# Assessment of Soil Fertility Status of Rayal Cheruvu Village in Ramachandrapuram Mandal of Tirupati District, Andhra Pradesh, India

## B. Sai Meghana [a*], G. P. Leelavathy [a++], B. Vajantha [b#], G. Prasad Rao [c†] and M. V. S. Naidu [a‡]

[a] *Department of Soil Science, S.V. Agricultural College, ANGRAU, Tirupati-517502, Andhra Pradesh, India.*
[b] *Department of Soil Science, Agricultural Research Station, Perumallapalle, Tirupati-517502, A.P, India.*
[c] *Andhra Pradesh Space Application Centre, Vijayawada-520010, India.*

*Authors' contributions*

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

One hundred soil samples from Rayal Cheruvu village in Ramachandrapuram mandal of Tirupati district, Andhra Pradesh were collected by using GPS to study soil fertility status. These samples were analysed for physico-chemical and chemical parameters. The results revealed that soils were slightly acidic to strongly alkaline in reaction and non-saline. Soil organic carbon was low to

[++] *Assistant Professor;*
[#] *Senior Scientist;*
[†] *Scientist F;*
[‡] *Professor and Head;*
*Corresponding author: E-mail: saimeghana112@gmail.com;*

medium. The available nitrogen was low, the available phosphorus ranged from low to high and the available potassium ranged from medium to high. The fertility status was used to assess soil fertility constraints in the study area.

## 1. INTRODUCTION

Soil is a crucial natural resource that sustains life on earth and evaluating its condition is essential to understand its productivity and the overall sustainability of the ecosystem. For the soil to maintain sustainable health, it is crucial that it aligns harmoniously with its inherent properties and productivity. In India, the enhancement of crop productivity over the past few decades can be attributed to the increased utilization of fertilizers driven by the rising demand for food. Various factors contribute to the nutrient imbalance in these soils, such as increased demand from high yielding crops, intensive cropping, continued expansion of cropping onto marginal land with low levels of micronutrients, increased use of chemically pure micronutrient free fertilizers, decreased recycling of crop residues and limited use of animal wastes [1]. Consequently, it becomes necessary to assess nutrient limitations in soils that undergo intensive cultivation with high-yielding crops. Though the data obtained through traditional soil survey methods were dependable and accurate, they lacked the ability to establish spatial variability layers of soil properties. Hence the present investigation was executed with the objective to assess the soil fertility status of the area and to link the status of fertility with agricultural practices for identifying the important nutrient constraints for sustainable production of crops in Rayal Cheruvu village in Ramachandrapuram mandal of Tirupati district, Andhra Pradesh.

## 2. MATERIALS AND METHODS

The study area lies in between 13° 29' 8.1708" to 13° 31' 19.938" North Latitudes and 79° 22' 32.7" to 79° 26' 37.3704" East Longitudes. It has a total geographical area of 819.08 ha. The study area experiences tropical climatic conditions with extremely high humidity. The mean annual rainfall recorded was 788.67 mm and the majority was received from July to November. The mean annual temperature was 27.65°C with a mean summer temperature of 32.79°C and a mean winter temperature of 22.51°C. The maximum temperature recorded was 43.7°C and the minimum temperature was 18.2°C in the

month of May and December, respectively. The natural vegetation of the study area comprises of *Argemone maxicana, Acacia nilotica, Azadirachta indica, Abutilon indica, Borassus flabellifer, Blumea lacera, Cynodon dactylon, Cyperus rotundus, Chenopodium alba, Cassia auriculata, Calotropis gigantea, Lamea pinnatifiea, Parthenium hysterophorus, Sygium cumini, Tamarindus indica* and *Tephrosia purpurea* etc.

**Table 1. Ratings for pH, EC, available N, $P_2O_5$ and $K_2O$**

| pH | Ratings |
|---|---|
| Slightly acidic | 6.1 – 6.5 |
| Neutral | 6.6 – 7.3 |
| Slightly alkaline | 7.4 – 7.8 |
| Moderately alkaline | 7.9 – 8.4 |
| Strongly alkaline | >8.4 |
| **EC(dS m$^{-1}$)** | |
| Non saline | <4 |
| Saline | >4 |
| **OC (%)** | |
| Low | < 0.5 |
| Medium | 0.5-0.75 |
| High | > 0.75 |
| **Nitrogen (kg ha$^{-1}$)** | |
| Low | < 280 |
| Medium | 280-560 |
| High | >560 |
| **Phosphorus ($P_2O_5$) (kg ha$^{-1}$)** | |
| Low | <25 |
| Medium | 25-59 |
| High | >59 |
| **Potassium ($K_2O$) (kg ha$^{-1}$)** | |
| Low | <145 |
| Medium | 145-340 |
| High | >340 |
| **Critical limits for DTPA extractable micronutrients (mg kg$^{-1}$)** | |
| Iron | 4.0 |
| Copper | 0.2 |
| Zinc | 0.6 |
| Manganese | 2.0 |

A total of 100 surface samples were collected and georeferenced coordinates were noted using a handheld GPS in each sampling site. The soil samples were air dried, ground, sieved (<2 mm)

and analysed for physico-chemical and chemical properties. The soil reaction (pH) and electrical conductivity (EC) of soils were measured using standard procedures as described by Jackson [2]. Organic carbon (OC) was determined using the Walkley-Black method [2]. Available nitrogen was estimated by the alkaline permanganate method [3]. Available phosphorus was measured using 0.5 *M* sodium bicarbonate ($NaHCO_3$) pH 8.5 as an extractant [4]. Available potassium was determined using the neutral normal ammonium acetate method [2]. The variability of data was assessed using mean, standard deviation and coefficient of variation for each set of data. Availability of N, $P_2O_5$ and $K_2O$ in soils were interpreted as low, medium and high and availability of micronutrients (Cu, Mn, Fe and Zn) were interpreted as deficient to sufficient by following the criteria given in Table 1 [5].

# 3. RESULTS AND DISCUSSION

## 3.1 Soil Reaction

Soils of the Rayal Cheruvu village were neutral to strongly alkaline (6.7 to 8.5) in reaction with a mean pH of 7.50, standard deviation of 0.38 and CV of 5.11 per cent. The major proportion of the village was neutral (52%) followed by slightly alkaline (25%), moderately alkaline (22%) and strongly alkaline (1%). The majority of soils exhibited neutral to slightly alkaline reaction (6.6-7.8) (Table 2). This wide variation in pH (6.7 to 8.5) might be attributed to the nature of the parent material, climate of the region, organic matter and topographic situation [6,7].

## 3.2 Electrical Conductivity

The electrical conductivity of soils in Rayal Cheruvu village was in the range of 0.09 to 0.98 dS m$^{-1}$ with mean of 0.60 dS m$^{-1}$ and standard deviation of 0.22 with CV of 34.36 per cent (Table 2). The soluble salt content in the soils of the study area revealed that, the area was non-saline. The normal EC may be ascribed to the removal of bases by percolating and drainage water and excess leaching of salts to lower horizons [8] (Satish et al., 2018).

## 3.3 Organic Carbon

Soil organic carbon content (OC) of Rayal Cheruvu village in Tirupati district varied from 0.03 to 0.54 per cent with mean OC of 0.40 per cent. The standard deviation was 0.11 per cent with CV of 29.98 per cent (Table 2). About 95% of the study area was low in organic carbon and 5% of the study area was medium in soil organic carbon. Low organic carbon content in these soils might be attributed to the prevalence of tropical conditions, degradation of organic matter at a faster rate coupled with low vegetation cover on the fields leaving less chances of accumulation of organic carbon in the soils [8,9].

## 3.4 Available Macronutrients

The available nitrogen in surface soils of the Rayal Cheruvu village varied from 63 to 202 kg ha$^{-1}$ with a mean of 98.10 kg ha$^{-1}$ and standard deviation of 27.95 with CV value of 28.49 per cent (Table 2). The study revealed that the total area of Rayal Cheruvu village was low in available N. This may be due to most of the farmers could not apply the required quantity of nitrogen to crops and also they applied more complex fertilizers than straight fertilizers which led to an imbalanced/ inadequate quantity of nitrogen supplied and also it is quite obvious that the efficiency of applied nitrogen is very low due to the fact that N is lost through various mechanisms like volatilization, nitrification, denitrification, chemical and microbial fixation, leaching and runoff [10].

The available phosphorus content in soils of Rayal Cheruvu village ranged from 11 to 72 kg $P_2O_5$ kg ha$^{-1}$ with mean and standard deviation value of 36.30 kg ha$^{-1}$ and 14.46, respectively with CV of 39.88 per cent (Table 2). The study area was low to high in available phosphorus. About 69% of the study area has medium available phosphorus content, 23% of the study area was in the low range and 8% of the area was under high availability of phosphorus. The low available phosphorus content could be attributed to the fixation of releasing phosphorus by clay minerals. Presence of a considerable amount of phosphorus may be attributed to the continuous application of phosphatic fertilizers to crops and adopting good management practices [11].

The available potassium content in soils of Rayal Cheruvu village ranged from 181 to 350 kg ha$^{-1}$ with a mean value of 234.2 kg ha$^{-1}$ and standard deviation of 58.22 with CV of 24.86 per cent (Table 2). The soils were medium to high in available potassium content. About 92% of the study area was medium in available potassium and 8% of the study area has high available potassium. Adequate available potassium in these soils may be attributed to the prevalence of potassium rich minerals like illite and feldspars [8,12].

**Table 2. Summary of ground truth analysis data of physico chemical properties and macronutrients of Rayal Cheruvu village**

| | pH | EC (dS m$^{-1}$) | OC (%) | Available N | Available P$_2$O$_5$ | Available K$_2$O |
|---|---|---|---|---|---|---|
| | | | | | (kg ha$^{-1}$) | |
| **Range** | 6.7-8.5 | 0.09-0.98 | 0.03-0.54 | 63-202 | 11-72 | 181-350 |
| **Mean** | 7.50 | 0.60 | 0.40 | 98.10 | 36.30 | 234.2 |
| **SD** | 0.38 | 0.22 | 0.11 | 27.95 | 14.46 | 58.22 |
| **CV** | 5.11 | 34.36 | 29.98 | 28.49 | 39.88 | 24.86 |

**Table 3. Summary of ground truth analysis data of soil DTPA extractable micro nutrients of Rayal Cheruvu village**

| | DTPA extractable Cu | DTPA extractable Mn | DTPA extractable Fe | DTPA extractable Zn |
|---|---|---|---|---|
| | (mg kg$^{-1}$) | | | |
| **Range** | 0.06-3.68 | 0.09-10.60 | 0.30-36 | 0.17-2.53 |
| **Mean** | 0.38 | 1.95 | 9.37 | 0.64 |
| **SD** | 0.49 | 1.37 | 6.56 | 0.44 |
| **CV** | 130.14 | 70.28 | 69.99 | 69.11 |

## 3.5 DTPA Extractable Micronutrients

### 3.5.1 Copper

The DTPA extractable copper in surface soils of the Rayal Cheruvu village varied from 0.06 to 3.68 mg kg$^{-1}$ with a mean of 0.38 mg kg$^{-1}$ and standard deviation of 0.49 with CV value of 130.14 per cent (Table 3). The study revealed that, 51% of the area was deficient and 49% of the area was sufficient in available copper content.

The higher concentration of copper in the surface soils might be due to higher biological activity and the chelating of organic compounds, released during the decomposition of organic matter left after harvesting of crop [13].

### 3.5.2 Manganese

The DTPA extractable manganese in surface soils of the Rayal Cheruvu village varied from 0.09 to 10.60 mg kg$^{-1}$ with a mean of 1.95 mg kg$^{-1}$ and standard deviation of 1.37 with CV value of 70.28 per cent (Table 3). The study revealed that, 74% of the area was deficient and 26% of the area was sufficient in available manganese content.

The significant differences in the availability of manganese observed in the soils of study area can be attributed to variations in the presence of minerals containing manganese, clay content, organic carbon levels, cation exchange capacity and other associated elements [14].

### 3.5.3 Iron

The DTPA extractable iron in surface soils of the Rayal Cheruvu village varied from 0.30 to 36.00 mg kg$^{-1}$ with a mean of 9.37 mg kg$^{-1}$ and standard deviation of 6.56 with CV value of 69.99 per cent (Table.3). The study revealed that, 92% of the area was sufficient and 8% of the area was deficient in available iron content.

The presence of organic carbon, which has a strong ability to affect the solubility and availability of iron through the chelation effect could potentially have protected iron from oxidation and precipitation. As a result, this could have led to enhanced availability of iron [15].

### 3.5.4 Zinc

The DTPA extractable zinc in surface soils of the Rayal Cheruvu village varied from 0.17 to 2.53 mg kg$^{-1}$ with a mean of 0.64 mg kg$^{-1}$ and standard deviation of 0.44 with CV value of 69.11 per cent (Table.3). The study revealed that, 59% of the area was deficient and 41% of the area was sufficient in available zinc content.

The higher levels of available zinc might be due to the varying intensity of soil pedogenic processes and the formation of complexes with organic matter, which led to the chelation of zinc. The occurrence of zinc deficiency in the study area was due to the non-application of zinc fertilizers by farmers. [16,17].

## 4. CONCLUSIONS AND RECOMMENDA-TIONS

From the study, it can be concluded that, the soils of Rayal Cheruvu village of Ramachandrapuram mandal in Tirupati district of Andhra Pradesh, India were neutral to strongly alkaline in reaction and non-saline. Soil organic carbon content was low to medium. Available N was low, $P_2O_5$ was low to high and $K_2O$ was medium to high. Available micronutrients (Cu, Mn, Fe and Zn) were deficient to sufficient in the study area.

The fertility status of nutrients in the study area revealed that, available nitrogen and zinc were important soil fertility constraints, indicating their immediate attention for sustained crop production. The deficient nutrients need to be replenished to avoid the crops suffering from their deficiency and for optimum utilization of other nutrients.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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