MICRO NUTRIENTS STATUS OF SOIL UNDER LONG-TERM APPLICATION OF FERTILIZER AND MANURE IN RICE-RICE CROPPING SYSTEM

[*1]SURESH, M.; [1]JAYASREE, G.; [1]SRILATHA, M.; [2]MALLA REDDY, M. AND [3]NARENDER REDDY, S.

PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL UNIVERSITY
RAJENDRANAGAR, HYDERABAD-500 030, TELANGANA

[*]*EMAIL: manchikunta.suresh5@gmail.com*

[1]*Dept. of Soil Science & Agricultural Chemistry, College of Agriculture, PJTSAU, Hyderabad-500 030*
[2]*Dept. of Agronomy, College of Agriculture, PJTSAU, Hyderabad-500 030*
[3]*Dept. of Crop physiology, College of Agriculture, PJTSAU, Hyderabad-500 030*

ABSTRACT

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. Twelve treatments were laid out in randomized block design with four replications. The twelve treatments were 50 % NPK (T_1), 100 % NPK (T_2), 150 % NPK (T_3), 100 % NPK + HW (T_4), 100 % NPK + $ZnSO_4$ (T_5), 100 % NP (T_6), 100 % N (T_7), 100 % NPK + FYM (10 t FYM/ha in kharif) (T_8), 100 % NPK –S (T_9), FYM (10 t FYM /ha in kharif and rabi) (T_{10}), Control (T_{11}) and Fallow (T_{12}). Results showed that there was a sharp decrease in DTPA-Zn, Fe, Cu and Mn content of the surface soil after 16 years. Application of $ZnSO_4$ to rice resulted in an increase in the available Zn content of the soil. There was no significant difference in micronutrients availability within the graded levels of NPK, but control plots had lower availability of micronutrients.

KEY WORDS: Cropping system, FYM, Micro nutrients, Nutrient management

INTRODUCTION

Soil is a key natural resource and soil quality is the integrated effect of management on most soil properties that determine crop productivity and sustainability. Good soil quality not only produces good crop yield, but also maintains environmental quality and consequently plant, animal and human health. With the advancement of intensive agriculture, soils are being degraded at an alarming rate by wind and water erosion, desertification and salinization, because of exploitative total farming practices for short term gains. Growing of crops without due consideration to total nutrient requirement has resulted in decline in soil fertility (Ghosh *et al.*, 2003). Soil quality assessment has been suggested as a tool for evaluating sustainability of soil and crop management practices (Hussain *et al.*, 1999).

Rice (*Oryza sativa* L.) is the principal food crop of the world, contributes to about 60 per cent of the world's food. India ranks second in rice production with 104.80 million tonnes and productivity 2.39 t/ha from an area of 43.86 million hectares (Anonymous, 2015-16). During 2013-14, Telangana rice production is about 66.22 lakh tonnes with a productivity of 3.31 t/ha from an area of 20.00 lakh ha (Raji Reddy, 2017). Higher production requirements for the future to meet the demands of growing population need to be achieved, maintaining the soil quality and sustainability of the productivity at the same time. Increase in cropping intensity with optimum use of production inputs like seed, water and fertilizers and effective plant production measures are the key for sustained crop yields.

In long term experiments, the treatments are applied for a long time sufficient to assess their impact on the resource base. Overall trends and cumulative impact of management systems are best studied through long term experiments. Long term experiments provide a reliable means to study the effect of continuous application of organic manures and inorganic fertilizers on the crop yields and productivity of the soil (Manna *et al*., 2005). The importance of long term fertilizer experiments in studying the effect of continuous cropping and fertilizer or manure application on soil quality and sustainability of crop production is widely recognized.

MATERIALS AND METHODS

The field experiment was conducted at Regional Agricultural Research Station, Polasa, Jagtial district of Telangana. The farm is geographically situated at $78^0 45'$ E to $79^0 0'$ E Longitude and $18^0 45'$ N to $19^0 0'$ N Latitude. The climate of polasa, Jagtial was classified as sub-tropical. The southwest monsoon usually sets in during June-October giving 40-50 rainy days per year. Winter was generally milder at Jagtial and temperature begins to rise from January and reach it peak by May. The present experiment is a part of All India Coordinated Research Project on long term fertilizer experiment initiated in *kharif* 2000-01. The present study was taken up in 2014-15 and 2015-16 (both in *rabi* and *kharif* seasons respectively) with a view to study the effect of long term fertilizer management on soil quality. Twelve treatments were laid out in randomized block design with four replications. The twelve treatments were 50 % NPK (T_1), 100 % NPK (T_2), 150 % NPK (T_3), 100 % NPK + HW (T_4), 100 % NPK + $ZnSO_4$ (T_5), 100 % NP (T_6), 100 % N (T_7), 100 % NPK + FYM (10 t FYM /ha in *kharif*) (T_8), 100 % NP –S (T_9), FYM (10 t FYM /ha in *kharif* and *rabi*) (T_{10}), Control (T_{11}) and Fallow (T_{12}).

Soil Sampling and Analysis

Soil samples were collected during *rabi* and *kharif* from the plow layer (0.0–0.15 m depth) from both the experimental sites after the harvest of *rabi* 2014-15 and *kharif* 2015-16 crop. These samples were partitioned and passed through standard prescribed sieves for further use in a different kind of analysis. The available micronutrients (Zn, Fe, Cu, Mn) were extracted using DTPA (0.005 M) + triethanolamine (TEA) (0.1M) + calcium chloride ($CaCl2 \cdot 2H_2O$) (0.01 M) reagent (pH 7.3) as suggested by Lindsay and Norvell (1978) and determined by AAS.

RESULTS AND DISCUSSION

Characterisation of initial soil sample

The results of initial soil sample analysed before the initiation of the experiment (*kharif* 2000-01) are presented in Table.1.

Available zinc

The results on available zinc content of soil after *rabi* rice are presented in Table 2. The available Zn content ranged from 1.79 mg/kg in control to 2.92 mg/kg in NPK + Zn. It was above critical level (0.6 mg/kg) in all the treatments. In all the treatments, the available Zn increased over control. The results on available zinc content of soil after *kharif* rice are presented in Table 3 and Figure 1. The available Zn content ranged from 1.77 mg/kg in control to 3.45 mg/kg in NPK + Zn. It was above critical level (0.6 mg/kg) in all the treatments. In all the treatments, the available Zn increased over control. Zn content increased over 100% NPK in both seasons *rabi* and *kharif* with addition of Zn (T_5) or FYM (T_{10}) or FYM along with 100% NPK (T_8) and Fallow (T_{12}). Available Zn status in these four treatments was significantly higher than that in all the other treatments. Highest Zn content in treatments was noted in the treatments receiving NPK + Zn and NPK + FYM. Similar results were also reported by Kharche *et al.* (2013).

Available iron

The results on available iron content of soil after *rabi* rice are presented in Table 2. Available iron content ranged from 12.01 mg/kg in control to 13.25 mg/kg in Fallow (T_{12}) treatment. Available Fe content was above the critical level (2.0 mg/kg) in all the treatments. During *kharif* season, the results on available iron content of soil after rice are presented in Table 3. Available iron content ranged from 12.08 mg/kg in control to 13.14 mg/kg in Fallow (T_{12}) treatment. Available Fe content increased in all the treatments over control (12.01mg/kg). The highest available Fe content was recorded under (T_{12}) Fallow (13.25 mg/kg) followed by FYM (12.89 mg/kg), 100% NPK+Zn (1270 mg/kg) and 100% NPK+FYM (12.78 mg/kg). Available Fe content under balanced fertilization (T_3, T_8, T_9, T_{10} and T_{11}) was more than that under imbalanced fertilization (T_1, T_6 and T_9) or control (T_{11}).

Available manganese

The results on available manganese content of soil after *rabi* rice are presented in Table 2. It ranged from 4.70 mg/kg in control to 7.86 mg/kg in FYM. It was above the critical level (4.0 mg/kg) in all the treatments. Mn content under FYM, NPK + FYM, 150% NPK and 100% NPK was more than that in all the other treatments. Available Mn content under balanced fertilization (T_2, T_3, T_4, and T_5) was more than that under imbalanced fertilization (T_1, T_6, T_7 and T_9) or control (T_{11}). The results on available manganese content of soil after *kharif* rice are presented in Table 3 and fig.1. It ranged from 4.68 mg/kg in control to 7.91 mg/kg in FYM. It was above the critical level (4.0 mg/kg) in all the treatments. Mn content under FYM, NPK + FYM, 150% NPK and 100% NPK was more than that in all the other treatments. Available Mn content under balanced fertilization (T_2, T_3, T_4, and T_5) was more than that under imbalanced fertilization (T_1, T_6, T_7 and T_9) or control (T_{11}).

Available copper

The results on available copper content of soil after *rabi* rice are presented in Table 2. It ranged from 1.94 mg/kg in 100% NPK to 2.46 mg/kg in FYM. Available Cu content was above critical level in all the treatments. The highest copper content was recorded in FYM followed by optimal dose of fertilizer application *i.e.*, 100% NPK + FYM (2.46 mg/kg). The available copper content under 100% NPK, NPK + FYM and 150% NPK was at par with each other. Copper content under balanced fertilization (T_2, T_4, T_5, T_8 and T_{10}) was more than that under imbalanced fertilization (T_6, T_9) or control (T_{11}). Similar results were reported by Ebin Masto *et al.* (2007) and Kharche *et al.* (2013). The results on available copper content of soil after *kharif* rice are presented in Table 3 and Figure 1. It ranged from 1.82 mg/kg in 100% NPK to 2.43 mg/kg in FYM. Available Cu content was above critical level in all the treatments. The highest copper content was recorded in FYM followed by optimal dose of fertilizer application *i.e.*, 100% NPK + FYM (2.36 mg/kg). The available copper content was not significantly differing with other treatments and these were at par with each other. Copper content under balanced fertilization (T_2, T_4, T_5, T_8 and T_{10}) was more than that under imbalanced fertilization (T_6, T_9) or control (T_{11}). Similar results were reported by Kharche *et al.* (2013).

Kharche *et al.* (2013) reported that application of organic materials enhanced the microbial activity in the soil and the consequent release of complex organic substances like chelating agents could have prevented micronutrients from precipitation, fixation, oxidation and leaching resulting in their higher availability. Application of FYM significantly increased the availability of micronutrients over chemical fertilization also due to the decomposition of FYM and consequent release of micronutrients (Swarup, 1991).

CONCLUSION

Long-term experiments are the valuable resources for studying the nutrient dynamics and overall assessment of the impacts of fertilization. After 16 years of various fertilizers and manure treatments, concentrations of DTPA-extractable Fe, Zn and Cu were significantly higher in NPK + FYM treatment as compared to control. The results of study showed that continuous addition of $ZnSO_4$ to rice crop alone resulted not only in the increase of DTPA-Zn content in the soil but also sustained it at a higher level. Manure application increased the concentrations of all the studied micronutrients in soil and hence maintained a positive balance for Fe, Zn and Cu. The balance of Mn was negative in all the treatments, because of its less addition and higher uptake by the rice crop. Long-term fertilization affects the amounts of Fe, Zn, Mn and Cu in soil through their effects on physical and chemical soil properties which in turn regulates the uptake of micronutrients by rice crop.

REFERENCES

Anonymous (2015-16). Annual Report – 2015-16. Department of Agriculture, Cooperation & Farmers' Welfare, Ministry of Agriculture & Farmers' Welfare, Government of India, New Delhi.

Ebin Masto, R.; Pramod, K.; Sing, D. and Ashok, K. (2007). Soil quality response to long term nutrient and crop management on a semi-arid Inceptisol. *Agric. Ecosyst. Environ*., **118**: 130-142.

Ghosh, P. K.; Dayal, D.; Mandal, K. G.; Wanjari, R. H and Hati, K. M. (2003). Optimization of fertilizer schedules in fallow and groundnut- based cropping systems and an assessment of system sustainability. *Field Crops Res*., **80**: 83-98.

Hussain, I.; Olson, K. R.; Wander, M. M and Karlen, D. L. (1999). Adaptation of soil quality indices and application to three tillage systems in southern Illinois. *Soil Till. Res*., 50: 237-249.

Kharche, V. K.; Patil, S. R.; Kulkarni, A. A.; Patil, V. S and Katkar, R. N. (2013). Long term integrated nutrient management for enhancing soil quality and crop productivity under intensive cropping system on vertisols. *J. Indian Soc. Soil Sci.*, **61**(4): 323-332.

Lindsay,W. L. and Norvell, W. A. (1978). Development of a DTPA soil test for zinc, iron manganese, and copper. *Soil Sci. Soc. America J.*, **42**: 421-428.

Manna, M. C.; Swarup, A.; Wanjari, R. H., Ravankar, H. N.; Mishra, B.; Saha, M. N.; Singh, Y. V.; Sahi, D. K. and Sarap, P. A. (2005). Long term effect of fertilizer and manure application on soil organic carbon storage, soil quality and yield sustainability under sub humid and semi arid tropical India. *Field Crop Res.*, **93**: 264-280.

Raji Reddy, D. (2017). Agriculture in Telangana http://niti.gov.in/writereaddata/files/ Telangana_Presentation_1.pdf).

Swarup, A. (1991). Long term effect of green manuring (*Sesbania aculeate)* on soil properties and sustainability of rice and wheat on a sodic soil. *J. Indian Soc. Soil Sci.*, **39**(4): 777-780.

Table.1. Initial properties of experimental soil (before *kharif* 2000-01)

Sr. No.	Soil Properties	
1	Soil type	Black clay
2	Sand (%)	34.88
3	Silt (%)	21.50
4	Clay (%)	43.62
5	Soil texture	Clay
6	pH	8.22
7	EC (dS/m)	0.47
8	Organic carbon (%)	0.79
9	Available Nitrogen (kg/ha)	107.6
10	Available P (kg/ha)	19.6
11	Available K (kg/ha)	364.0
12	Available S (mg/kg)	14.0
13	Available Zn (mg/kg)	2.64
14	Available Cu (mg/kg)	2.58
15	Available Fe (mg/kg)	14.48
16	Available Mn (mg/kg)	8.72

Table 2: Effect of different INM treatments on soil quality indicators after *rabi* rice in 2014-15

Treatments	Zn	Fe	Cu	Mn
	mg/kg			
50% NPK	1.86	12.16	1.95	4.90
100% NPK	1.98	12.43	2.21	6.80
150% NPK	1.98	12.33	2.05	7.10
100% NPK + HW	1.90	12.36	2.20	6.20
100% NPK + Zn	2.92	12.70	2.27	5.86
100% NP	1.93	12.37	1.94	5.90
100% N	1.82	12.41	2.14	5.40
100% NPK + FYM	2.03	12.78	2.31	7.40
100% NPK - S	1.87	12.45	2.06	6.20
FYM	2.34	12.89	2.46	7.86
Control	1.79	12.01	2.00	4.70
Fallow	2.50	13.25	2.09	6.60
S. Em. ±	0.14	0.37	0.12	0.25
CD (0.05)	0.40	NS	NS	0.745

Table 3: Effect of different INM treatments on soil quality indicators after *Kharif* rice in 2015-16

Treatments	Zn	Fe	Cu	Mn
	mg/kg			
50% NPK	1.84	12.26	1.98	4.84
100% NPK	2.06	12.53	2.26	6.88
150% NPK	1.92	12.41	2.11	7.24
100% NPK + HW	1.93	12.48	2.16	6.32
100% NPK + Zn	3.45	12.75	2.19	5.76
100% NP	1.86	12.29	1.82	5.84
100% N	1.80	12.52	2.01	5.32
100% NPK + FYM	2.12	12.82	2.36	7.51
100% NPK - S	1.85	12.39	2.01	6.27
FYM	2.38	12.94	2.43	7.91
Control	1.77	12.08	2.03	4.68
Fallow	2.55	13.14	2.15	6.54
S. Em. $\pm$	0.16	0.37	0.12	0.26
CD (0.05)	0.48	NS	NS	0.75

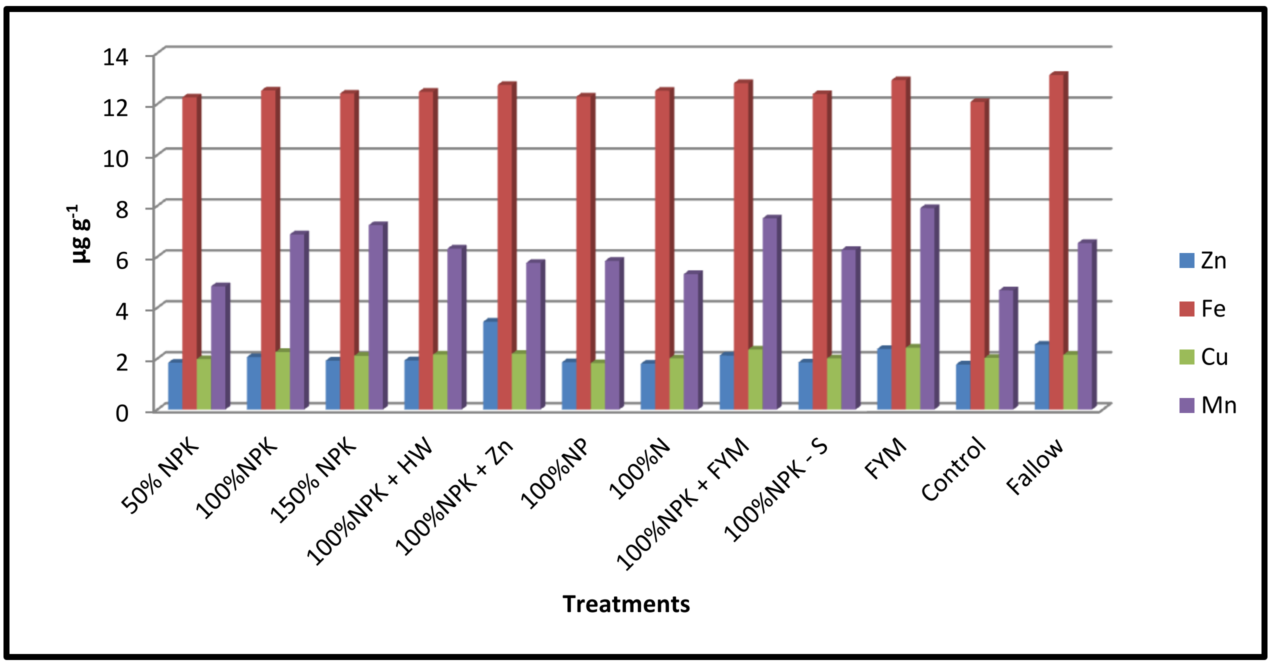

Fig.1: Graphical representation of available micronutrient values of the soil for each treatment after kharif season

[MS received : July 12, 2017] *[MS accepted : July29, 2017]*