Assessment of Soil Fertility Status of Greenhouse for Sustainable Crop Planning in a Hilly Terrain of Assam

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Abstract—*The intensively cultivated agricultural soil without adequate and balance use of chemical fertilizers and with little or no use of organic manure have caused severe fertility deterioration of soils resulting in stagnating or even declining of crop productivity in Assam. The need of the hour is to achieve substantially higher crop yield than the present yield levels from our limited land resources on a sustainable basis. In this context a study was conducted in newly-built greenhouse in agricultural farm land of Department of Agricultural Engineering, Assam University, Silchar during June 2014 with the objective to find out nutrient status of the greenhouse farm soils to formulate and optimize use of fertilizer doses. Soil samples were collected from six different blocks of greenhouse farm from the soil depth of 0-30 cm to determine physicochemical parameter of the soil. The soil profile analysis of all the blocks of the study site revealed that texture of the soils were found sandy loam in nature with average clay, silt and sand percentage of 8.33%, 16.74% and 74.92 respectively.The pH of all soil samples were shown to be less than 5 (pH < 5) with a general average of 4.7 while soil conductivity and water holding capacity were found at the range of (79.33-111.20) µS and (38.76-46.28) % respectively. The total soil organic carbon and total nitrogen were found (0.53-0.92) % and (28-70) mg/kg respectively. However, average value of total phosphorous and potassium were found at the range of (0.12-0.51)mg/kg and (16-20) mg/kg respectively. There is a significant positive correlation (r =0.95) between total nitrogen and total phosphorus. It is also observed that the soil health is not in accordance with the fertility rating chart given by ICAR (2005). The projected assessment of soil physico-chemical properties at a generic level revealed that the soil nutrients of greenhouses contain insufficient quantities of mineral nutrients. This implies that, to enhance the nutrients of the greenhouse soil, sustained application of organic manures or supplementation through inorganic fertilizers is recommended.*

Keywords: *Chemical fertilizer, Greenhouse, Nutrients, Organic manure, Sustainable.*

1. INTRODUCTION

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. In Assam, greenhouse crop production has become a highly industrialized process with full control of growing conditions. Greenhouses increase crop yields by as much as 4 to 10 times as plants grown under open field conditions, the quality of the product is normally higher than open field and the dependency on chemicals is drastically reduced[3]. So, greenhouses with a large scale production and product handling are able to provide fresh horticultural fruits and crops throughout the year. [13].

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. The pH level is controlled by the addition of specific fertilizers, but is also affected by the addition of the fertilizers added to improve the nutrient status. A decreased osmotic potential (increased EC value) is sometimes required to reduce lush growth of crops under poor light conditions or to improve the quality of the harvested produce, being favourable effects of a decreased osmotic potential.

However soil improvers are widely used in greenhouse cultures to stabilize or increase the organic matter content of soils. Besides an increased water holding capacity and cation exchange capacity, most soils show an improved structure by the addition of organic matter. The latter, especially is the case with clayey soil types, but also on loamy soils such effects can be expected. On sandy soils the addition of organic matter is merely important for an improved water holding capacity and an improved cation adsorption capacity. With heavy additions of organic matter, especially the more stable compounds like peaty materials, the organic matter content of sandy soils can become too high, with as consequence that the space between the aggregates are filled with organic matter, which hinders the vertical transport of water. Such effects can occur with sandy soils when organic matter contents increases over 10%. Therefore, it is recommended to increase the organic matter content on sandy soils not above 5%, being the optimum level for such soils.

Prior to planting the crops in the greenhouse, it should carry out the physic-chemical analysis of soil, this will provide an idea of which nutrients the soil needs There are three main major nutrients, which are needed during the life cycle of the plant for its growth and development. Applications of N and P fertilizers and manure improved crop yield and reduced the impact of yield loss due to erosion . The benefits of soil moisture conservation were more visible where soil fertility improvement measures were considered and incorporated . Many studies show that crop yields were increased through conservation of soil, water and nutrients . The availability of nutrients maximizes the use of stored water in the root zone . For improving fertilizer use efficiencies, it is a pre-requisite to collect informations about the nature and severity of nutrient disorders in a particular soil-cropping system. Therefore, the main objective of present study was to assess of the fertility status of greenhouse for sustainable crop planning in order 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 study was conducted in a newly-built greenhouse in agricultural farm land, Department of Agricultural Engineering, situated on a hilly terrains in the Assam University agricultural field, Silchar Cachar district, southern part of the Assam during June 2014. Fig. 1. shows newly build Greenhouse in Agricultural farm land. 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).

Fig. 2: Shows newly build Greenhouse in Agricultural farm land.

The geographical area covered by Cachar district is 3,786 Sq. Km. Silchar covered total hill top area of about10000 $m^{2.}$ 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. The soil pH ranges from 4.6 to 5.7.

2.2 Soil sampling and physic-chemical analysis

Soil samples were collected from six different blocks of greenhouse with the soil depth of 0-30 cm with three replicate from each block. Soil texture was determined by using Bouyoucos soil hydrometer method [9] with the accessories such as volumetric cylinder, density hydrometer, type ASTM no.152H (Bouyoucos hydrometer). The water holding capacity was determined by kin box method. Electrical conductivity of soil was determined in the soil: water suspension (1:2.5)[8]Soil pH was determined from 1:2.5 soil-water suspensions using a digital pH meter (GeNei pH meter). Soil organic carbon, total nitrogen, total phosphorus and total potassium were determined following standard protocol ([10] The factor of 1.724 was used to convert the organic carbon percentage into soil organic matter (%). Statistical analysis was carried out for each set of data using the software SPSS (Version 20.0) at the level of $p < 0.01$, to evaluate the significance of differences.

3. RESULTS AND DISCUSSION

3.1 Soil physical properties status

The summary of the observed soil physical properties in relation to different block of the study site and soil depths is presented in Table 1. According to USDA textural classification triangle, texture of the soils were found sandy loam in nature with average clay, silt and sand percentage of 8.33%, 16.74% and 74.92 respectively. This indicating the coarse nature of the soil and the low water retention characteristics. The texture of soil cannot be changed easily in such a way that there is a preferential migration of finer soil particles to the lower layers due to the changes brought by organic matter and root activities of plants under the plantation [4]and [5]. Soil texture may affect productivity in a variety of way i.e. by affecting moisture availability, soil temperature, nutrient supply and the accessibility of soil organic matter to microbial Decomposition[12] and [6] In the present findings, the soil texture of the study area was found to be sandy clay in nature, which might have favoured variety of crop plantation. The average water holding capacity (WHC) were ranged from (38.76±2.2 to 46.28±4.0) percentage. The water holding capacity increased with the increase in the clay content at all the sites and was low on the sites, where percent sand washigher. Sandy soils generally have less favorable moisture holding capacity and nutrient retention characteristics than non-sandy soils [11].

Table 1: Physical properties of soil of different blocks in greenhouse

		Soil Texture

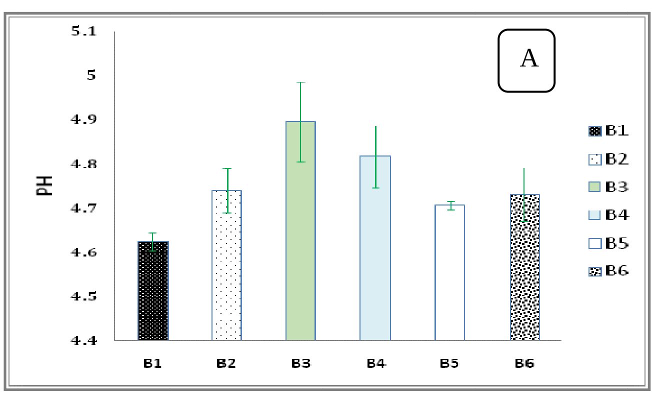
Block	WHC %	(silt+clay) %	Clay %	Silt %	Sand %	Soil type
B1	46.28±1.0	27.5	7.50	20.01	72.50	sandy loam
B2	43.93±1.9	25.125	10.01	15.12	74.87	sandy loam
B3	40.41±1.1	27.7	7.52	20.2	72.30	sandy loam
B4	43.62±1.3	25	7.51	17.5	75.02	sandy loam
B5	43.32±1.8	22.625	10.11	12.62	77.37	sandy loam
B6	38.76±1.2	22.5	7.50	15.11	77.5	sandy loam

WHC= Water holding capacity

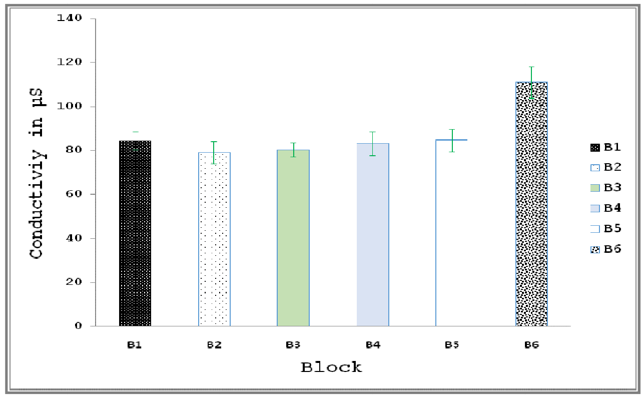
3.1 Soil Chemical properties status

The observed chemical properties (pH, conductivity, soil organic carbon, soil organic matter, total nitrogen, total phosphorous and total potassium) of soil in relation to different block of the study site of the were shown in Fig. 2, 3 and Fig. 4. The soil pH of the study area was observed in the ranges from 4.62±0.92 to 4.89±1.04. The electrical conductivity of the soil in the study site was found in the ranged from 79.33±4.06 µS to 111.20±7.05 µS. The soil organic carbon and soil organic matter ranged from 0.53±0.01 to 0.92±0.01% and 0.91 to 1.59 %, respectively. The total nitrogen contents of the soil was found in the ranged from 28±0.21 mg/kg to 70±0.09 mg/kg. The total phosphorus content of soil was found in the range of 0.12±0.02 mg/kg to 0.51±0.01 mg/kg, respectively. The total potassium content of the soil was obtained in the range of 16±0.05 mg/kg to 20±0.10 mg/kg . Table 2. Shows the correlation of chemical properties (pH, conductivity, soil organic carbon, total nitrogen, and total phosphorous and total potassium) of soil in relation to different block of the study site. There is a significant positive correlation

(r =0.95) between total nitrogen and total phosphorus.



(a)



(b)

Fig. 2: Showing pH status (A) and conductivity Status (B) of the study area

4. 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. The hilly terrain is not suitable for the cultivation of rice as it is a well drained land and rice requires lot of water during its plantation period.

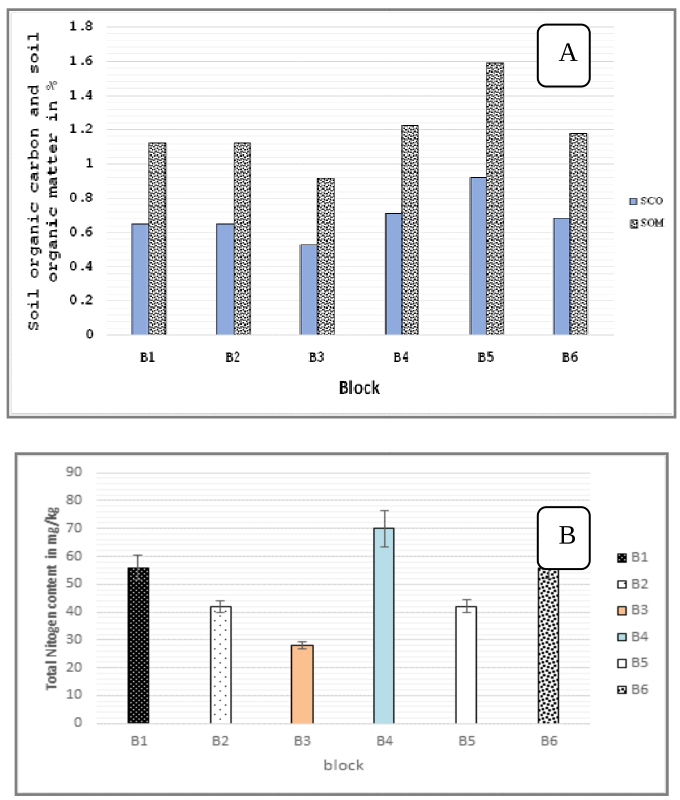
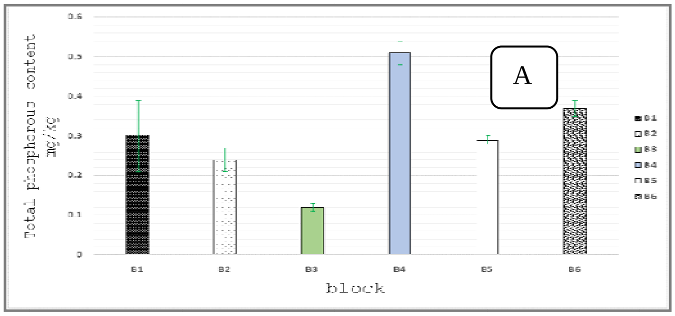


Fig. 3: Showing Soil organic carbon, soil organic matter status (A) and Total nitrogen Status (B) of the study area

However, low water requirement crops like carrot, maize, tomato, sweet potato, peas and flowers like roses, cosmos, marigold, hibiscus and calendula are suitable for cultivation in greenhouse. Based on the basic research with the specific parameters of soil, the crop planning for sustainable agriculture in greenhouse is proposed.



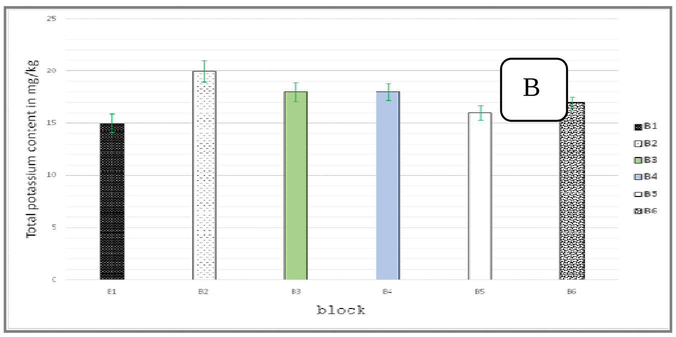


Fig. 4: Showing Total Phosphorous status (A) and Total Potassium Status (B) of the study area

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.

Table 2: Correlations matrix among various soil chemical properties

Variable	pH	Conductivity μS	SOC %	Total N mg/Kg	Total P mg/Kg	TotalK mg/Kg
pH	1.00					
Conductivity μS	-0.21	1.00				
SOC %	-0.43	0.08	1.00			
Total N mg/Kg	-0.33	-0.31	0.22	1.00		
Total P mg/Kg	-0.20	0.32	0.38	0.95**	1.00	
Total K mg/Kg	0.57	-0.25	-0.36	-0.21	--0.13	1.00

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

5. CONCLUSIONS

The soil nutrient status largely determines the soil's water and air supplying capacity to plants. Many soil nutrient status change with changes in land use system and its management such as intensity of cultivation, application of fertilizers, amount of irrigation. So, the present study was carried out to assess soil nutrient status of a hilly terrain situated in Assam University, Silchar and surrounded by many low hills of Assam state. The nutrient status of the soil samples were determined using standard methods.

The findings provide the logistic and basic information for a sustainable agricultural planning in the study site. However, for increasing the yield of the crops to be grown in the hilly terrain a detailed fertility status with other physic-chemical properties are also to be studied.

Soil texture influences crop production in a variety of manners, i.e., by affecting moisture availability, soil temperature, nutrient supply and the accessibility of soil organic matter to microbial decomposition. [6] Since the soil texture of all the study area were found to be sandy loam in nature which might help for the cultivation of varieties of crops. This soil indicates good granulation, high infiltration and good aeration conversely. In all the blocks of the study areas of the present study water holding capacity increased with the increase in the clay content at all the sites and was low on the sites, where percent sand was higher. Sandy soils generally have less favourable moisture holding capacity and nutrient retention characteristics than non-sandy soils. The soil pH of all the blocks of the study sites found 5 (pH < 5) and clearly documents that the soil in these areas is acidic.

The observed data for total Phosphorous (P) and total Potassium (K) of the studied soils indicate that the values found low. On the basis of the findings of this study, the overall soil quality has been observed as declining. Maximum values are quite lower than the critical value accordance with the fertility rating chart given by ICAR (2005) for cropping. So, it is urgently necessary to consider lime treatment and/or organic base fertilizer for maintaining the active acidity level. So, a proper soil nutrient management practice like retention of green needs to be carried out to get high amount of organic matter in situ and use of bio-fertilizers is required to improve soil health, achieve sustainable productivity and reduce inorganic fertilizer load greenhouse soil. The findings provide the logistic and basic information for a sustainable agricultural planning in the newly build green house.

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