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*Research Article*

# Assessing Agricultural Soil Variability in Mandal Taluka, Ahmedabad, Gujarat: Implications for Crop Suitability and Ecosystem Dynamics

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**Abstract**

Land degradation poses a significant threat to food security and socioeconomic well-being, exacerbated by various human activities such as construction, dumping, deep plowing, continuous agricultural land use, deforestation, changes in land use, alterations in land topography, deep soil modifications, regulation of soil water, excessive use of nutrition and fertilizers, and heavy reliance on pesticides and insecticides, resulting in nutrient depletion and loss of topsoil. There is an urgent need for a thorough reevaluation of soil conditions to enhance soil quality. This paper presents a study focused on the physicochemical parameters of soil in Mandal Taluka, Gujarat.

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**Keyword:** Soil Variability, Crop Suitability, Pesticides, Fertilizers, Boron, *Gossypium herbaceum*

## 1. Introduction:

Land degradation is one of the important issues, which have a direct relation with the food security of the world due to its major threats to crop protection. Factors such as Geographical location, climate change, and economic conditions are important factors related to land degradation. An increase in Stalinization, alkalization, and waterlogging are factors that affect land degradation in the Nile Delta region (Mohamed *et al*., 2019) [8]. Other factors such as a rapid increase in human population, soil erosion, decreasing green cover, and unbalanced crop and livestock production are also important factors in Ethiopia (Taddese *et al*., 2001)[21].

Heavy use of pesticides and fertilizers (Shaviv and Mikkelse, 1993; Hossain *et al*., 2022)[19][4], ammonia emission from synthetic fertilizers (Ouyang *et al*., 2018)[11], overgrazing (Kairis *et al*., 2015, Niu *et al*., 2019)[5][10], Stalinization (Modaihsh *et al*., 2014)[7], land use (Senjobi and Ogunkunle., 2011)[18], desertification (Vogt *et al*., 2011)[23], Sodicity (Qadir *et al*., 2006)[16]. India's western regions especially Rajasthan and Gujarat are considered as semi-arid zone (Patel *et al*., 2022)[14]. The Mandal region of Ahmedabad district is also belonging to this region. The soil region of Mandal is less fertile due to an excess amount of salt concentration. Soil microflora amount is low due to less water holding capacity and soil structure is unfavorable for bacteria and fungi. This is one of the reasons behind the land degradation in this area (Garg, 1998; Bhawmik *et al*., 2019)[1][3]. Desertification decreases soil fertility, land does not support life, and agricultural crops and domestic animals survive. It influences ecology, the economy, and social life (Pilania *et al*., 2015; Parmar *et al*., 2021)[13][15].

In Gujarat, 29.32% of soil is under the degradation of the total geographical area in 2011-2013 by a survey of SAC, 2016. Gujarat has the 4$^{th}$ highest land degradation in India. Many reasons are responsible, such as poor cultivation, inappropriate land management, and drought. The major impact of soil degradation is increasing the input cost and decreasing the output in agricultural practices. Soil erosion is one of the main factors responsible for land degradation (Pilania *et al*., 2015; SAC, 2016)[15] [20]. The second reason is water erosion, 19.67% land of the TGA is degraded by water erosion. total degraded area in the state is 3,129 thousand hectares. vegetative cover of soil is decreased by excessive grazing and reduced agricultural practice (Patel *et al*., 2022)[14].

Samples from Gandhinagar district of Gujarat represents lower nitrogen content and higher sodium and phosphorous, potassium content (Chavda et al., 2018) [2]. In Gujarat 8 types of soil is present. In Mandal region, the soil is slightly salty semi-arid type. The soil is dry at certain level. The climatic water status of mandal is low. Rainfall is 521 mm, potential evapotranspiration is 1794 mm, actual evapotranspiration 521.7 mm, and water surplus is 0.0 mm, water deficit 1272.3 mm, moisture index 70.9% (Pandey and Shekh, 1999) [12]. Agriculture is the mainstay of Indian economy and is characterized by small land holdings, a diversity of crops and a wide variation in agricultural practice (Sahai et al., 1989)[17]. Agriculture in Gujarat is marked by erratic and irregular rainfall. The state received only rainfall during June to September. Precarious and irregular nature of rainfall result in scarcity condition in various region of Gujarat (Mathur and Kashyap, 2002) [6].

Construction, dumping, deep plowing, continuous use of agricultural land for cropping, deforestation, changes in land use, changes in land topography, deep soil changes, regulation of soil water changes, addition of large amount of nutrition/ fertilizers, heavy use of pesticides/insecticides loss of top soil are the induced nutrition depletion. There is need to reinvestigation of soil status for the improving the quality of soil. (Tan *et al*., 2005)[22].

There is a lack of qualitative and quantitative data for the mitigation of challenges in soil degradation (Montanarella, 2007)[9]. Inventory of soil data is required for better management Hence it is very important and urgent to evaluate the soil status for the crop in Mandal taluka for the mitigation purpose.

## Methodology

### Collection of soil sample:

The soil sample is collected from the five different locations of mandal taluka. Soil sample collected from the 3 different depths, one is 0-15 cm, 15-30 cm and 30-45 cm. after that 3-sample mixed thoroughly. All these sample air dried and packed in separate polythene bag for laboratory analysis. There are certain parameters which analysis is necessary for soil health and cultivation of crop such as pH, Bulk density, Electric conductivity, Boron, Potash, Iron, Zinc, Manganese, Copper and Sulphur.

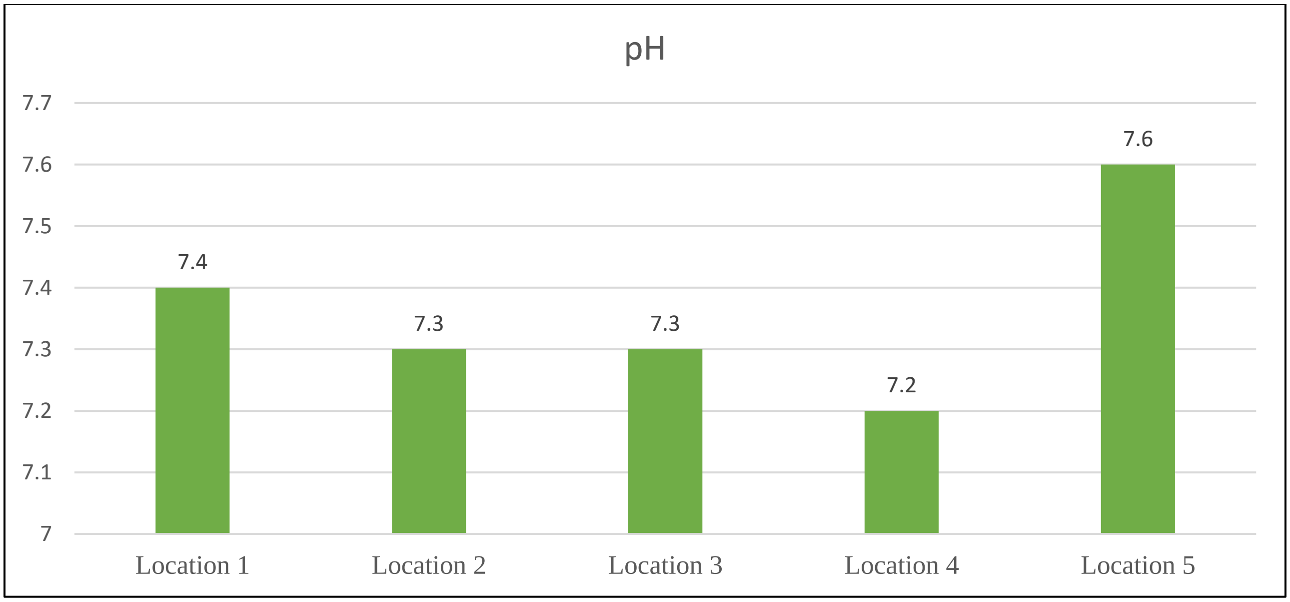
### Analysis of physio-chemical properties of soil:

pH of soil is measured by pH meter after preparing soil paste with distilled water (1:5). Electric conductivity is measured E.C meter. Boron, Potash, Iron, Zinc, Manganese, Copper and Sulphur were measured by Atomic Absorbance Spectrometer (AAS) following Lindsay and Norvell (1978).

## Results

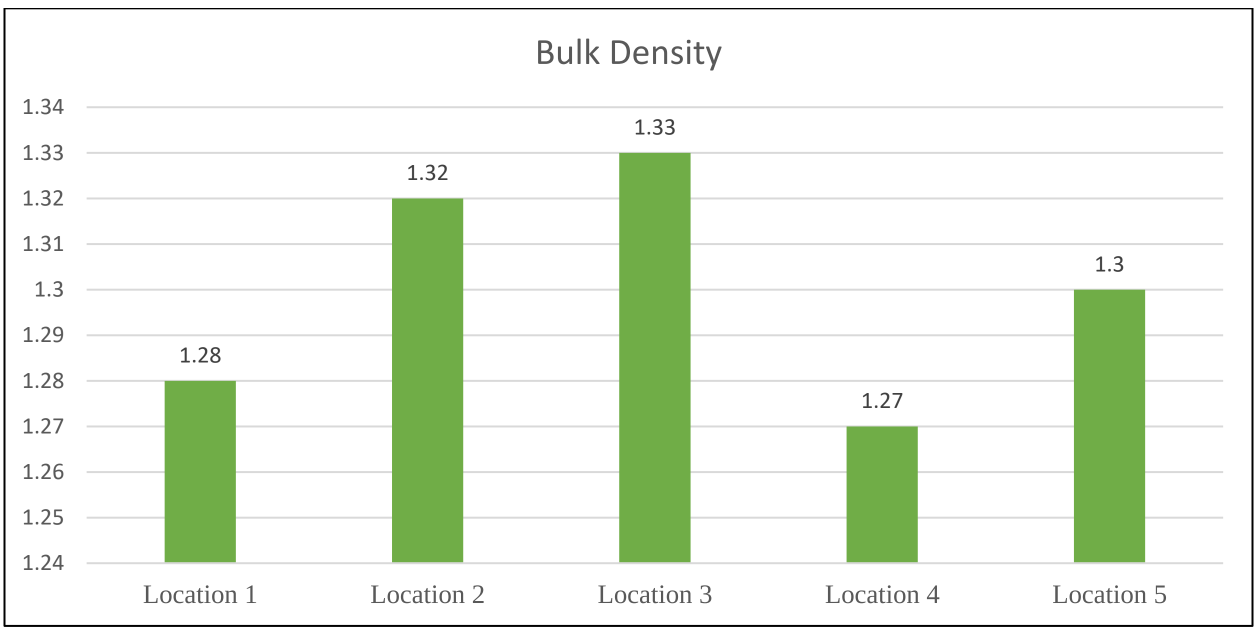
Analysis of physio-chemical properties of soil:

1. **pH:** The appropriate soil pH is necessary for crop plant. Various crop grows in various pH range. Its play important role in soil biogeochemistry processes such as nitrification, enzymatic activity and ammonia volatilization. It maintains the carbon storage, soil fertility and food production (Neina, 2019). The soil pH is changed if it is decreased or increased impact on solubility of various compounds and soil microbes, which is mainly responsible for crop production (Alam *et al*., 1999). pH at location 4 have lowest pH and Location 5 shows highest pH i.e 7.6. pH range is 7.2 to 7.6.



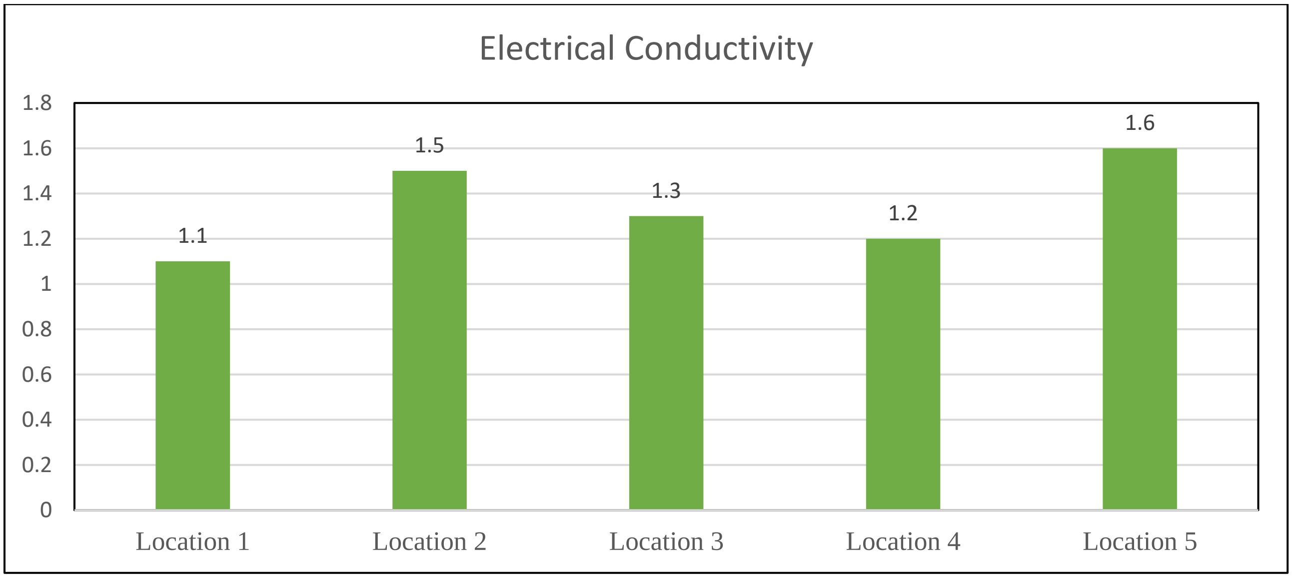

**Graph 1:** Soil pH of different location

2. **Bulk Density:** The structure of soil is must important for growing any crop plants. It varies region to region. For the appropriate growth of root its crucial element of soil (Keller and Hakasson, 2010). Bulk density of soil affects the population of microbes and enzymatic activity (Li *et al*., 2002). Density of soil helpful in water holding and provide the water to roots of plant (Katterer, 2006). Location 1 and location 4 have shown low bulk density i.e 1.27 -1.28 comparatively higher Bulk density is shown in location 2, 3,5.



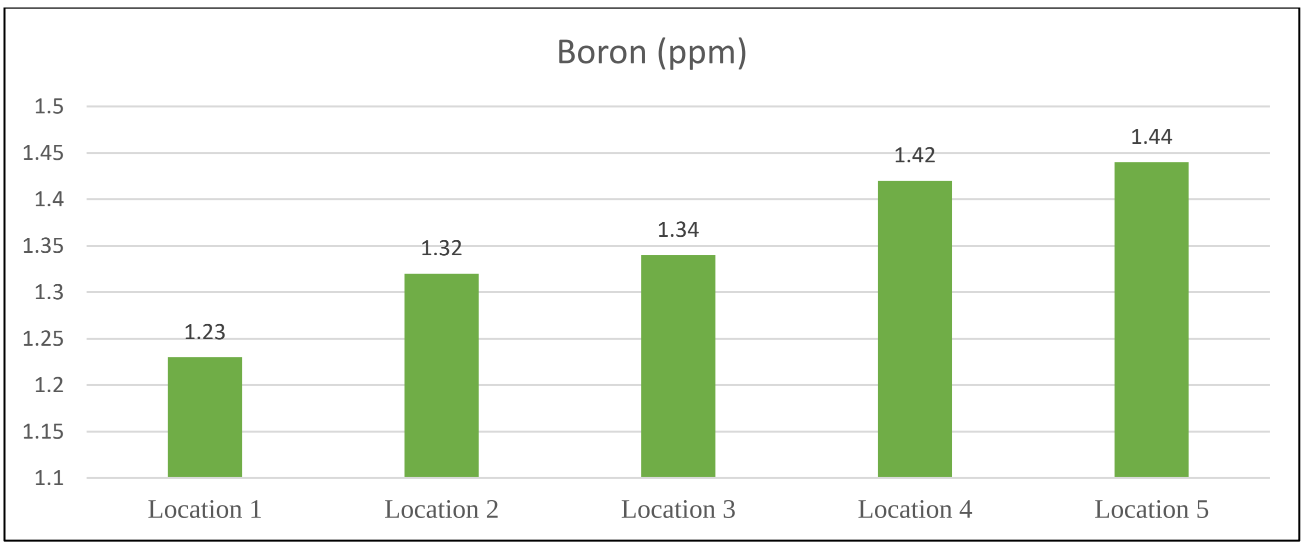

**Graph 2:** Soil Bulk density of different location

3. **Electrical Conductivity:** The elective conductivity is helpful for nutrient uptake in roots. The appropriate level of EC will increase the productivity of soil and extreme lower or extreme higher the EC reduced the nutrient uptake and growth of plants (Samarkoon *et al*., 2006). Different development level of plants such as vegetative phase, flowering and fruiting require different EC value for proper growth (Bodale *et al*., 2021). EC ranges from 1.1 to 1.6 which its shows little hindrance of salts which do not hampers the growth of plants in adversely.



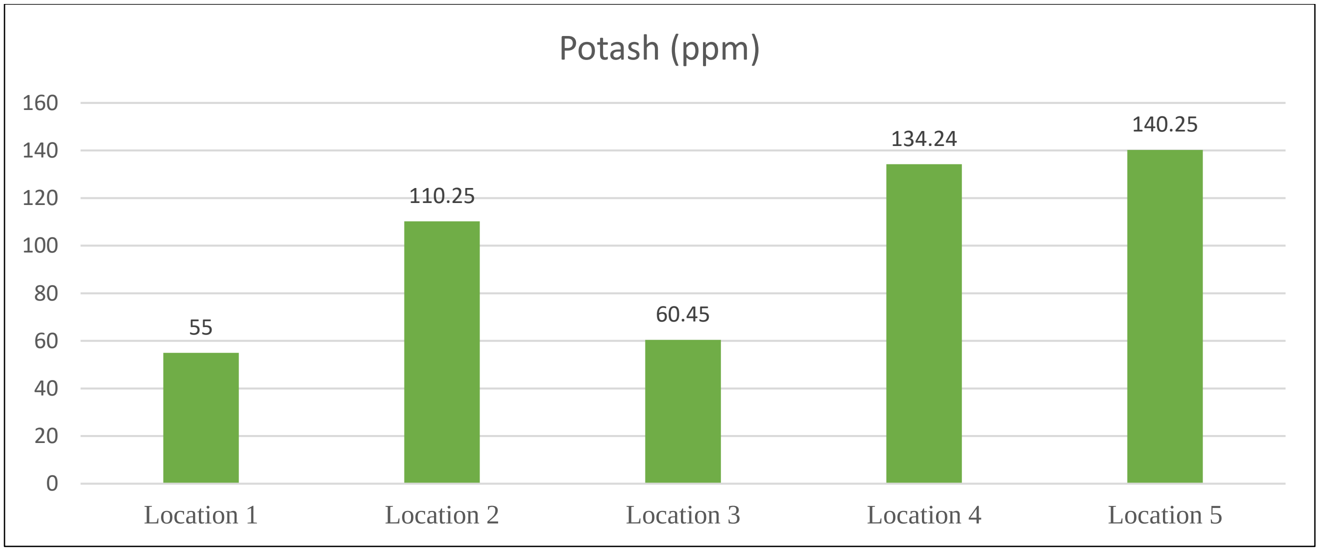

**Graph 3:** Soil Electrical Conductivity of different location

4. **Boron:** Boron is important for elongation, hormone response and nucleic acid synthesis (Robertson and Loughman, 1974). It also requires for maintain the cell membrane structural integrity and root growth. Boron directly associated with carbohydrate metabolism, auxin and phenolic compounds (Pilbeam and Kirkby, 1983). Deficiency of boron cause the black necrosis of the young leaves and affect the photosynthesis capacity (Brdar-Jokanovic, 2020). Location 1 shows lower i.e 1.23 and location 5 have maximum boron content.



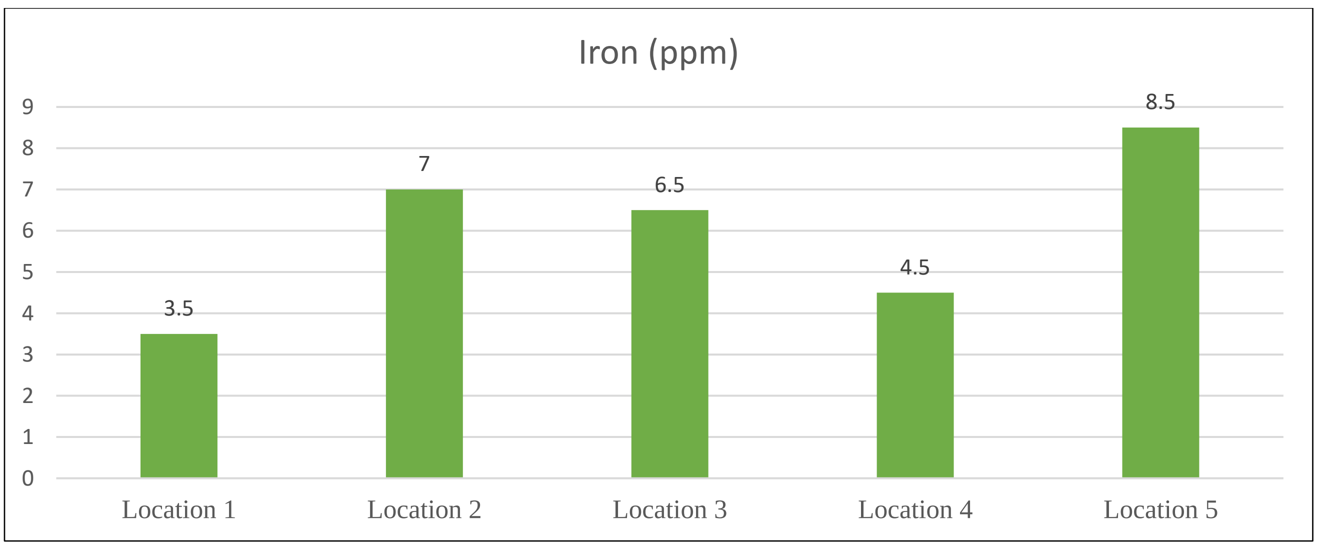

**Graph 4:** Boron concentration in soil of different location

5. **Potash:** Potash is essential micronutrient and play important role in stabilizing microbes which is help in improve the soil fertility (Siyad *et al*., 2015). It increased self-life of fruits (Javaria *et al*., 2012). Potash deficiency cause the lodging of stem, short internode and weaker stem of plant (Dahiya *et al*., 2018). Marginal chlorosis is one of the major effects of potash deficit (Besford, 1978). Location 1 and location 3 shows lower potash content i.e 55 and 60.45. and higher potash in location 2, 4 and 5 i.e 110.25, 134.24 and 140.25 respectively.



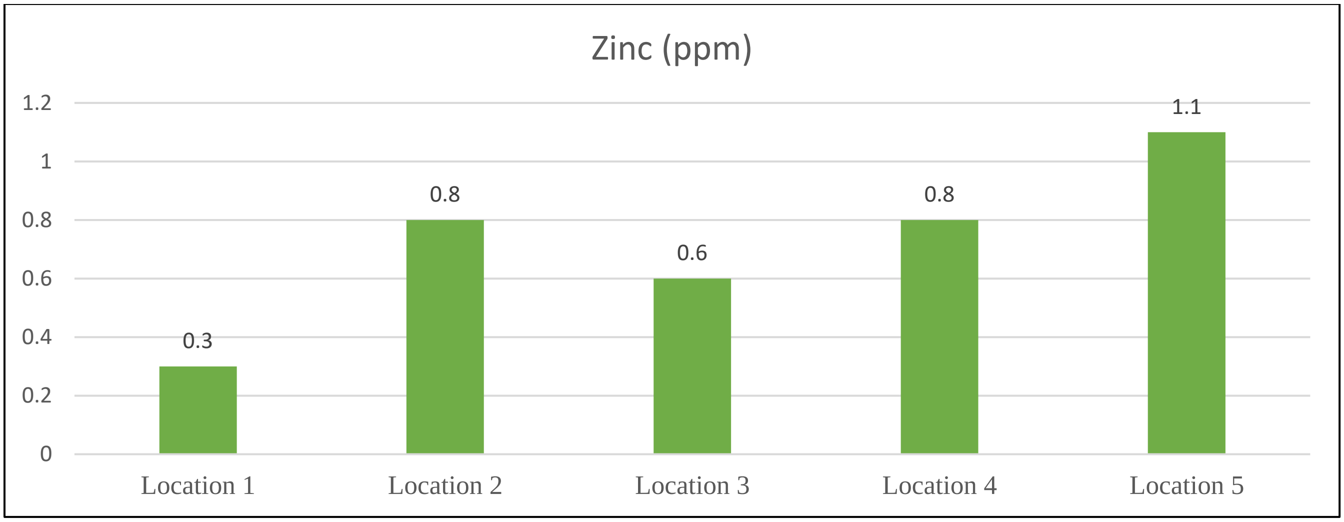

**Graph 5:** Potash concentration in soil of different location

6. **Iron:** Iron is one of the main elements of nutrient for the plant growth. Deficiency of iron cause the interveinal chlorosis in leaf (Vose, 1982). It plays role in various physiological process and redox reaction. Its interaction with other element and enhance various enzymatic activity (Lindsay, 1984). Now a days scientist understands the mechanism of iron deficiency tolerance mechanism in plant by the help of genetic engineer (Lucena *et al*., 2017). Graph shows the higher value of iron content in location number 5 is 8.5 and lowest value is 3.5 in location number 1. The range of iron content is 3.5 to 8.5 in present study locations.



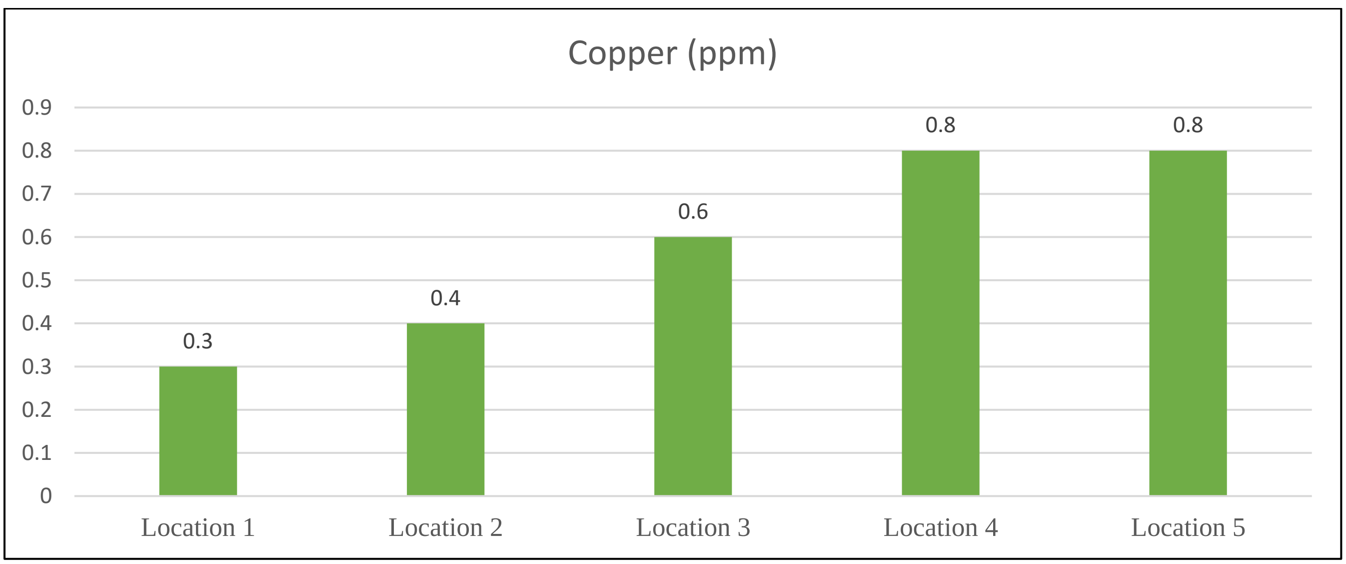

**Graph 6:** Iron concentration in soil of different location

7. **Zinc:** Zinc is essential nutrient element for auxin synthesis. Zinc deficiency seen in leaf as white necrosis spot. Stem is shorter due to reduction in intermodal region. For the chlorophyll synthesis zinc is must important compound. Zinc absorption is depended on pH, if the pH was increase then uptake of zinc is decreased (Rengel and Graham, 1995; Thorne, 1957). Zinc range is 0.3 to 1.1 ppm, the highest amount of zinc 1.1 ppm in location number 5 and lowest in location 1 is 0.3 ppm.



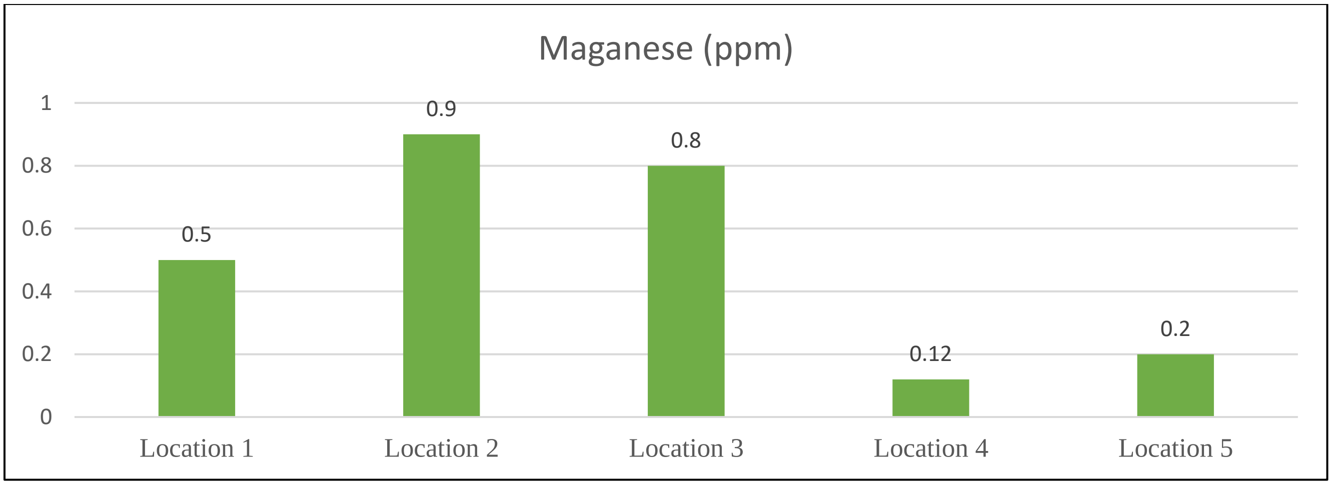

**Graph 7:** Zinc concentration in soil of different location

8. **Copper:** Copper deficient plant produce twisted and malformed leaves and also seen the necrotic spots appear at tips of young leaves (Behboudian *et al*., 2016; Uchida, 2000). The high amount of copper decreases the rate of photosynthesis by interfering in electron transport chain (Yruela, 2005). Copper one of the best antioxidant element and role in respiration. In plant body copper homeostasis regulate by copper protein and copper delivery system (Pilon *et al*., 2006). The maximum copper content available in location number 4 and 5, and lowest value is 0.3 ppm in location number 1.



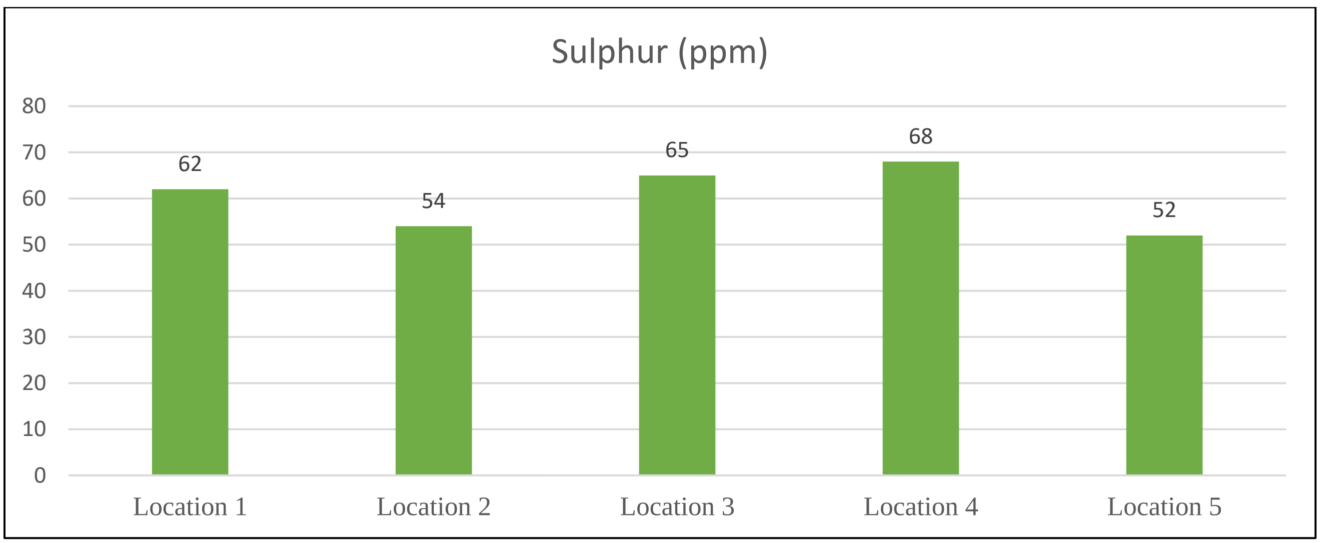

**Graph 8:** Copper concentration in soil of different location

9. **Manganese:** Manganese is micronutrient and important part of fertilizer. Manganese deficiency reduce the crop productivity and leaf necrosis (Schmidt and Husted, 2019). It plays important role in various cellular process such as oxidation and reduction in ETS. Major role in chlorophyll synthesis and act as cofactor in various physiological process. It activates the various enzyme enhance the carbohydrate synthesis (Mousavi *et al*., 2011). Maximum content of manganese has been reported in location 2 and lowest in location 4 i.e 0.12




**Graph 9:** Manganese concentration in soil of different location

10. **Sulphur:** Sulphur play significant role in nitrogen metabolism (Yu *et al*., 2018), enzyme activity, protein synthesis and organic and inorganic compounds which are soluble. (Jamal *et al*., 2010), deficiency of Sulphur causes weak stem yellowing of leaves in crown of plants. Out of 27000 samples of 12 states in India have been collected from 12 states of India. Study reports 40 percent soil samples are Sulphur deficient. (Biswas *et al*., 2004). Sulphur content is higher in location number 4 and lowest in location number 5. Its range between 52 to 68 ppm.




**Graph 10:** Sulphur concentration in soil of different location

## Conclusion

A soil analysis study was conducted on samples collected from the agricultural fields in Mandal Taluka, Ahmedabad, representing the agro-ecosystem of the region. The inherent variability in results observed across different fields can be attributed to diverse agricultural practices and soil management treatments implemented by farmers. The findings of the study reveal the soil's favorable conditions for plant growth, particularly conducive for the cultivation of specific crops, including *Cajanus cajan*, *Ricinus communis*, *Gossypium herbaceum*, and *Solanum annum*. This nuanced assessment underscores the intricate relationship between soil characteristics, cultivation practices, and the potential suitability for specific crop varieties within the studied agro-ecosystem.

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