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Effect of Metal and Non-Metal Toxicity on the Rate of Vegetable Sprouting and Growth

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Abstract
Elemental ratios plays vital role in the rate sprouting and growth of plants. Seed germination depends on the quality of the soil which contains organic and inorganic substances. The present experiment was focused to the toxicity caused by elements present in large ratio. Three different soil samples were under experiment having pH ranging from 8.03 to 8.32 which indicates that all soil samples were alkaline in nature. Carbon to nitrogen ratio of the soil samples ranges 1:1-1:3.6 where the soil K_1 shows maximum ratio to that of H_3 having lower ratio. Sample K_1 shown a decline in the vegetation and rate of sprouting. Na/K ratio for H_3 is 3:3.5 with relatively higher concentration of sodium compare to other soils. Higher concentration of sodium increases the salinity of the soil and retards the fertility of the by spoiling the quality of soil. H_3, H_4, R_1 and $R_2$are reported maximum phosphorus content which avoids adsorption and transportation of Cu and Zn. H_4 shown relatively higher percentage of sodium which reduce the capillary action. Thus, increased phosphorus, insoluble carbon, sodium, copper and zinc causes elementary toxicity to the fertile soil and affect the rate of plant sprouting and their growth.

Key words: Vegetation, Toxicity, Elementary, capillary action, Sprouting, Salinity

Introduction

Soil is as fundamental as air and water for the persistence of humankind. Soil is considered a weather condition layer or an earth structure for living things. Soil is the most vital piece of the world's outer layer and is a mix of ordinary as well as weather conditions rock and materials[1]. Soil is a complex physio-normal framework that gives water, minerals, salts, supplements, isolated oxygen, etc. A solid typical body on the outer layer of the earth, where plants are made, produced using minerals and normal materials and residing plants. Soil is a storeroom of metallic compounds, a base of water, a guarder of soil efficiency, a protector of vegetative yields, and a shelter of wildlife livestock[2]. Soil is genuinely the deterioration and decay of rocks due to continuing. The course of soil improvement integrates two phases: persisting and paedogenesis. The strategy of the dirt is inorganic compounds 45%, distinct substance 5%, ground water 25%, and aerated soil 25%. The parts associated with continuing with living things are oxygen, carbon, hydrogen, nitrogen, phosphorus, sulphur, chlorine, iodine, calcium, magnesium, and silver[3]. The charge density of soil particles are influenced by vital parameters such as pH and ionic strength. Soil management has been effected through surfactant adsorption which ensures the soil morphology and permeability[4]. It contains many life forms[5] like primary producers in ecosystems; inorganic nutrients from soil animals which is affected by environmental factors such as soil properties, temperature, water, redox conditions, carbon dioxide, and light[6]. SOM (soil organic matter) plays a visible role in the global balance which brings equilibrium climate change acting as source and sink for carbon.

Efficiency of a biological system depends on the nature of the soil. A few boundaries were over as far as possible and some were underneath as far as possible which influences the quality and efficiency of soil. Soil has a characteristic body in significant abiotic factor on the planet. Soil invertebrates are indispensable part and the sample of soil tests taken from the two close sites covered remarkable changes in compound boundaries like natural Carbon, Potassium, and Phosphorus[7, 8, 9]. The actual properties of soil such as mass thickness, water holding limit (WHC), pH, and natural carbon (OC) content of soil are great impact of soil quality and efficiency on account of their positive consequences for the physicochemical and organic properties of soil. Soil pH influences the chemical reactions in the soil. Extremes of pH in soils will lead net negative surface charge, thus increase the soil's affinity for metal ions[10, 11, 12, 13].

To compile data on the course of soil improvement composition of the soil's minerals in our area of Rampura, Hanur taluk, Kuderu village, Chama raja nagara districts and Halepura village Nanjund taluk, Mysore district has been conducted and we registered the vegetative stress on the different soils samples .named as H_3, H_4, K_1, K_2, K_3 and R_1, R_2 by growing commonly available green vegetables. The main aim of soil analysis leads to determine acceptability, excess or deficiency of required nutrients for the growth of crops and guides in forming methods in our villages to raise awareness of vegetation in the soil.

Materials and Methods

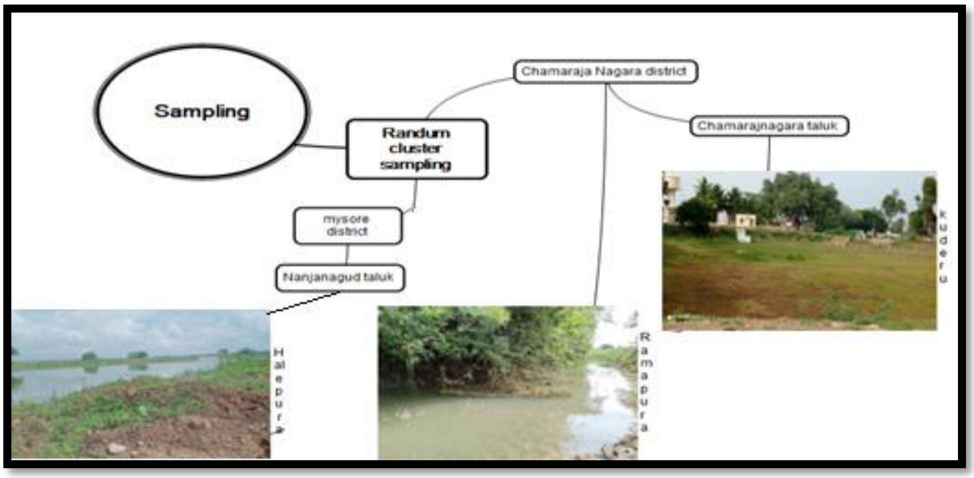
Chemicals

Hydrochloric acid, Sulphuric acid, $K_2Cr_2O_7$, Ammonium molybdate, EDTA, Ammonium Chloride, Double distilled water. All chemicals are analytical and laboratory reagent grade and purchased from Nice Chemical suppliers

Sample collection

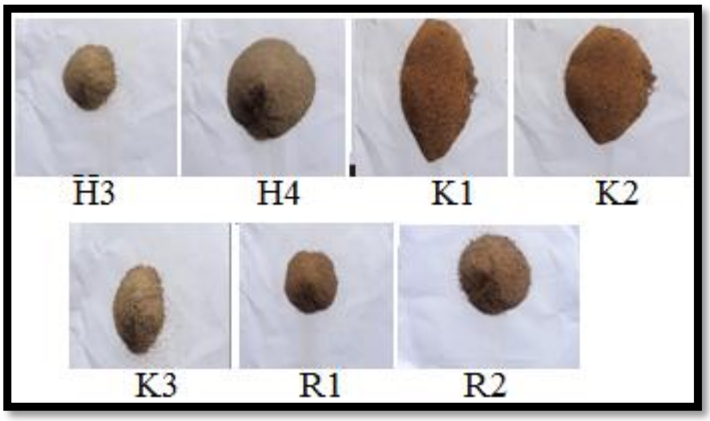
Soil samples were collected from different villages like Halepura and Nanjanagudu from Mysore district, Kuderu and Ramapura from Hanur, Chamarajanagara district of Karnataka,

India. The diagrammatic representation of sample collection is as shown



Sampling

The collected soil samples were ground, dried and sieved through2mm sieve. All samples were preserved in air tight glass bottles and coded as shown below.



Sample Codes	Place/ Soil type
H_3, H_4	Halepura/ Agriculture land
K_1, K_2, K_3	Kuderu/ Dry land area
R_1, R_2	Ramapura / Wet land area

Determination of Soil pH

pH of the soil was found for 1:25 soil-water suspension. 1 gram sample of soil was sieved through a 2mm sieve into a100 ml beaker and added 25ml double distilled water, stirred well using magnetic stirrer for about 10 minutes, allowed to settle. pH was determined by using Elico pH meter of accuracy 0.001

Determination of organic carbon

Amount of organic matter was determined by spectrophotometric method. 1 gram of soil sample was added with 10ml of 1N $K_2Cr_2O_7$ and 10 ml of concentrated H_2SO_4 in a 250ml conical flask. The mixture was shaken well, kept for 30 minutes and centrifuged 2000 rpm. The green chromium sulphate colour of the supernatant layer is read in calorimeter at 660 nm of accuracy 0.001.

Determination of Phosphorus

The quantity of phosphorus was determined by spectrophotometric method.1gm of soil sample mixed 200 ml of 0.002 N H_2SO_4 in 500ml conical flask. The suspension was stirred using magnetic stirrer 30minutes and filtered. 50 ml of filtrate was added with2ml 2 ml 2% of ammonium molybdate and 5 drops of $SnCl_2$ in beaker. Blue colour developed was read at 690 nm on spectrophotometer using deionised water as blank. Quantitatively phosphorus was determined using standard calibrated curve which is constructed by using potassium hydrogen phosphate.

Determination of Zinc

Zinc is quantitatively determined by complex metric titration.1g of soil sample was taken in 100ml Standard flask and made up to the mark using distilled water and mixed well.10ml of soil sample solution was pipette into a conical flask and added 5ml of ammonia- ammonium chloride buffer, a pinch of EBT indicator and titrated against 0.1M EDTA to the end point wine red to blue colour.

Determination of Cu

Copper is determined by spectrophotometric method.10ml of sample solution was pipette into a clean beaker and added about 2.0ml of buffer solution (pH 2.2). Resulting solution was stirred well with standard EDTA. The absorbance of this solution was recorded at 745 nm for each addition of 0.5ml EDTA. A graph of absorbance against the volume of titrant added was plotted. The intersection of the 2 straight lines is the endpoint.

Determination of Nitrogen

Total nitrogen in the soil sample is determined by the Kjeldahl method in which total nitrogen is converted into ammonia and determination was done using the formula,

$$\%N = \frac{(a\text{-}b) \times N \text{ of HCl} \times 1.4 \times V}{v \times s}$$

a = Volume of HCl in sample
b = Volume of HCl in blank

V = Total digest volume
v = Digest distillate volume
s = Weight of soil

Determination of Sodium and Potassium

Na and K are determined by Flame Photometry.0.05g of soil dissolved in 50ml of distilled water, then pipette out 10ml of sample solution into another 50ml of standard flask then makeup to the mark.

Prepared 100ppm solutions of sodium chloride

Working Standard = 20ml of 100ppm solution was diluted to 100ml and used for the analysis.

Selection of green vegetables to study elemental toxicity

In this research article, the green vegetables such as Amaranths spinosus, Amaranths dubious and Fenugreek were selected to study elemental toxicity for their sprouting rate and growth. Essential elements needed for their growth are includes metals and non-metals.

Results and Discussion

Soil pH

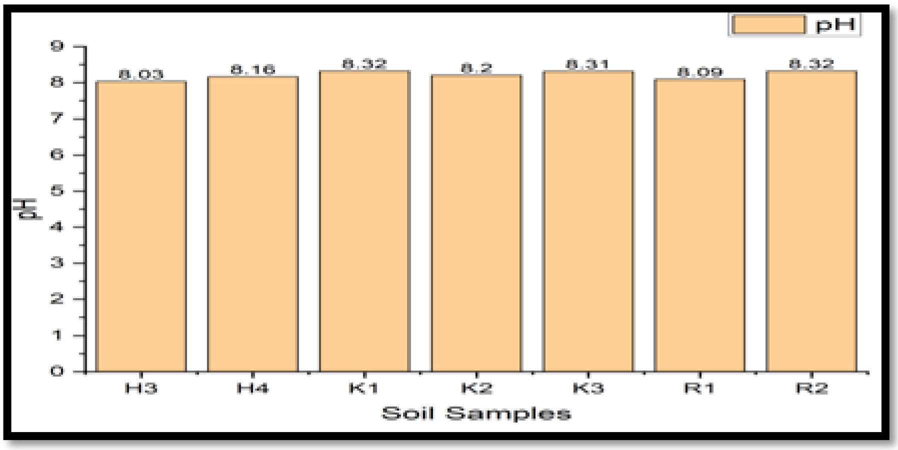


Fig.1. Relative pH of soil samples

From theFig1, it is cleared that the soil samples show variable pH ranging from8.03 to 8.32 indicating that all soil samples are basic or alkaline in nature. pH values of the soils show slightly higher value that normal soil(pH=7.5) and this may affect some nutrients and micronutrients available for plant growth. Increased alkalinity retards availability nutrients from fertilizers such as ammonium, organic matter, aluminium sulphate and sulphur.

Percentage of Zn, copper, Carbon, and Phosphorous in soil samples.

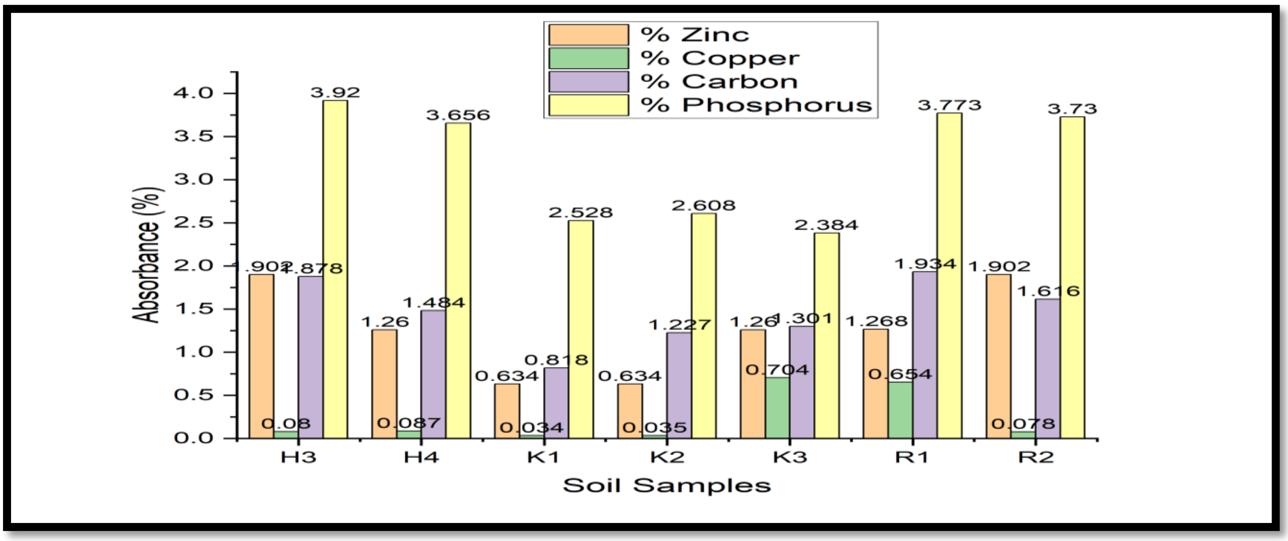


Fig.2. Comparative % of Zn, Cu, C, and P in soil sample

The Figure2 indicates the presence of copper, zinc, carbon and phosphorus in the available cultivating land soil sample. Copper is least present in soil samples K1and K2 whereas H3, H4 and R3 shown slight increase in the percentage of zinc. Soil samples K3 and R1 contain moderate amount of copper. Percentage of zinc and carbon are ranges from 0.634 to1.9%where as all soil samples shown maximum percentage of phosphorus ranging from 2.4 to 3.92 %. Protein synthesis and photosynthesis process are assisted through copper and zinc which plays key role in the management of stress caused by oxidation and biogenesis of molybdenum cofactor. Zinc is an effective constituent in ribosomes and an active element in biochemical processes. A deficiency of essential elements changes the main functions during metabolic process. Active phosphorus interferes with Zn uptake by plants and reduce the the concentration with increase of phosphorus in the soil.

At lower pH, dissolution of copper increases showing weaker adsorption. At higher pH, organic matters in the solid phase and dissolved organic carbon increases Cu concentration in the soil solution[14].

C/N Ratio in the soil samples

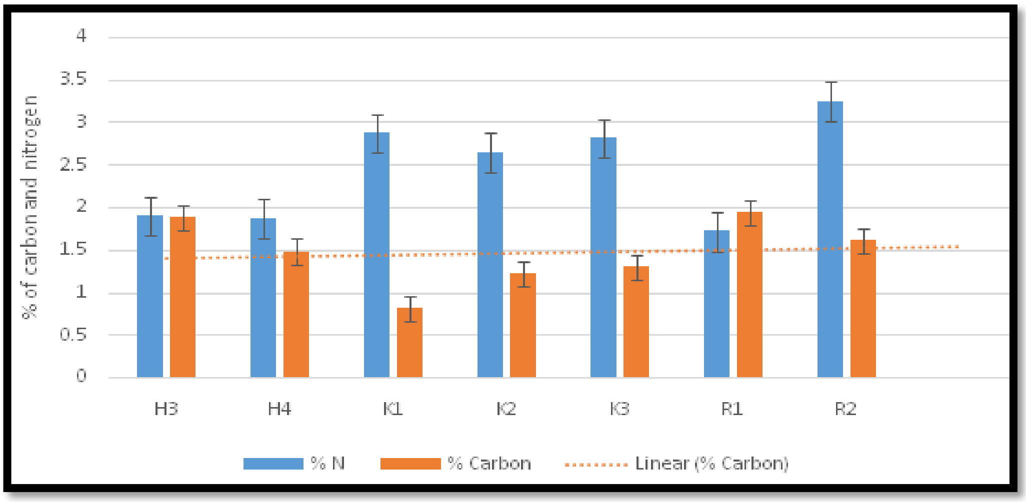


Fig.3. Ratio of carbon and nitrogen in the soil samples

Figure3 indicates that the soil samples K_2, K_3, R_2 shows 1:2 ratios of C:N whereas H_3 and H_4 has 1:1 and 1:1.2 ratios respectively. Soil sample K_1 shown maximum C: N ratio of 1:3.6. The carbon and nitrogen ratio is crucial for maintaining soil quality functions like filtering and buffering[15, 16, 17]. The K_1 sample shows lesser carbon compare to nitrogen in the ratio indicating that there is a decline in the plant vegetation and rate of sprouting.

Percentage of Sodium and Potassium in soil samples

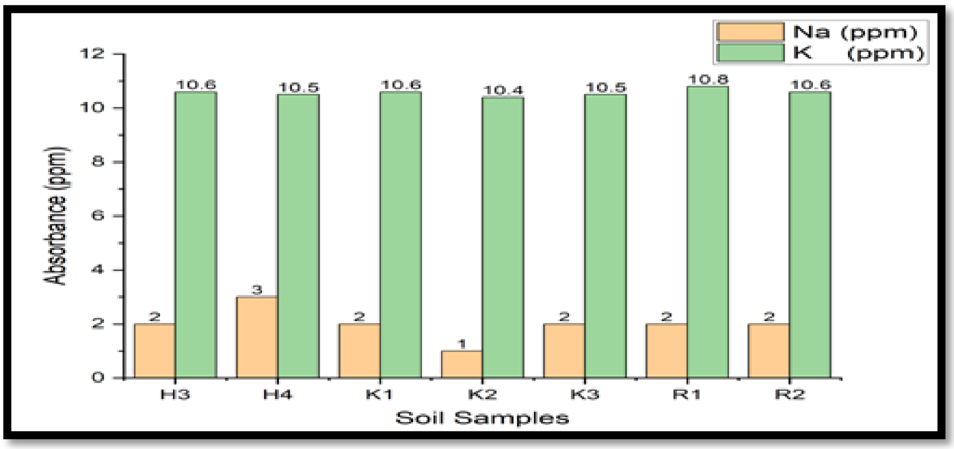


Fig.4. Relative % of Sodium and Potassium

It is well known that Na can harm soil structure and reduce water infiltration rates. Increased concentration of NaCl enhances total dissolved solids (TDS), soil alkalinity (pH), electrical conductivity (EC), and sodium adsorption ratio (SAR). This spoils soil ecosystem by affecting textures like Vertisols and Mollisols from arid and semi-arid regions with shallow groundwater. In those areas, the salts absorbed through root zone with the help of capillary action with increased evapo-transpiration which rise

soil salinity and crop water use[18, 19]. The solubilised sodium ions pierce into the clay layers, impating expansion and dispersion of soil thereby retarding soil infiltration and overall structure [20].
Higher the concentration of potassium in the soil sample, enhance the overall level of soil fertility, whereas alkalinity dissolves soil organic carbon. The processes that control the concentration of potassium in soils depend on the rate of potassium release, leaching and plant bioavailability[21].

Sprouting of green vegetables

Sprouting rate of Amaranths dubious, Amaranths spinosus and Fenugreek seeds were studied by germination. The seeds were germinated using soil samples at optimum wetness and temperature taken in plastic bowls with aerated pores.

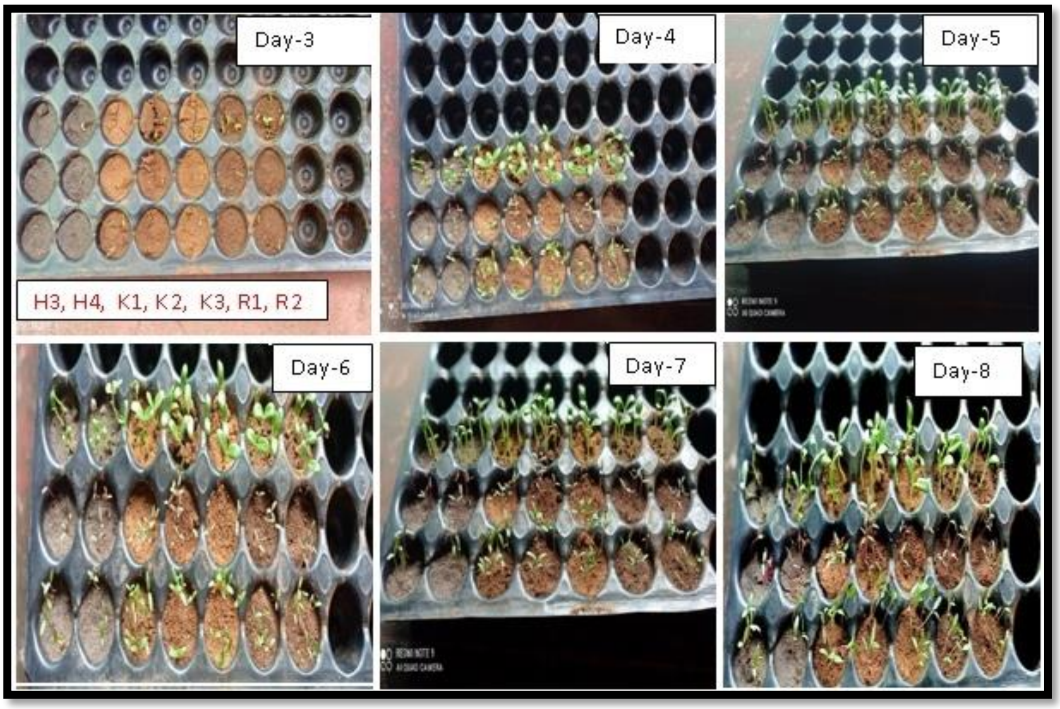


Fig.5. Sprouting and growth of green vegetables sprouting rate of green vegetables

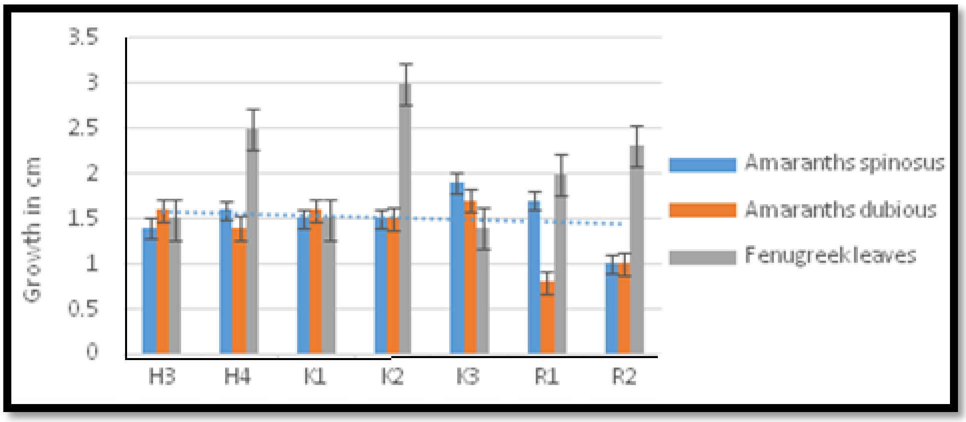


Fig.6.Comparative rate sprouting and growth of Amaranths dubious, Amaranths spinosus and Fenugreek

Form the above graph we came to know that the growth of **Fenugreek** leaves are more in K_2, H_4, R_2 and R_1 soil samples, there will be more tendency to germinate of **Fenugreek** even though rich in potassium and sodium is much higher in K_2,H_4, compared remaining samples. Therefore it increasing the soil salinity reduces the capillary action, which it will need for the germination properties of the plant (height and diameter width of the plant and leaves). The results clearly indicate that fenugreek germinates in 3-10days the first trifoliate leaf is formed within 5 – 8 days [22] as in fig 5.

Percentage of zinc and carbon nitrogen ratio is more in K_2, H_4, R_2 and R_1 which plays vital role during photosynthesis and respiratory electron transport process.As fenugreek belongs to nitrogen fixing legume, seed must be properly inoculated with a suitable Rhizobium inoculum to increase growth rate. Researchers confirmed the common nodule- forming bacteria is Gramnegative, aerobic, non-sporulation, rod shaped bacterium, *Rhizobium meliloti* [23] to improve quality and amount of seed generated.

Conclusion

Selected green vegetables are made sprout and grow in the different soil samples in the expeperment. Zinc is an important element in the soil for vegetable growth and play role as a main constituent in riosomes. In experimental samples, phosphorous and carbon are abundant but Zinc and copper (Cu) vary with (H_3, H_4) Halepura Village, (K_3) Kuderu Village and (R_1, R_2) Ramapura Village samples. . K_3 and R_1 have more alkaline samples and are both rich in % of copper and zinc compared to K_1, and K_2. Percentage of zinc and carbon nitrogen ratio is more in K_2, H_4, R_2 and also high in $R_{1.}$

Phosphorus (P) is a vital element for plant growth but excess phosphorus interferes with absorption of zinc and reduces its concentration. Increased concentration of NaCl maximizes the total dissolved solids and pH value. The high potassium K levels have been found to increase the overall level of soil fertility. It was observed that plant growth varies with different areas of soil samples which have different physical chemical properties, especially due to plant physiological factors of green vegetables that also influence the growth rate, which is different in these soil samples. On studying sprouting rate for different soil samples, it takes importance for monitoring the periodical farming with proper supplementation of specific fertilizer. Thus this research study imparts light the management of soil for high yield by supplementing organic matter, liming materials and inorganic fertilizers. **Acknowledgement**

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Conflict interest

The authors do not have any conflict of interest

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