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Investigation of Soil Micronutrients Status of Greenhouse for Enduring Crop Planning Hilly Terrain of Assam

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Abstract—*Soil micronutrients are essential for high quality enhancement of crop produce, yield maximization and very less attention are given by the researcher and farmer for sustainable crop intensification. The crops grown inside the greenhouses aimed to have 4 to 10 times more crop growth and yield than open field conditions. The quality of the product has also been found higher than the open field but the dependency on macronutrient and micronutrient are not yet focussed. Keeping on this view, a field experiment was carried out inside the greenhouse (100m^2) situated in the hilly terrains in experimental farm area of Department of Agricultural Engineering, Assam University, Silchar during June 2014 to assess the soil micronutrient status of the greenhouse farm soils. A total of 36 soil samples were collected from six different blocks (each of 16m2) of greenhouse farm from the soil depth of 0-30 cm to determine micronutrients such as Manganese (Mn), Iron (Fe), Copper (Cu) and Zinc (Zn). Micronutrients were extracted using diethylenetriamine-penta-acetic acid (DTPA) and their concentration was determined using atomic absorption spectrophotometer (AAS). In the study, the available Iron and Manganese were found (83.44-170.36) ppm and (0.05-0.96) ppm, respectively. While the average values of available Copper and Zinc were found at the range of (0.07-0.12) ppm and (0.41-0.74) ppm, respectively. Zn and Cu showed positive correlation with Fe with a significant level of 0.843 and 0.837, respectively. The study also revealed that the observed values micronutrients are highly significant. But, the content of Fe was found very high as accordance to critical nutrient limit of soil properties (followed by MMSOIL-Gov. of India 2011). Therefore, it is suggested for sustained application of micronutrients and supplements through inorganic fertilizers for effective soil, crop and water management inside the greenhouses.*
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Keywords: *Chemical fertilizer, DTPA extractable, greenhouse, inorganic fertilizers, micronutrients, sustainable crop.*

1. INTRODUCTION

Micronutrients are metallic chemical elements essential for plant growth in only extremely small amounts. Although micronutrients are required in minute quantity but have the same agronomic significant as macronutrients have and perform a vital role in the plant growth [13]. These micronutrients elements include Zinc (Zn), Iron (Fe), Copper (Cu) and Manganese (Mn), amongst others. Most micronutrients tend to be associated to the enzymatic system of plants and other physiologically active molecules. [5] For instance, Zn is known to promote the formation of growth hormones, starch and seed development, Fe is important in chlorophyll formation, Cu in photosynthesis and Mn activates a number of important enzymes and is important in photosynthesis and metabolism [4].

The primary sources of these micronutrients are parent material, sewage sludge, town refuse, farmyard manure and organic matter. These nutrients are contained in a small amount which range from few kg^{-1} to several thousand mg kg^{-1} in soils. The availability of micronutrients is very sensitive to changes in soil environment. Studies have indicated widespread deficiencies of micronutrients limiting the realization of crop productivity potential [2-3], [13-16] and [19] reasons for occurrence of these deficiencies tend to be nutrient mining under intensive farming and undue consider large analysis NPK fertilizers while ignoring the micronutrients.

Cultivation of crops in greenhouse is one of the most recently developed specializations of horticulture [1]. In greenhouse system cleaner crops are produced at better quality with less pesticide, less land and more carefully directed fertilization compared to open field production [2]. It also allows year round production in regions where this is not possible in the open field. The crops grown inside the greenhouses aimed to have 4 to 10 times more crop growth and yield than open field conditions. The quality of the product has also been found higher than the open field [7]. So, greenhouses with a large scale production and product handling are able to provide fresh horticultural fruits and crops throughout the year. [18]. Fertilizers as well as soil improvers are widely used in greenhouse. Fertilizers are mainly applied to optimize the physical-chemical conditions of the root environment and are used for growing in soils in situ as well as for growing in substrates. Thus, the application of most fertilizers is primarily essential to restore the soil nutrient status.

Ahead of planting the crops into the greenhouse, it must carry the soil analysis off to understand soil characteristics, this can provide a knowledge of which nutrients the soil needs. Many study reports show that crop yields were increased through conservation of soil, water and nutrients. The option of nutrients maximizes the application of stored water within the root zone. For improving fertilizer usage efficiencies, it is a pre-requisite to collect information about the nature and severity of nutrient problems in a particular soil-cropping system. Keeping on this view, a field experiment was carried out inside the greenhouse for sustainable crop planning in order to assess the soil micronutrient status to provide scientific guiding to balance fertilization, which has important practical significance on soil sustainable utilization of greenhouse.

2. MATERIALS AND METHODS

2.1 Study area

The present a field experiment was carried out inside the greenhouse (100m^2) situated in the hilly terrains in experimental farm area of Department of Agricultural Engineering, Assam University, Silchar during June 2014. Fig. 1. shows the location map of the study site. The district lies between 92° 24' E and 93° 15' E longitude and 24°22' N and 25° 8' N latitude and situated at 36.5 (MSL). The geographical area covered by Cachar district is 3,786 Sq. Km. Silchar covered total hill top area of about 10000 m^2. The climate of the Silchar is warm and humid during summer where average relative humidity is 85% and in winter it is about 78%. The area receives an average of 2196 mm rainfall during the year. Soils of the zone vary from sandy type to clay soil mostly suitable for field crops including horticultural crops [9].

2.2 Soil sampling and physic-chemical analysis

A total of 36 soil samples were collected from six different blocks (each of 16m^2) of greenhouse farm from the soil depth of 0-30 cm to determine micronutrients such as Manganese (Mn), Iron (Fe), Copper (Cu) and Zinc (Zn).

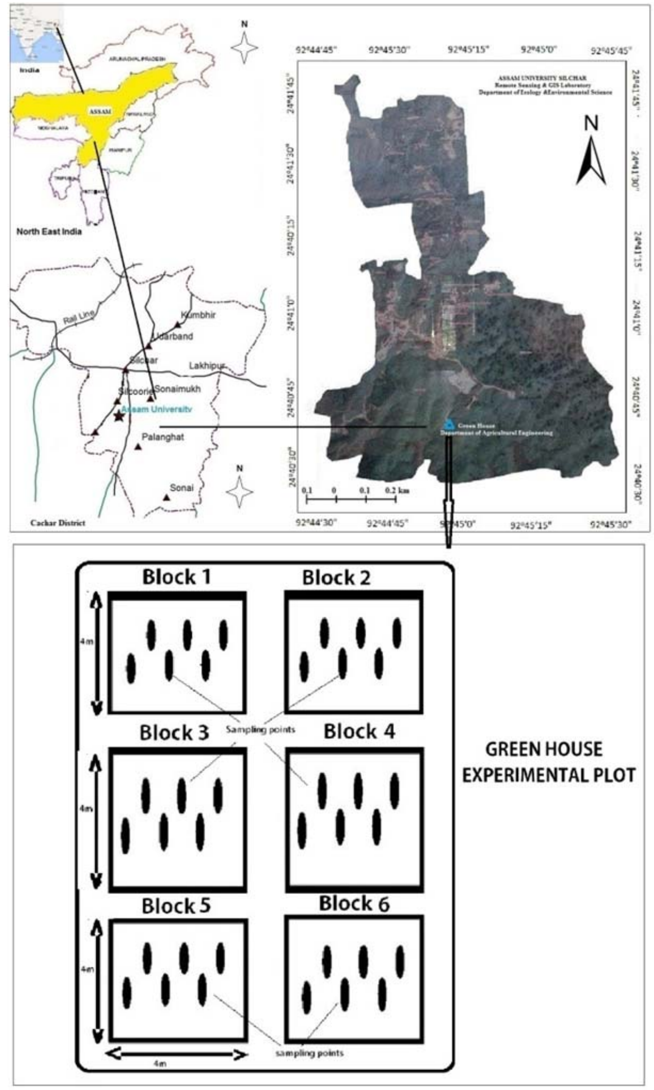


Fig. 1: Location of the Experimental Site of Agricultural Farm Land Assam University, Silchar, India.

All soil samples were dried in air for 4 days and then mesh, sieve with 200 μm a pore size. For the determination of micronutrients (Fe, Mn, Cu, and Zn) all chemical used were 'A' grade, analyzed by different techniques (chemicals, reagent, Atomic absorption spectrophotometer)

The available Fe, Mn, Cu and Zn in soil samples were extracted with a DTPA solution (0.005M DTPA + 0.01 M $CaCl_2$ + 0.1M triethanolamine, pH 7.3 as outlined by [10] and [20-21]. The concentration of micronutrients in the extract was determined by atomic absorption spectrophotometer (AAS).

Statistical analysis

A Pearson's correlation analysis is used to confirm the relationship among micronutrients and One way ANOVA used to find out difference in the means level of the four micro nutrients (Fe, Cu, Mn and Zn) **[6]** All micro nutrition was treated as the testing variable and the site location was treated as grouping variable. Further the mean was used to give more informative conclusion using the software SPSS (Version 20.0) at the level of an $p < 0.01$ and $p < 0.05$, to evaluate the significance of differences.

3. RESULTS AND DISCUSSION

The observed available micronutrients viz., Fe, Mn, Cu and Zn of soil in relation to different block of the study sites were shown in Fig. 2, 3, 4, and 5. The content of DTPA- Fe and Mn in soils varied from 83.44 to 170.36 ppm with an average value of 109.34 ppm and 0.05 to 0.96 ppm with an average value of 0.415 ppm respectively. Available Cu content of the soil samples varied from 0.07 to 0.12 ppm with the mean value of 0.106 ppm while available Zn in the soil samples varied from 0.41 to 0.74 ppm with the mean value of 0.518 ppm. Zn and Cu showed positive correlation with Fe with a significant level of 0.843 and 0.837, respectively Table 1. But, the content of Fe was found very high as accordance to critical nutrient limit of soil properties (followed by MMSOIL-Gov. of India 2011) [12] Table 3.

Table 1: Correlations matrix among various soil chemical properties

Variable	Fe	Zn	Cu	Mn
Fe				
Zn	0.843*	1		
Cu	0.837*	0.599	1	
Mn	0.154	0.626	-0.119	1

** Correlation is significant at the 0.01 level (2-tailed).

All the four micro nutrition entered as a testing variable and site location variable treated as the grouping variable. Table 2 provides the significant difference in the mean level of micro nutrition of two difference sites. The conclusion is same as the discriminant analysis.

Table 1: Variation of soil chemical properties among different blocks

Micronutrients		Sum of Squares	df	Mean Square	F	Sig.
Fe	Between Groups	15209.7	5	3041.9	655.651	.000
	Within Groups	55.675	12	4.640		
	Total	15265.4	17			
Cu	Between Groups	.013	5	.003	26.400	.000
	Within Groups	.001	12	.000		
	Total	.014	17			
Zn	Between Groups	.229	5	.046	4.678	.013
	Within Groups	.117	12	.010		
	Total	.346	17			
Mn	Between Groups	2.713	5	.543	500.871	.000
	Within Groups	.013	12	.001		
	Total	2.726	17			

Planning of greenhouse crop

The development of plants and measures to achieve greater and more efficient output from agriculture; a sound agriculture policy should be able to reconcile three basic needs: the production of food and agricultural products, protection of the environment and the maintenance of the agricultural farm [11] and [17]. Agricultural intensification without adequate restoration of soil fertility may threaten the Sustainability of agriculture. Quantitative estimation of plant nutrient depletion from soils is useful for comprehending the state of soil degradation and for devising corrective measures.

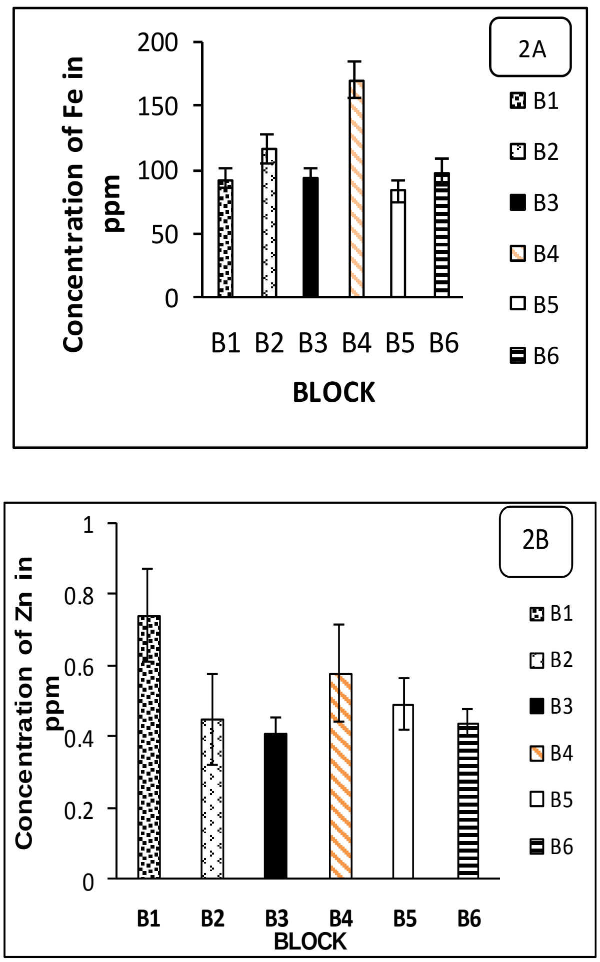
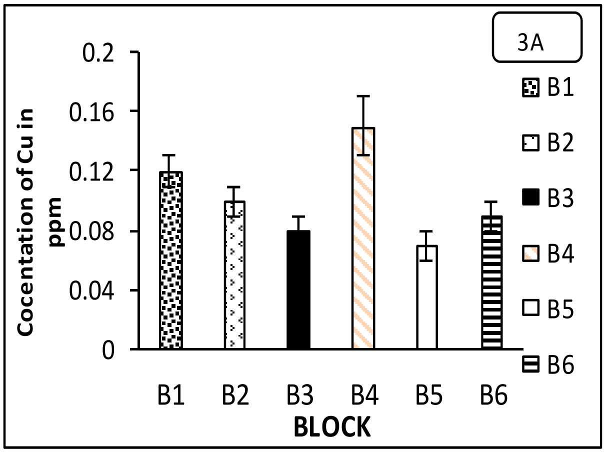


Fig. 2: Showing The Concentration of Available Fe Status (2A) and Available Zn Status (2B) of the Study Area.



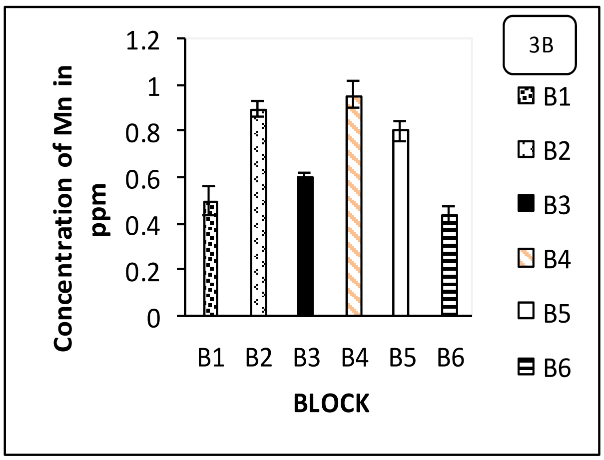


Fig. 3: Showing the Concentration of Available Cu Status (3A) and Available Mn Status (3B) of the Study Area.

4. CONCLUSION

The micronutrients analysis reveals nutrient deficiencies and imbalance of nutrients inside the greenhouse. Among the four micronutrients namely, Fe, Zn, Cu and Mn, only Fe was found to be clearly sufficient in soils. Most of the micronutrient levels are quite lower than the critical value accordance with the fertility rating chart given by MMSOIL-Gov. of India 2011 for cropping. This infers that there is low content of Zn, Cu and Mn in the parent materials of the soils. However, available micronutrients, copper show significant positive correlation with zinc. The significant relationship among the micronutrients points to the fact that, their availability is controlled by similar factors. In view of the above observations it is suggested that supplementary application of Mn, Cu and Zn will be required for sustainable arable crop production in the soils and application of organic matter to improve the overall fertility of the soil inside the greenhouse. The findings provide the logistic and basic information for a sustainable agricultural planning in the green house.

Table 4: Critical limit of Soil properties

Parameters	Interpretation	
Fe ppm	0.0 – 2.0	Very Low
	2.0-4.0	Low
	4.0-6.0	Medium
	6.0-10	High
	>10	Very High
Cu ppm	0.0 - 0.1	Very Low
	0.1 - 0.3	Low
	0.3 - 0.8	Medium
	0.8 - 3	High
	> 3.0	Very High
Mn ppm	0.0 - 0.5	Very Low
	0.5 - 1.2	Low
	1.2 - 3.5	Medium
	3.5 - 6	High
	> 6	Very High
Zn ppm	0.0 - 0.5	Very Low
	0.5 - 1.0	Low
	1.0 - 3.0	Medium
	3.0 - 5.0	High
	> 5.0	Very High

Source: Method manual-soil testing in India-Gov. of India-2011

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