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A comparative study on the physico-chemical parameters of banana leaf margin affected and healthy banana gardens of Hiriyur Taluk Chitradurga district, Karnataka

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Abstract
The examination of soil from a physico-chemical perspective involves the analysis of several key parameters, such as pH, Electrical Conductivity (EC), and the levels of primary macronutrients (nitrogen, phosphorus, and potassium), as well as secondary nutrients (sulfur), Organic Carbon (OC), and various micro-nutrients. Assessing the soil's fertility is vital for promoting sustainable agricultural practices in a given region. The optimal proportions of primary macronutrients and micronutrients within the soil provide valuable insights into its fertility, which in turn plays a pivotal role in regulating crop yields. For the purposes of our study, we selected the Hiriyur taluk in the Chitradurga district of Karnataka. Here soil samples were gathered from a depth of 0-30 cm in a random fashion within banana-farming communities in Hiriyur taluk and conducted a comparative analysis of their physico-chemical properties. The outcomes of this investigation offer valuable information to farmers, enabling them to identify soil-related issues, assess its nature, and gauge nutrient levels, all of which are instrumental in enhancing sustainable agricultural production.

Keywords: pH, electrical conductivity, macronutrients and micronutrients, leaf margin affected and healthy banana gardens

Introduction
Soil fertility represents the inherent capacity of soil to supply essential plant nutrients in the right amounts and proportions necessary for optimal plant growth and development. The characterization of soil in a given region plays a pivotal role in achieving sustainable agricultural productivity. Macronutrients and micronutrients, as critical constituents of soil, exert a profound influence on soil fertility and subsequently enhance crop yields, as emphasized by Singh (2012) [19]. In the absence of the correct concentration of essential nutrients, plant functionality is adversely affected. The primary objective of our study was to acquire a comprehensive understanding of the physicochemical attributes of soils in various villages within the Hiriyur taluk of Chitradurga District, an area located in the Central Dry Zone of Karnataka. Notably, a substantial portion of this region, approximately 1529 hectares, is devoted to fruit crops, and this area continues to expand annually. As highlighted earlier, the quality and quantity of fruit production are predominantly contingent on the soil's potential for supporting crops, a factor intricately linked to soil properties. For our research, we specifically selected the following villages: Babbur Farm, Chillhalli, Venakalgudda, KC Roppa, Goguddu, Gudihalli, Biranhalli, Gounahalli, and Vadadhalli.

Material and Methods
The current research was conducted across various villages within the Hiriyur taluk through an extensive survey. To effectively characterize the soils, soil samples were diligently collected from the surface soil at a depth of 0-30 cm. In each of the ten selected villages, ten soil samples were gathered, resulting in a total of 100 samples that were meticulously analyzed for detailed characterization. The study area encompassed a range of villages, namely Babbur Farm, Chillhalli, Venakalgudda, KC Roppa, Goguddu, Gudihalli, Biranhalli, Gounahalli, and Vadadhalli, all located within the Hiriyur taluk of Chitradurga. Soil samples from each of these villages were obtained, and composite soil samples were carefully prepared from the 0-30 cm depth range.

These samples were subsequently subjected to air-drying and sieved to ensure they passed through a 2 mm sieve, following which they were meticulously analyzed for various parameters such as pH, Electrical Conductivity (EC), Organic Carbon (OC), and macronutrient content using established standardized methods. Additionally, micronutrient analysis was performed using atomic absorption spectroscopy (AAS) in the soil test laboratory at UAHS, Shivamogga. The resulting data trends are graphically presented for comparative purposes.

Results and Discussion

Soil pH and Electrical Conductivity

The pH levels in gardens affected by banana leaf margin issues exhibited a range from 7.82 to 9.2, indicating an alkaline environment, with a calculated average pH of 8.34 in the upper soil layers. In contrast, the pH levels in healthy banana gardens fell within the range of 6.9 to 7.82, closer to a neutral pH, with an average pH of 7.30. Notably, the pH in gardens with affected leaf margins was notably higher than that in healthy gardens. This observation aligns with findings from Malo *et al.* (2005) [11], who noted that the increasing pH with soil depth may be attributed to higher carbonate levels and reduced rates of weathering. Similarly, Rupa and Shukla (1996) [13] and Reddy (1997) [14] reported relatively lower pH values in the case of healthy banana gardens, which could be attributed to a more pronounced leaching of basic elements.

The gardens affected by leaf margin issues exhibited a broad range of electrical conductivity, spanning from 3.38 to 4.6 dS m^{-1}, and the mean value stood at 4.17 dS m^{-1}. Conversely, the electrical conductivity in the case of healthy banana gardens encompassed a narrower spectrum, varying between 0.62 and 1.31 dS m^{-1}, with a mean value of 1.09 dS m^{-1}. These findings distinctly demonstrated that healthy banana gardens contained fewer soluble salts. This outcome is in alignment with findings presented by Rudramurthy and Dasog (2001) [17], which corroborate the observation that electrical conductivity tends to be lower in gardens that are thriving and healthy.

Organic Carbon

The organic carbon content within gardens affected by banana leaf margin issues displayed a considerable range, varying from 3.58 to 13.36 g kg^{-1}, with a mean of 9.69 g kg^{-1}. In contrast, the surface layers of healthy banana gardens had organic carbon levels ranging from 2.2 to 10.18 g kg-1, with an average value of 6.29 g kg^{-1}. The higher organic carbon content in healthy banana gardens could be attributed to the accumulation of organic matter in the surface layer and the presence of crop residues within the topsoil. These observations align with previous findings by Reddy and Sharma (1982) [15], Rupa and Shukla (1996) [13], and Ashok (1998) [15], who reported similar trends in organic carbon content, affirming the link between soil health and organic carbon accumulation.

Nitrogen

The nitrogen content exhibited variations across the range of 188.7 to 320.7 kg ha^{-1}, with an average value of 281.46 kg ha^{-1}, according to the assessment criteria outlined by Subbiah and Asija in 1956, categorizing the available nitrogen as medium in all soil samples. In contrast, the gardens affected by banana leaf margin issues displayed a nitrogen range from 283.7 to 341.23 kg ha^{-1}. This discrepancy may be attributed to the lower levels of organic carbon and reduced microbial populations in the gardens impacted by leaf margin issues. These findings align with prior research conducted by Ramamurthy and Bajaj in 1969, Rao and Vasudeva in 1986, and Vijayasankar and Seshagiri in 1991, reinforcing the notion that nitrogen content is influenced by organic carbon levels and microbial activity.

Available P_2O_5

The available phosphorus levels in gardens affected by banana leaf margin issues exhibited a range from 14.93 to 36.58 kg ha^{-1}, with an average value of 25.30 kg ha^{-1}. In contrast, the available phosphorus content in healthy banana gardens showed a broader spectrum, varying between 29.87 and 63.87 kg ha^{-1}, with a mean value of 43.91 kg ha^{-1}. This decreasing trend in phosphorus content is attributed to the declining organic matter levels. A similar pattern was observed by Sankaraiah (1992) [6], who reported analogous variations in available phosphorus content in the soils of Kadapa and Kurnool, emphasizing the influence of organic matter on phosphorus availability.

Available K_2O

The potassium availability in gardens affected by banana leaf margin issues displayed a range from 209.66 to 301.63 kg ha^{-1}, with an average value of 245.81 kg ha^{-1}. Similarly, in healthy banana gardens across Hiriyur taluk, the potassium availability also ranged from 209.66 to 301.63 kg ha^{-1}, with a mean value of 245.81 kg ha^{-1}. It's notable that the potassium availability remained consistently high in both gardens impacted by leaf margin issues and the healthy banana gardens within Hiriyur taluk. These findings are in line with the observations made by Ramamoorthy and Bajaj in 1969, further confirming the presence of ample potassium levels in this region.

Available S

The available sulphur content of healthy banana gardens varied from 39 to 93 mg kg^{-1} with a mean value of 65.10 mg kg^{-1} and 30.50 to 71.25 mg kg^{-1} with a mean value of 56.12 mg kg^{-1} and the available sulphur content of banana leaf margin affected gardens of Hiriyur taluk varied from 30 to 79.8 mg kg^{-1} with a mean value of 47.22 mg kg^{-1}. The available sulphur content was recorded to be sufficient in leaf margin affected and healthy banana gardens of Hiriyur taluk, considering 10.00 mg kg^{-1} soil (Tandon, 1991) [4] as a critical limit for available sulphur for normal plant growth.

Available micronutrients (Fe, Mn, Cu, Zn, B and Cl)

In the banana leaf margin-affected gardens of Hiriyur taluk, the available iron (Fe) content within the soil exhibited a range from 10.02 to 20.3 mg kg^{-1}, with a calculated mean value of 12.50 mg kg^{-1}. Conversely, in the healthy banana gardens of Hiriyur taluk, the available Fe content in the soil spanned from 11.24 to 23.6 mg kg^{-1}, with an average value of 15.95 mg kg^{-1} in the surface soil. According to the critical limit for available Fe, as established by Lindsey and Norvell in 1978 (set at 4.5 mg kg^{-1} soil), it is evident that all the banana gardens in Hiriyur taluk possessed sufficient iron content in their soil. These results align with the findings of Kadao *et al.* (2002) [2], who reported a similar range of Fe content, ranging from 6.28 to 12.87 mg kg^{-1}, in banana-cultivated soils in Wardha district.

In the banana leaf margin-affected gardens of Hiriyur taluk, the available manganese (Mn) content within the soils showed a range from 6.34 to 11.43 mg kg^{-1}, with a calculated mean value of 9.17 mg kg^{-1}. In the case of healthy banana gardens within Hiriyur taluk, the available Mn status ranged from 9.96 to 13.19 mg kg^{-1}, with a mean value of 11.60 mg kg^{-1} in the soil. These findings underscore that there was ample manganese content available in both the banana leaf margin-affected and the healthy banana gardens of Hiriyur taluk, confirming the sufficiency of manganese levels in the soil for these agricultural purposes.

In the banana leaf margin-affected gardens of Hiriyur taluk, the available copper (Cu) content within the soils demonstrated a range from 1.52 to 4.21 mg kg^{-1}, with an average value of 2.35 mg kg-1. In healthy banana gardens of Hiriyur taluk, the available copper status spanned from 1.78 to 6.1 mg kg^{-1}, with a mean value of 3.19 mg kg^{-1} in the soil. Importantly, all the soils in these gardens met the criteria for adequate available copper content, as established by the critical limit of 0.2 mg kg^{-1} soil according to Lindsey and Norvell in 1978 [3]. This underscores that there is sufficient copper available in the soils for agricultural purposes in both leaf margin-affected and healthy banana gardens in Hiriyur taluk.

The available zinc status in banana leaf margin-affected gardens showed a range from 1.43 to 2.87 mg kg^{-1} in the soil, with a mean value of 2.24 mg kg^{-1} in the surface soil. In contrast, the available zinc status in healthy banana gardens ranged from 2.51 to 3.85 mg kg^{-1} in the soil, with an average value of 3.08 mg kg^{-1}. Importantly, all the soils in both types of gardens met the criteria for adequate available zinc content, as per the critical limit of 0.2 mg kg^{-1} soil, as established by Lindsey and Norvell in 1978 [3]. This confirms that there is ample zinc available in the soils for agricultural purposes, whether in leaf margin-affected or healthy banana gardens.

The available boron content in banana leaf margin-affected gardens exhibited a range from 0.4 to 1.5 mg kg^{-1} in the soil, with a mean value of 0.89 mg kg^{-1}. In contrast, the available boron status in healthy banana gardens ranged from 0.55 to 1.5 mg kg-1 in the soil, with an average value of 1.17 mg kg^{-1}. It is worth noting that there is a notable difference in the boron content between banana leaf margin-affected and healthy banana gardens. These results align with the ranges suggested by Ramasubbaiah (2002) [18] in soils where papaya is grown in the Rayalaseema region, highlighting the variability in boron content in different soil conditions.

In the banana leaf margin-affected gardens, the soluble chloride content ranged from 293.32 to 442.35 mg kg^{-1}, with a mean value of 355.07 mg kg-1. In healthy banana gardens, the soluble chloride levels exhibited a narrower range, varying from 193.81 to 246.82 mg kg^{-1}, with a mean value of 225.45 mg kg^{-1}. It was apparent that the concentration of chloride in the leaf margin-affected gardens had reached toxic levels, whereas significantly lower levels of chloride were observed in the healthy banana gardens. However, it's essential to recognize that anthropogenic activities often contribute to the excessive accumulation of chloride in the soil. These activities may include the application of chloride-containing fertilizers, irrigation water rich in chloride, and the presence of animal wastes with high chloride content. These findings are consistent with the observations made by Ali *et al.* (2014) [1], underscoring the influence of human activities on soil chloride levels.

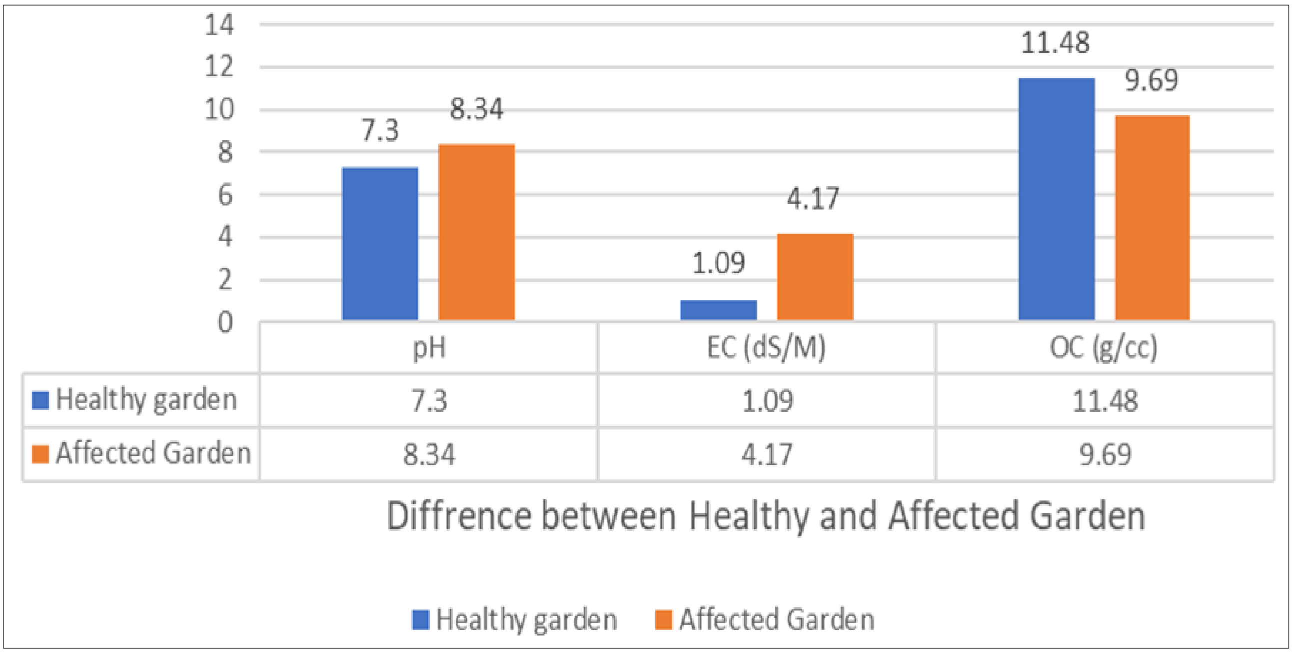
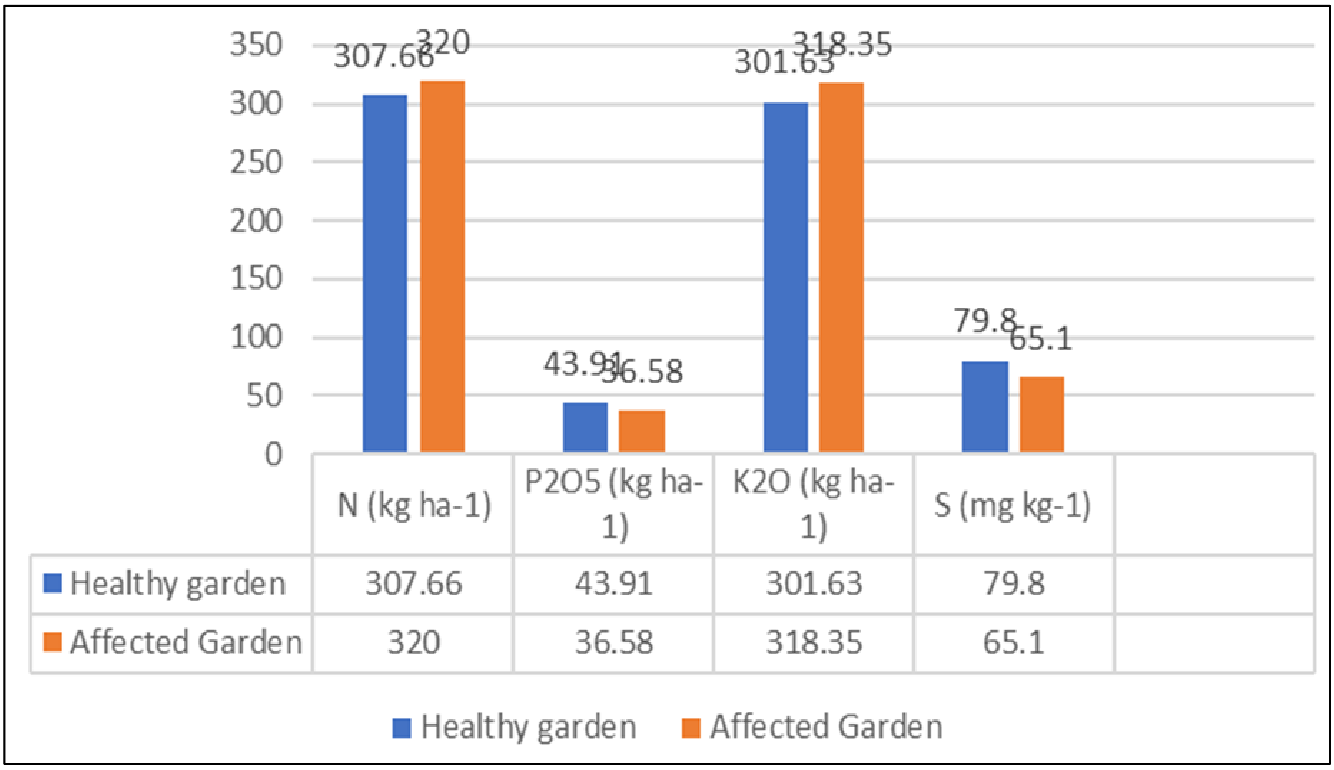
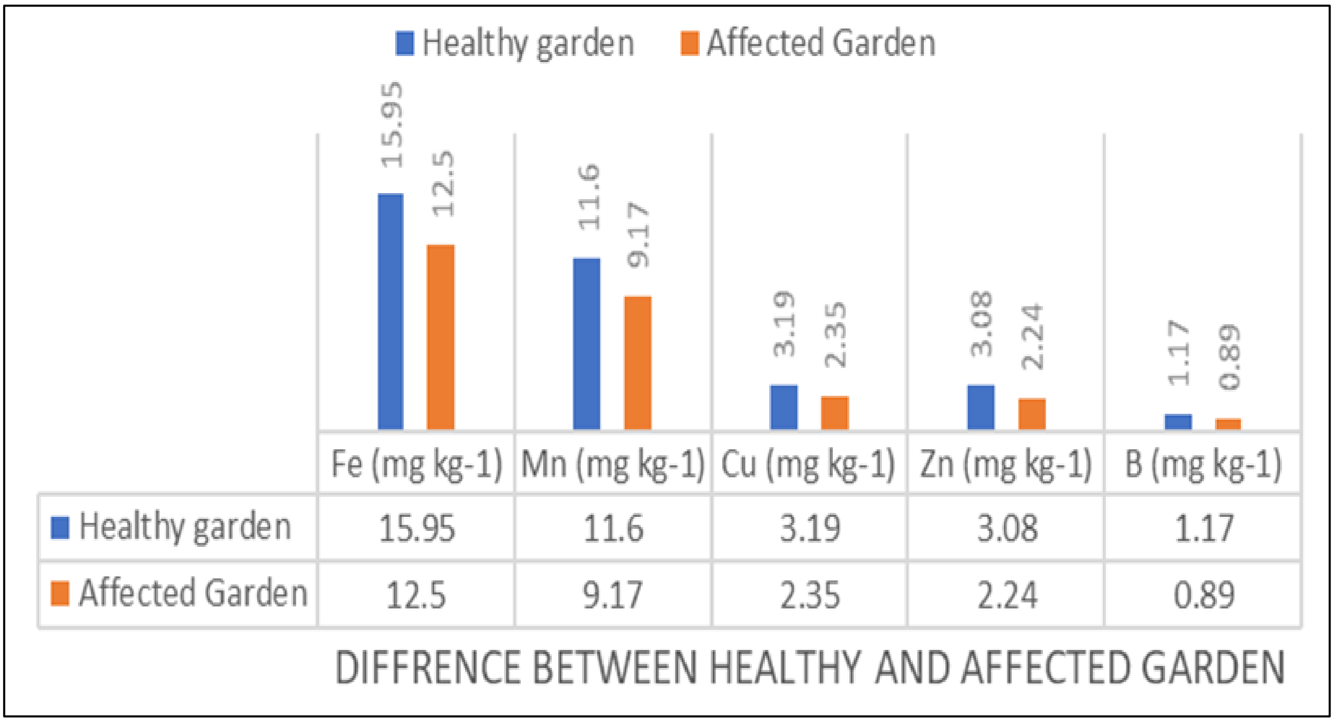


Fig 1: Graphical representation of pH, EC and OC



	N (kg ha-1)	P2O5 (kg ha-1)	K2O (kg ha-1)	S (mg kg-1)
Healthy garden	307.66	43.91	301.63	79.8
Affected Garden	320	36.58	318.35	65.1

Fig 2: Graphical representation of Available N, P_2O_5 and K_2O



	Fe (mg kg-1)	Mn (mg kg-1)	Cu (mg kg-1)	Zn (mg kg-1)	B (mg kg-1)
Healthy garden	15.95	11.6	3.19	3.08	1.17
Affected Garden	12.5	9.17	2.35	2.24	0.89

Fig 3: Graphical representation of Micronutrients

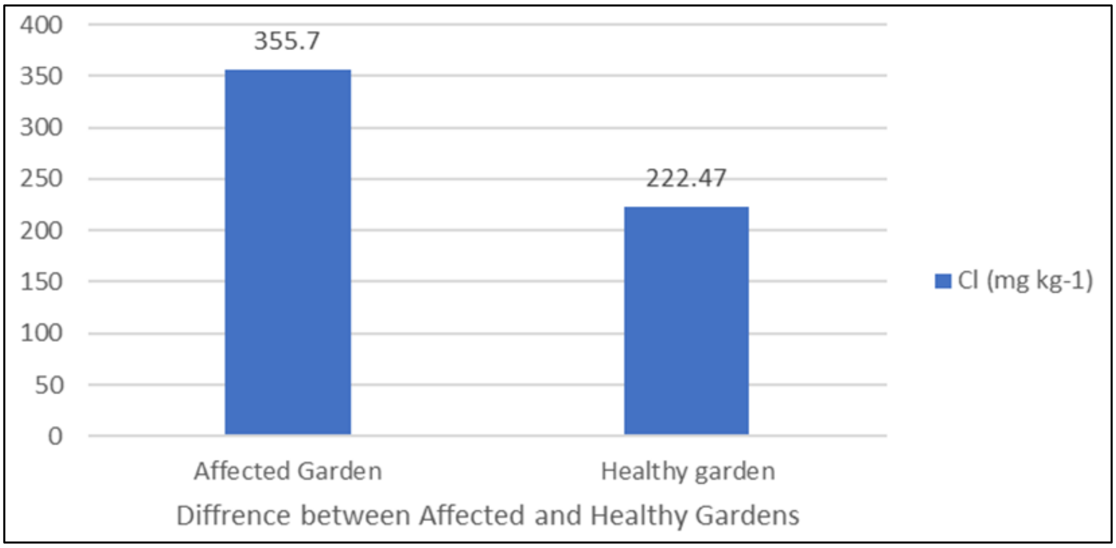


Fig 4: Graphical representation of Soluble Chloride

Conclusion

This study highlights a stark contrast in the levels of pH and electrical conductivity (EC) between gardens affected by banana leaf margin issues and those in good health. Gardens with leaf margin problems showed elevated pH and EC levels, whereas the gardens that were thriving in all villages within the Hiriyur taluk of Chitradurga district consistently maintained lower pH and EC values. Furthermore, it's noteworthy that the healthy gardens in these villages demonstrated significantly higher concentrations of both macro and micronutrients. This emphasizes the strong positive relationship between soil health and nutrient content, underlining the critical role soil conditions play in fostering nutrient-rich environments for plant growth. This underscores the robust positive connection between soil vitality and nutrient abundance, emphasizing the pivotal role that soil conditions play in cultivating nutrient-rich environments conducive to plant growth.

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