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Determination of soil textural class by using USDA soil texture triangle

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Abstract

In this paper an attempt has been made to determine the soil textural class by using USDA (United State Department of Agriculture) soil texture triangle. The physical capacities of soil are influenced by the size, proportion, arrangement and composition of soil particles. Soil texture is determined by relative proportion of soil separates (Like sand, silt and clay) in a particular soil. The dielectric constant depends on the texture of soil. These dielectric properties of soil can be used to determine soil fertility and health. In this paper six soil samples were collected from different sites of Arpa River of Bilaspur, Chhattisgarh. The laboratory procedure used for determination of amount of the various separates present in the soil is known as mechanical analysis. The international pipette method and bouyoucos hydrometer are widely for determination of texture. From the result of mechanical analysis, a textural triangle can be used to determine soil textural class. By using this USDA triangle, it is observed that sample one, two and six are sandy clay loam, sample three is sand, sample four is sandy loam and sample five is loamy sand. Soil textural profile has a great influence on plant growth. Soil texture helps to determine which type of crop can be grown on a specific land.
Keywords: - Texture, Dielectric Constant, USDA Triangle, Mechanical Analysis.

1. Introduction

The soil is composed of different sized particles. These small particles are the result of massive rocks (of different mineralogy) that have weathered to produce smaller rock fragments and finally soil particles are formed. Soil particles vary in size, shape, colour and chemical composition depending on various factors. The relative size of the soil particle is expressed by the term texture, which refers to the fineness or coarseness of soil. So, soil comprises “soil particles” of varying sizes. The soil particle size groups called as “soil separates” and it is sand (the course), silt and clay (the smallest). Soil texture is determined by the relative proportion of the soil separates in a particular soil [1]. For example, if most particles are large and coarse the soil is called sand. It looks and feels sandy. A silt soil is dominated by medium-sized particles and feels like flour. Small-sized soil particles primarily make up a clay soil which feels slippery or greasy when wet. The two prominent classifications are evolved over the year is the United State Department of Agriculture (USDA) and International Society of Soil System (ISSS).

1.1 Important Characteristics of Sand, Silt and Clay Particles

Table 1.1 Characteristics of Sand, Silt and clay.

S. No.	Characteristics	Sand	Silt	clay
1.	Looseness	Good	Fair	poor
2.	Air space	Good	Fair to good	poor
3.	Drainage	Good	Fair to good	poor
4.	Tendency to form clods	Poor	Fair	Good

5.	Ease of working	Good	Fair to good	Poor
6.	Moisture-holding ability	Poor	Fair to Good	Good
7.	Fertility	Poor	Fair to Good	Good

1.2 Function of Sand, Silt and Clay

Textural name of given soil is based on the relative proportion of each of three soil separates: sand, silt and clay. Soil with very high clay content is called clayey (Textural class), those with high silt content are called silt (Textural class), those with high sand percentage are sand (Textural class). A soil that does not exhibit the dominant physical properties of any of these three groups is called loam but loam does not contain equal percentage of sand, silt and clay [2].
The sand particles are of comparatively large size and hence expose little surface compared to that exposed by equal weight of silt and clay particles. Due to small surface of sand separates, the part they play in physical and chemical reaction is almost negligible. The smaller sand particles may contain a sufficient coating of very small clay separate to attain some activity. Sand is inactive, their main function in soil is to serve as a framework around which the active part of the soil is associated. Sand is present in too small proportion; the sand increases the size of space between particles, thus facilitating movement of air and drainage water.
The coarse silt particles are very similar to the finer sands in term of surface exposed hence silt particles also takes very little part in chemical activities. The finer silt has sufficient surface to take part in chemical activities.
The clay separate is composed of the smaller particle. The amount of surface in a gram of clay is much more than that same weight of silt and sand. The amount of clay in a soil has a great influence on its water holding capacity because a large part of water in soil is held as a film on the surface of clay particles. Also, certain nutrients are held on the surface of clay particles. Therefore, clay acts as a storage reservoir for both water and nutrients. Clay particles may have thousands of times more surface area per gram than silt and nearly a million of times more surface area per gram than coarse sand. The clay fraction has a dominant influence on the electromagnetic properties of soil because the small particles have such a large area and therefore has the ability to retain water.

2. Method

The laboratory procedure used for the determination of the amount of the various separates present in the soil is known as mechanical analysis. Before a soil can be divided into groups of particles on the basis of size, it is essential to overcome the tendency of the very small particles to cling to the larger one and to each other. Every particle should exist as an individual. Organic matter is one of the main agents, which binds particles together and hence first problem is to destroy this cementing material. The commonly accepted procedure is to oxidize the organic matter by boiling the sample in the hydrogen peroxide solution.
The International pipette method is based on the principle of sedimentation, i.e. different sized particles fall at different velocities. In this process time is recorded that a specific weight of soil particles to fall to the bottom of a tall cylinder filled with water.

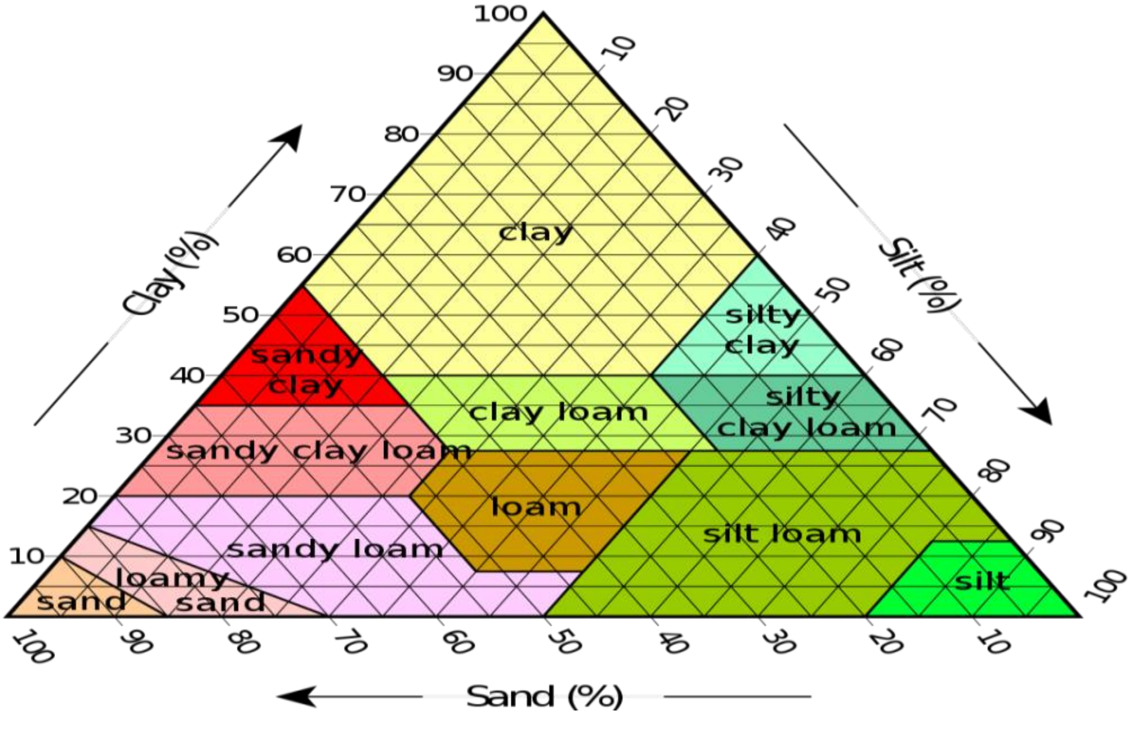

Figure- 2.1 USDA soil texture Triangle.

From the results of a mechanical analysis, a textural triangle can be used to determine soil textural class. The diagram given above shows that a soil is mixture of different size particles (sand, silt, clay). In this figure, 100 units of soil are used in the analysis, so that the sum of the weights of the three soil separates will be total 100 and can be easily converted to percentages. The textural triangle (Fig 6.1) represents all possible combinations of soil separates. This figure shows a gradual change of properties with change in particle size. Al the three sides of the textural triangle represent increasing or decreasing percentages of sand, silt and clay particles. The textural triangle is very easy to use. Assume that in a soil there is 50 percent clay, 30 percent silt and 20 percent sand. The percent of clay is identified on the left side part of the triangle. From the lower left corner to the top of the triangle, the percent clay increases from 0 to 100 percent. Move along the left side of the triangle until you reach 50 percent clay. Then draw a line at 50 percent clay that is parallel to the bottom of the triangle. The percent silt is identified along the right side of the triangle. From the top of the triangle to the lower right, the percent silt increases from 0 percent to 100 percent. Move along the right side of the triangle until you reach 30 percent silt. Now draw a line at 30 percent silt that is parallel to the left side of the triangle. The bottom of the triangle identifies the percent sand. From the lower right corner to the lower left corner, the percent sand increases from 0 percent to 100 percent. Move along the bottom of the triangle until it reach 20 percent sand. Draw a line at 20 percent sand that is parallel to the right side of the triangle. The point at which these three lines intersect will define the soil's texture. Some small rock fragments may be present in soil as stones or gravel. While these rock fragments play a role in the physical properties and processes of soil, they are not considered in the determination of soil texture.

3. Results

Table 3.1 Classification of six soil sample by using USDA triangle.

S. No.	Sample No.	Sand (%)	Silt (%)	Clay (%)	Classification
1.	Sample 1	49	23	28	Sandy clay loam
2.	Sample 2	59	15	26	Sandy clay loam
3.	Sample 3	90	5	5	Sand
4.	Sample 4	70	14	16	Sandy loam
5.	Sample 5	83	6	11	Loamy sand
6.	Sample 6	56	14	30	Sandy clay loam

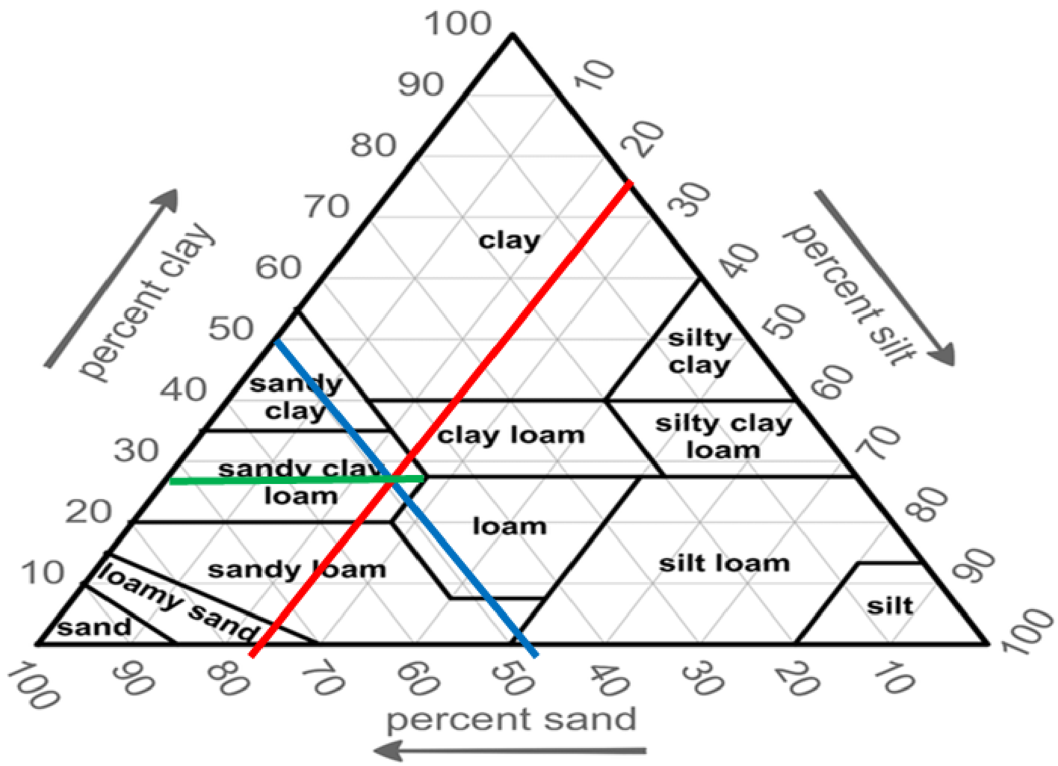

Figure- 3.1 sample 1 classification.

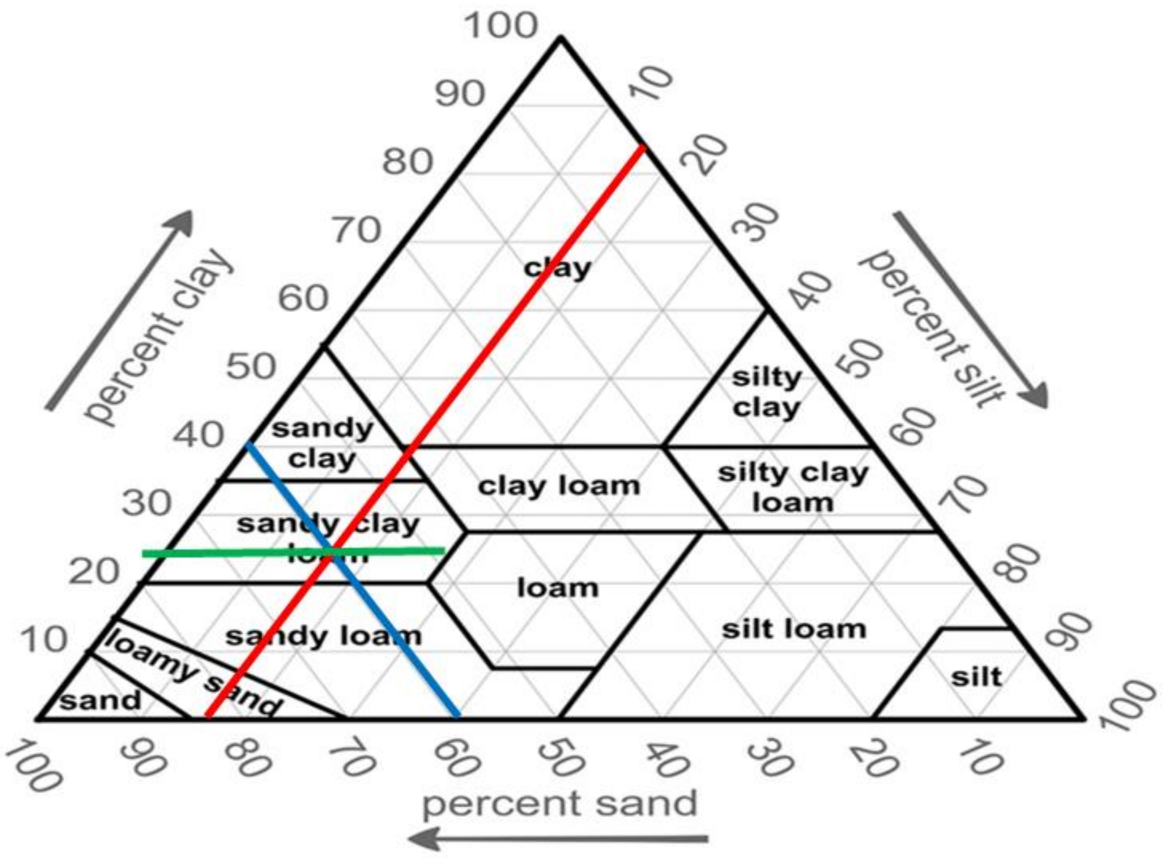

Figure- 3.2 soil sample 2 classification.

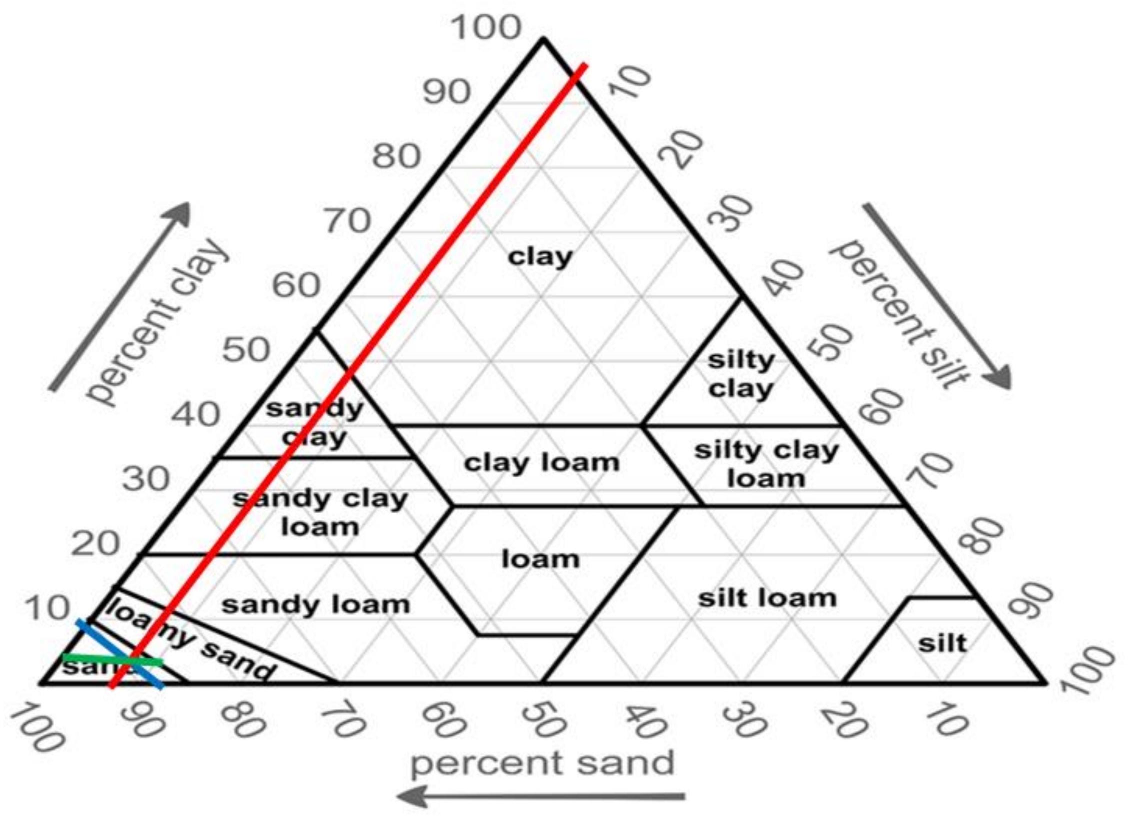

Figure- 3.3 Sample 3 Classification.

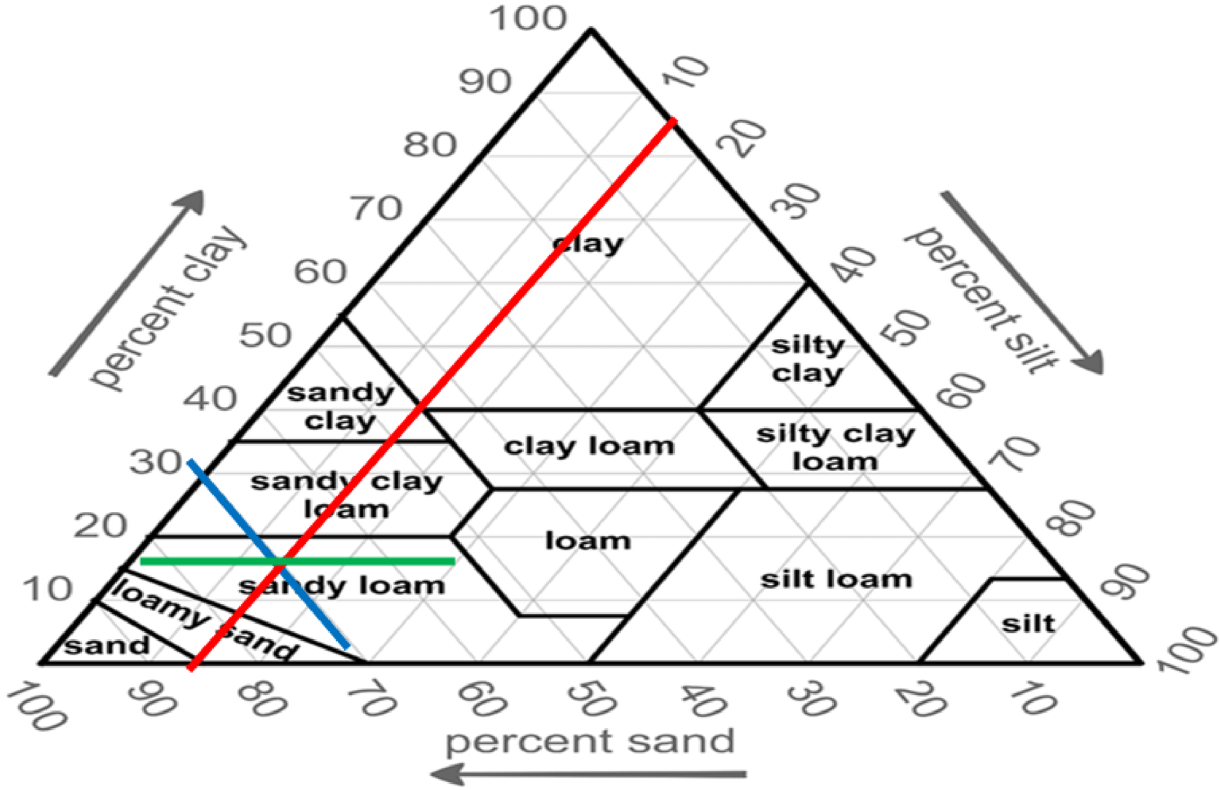

Figure-3.4 sample 4 classification.

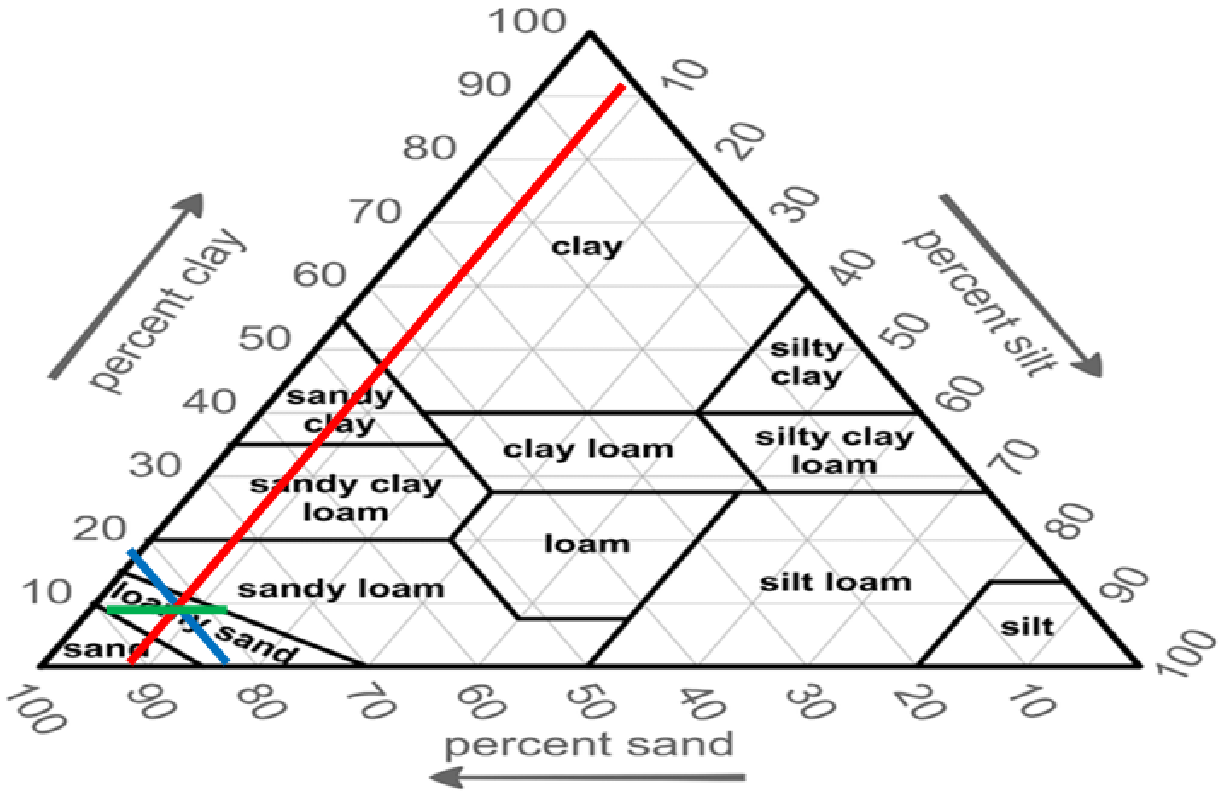

Figure-3.5 Soil Sample 5 classification.

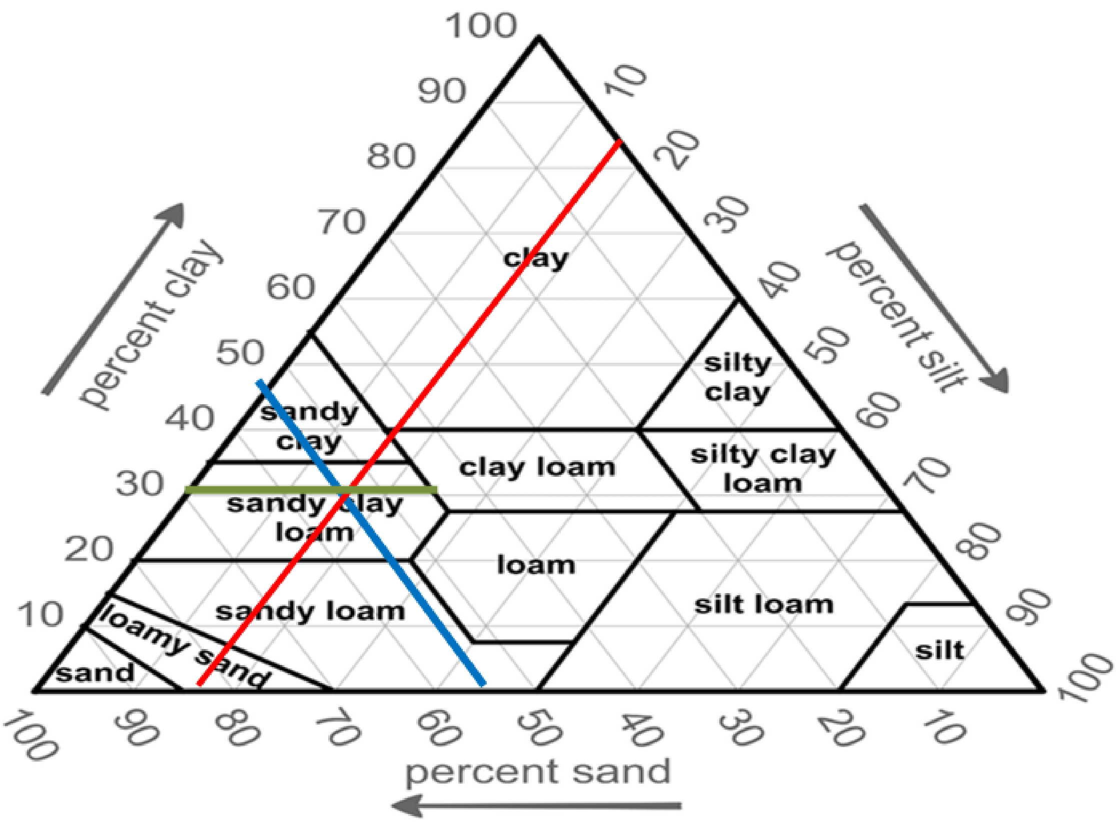

Figure-3.6 Sample 6 classification.

4. Discussion

Texture is interrelated with the soil fertility and quality in the long term. Soil texture is very important to gardener and farmers in the following ways:

- Soil texture is useful in the evaluation of soil ability and fertility.
- Soil texture has an important role in nutrient management because it influences nutrient retention.
- One of the key functions of soil texture is that it supports living of all microorganisms essential for plant growth.
- Soil texture helps to determine which type of crop can be grown on a specific land.
- Soil texture enables a farmer to know the type of soil and its productivity.

Soil texture also helps in determination of the relative proportion of air and water present in a given sample, as it strongly influences the soil's ability to retain and transmit water and air, both of these are important to plant growth. The soil texture is associated with soil porosity, which in terns regulates water hold capacity, gaseous diffusion and water movement that determine the soil health.

5. Conclusion

The knowledge of soil texture plays a pivotal role in plant growth. The textures of the various horizons in a soil profile are usually different. Up to a certain point, an increase the amount of clay in the subsoil is desirable, because it can increase the amount of water and nutrients stored in that zone. Soil texture is interrelated with the soil fertility and quality in the long term.

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