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Quantitatively Physico-Chemical and Minerals Analysis of Some Soil Samples of Junagadh and Gir Somnath District, Gujarat

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Abstract: **Surface (0–15 cm) soil samples were taken from a few selected villages in the Junagadh district (Kanek, Gadu, Barula, Jangar, and Dhrabavad) and Gir somnath district (Dhanej, Ramrechi, Gundaran, Surva, and Bamnasa). Water-holding capacity, soil moisture, soil texture, pH, electrical conductivity, total organic matter, organic carbon, calcium, magnesium and chloride were all measured in ten representative samples. Soil pH was determined to be between 7.20 to 7.66, electrical conductivity ranged from 0.08 to 1.07 mS/m, organic carbon was between 0.31 to 3.00%, soil moisture ranged from 4.08 to 4.78 gm, water-holding capacity was between 35% to 60%, Total organic matter ranged from 0.53 to 5.17 %, calcium ranged between 0.13 to 0.26 meq.100 g^{-1}, magnesium ranged between 09.63 to 23.17 meq.100 g^{-1}, and chloride ranged between 0.04 to 0.06 meq.100 g^{-1}. Thus, we are unable to achieve the best possible crop growth, production and soil health. The balance of nutrients in the soil and crops is ultimately unfavorable Crop and soil health can be attained based on the results of soil tests. Thus, soil analysis will be necessary in the future to increase agricultural yield, nutrient deficiencies and soil fertility.**

Keywords: **Soil, Agriculture, Soil Fertility, Physicochemical parameter, Mineral Analysis.**

1. INTRODUCTION

One of nature's most valuable resources is soil. The development of soil is greatly affected by the climate and other factors. Due to popular belief, soil is not a dead, inert mixture of minerals. However, microbes are active and energetic in healthy soil. The topmost soil layer supports the greatest number of bio-farms and is relatively richer in nutrients. Particularly in terms of its depth, color and composition, the profile character changes greatly from location to location. The chemical characteristics of soil control its mineral makeup, organic matter, and environmental conditions. The biological processes in soil that affect the growth of plants, animals, and humans are covered by soil science (Tale, Ku Smita, et. al.,2015).

The supply of nutrients has a direct impact on the growth and development of plants. In general, plants require a variety of nutrients, which are divided into two categories based on their needs: macronutrients and micronutrients. Nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), zinc (Zn), iron (Fe), boron (B), sulfur (S), magnesium (Mg) and more are some examples of these nutrients. Numerous nutrients in the plant body affect biochemical processes, enhance disease resistance, and ultimately degrade crop quality. Given the rapidly growing global population and the declining trend in crop yields, food safety is a major concern. Additionally, nutrients are important for soil fertility and increase soil productivity for plant growth (Toor, Muhammad Danish, et al.2021).

The production of crops in agriculture depends on soil, and microbial activity is essential for improving soil health for good crop growth since microbial communities play an essential role in creating a complex connection between plants and soil. In reality, microbiomes from a variety of niches have become attractive instruments for enhancing plant growth and production through a variety of mechanisms, such as biotic and abiotic stress tolerance, nitrogen fixation, hormone stimulation and nutrient solubilization. Additionally, these microbiomes have a huge potential to preserve the fertility and health of the soil (Yadav, et. al., 2021).

For soil development, soil texture is extremely important. It can help in our understanding of the soil's age and growth process. In actuality, it determines all soil characteristics and overall fertility. Texture affects a variety of soil characteristics, including organic matter concentration, cation exchange capacity (CEC), pH buffering capacity, aeration, water-holding capacity and erosion susceptibility (Dilkova R.,1998).

The size distribution of soil particles, such as clay, silt, and sand, determines the texture of the soil. The parent material's climate also has a significant impact on soil texture. Soil texture controls the soil's density, porosity, water-holding capacity, organic matter concentration, and erosion sensitivity (Chakraborty, et. al., 2015). "The geographical variation of the different components or properties of soil" is the definition of soil structure. Several soil processes are known to be regulated by soil structure. It controls gaseous exchanges, soil organic matter and nutrient dynamics, root penetration, water retention and infiltration, and erosion susceptibility (Rabot, Eva, et al. 2018).

Plant growth can be affected by soil structure in a variety of ways. Very friable soil promotes the fastest growth of roots, but poor contact with the solid and liquid phases of the soil may restrict their ability to absorb water and nutrients. Even if the roots are currently able to absorb enough water and nutrients, the structure of the soil influences their ability to grow and to provide the leaves with nutrients and water. If the soil structure is unfavorable, it also causes the roots to produce hormone signals that slow the growth of the shoot (Passioura, et. al., 1991).

The process of changing or maintaining one or more characteristics of the soil in order improve a soil's engineering qualities and performance is known as soil stabilization. These stabilizing compounds can be utilized as bonding and waterproofing agents, improve and preserve the moisture content of the soil, and raise the bonding ability of the soil particles (Afrin, Habiba.,2017).

Many ecosystems around the world, such as grasslands, rivers, and coastal wetlands, depend heavily on plants to stabilize the soil. Individual biotic (like root biomass) or abiotic (like soil type) factors' effects on soil stability are well-measured; however, little is known about how several elements, such as plant biodiversity, which may be a predictor of root biomass, work together to reduce soil erosion (Ford, Hilary, et al., 2016). The ability of a particular type of soil to function within its limits and within the limits of a natural or managed ecosystem, to support plant and animal productivity, to preserve or improve the quality of the water and air, and to support human health and habitation is known as soil quality (DL Karlen, et. al., 1998). The ability of the soil to support crop development without polluting the soil or harming the ecosystem is known as soil health. Soil quality and soil health are synonymous terms. Providing a medium for plant growth, controlling and dividing water movement through the environment, and providing as an environmental barrier are the three primary roles of soil. Human activities, such as land usage and farming methods, may affect the properties of a natural soil (Acton, et. al., 1995).

An outstanding gift from nature, soil contains many vital minerals and nutrients that are necessary for the survival of living organisms, including bacteria, plants, and animals. A important phenomena known as "soil genesis" or "pedogenesis", microorganisms' biological activity opens up a variety of possibilities for increasing the soil formation process.Well-known "soil engineers," such as bacteria, fungi, cyanobacteria, and lichens, are thought to actively contribute to pedogenesis by initiating the biological weathering of rocks, organic matter decomposition, and nutrient cycling processes (Kaviya, N., et al. 2019).

Fertility and soil structure are improved by a healthy soil microbiome. the role that soil biodiversity plays in lowering the need for chemical fertilizers and supporting long-term agricultural output (Van der Heijden, et al. 2008). A large amount of fertile land can be lost as a result of soil erosion, which is frequently transported on by improper farming methods such overgrazing, deforestation, and heavy tilling. In addition to removing topsoil, which is rich in vital nutrients, erosion also affects the ecology as a whole, which lowers agricultural output. Crop rotation, agroforestry, and contour farming are examples of soil conservation techniques that are essential for maintaining soil health and reducing erosion (Pimentel, D. 2006).

Various types of soil in Gujarat and are mostly found along the coast and in river basins. They are perfect for agriculture because they are high in nutrients and minerals. Typically, areas such as Saurashtra, the Kutch, and the state's northern portions are home to alluvial soils. A variety of crops, including rice, wheat, and cotton, can be grown on these soils, which are typically light to medium broad (Singh, J. et. al., 2013). Regur soils, another name for black soils, are extremely productive and primarily found on Gujarat's Deccan Plateau. They are ideal for growing cotton because they are abundant in clay and minerals including iron, lime, and magnesia (Rai, et. al., 2012). Saline and alkaline soils are common in Gujarat's low-lying and coastal regions. Due to their high salt content, these soils are frequently unsuitable for agricultural use if improperly treated (Pandey, et. al., 2007). Arid and sandy desert soils are found mostly in the Kutch region. Modern farming methods can grow crops like wheat, groundnuts, and pearl millet despite their initial sterility (Mehta, et. al.,2010). The

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acidic to neutral soils of Gujarat's forests, which are primarily located in the state's southern and eastern regions. Teak, bamboo, and other forest plants are among the many types of forest vegetation that grow on these soils (Sharma, et. al., 2015).

The aim of soil analysis in these regions is to better understand the characteristics, makeup and behavior of soils in different types of environments. Studying soils in this research is essential for preserving ecological balance, managing the environment, promoting sustainable agriculture, building infrastructure, preventing land degradation, improving climate resilience and ultimately enhancing the long-term well-being and prosperity of these delicate and dynamic areas.

2. METHOD AND MATERIAL

➢ Study area

Ten sites in all, located in the Junagadh and Gir somnath district region's Maliya and Talala Taluka, have been selected as the study area for this soil analysis. In the Maliya taluka, there were five villages: Kanek, Gadu, Barula, Jangar, and Dhrabavad ; in the Talala taluka, there were five villages: Dhanej, Ramrechi, Gundaran, Surva, and Bamnasa.

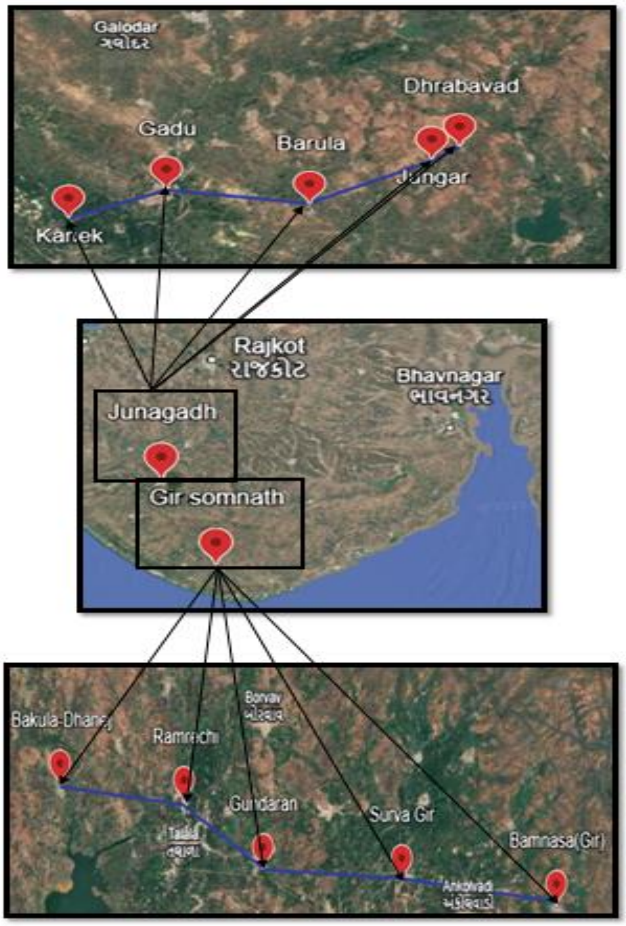
➢ Soil sample collection and preparation: -

✓ Collection –

Soil sample collection is the first phase in the soil-testing program. Only a little amount of soil used in laboratories is often used to determine fertilizer recommendations for field crops. The sample's identity and characteristics must be preserved at every step of preparation, and it must be kept as near to its first state as possible. About 1 kg of soil samples, ranging in depth from 0 to 15 cm, was collected and placed in zip-locked polythene bags.

✓ Preparation –

One part dried soil and two parts distilled water have been mixed to create a 1:2 ratio soil sample for testing.



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1. pH (Potential of hydrogen)

- pH is measured by Digital pH meter 335.
- Take 10 ml sample in beaker then set pH meter and first take reference reading and then take sample reading (Schofield, et. at., 1955).

2. EC (Electrical Conductivity)

- EC is measured by EC meter (Auto Digital Conductivity Meter) (Smith, Jeffrey L, et. al., 1997).

3. Soil Moisture

- Collect soil samples from multiple locations and depths. Weigh 5 gm soil each sample while it's wet. Dry the sample in an oven at a temperature around 50°C until it's completely dry. Weigh the sample again (Reynolds, S. G. 1970).

4. Texture

- Soil texture analyzed by using the jar test.
- Remove debris from the soil using a sieve. Fill a jar one-third full with soil. Fill the jar with water, leaving some space at the top. Seal the jar and shake until the soil is a uniform slurry. Let the jar sit for one minute. Mark the level of the coarse sand layer. Let the jar sit for two hours. Mark the level of the silt layer. Let the jar sit for 48 hours. Mark the level of the clay layer. Measure the height of each layer and the total height (Paltseva, Anna. 2024).

5. Water holding capacity

- Drying the soil in an oven until it's completely dry. Take 10 gm soil. Add 10 gm soil in funnel. After Add 20 ml water in soil sample. Filter the mixture with filter paper. Saturate the soil with water until it stops dripping. Measure the water which collected in measuring cylinder. Calculating the water holding capacity in % (Margesin, et. al., 2005).

6. OC (Organic carbon)

- To each 200 ml beaker containing 1 gm soil sample add 10 ml potassium dichromate. Add 20 ml conc. H_2SO_4. 30 min rest in darkness and then Add 200 ml D\W with 10 ml Orthophosphoric acid and 1 ml diphenylamine indicator. Titrate with diammonium ferrous sulphate that observation black to dull green or brilliant green (Ciavatta, C., et. al., 1989).

7. TOM (Total Organic Matter)

- Total Organic matter is measured TOC value by a conversion factor, typically around 1.72 (Bisutti, Isabella, et. al., 2004).

8. Calcium

- Calcium is measured by EDTA Titration Method.
- Take 10 ml sample in conical flask then add 2 ml NaOH solution (pH should > 10). Add small amount of nearly a pinch of Murexide indicator. Titrate with standard EDTA solution, slowly with continuous stirring until color changes from pink to purple (Steagall, et. al.,1966).

9. Total Hardness

- The EDTA Titration Method is used to measure Total Hardness.
- Take 50 ml sample. Than add 10 ml buffur solution; add 0.2 to 0.4 g EDT powder. Calmagite may also used as alternative. Titration with EDTA solution until wine red colour turns purple blue (Tucker, B. B., et. al., 1961).

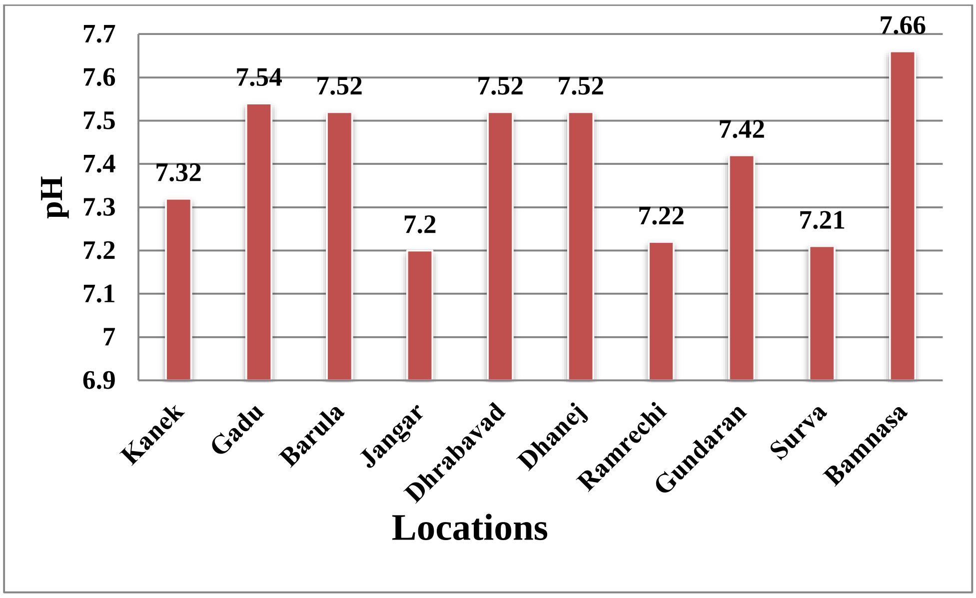
10. Cloride

- Using the Argentometric Method, chloride is measured.
- Take 10 ml sample in beaker and then add 1ml potassium chromate. Titrate with silver nitrate and also take blank reading in observation that brick red colour found. Then calculate with following formula (Rahbar, et. al., 2019).

3. RESULT

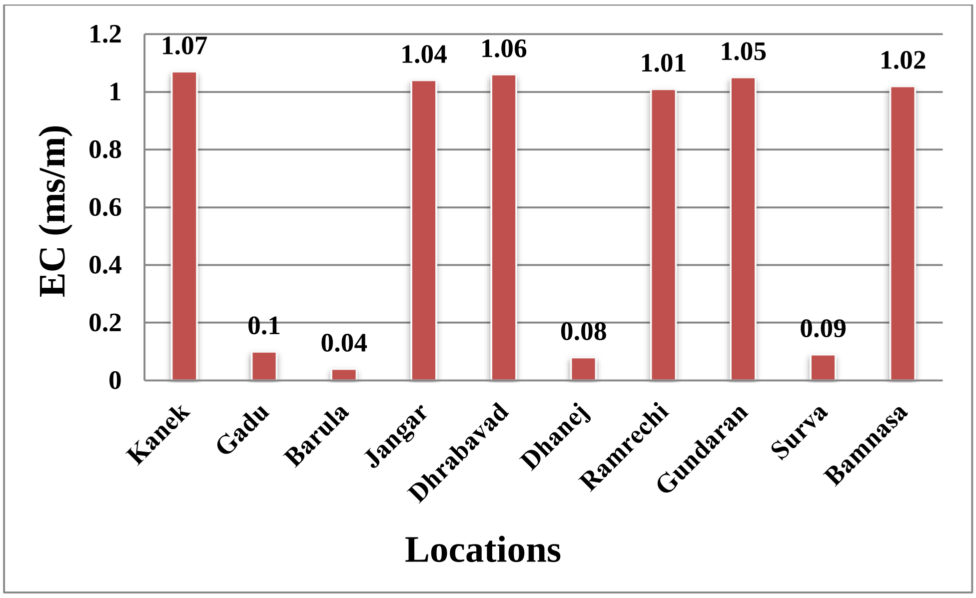
- Phytochemical Parameter :

Graph 1. pH analysis of different ten locations



According to graph 1 pH range is observed between 7.20 to 7.66. In Kanek pH is noted 7.32. In Gadu pH is noted 7.54. The pH in Barula is 7.52. In Jangar, the pH is 7.20. The pH of Dhrabavad is 7.52. In Dhanej pH is noted 7.52. The pH in Ramrechi is 7.22. In Gundaran, the pH is 7.42. The pH of Surva is 7.21. In Bamnasa pH is noted 7.66. According to observation, Among 10 locations, the lowest pH is observed in Jangar and the highest pH is observed in Bamnasa.

Graph 2. EC (Electrical conductivity) analysis of different ten locations



According to graph 2 EC (Electrical conductivity) is observed between 0.08 mS/m to 1.07 mS/m. The observed EC in Kanek is 1.07 mS/m. The EC in Gadu is 0.10 mS/m. In Barula, EC is 0.04 mS/m. EC is 1.04 mS/m in Jangar. The observed EC in Dhrabavad is 1.06 mS/m. The EC in Dhanej is 0.08 mS/m. In Ramrechi, Ec is 1.01 mS/m. EC is 1.05 mS/m in Gundaran. EC is recorded as 0.09 mS/m in Surva. EC is recorded as 1.02 mS/m in Bamnasa. According to observation, among 10 locations, the lowest EC is observed in Barula and the highest EC is observed in Kanek.

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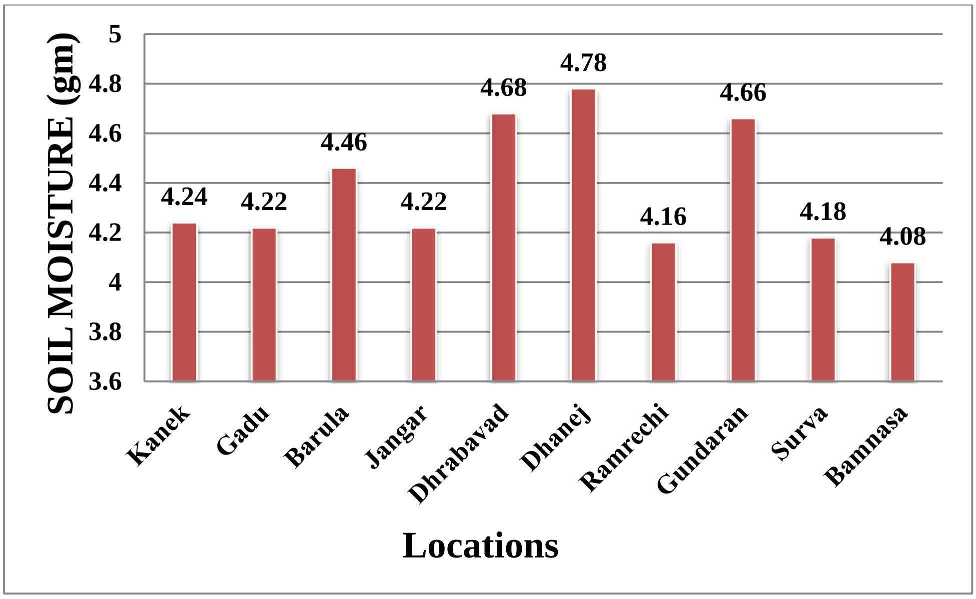
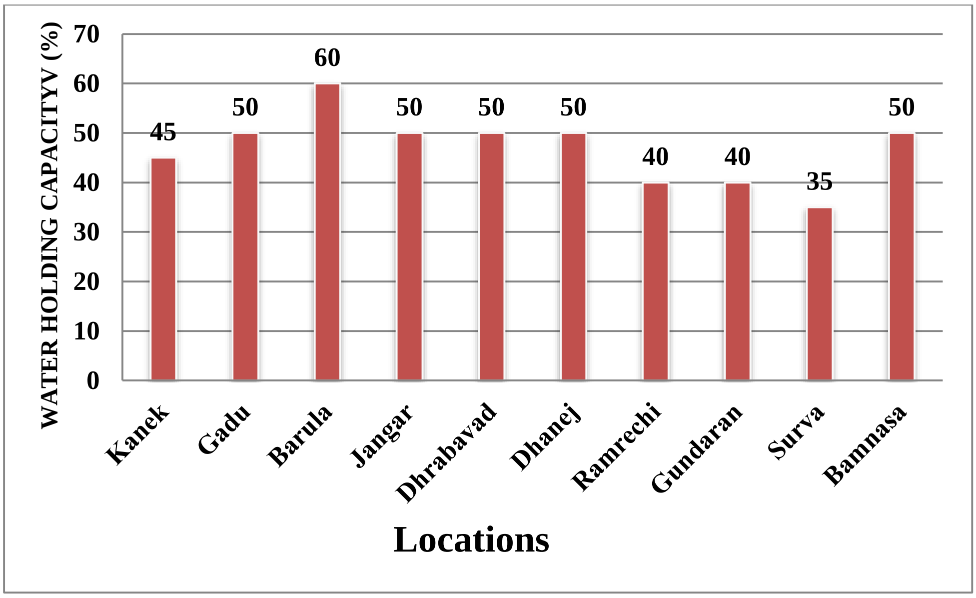
Graph 3. Soil Moisture analysis of different ten locations



According to graph 3 Soil moisture observed between 4.08 gm to 4.78 gm. In Kanek soil moisture is noted 4.24 gm. The soil moisture content in Gadu is 4.22 gm. Soil moisture in Barula is 4.46 gm. 4.22 gm of soil moisture are found in Jangar. Soil moisture in Dhrabavad is 4.68 gm. In Dhanej soil moisture is noted 4.78 gm. The soil moisture content in Ramrechi is 4.16 gm. 4.66 gm of soil moisture are found in Gundaran. In Surva soil moisture is noted 4.18 gm. The soil moisture content in Bamnasa is 4.08 gm. According to observation, among 10 locations, the lowest soil moisture is observed in Bamnasa and the highest soil moisture is observed in Dhanej.

Graph 4. Water holding capacity analysis of different ten locations



According to graph 4 water holding capacity observed between 35% to 60%. In Kanek water-holding capacity is noticed 45%. The water holding capacity of Gadu is 50%. The water holding capacity of the Barula is observed to be 60%. The water holding capacity in Jangar is 50%. There is a 50% water holding capacity in Dhrabavad. A 50% water holding capacity is seen in Dhanej. Ramrechi water holding capacity is noticed 40%. The water holding capacity of Gundaran is 40%. The water holding capacity of the Surva is observed to be 35%. The water holding capacity in Bamnasa is 50%. According to observation, among 10 locations, the lowest water holding capacity is observed in Surva and the highest water holding capacity is observed in Barula.

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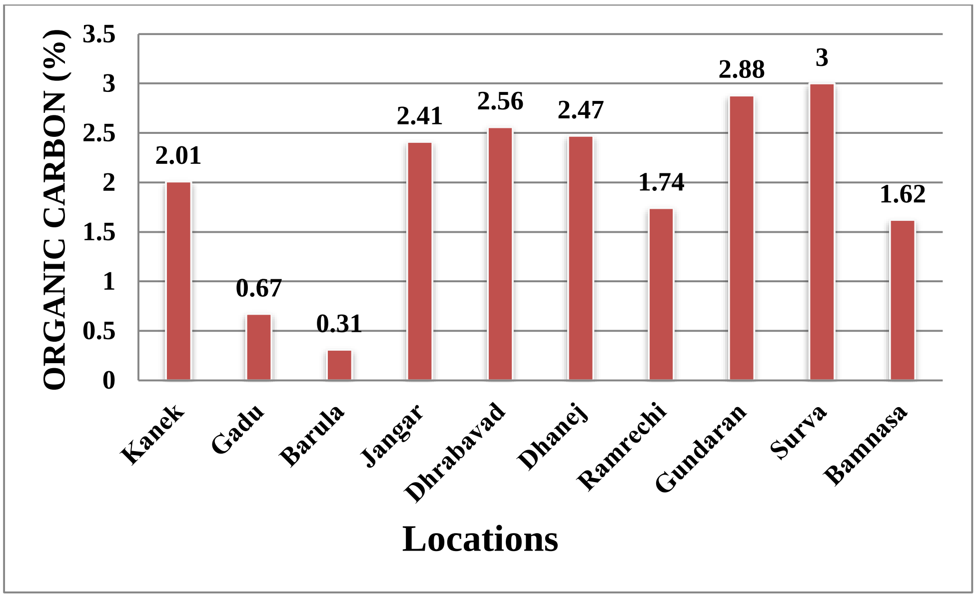
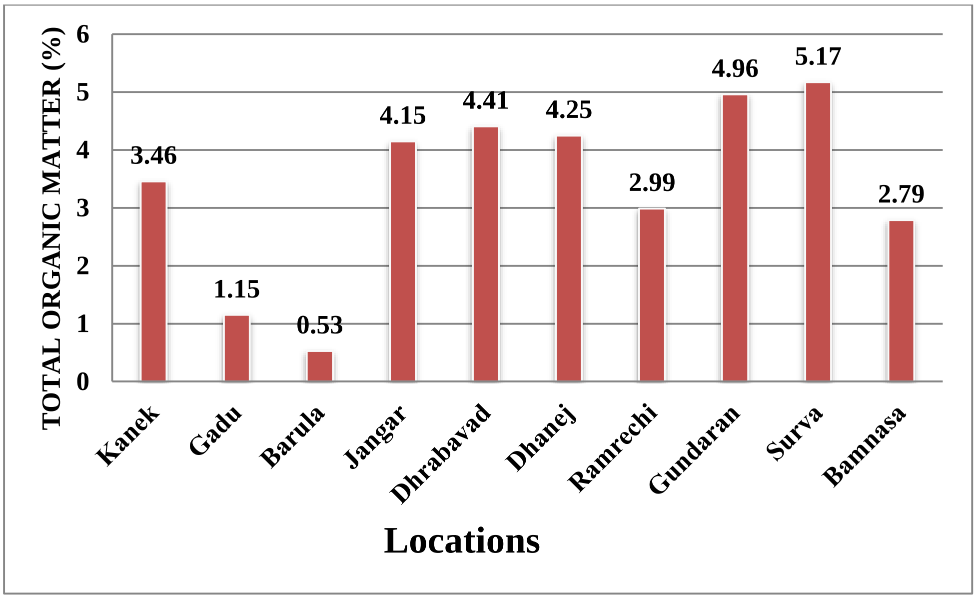
Graph 5. Organic Carbon (OC) analysis of different ten location



According to graph 5 Organic carbon observed between 0.31 % to 3.00 %. In Kanek Organic carbon is noted 2.01 %. In Gadu Organic carbon is noted 0.67 %. The Organic carbon in Barula is 0.31 %. In Jangar, the Organic carbon is 2.41 %. The Organic carbon of Dhrabavad is 2.56 %. In Dhanej Organic carbon is noted 2.47 %. The Organic carbon in Ramrechi is 1.74%. In Gundaran, the Organic carbon is 2.88%. The Organic carbon of Surva is 3.00%. In Bamnasa Organic carbon is noted 1.62%. According to observation, Among 10 locations, the lowest Organic carbon is observed in Barula and the highest Organic carbon is observed in Surva.

Graph 6. Total organic matter (TOM) analysis of different ten locations



According to table 7 Total organic matter is observed between 0.53% to 5.17%. The observed Total organic matter in Kanek is 3.46%. The Total organic matter in Gadu is 1.15%. In Barula, Total organic matter is 0.53%. Total organic matter is 4.15 % in Jangar. The observed Total organic matter in Dhrabavad is 4.41%. The Total organic matter in Dhanej is 4.25% . In Ramrechi, Total organic matter is 2.99%. Total organic matter is 4.96% in Gundaran. Total organic matter is recorded as 5.17% in Surva. Total organic matter is recorded as 2.79% in Bamnasa. According to observation, among 10 locations, the lowest Total organic matter is observed in Barula and the highest Total organic matter is observed in Surva.

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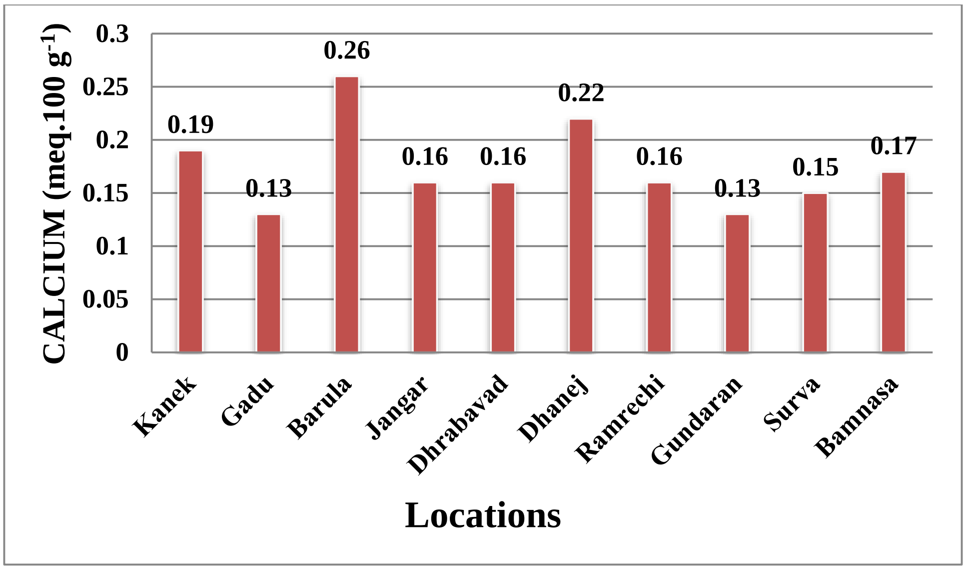
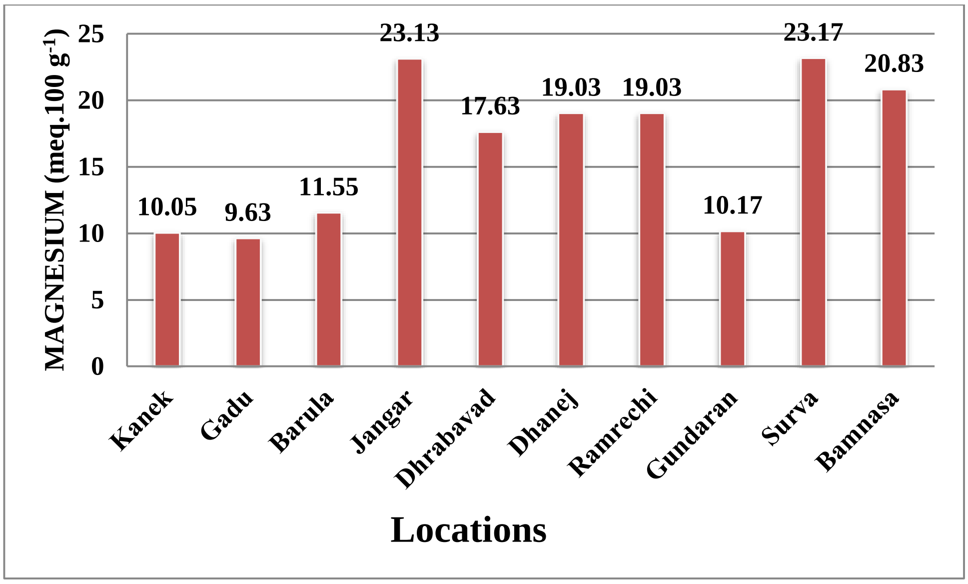
- Mineral analysis :

Graph 7. Calcium analysis of different ten locations



According to graph 7 Calcium is observed between 0.13 meq.100 g^{-1} to 0.26 meq.100 g^{-1}. In Kanek soil, calcium contant is 0.19 meq.100 g^{-1}. The calcium content of gadu soil is 0.13 meq.100 g^{-1}. Calcium content in barula soil is 0.26 meq.100 g^{-1}. Jangar soil contains 0.16 meq.100 g^{-1} of calcium. Dhrabavad soil has a calcium concentration of 0.16 meq.100 g^{-1}. In Dhanej soil, calcium contant is 0.22 meq.100 g^{-1}. The calcium content of Ramrechi soil is 0.16 meq.100 g^{-1}. Calcium content in Gundaran soil is 0.13 meq.100 g^{-1}. Surva soil contains 0.15 meq.100 g^{-1} of calcium. Bamnasa soil has a calcium concentration of 0.17 meq.100 g^{-1}. According to observation, among 10 locations, the lowest Calcium is observed in Gadu and Gundaran and the highest Calcium is observed in Barula.

Graph 8. Magnesium analysis of different ten location



According to graph 8 Magnesium is observed between 09.63 meq.100 g^{-1} to 23.17 meq.100 g^{-1}. Kanek soil has a magnesium level of 10.05 meq.100 g^{-1}. Gadu soil contains 09.63 meq.100 g^{-1} of magnesium. Barula soil has an 11.55 meq.100 g^{-1} magnesium concentration. The amount of magnesium in Jangar soil is 23.13 meq.100 g^{-1}. There is 17.63 meq.100 g^{-1} of magnesium in Dhrabavad soil. Dhanej soil has a magnesium level of 19.03 meq. 100 g^{-1}. Ramrechi soil contains 19.03 meq.100 g^{-1} of magnesium. Gundaran soil has an 10.17 meq.100 g^{-1} magnesium concentration. The amount of magnesium in Surva soil is 23.17 meq.100 g^{-1}. Bamnasa soil has a magnesium level of 20.83 meq.100 g^{-1}. According to observation, among 10 locations, the lowest Magnesium is observed in Gadu and the highest Magnesium is observed in Surva.

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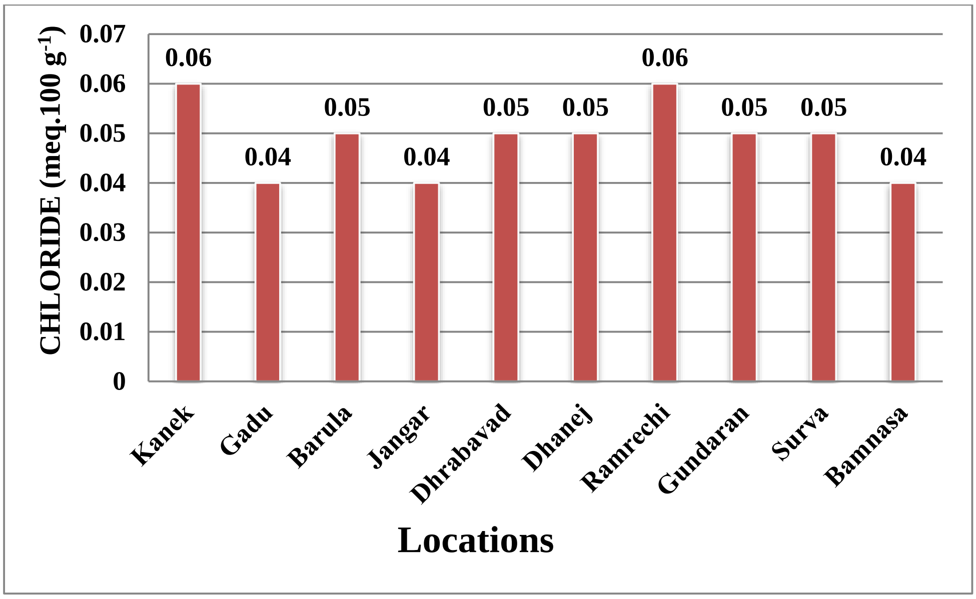
Graph 9. Chloride analysis of different ten locations



According to graph 9 Chloride is observed between 0.04 meq.100 g^{-1} to 0.06 meq.100 g^{-1}. 0.04 meq.100 g^{-1} Chloride is found in Gadu, Jangar, Bamnasa. Barula, Dhrabavad, Dhanej, Gundaran, Surva contain 0.05 meq.100 g^{-1} of chloride. Chloride levels in Kanek and Ramrechi are 0.06 meq.100 g^{-1}. According to observation, among 10 locations, the lowest Chloride is observed in Gadu, Jangar, Bamnasa and the highest Chloride is observed in Kanek and Ramrechi.

Table 1. Soil Texture analysis of different ten locations

Location	Soil Type (Sand, Loam or Clay)
Kanek	Loam
Gadu	Loam
Barula	Loam
Jangar	Loam
Dhrabavad	Loam
Dhanej	Loam
Ramrechi	Sand
Gundaran	Loam
Surva	Loam
Bamnasa	Loam

According to table 1 there are two type (loamy and sandy) of soil observed among three type in 10 locations. Loam soil is found in Kanek, Gadu, Barula, Jangar, Dhrabavad, Dhanej, Gundaran, Surva and Bamnasa. In Ramrechi, sand soil is observed.

4. CONCLUTION

The study area for this soil study includes ten sites, which are situated in the Maliya and Talala Taluka of the Junagadh and Gir somnath district regions. There were five villages in the Talala taluka (Dhanej, Ramrechi, Gundaran, Surva, and Bamnasa) and five in the Maliya taluka (Kanek, Gadu, Barula, Jangar, and Dhrabavad).

It has been noticed that out of ten locations, Jangar has the lowest pH (7.20) and Bamnasa has the highest pH (7.66), the lowest EC (0.04 mS/s) is observed in Barula and the highest EC (1.07 mS/s) is observed in Kanek, Dhanej has highest soil moisture (4.78) and Bamnasa has the lowest soil moisture (4.08), Surva has the lowest water holding capacity (35%) while Barula has the largest water holding capacity (60%), Barula has the lowest organic carbon (0.31%) and Surva has the greatest (3.00%), Barula has the smallest amount of Total organic matter (0.53%) and Surva has the highest quantity

(5.17%), Barula has the highest calcium content (0.26 meq.100 g^{-1}) and Gadu and Gundaran have the lowest (0.13 meq.100 g^{-1}), Gadu has the lowest magnesium levels (09.63 meq.100 g^{-1}) and Surva has the greatest magnesium levels (23.17 meq.100g^{-1}). Gadu, Jangar, and Bamnasa have the lowest levels of chloride (0.04 meq.100 g^{-1}) and Kanek and Ramrechi have the highest levels (0.06 meq.100 g^{-1}). Observations show that there are two types of soil in 10 different locations : sandy (Ramrechi) and loamy (Kanek, Gadu, Barula, Jangar, Dhrabavad, Dhanej, Gundaran, Surva, Bamnasa).

One useful agricultural technology for finding out the precise amount of crop nutrients in the soil is soil analysis. In order to increase the quality of soil, soil analysis provides important information. A farmer may easily regulate fertilization depending on crop and soil needs by monitoring the precise concentration of soil nutrients. Utilizing information that improves plant growth for maximum output, farmers can benefit from fertilizer suggestions. By determining the soil, farmers may make well-informed decisions to maximize crop yield and make sure the soil supplies the nutrients plants require for optimal growth. Because it maintains soil fertility and supports long-term agricultural productivity, soil analysis is essential to sustainable farming.

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