ROLES OF MICRONUTRIENTS IN ORGANIC RICE PRODUCTION IN IHETTE UBOMA , IMO STATE

Christopher I Igbozuruike
Imo State University, Owerri
farstdc@yahoo.com

ABSTRACT

The role of micronutrient in organic rice production was investigated in Ihitte Uboma LGA using Lowa and Ikperejere Rice producing paddies. Organic rice producing paddies and non-organic rice producing paddies in Lowa and ikperejere respectively were sampled during and after rice harvest. The sources of organic enhancement used by the farmers were decomposed poultry droppings, cow dung and pig waste which were occasionally mixed with wood shavings (Sawdust). Twelve (12) samples were collected from each site and 4 samples bucked for 3 composites replicates. Samples were emptied into a plastic envelop respectively. The reference sites (control) were sampled from fallow land close to each rice paddy and samples were also bucked for composite samples. The micronutrient investigated were Zinc, Copper, Iron and Molybdenum, and were determined using while physicochemical properties were done routinely. The findings indicated that organic rice cultivation significantly increased the concentrations of the micronutrients (Zinc, Copper, Molybdenum and Iron (40 Zn, 36 Cu, 10 Mo and 23 Fe mgkg1) elements investigated compared with the control Zn 15, Cu 12, Mo 8 and Fe 10 $Mgkg^1$ and non-organic paddy (13 Zn, 8 Cu, 5 Mo and 8 Fe $mgkg^1$ respectively. In all case, the nutrient levels are not below critical micronutrient levels at which deficiency may occur. However, Further findings on yield ration indicated that organic plots performed better with mean yield value of 740 kg per hectare compared with 639 kg yield per hectare from non-organic plot. The yield advantage could be attributed to addiction of organic matter which not only supplies nutrients in forms needed by plants but also helps in water and nutrient holding and release, create site for soil biota activities and formation of chelates for micronutrients availability to plants. The soil is of moderate fertility.

Keywords: Micronutrients, organic farming, rice production, soil fertility

1 INTRODUCTION

Improving soil fertility for increased productivity, and consequently the realization of optimum yield is one farming method that farmers employed during cultivation. While some farmer depends on synthetic fertilizers, others relied on traditional farming system such as crop rotation, shifting cultivation, intercropping etc, and others chooses organic farming through the addiction of plant and animal manure as well as vermicompost. Organic manure additions return nutrients and organic matter to the soil through their effects on soil physical and chemical properties (Bamka *et al*., 1999). McGrath and Jane (1989) reported that organic matter additions may still be significant three years after application.

Consequently, these manures enhance soil fertility and improves yield capacity (Anikwe and Nwobodo, 2002). Soils vary widely in their micronutrients content and ability to supply micronutrients in quantities sufficient for optimal crop growth (Solberg *et al*., 1999). Mangel *et al*. (2001) revealed that If any element is lacking in the soil or not adequately balanced with other nutrients, growth suppression and, or even death may result.

Micronutrients are just as essential as macronutrients but are required by plants in small quality or amount. There are eight essential micronutrients needed by plants which include; Iron (Fe), Zinc (Zn) Copper (Cu), Manganese (Mn), Boron (B), Chloride (Cl), Manganese (Mo) and Nickel (Ni). Micronutrients often act as co-factors in enzyme system and participate in redox reactions, in addition to having several other vital functions in the key physiological processes of photosynthesis and respiration (Marschner, 1995). Many studies (Jacobsen and Jasper, 1991; Akirinde and Obigbesan, 2000), have revealed micronutrient deficiency in crops.

Researcher have also shown that the adverse effects of Micronutrients deficiencies include stress in plant, thereby resulting in low yield and quality, damage plant morphological structure (Benneth, 1993).

Some farmers in the study area emphasized that organic farming improves crop yield. Therefore, knowledge about the availability of micronutrients in the soil is paramount, as this will help to boast not only rice production, but other major crops. Rice is one crop that is almost eaten universally, ways of improving the production is critical. Many farmers reported that their choices of organic food production were that food produced organically are not only healthier, but also that organic amendments increase the organic matter and micronutrient contents of the soil which depletes with continuous cultivation.

2. MATERIALS AND METHOD

The study area.

Rice producing areas in Lowa and Ikperejere in Ihitte Uboma LGA, Imo State were studied. Ihiette Unoma is purposely selected for his study because farmer in the area produce rice both organically and inorganically. The Micronutrients investigated includes Zinc (Zn), Copper (Cu), Molybdenum (Mo), and Iron (Fe).

Soil sampling

Random (Brown, 1987) collection of representative soil sample was done with the aid of spade at a depth of 0-30 cm according to Nyanagababo and Hamya (1986). Two (2) rice producing sites were sampled. Organic rice producing field (poultry droppings, pig waste and cow dung were in use) and non-organic rice producing field. This latter site applies synthetic fertilizer without micronutrient addition and sometimes no addition of any kind of fertilizer during the cropping season). Twelve (12) samples were collected from each site and 4 samples bucked for 3 composites replicates. Samples were emptied into a plastic envelop respectively. The reference sites (control) were sampled from 2 fallow lands close to each production sites and samples were bucked for composite samples.

sample preparation and laboratory analysis

Soil Sample Analysis: Soil samples were for air dried spread on clean paper sheet and crushed in clean ceramic mortar using a small ceramic piston. The samples were sieved with a 2-mm sieve to get a fine soil fraction (Nelson and Sommers, 1982). The fine soil fraction was used to extract micronutrient using DTAP method (Lindsay and Novell, 1978). A 10g of soil sample was mixed with 20ml DTPA (0.05m-adjusted to pH 7.3) with TEA), then a mechanical shaker was used to shake the mixture for about 30-45minutes before filtering through whatman No.1 fitter. The filtrates were analyzed for micronutrient (Cu, Zn, Mo, Fe) determination using Atomic Absorption

Spectrophotometer (AAS) (Adepetu, 1990). Soil pH was determined in distill water (1.2.5 soil water using glass electrode pH meter Organic Carbon was determined by multiplying organic Carbon by 1.724 (Van Bemellen's Factor). Exchangeable acidity was determined by the titration method (Mclean, 1982). Cation exchange capacity (CEC) was determine using summation method (Nelson and Sommers, 2005). Particle Size Distribution was determined using hydrometer method of mechanical analysis. Percentage Base Saturation was calculated by dividing total exchangeable bases by effective cation exchange capacity value and multiplied by 100. Total Nitrogen was determined using Kyeldahl method (Bremmer and Muvaney, 1982). Available Phosphorus was determined using Bray 2 method. Effective Cation Exchange Capacity was determined using summation method that is exchangeable base plus exchangeable and expressed in $CMolkg^{-1}$.

Data analysis

Simple statistical method was used. Values were summed and means produced respectively and compared with control and fertility indices.

3. RESULTS AND DISCUSSION

Micronutrient Content

The result of micronutrients are shown in Table 1. Rice cultivation significantly reduced the micronutrients studied except in organic rice paddy. This was evident when compared with control. According to John (*et al.*, 2005), tropical soils are generally low on micronutrients. However, repeated cultivation depletes the nutrient more rapid that deficiency may occur. The higher levels of Zn, Cu, Mo and Fe in the organic field may be attributed to organic matter because Bamka *et al*. (1999) reported that addition of organic manure returns nutrients and organic matter to the soil through their effects on soil physical and chemical properties. Mangel *et al*. (2001) revealed that micronutrient deficiency can impede vital physiological processes in plant, thus limiting grain yield. This was supported by Bennett, (2003) who indicated yield advantage of 80% in organic rice field. For example, Boron (B) deficiency can substantially reduce yield in wheatZinc deficiency is a major yield –limiting factor in several Asian countries (Westerman, 1990). Organic manure addition significantly increased the micronutrient levels with increase in rice yield as shown in table 3.

Table 1 Micronutrient Content as influenced by Rice production

Sources	Zn	Cu	Mo	Fe
	← Mg/kg →			
Organic	40	36	10	23
Non Organic	13	8	5	8
Control	15	12	8	10

The chemical Property of the Soil.

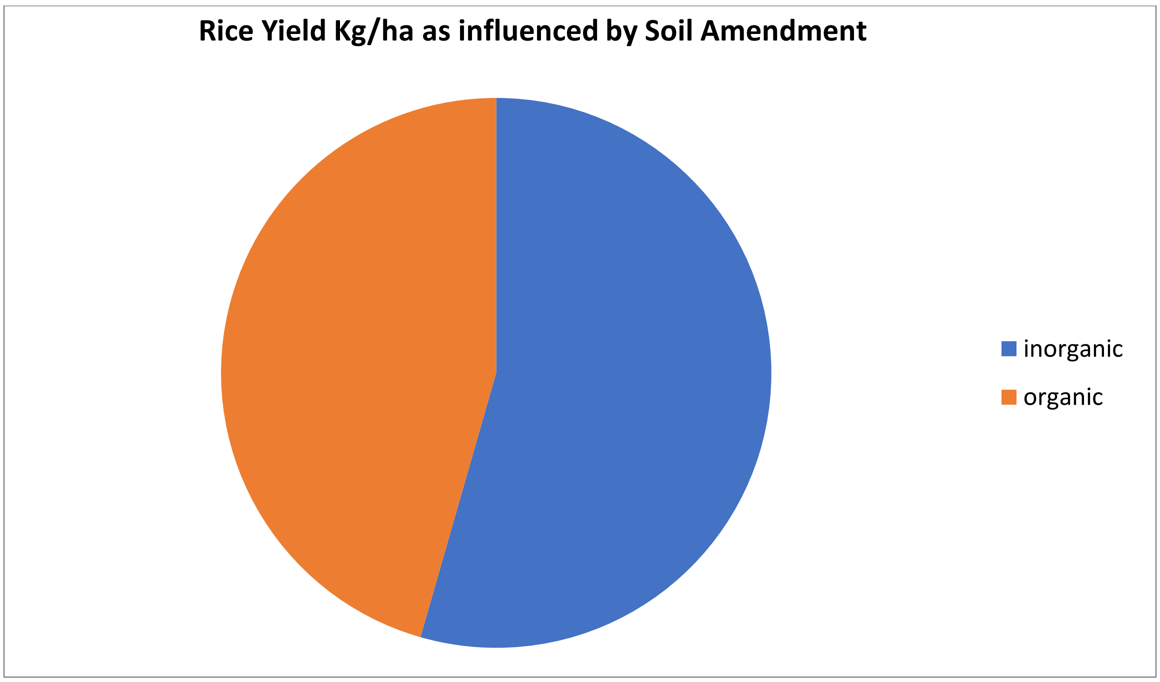
Table 2 showed the concentrations of major fertility parameters. There were significant differences between organic field and non organic field. Organic field had higher means in some parameters followed by fallow plots when compared with non-organic plot. Generally, the location is of moderate fertility.

Table 2: Chemical Properties of Soils of the treatments

Sites	Txt	pH (H_2O)	% OM	gkg^{-1} TEA	gkg^{-1} TN	$mgkg^{-1}$ P	gkg^{-1} Ca	$Cmolkg^{-1}$ Mg	$Cmolkg^{-1}$ K	$Cmolkg^{-1}$ Na	$Cmolkg^{-1}$ CEC	% BS
Organic	Sl	6.43	3.61	1.20	0.18	16.36	4.00	3.80	0.16	0.17	9.33	87.13
Non Organic	Sl	6.26	1.55	1.60	0.13	7.11	4.00	2.40	0.22	0.14	8.36	80.86
fallow (control)	Sl	5.28	2.06	1.40	0.10	5.63	3.20	2.45	0.24	0.18	7.47	81.26

Rice Yield

The yield is significant different between plots. Organic rice plots have mean yield value greater than non-organic plot. The yield is significant different between plots involved. Organic plots performed better than non-organic plot except for plot ii. This is an indication that synthetic fertilizer when adequately applied is capable of given corresponding yield advantage all things been equal.



It is known that long term cropping affect the availability of soil micronutrients (Ward, 1995).

However, poor management of plant nutrients can leads to decrease in yield production. It is found that the application of micronutrients such as zinc, copper, manganese and Boron is not a usual practice. A marked incidence of Micronutrient deficiencies is found in crop due to intensive cropping, loss of fertile topsoil and losses of nutrients through harvest are daringly widespread across the globe (Mengel and Kirkby, 1997).

Intensive rice farming of two seasons a year further depletes the exhausted micronutrients pool in the soil. The deficiencies of micronutrients develop over time due to intensive farming systems and are likely due to large amounts of nitrogen, phosphorus, potassium fertilizers and lime application that promote nutrient imbalance, increasing micronutrients demand, altering micronutrients availability, and hastening the depletion of readily available soil micronutrients pool (White and Zaoski, 1999). Zinc has been identified as one of the most limiting factors in rice production (Yang *et al*., 2009).

CONCLUSION

There was better rice yield in organic rice production plots. This was as a result of organic inputs which consequently added organic matter and available nutrients to the soil. Organic matter can increase the nutrient content of soil and improves its physical and chemical properties (Bamka*et al*., 1999). It also enhances soil water and nutrient holding capacity and serves as chelates in micronutrient retention, release and availability. It also serves as sources of both macro and micronutrients to plants and therefore provides organic forms of these nutrients in utilizable forms. These contributed to greater yield in organic plots compared to non organic plots. Reduced yield occurs in paddies with water table exceeding 5cm during fertilizer application, and is more severe in tropical soils with low fertility index. The result showed that micronutrient is important in rice production.

Deficiency of **zinc** results in light green, yellow or white areas between leaf veins, particularly in older leaves, premature foliage loss, malformation of fruits, often little or no yield, may occur. Zn in soil solution ranges from 2-70 Mg/kg[1].with more than half complexed with organic matter. Deficiency of Zinc are usually associated with concentrations of less than 10- 20 Mg/kg[1]. (Paterson, 2002). Depending on the crop, toxicity will occur when the leaf concentration of Zn exceeds 400 Mg/kg[1].

Copper deficiency and toxicity are not as common as other micronutrients deficiency. Copper deficiency include chlorosis in young leaves, and stunted. In advance stage, necrosis along leaf tips and edges appears. Stem melanosis, root rot and ergot infection can occur in small grains (Solberg *et al*., 1999). Cu toxicity include reduced shoot vigor, poorly developed and discolored root systems. Toxicity is uncommon, occurring where there are high deposits of waste such as municipal, sewage sludge etc. Concentration of Cu in soil ranges from 1- 40 Mg/kg[1].and averages about 9 Mg/kg[1].

Molybdenum deficiency is not common but is similar to interveinal chlorosis in Iron deficiency. Excessive amount of Molybdenum are toxic, especially to grazing cattle or sheep. Mo toxicity cause stunted growth and bone deformation in animal and can be corrected by oral feeding of Copper (Paterson, 2002). The soil concentration of Mo ranges from 0.2 to 5 Mg/kg[1] (Benett, 2003).

Iron deficiency symptoms include interveinal chlorosis, which progresses rapidly over the entire leaf. In severe cases, leaves turn entirely white and necrotic (Van Dijk *et al*., 1993). Iron toxicity can occur under certain condition, for example in rice grown or poorly drained or submerged soils, leaf bronzing symptoms occur with 300 Mg/kg of Fe in rice leaves. Fe concentration is usually very low, 0.1- 0.50 Mg/kgand only the chelate dynamics make Fe more available (Van Dijk*et al*., 1993).

REFERENCES

Adepetu, J.A. (1990). A preliminary survey of the fertility status of soils in ondo state under traditional cultivation" Ife journal of agriculture. 1: Pp 134-149.

Akinrinde, E.A. and Obigbesan, G.O (2000). Evaluation of organic matter P. 539-579. In Page A.L led Method) of soil Analysis part 2, 2nd ed. Agronomy monogr, 9 ASA, Madeson, WT.Answers, Vol, 8, #3. Bozeman, MT montan

Bamka, R.J., Boyles, L.S., Garrison, S.A., Heckman, J. R., Hlubik, w. T., Infante, M., Kluchinski, D., Krogmann W., Lee, D.L. and Samulis, R.J. (1999). Land Application of Sewage Sludge (Biosolids) #1: Questions to ask before considering application to farmland. Rutgers cooperative Research Extention, New Jersy Agricultural Experiment Station. FS 951. 2p.

Bennett, W.F. (2003) Nutrient Deficiencies and toxicities in Biogeochemistry, Biotechnology and Bioremendiation (RC Press) P. 726.421- 28

Bremmer, J.M. (1996). Nitrogen Total. Sparks D.L (Ed.) Methods of Soil Analysis, parts chemical method. 2nd ed., SSSA Book Series No. 5, SSSA, Madison, WI 1085-1122.

Heanes, D.L. (1984). *Determination of total organic C in soils by an improved chromic acid digestion and spectrophotometric*

Jacobsen, J.S. and Jasper, C.D. (1991). *Diagnosis of Nutrient Deficiencies in Alfalfa and Wheat.* EB 43, February 1991. Bozeman, MT. Montana State University Ext.

Marschner, H.J, (1995). Mineral Nutrition of Higher plants academy press. San Diego. Pierce, L.C., 1987. Vegetables Charateristerics, Product, and marketing J. Wiley and sons NY.

Mclean, E.O. (1982). Soil pH and lime requirement. In AL Page (ed) Methods of soil Analysis, Part 2: Chemical and Microbiological Properties. 2ed. Agronomy #9.pp.199–224. American Society of Agronomy Inc, and Soil Science Society of America Inc. Madison.

Mengel, K. and F.A. Kirkby, (1997). Principles of Plant Nutrition.4thEdn.,International Potash Institute, Bern ,Switzerland,pp:685.

Nelson, D.W and Sommes, L.E. (1982) Total organic carbon and inorganic matter.Pp. 539-579. In page A.L.(ed). Methods of soil analysis part 2, 2nd ed. Agronomy monogr .9. ASA, Madison, w1

Njana-gababo J.T. and Hamya, J.W (1986). The Nutrient Deficiencies in Alfalfa and wheat Ed 43, February 1991. Bozemain, MT Montana State University Ext.Nutrient Deficiency Toxicities in crop plants St. Paul, MN, APS Press 202p.

Nwite, J.C., S.E Obalum, C.A. Igwe and T. Wakatsuki 2011. soils in Ondo state under Traditional Cultivation" Ife Journal of Agriculture. I:Pp 134-149.

Rekasem, B. and S. Jamod, 2004. Boron deficiency in wheat: a review field crops research 89:73 -186

Snedecor, G. W. and Cochran, W.G. (1980). *Statistical Methods*. The Iwoa state univ. press Ames.

White, J.G, and R.J Zasoki .1999. Mapping soil micro nutrients. Field crops research. 60:11-26.

Solberg, E., I. Evans, and D. Penny (prepared by). (1999). Copper Deficiency: *Diagnosis and Correction.*Agdex 532-3, September. Retrieved April 7, 2003 from Alberta Agric., Food, and Rural Devpt. web site: http://www.agric.gov.ab.ca/agdex/500/532-3.

Van Dijk, S .and Biefait, C. (1993). Iron deficiency chlorosis in scots pine growing on acid soils. Plant soil, 153: Pp255-263.

Ward, N.I.(1995). *Trace elements*. In Environmental Analytical Chemistry. (Eds F.W. Fifeld, H.R.J.Blackie) p 321. Glasgow: Academic and Professional.

Westerman, R.L. (1990). Soil Testing and Plant analysis, (ed). 3rd ed. Madison, wis: Soil sci. soc. Amer. pp. 12-15.

Wisese, M.U. (2010). Wheat and other small grain. In Nutrients Deficiencies and toxicities in crop plants . St Paul ,MN.Aps press.202p

Yang, M.,L. Shi, F.S xu, J.W Cu, and Y.H Wang. (2009). Effects of B, Mo, Zn, and their interactiosn on seed yield of rapeseed (Biasics Napus L.) Pedasphere 19 (11): 53-59.