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Physio-Chemical Aspects For Assessing Agricultural Soil Fertility And Productivity

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Ilika Kaushik
Student,
School of Biotechnology,
Gautam Buddha University, Greater Noida, Uttar Pradesh, India

Abstract

The instant study is named as "Physio-Chemical Aspects for assessing agricultural soil fertility and productivity." was conducted with soil samples from the agricultural farmlands of village Bharthani, tehsil Mariahu, district Jaunpur, U.P. to observe presence and effects of physio-chemical parameters and thereby analysing fertility levels in it.

The soil samples were freshly collected, cleaned and stored for the study. The alluvial soil samples were subjected to tests which show the presence of the physio-chemical parameters like p.H., content of organic carbon and phosphorus content. The results obtained from these tests were then calculated using specific formulas in order to ascertain the exact amount of soil organic carbon and phosphorus. Through these tests relationships between soil fertility and physical parameters were established and an idea was created for improving the fertility levels in the soil, as well as the relation between soil fertility and soil productivity was noted and analysed. Results show that there was an extreme presence of organic carbon and phosphorus. Also some samples had high p.H. value. In order to counteract the adverse effects some alternative ways are also discussed here.

Keywords: Agricultural Soil, Physio-Chemical Properties, Soil Fertility, Soil Productivity, Soil p.H., Soil Organic Carbon, Soil Phosphorus Content.

Introduction

Since the birth of civilization, humans have been using agricultural practices to complete the basic need of food. Agriculture history in India goes back to the ancient Indus Valley Civilization Era and perhaps beyond that in some Southern Indian parts. Indian agricultural systems are utilized strategically; keeping in mind the suitability of the locations. Subsistence farming, organic farming and industrial farming are significant farming systems which contribute greatly to Indian agricultural practises. Naturally soil contains nutrients like nitrogen, phosphorus, organic carbon, calcium and potassium. These help the crops to grow. When such nutrients are missing or are in shortage then plants suffer from nutrient deficiency and have stunted growth; fertilisers are therefore added to the soil so that proper health of the crops may be ensured. Although they fulfil the nutrient requirement yet they pose serious threats and are used continuously over a long period of time. Like:-

1. Such fertilisers are chemically made.
2. Expensive.
3. Not readily available in the hour of need and in required quantity.
4. Excessive use may deplete the natural content of the soil.
5. Chemicals in fertilizers may also enter in the underground water table and may also enter in food chains. (Yudhisther et al., 2018).
6. Occurance of soil organic matter degradation, soil acidity and environmental pollution. (Manoj et al, 2019)

For determining soil's suitability for agriculture, various physical properties play an important role. Physical properties like supporting capability, movement, retention, availability of water, presence of nutrients, penetration speed, air and heat flow are some of the properties which are related to the soil health directly. Physical properties also tend to influence chemical and biological properties of the soil.(Phogat et al. 2015).

Physcio-Chemical characteristics like moisture content, specific gravity, p.H. measurement and evaluation of magnesium, phosphorus, organic carbon, nitrogen, potassium, chloride, etc give us detailed information about soil health. Most importantly, the fertility of soil greatly depends on concentration of nitrogen, phosphorus, potassium, organic material, inorganic materials and water. (Jain et al. 2014). Since soil is an end result of pedogenic processes resulting from weathering of rocks, therefore they have high variability from depth to surface of earth and hence provides medium for plant growth. Therefore in order to find out fertility, soil

testing is very important. It can be mentioned here that these properties are very sensitive and can change with even minute disturbance.(Iram and Khan, 2018).

The neutron method and the γ-radiation method are the two methods for the assessment of water content and were developed with the recent advances in nuclear technology. pH of the soil is nothing but the activity of hydrogen ions in the soil-water system and mathematically it can be expressed as:- p.H.= -log a H+ . Through p.H. indication of soil reactivity is also indicated i.e. if the soil is acidic, neutral or basic in nature.

The soil reaction greatly affects the nutrient availability.(Thakur et al. 2011). Similarly, various protocols including titrimetric methods, spectroscopy methods and use of atomic absorption spectroscopy are available for assessing various physical, physcio-chemical properties.

Plant/crop roots that are deeply embedded within the soil have a very huge range of organic nutrients that send out signals to attract various microbial populations, mostly have the ability for metabolizing plant excluded compounds and that can proliferate in the habitat. (Badri and Vivanco, 2009)

Soil microbes can be divided into five groups such as bacteria, fungi, algae, protozoa and viruses. Each group has different features and performs different functions within the soil. Furthermore, the most important factor is that they do not live in isolation but interact with each other and hence influence soil fertility more or equal to the organism's own function.(Johns, 2017)

Unfortunately, with the occurrence of many disturbing events like excessive land clearance, stubble burning, inappropriate use of fertiliser, over tilling of soil, etc has led to the damaging conditions of salinity, acidification, soil structure decline and soil desertification. These events turned to the depletion of soil microbial community and hence damaging the soil health.(Johns, 2017) Sometimes in the absence of mineral nutrients, certain microbes tend to act like that of higher plants. For example., growth of Azotobacter or A. niger indicates nutrient deficiency in soil.

Materials and Methods

Sample Collection

The soil sample was collected from the agricultural farmlands of village Bharthani, tehsil Mariahu, district Jaunpur, Uttar Pradesh. A total of 11 samples were collected. The samples were stored in a clean and dry plastic bag, packed and moved to the lab for further testing. At the lab the samples were removed from their package and placed on a large plastic tray for sieving so as to remove roots, twigs or other organic matter. Each sample was sieved and stored in fresh and clean plastic with proper labelling.

Determination of Soil p.H.

20 g of soil was taken and was mixed with 40 ml of DW in a 100ml beaker. This solution was stirred with the help of a glass stirrer regularly for 30mins. Then by immersing the electrodes in suspension the pH was measured and noted. (Thakur et al. 2011) This procedure was performed for all 11 soil samples.

Determination of Soil Organic Carbon%

1g of soil was mixed with 10ml of 1N $K_2Cr_2O_7$ in a 500ml conical flask. To this solution, 20ml of conc. H_2SO_4 was added and the flask was swirled for 2-3 mins. The flask was allowed to stand for further 30 mins. After this, to dilute the suspension, 200ml of water was added. The suspension was filtered. To the filtrate 10ml of 85% of orthophosphoric acid was added and 1ml of phenolphthalein indicator. This entire solution was titrated against 0.5N ferrous ammonium sulphate hexahydrate till the colour changes from violet through blue to bright green. The volume of ferrous ammonium sulphate hexahydrate used was noted. A blank titration was also performed. This procedure was followed for all 11 soil samples (Thakur et al. 2011)

Organic Carbon%= (Blank − Reading) × 10 × 0.003 × 100/ Blank × Weight of soil

Where:-

Weight of the sample = 1g

Normality of K2Cr2O7 = 1N

Volume of K2Cr2O7 = 10ml

Normality of Ferrous Ammonium Sulphate Hexahydrate = 0.5N

(Thakur et al. 2011)

Determination of Phosphorus

1g of soil was taken and 20ml of 0.5N extracting solution was added. This entire solution was kept on a shaker incubator at 200 rpm for 30mins at room temperature. After incubation the solution was filtered. OD was taken on a spectrophotometer at 660 n.m. (Thakur et al. 2011) This process was repeated for all 11 samples.

P(mg P per kg soil) = 0.020l(amount of extracting solution)/ 0.001kg(amount of sample taken) × OD

Soil P.H. Value

The p.H. values of all 11 soil samples were measured and are tabulated in the following table:-

Results and Discussion

Table 06:- Observed p.H. values of the Collected Samples

S.No.	Sample	p.H. Value	Remarks
1	Sample 01	9.3	Very Strongly Alkaline
2	Sample 02	9.2	Very Strongly Alkaline
3	Sample 03	8.4	Moderately Alkaline
4	Sample 04	7.3	Neutral
5	Sample 05	7.4	Slightly Alkaline
6	Sample 06	7.3	Slightly Alkaline
7	Sample 07	8.0	Moderately Alkaline
8	Sample 08	8.8	Strongly Alkaline
9	Sample 09	6.6	Neutral
10	Sample 10	6.9	Neutral
11	Sample11	8.1	Moderately Alkaline

From the observed values it is very clear that sample 04, 09 and10 are having neutral p.H.while the rest are on alkaline side. Soil p.H. is said to be as a main parameter or master parameter of soil fertility as the chemical processes are somehow linked with it. Increase in the alkalinity is due to weathering of silicate, aluminosilicate and carbonate which may enter through water having such mineral chemicals dissolved in them. Certain external factors like arid conditions or poor internal soil drainage can also result in high alkalinity of soil.(Handbook of soil sciences- properties and processes)

Soil Organic Carbon %

After performing titration the available organic carbon of all 11 soil samples were measured and are tabulated in the following table:

Table 07:- Observed titre values and calculated soil organic carbon% of the collected Samples .
Back Titration Value = 15.6 ml

S.No.	Sample	Titre Value (ml)	Soil Organic Carbon%	Remarks
1.	Sample 01	5.9ml	1.86%	Satisfactory
2.	Sample 02	7.5ml	1.55%	
3.	Sample 03	7.0ml	1.65%	
4.	Sample 04	6.9ml	1.67%	
5.	Sample 05	5.5ml	1.94%	
6.	Sample 06	5.0ml	2.03%	
7.	Sample 07	5.7ml	1.90%	
8.	Sample 08	8.0ml	1.46%	
9.	Sample 09	4.9ml	2.05%	
10.	Sample10	4.0ml	2.23%	
11.	Sample 11	4.5ml	2.13%	

The levels of organic carbon in all the samples were found to be satisfactory. Soil organic carbon level is an important factor related to soil health. Soil organic carbon levels are maintained because of various ecological procedures like photosynthesis, decomposition, respiration etc. (Ontl, T. A. and Schulte, L. A., 2012)

Soil Phosphorus Content

After doing the spectrophotometric analysis the observations for all 11 soil samples are as
follows:-

Table 08:- Observed OD and calculated Soil Phosphorus Content of The Collected Samples
Blank = 0.00

S.No.	sample	OD at 660 n.m	Calculated Phosphorus Content (mg P/Kg soil)	Remarks
1.	Sample 01	1.268	25.36 (mg P/Kg soil)	High
2.	Sample 02	2.534	50.68 (mg P/Kg soil)	Very High
3.	Sample 03	2.273	45.46 (mg P/Kg soil)	Very High
4.	Sample 04	2.123	42.46 (mg P/Kg soil)	Very High
5.	Sample 05	2.592	51.84(mg P/Kg soil)	Very High
6.	Sample 06	1.662	33.24 (mg P/Kg soil)	High
7.	Sample 07	2.498	49.96 (mg P/Kg soil)	Very High
8.	Sample 08	1.203	24.06 (mg P/Kg soil)	High
9.	Sample 09	2.264	45.28 (mg P/Kg soil)	Very High
10.	Sample 10	2.102	42.04 (mg P/Kg soil)	Very High
11.	Sample 11	1.114	22.28 (mg P/Kg soil)	High

The results clearly show that there is an accumulation of phosphorus in soil and this can also imply that the plants/crops are unable to take up phosphorus from soil. Furthermore, excessive phosphorus can be harmful for the environment and can lead to leaching into nearby water bodies (Bai et al, 2013). It can also reduce the ability of the plant to intake iron, zinc and other micronutrients from the soil.

Conclusions

It was seen that apart from few the other soil samples were having very high p.H. and this is a concerning factor. Soils having high p.H. on becomes sodic and dispersive. They would have slow infiltration rate and low hydraulic conductivity. This could also result in poor available water capacity.(Ellis and Foth, 2017) . Plants growing on such type of soil would be restricted since the aeration is poor and the soil mostly remains wet. Slowly the soil would become hard and cloddy. Reducing the p.H. of such soils to normal level is done through many ways like use of grass cultures, organic compost, organic garbage, etc. These processes would ensure the incorporation of acid material in the soil thereby, maintaining the balance in it. (Chhabra, 1996)

During the course of study it was found that the organic carbon% in all the samples were satisfactory. This means the soil health is not in the dangerous zone. But still if the levels need to be changed then certain agricultural practices like excessive use of chemically laden artificial

fertilisers and stubble burning must be discouraged. More and more use of organic matter or addition of nitrogen fertilisers would maintain the level of organic carbon in the soil.(Young and Young, 2001)

The phosphorus levels in the sol samples were found to be in high concentration. This can cause phosphorus leaching through soil and the excessive phosphorus would be added in the water streams. One of the major reasons for the high levels of phosphorus in soil is the increased p.H. level. At the normal range of p.H. would be maximum uptake of phosphorus from the soil. Contrary to this if the p.H. is on the higher side then phosphorus uptake is hindered like most of the other plant nutrients.(Penn and Camberato, 2019) Apart from this, excessive use of inorganic, artificial fertilisers can also result in the high phosphorus levels. All this would only disrupt plant growth, health and productivity. By maintaining the levels of p.H., it would ensure that a proper amount of phosphorus is being uptaken from the soil and no accumulation is being made. Using organic fertilisers would further maintain the phosphorus levels and thereby maintain soil health and productivity.

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