Physiochemical analysis of agriculture soil of majra region

[1*]Savita Goyal Aggarwal and [2]Priya Thakur

[1*]Assistant Professor, Department of Chemistry, MKP PG College, H.N.B. (Central University), Srinagar (Garhwal), Uttarakhand, India

[2]Student Msc. Chemistry, MKP PG College, H.N.B. (Central University), Srinagar (Garhwal), Uttarakhand, India

[*]Email: goelsavishivi@gmail.com

DOI 10.51129/ujpah-2024-37-2(2)

Received – September 24, 2024
Revised – September 30, 2024
Accepted – October 05, 2024
Published – December 07, 2024

Abstract- The status of soil structure, porosity, and water holding capacity greatly affects plant growth and health. Soil water relationship and soil plant relationship is affected by soil physical parameters. Soil is the main resource of the natural and agricultural ecosystem. An increase in the content of heavy metals in soils is an environmental threat to agriculture, as it is associated with the accumulation of toxicants in plants, which negatively affects the quality of crop production and poses a danger to human health. Each region has its own specifics crop yield, but due to rapid urbanization and increase in different types of pollutions; there is change in nature, quality and quantity of crop. The article presents the analysis data of soil of Majra, Dehradun region.

Introduction

Soil quality is an indicator of environment quality (National research council 1993) and food security (Lal 1999) Soil quality refers to the status of soil as a result of management (Karlen et al 2003) soil quality parameter is divided into physical chemical and biological parameters i.e, water holding capacity, relative field capacity to water saturation, macro porosity, bulk density, cation exchange capacity, contamination presence, pH, exchangeable, sodium etc (Reynolds et al. 2009, Zaid et.al. 2017). Degradation of soil in arid and semi-arid regions is due to lack of knowledge about soil conditions for farmers and lack of proper equipment. Also in such Circumstances soil was found to be with poor soil quality, high temperature, poor soil fertility, low available water holding capacity, soil organic carbon and high concentration of salt and pH (Zaid et al. 2017). The status of soil structure, porosity, and water holding capacity greatly affects plant growth and health. Soil water relationship and soil plant relationship is affected by soil physical parameters. Soil is the main resource of the natural and agricultural ecosystem. Only 22% (3.26 billion ha) of the total area of the planet is suitable for agriculture and only 3%. (450 million ha) has high production capacity (Lal 1993).The diversity of contaminants is constantly evolving due to agrochemical and industrial developments.

This diversity and the transformation of organic compounds in soils by biological activity into diverse metabolites, makes soil surveys to identify the contaminants both difficult and expensive. The effects of soil contamination also depend on soil properties since these controls the mobility, bioavailability, and residence time of contaminants (FAO and ITPS, 2015).

Soil pollution is an alarming issue. It has been identified as the third most important threat to soil functions in Europe and Eurasia, fourth in North Africa, fifth in Asia, seventh in the Northwest Pacific, eighth in North America, and ninth in sub-Saharan Africa and Latin America. The presence of certain pollutants may also produce nutrient imbalances and soil acidification, two major issues in many parts of the world, as identified in the Status of the World's Soil Resources Report (FAO and ITPS, 2015).

The unique global estimate of soil pollution was done in the 1990s by the International Soil Reference and Information Centre (ISRIC) and the United Nations Environment Programme (UNEP), which estimated that 22 million hectares had been affected by soil pollution (Oldeman, 1991). The Revised World Soil Charter (FAO, 2015b) recommends that national governments implement regulations on soil pollution and limit the accumulation of contaminants beyond established levels in order to guarantee human health and well-being.

Recently, the United Nations Environmental Assembly (UNEA-3) adopted a resolution calling for accelerated actions and collaboration to address and manage soil pollution in the framework of Sustainable Development. This consensus achieved by more than 170 countries is a clear sign of the global relevance of pollution and of the willingness of these countries to develop concrete solutions to address pollution problems (UNEP, 2018).

Physical properties of soil: Soil texture and soil structure are the two important physical properties of soils. Some of the other important physical properties are moisture, colour, density, porosity and temperature (Brady and Weil, 2001).

Soil Texture: Solid phase of the mineral soil mainly consists of discrete mineral particles as the amount of amorphous material including organic matter is usually small. Mineral particles are not exactly spherical but vary widely in their shape, therefore, these particles are usually classified into three conveniently separable groups according to certain size range based on their equivalent diameter (diameter of a sphere that has a velocity of fall in a liquid medium equal to that of the specific particle). The groups of different size range of mineral particles are known as soil separates, primary particles or textural fractions, namely: sand, silt and clay. Soil texture refers to the prominent size range of mineral particles, and is defined both qualitatively and quantitatively. Qualitatively, it refers to the feel of soil whether coarse and gritty or fine and smooth when rubbed between thumb and forefinger.

Quantitatively, soil texture is the relative proportion of sand, silt and clay content on weight basis. The term soil texture is often used interchangeably with mechanical composition of soil. It is more or less a static property affecting almost all others soil properties. For instance, a soil containing 40 percent sand, 40 percent silt, and 20 percent clay is called loam soil. (Jackson, 1962) Soil texture describes the distribution of these different size particles in a soil. There are twelve soils based on the distribution of sand, silt and clay.

Soil structure: Soil structure describes the arrangement and organization of soil particles in the soil, and the tendency of individual soil particles to bind together in aggregates. Aggregation affects water and air transport, which affects the movement of solutes and pollutants and effects biologic activity, including plant growth. The development of soil structure is influenced by the amount and type of clay, as well as the exchangeable ion on the clay.

Soil density: Soil density is related to the mineral and organic composition of a soil and to soil structure. The standard measure of soil density is bulk density, defined as the proportion of the weight of a soil relative to its volume. It is expressed as a unit of weight per volume, and is commonly measured in units of grams per cubic centimeter (g/cm3). Bulk density is an indicator of the amount of pore space available within individual soil horizons, as it is inversely proportional to pore space. Soils with high density may also impede root growth. Even at sites where selective grading is employed, compaction occurs as a result of construction equipment, stockpiling and vehicle traffic (Randrup, 1998; Lichter and Lindsay, 1994)

Soil porosity: Although porosity is related to density, pore size is an important factor affecting soil processes. Soils with similar porosity may have different distributions of pore sizes. The smallest pores (>0.1 µm diameter) hold water too tightly for use by plant roots. Plant-available water is held in pores 0.1–75 µm in diameter. Macropores (>75 µm diameter) are generally air-filled when the soil is at field capacity, but they can rapidly transport water and solutes to deeper depths in the soil. The pore size distribution affects the ability of plants and other organisms to access water and oxygen; large, continuous pores allow rapid transmission of air, water and dissolved nutrients through soil, and small pores store water between rainfall or irrigation.

Material and Methods

Sample Collection

The soil sample was collected from different location of Majra, Dehradun. This

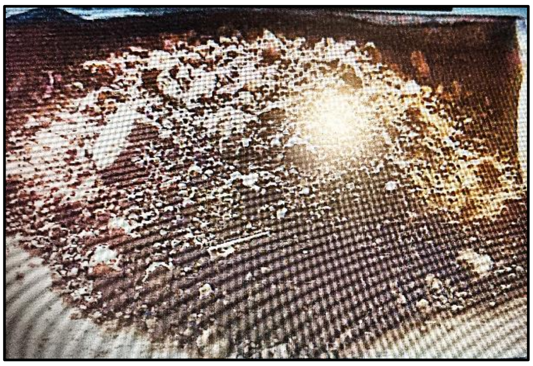

Figure-1 Soil sample

region was once famous for basmati rice variety and Litchi. Soil samples were collected in plastic sample bags. Plant residues and stone pieces were removed by hand.

Soil sample were air dried and passed through a 2 mm brass sieve. Samples were stored at 30°C temperature in oven until use. Then 100g soil sample was transferred to sample bag. Sampling date, location of the sampling and sampling number were marked on the bags and soil samples were brought to the laboratory. Samples study carried out which based on wide range of physio-chemical properties and chemical properties.

The soil samples were brought to laboratory for further analysis. The soil reaction (pH) was determined by using pH meter. Temperature of a soil is measured with help of a routine mercury thermometer in a metal cone by penetrating it into the soil up to 2 cm depth. Water holding capacity of soil usually refers to amount of maximum water which can be held by saturated soil. Specific gravity is determined by using pycnometer. Grain analysis test is done by using sieve of different size.

Proper pH in the field is essential for plant productivity, and either too high or too low pH will adversely affect crop growth. The development of strongly acidic soils (< 5.5

pH) can result in poor plant growth as a result of one or more of the following factors:

- aluminium toxicity
- manganese toxicity
- calcium deficiency
- magnesium deficiency
- low levels of essential plant nutrients such as phosphorus and molybdenum.

Alkaline soils may have problems with deficiencies of nutrients such as zinc, copper, boron and manganese. Soils with an extremely alkaline pH (greater than 9) are likely to have high levels of sodium.

The correct balance is where the soil pH is between 5.5 and 7.5, so every effort should be taken to check soil pH levels regularly. Early identification of soil pH problems is important as it can be both costly and difficult to correct long-term nutrient deficiencies.

Testing pH of soil

One calculates its hydrogen ions. pH values may range from 0 to 14. Grain size analysis is essential in determining the permeability, porosity, compressibility, and shear strength, which helps in making informed decisions for various engineering and environmental applications.

Experimental Investigation

The overall testing program was conducted in two phases. In the first phase, the geotechnical characteristics of soil were studied by conducting laboratory test. In the second phase soil mixed with geo grid with different height of mould was subjected to various test.

Following tests were conducted:

Specific Gravity Test

This test is very important to study any type of soil which is defines as a ratio of mass of a given volume of solids to the mass of an equal volume of water. The specific gravity of solids for most natural soils which falls in the general range of 2.65 to 2.80, the smaller values are for the coarse-grained soils. It may be mentioned that specific gravity of different particles in a soil mass may be not same. Whenever the specific gravity of soil mass is indicated, it is the average value of all the solid particles present in the soil mass.

Specific gravity of the solid is an important parameter. It is used for the determination of void ratio and particle size. In the present study of soil, specific gravity of solid particles was found to be 2.70 and for this test pycnometer method is used which consists of 1000 ml capacity. The specific gravity of the soil particles is 2.2gm. Soils containing organic matter and porous particles may have specific gravity value below 2.0. Soils having heavy substances may have values above 3.0.

Grain Size Analyses

For grain size distribution, divide the soil in different category based on grain size. There are two categories that is coarse grain size and fine grain size. If the size of soil particle is more than 4.75 mm which is called coarse grain aggregate and if the soil particle is less than 4.75 mm which is called fine grain aggregate in geo technical terms. Fine aggregate grain size distribution is done by two methods, sieve analyses and hydrometer test. In the present study we adopted wet sieve analyses test. In this method 1 kg of oven dried soil was taken in 0.075 mm sieve through which water was flowed for a period until transparent water was flowing from the sieve. This sieve with wetted retained soil was kept in oven for someday to get oven dried soil. The oven dried soil was sieved through set of sieves which are generally made up of brass and sieve cloth. The set of sieves placed one above other in descending sequence like 4.75 mm, 2mm, 1mm, 600-micron, 425-micron, 300-micron, 150-micron, 75 microns, and pan for both retain.

Soil Acidity Test (pH)

Knowing the pH level of your soil is essential to ensure an optimal plant growth. pH test results will guide in the decision whether and how much the soil needs supplements, like fertilizers and soil pH adjusters.

Collected samples of soil from the test area. (The soil should be taken from the same depth below the surfaces each time you test.) Took more samples around the plant and mixed them to get a homogenous sample.

Weighed out 1 unit soil (100 g is recommended). Added 2 unit (200 ml) distilled water to it. Stirred the sample for 30 seconds. Let it sit for 15 minutes. Filtered liquid into clean cup. Stirred it again, then look the measurement with Adwa pH meter. Held the electrode in the sample min. 1 minute before the reading.

4. Water Content Test

To find the moisture content of soil consists of the following steps: Cleaned and dried the container and weighed it (W1). Took a specimen of the sample in the container and weigh it (W2). Place the container in the hot air oven, arranged temperature to 110ºC ± 5ºC and allow it to dry for a period varying with the type of soil (usually 24 hours). Recorded the final constant weight (W3) of the container with dried soil sample.

Result and Discussion

Each test was repeated thrice and the average mean value was reported as result. The results of different physical parameters of soil sample tests were represented in Table 1.

Table 1: Different Physical Test carried out on Soil Sample

S.No	Test	Result
1	pH	7.44
2	Water content	8.1 %
3	T.D. S	2.0 gm
4	Temperature	75 °F
5	Density	1.3 g/cm³

Physical parameters of soil

The soil sample was collected from different locations of majra, Dehradun. This region was once famous for basmati rice variety and Litchii. The results found were related to pH, temperature, specific gravity, grain analyses, moisture content and density of soil. The results are shown in (Table 1).

The acidity of the soil can be studied by soil reaction or pH. The pH is very important property of soil as it determines the holding capacity. The pH value of the soil is acidic then it is acidic; 6.5 if it is normal 6.5 – 7.8, alkaline 7.8 – 8.5, alkali >8.5. This one of the most important soil properties which effect drop growth. With the water holding capacity range from 0.14 ml/gm to 0.42 ml/gm and the moisture content range from 7.4% to 5.4%. Soil type was found to be silty and derbies. The optimum temperature for growth of plant ranges between 68°F and 86°F. High temperature even for short period, affects crop growth especially in temperate in case of wheat. Specific gravity of soil sample ranged from 2.17 – 2.32. this value it tells how much Heavier/lighter the material is in water. The grain analyses test is performed to determine the percentage of each size of grain within a soil sample.

Water content

The optimal range of soil moisture content for crops depends on the specific plant species, but the range for most crops was found between 20% and 60%.

TDS levels below 700 mg/L and SAR below 4 are considered safe; TDS levels between 700 and 1,750 mg/L and SAR levels between 4 and 9 are considered possibly safe, while levels above these are considered hazardous to any crop. For irrigation, the TDS has been classified as TDS < 450 mg/l and is preferred for irrigation and TDS > 450–2000 mg/l is slight to moderate and TDS > 2000 mg/l is unsuitable for agricultural purpose (FAO 2006)

The optimal and critical limits of soil BD are dependent on soil texture, particle size, management practices, and organic matter content (Reichert et al., 2009). A BD of less than or equal to 1.3 g cm^{-3} is good, between 1.3 and 1.55 g cm^{-3} is fair, and greater than 1.8 g cm^{-3} is considered extremely bad.

Considering this concept (Eqs. 17.2 and 17.3), the bulk or dry density is defined as the ratio of mass of solid to the total volume of soil. Typical values of the dry or bulk density of most soil vary within the range of 1.1–1.6 g/cm^3. An average value would be 1.3 g/cm^3 for loamy soil.

Conclusion

The results of different physical chemical test of soil sample showed that soil was still having good agricultural value but due to rapid conversion to urbanization, soil lost its agricultural value and fertility.

Disclaimer Statement

Authors declare that no competing interest exists. The products used for this research are commonly used products in research. There is no conflict of interest between authors and producers of the product.

References

Brady, N.C. and Weil, R.R. The Nature and Properties of Soils. *Pearson*, 2016.

Brady, N.C. and Weil, R.R. The Nature and Properties of Soils. 2001, Thirteenth Edition.

Chandra, et al. A correlation between soil biological and physico– chemical properties. 2016.

Efficacy evaluation for the Registration of Plant Protection Products. Rome, Italy, Food and *Agriculture Organization of the United Nations*, 2006.

FAO. International Code of Conduct on the Distribution and Use of Pesticides, 2006.

FAO. World Soil Charter., $p_{p.10}$. Rome, Italy, Food and *Agriculture Organization of the United Nations*, 2015b.

FAO and ITPS. Status of the World's Soil Resources (SWSR) - Main Report. Rome, Italy, Food and *Agriculture Organization of the United Nations* and *Intergovernmental Technical Panel on Soils*, 2015. (also available at http://www.fao.org/3/ a-i5199e.pdf).

GSP. Report of the Fifth Meeting of the Plenary Assembly (PA) of the Global Soil Partnership. GSP Rome, Italy, Food and *Agriculture Organization of the United Nations*, 2017.

https://www.qld.gov.au/environment/land/ management/soil/soil-properties/pH

Lal, R. and Shukla, M. K. Principles of Soil Physics. Marcel Dekker Inc., New York, 2004.

Lal, R. Soil management and restoration for C sequestration to mitigate the Greenhouse effect. *Progress in Environmental Science*, 1999, 1:307-326.

Jackson, M. L. Soil Chemical Analysis. *Prentice Hall of India Pvt. Ltd.*, New Delhi, 1962.

A Mccauley – Basic soil properties: Soil and water management module I, Montana State University.

Mohamed Soliman Zaid, Ahmed Hamdy Rizk, Ali Mohamed, Abd Elwhab Mashhour, Wanas Mohamed Ahmed. Inter-relationships Between Soil Quality Parameters and Wheat Productivity for Some Soils of Monufyia Governorate. *Journal of Biomaterials*, 2017, 1(1).

Oldeman, L.R. World map on status of human-induced soil degradation. Nairobi, Kenya: Wageningen, Netherlands, *UNEP*, *ISRIC*, 1991.

Randrup Thomas Barfoed, Georg Paludan-Müller, Henrik Saxe. Differences in salt sensitivity of four deciduous tree species to soil or airborne salt. *Lars Bo Pedersen*, 2002, Vol. 114, Issue 2, February, pp. 223-230, physiologia plantarum

Reichert, et al. Reference bulk density and critical degree-of-compactness for no-till crop production in subtropical highly weathered soils. *Soil and Tillage Research*, March 2009, 102 (2):242-254

Roberston, et al. Soil organics in cropping and pasture system, 2016.

Toy, T.J. and Shay, D. Comparison of some soil property, 1987.

UNEP. World commits to pollution-free planet at environment summit. In: UN Environment [online]http://www.unenvironment.org/newsand-stories/press-release/world-commits-pollution-free-planet-environmentsummit, 2018.