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Analysis of Soil Samples for its Physicochemical Parameters of Soil in Bawal Block of Haryana

Manju Yadav[1]
emails2manju@gmail.com
Dr. Arpana[1*]
Dr. Yashpal Sharma[2]
[1], Ph.D. Research Scholar, Department of Chemistry, Baba Mastnath University, Rohtak
[1*]Assistant Professor, Department of Chemistry, Baba Mastnath University, Rohtak
[2]Assistant Professor, Post Graduate Department of Chemistry, RPS Degree College, Balana, Mahendergargh

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Abstract - Without a question, the oldest occupation on Earth is agriculture. The soil was virgin in the early stages of evolution, and farming was done very differently than it is now. Growing more food in a less amount of space has made it necessary to plant more crops more frequently and to use omnicides and fertilizers frequently. Excessive use of fertilizers and omnicides negatively impacts soil characteristics, air and water pollution levels. The study of agricultural science or soil science has piqued people's curiosity. An attempt has been made to address the aforementioned issues in this work. The soil in the area being studied has been physicochemical characterized.

***Key Words*:** Water Holding Capacity, High-performance Liquid Chromatography, Nutritive index, Fertility index

1. INTRODUCTION

The word soil is derived from a Latin word "solum" meaning earthy material in which plants grow. It provides water and nutrients to the living organisms. The soil is made up of mineral particles, humus, soil-air, and soil-water and soil micro-organisms. The physical properties of soil depend on the nature and arrangement of the soil particles. We analyses soil according to the size of the particles and the size of the particles determine to a great degree the different tillage's, crop rotation and different crops to be grown on the soil [1]. The mineral fractions of soil consist of particles of various sizes.

Soil separates constitute sand, silt and clay. The sand particles when coated with clay take very active part in chemical reactions. Sands increase the size of pore spaces between soil particles and facilitate the movement of air and water in the soil. Silty soils contain sufficient quantities of nutrients both organic and inorganic, that's why they are fertile and are good for agriculture. Clay soils have highest wafer holding capacity [2].

The soil is a natural medium for plant growth. Soil supplies nutrients for growing plants and plants manufacture feed for animals and food for man. Some soils are naturally productive and support luxuriant crops of great value with every little human effort while other soils are so unproductive that they support almost no useful plant life regardless of what is done to them. Between these two extremes lie the majority of soils, which must be fertilized to make them desirably productive? In order to increase the soil fertility and crop production different fertilizers and omnicides are added. Modern agricultural practices introduce numerous pesticides, fungicides, bactericides, insecticides, biocides, fertilizers and manures resulting in severe biological and chemical contamination of land [3]. Apart from all these, direct pollution of soil by deadly pathogenic organisms is also of major importance. Soil pollution and contamination of soil is a serious problem especially in country as densely populated as India. The progress of civilization since the independence has been phenomenal but rapid industrialization also brought with it the danger of soil pollution. Today, almost everything around us, e.g. the air we breathe, the water we drink and even the soil we grow over food on, is severely polluted. Indiscriminate deforestation, digging for minerals, destruction of grazing lands for human habitation have done irreparable damage to the environment and even led to harsh climatic changes. To make the situation worse, there are poisonous effluents from industrial units, locomotives, automobiles and high flying air crafts [4]. Some of the dangers posed to soil pollution are due to the fact that while number of the earth's inhabitants is increasing, the earth's natural resources are by and large fixed as well as limited. Thus soil gets heavily polluted day by day by hazardous chemicals with the result that micro-organisms enter our food chain, air and water, which are consequently ingested by man.

Fertilizers and omnicides unconsumed and unused by plants must be taken into account in making significant contribution to the pollution level of soil and water. Though, it is not taken into consideration, it plays an important role in deciding the quantity of fertilizers for further application to the soil and plant. For this purpose estimation of residual values of fertilizers and omnicides after harvesting the crop becomes essential [5].

2. MATERIALS AND METHODS

The physical properties of soil are soil separates and texture, structure, moisture, weight and density, porosity, permeability, water holding capacity (WHC), color, temperature, plasticity, pH and electrical conductivity.

The soil samples from five different villages namely Karnawas, Suthana, Banipur, Khatiwas and Rasiawas were collected. The soil samples were put to analysis for their physico-chemical characterization [6] adopting the usual sampling techniques [7]. The mechanical analysis [8] was carried out for the determination of soil separates and texture.

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There are several methods of mechanical analysis like pipette method and Bouyoucos Hydrometer method [9].
The structure of soil was studied [10] in the field under natural conditions. The four principal geometric forms of soil structure were determined. These are plate-like, prism-like, block-like and spheroidal.
Soil gets moisture from infiltration of precipitated water and irrigation. Its content depends upon the water holding capacity of soil. The moisture content of the soil may be measured in several ways, viz, equilibrium tension method, electrical conductivity method, neutron scattering method and gravimetric method [11]. The transfer of soil moisture depends upon soil physical properties and climatic conditions [12]. Different methods have already been adopted by different workers for soil moisture assessment [13] and water loss [14, 15].
Soil density may be expressed in two well accepted concepts i.e. particle density and bulk density. The weight per unit volume of solid portion of soil is called particle density. It was determined by measuring the mass and volume of soil solids as adopted in computerized tomographic method [16]. The bulk density or apparent specific gravity of soil is the mass of a unit volume of soil bulk including pore spaces. It is determined by dividing the weight of the soil with its volume. The bulk density was estimated [17] by determining the oven dry weight of an undisturbed core of soil.
Porosity of soil is the fraction of soil volume not occupied by soil particles. Two-dimensional image analysis [18] of soil porosity has already been used to study in different experimental sites. Porosity of the soil was measured [19] with the help of bulk density and particle density of soil.
Permeability is characteristic that determines the air and water movement through soil. It is basically dependent on the pore size distribution in the soil. Larger the number of macro pores the greater is the permeability. It has already been studied [20] by Baver et al. The permeability of a soil depends upon the moisture status. Texture and structure of the soil were often studied [21] in the field for qualitative assessment of permeability.
When we separate the soil absolutely with water, it fills all the pores between the particles of soil and no air space exists there. Such a soil is said to be at its maximum water holding capacity or saturation. For the measurement of WHC an usual method [22] was adopted.
The color of the soil varies widely amongst various kinds of soil as well as within different horizons of a soil profile.
It is an easily observable characteristic. The variations in soil color are due mainly to the organic matter content [23]. The soil color influences the absorption of heat radiation. Such an attempt [24] was made at Poona (Maharashtra). The color of soil was determined by using standard color chart also known as 'Munsell soil color chart'. The soil temperature is greatly influenced by the chemical and biological activities in the soil. Generally, the mean annual temperature of soil was found higher than that of its surrounding atmosphere.
An attempt has been made by different workers [25, 26] at Djakarta and Poona for the determination of mean annual temperature of soil. It influences [27, 28] the CO_2 concentration and some other physical properties also.
Plasticity refers to the ability of soil materials under wet conditions to change shape continuously under the influence of an applied force and to retain the impressed shape on release of the force and even after drying. The tensil strength [29] and mechanical properties [30, 31] of different types of soil under different ecological conditions has been studied.
The pH value is a measure of the H^+ or OH^- activity of the soil water system indicating whether the soil is acidic, neutral, or alkaline in reaction. Since the crop growth suffers much both under very low as well as at high pH, suitable reclamation measures become necessary. An indicator dye method [32], quantitative [33] and spatial field measurements have already been attempted.
The capacity of a substance to conduct electric current in soil or water is known as electrical conductivity. It depends upon mineral composition, water content and electrolyte concentration and the variations of electrical conductivity depend on soil spatial variations on soil structure [318].
The nitrogen pool of the soil was estimated by Kjeldahl's method [35] which was also taken in practice by others [36]. The quantitative estimation of phosphorus content was experienced by Olsen's method [37].
The available or exchangeable potassium in the soil was estimated by "Flame photometry" method [38], which was also carried out by other workers [39]. Among the insecticides, the organo-chlorine compounds viz. DDT, BHC, dieldrin, aldrin, endrin, heptachlor, chlordane, toxaphene etc. have widely been used and these persist in the environment and are not easily biodegradable. The quantitative estimation of these pesticides/omnicides has been done by gas Chromatography [40] and high-performance liquid chromatography [41] (HPLG).
The organic matter content especially organic carbon and organic phosphorus has already been estimated by different methods [42. 43]. The quantitative estimation [44, 46] of micro-nutrients viz. Fe Ca, Mg and Zn was done by adopting the usual procedure.
The biotic contaminants of soil include microflora and fauna. Among these algae, fungi, nematodes, bacteria, actinomycetes mid earthworms are common ones. The biotic contaminant (earthworm) in soil by using various culture media and temperature has already been estimated [47, 48]. The effect of density of earthworm on percent germination and growth rate has also considered.

2.1 Sampling Techniques of Soil

The method [7] of soil sampling to be used and the amount of soil to be taken mainly depends on the purpose for which sample is required and the nature of soil. For soil fertility point of view, normally the samples should be taken to the plough layer i.e. up to 0-15 cm depth. This is applicable for the fields growing cereals and other seasonal crops. In case of deep-rooted crops like sugarcane and under dry farming conditions, it may be necessary to obtain samples from different depths or layers of soil.

Tools and Materials

1. Different soil sampling equipment like soil tube auger, screw type auger, post-hole auger, kassi & khurpi were used for taking samples.
2. For sampling of soft and moist soil, the tube auger, khurpi can be used satisfactorily. Tools for collecting the samples should be free from dust or any foreign materials which may contaminate the samples.
3. A bucket for collecting and mixing the composite sample.

Sampling for Fertility Evaluation

1. The field was divided into areas so that each sample represents an area of approximately 1.0 ha. The samples were collected separately from areas which differ in soil color or post management e.g., liming, manuring, fertilization, cropping pattern etc.
2. The surface and inserted auger or sampling tubes were scraped away to a plough depth. 10-15 samples were taken randomly distributed over each area and placed them in a clean bucket.
3. The soil samples taken from different spots from each area were thoroughly mixed in a bucket. By quartering, reduced the bulk and about 500g of the composite sample was retained.

The thoroughly mixed soil sample was divided into four equal parts and discarded two opposite quarters. The remaining two quarters were remixed and again divided into four parts and rejected two. This procedure was repeated until about 500g of soil left. The soil was placed into a clean bag, numbered cloth bag after air drying in shade at room temperature.

Sampling for Soil Reclamation

For reclamation purpose the sample was taken by using a soil auger by digging up to 90cm. The soil sample was collected as:

1. One side of the pit was made vertical and put marks on it at 15, 30, 60 and 90 cm depth from the surface.
2. A suitable container was held at 15 cm mark and scraped off a uniform slice of the soil from the surface down to this mark and collected about 500g of the soil sample. The sample was transferred to a cloth bag and marked it as 0-15cm.
3. 500g soil sample was collected from each layer i.e. 15-30, 30-60 and 60-90cm and put them separately in three cloth bags after drying in shade.
4. A separate sample of the surface crust was also taken.
5. Two labels for each sample were prepared showing the depth from which sample was taken.
6. The sample along with information sheet was put for analytical analysis.

2.2 Measurement of Soil Separates and Texture

The following procedure was adopted for the measurement of soil separates and texture.

Method:

The process of determining the amounts of individual soil separates below 2 mm in diameter i.e. sand, silt and clay is called a mechanical analysis. During mechanical analysis, the soil sample was first lightly crushed and screened through a 2 mm round hole sieve. All the rocks, pebbles, leaves, and plant roots that were retained on the sieve were discarded. For destroying organic matter content and other binding materials viz. carbonates and oxides, the sample was treated with H_2O_2, HC1 and with water for washing. The sample after complete drying and dispersion was put to mechanical analysis by applying the Bouyoucos hydrometer method [9].

2.3 Measurement of soil Structure and Moisture

The four geometric forms of soil structure were determined. The gravimetric method [6] was taken in practice for the determination of soil moisture.

Method:

Fresh homogenized soil sample was taken and weighed. It was dried in an oven at about 105°C until a constant weight was obtained. Cooled it in a desiccator and recorded the final weight of sample.

Calculation:

% Moisture = (Lossinweight/Ovendryweight) *100

Moisture content (%) = $((x_1-x_2)/x_1)$ *100

Where x_1 = Initial weight of sample (g)

x_2 = Final weight of dried sample (g)

2.4 Measurement of Soil Weight and Density

Different containers of marked volume were filled with soil samples under identical pressure and weighed. The weights were in the ratio of their densities. The soil samples were demoistened to the extent of a constant weight.

2.4.1 Measurement of Particle Density of Soil (D_p)

The particle density was measured by the following method.

Method:

After weighing the pycnometer, it was filled with water completely. 10 g of air-dried soil was taken in a small beaker and added few mL of water and boiled for a short time to expel whole air. Empty the pycnometer and filled it with the soil transferring from the beaker with a jet of water. The pycnometer was allowed to cool to the room temperature and find its weight.

The weight of the soil divided by the weight of water displaced gives the true density of the soil.

Observation:

Weight of empty pycnometer = W_1g

Weight of empty pycnometer+water = W_2g

Weight of empty pycnometer+water and soil = W_3g

Weight of soil taken =10g

Calculation:

Weight of water displaced by soil= $(W_2+10)-W_3$g

Particle density (D_p) of soil $10/((W_1 + 10)-W_3)$

2.4.2 Measurement of Bulk Density of Soil (D_b)

The bulk density of soil was measured by the following method.

Method:

A large weighing bottle of about 50 ml capacity was weighed. It was filled with soil and weighed. Removed the soil and then filled the bottle with water by means of burette and noted the exact volume of water needed to fill the bottle. The bulk or apparent density was obtained by dividing the weight of the soil with volume of the soil.

Calculation:

Weight of empty bottle = W_1g

Weight of bottle + soil = W_2g

Volume of water needed to fill the bottle V mL

Weight of soil = W_2-W_1

Volume of soil = V Cm^3

Bulk density = Weight of soil (g) / Volume of soil (cm^3) = $(W_2-W_1)/V$

2.5 Measurement of Porosity of Soil

Porosity of the soil was determined [19] with the help of D_b and D_p as follows:

% solid space = (Bulkdensity / Particledensity) * 100

Since % pore space + % solid space = 100

Then % pore space = 100- (% solid space)

% pore space = 100 - ((Db/Dp) * 100)

Where D_b = Bulk density g/cm^3

D_p = Particle density g/cm^3

2.6 Measurement of Permeability of Soil

Experimental procedure:

For the measurement [21] of permeability, soil samples from ten different spots of the experimental site were collected and well mixed. Nearly 750 g soil was taken out and demoistened

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by heating to a constant weight. Demoistened soil was taken in a graduated glass cylinder which was compressed by a weight on surface pan. 250 mL of water was poured slowly, and its permission rate was noticed. The same experiment was repeated with soil samples taken from different experimental sectors.

2.7 Measurement of Water Holding Capacity (WHC)

Method:

The soil sample was allowed to dry in an oven at 105°C. A filter paper was placed inside the perforated bottom of the circular soil box and then weighed. Now filled it with dried soil sample. Then, calculated the weight of box filled with dried soil. The box was kept in a petridish having water for about 12 hours, so that water enters the box and soil became saturated. Removed the box out of water, wiped it dry on the outside and calculated its weight [21].

Calculation:

% water Holding Capacity = $((W_3-W_2)-(W_2-W_1))/(W_2-W_1)$

Where, W_1 = Weight of empty box

W_2 = Weight of box with dried soil

W_3 = Weight of box with water saturated soil

2.8 Assessment of Soil Color, Temperature and Plasticity

The usual methods adopted for the determination of soil color, temperature and plasticity are as follows:

Method:

The soil sample was spread uniformly over a cardboard sheet. The particles of soil were matched with chips of several colors in the Munsell's soil color chart. The chip with which the soil color matches was taken out arid the notation indicated on the chart was noted which gives the color characteristic of the soil.

The temperature of soil was measured by a special type of thermometer i.e. soil thermometer, which has vertical arm with bulb at one end and a dial with deflection needle on the other end. The bulb of thermometer was buried at different depths i.e. I", 6", 12", 18" cm of the soil. The temperature (°C) values were noted at these depths.

The soil sample of about 100 g was placed in a dish and then mixed water with it gradually until it began to show plastic tendencies. This state came when soil was rolled into a ball. Rolled

a portion of soil into a ball of about 1.0-2.0 cm in diameter. A ball on a clean glass plate was put and it was rolled out to thread 3 mm in diameter with the help of palm of the hand. When soil was rolled into a 3 mm diameter in making so, the thread started breaking into pieces of the length 1.25-1.50 cm long then the soil was at the plastic limit. The soil was kept in a moisture box and determined the moisture content.

Observations:

Weight of moisture box = x g

Weight of moisture box+wet soil = y g

Weight of moisture box+dry soil = z g

Calculation:

Weight of soil (z-x) g

Weight of moisture = (y-z) g

% moisture content= ((y-z)/(z-x)) *100

With the help of this formula the plasticity was determined.

3. RESULTS AND DISCUSSION

The physico-chemical analysis of soil forms the basis of its economic evaluation. It is remarkable that small scale farming contributes large share of fertilizer and pesticidal pollution than the large-scale farming. With increasing population of India, the small-scale farming will dominate upon the large-scale farming evolving a greater prospect of pollution leading the situation from bad to worse. Thus, among the farmers if adequate awareness is not developed there will be extravagance, on one hand and terrible pollution hike on the other hand causing health hazards to the poor villagers. The experiments lead the conclusion that none of the crops utilize the fertilizers and omnicides in toto, rather they are partly utilized by the plants and a lion-share passes into the environment through leaching and surface flow and causes soil, water, and air pollution.

3.1 Analytical study of soil separates of the area under investigation

The percentages of different size groups of particles in soil can be determined by its mechanical analysis. The size distribution systems in common use are of two types, one propounded by U.S. department of agriculture and international society of soil science and another given by E.C.H. Mohr, called Mohr's 10 fraction system.

In India the International system is in common use. A three-component phase diagram system consisting of sand, silt and clay can be used for the textural classification of soils. The soil texture is a property which controls the physical properties and the chemical properties in general of soils. The effect of average particle size and particle surface area play an important role in deciding the porosity, density, color, water holding capacity and the soil texture. Based on Size distribution in Karnawas sector I consist of silt, II sand loam, III silt loam and IV loam type of soil separates. In the village Suthana sand, loamy sand, sandy loam, and loam types of soil separates are found in sector I, II, III and IV respectively. In Banipur, the I sector overall comprises of silt, II of silt loam, the sector III contains sandy clay loam and the IV has clay loam. In Khatiwas village the soil of sector I mainly contain silty clay loams, II silty clay III sand clay and IV clay. Similarly, the mechanical analysis of soil of village Rasiawas reveals that the sandy clay soil separates are found in sector I clay loam in sector II, silty clay in sector III and clay in sector IV.

For the textural classification of soil in area under investigation an effort has been made by determining the percentage of sand, silt, and clay. The soil classification based on percentage range of sand, silt and clay has been found to be the same.

3.2 Depth wise percentage of soil separates of investigated areas

The depth wise percentage of sand, silt, and clay in the soil of investigated areas has been done. The depth range is from 0-115 cm which covers the soil surface and the maximum depth within the reach of common crops in India. The analysis indicates that the depth wise soil character of every village differs a lot.

The surface soil (range 0-18 cm) has the highest percentage of sand (28%) in sector I of Rasiawas while the lowest value has been found in sector I of Karnawas. The sand percentage in the depth range (19-40 cm) has the maximum sand percent (25%) in sector II of Rasiawas which is lowest in sector II of Karnawas. The sand percent order in the depth range of (41-70 cm) in III sector of studied area lies as Karnawas sector III (18%) Khatiwas sector III (21%), equal to Suthana sector III, Banipur sector III (22%), Rasiawas sector III (24%). In the depth range of 71-115cm the increasing order of sand percent has been found to be sector IV of Karnawas 15% the same sector of Suthana 19%, Banipur and Khatiwas 20% each and Rasiawas scoring the highest value of 22%. On considering the average value of sand percentage the village Karnawas has the lowest 19.25%, Suthana 22.0%, Khatiwas 22.5%, Banipur 23.25% and Rasiawas as high as 24.25%. Thus, the sand percent on an average is the minimum for Karnawas and maximum for Rasiawas. The physical properties of these villages are in accordance with the ingradient ratio.

The percentage of silt in the surface soil (0-18cm) has the highest value in sector I of Suthana village while the lowest value has been found in same sectors of Khatiwas and Rasiawas. The silt percentage in the depth range (19-40 cm) has the maximum silt percent (51%) in sector II of Suthana which is lowest in the same sectors of Khatiwas and Rasiawas. The silt percent order in the depth range of (41-70 cm) in III sector of investigated area comprise as Rasiawas sector III (50%), Khatiwas sector III (51%), Banipur sector III 52%, Karnawas sector III 53% and Suthana sector III 55%. In the depth range of 71-115 cm the increasing order of silt percentage has been found to be (54%) in sectors IV of Rasiawas and Khatiwas villages. The same sector of Banipur village has 55% silt. The IV sectors of Suthana and Karnawas have been found to be 58% each scoring the highest value.

The overall scanning of the area under investigation indicates that the average value of silt percentage of the villages Rasiawas has the lowest 48.25%, Khatiwas 48.5%, Banipur 49.5%, Karnawas 51.0% and Suthana as high as 52.75%. Thus, the silt percent on an average is minimum for Rasiawas and maximum for Suthana. All other properties are also in accordance with these ingradients.

The percentage of clay in the surface soil (0-18 cm) has the highest value in sectors I of Karnawas and Khatiwas villages while the lowest value has been found in sector I of Suthana. The clay percentage in the depth range (19-40 cm) has the maximum value 31% in Karnawas while it is minimum 26% in Suthana village. The clay percentage in the depth range (41-70 cm) in the III sector of investigated area indicates Suthana 24% Banipur and Rasiawas 26% while 29% in Karnawas respectively. The IV sector of depth range 71-115 cm has the percentage of clay 23% in Suthana, 24% in Rasiawas 25% in Banipur, 26% in Khatiwas and 27% in Karnawas respectively.

The area under investigation in terms of percentage of clay leads to the conclusion that the average value of clay percentage is minimum in Suthana (25.25%) while it is maximum in Karnawas 29.75%.

3.3 Analytical study of soil structure of investigated areas

The structure of soil leads to the conclusion that the soil structure of sector I of Karnawas is blocky sector II prismatic, sector III columnar and sector IV platy. Similarly, in Suthana the soil structure of sector I is granular sector II crumb sector III prismatic and sector IV platy. Likewise in village Banipur the soil structure of sector I is blocky, sector II Columnar, sector III crumb and sector IV platy. The sector I, II, III and IV of village Khatiwas indicate the structure of soil platy, granular, crumb and platy respectively. All the four sectors (I, II, III and IV) of village Rasiawas regard the structure crumb, platy, granular and platy. The sector II and IV of village Rasiawas have same soil structure.

3.4 Analytical study of soil moisture content and water in inches

The soil moisture calculations in percentage on a weight basis have been commonly used, but this does not give a true picture of soil moisture relationship. Two soils may have similar moisture content on a weight basis but not on a volume basis.

Calculations on a volume basis are more meaningful because water is retained in the soil within a given volume and roots also obtain moisture from a volume of soil. Further, soil moisture calculations on a volume basis can be easily converted into inches/foot or acre/inches which are of more practical significance for water use and management.

To change percentage soil moisture on a weight basis to percentage soil moisture on a volume basis the calculation is as follows:

% moisture by weight * bulk density = % moisture by volume.

Available water is the range of soil moisture between the wilting percentage (lower limit) and the field capacity (upper limit). This is approximately equal to the capillary water as it is mainly held in capillary sized pores. For crop growth purposes, this is the most important range of soil moisture.

The data regarding the soil moisture content shows that the percent moisture by weight and volume in village Karnawas having depths 3.0, 6.0, 9.0 and 12.0 inches are found to be 25.0,28.0,30.0 and 27.0,33.6,38.4,47.2% respectively.

The water in inches acre^{-1} is regarded as 0.81, 2.00, 3.45 and 5.66%. In village Suthana, the four sectors of same depth as previous the moisture percentage by means of weight and volume are regarded as 20.0, 25.0, 28.0, 30.0 and 26.4, 41.2, 50.4 and 52.5% respectively. The percentage of water in inches acre^{-1} is found to be 0.79, 2.47, 4.53 and 6.30%. The moisture content by weight and volume in all the four sectors of village Banipur are depicted as 23.0, 25.0, 36.0, 54.0 and 0.69, 1, 38, 4.32, 4.86% respectively. All the four sectors of village Khatiwas of considered depth shows the weight and volume percentage of moisture 25.0, 38.0, 35.0, 30.0 and 38.7, 41.8, 52.5, 63.3% individually.

The depth wise variation of moisture content by weight and volume in all the four sectors of Rasiawas village are found to be 30.0, 22.0, 35.0, 25.0 and 2.83, 0.99, 6.08, 3.22% respectively.

The overall scanning of the area under investigation leads to the conclusion that the percent moisture by weight, volume and water in inches acre-1 are found maximum 32.0%, 49.15% and 3.70% in Khatiwas while it is minimum having values 24.25%, 34.5% and 2.81% respectively in Banipur.

Data regarding the soil moisture fit well to the capillary phenomena, bulk and particle density, porosity, permeability, and water holding capacity of the soil.

3.5 Analytical study of density and porosity of soil

The scanning of data according to the density (Db & Dp) of soil reveals that the bulk density of sectors I, II, III and IV of Karnawas village are found to be 1.08, 1.20, 1.28 and 1.35 respectively. As regards the particle density and porosity of same sectors of investigated area are 2.40, 2.42, 2.45, 2.50 and 50.0, 50.5, 47.8 and 46.0% individually. In village Suthana the bulk density of all the four sectors is 1.32, 1.65, 1.80 and I. 75. The particle density and porosity regarding the same sectors of the village are regarded as 2.48, 2.52, 2.54, 2.53 and 46.8, 34.6, 28.6 and 30.8 respectively. The bulk density of sectors I, II, III. and IV of village Banipur are measured as 1.15, 1.25, 2.00 and 1.20 while the particle density and porosity are 2.35, 2.43, 2.65, 2.42 and 51.1, 48.6, 24.6, 50.5%. The four different sectors of village Khatiwas have bulk densities 1.55, 2.12, 1.50 and 1.10 while the particle density and porosity are 2.48, 2.65, 2.55, 2.41 and 37.5, 20.0, 41.2, 54.4%. The bulk density of all the four sectors of investigated area Rasiawas are recognized as 1.50, 2.15, 1.05, 1.45, whereas the particle density and porosity are 2.55, 2.65, 2.46, 2.52 and 41.2, 18.9, 56.3 and 42.5% respectively. Porosity varies with the texture of soil, shape of individual particles, soil structure, amount of organic matter and the compactness.

In sandy soils, although the pores are quite large, yet the total pore space is small. Porosity of soil indicates total pore space and not the size and form of individual pores. Depending upon the size of pores, macro and micro-pores are recognized. Macro pores allow ready movement of air and water and do not hold much water under normal conditions. Micro-pores can hold more water but the movement of air and water is restricted to same extent. Porosity normally decreases with depth in the soil.

The average value of these parameters leads to the conclusion that bulk density is highest 1.63 gm/cc for village Suthana while it is minimum for Karnawas i.e. 1.22 gm/cc. The average particle density is maximum in village Rasiawas and minimum for Karnawas. The average porosity is maximum 49.82% in Karnawas while minimum in Suthana 35.2% respectively. The density and porosity as observed in the different zones of the area under study may be employed to assess other physical properties of the soil. The analysis reveals that these properties are linearly related to other characteristics controlling the chemical composition, nutritive index, and fertility factor of the soil.

3.6 Analytical study of permeability of soil

The colloidal properties of clay become more dominant in determining permeability at lower depths. For the assessment of permeability of soil of different areas under study the infiltration rate (cm/hr) has been measured. The data lead to the conclusion that in Karnawas sectors I & IV, in Suthana, sector IV, in Banipur, sectors I & IV, in Khatiwas, sector II and in Rasiawas sectors II & III have slow permeability while the same is very slow in sectors IV of Khatiwas and Rasiawas. The permeability rate is moderate in sectors II, III of Karnawas, Suthana, Banipur while similar behavior is shown by sectors I & III of Khatiwas and sector I of Rasiawas. A single sector in the entire area of studies namely I of Suthana exhibited rapid permeability to an extent of even greater than 2.54 cm/hr. This property is highly useful in selecting the crop for this sector.

3.7 Analytical study of water holding capacity of soil

The water holding capacity (WHC) is the amount of water held in the soil when all pores are filled and when drainage is restricted. Under natural conditions only poorly drained soils are at their maximum water holding capacity for long periods of time. Results leads to the conclusion that water passes very quickly through the sandy soil, less rapidly through the loam and very-very slowly through clay. If a soil allows water to pass through it quickly, the upper layer soon becomes dry and the plant suffers from lack of moisture. On the other hand, water may pass through a soil too slowly, as in the case of some clay soils.

3.8 Analytical study of soil temperature, electrical conductivity, and color

The depth-wise variation of soil properties like temperature, electrical conductivity, and color in the areas under consideration can be easily understood. The soil color differs in different depths due to varying availability of organic matter content. Data regarding these soil parameters indicate that from 0-20 cm depth the average soil temperature and electrical conductivity of Karnawas village was found to be 66.25°F and 2.18 m. mhos respectively. The color of the soil under depth 0-5, 6-10, 11-15 and 16-20 cm as observed was grey, light grey, yellow and light yellow. In Suthana soil temperature and electrical conductivity under the same depth was found to be 64.42°F and 2.24 m. mhos on an average. The color of the soils under varying depths was found to be whitish, white-grey, green-yellow, and yellowish-black individually. Regarding the same parameters for Banipur village the mean soil temperature and electrical conductivity involving same depth were found to be 67.1°F and 2.28 m. mhos whereas the color for varying depths was found whitish-grey, grey-yellow, yellow-black, and black. In Khatiwas village the soil temperature and electrical conductivity has an average value 65.8°F and 2.28 m. mhos while the color was grey, yellow-grey, and black. The mean soil temperature and electrical conductivity for Rasiawas village was regarded as 64.3°F and 2.36 m. mhos respectively and the color was white-grey, yellow-grey, grey-black, and black.

The scenario of the whole area led to the conclusion that the soil temperature was highest for Banipur (67.1°F) while lowest for Rasiawas on the other hand electrical conductivity value was maximum for Rasiawas and minimum for Karnawas. This is since soils temperature will be highest for those soils which have highest organic matter content which forms the basis of categorization of soil.

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