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# Evaluation of soil fertility using soil nutrients and chemical properties as parameters in fields of Honnalitaluk of Davanagere District, Karnataka

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**Key words:** Soil nutrients, Soil fertility, Chemical properties, Soil analysis

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**Abstract**

A study was conducted to analyse the nutrient status and chemical properties of soils of Honnali Taluk of Davanagere District, Karnataka state. Eight villages were included in the study. Soil samples were collected and analyzed as per the standard protocols. Chemical properties *viz* pH, electrical conductivity and organic carbon content were found to be good for crop growth. Amount of primary nutrients was high except for nitrogen. Other nutrients *viz* sulphur, zinc, iron, manganese and copper were also high in the soil except for boron. Supplementation need to be given for nitrogen and boron. Crops like cereals, pulses, vegetables, flowers and plantation crops can be successfully grown in these soils with proper management practices.

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## Introduction

A fertile soil has the inherent capacity to supply plant nutrients in sufficient amount, appropriate proportion and free from toxic substances (Agegnehu, G 2012; Carter M.R *et al.,* 2007). Effective management of nutrients in soils is needed enhance the crop productivity to feed the growing population of the world. Soil sampling and the use of nutrient application rates based on scientific principles and research are critical components of nutrient management (Chatterjee, 2009; Du, 2009; Ebinger, 2009; Hag Husein *et al.,* 2021). Most of the times, the average person treats the soil like dirt. A wise farmer will care for the soil because he knows that man is dependent on the top 6 inches (15.2cm) of soil. In the plant-animal-soil continuum, soil is often neglected because it does not indicate stress in an obvious way. Animals and plants show physical symptoms but the soil must be looked at more carefully to monitor good health (Hartemink, 2006; Houba *et al.*, 1996).

Soil is a major source of nutrients needed by plants for growth. The three main nutrients are nitrogen (N), phosphorus (P) and potassium (K). Other important nutrients are calcium, magnesium and sulphur. Plants also need small quantities of iron, manganese, zinc, copper, boron (micro nutrients), molybdenum, nickel and aluminium, known as trace elements because only traces are needed by the plant. The role these nutrients play in plant growth is complex. The availability of plant nutrients also depends on chemical properties of soil (Kekane, 2015; Khadka *et al.,* 2017). Soil pH, electrical conductivity and organic carbon are three major chemical properties of soil that decide the success of crop production.

Study on soil nutrients and chemical properties in fields are necessary to understand the soil quality. Soil nutrients and chemical properties play a major role in success of agriculture. Soil reclamation practices, soil health management, soil flora and fauna all depend on these two characters (Komatsuzaki, 2008; Li, 2014; Metson, 1957; Mewally, 2019; Mo Mtsara *et al.,* 2015).

The present study was conducted to analyse the soils of fields in Honnali Taluk of Davanagere District, Karnataka state. Honnali is a major area of both horticulture and agriculture crops in Karnataka. Arecanut, sugarcane, rice and maize are the major crops along with fruits, vegetables and flowers seasonally (Peech *et al.*, 1997). This study will help to understand the soil status with respect to nutrients and chemical properties in Honnali taluk and the data furnished can be used by the farmers to choose the crops, to choose nutrients sources and to take up soil management practices accordingly (Powlson *et al.,* 2011).

## Materials and methods

*Ideal time for soil sampling*

Generally the soil samples was taken one time in a year, after harvesting of paddy crop, when there is no standing paddy crop in the field.

*Collection of soil samples from farmers' paddy field and Processing of soil samples:*

For the evaluation of variation in soil nutrients and chemical properties of soil in Honnali Taluk, soil samples were collected across 8 different villages. Soil sampling for all sites was carried out according to a standard protocol by Carter and Gregorich (2007).

Subsampling was done in a zig zag manner and pooled together to make a composite sample. The sample was reduced to 1kg to 500gm by quartering technique. Each soil sample was assigned a sample number and entered in the sample register of a soil testing laboratory. Care was taken to avoid admixture and entry of foreign materials. Before analysis the soil sample was subjected to dry under a shade by spreading on a clean sheet of paper after breaking the large lumps if present. Each soil sample was spread on a separate paper or a clean polythene sheet and it was powdered using wooden mallet and sieved to obtain soil particles of 2-mm size. (Ravikumar, 2013; Sarwar *et al.,* 2008). Before analysis the soil sample was subjected to shade drying. This ultimate soil sample which was taken in new polythene bag with proper labelling for laboratory analysis. Onekg of the sample in each type was collected and quality was assessed according to HSQI table consisting of the eight

important parameters namely available N (kg/ha), pH, water holding capacity (%), available P (kg/ha), texture, available K (kg/ha), OC (%), micro and macro nutrients, electrical conductance (mmho/cm). The values of each test were determined using the methods given in (Table 1).

*Study Area*

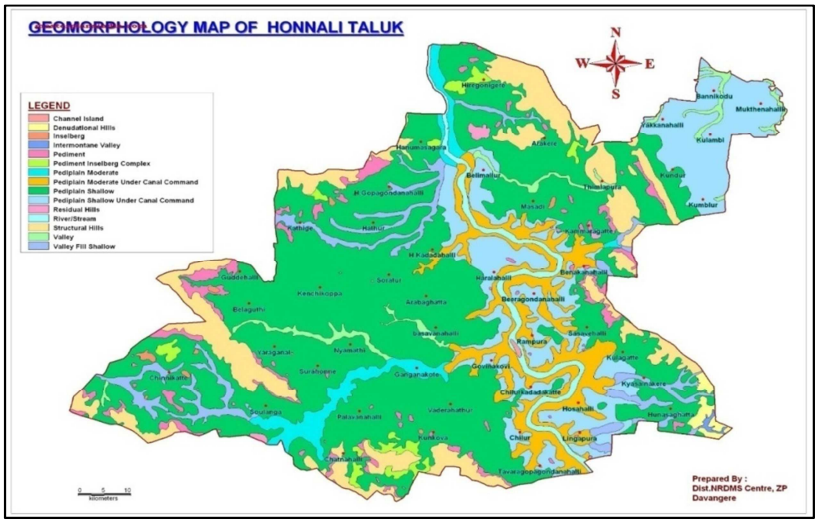


**Fig. 1.** Geographical Location of study Area in Honnalli Taluk Davanagere District

Source: https://download.masterplansindia.com/maps/karnataka/davanagere/geomorphology-honnali-taluk-map.jpg. Honnali is situated in davanagere district Karnataka and Postal code is 577224 with latitude 14.2625177 and longituted 75.3598953. From this the Tungabhadra famous river moves across the honnalithaluku at nearly 30Km, and the study area is which is located honnalithaluk and it is 50 Km from shivamogga city in India as shown in Fig. 1.

**Table 1.** Methods used in soil analysis

| Particulars | Methods | Reference |
|---|---|---|
| pH | Potentiometric method | Metson, 1957 |
| EC | Immersion type conductivity meter | Metson, 1957 |
| OC | Walkley-black method | Metson, 1957 |
| Nitrogen | Micro-kjeldahl distillation and titration | Motsara and Roy, 2015 |
| Phosphorus | Spectrophotometermethod | Motsara and Roy, 2015 |
| Potassium | Flame photometer method | Motsara and Roy, 2015 |
| Sulphur | Turbidometry | Motsara and Roy, 2015 |
| Copper | DTPA/AAS | Motsara and Roy, 2015 |
| Zinc | DTPA/AAS | Motsara and Roy, 2015 |
| Boron | Hot water soluble Azomethane H method | Motsara and Roy, 2015 |
| Iron | DTPA/AAS | Motsara and Roy, 2015 |
| Manganese | DTPA/AAS | Motsara and Roy, 2015 |

*OC- Organic carbon, *EC- Electrical conductivity.


**Fig. 2.** Soil sample collection in paddy field at various spot.

*Creation of data base*

In the month April, May, 2021, 40 soil samples were collected from Ujjinipura, Hottepura, Sadashivapura, Beeragondanahalli, Kambargatte, Rampura, Chikkabasuru, in Honnalitaluk. In each site 08 samples were taken of 1-3 km distance, approximately 2kg of in depth soils was obtained from (0-30cm land surface) and it kept in air tight plastic ziplock bags as shown in Fig. 2. Little bits of some impure soil contaminated from the soil samples were removed by hand picking before analysis, and taken for examination to the laboratory.

We also used Global Position System to record the similar Geographical Coordinates. These soil samples divided into two portions one for spectral measurement & other for laboratory chemical analysis (Ravikumar *et al.,* 2013).

**Results and discussion**

The collected soil samples were analysed for pH, electrical conductivity, organic carbon (OC), nitrogen (N), phosphorus (P), sulphur (S), copper (Cu), zinc (Zn), boron (B), iron (Fe), manganese (Mn) and physico-chemical analysis. The results are presented in following Tables. The data shows variation in chemical properties and nutrient levels among selected different villages and the name of villages are mentioned below (Sarwar *et al.,* 2008) Table 2.

**Table 2.** Soil chemical properties.

| Village | pH | EC (dS/m) | OC (%) |
|---|---|---|---|
| Sadashivapura | 7.1 | 00.10 | 0.62 |
| Hotyapura | 6.89 | 00.12 | 0.44 |
| Chikkabasuru | 6.78 | 00.13 | 0.52 |
| Ramapura | 7.12 | 00.13 | 0.85 |
| Kambarghatte | 7.79 | 00.08 | 0.76 |
| Bheeragondanahalli | 7.05 | 00.05 | 0.79 |
| Ujjanipura | 6.44 | 00.06 | 0.92 |
| Benakanahalli | 7.57 | 00.10 | 0.83 |

*Soil pH*

The Table 2 shows that, the pH measure the relative hydrogen ion concentration in the solution. The soil pH was determined by pH meter (potentiometric) using 1:2.5 soil water suspension ratio by Jackson. The data shows for soil chemical properties of different villages of Honnali Taluk. Soil pH values are varied with the different selected villages.

The Soil pH of the village Sadashivapura (7.1), Ramapura (7.12), and Bheeragondanahalli (7.05) recorded neutral pH. Alkaline pH was recorded in Benakanahalli (7.57) and Kambarghatte(7.79). Slightly acidic pH was recorded in soils of Hotyapura (6.89), Chikkabasuru (6.78) and Ujjanipura (6.44). Highest pH was recorded in Kambarghatte (7.79) whereas lowest pH was recorded in Ujjanipura (6.44). The value of pH showed lie in the alkaline side, pH of these soils is in between 7.57 to 7.79. Alkalinity is measure of saline or salt effected soil.

If pH in between 6.44 to 6.89 in this soil group is acidic, the soil pH range from 06 - 8.8 its type is normal soil and greater than 8.5 then it is said to be alkaline type soil as shown in Fig. 3.

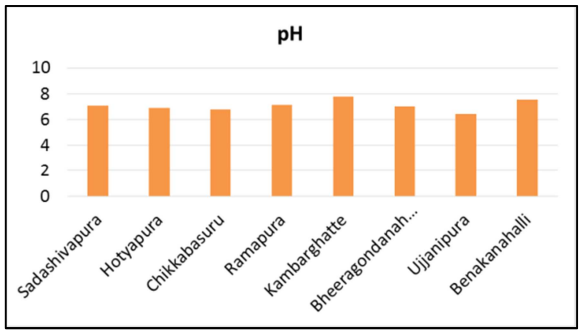


**Fig.s 3.** Examination of pH of soil samples in different villages at Honnalli Taluk.

*Electrical conductivity of soil sample (EC)*

EC is very important property of the Soil. It indicates total soluble salts content of the soils. The electrical conductivity is the measure of ions present in the soil sample. During this process the cations of the colloidal partials are transferred in equivalent quantities with the ions of soil and alkali solutions. This process of exchanges of cation of soil and salt solution is known as cation exchange. Cations like calcium, magnesium, sodium, potassium and anions such as $CO_3$, $HCO_3$, $PO_4$.The conductivity values can be vary with physico-chemical properties of soil. EC was recorded in the range from 0.13 to 0.05 $dSm^{-1}$ soils of Chikkabasuru and Ramapura showed highest electrical conductivity while Bheeragondanahalli soil recorded lowest as shown in Fig. 4.

*Organic carbon (OC)*

The soil OC is an important of the soil that contributes to soil fertility and it releases the nutrient for plant growth and promotes the structure, biological and physical health of the soil (Peech *et al.*, 1947). The data given in Table 2. OC ranges from shows 0.44 to 0.92%. Medium proportion of OC. Organic carbon content was highest in soils of Ujjanipura with 0.92%. Hotyapura soil showed the less organic carbon content (0.44%). The excess of $K_2Cr_2O_7$ unused is titrated against standard FAS in presence of NsF or $H_3PO_4$.

*Principle Reaction Mechanism*

The excess of $K_2Cr_2O_7$ unused is titrated against standard FAS in the presence of sodium fluoride (NsF) or Orthophospuric acid ($H_3PO_4$)

$$2K_2Cr2O_7 + 8H_2SO_4 + 3C + 6(O) \longrightarrow 2K_2SO_4 + 2Cr_2(SO_4)_3 + 3CO_2 + 2H_2O$$

**Table 3.** Amount of primary nutrients in soil.

| Village | Nitrogen (kg/ha) | Phosphorus (kg/ha) | Potassium (kg/ha) |
|---|---|---|---|
| Sadashivapura | 254.62 | 132.89 | 121.29 |
| Hotyapura | 263.14 | 134.69 | 156.32 |
| Chikkabasuru | 248.65 | 164.32 | 144.20 |
| Ramapura | 263.41 | 191.65 | 165.32 |
| Kambarghatte | 131.71 | 63.48 | 235.78 |
| Bheeragondanahalli | 241.47 | 141.77 | 185.33 |
| Ujjanipura | 304.19 | 68.77 | 283.18 |
| Benakanahalli | 265.42 | 42.84 | 365.16 |

*Chemical analysis of Macronutrients (N, P and K)*

*Nitrogen (N)*

Plant require more percent of nitrogen than any other types of macro and micro nutrients but only small amount of soil is available for plants; 98% of 'N' in soil as organic form. Most of time the organic form of 'N' cannot take by plant directly.

In contrast a plant absorbs N from soil in the form of nitrate ($NO_3^-$) and ammonia ($NH_4$). The amount of mineral 'N' in soil amount for only 3% of the $N_2$ present in soil. Soil Iron, Zn, Cu, Pd, Al convert form of the 'N' to minerals form of nitrogen when they decompose OC and fresh plant residues. This process is known as "mineralization". Soils of villages under study showed varying levels for amount of primary nutrients in soil (Table 3). Soil of Ujjanipura had the highest nitrogen with 304.19kg/ha while Kambarghatte soil had the lowest nitrogen with 131.71kg/ha. Except for Ujjanipura all other villages were deficient in nitrogen (≤ 280kg/ha).

*Phosphors (P)*

Phosphorous is a very essential elements classified as a micro-nutrients because of the relatively large amount of 'P' required by plants. In soil phosphorous exists in many different forms and the solubility of 'P' is very low. The phosphate used in fertilizers and manure is little bit soluble and available in nature. The 'P' fertilizers and manure of phosphate come contacts with soil, various reaction starts occurring that result in less soluble and less available of phosphate. Plants can take up only soluble inorganic minerals and simple form of phosphate from soil and since most phosphorous in organic form, only a small fraction of inorganic 'P' is present in plant. Phosphorous is most frequently determined by the Olsen method. Phosphorus content varied from 191.65kg/ha in Ramapura to 42.84kg/ha in Benakanahalli. 'P' content of villages were good and high (≥12.5kg/ha).

*Potassium (K)*

Potassium (K) plays an important role in different physiological processes of plants. 'K' is major micronutrients for the production of superior quality crop. In potassium (K) deficient soil, plant growth gets altered, and the productivity of yield is decreases. As the content of potassium (K) increases moments get increase in the most of the soil. 'K' contest was highest in soils of Benakanahalli with 365.16kg/ha. Sadashivapura (121.29kg/ha) soil had least 'K' content and was said to be deficient (≤141kg/ha). Normally 'K' content majored by the using photometer.

**Table 4.** Amount of other nutrients in soil.

| Village | Sulphur (ppm) | Zinc (ppm) | Boron (ppm) | Iron (ppm) | Manganese (ppm) | Copper (ppm) |
|---|---|---|---|---|---|---|
| Sadashivapura | 16.32 | 00.40 | 0.42 | 18.63 | 04.69 | 01.46 |
| Hotyapura | 21.65 | 02.10 | 0.46 | 13.94 | 03.41 | 02.36 |
| Chikkabasuru | 20.89 | 01.36 | 0.40 | 12.54 | 05.63 | 03.10 |
| Ramapura | 23.14 | 00.95 | 0.37 | 14.06 | 04.86 | 00.97 |
| Kambarghatte | 23.14 | 00.98 | 0.28 | 14.31 | 04.51 | 02.21 |
| Bheeragondanahalli | 20.86 | 00.85 | 0.18 | 32.85 | 12.37 | 03.86 |
| Ujjanipura | 21.04 | 01.83 | 0.30 | 31.15 | 11.99 | 02.43 |
| Benakanahalli | 22.31 | 01.11 | 0.12 | 31.42 | 11.34 | 03.84 |

*Chemical analysis of Micronutrient (S, Zn, B, Fe and Mn)*

*Soil Sulphur*

Soil sulphur (S) fertilizer applications have worldwide shown little historic growth, because the value of S as a component of multi-nutrient fertilizers was not recognized (Ceccotti, 1994). The amount of S consumed in all S containing fertilizers fluctuated worldwide around 10 millionmg per year during the

last 20 years, while the consumption of nitrogen almost doubled during this period of time from about 39 millionmg in 1973 to almost 75 millionmg in 1991. Already in 1991 the Sulphur Institute in Washington (TSI) estimated a total unrealized world market potential for S as a plant nutrient of 6.4mg. The world deficit for S as a plant nutrient is projected to reach 7.5 millionmg annually in the year 2000 and will increase to 10.4 millionmg in the year 2010. An intensive agriculture with use of improved cultivars and high analysis fertilization offers conditions of nutrients exhaustion resulting in nutrient imbalance in soils. Fazili *et al.* (2008) reported that lack of S limits the efficiency of added nitrogen; therefore, sulphur addition becomes necessary to achieve more efficiency of applied nitrogenous fertilizer. Soils were also analysed for other nutrients and results are presented in table 4. Sulphur content was highest in Ramapuraand Kambarghatte with 23.14 ppm. It was lowest in Sadashivapura (16.32 ppm). All villages had optimum amount of sulphur in soil (≥ 10 ppm).

*Zinc (Zn)*

Soil Zinc helps in the synthesis of plant growth hormone and some enzyme and also it helps in the seed germination time and it has maximum in Hotyapura soil with 2.1 ppm and minimum in Sadashivapura (0.4 ppm). All villages had high Zn content except for Sadashivapura which was deficient (≤0.6 ppm).

*Boron (B)*

Boran is a very essential micro-nutrient for the germination of pollen grains and growth of pollen tube and also required for seed and cell wall formation and also it is very necessary for sugar translocation. In soil phosphorous exists in many different forms and the solubility of phosphorous is very low. The soil sample of Hotyapura had highest Boron (0.46 ppm) and Benakanahalli had lowest (0.12 ppm). Soils under study were deficient for boron (≤0.5ppm).

*Iron (Fe)*

Iron acquisition by paddy, which results in the removal of soluble iron from the rhizosphere solution, is able to affect the chemical equilibrium between the different iron forms and therefore the extent of the weathering of Fe-bearing minerals in this specific volume of soil. Where the Fe uptake mechanism is based on the acquisition of iron(III) in a complex form with PSs (monocots, strategy II) or MSs (microbes), the depletion of iron in the paddy soil solution occurs simultaneously with that of the ligands (PSs and/or MSs). However, in strategy I paddy, because the intake in root cell of iron(II) is in its ionic form, the Fe acquisition process has an impact on the Fe concentration in the paddy soil field but not on the availability of ligands that could, theoretically, mediate the Fe-mobilization process after their release. As a consequence, the weathering of Fe-bearing soil components could be even more accelerated. Iron plays an important role in different physiological processes of plants and it involved in the cell division and growth and it also act as a oxygen carrier. And further iron content in soil was highest in Bheeragondanahalli with 32.85 ppm and lowest in Chikkabasuru with 12.54 ppm. 'Fe' content of soils under study was high for all the villages (≥6.5 ppm).

*Manganese (Mn)*

It increases the availability of 'P' and 'Ca' and also involve in activation of some enzymes. Mn content in soil was also high for all the villages (≥ 2 ppm) and it varied from 12.37 ppm (Bheeragondanahalli) to 3.41 ppm (Hotyapura).

*Copper (Cu)*

It involves in photosynthesis and gives a proper colour to the plant and improves the quality of flowers, fruits and vegetables. Amount of copper was highest in Bheeragondanahalli with 3.86 ppm and lowest in Ramapura with 0.97 ppm. 'Cu' content was high in all the villages (≥0.2 ppm). Soils of villages under study were fairly fertile. Among the nutrients, nitrogen and boron are found to be deficient. Remaining nutrients are high in soil. Chemical properties like pH, EC and OC are suitable for agriculture. Management practices need to take to increase the level of nitrogen and boron (Komatsuzaki and Ohta, 2007) (Selim *et al.*, 2009). Crops like cereals, pulses, vegetables, flowers and plantation crops can be successfully grown in these soils with proper management practices. Integrated nutrient management, use of biofertilizers, green manuring and reclamation practices can be applied to keep the soil in healthy condition (Smith and Powlson *et al.*, 2007).

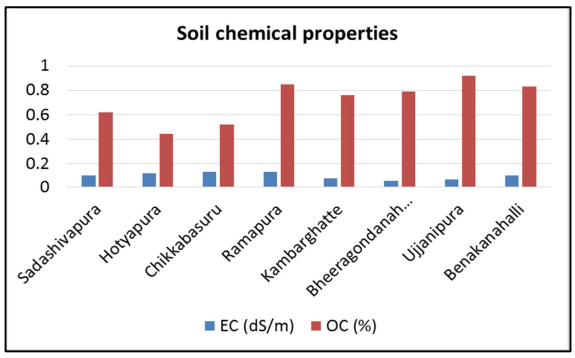


**Fig. 4.** Evaluation of soil chemical properties of different area using physic-chemical techniques.

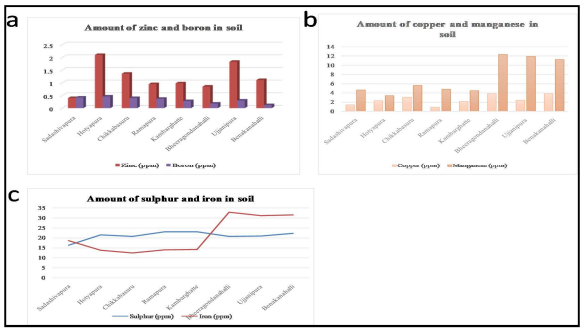


**Fig. 5.** Examine the amount of primary nutrients in soil.

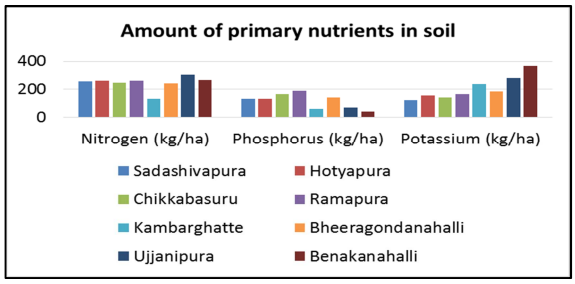


**Fig. 6.** Examine the amount of micro and macro nutrients in soil (a) Zn and B, (b) Cu and Mn and (c) Sulphur and Iron (S, and Fe).

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**Declaration of interests**

Authors have no conflict of interests.

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