.65 mg kg^{-1} and Cu 0.20 mg kg^{-1}) given by AICRP on micronutrients in soils. The soil available Zn with treatment 100% NPK + Zn was significantly higher as compared to the other treatments. The accumulation of this available Zn might be due to the continuous application of $ZnSO_4$ every year since *kharif*, 2000. The similar findings were reported by several workers Sharma, A.R and Mitra, B.N. (1988) [5]; Yang *et al.*, (1990) [8]; Rajeev Kumar *et al.*, (1993) [3] and Bellakki and Badanur, (1997) [1]. Build-up of available Zn due to application of FYM @ 10 t ha^{-1} might be ascribed to the formation of complexes with Zn by the organic compounds present in FYM. The complexing properties of FYM might have prevented the precipitation and fixation of Zn due to organic matter. Similar results were also reported by several workers (Sakal *et al.*, (1996); Singh *et al.*, (1998) and Singh *et al.*, (1999)) [4, 6, 7]. The increase in available micronutrients due to application of organic manures was reported by Beri *et al.*, (1992) [2].

Table 2: Effect of long term fertilizer and manure application on DTPA extractable micronutrients (mg kg^{-1})

Treatments	Fe	Mn	Zn	Cu
T_1 - 50% NPK	12.12	4.86	1.98	2.34
T_2 - 100% NPK	12.34	6.68	2.22	2.20
T_3 - 150% NPK	12.46	7.15	2.04	2.06
T_4 - 100% NPK + HW	12.49	6.34	2.1	2.11
T_5 - 100% NPK + Zn	12.80	5.74	3.57	2.17
T_6 - 100% NP	12.45	5.87	1.99	1.83
T_7 - 100% N	12.51	5.28	2.16	2.03
T_8 - 100% NPK + FYM	12.87	7.68	2.31	2.27
T_9 -100% NPK –S	12.36	6.27	2.08	2.03
T_{10}-FYM	12.44	7.75	2.49	2.44
T_{11}- Control	11.85	4.53	1.86	1.66
T_{12}–Fallow	13.26	6.49	2.92	1.76
S. Em. $\pm$	0.44	0.39	0.25	0.22
CD (0.05)	NS	0.80	0.51	NS
CV(%)	4.98	8.98	15.48	14.92
Initial	14.48	8.72	2.64	2.58

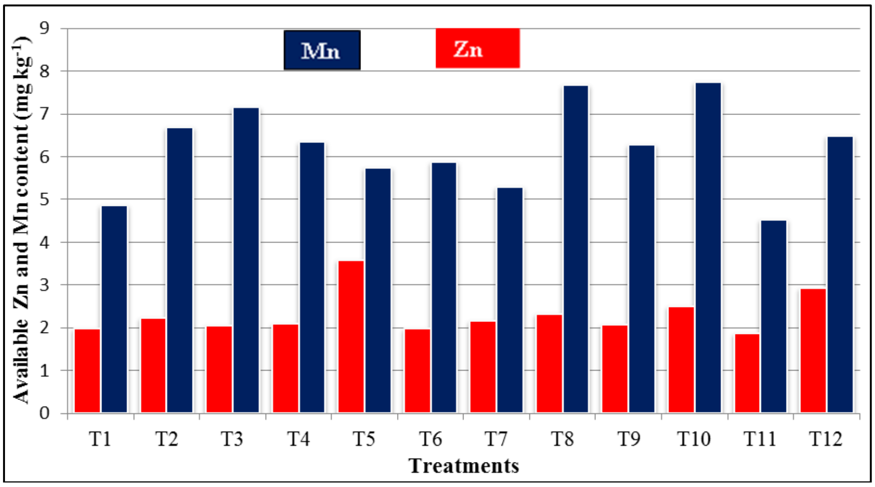

Fig 1: Effect of long term fertilizer and manure application on soil Mn, Zn extractable micronutrients (mg kg^{-1})

Conclusions

Among the DTPA extractable micronutrients available Fe and Cu content was not influenced due to continuous cropping with different treatments. Zinc content in the soil was increased and more pronounced in 100% NPK + Zn applied treatments *i.e.*, 3.57 mg kg^{-1}. Zinc status of soil was above the critical limits of 0.6 mg kg^{-1} in all the treatments and FYM application significantly increased the Zn content to an extent of 25.3 percent as against control (1.86 mg kg^{-1}). Significant influence also observed in Mn content of soil. Manganese content was decreased in all treatments over an initial value of 8.72 mg kg^{-1}. Incorporation of FYM @ 10 t ha^{-1} either alone or in conjunction with inorganic fertilizers significantly increased the Mn content of soil as against control. For sustaining soil quality and crop productivity supplementing the inorganics with organics is the best strategy. This clearly indicated the complete supply of all the essential nutrients in sufficient amounts in balanced ratio during the crop growth period.

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