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MAPPING OF MICRONUTRIENTS STATUS IN SOILS UNDER MULTI-VARIETAL *CITRUS SINENSIS* PRODUCTION FOR PRECISION AGRICULTURE

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Abstract
Citrus production in Nigeria is below the world average, majorly caused by poor soil management among other things. The situation is further acerbated by blanket fertilizer application and low application of precision in soil fertility management. A study was carried out on a 34- year-old multi-varietal citrus orchard under sweet orange (Citrus sinensis) to determine the current soil fertility status and variability of micronutrients. Soil samples were collected at a sampling depth of 0-15cm to determine soil micronutrient level. The sampling were done at 7x7m interval using a hand held GPS while spatial analysis was done using ArcGIS software. The results showed that mean value of Mn, Fe, Cu and Zn were as follows: Mn 330.08±88.84; Fe 115.7±30.74; Cu 3.14±0.72 and Zn 8.81±3.65mg/kg, with a kurtosis of 0.44, -0.53, -0.098 and 0.94 and skewness of 0.28, 0.43, -0.31 and -0.06 for Mn, Fe, Cu and Zn respectively. Due to the micronutrient's variability of the orchard soils, it is important to use precision agriculture for management in order to improve yield and soil quality.
Keywords: Mapping, micronutrients, citrus, variability, soil fertility, precision

Introduction

Attainment of sufficiency in citrus production in Nigeria remains a challenge. This is due to limiting factors such as low availability of quality rootstock material, climate change, low agricultural input, lack of precision and poor use of fertilizer, high post-harvest losses and low value addition. Of importance in increasing citrus yield in Nigeria is the need for intensive soil fertility management as most farms in Nigeria are low in fertility due to low application/ precision in use of fertilizer and blanket fertilizer application. Nigeria currently has a fertilizer index rate of 5.5kg/ha of arable land. This has grossly affected soil and plant nutrient needs leading to micronutrient deficiency and crop failure in many cases. Consequently, there is need for improved micronutrient fertility in Nigerian agriculture. Micronutrients are essential in crop growth and are usually required in little quantity. Raja (2009) observed that the role of micronutrient in crop production include improved crop quality, increase in yield, improved disease resistance and prevention of physiological disorder. Beyond the supply of micronutrients, soil organic matter needs to be given serious attention as there is a strong correlation between organic matter and most crop properties (Ogunkunle and Awotoye, 2011). Precision in agricultural practice has improved its productivity significantly (Yousefi and Radzari (2014). Continuous cultivation and low application of fertilizer has led to soil fertility decline (Aduramigba-Modupe *et al.,* 2017). Due to the inherent variability of soil properties as a result of land use (Borusiewicz, 2016) and climatic change (Pareek, 2017), it is important to use precise management to ensure soil conservation and improve its quality. Precision agriculture has been a viable tool for soil variability management (Zude-Sasse *et al.,* 2016) as it helps to reduce low and poor utilization of farm input due to variation in factor of agricultural production. Shaato *et al*., (2005) observed that studies on micronutrient in Nigerian soil are limited. Therefore, this study was carried out to map micronutrient status of a citrus orchard in order to enhance its fertility management precision.

Materials and Methods

Soil samples were collected from multi-varietal citrus collection block at National Horticultural Research Institute (NIHORT), Ibadan (with the coordinates - N07^{O}24.578 and E003^{O}51.150, 196m above sea level). It consists of 12 sweet orange varieties (Bende, Meran, Umudike, Agege, Pineapple and Parson Brown among others) planted at a spacing of 7m x 7m. Soil samples were taken from 0 - 15 cm depth using a soil auger. The samples were analyzed for micronutrients (Mn, Fe and Zn) using standard laboratory procedures of IITA (1990). Data were subjected to descriptive statistics while spatial analysis was carried out using GIS software package (ESRI, 2019).

Results and Discussion

Table 1 shows the descriptive statistics of the micronutrient's concentration of the study area. Micronutrient play vital role in citrus productivity. As shown in Table 1, the mean values of Mn, Fe and Zn are adequate for citrus production while mean concentration of Cu was indicative of low nutrient concentration for citrus production as recommended by (Chen *et al.,* 2007). Improved fertility management of soil micronutrient is important because of its effect on crop quality and productivity (Patil *et al.,* 2018). Coefficient of variation (CV) is an indicator of the level of variability of soil properties. Wilding and Dress (1983), characterized CV values as follows: 0-15 (low variability), 15-35 (moderate variability) and >35 (high variability). From the foregoing, (Mn, Fe and Cu) were moderately variable while Cu was highly variable. Consequently, Cu fertility management should be more precise and site specific. Application of fertilizer without recourse to site specific needs of the soil and crop leads to wastage of resource and poor yield (schellberg *et al.,* 2008**)**.

Table 1: Descriptive Statistics of Micronutrients Values of the Orchard

Micronutrient	Mean (mg/kg)	CV	Kurtosis	Skewness
Mn	330.08±88.84	29.91	0.44	0. 28
Fe	115.7±30.74	26.56	-0.53	0.43
Cu	3.14±0.72	22.85	-0.01	-0.31
Zn	8.81±3.65	36.83	0.94	-0.06

Precision agriculture helps to restrict resource use to particular area, improve yield and farm efficiency, thereby reducing wastage (Chan, 2006). Mapping aids visibility and presentation of soil properties to enhance farm and soil management. The micronutrient maps of the citrus orchard are presented in Figures 1 and 2. Mean value of Cu (3.14mg/kg) across the orchard indicated low nutrient status but the map (Figure 1) showed particular areas of deficiency.

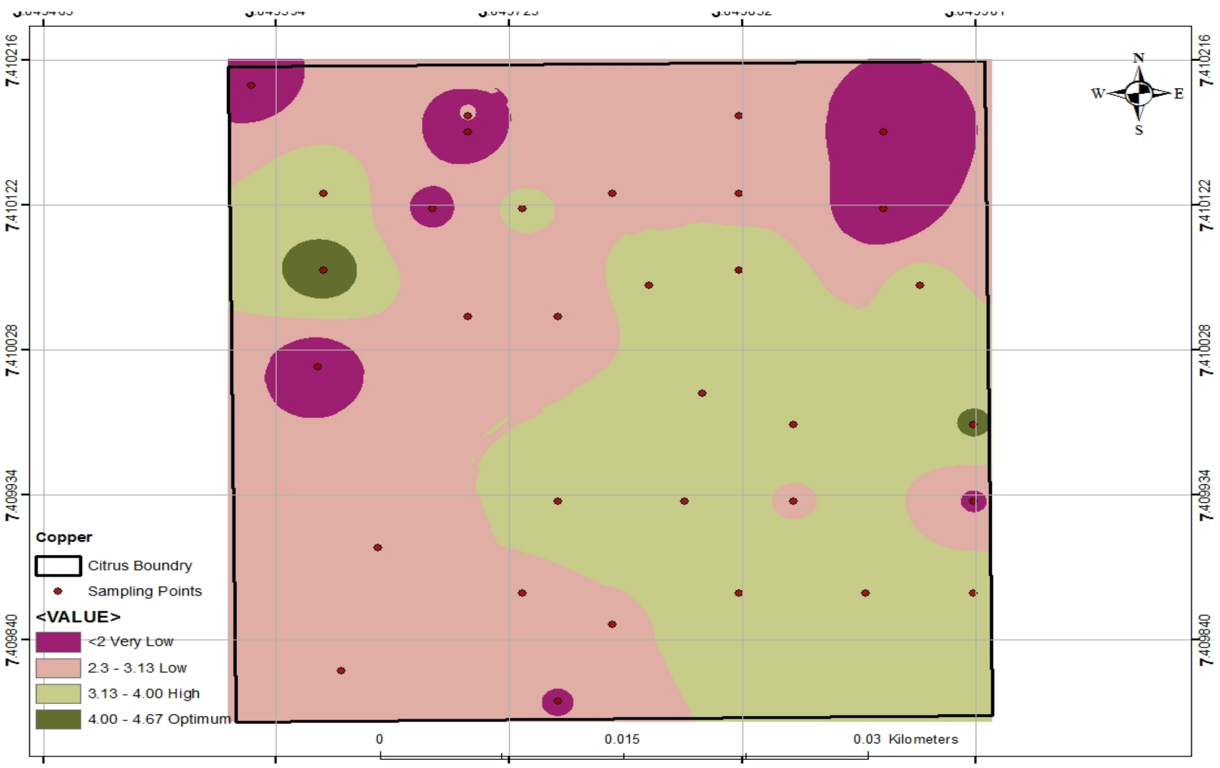

Figure 1: Distribution of Cu within the orchard

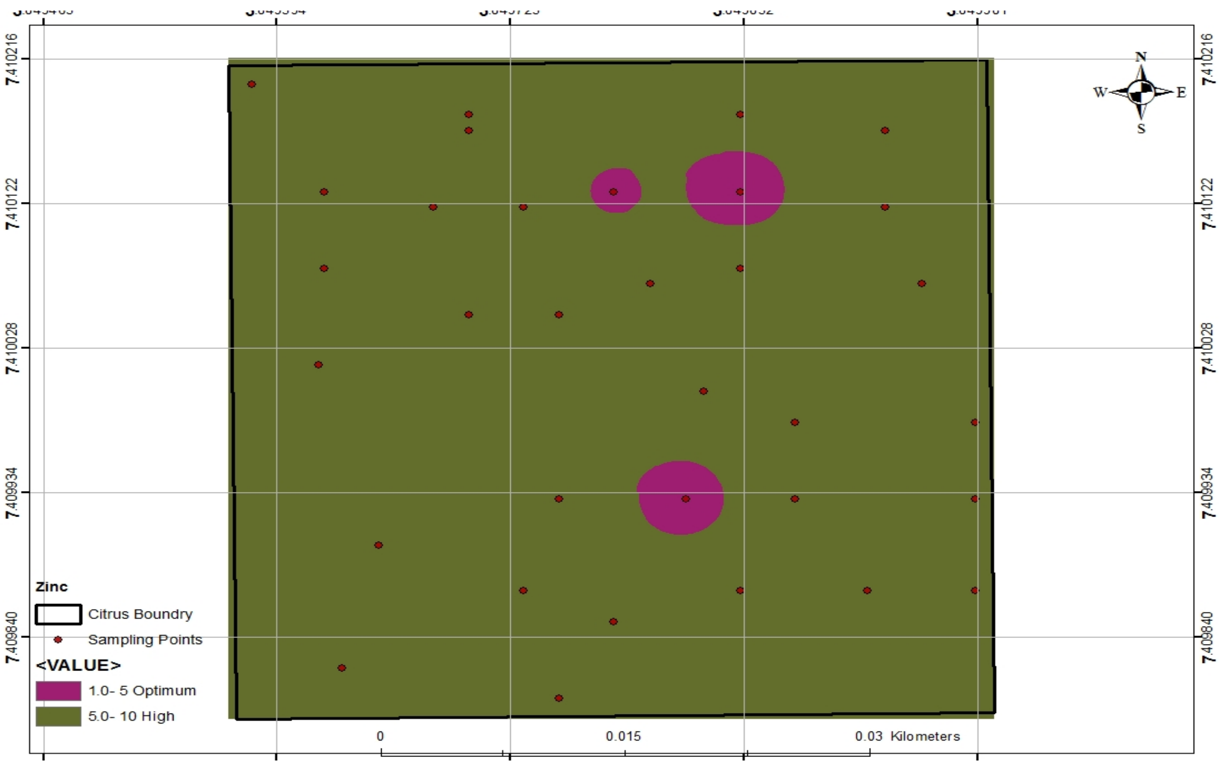

Figure 2: Distribution of Zn within the orchard

Conclusion

Precision and site-specific management are required to improve Cu concentration of the orchard, enhance yield, improve soil quality and reduce wastage of fertilizer; while blanket fertiliser application should be avoided.

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