International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 845-848

Received: 25-05-2019
Accepted: 27-06-2019

Ayesha Mohanty
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Bhubaneswar, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Kshitendra Narayan Mishra
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Bhubaneswar, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Lalit Mohan Garnayak
Department of Agronomy, College of Agriculture, Bhubaneswar, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Correspondence
Ayesha Mohanty
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Bhubaneswar, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Effect of mulching and integrated nutrient management on soil micronutrient status in an inceptisols under coastal agro-ecosystem of Odisha

Ayesha Mohanty, Kshitendra Narayan Mishra and Lalit Mohan Garnayak

Abstract
A field experiment has been initiated at Central Research Station, OUAT, Bhubaneswar in split plot design to assess the impacts of mulching on soil micronutrient status in an inceptisols under coastal agro-ecosystem of Odisha at the end of the 5^{th} cropping cycle. The treatment details include two crop establishment methods and two cropping systems that were allotted to the main plots and combination of two mulching to rabi and summer crops and two nutrient management practices to all the crops to the sub-plots, resulting a total of sixteen different combinations. Changes in chemical properties of some micronutrient (Fe, Mn, Cu and Zn) status of a sandy loam soil were measured after 5 years of establishing different soil management strategies, which were deemed to be environmentally sound. The soil micronutrient status of these sandy loam soils was readily altered when large amounts of nutrients were contained in applied mulches and integrated nutrient management. Organic mulch materials, such as crop residues mulch, break down over time. The decomposing mulch must have added nutrient-rich organic matter to the soil that has resulted in increased Fe content (63.14 ppm), Cu content (1.81 ppm), Mn content (8.92 ppm) and Zn content (0.98 ppm). The inclusion of mulch in the cropping system significantly enhanced the Fe (+15.05%), Cu (+26.57%), Mn (+29.28%) and Zn (+10.11%) over the soils without mulching. Integrated nutrient management (INM) is an approach that seeks to both increase in agricultural production and safeguard the environment for future generations. It is a strategy that incorporates both organic and inorganic plant nutrients to attain higher crop productivity, prevent soil degradation, and thereby help meet future food supply needs.

Keywords: Micronutrients, mulching, INM & inceptisols

Introduction

Plant nutrition is one of the prime considerations for getting higher yield (Saha *et al.* 2010) [14]. Micronutrients are essential for plant growth and play an important role in balanced crop nutrition. As soil is the most vital resource for providing food to the ever increasing population, it is mandatory that soil should be used rationally and conserved properly for realizing agricultural productivity on a sustainable basis. Conservation agriculture (CA) practices with the principles of minimal soil disturbance, permanent soil cover and diversified crop rotation are becoming economically and ecologically more viable option as they provide more favorable soil conditions for sustainable crop production (Choudhury *et al.*, 2014) [3]. Mulching with crop residues improves nutrient availability (Lal, 2004) [8], regulates soil temperature, encourages favourable soil microbial activities, worms, soil organic matter and carbon storage, suppresses weed growth, improves quality of produce, there by enhances the wellbeing and production of crops (Bhardwaj *et al.*, 2013) [1]. Mulched treatments consistently produced the highest average grain yields, leaf area index and faster rate of change in available P (Henry *et al.*, 2013) [5].

Inefficient management of inorganic fertilizers leads to higher cost, pollution of the environment and increasing emission of GHGs such as CH_4 and N_2O leading to global warming. A good quality organic input with lower dose of chemical fertilizers augments under integrated nutrient management practices improves soil micronutrient status, soil enzyme activities, improves the microbial biomass carbon and organic carbon (Nath *et al.*, 2012) [10].

Research with mulches has been carried out with plastic sheets, resinous material, different crop residues and by products. However, studies on effective mulches for various rice based cropping systems and comprehensive information on the advantageous effects of mulching on soil micronutrients status in the rainfed agro-ecosystems of Odisha is sparse. Micronutrients have been reported to influence the productivity levels of upland rice significantly (Deb, 1997) [4]. Among the micronutrients, deficiency of Zinc (Ingle *et al.,* 1997) [6] and iron (Sakal *et al.,* 1982) [15] is wide spread, more so, under rainfed upland conditions. Hence, location specific studies on these micronutrients are also required. The objectives of the present study was to determine the effect of mulching on soil micronutrient status at the end of 5th cropping cycle in a sub-humid tropical agricultural soil.

Materials and Methods

The experimental site is at the Central Research Station of Orissa University of Agriculture and Technology; Bhubaneswar (20^{0}15´ N and 85^{0}52´E, 25.9 m above MSL and at about 64 km away from the Bay of Bengal) comes under the East and South Eastern Coastal Plain Agro-climatic Zone of Odisha. The region is characterized by a sub-tropical climate with a hot and humid summer (March-June), hot and wet monsoon (late June-mid October) and a mild and dry winter (November-February). Broadly, the climate falls in the group of moist hot type with mean annual rainfall at of 1527 mm. The present study is a part of long term experiment on "Development of innovative farming practices to mitigate the effects of climate change" under the AICRP on Integrated Farming Systems, which was initiated in 2011-12. The field experiment was conducted in split-plot design with three replications. There are a total of 16 treatment combinations. Two crop establishment methods and two cropping systems were allotted to the main plots and combination of two mulching to rabi and summer crops and two nutrient management practices to all the crops to the sub-plots (Table 1). The rabi and summer crops were mulched with the residues of previous crops @ 8 t ha -1 after 1st hoeing and earthing up between 21 to 30 days after sowing (DAS).

The soil samples of the field experiment were drawn from a depth of 0-15 cm at the end of the 5th cropping cycle (2015-16) and brought to the laboratory immediately for analysis of various soil micro-nutrients. Micro-nutrients of the soils from all the treatments of the experimental sites were determined by atomic absorption spectrophotometer using DTPA extract method as described by Lindsay and Norvell (1978) [9]. The extractant consists of 0.005M DTPA (Diethylene triamine penta acetic acid), 0.1M Triethanolamine, and 0.01M $CaCl_2$, with a pH of 7.3. The soil test consists of shaking 10g of air-dry soil with 20 ml of extractant for 2 hours. The leachate is filtered and Zn, Fe, Mn, and Cu are measured in the filtrate by atomic absorption spectrophotometry.

Results and Discussion

The following results were obtained for different micronutrients when mulching and integrated nutrient management were applied to the soil.

Fe (Iron)

Soil analysis data recorded in table 2. revealed that postharvest soil micronutrient Fe in the mulched plots was significantly higher than the no mulch treatments. Application of organic mulch in previous crops also resulted in increased Fe content (63.14 ppm) than without mulch (54.88ppm) (Fig 1). Similarly, integrated nutrient management (F2) enhanced the soil Fe status by 19.37 per cent over RDF (53.80 ppm), irrespective of stand establishment techniques. The treatments under mulching and INM showed significant increase in Fe content due to accumulation of organic matter and the increase was in the tune of 43.93% and 46.39% over the initial value (43.87ppm), respectively (Fig 2).

Cu (Copper)

Micronutrient Cu content in soil tabulated in table 2 revealed that it was higher in mulched plots under SRI method of establishment (1.85 ppm) than conventional method (1.39 ppm). Mulching (M2) and integrated nutrient management (F2) treatment improved the soil Cu content slightly by factors of 0.38 and 0.58 over no mulch (1.43 ppm) and RDF (1.33 ppm) respectively. Initially the Cu status of soil was low i.e.1.08 ppm. Application of organic mulch in previous crops resulted in increased Cu content (1.81 ppm) than without mulch (1.43ppm) (Fig 1). Similarly, integrated nutrient management (F2) enhanced the soil Cu status by 43.61 per cent over RDF (1.33 ppm) (Fig 2). The use of mulches would add organic matter to the soils, and could at the same time sequester carbon and improve physical and chemical aspects of soil quality (Neilsen *et al*. 1998) [11].

Mn (Manganese)

Similarly as like iron and copper it is evident from the table that the status of Mn in soil was significantly higher under mulched plots under SRI method (9.11 ppm) than conventional method (6.71 ppm). Mulching and integrated nutrient management significantly increased the Mn content of soil by 29.28% and 44.14% (Fig 1.) over no mulch (6.90 ppm) and RDF (6.48 ppm) respectively. The treatments under mulching with integrated nutrient management showed significant increase in Mn status and the increase was in the tune of 53.53% and 60.76% over the initial value of 5.81ppm, (Fig 2) respectively.

s

Zn (Zinc)

Among micronutrients, zinc is very important for crop production. Zinc is a precursor of auxin and it helps in the formation of chlorophyll in leaves thereby increases photosynthesis for better growth and development of the plant (Torres 1974). Soil analysis data of Zn showed the similar trend as the other cationic micronutrients which are reported in table 2. Zn content under mulched plots of SRI treatments (0.99 ppm) was slightly higher than conventional plots (0.89 ppm). Application of organic mulch in previous crops also resulted in a significant increase in Zn content (0.98 ppm) than without mulch (0.89 ppm). Similarly, integrated nutrient management (F2) enhanced the soil Zn status by 12.5 per cent over RDF (0.88 ppm). Initial Zn status in the soil was found to be 0.67ppm. Beneficial interaction between mulches and micronutrients particularly with application of paddy straw mulch might be due to better conservation of soil moisture followed by better uptake and assimilation of applied nutrients. (Prasad and Chakravorty; 2017.) [13]

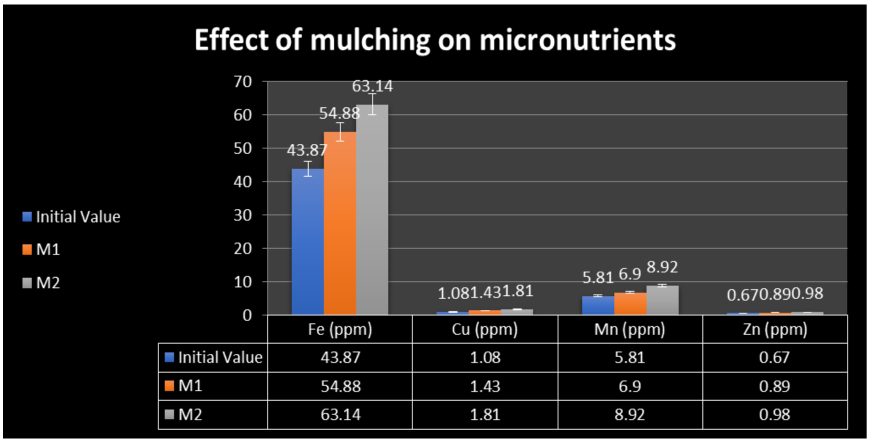

Fig 1: Comparative graph showing the effect of mulching on different micronutrients

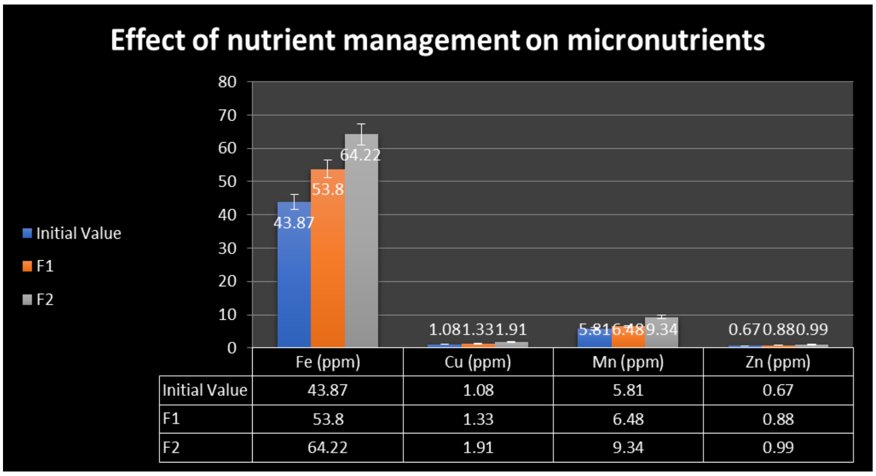

Fig 2: Comparative graph showing the effect of nutrient management on different micronutrients

Table 1: Treatment Details

Main plot (4): Crop establishment (2) x Rice based cropping systems (2)	
Crop establishment (2)	
T_1	System of Rice Intensification (SRI)
T_2	Conventional method of transplanting
Cropping systems (2)	
CS_1	Rice-groundnut-fallow
CS_2	Rice-toria-green gram
Sub-plots (4): Mulching (2) x Nutrient management (2)	
Mulching to rabi & summer crops (2)	
M_1	No mulch
M_2	Crop residues mulch to rabi & summer crops only
Nutrient management (2)	
F_1	RDF to all crops
F_2	75% RDF + 25% N through FYM to all crops

Table 2: Effect of mulching and nutrient management on different micronutrients

Particular	**Fe (ppm)**	**Cu (ppm)**	**Mn (ppm)**	**Zn (ppm)**
Mulching (M)				
M1 (no mulch)	54.88	1.43	6.90	0.89
M2 (mulch)	63.14	1.81	8.92	0.98
SEm (±)	1.13	0.05	0.12	0.008
CD (0.05)	3.29	0.15	0.37	0.025
Nutrient Management (F)				
F1(100% RDF)	53.80	1.33	6.48	0.88
F2(75% RDF + 25% N through FYM)	64.22	1.91	9.34	0.99
SEm (±)	1.13	0.05	0.12	0.008
CD (0.05)	3.29	0.15	0.37	0.025
Initial	43.87	1.08	5.81	0.67

Conclusion

Plant nutrition is highly essential to get higher yield and it was observed that balanced application of fertilizers is the prerequisite for obtaining higher yield and better quality of the produce (Brahma *et al.* 2002) [2]. Micronutrients are essential for plant growth and have importance in balanced plant nutrition. Kumar *et al.* (2008) [7] reported that combined use of crop residue, organic amendments and chemical fertilizers significantly increased the availability of micronutrients Fe, Mn, Zn and Cu in soil over chemical fertilizers alone. Available Zn, Fe, Cu and Mn increased in soil when different levels of fertilizers were applied along with crop residues and organic manure. Prasad and Sinha, (2000) [12]. Mulching with crop residues not only improves nutrient availability, it regulates soil temperature, encourages favourable soil microbial activities, soil organic matter and carbon storage, suppresses weed growth, improves quality of produce, there by increases production of crops. Accumulation of crop residue mulch on the soil surface elevated the soil micronutrient status. Mulching resulted in an increased soil Fe content (63.14 ppm), Cu content (1.81 ppm), Mn content (8.92ppm) and Zn content (0.98ppm) than no mulched treatments (54.88ppm, 1.43ppm, 6.90ppm and 0.89ppm) respectively. Again, mulching along with the components of integrated nutrient management practice ensured physical protection of SOM contents, which in turn, contributed significantly in the increase of micronutrients Fe, Cu, Mn and Zn status of the soil. Similarly, inclusion of integrated nutrient management (F2) enhanced the soil Fe status, Cu status, Mn status and Zn status by 19.37%, 43.61%, 44.14% and 12.5% over RDF (53.80 ppm, 1.33ppm, 6.48ppm and 0.88ppm) respectively, irrespective of stand establishment techniques. So it can be concluded that organic mulching along with integrated nutrient management are the best possible practices to improve the micronutrient status of the soil.

References

1. Bhardwaj RL. Effect of mulching on crop production under rainfed condition- A review, Agricultural Review. 2013; 34(3):188-197.
2. Brahma S, Phookan DB, Gautam BP, Bora DK *et al*. Effect of nitrogen, phosphorous and potassium on growth and yield of broccoli (*Brassica oleracea* L. var. *italica*) cv.KTS-1. Vegetable Science. 2002; 29(2):154-156.
3. Choudhury SG, Srivastava S, Singh R, Chaudhari SK, Sharma DK, Singh SK *et al*. Tillage and residue management effects on soil aggregation, organic carbon dynamics and yield attribute in rice–wheat cropping system under reclaimed sodic soil. Soil and Tillage Research. 2014; 136:76-83.
4. Deb DL. Micronutrient research and crop production in India. Journal of Indian Society of Soil Science. 1997; 45:675-692.
5. Henry A, Mabit L, Jaramillo R, Cartagena Y, Lynch J *et al*. Land use effects on erosion and carbon storage of the Rio Chimbo watershed, Ecuador. Plant and Soil. 2013; 367(1-2):477-491.
6. Ingle SN, Borkar DK, Chaphale SD, Thakre SK. *et al*. Effect of Sources and levels of zinc on yield and nutrient uptake by rice. Journal of Soils and Crops. 1997; 7(2):157-159.
7. Kumar B, Gupta RK, Bhandari AL. *et al*. Soil fertility changes after long-term application of organic manures and crop residues under rice-wheat system. Journal of Indian Society of Soil Science. 2008; 56(1):80-85.
8. Lal R. Soil carbon sequestration to mitigate climate change. Geoderma. 2004; 123(1-2):1-22.
9. Lindsay WL, Norvell WA *et al*. Development of a DTPA Soil Test for Zinc, Iron, Manganese, and Copper. Soil Science Society of America Journal. 1978; 42(3):421-428.
10. Nath DJ, Ozah B, Baruah R, Barooah RC, Borah DK, Gupta M *et al*. Soil enzymes and microbial biomass carbon under rice-toria sequences as influenced by nutrient management, Journal of the Indian Society of Soil Science. 2012; 60(1):20-24.
11. Neilsen GH, Hogue EJ, Neilsen D, Zebarth BJ *et al*. Evaluation of organic wastes as soil amendments for cultivation of carrot and chard on irrigated sandy soils. Canadian Journal of Soil Science. 1998; 78(1):217-225.
12. Prasad B, Sinha SK *et al*. Long-term effects of fertilizers and organic manures on crop yields, nutrient balance and soil properties in rice – wheat cropping system in Bihar. Rice -Wheat Consortium Paper Series. 2000; 6:105-119.
13. Prasad BVG, Chakravorty S *et al*. Performance of Mulches and Micronutrients on Production Economics of Broccoli (*Brassica oleracea* L var. *italica* Plenck). Research Journal of Agricultural Sciences. 2017; 8(1):237-241.
14. Saha P, Chatterjee R, Das NR *et al*. Effect of foliar application of boron and molybdenum in sprouting Broccoli (*Brassica oleracea* var *italica* Plenck) under Terai region of West Bengal. Research Journal of Agricultural Sciences. 2010; 1(4):335-337.
15. Sakal R, Singh BP, Singh AP *et al*. Iron nutrition of rice and maize as influenced by iron carriers and compost application in calcarious soils. Journal of Indian Society Soil Science. 1982; 30:190-284.
16. Torres FP. Evaluation of zinc status of several Ecuadorian soils, 1974. https://books.google.co.in/books?id.