

**FERTILITY EVALUATION OF
UPLAND SOILS OF
KRISHNA DISTRICT,
ANDHRA PRADESH**

By
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B.Sc. (Ag.)

**THESIS SUBMITTED TO THE
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CHAIRPERSON: Dr. P. Ravindra Babu



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2018**

DECLARATION

I, Mounika.P hereby declare that the thesis entitled “**Fertility evaluation of upland soils of Krishna district, Andhra Pradesh** ” submitted to the **Acharya N. G. Ranga Agricultural University** for the degree of **Master of Science in Agriculture** in the major field of **Soil Science and Agricultural Chemistry** is the result of original research work done by me. I also declare that no material contained in the thesis has been published earlier in any manner.

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CERTIFICATE

Ms. P.Mounika has satisfactorily prosecuted the course of research and that thesis entitled “ **Fertility evaluation of upland soils of Krishna district, Andhra Pradesh** ” submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that neither the thesis nor its part has been previously submitted by her for a degree of any University.

Date :

(P. RAVINDRA BABU)
Chairperson

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This is to certify that the thesis entitled “**Fertility evaluation of upland soils of Krishna district, Andhra Pradesh**” submitted in partial fulfilment of the requirements for the degree of ‘**Master of Science in Agriculture**’ of the Acharya N. G. Ranga Agricultural University, Hyderabad is a record of the bonafide research work carried out by **Ms. P. Mounika** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

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Place:

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LIST OF SYMBOLS AND ABBREVIATIONS

AAS	=	Atomic absorption spectrophotometer
@	=	At the rate of
BD	=	Bulk density
BS	=	Base saturation
Ca	=	Calcium
CEC	=	Cation Exchange Capacity
cmol (p+) kg ⁻¹	=	Centimole of unit positive charge per kilogram
Cu	=	Copper
DTPA	=	Diethylene triamine penta acetic acid
dS m ⁻¹	=	Deci Siemen per meter
EC	=	Electrical conductivity
EDTA	=	Ethylene diamine tetra acetic acid
<i>et al.,</i>	=	And other co-workers
Fe	=	Iron
Fig	=	Figure
FS	=	Fertility status
GIS	=	Geo-graphic information system
GPS	=	Global positioning system
<i>i.e.,</i>	=	That is
K	=	Potassium
K ₂ O	=	Potassium oxide
kg ha ⁻¹	=	Kilogram per hectare
Mg	=	Magnesium

Min	=	Minute
Mg m ⁻³	=	Mega gram per cubic metre
Mn	=	Manganese
N	=	Nitrogen
NI	=	Nutrient index
OC	=	Organic carbon
P	=	Phosphorus
P ₂ O ₅	=	Phosphorus pentaoxide
PBS	=	Percent base saturation
pH	=	Negative logarithm of hydrogen ion Activity
ppm	=	Parts per million
%	=	Per cent
r	=	Correlation coefficient
S	=	Sulphur
Scl	=	Sandy clay loam
S.No	=	Serial number
SO ₄ -S	=	Sulphate sulphur
TEA	=	Tri ethanol amine
USDA	=	United States Department of Agriculture
viz.,	=	Namely
Zn	=	Zinc

ABSTRACT

Name of the Author : **P. MOUNIKA**

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An investigation was taken up to evaluate the fertility status of upland soils of Krishna district in Andhra Pradesh. Places were selected and soils were dug vertically down at two different depths (0-15 & 15-30 cm) and samples were collected for analysis from farmers fields in Vijayawada and Nuzivedu divisions of Krishna District. The coordinates at each location were recorded by using GPS equipment.

The study area falls in semi-arid climate which is located on the east coast of India between 15°43'N and 17°10'N latitude and between 80°00'E and 81°33'E longitude. The climatic conditions of the district consist of extremely hot summers and moderately cold winters and may be classified as tropical. The mean annual rainfall in the region is about 1028 mm and is contributed mostly by the Southwest monsoon.

The soils of study area comprised of two different textural classes, viz. sandy clay loam and clay for both surface and subsurface soil samples. Black soils are most dominant group in the study area and exhibited clayey in texture. The surface and subsurface soils were found to be neutral to highly alkaline in reaction. Electrical conductivity (EC) of the surface and subsurface samples varied from 0.12 to 0.72 dS m⁻¹ and from 0.11 to 0.83 dS m⁻¹ with mean values of 0.42 dS m⁻¹ and 0.47 dS m⁻¹, respectively.

Cation exchange capacity (CEC) of surface soils ranged from 13.0 to 60.9 cmol (p+) kg⁻¹ with a mean value of 36.95 cmol (p+) kg⁻¹ while it ranged from 15.2 to 64.8 cmol (p+) kg⁻¹ with a mean value of 40 cmol (p+) kg⁻¹ in subsurface soils. Percent Base Saturation of surface soils ranged from 51.2-99.4% with mean of 75.3% while in subsurface soils it ranged from 27.6-99.7% with mean of 63.65%. Among the exchangeable cations, Ca²⁺ was most dominant cation on the exchange complex followed by Mg²⁺, K⁺ and Na⁺ in surface and subsurface soils of Krishna district. The divalent cations, like Ca²⁺ and Mg²⁺ were relatively less mobile yet among the two, Mg²⁺ ions were more mobile than Ca²⁺ ions. Relatively lower PBS has been observed in subsurface soils which might be due to less clay content and enhanced leaching of basic cations besides surface soils. High base saturation might be due to moderately alkaline reaction and high CaCO₃ content, as the exchangeable complex of the soils were dominated by calcium and magnesium, which are main sources for base saturation.

The surface and subsurface soils of the present study area were found to be low to medium in organic carbon content. The soils were low in available nitrogen and high in potassium. The available phosphorus ranged from low to medium in different samples with high amounts at surface. In general they followed a decreasing trend with depth. The available sulphur was sufficient in major part of the study area.

Among micro nutrients copper and manganese were sufficient at both depths, while zinc was sufficient in 34 per cent and deficient in 66 per cent of surface soils where as in subsurface soils 73.6 percent are deficient. Iron was sufficient in 86 per cent and deficient in 14 per cent of surface soil and in subsurface soils, 85 percent are sufficient and 15 percent are found to be deficient.

Chapter – I

Introduction

Chapter – I

INTRODUCTION

Soil, being the natural medium for plant growth has a direct impact on yield and quality of crops growing on it. It is the most important resource for agriculture and needs to be utilized precisely for sustainable crop production.

Present day exploitive agriculture, which involved efforts to increase crop yield has not only depleted our soils of their nutrient reserve, but also resulted in the emergence of a number of new nutrient deficiencies. The indiscriminate use of fertilizers over a period of time has resulted in imbalance of nutrients and deficiency of nutrients like sulphur and zinc in many soils (Sharma, 2004).

The per capita availability of agricultural land has declined from 0.32 ha in 1950 to 0.14 ha in 2010 and will be further reduced to 0.10 ha by 2025 (Mahendra Singh, 2010) with subsequent decrease in the production of food grains. Thus there is need to increase productivity of the soils to meet the requirement of increasing population i.e., possible through measurement of fertility of an agricultural soil (soil fertility evaluation) or characterization of soils that tells much about the productive potential. It mainly involves the estimation of the nutrient supplying power of a soil, where proper evaluation of the fertility of a soil before planting a crop helps in adopting appropriate measures to make up for the shortcomings ensuring a good crop production.

Out of several diagnostic techniques of fertility evaluation, soil testing provides the most accurate information about the fertility and productivity of the soils (Dhanke and Olsen, 1990) and is beneficial to formulate specific fertilizer recommendations to various crops (Anil Sood *et al.*, 2003).

Therefore soil characterization in relation to evaluation of fertility status of the soils of an area or region is an important aspect in the context of sustainable production. Hence, for sustainability of the present agricultural system and for

management of our soil resources, a spatial data base regarding the fertility status of soils is required. Hence present study is proposed to be taken up with the following objectives

1. To evaluate the nutrient status of upland soils of Krishna district.
2. To prepare soil fertility map for each nutrient status (organic carbon, available N, P, K, S and micronutrients Zn, Fe, Mn and Cu).
3. To correlate the yield of different crops with soil fertility status.

Chapter – II

Review of Literature

Chapter - II

REVIEW OF LITERATURE

The present study was carried out to know the fertility status of upland soils of Krishna district, Andhra Pradesh. The literature related to fertility aspects of soils are reviewed in this chapter.

2.1 PHYSICAL PROPERTIES

2.1.1 Particle Size Distribution & Texture

Soil texture may be defined as the relative proportion of the various soil separates *viz.*, sand, silt and clay in a given soil. The proportion of each size group in a soil cannot be altered easily that is why texture is considered as a basic property of soils.

Bhan and Gopalachari (1978) reported that the dominant textural class in soils of Kandukuru was sandy loam, while Krishnamurthy *et al.* (1979b) found that the textural class in southern red soils zone (Nellore and Prakasam), northern light soils zone (East and West Godavari), and traditional black soils zone (Guntur, East Godavari and Prakasam) as loam to loamy sand, sandy loam to loamy sand and clay soils, respectively.

Ballito and Valentin (1987) found that the textural classes in flue-cured tobacco growing areas of north western Luzon were silt loam, silty clay loam and clay loam, where as sand and sandy loam texture in tobacco soils of transitional belt of Karnataka (Murthy and Devappa, 1987).

The dominant textural class in tobacco growing soils of East Godavari and West Godavari districts of Andhra Pradesh was sandy loam (Srinivas and Sessaiah, 1993), while the dominant textural class in red soils of Kandukuru division was sandy loam (Jagannadham *et al.*, 1995).

According to Venkateswarlu *et al.* (1995) majority of soils comes under clay textural class in black soils of Kandukuru division in Prakasam district. According to Anitha (1996) the black soils of Gurajala mandal of Guntur district in Andhra Pradesh were found to be clay in texture throughout the depth up to murrum layer. The alluvial derived soils of Mussouri river flood plain of western low land had silty clay to clay texture (Khan and Fenton, 1996). Krishnamurthy and Ramakrishnayya (1997) reported that the textural class was sandy loam in flue-cured tobacco growing soils of southern light soils (Alfisols of Kandukuru) of India.

Viswasarao (1998) reported that the texture of the soils of Tiruvuru mandal of Krishna district ranged from sandy loam to clay. The soils of A. Konduru mandal of Krishna district had texture ranging from sandy clay loam to clay (Suribabu, 1999).

According to Sanjaysrivastava *et al.* (2000) the texture of black soils of Zaheerabad, Andhra Pradesh varied from clay to sandy clay loam. Challa *et al.* (2000) identified the texture of some black soils of semi-arid ecosystem of Maharashtra plateau as clay throughout the profile. The soils developed from alluvial parent material showed clay loam to clay texture (Nayak *et al.*, 2000).

Shetty *et al.* (2001) surveyed the soils of Karnataka light soils region and found that the dominant textural class as sandy loam in tobacco growing soils. The textural classes were sandy, sandy loam and sandy clay loam in villages of flue-cured tobacco growing soils of northern light soils of Andhra Pradesh at depth of 0 to 18cm (Rao *et al.*, 2001). Ratnam *et al.* (2001) noticed loamy sand to sandy clay loam texture in soils Ulavapadu mandal in Prakasam district.

Mandal *et al.* (2003) reported that some Typic Haplusterts of central India showed clay texture. Murthy *et al.* (2003) reported that the textural classes in FCV tobacco grown light soils of Karnataka were sandy, sandy loam and loamy sand. The dominant textural class was sandy loam in cigarette natu, bidi, oriental soils of Kurnool and burley tobacco soils of Guntur, Andhra Pradesh according to Krishnamurthy and Singh (2003).

Bandypadhyay *et al.* (2004) reported clay texture in Vertisols of Bhopal, Madhya Pradesh. According to Ghelani *et al.* (2004) the tobacco growing soils were sandy to sandy loam texture in middle Gujarat region. Bhaskar *et al.* (2004) and Patil & Prasad (2004) reported that the dominant textural class in soils of *Jhum* cultivated hill slopes of Narang- Kongripara watershed in Meghalaya and in Dindori district of Madhya Pradesh is clay. In coastal areas of Andhra Pradesh, the soil texture varied from sandy clay loam to sandy (Seshagirirao *et al.*, 2004).

The black soils formed over basaltic land forms in Nagpur, Maharashtra had clay texture (Maji *et al.*, 2005). Maity *et al.* (2006) reported that the texture of the soils of Indian Agricultural Research Institute farm, varied from coarse loamy to fine loamy. The sand, silt and clay contents ranged from 22.90-64.22, 24.60-52.76 and 9.63-29.61 % respectively.

Meena *et al.* (2006) reported that the soil texture varied from loamy sand to clay in soils of Tonk district of Rajasthan and the clay content was in the range of 7.71-42.40 per cent. Sharma *et al.* (2006) reported that the recent and old alluvial deposits of Amritsar district of Punjab were light to medium in texture with wide variations of sand, silt and clay contents (7.5-30.8, 38.8-90 and 2.5-26.3 %, respectively).

The texture of some soils of coastal ecosystem in West Bengal showed sandy clay loam, clay loam and clay (Garai *et al.*, 2007). Krishnamurthy *et al.* (2007) reported that the dominant textural class in tobacco cultivated soils of Periyapatna in Mysore district, Karnataka were sandy loam in surface and sandy clay loam in sub surface, similarly Rao and Krishnamurthy (2007) studied the tobacco growing soils of Khammam district, Andhra Pradesh and reported that the textural classes in these areas as sandy, loamy sand, loam, clay loam, silty clay loam and clay.

Chaudhary *et al.* (2008) studied the fluvents of coastal saline soils of Paradip in Orissa and reported that sand, silt and clay contents ranged from 37 to 41, 20 to 27 and 33 to 40 per cent, respectively. The sand, silt and clay contents

varied from 30.7 to 95.2, 3.0 to 33.4 and 1.8 to 35.9 per cent, respectively in coastal alluvium plains of Karnataka (Shamsudheen *et al.*, 2008). Singh *et al.* (2008) studied the Vertisols of eastern Rajasthan and reported that the clay content of soils varied from 42.5 to 54.5 per cent. Gurumurthy *et al.* (2008) recorded that the texture of FCV tobacco growing soils of Karnataka light soils regions under southern transition zone was sandy loam to sandy clay loam.

Ghosh *et al.* (2009) studied the soils of Puruliya district, West Bengal and reported that the sand, silt and clay contents varied from 23.2 to 88.0, 1.50 to 47 and 6.80 to 36.3 per cent, respectively. The soils of Yerpedu Mandal, Andhra Pradesh were dominant in sand (35.17 to 95.74 %) followed by clay (2.13 to 51.76 %) and silt (2.04 to 50.16 %) contents (Leelavathi *et al.*, 2009). Kumar and Prasad (2010) studied the soils of Ahmadnagar district of Maharashtra and reported that the sand, silt and clay content ranged from 24.2 to 62.5, 5.6 to 45.2 and 5.0 to 70.2 per cent, respectively. The texture was sandy loam in Karnataka light soils, northern light soil, southern light soil and clay in northern black tobacco growing soils (Subhashini *et al.*, 2011).

Reddy and Goverdhan (2012) stated that the texture of the soils in Nagarjuna sagar left bank command areas of Nalgonda district ranged from loamy sand to clay. Lenka *et al.* (2012) studied the soils of Meghalaya and reported that the average values of sand, silt and clay content was varying from 5.31 to 63.3, 8.08 to 12.6 and 27.5 to 34.3 percent, respectively. Singh and Kumar (2012) studied the black soils of Varanasi and reported that the sand, silt and clay content varied from 30.7 to 46.6, 16.0 to 33.0 and 32.3 to 48.4 per cent with an average of 35.0, 39.7 and 25.1 per cent, respectively.

The red and black soils of Naira village of Srikakulam district, Andhra Pradesh varied in texture from sandy loam to sandy clay (Jayaramarao *et al.*, 2013). The soils in Talakona forest of Chittoor district, Andhra Pradesh showed wide textural variation from loam to clay in surface and sandy loam to clay in sub-surface soils (Rao, 2013). Sharma *et al.* (2013) studied the soils of rice land use system of Nagaland and reported that the sand, silt and clay content of the soils ranged from 17.8 to 56.0, 22.0 to 57.0 and 14.5 to 36 percent.

Ram *et al.* (2014a) reported that the texture of soils in different physiographic divisions of Markapur mandal, Prakasam district were clay loam, sandy clay, sandy clay loam and clay, while Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and stated that these soils were clay loam, sandy clay, sandy clay loam and clay.

2.2 PHYSICO CHEMICAL PROPERTIES

2.2.1 Soil Reaction (pH)

It is the negative logarithm of hydrogen ion activity which indicates whether the soil is acidic / neutral / alkaline in reaction.

According to the findings of Gopalachari (1976) the pH in soils of Mahadevapuram and Kandukuru of Andhra Pradesh was 7.4 and 7.5. Bhan (1977) found that 67.5, 17.0, 9.5, 6.0 per cent soil samples were acidic (<6.5), slight acidic to neutral (6.5-7.0), moderately alkaline (7.0-8.8) and alkaline (>8.8) in flue-cured tobacco growing soils of Ongole district, Andhra Pradesh, respectively, similarly Bhan and Gopalachari (1978) reported that the average pH in soils of Kandukuru was 7.5 and Prakasam district ranged from 5.6 to 9.5.

Krishnamurthy *et al.* (1979b) studied southern red soil zone (Nellore and Prakasam), northern light soils zone (East and West Godavari) and traditional black soils zone (Guntur, East Godavari and Prakasam) and reported that the pH of these soils ranged from 5.1 to 8.6, 5.9 to 8.6 and 7.0 to 8.7, respectively, while Krishnamurthy *et al.* (1979c) reported that the pH of these soils ranged from 5.0 to 8.8 in West Godavari district. Soils of Guntur district were also surveyed by Krishnamurthy *et al.* (1981) and reported that the pH of tobacco grown soils ranged from 7.3 to 9.0. The pH of soils ranged from 4.8 to 8.7 in East Godavari district as reported by Krishnamurthy *et al.* (1983a), similarly Krishnamurthy *et al.* (1983b) reported that the pH of tobacco growing soils ranged from 7.2 to 9.0 in Krishna district. Out of 608 samples analysed, 224, 335, 49 samples and out of 760 samples analysed, 145, 531, 84 were acidic, neutral and moderately alkaline, respectively in of flue-cured tobacco growing soils of East Godavari and West Godavari districts, Andhra Pradesh (Krishnamurthy and Ramakrishnayya, 1986).

Balito and Valentin (1987) surveyed flue-cured tobacco growing areas in north-western Luzon and reported that the pH ranged from 6.3 to 8.3 in these soils. According to the findings of Krishnamurthy *et al.* (1987) 2.8, 95.7 and 1.5 per cent soil samples were neutral, moderately alkaline and alkaline pH in Vertisols and 6.9, 35, 54.4 and 3.7 per cent were acidic, neutral, moderately alkaline and alkaline pH, respectively in Alfisols of Prakasam district. Whereas Murthy and Devappa (1987) reported that the pH of tobacco growing soils of transitional belt of Karnataka ranged from 5.4 to 7.6.

Chandrasekharareddy and Narasimharao (1990) studied the alluvial soils of Endakuduru village, Krishna district and found that the soils were alkaline in reaction (7.4 to 8.75) and the difference in pH was negligible up to a depth of 60 cm depth and slightly increased thereafter in all profiles. The average pH in surface soils of white burley tobacco growing soils in East Godavari district, Andhra Pradesh ranged from 4.8 to 8.0 (Krishnamurthy *et al.*, 1992).

The pH range in tobacco growing soils of Shimoga area in Karnataka was 5.2 to 8.3 as reported by Gajanan *et al.* (1993). The mean pH of tobacco growing soils of East Godavari and west Godavari districts, Andhra Pradesh was 6.66 (Srinivas and Seshaiyah, 1993), while Venkateswarlu *et al.* (1995) stated that the mean pH of black soils (0-20 cm) of Kandukuru division was 7.40. As per the studies of Jagannadham *et al.* (1995) the pH in the surface samples in red soils of Kandukuru division ranged from 6.8 to 7.2.

The pH of the middle and lower Narmada valley of Central India ranged from 7.2 to 7.7 (Thakur, 1996). Walia and Rao (1996) reported an increase in pH with depth, which was attributed to leaching of bases to lower horizons in soils of Bundelkhand region. Similar trend within pH range of 6.7 to 7.9 was noticed in Eastcoast soils by Sahu and Mishra (1997).

Krishnamurthy and Ramakrishnayya (1997) reported that the average pH in flue cured tobacco growing soils of southern light soils (Alfisols) of Kandukuru division, Prakasam district was 7. Surekha *et al.* (1997) reported that the soil reaction of Vertisols of Andhra Pradesh varied from 7.9 to 9.2. Ramesh *et al.* (1997, 1998) surveyed Kandukuru and Jarugumalli mandals of Prakasam district and found that the mean soil pH of these areas were 8.3 and 7.2 respectively.

Rao *et al.* (2001) studied 4 villages of flue-cured tobacco growing soils in northern light soils of Andhra Pradesh and stated that the pH range of these soils varied from 6.3 to 7.0, whereas the soil pH of Ulavapadu mandal, Prakasam district ranged from 6.5 to 7.2 (Ratnam *et al.*, 2001).

Hong and Kim (2002) studied tobacco fields and stated that the pH of these soils varied from 4.5 to 7.0. Shetty *et al.* (2001) surveyed fertility status of light soils region of Karnataka and found that the pH ranged from 5.2 to 6.9. The average pH of two decades of FCV tobacco cultivation in northern light soils was 6.6 (Krishnamurthy and Chandra, 2002).

According to Kadao *et al.* (2002), the black soils of Wardha district of Maharashtra were moderately alkaline and pH ranged from 7.9 to 8.4.

Surendra *et al.* (2003) reported that pH of rice growing soils of east Singhbhum ranged from extremely acidic to moderately alkaline while Patil and Prasad (2004) reported that the pH of the soils of Dindori district of Madhya Pradesh ranged from 5.6 to 6.8.

According to Krishnamurthy and Singh (2003) the pH ranged from 6.5 to 7.6 in cigarette natu, bidi, oriental tobacco soils of Kurnool and H.D. burley tobacco soils of Guntur district, Andhra Pradesh. The pH of black soils of Central India ranged from 7.6 to 8.9 among different horizons and the pH increased with depth (Hajare and Mandal, 2003). Kadao *et al.* (2003) and Murthy *et al.* (2003) recorded that the pH values of black soils ranged from 7.9 to 8.4.

Out of 278 soil samples analysed 15.82, 42.80, 41.36% samples were low, medium and high in pH respectively in tobacco growing soils of middle Gujarat region (Ghelani *et al.*, 2004). From the findings of Ratnakumari *et al.* (2005) it was concluded that the pH of cotton growing soils in nine mandals of Guntur district varied from 7.5 to 8.6 which were alkaline in reaction.

Rudramurthy *et al.* (2006) revealed that the mean soil pH under tobacco land use ecosystem in southern transitional zone of Karnataka was 4.6. Chalwade *et al.* (2006) stated that the pH varied from 7.8 to 8.5 in Vertisols of Parbhani and Nanded districts of Maharashtra. Maity *et al.* (2006) and Meena *et al.* (2006) reported that the pH ranged from 7.0 to 8.5 and 7.1 to 8.6 in the Inceptisols of Indian Agricultural Research Institute farm and sandy soils of Tonk district of Rajasthan, respectively. The pH in black soils of Karimnagar district ranged from 6.9 to 8.4 (Shankaraih *et al.*, 2006) while in Anantapur district, Andhra Pradesh varied from 7.4 to 8.7 (Vijayasankarbabu *et al.*, 2006).

As per the reports of Krishnamurthy *et al.* (2007) the pH of continuous cultivated tobacco soils of Periyapatna in Mysore district, Karnataka ranged from 4.8 to 8.6, 4.6 to 8.9 in surface soil (0-22.5 cm) and sub surface soils (22.5-45 cm) in 1986 and in 2004, pH ranged from 4.7 to 7.8, 4.1 to 8.2 in surface and sub surface soil samples, respectively. Rao and Krishnamurthy (2007) studied the tobacco growing soils of Khammam district, Andhra Pradesh and reported that the pH values of 27 selected villages varied from 5.7 to 8.1. The pH of the Vertisols of Nasik district was varied from 8.0 to 8.9 in different horizons, which increased with depth (Balpande *et al.*, 2007).

Gurumurthy *et al.* (2008) found that pH in the jurisdiction of FCV tobacco growing soils of Karnataka light soils regions under southern transition zone ranged from 5.2 to 7.5, while Subhashini *et al.* (2011) reported that the mean pH of tobacco growing soils of Karnataka light soils, northern light soils, southern light soils and northern black soils were 5.5, 5.8, 6.6 and 8.2, respectively.

Varaprasadrao *et al.* (2008) studied the black soils and their associated soils in Ramachandrapuram mandal of Chittoor district in Andhra Pradesh and observed the pH variation from 6.9 to 8.3 (plains), 6.8 to 8.2 (upland), 7.2 to 7.6 (hill slopes).

Dhale and Jagdishprasad (2009) categorized the soils of Jalna district of Maharashtra as moderately alkaline based on pH (8.2 to 8.9). Jibhakate *et al.* (2009) reported that the clayey soils of Katol Tahasil in Nagpur district recorded the pH values from 7.1 to 8.2. The pH in soils of rainfed areas of different agro-climatic zones of Jammu and Kashmir was in the range of 6.5 to 8.6 (Sharma *et al.*, 2009).

Perveen *et al.* (2010) reported that the pH in the vegetable soils of Peshawar area of Pakistan ranged from 7.5 to 8.5 with a mean value of 7.9. Srinivas *et al.* (2011) recorded that pH of soils of Krishna western delta of Andhra Pradesh varied from 7.0 to 7.8. Sudharani and Jayasree (2012) observed that soils of Nalgonda district were slightly acidic to alkaline in nature with a pH ranging from 5.5 to 8.5.

Jayaramarao *et al.* (2013) conducted a survey in red and black soils of Naira village of Srikakulam district, Andhra Pradesh and reported that the pH ranged from 4.40 to 7.79 with a mean of 5.92. Parihar *et al.* (2013) conducted a survey in Guava orchard soils of Satpura hills of Madhya Pradesh and stated that the pH of the soils ranged from 7.0 to 9.0 (neutral to alkaline).

Salam *et al.* (2013) reported that the pH of the soils of Kowga area in Buner district, Pakistan ranged from 8.0 to 8.4 with a mean value of 8.2. The pH of soils under forest land use system varied from 4.0 to 5.0 and 4.1 to 5.5 in rice land use systems in Mokokchung district of Nagaland (Sharma *et al.*, 2013).

Ram *et al.* (2014a) also reported that the pH of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 7.5 to 8.5, while Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that the pH of these soils varied between 6.4 and 9.9.

2.2.2 Electrical Conductivity

Chandrasekharareddy and Narasimharao (1990) reported that the alluvial soils of Endakuduru village, Krishna district recorded a mean EC value of 8.24 dS m⁻¹. The EC values varied from 1.6 to 4.6 dS m⁻¹ in Vertisols of Thungabhadra command area (Hebbara *et al.*, 1992). Gajanan *et al.* (1993) reported that the electrical conductivity range in tobacco growing soils of Shimoga area in Karnataka was 0.04 to 0.54 dS m⁻¹. The mean electrical conductivity of tobacco growing soils of East Godavari and West Godavari districts, Andhra Pradesh was 0.11 dS m⁻¹ (Srinivas and Sessaiah, 1993).

Vijaykumar *et al.* (1994) reported that EC was within the range of 0.01 to 0.79 dS m⁻¹ in the soils of northern Telangana region of Andhra Pradesh.

According to Venkateswarlu *et al.* (1995) the average electrical conductivity in black soils of Kandukuru division was 0.26 dSm⁻¹, Whereas Ramesh *et al.* (1997, 1998) surveyed the soils of Kandukuru and Jarugumali mandals of Prakasam district and found that the mean electrical conductivity of these areas were 0.23 and 0.28 dS m⁻¹ respectively.

The flood plain soils of Punjab had EC values varying between 0.11 and 0.54 dS m⁻¹ (Dhaliwal *et al.*, 1996). Anitha (1996) studied that EC values of black soils in Gurazala mandal of Guntur district of Andhra Pradesh was varying from 0.238 to 1.639 dS m⁻¹.

Kumaraswamy *et al.* (1998) reported that the EC of sugarcane grown soils was 0.2 dS m⁻¹. Sivaramu *et al.* (1998) reported that the EC values were within the range of 0.13 to 0.29 dS m⁻¹ in shrink-swell soils around Nagpur.

Anitha *et al.* (2001) observed that the sandy loam soils of Martur mandal, Prakasam district had the electrical conductivity varied from 0.6 to 3.16 dS m⁻¹ with mean value of 4.02 dS m⁻¹. Krishna *et al.* (2001) reported that the salt concentration of the calcareous soils of Ghagger river basin, Rajasthan varied from 0.18 to 5.67 dS m⁻¹. Rudramurthy and Dasog (2001) reported that the

electrical conductivity was lower in red soils compared to their black counterparts. The EC values in medium black soils of Rajgarh district, Madhyapradesh varied from 0.10 to 0.27 dS m⁻¹ (Sharma and Gupta, 2001). Hebsur and Satyanarayana (2001) studied some sugarcane growing soils of north Karnataka and reported that the EC values ranged from 0.1 to 0.32 dS m⁻¹.

Rao *et al.* (2001) surveyed 4 villages of flue cured tobacco growing soils in northern light soils of Andhra Pradesh and stated that the electrical conductivity of these soils ranged from 0.04 to 0.14 dS m⁻¹. The electrical conductivity of Ulavapadu mandal, Prakasam district ranged from 0.08 to 0.13 dS m⁻¹ (Ratnam *et al.*, 2001).

Hong and Kim (2002) studied tobacco fields and stated that the average electrical conductivity of these soils was 0.5 dS m⁻¹. RamaLakshmi *et al.* (2002) reported that the soils derived from deltaic alluvium had EC values < 1 dS m⁻¹. The electrical conductivity in black soils of Wardha district of Maharashtra ranged from 0.02 to 0.2 dS m⁻¹ (Kadao *et al.*, 2002) while in central India, it varied from 0.10 to 0.27 dS m⁻¹ (Hajare and Mandal, 2003). The EC values ranged from 0.75 to 1.25 dS m⁻¹ in Typic Haplusterts of central India (Mandal *et al.*, 2003). According to Krishnamurthy and Singh (2003) the electrical conductivity ranged from 0.17 to 0.52 dS m⁻¹ in cigarette natu, bidi, oriental tobacco soils of Kurnool and H.D. burley tobacco soils of Guntur district, Andhra Pradesh.

The salt concentration varied from 0.75 to 1.25 dS m⁻¹ in some Typic Haplusterts of central India (Mandal *et al.*, 2003) and in grape vine yards of Hyderabad, Sairam (2004) reported that it ranged from 0.14 to 2.5 dS m⁻¹.

Out of 278 soil samples analysed, 98.20 % were low (<0.70 dS m⁻¹) and remaining 1.79 % were medium (0.7-1.4 dS m⁻¹) in electrical conductivity in tobacco growing soils of middle Gujarat region (Ghelani *et al.*, 2004).

The electrical conductivity of red and associated soils of Chandragiri mandal and soils in Kandi belt of Jammu district and in Vertisols formed over basaltic terrain in Nagpur varied from 0.1 to 0.21, 0.18 to 0.36 and 0.13 to 0.25 dS m⁻¹, respectively. (Basavaraju *et al.*, 2005 and Maji *et al.*, 2005).

The electrical conductivity of red soils of Andhra Pradesh ranged from 0.11 to 0.52 dS m⁻¹ and in Alfisols of eastern region of Uttar Pradesh, mean was found to be 0.09 dS m⁻¹. (Ramesh and Rao, 2005 and Singh and Agarwal, 2005).

Thangasamy *et al.* (2005) conducted a survey on the black soils of Sivagiri micro watershed of Chittoor district in Andhra Pradesh and reported that it ranged from 0.02 to 0.36 dS m⁻¹.

The electrical conductivity in Vertisols of Anantapur district ranged from 0.12 to 0.49 dS m⁻¹ (Vijayasankarbabu *et al.*, 2006). As per the reports given by Rudramurthy *et al.* (2006) the average electrical conductivity under soils of tobacco land use ecosystem in southern transitional zone of Karnataka was 0.04 dS m⁻¹.

Rao and Krishnamurthy (2007) surveyed the tobacco growing soils of Khammam district, Andhra Pradesh and reported that the electrical conductivity of the soils of 27 selected villages varied from 0.07 to 0.58 dS m⁻¹. The average electrical conductivity of continuously cultivated tobacco soils of Periyapatna in Mysore district, Karnataka was 0.07 dS m⁻¹ in both surface (0-22.5 cm depth) and sub surface (22.5-45.0 cm depth) soils in 1986 and in 2004 average electrical conductivity was 0.20, 0.25 dSm⁻¹ in surface and sub surface soil samples, respectively (Krishnamurthy *et al.*, 2007). Gurusurthy *et al.* (2008) found that electrical conductivity in areas of FCV tobacco growing soils of Karnataka light soils ranged from 0.01 to 0.13 dS m⁻¹.

Sudharani and Jayasree (2012) observed that the electrical conductivity of rice growing soils of Nalgonda district, Andhra Pradesh varied from 0.13 to 1.37 dS m⁻¹.

Jayaramarao *et al.* (2013) observed that the electrical conductivity of red and black soils of Naira village of Srikakulam district, AP ranged from 0.03 to 0.99 with a mean of 0.21 dS m^{-1} .

Sharma *et al.* (2013) conducted a survey to evaluate the fertility status of the forest and rice land use systems in Mokokchung district of Nagaland and observed that the electrical conductivity of the soils under both forest and rice land use systems varied from 0.10 to 0.28 dS m^{-1} .

Parihar *et al.* (2013) conducted a survey in Guava orchard soils of Satpura hills of Madhya Pradesh and stated that the electrical conductivity of the soils ranged from 0.01 to 1.1 dS m^{-1} .

Ram *et al.* (2014a) also reported that the electrical conductivity of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 0.15 to 1.12 dS m^{-1} . Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that the electrical conductivity of these soils varied between 0.22 and 1.36 dS m^{-1} in surface soils.

2.2.3 Organic Carbon

The organic carbon content of soils depends upon climate, vegetation, soil type etc, which in turn influence the fertility status of soils.

According to Govindarajan and Hirekerur (1971), the organic carbon content in cigar chewing tobacco growing soils of Veda sandur (Tamilnadu) and hookah and chewing tobacco growing areas of Pusa (Bihar) was 0.52 and 0.20 percent, respectively.

The organic carbon content in surface soils of Guntur, Rajahmundry and Chinnayagudem of Andhra Pradesh were 0.35, 0.52 and 0.12 percent, respectively (Ramakrishnayya, 1971).

Kumarsastry and Balakaranmathur (1972) reported that the soils of Andhra Pradesh in general were low in organic matter status. Joshi *et al.* (1973) stated that the organic carbon content of the soils is directly related to the nitrogen supplying power of the soils. The organic carbon content in alluvial soils of north India ranged from 0.13 to 3.17 per cent (Rajani, 1973).

Adityachaudhury and Saha (1973) studied the rice growing soils of West Bengal and reported that the organic carbon content of soils ranged from 0.642 to 1.798 per cent. The per cent organic carbon content can be used as an index of available N (Thakur *et al.*, 1976). The organic carbon content in Mahadevapuram and Kandukuru, Andhra Pradesh was 0.46 and 0.17 per cent in surface soil samples, respectively. (Gopalachari, 1976).

Bhan and Gopalachari (1978) reported that the organic carbon content of soils of Prakasam district ranged from 0.03 to 0.78 per cent.

Krishnamurthy *et al.* (1979c) surveyed West Godavari district and reported that the organic carbon content of these soils ranged from 0.03 to 1.74 per cent. Krishnamurthy *et al.* (1979a) surveyed Nellore district and reported that the organic carbon content of these soils ranged from 0.03 to 1.05 per cent, similarly Krishnamurthy *et al.* (1981) studied tobacco growing soils of Guntur district and reported that the organic carbon content of these soils ranged from 0.02 to 0.99 per cent. Krishnamurthy *et al.* (1983a) recorded organic carbon content ranged from 0.03 to 1.05 per cent in tobacco growing soils of East Godavari district. According to Krishnamurthy *et al.* (1983b) the organic carbon content in tobacco growing soils of Krishna district ranged from 0.03 to 1.05 per cent

Sahu and Krishnamurthy (1984) reported, high content of organic carbon in surface soils of north Kerala which decreased with depth. Jamuna *et al.* (1984) revealed that the organic carbon content in soils of Prakasam district ranged from 0.08 to 0.25 percent. Out of 537 soil samples analysed in light soils, 530 samples were low (<0.50%) and remaining 7 were medium (0.50-0.75) and out of 963 soil

samples analysed in heavy soils, 915 samples were low and remaining 48 samples were medium organic carbon content in soils of flue-cured tobacco growing soils of Prakasam district, respectively (Krishnamurthy *et al.*, 1984).

Murthy and Devappa (1987) reported that the organic carbon content in tobacco growing soils of transitional belt of Karnataka ranged from 0.21 to 0.40 per cent. Sahu *et al.* (1990) reported that the organic carbon content of soils of northern plateau zone of Orissa ranged between 0.20 and 0.71 per cent. According to Krishnasamy and Krishnamoorthy (1991) the organic carbon content in surface soil samples of all major soil series of Tamil Nadu varied between 0.14 and 0.72 per cent. The mean organic carbon content in white burley tobacco growing soils of agency area of East Godavari district, Andhra Pradesh ranged from 0.09 to 0.87 per cent (Krishnamurthy *et al.*, 1992).

According to the findings of Venkateswalu *et al.* (1995) the average value of organic carbon in black soils of Kandukuru division, Prakasam district was 0.37 per cent, whereas Jagannadham *et al.* (1995) recorded that organic carbon content in red soils of Kandukuru division ranged from 0.18 to 0.39 per cent.

Ramesh *et al.* (1997, 1998) surveyed Kandukuru and Jarugumali mandals of Prakasam district and found that the mean soil organic carbon content of these areas were 0.47 and 0.21 per cent.

According to Shetty *et al.* (2001) the organic carbon content ranged from 0.24 to 1.02 per cent in tobacco growing soils of Karnataka light soil region. Rao *et al.* (2001) surveyed 4 villages of flue-cured tobacco growing soils in northern light soils, Andhra Pradesh and stated that the organic carbon content ranged from 0.08 to 0.32 per cent in these soils. The organic carbon content in Ulavapadu mandal of Prakasam district ranged from 4.1 to 5.0 g kg⁻¹ (Ratnam *et al.*, 2001).

The organic carbon content of some black soils of Andhra Pradesh varied from 0.08 to 0.64 per cent and addition of plant residues or farm yard manures resulted in higher organic carbon content of surface horizons (Ramalakshmi *et al.*,

2002). Out of 278 soil samples analysed, 82.01% samples were low, 15.82% samples were medium and 2.15% samples were high in organic carbon content in tobacco growing soils of middle Gujarat region (Ghelani *et al.*, 2004).

The organic carbon content in plain soils of Chandragiri mandal of Chittoor district, Andhra Pradesh ranged from 0.6 to 6.3 g kg⁻¹ (Basavaraju *et al.*, 2005).

Nayak *et al.* (2006) recorded 3.0 to 5.3 g kg⁻¹ of organic carbon content in surface soils of Vertisols collected from different locations in India. As per the reports given by Rudramurthy *et al.* (2006), the soil organic carbon content under tobacco land use ecosystem in southern transitional zone of Karnataka was 2.40 g kg⁻¹.

Mini *et al.* (2007) stated that the organic carbon content in surface soils was higher than subsurface soils due to high amount of plant residues at the surface. The average organic carbon content in continuously cultivated tobacco soils of Periyapatna of Mysore district, Karnataka were 0.46, 0.47 in surface (0-22.5 cm depth) and sub surface (22.5-45 cm depth) soils, respectively in 1986 and during 2004 it was 0.35 and 0.34 percent in surface soil and sub surface soil samples, respectively. (Krishnamurthy *et al.*, 2007).

Girish *et al.* (2010) stated that the soil organic carbon content varied from 1.0 to 16.0 g kg⁻¹ in clayey soils of Lendi watershed, Chandrapur district of Maharashtra.

The sandy soils of Churu district of western Rajasthan and black soils of Krishna western Delta, Andhra Pradesh had organic carbon content ranged from 0.05 to 0.40 and 0.27 to 0.62 per cent, respectively with a mean value of 0.13 and 0.49 per cent, respectively. (Maheshkumar *et al.*, 2011 and Srinivas *et al.*, 2011).

Singh and Mishra (2012) reported that the organic carbon content in soils of Varanasi district ranged from 0.30 to 0.75 with an average of 0.45 per cent. Sudharani and Jayasree (2012) reported that the organic carbon content in rice

growing soils of Nalgonda district varied from 1.1 to 4.8 g kg⁻¹. Salam *et al.* (2013) reported that the organic carbon of the soils of Kowga area in Buner district, Pakistan ranged from 0.15 to 2.12 per cent with a mean value of 0.95 per cent.

Ram *et al.* (2014a) also reported that the organic carbon content of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 0.25 to 0.57 per cent, similarly Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that organic carbon content of these soils varied from 0.11 to 0.59 per cent.

2.3 CHEMICAL PROPERTIES

2.3.1 Cation Exchange Capacity (CEC)

The CEC is an indication of the nutrient storage/retention capacity of soils that depends mainly on amount and type of clay minerals present in the soils.

Subbaiah and Manickam (1992) reported that the CEC of the soils of Andhra Pradesh ranged from 46.3 to 67.8 cmol (p⁺) kg⁻¹ soil and the mean cation exchange capacity of tobacco growing soils of East Godavari and West Godavari districts, Andhra Pradesh was 12.3 cmol (p⁺) kg⁻¹ (Srinivas and Seshiah, 1993).

Venkateswarlu *et al.* (1995) studied black soils of Kandukuru division, Andhra Pradesh and they reported that the values of cation exchange capacity in Veeraraghavunikota (0-17cm depth), Valetivaripalem (0-15cm depth), Pedampadu (0-21 cm depth), Narsapuram (0-19 cm depth), Mudlamuru (0-19 cm depth) and Budithpalem (0-22 cm depth) were 34.58, 28.49, 37.33, 28.49, 41.55 and 36 cmol (p⁺) kg⁻¹, respectively.

Jagannadham *et al.* (1995) studied the red soils of Kandukuru division, Andhra Pradesh and reported that the cation exchange capacity in Valetivaripalem (0-17cm depth), Madhavaram (0-13cm depth), Tummagunta (0-28 cm depth), Darasiguntapeta (0-19 cm depth), Buradapalem (0-19 cm depth) and Potturu (0-13 cm depth) were 10.0, 5.65, 3.48, 8.26, 10.0 and 9.13 cmol (p⁺) kg⁻¹, respectively.

Maji *et al.* (1998) stated that the variation in the values of CEC was due to variation in clay and organic matter content. Cation exchange capacity of soils in Tiruvuru mandal of Krishna district ranged from 12.24 to 49.2 cmol (p⁺) kg⁻¹ of soil (Viswasarao, 1998).

Mahapatra *et al.* (2000) stated that the variation in the CEC of soils related with the variation in content and nature of inorganic and organic colloids in the soils.

Anitha *et al.* (2001) stated that the cation exchange capacity in sandy clay loam soils of Marturu mandal, Prakasam district of Andhra Pradesh was low and it varied from 5.8 to 36.6 cmol (p⁺) kg⁻¹. The cation exchange capacity ranged from 6.3 to 11.9 cmol (p⁺) kg⁻¹ in tobacco growing soils of Karnataka light soils region (Shetty *et al.*, 2001).

Satyavathi and Suryanarayana Reddy (2004) studied the black soils of Telangana region of Andhra Pradesh and reported that the CEC values ranged from 40.0 to 58 cmol (p⁺) kg⁻¹ soil. The cation exchange capacity in black soils of Wardha district of Maharashtra ranged from 8 to 73 cmol (p⁺) kg⁻¹ while in Tiruvur mandal of Krishna district of Andhra Pradesh it ranged from 4.81 to 60.15 cmol (p⁺) kg⁻¹ (Kadao *et al.*, 2002 and Viswasarao *et al.*, 2005).

The CEC values of black soils of Vidarbha region ranged between 51.16 and 62.98 c mol (p⁺) kg⁻¹ soil (Gabhane *et al.*, 2006). Gurusurthy *et al.* (2008) found that cation exchange capacity of FCV tobacco growing soils in Karnataka light soils regions under southern transition zone ranged from 7.10 to 10.34 cmol (p⁺) kg⁻¹.

Dhale and JagdishPrasad (2009) recorded CEC values in Vertisols of Jalna district, Maharashtra which varied from 38.8 to 67.8 c mol (p⁺) kg⁻¹soil. The clay to clay loam soils of Katol Tahasil in Nagapur district, sandy loam soils of Ganapavaram pilot area of Nalgonda district, Andhra Pradesh and sandy soils of Degana district, Rajasthan had CEC values ranged from 38.37 to 55.77, 11.4 to 34.82 and 8.18 to 12.82 cmol (p⁺) kg⁻¹, respectively (Jibhakate *et al.*, 2009; Rajeshwar *et al.*, 2009 and Yadav and Meena, 2009).

The average cation exchange capacity of sandy loam to sandy clay loam soils of Himachal Pradesh was 18.4 cmol (p⁺) kg⁻¹ (Sharma and Kanwar, 2010). The cation exchange capacity of black soils of Krishna western delta, Andhra Pradesh ranged from 1.75 to 47.4 with an average of 34.5 cmol (p⁺) kg⁻¹ (Srinivas *et al.*, 2011).

The cation exchange capacity of soils of forest and rice land use systems varied from 10.9 to 12.9 and 11.5 to 13.1 with an average of 12.3 cmol (p⁺) kg⁻¹ in Mokokchung district of Nagaland (Sharma *et al.*, 2013).

Ram *et al.* (2014a) reported that the cation exchange capacity of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 17.7 to 42.5 cmol (p⁺) kg⁻¹, while Ram *et al.* (2014b) studied soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that the cation exchange capacity of these soils varied between 11.2 and 44.4 cmol (p⁺) kg⁻¹.

2.3.2 Base Saturation

It is the percentage of basic cations (Ca⁺², Mg⁺², K⁺ and Na⁺) to that of cation exchange capacity.

Jamuna *et al.* (1984) reported that the exchangeable calcium and magnesium content ranged from 0.25 to 1.80 and 0.10 to 2.62 meq 100g⁻¹ in soils of Prakasam district, Andhra Pradesh.

According to Rao *et al.* (1995) black soils of Telugu Ganga Project area recorded high base saturation in lower layers indicating restricted internal water movement. Kudrat *et al.* (1995) reported that laterite soils of Ajoy catchment in West Bengal had high (more than 60 per cent) base saturation. Jagannadham *et al.* (1995) surveyed red soils of Kandukuru division, Andhra Pradesh and reported that the base saturation in Valetivaripalem (0-17cm depth) , Madhavaram (0-13cm depth), Tummagunta (0-28 cm depth), Darasiguntapeta (0-19 cm depth), Buradapalem (0-19 cm depth) and Potturu (0-13 cm depth) were 74.70, 70.09, 71.26, 77.72, 79.90 and 76.34 per cent, respectively.

Venkateswarlu *et al.* (1995) studied black soils of Kandukuru division, Andhra Pradesh and reported that the base saturation in Veeraraghavunikota (0-17cm depth), Valetivaripalem (0-15cm depth), Pedampadu (0-21 cm depth), Narsapuram (0-19 cm depth), Mudlamuru (0-19 cm depth) and Budithpalem (0-22 cm depth) were 96.3, 96.8, 96.4, 95.1, 97.2 and 97.4 per cent, respectively.

The base saturation values of the black soils of Nagpur district, Maharashtra ranged from 86.3 to 97.9 per cent (Mohekar and Challa, 2000). The per cent base saturation in black soils of Nagpur district, Maharashtra ranged from 86.3 to 97.9 and in Zaheerabad, Andhra Pradesh it was 99.8 to 100. (Mohekar and Challa, 2000; Sanjaysrivastava and Srinivasarao, 2000).

From the findings of Anitha *et al.* (2001), it was observed that the base saturation of sandy clay loam soils of Marturu mandal, Prakasam district of Andhra Pradesh ranged from 91.1 to 99.1 percent. The calcium and magnesium ranged from 5.8 to 7.4 and 2.4 to 6.1 cmol (p⁺) kg⁻¹, respectively in Ulavapadu mandal of Prakasam district (Ratnam *et al.*, 2001).

Mandal *et al.* (2002) studied the cotton growing black soils of Nagpur district and found the base saturation varied between 85.2 to 99.7 per cent. The base saturation in the black soils of Dindori district, Madhya Pradesh varied from 88.1 to 88.6 per cent (Patil and Jagdish Prasad, 2004). Thangasamy *et al.* (2005) recorded the base saturation values ranging from 31 to 92 per cent in Sivagiri micro watershed in Chittoor district of Andhra Pradesh.

The base saturation values varied from 60.0 to 96.0 per cent in black soils of Ramachandrapuram mandal of Chittoor district in Andhra Pradesh (Varaprasad Rao *et al.*, 2008).

Dhale and Jagdishprasad (2009) reported that the base saturation in Vertisols of Jalna district of Maharashtra ranged from 83.9 to 98.9 per cent.

According to findings of Demiss and Beyene (2010) the exchangeable bases *i.e* Ca, Mg, K, Na varied from 1.36 to 10.98, 0.25 to 2.25, 0.50 to 5.93 and 0.17 to 0.92 cmol (p⁺) kg⁻¹ in southern Ethiopia.

Pulakeshi *et al.* (2014) observed that the range of exchangeable bases *i.e* Ca, Mg, K, Na in northern transition zone of Karnataka were 7.80 to 41.10, 2.80 to 15.30, 0.57 to 10.30 and 0.41 to 1.36 cmol (p⁺) kg⁻¹, respectively.

Ram *et al.* (2014a) reported that the base saturation of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 66.6 to 81.8 per cent, similarly, Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that the base saturation of these soils varied between 63.3 and 80.7 per cent.

2.3.3 Available Nutrients

2.3.3.1 Nitrogen

Jagannadham *et al.* (1995) reported that the surface samples of red soils of Kandukuru division were low in available nitrogen (125 to 219 kg ha⁻¹), while Venkateswarlu *et al.* (1995) found that majority of black soils of Kandukuru division were low in nitrogen ranged from 141 to 203 kg ha⁻¹.

Ramesh *et al.* (1997) surveyed Kandukuru and Jarugumali mandals of Prakasam district and found that the mean nitrogen content of these soils were 250 and 168 kg ha⁻¹, respectively.

Available N of the soils of a A. Konduru mandal of Krishna district was low (Suribabu, 1999). Anitha *et al.* (2001) stated that the available nitrogen content was low to medium in status with maximum value of 392 kg ha⁻¹ in sandy clay loam soils of Konanki village, Prakasam district, Andhra Pradesh. As per the reports given by Ratnam *et al.* (2001) the mean available nitrogen content in Ulavapadu mandal soils of Prakasam district varied between 112 and 139 with a mean of 128 ppm. Madhuvani *et al.* (2001) studied the nutrient status of black soils of Vatticherukur mandal, Guntur district of Andhra Pradesh and reported that the available nitrogen content was low in all the locations.

According to Channabasavanna *et al.* (2002) the available nitrogen content of deep black soils of Sirugappa, Karnataka was 260 kg ha⁻¹.

Anilsood *et al.* (2003) reported that the sandy soils of Punjab recorded 62 to 187 kg ha⁻¹ of nitrogen. Available nitrogen content of the Vertic Haplustepts and Typic Haplusterts of central India ranged from 143.80 to 240.21 kg ha⁻¹ (Hajare and Mandal, 2003). While in black soils of Jammu and Kashmir, Najjar *et al.* (2005) recorded 82 to 144 kg N ha⁻¹.

Thangasamy *et al.* (2005) reported that the available nitrogen content of the black soils of Sivagiri micro watershed in Chittoor district of Andhra Pradesh varied from 59.0 to 502 kg ha⁻¹.

Ramesh and Rao (2005) reported that the available nitrogen content ranged from 125 to 344 kg ha⁻¹ with a mean value of 209 kg ha⁻¹ in coastal soils of Prakasam district, Andhra Pradesh, while in Amreli district, Gujarat, Polara and Kabaria (2006) recorded a mean value of 186.5 kg ha⁻¹.

The available nitrogen content in black soils of Parbhani and Nanded districts, Maharashtra and in Anantapur district, Andhra Pradesh varied from 175.61 to 269.69 and 124.7 to 163.0 kg ha⁻¹, respectively (Chalwade *et al.*, 2006 and Vijayasankarbabu *et al.*, 2006). According to Chalwade *et al.* (2006) available N was low in most of the sugarcane growing soils of Nanded and Parbhani districts of Maharashtra. The available nitrogen content of the soils in Chittoor district, Andhra Pradesh varied from 54.0 to 102 kg ha⁻¹ (Varaprasad Rao *et al.*, 2008).

Jamuna *et al.* (2008) studied the fertility status of sandy loam soils in Vizianagaram district, Andhra Pradesh and reported that fertility index value with respect to nitrogen was low (1.43). Similarly, Sharma *et al.* (2008) reported that the sandy soils of Amritsar district, Punjab were low in available nitrogen and it ranged from 63 to 170 kg ha⁻¹ with a mean value of 117 kg ha⁻¹.

The available nitrogen content in sandy clay loam to clay textured soils of Varanasi district and sandy clay loam to clay soils of Jaunpur district, Uttar Pradesh varied from 168.0 to 268 and 282 to 328 kg ha⁻¹, respectively (Mishra and Singh, 2008 and Raghubanshi and Singh, 2008).

The available nitrogen content in subtropical agroclimatic zone of Jammu and Kashmir and Ausa tahsil of Latur district of Maharashtra varied from 75 to 599 and 102.22 to 385.72 kg ha⁻¹, respectively (Pardeepwali *et al.*, 2009 and Waghmare *et al.*, 2009). Dhale and Jagdish Prasad (2009) reported the available nitrogen content in black soils of Jalna district, Maharashtra which ranged from 68 to 313 kg ha⁻¹.

Ram *et al.* (2014a) also reported that the nitrogen content of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 213.2 to 376.3 kg ha⁻¹, while Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and concluded that the nitrogen content of these soils varied from 112.9 to 376.3 kg ha⁻¹.

2.3.3.2 Phosphorus

ChadrsekharReddy and NarasimhaRao (1990) found that the available phosphorus in alluvial soils ranged from 6 to 21 kg ha⁻¹.

Jagannadham *et al.* (1995) stated that in the red soils of Kandukuru division, the available phosphorus content ranged from 9 to 16 kg ha⁻¹. Venkateswarlu *et al.* (1995) reported that majority of black soils of Kandukuru division were medium in phosphorus content that ranged from 14-27 kg ha⁻¹.

Ramesh *et al.* (1997) studied the fertility status of soils of Kandukuru and Jarugumali mandals of Prakasam district and found that the mean phosphorus (P_2O_5) content of these areas was 23.6 and 34.5 kg ha⁻¹, respectively.

The available phosphorous content ranged from 8.5 to 111 kg ha⁻¹ in five platforms of tobacco growing soils of Karnataka light soils region (Shetty *et al.*, 2001). Ratnam *et al.* (2001) found that the average available phosphorus content in Ulavapadu mandal, Prakasam district varied from 12 to 16 with a mean of 15 ppm.

Available phosphorus content of the Vertic Haplustepts and Typic Haplusterts of central India ranged from 13.30 to 27.82 kg ha⁻¹ (Hajare and Mandal, 2003). Out of 278 soil samples analysed 3, 81, 194 samples were low, medium and high respectively in available phosphorus (P_2O_5) status of tobacco growing soils in middle Gujarat region (Ghelani *et al.*, 2004).

The available P_2O_5 content of the black soils of Krishna western delta region of Andhra Pradesh varied from 8.7 to 44.9 kg P_2O_5 ha⁻¹ with a mean of 20.1 kg P_2O_5 ha⁻¹ (Venumadhav and Prasadrao, 2003) and in Krishna district of Andhra Pradesh, it was low to medium (Viswasarao *et al.*, 2005). In sandy and clay textured soils of Madanapalli division of Chittoor district, Andhra Pradesh the nutrient index value with respect to phosphorus was medium to high (Revathi *et al.*, 2005).

Thangasamy *et al.* (2005) reported that the available phosphorus content of the soils in Sivagiri micro watershed in Chittoor district of Andhra Pradesh varied from 4.5 to 29.3 kg ha⁻¹.

The available phosphorus status was found to be medium and it ranged from 3.2 to 116.0 kg P_2O_5 ha⁻¹ with an average value of 38.44 kg P_2O_5 ha⁻¹ in coastal soils of Amreli district, Gujarat (Polara and Kabaria, 2006).

Chandrasekhararao and Krishnamurthy (2007) reported that available phosphorus content in black soils of Khammam district varied from 2.81 to 48.2 kg P_2O_5 ha⁻¹. Krishnamurthy *et al.* (2007) revealed that the phosphorus (P_2O_5) content of continuous cultivated tobacco soils of Periyapatna in Mysore district,

Karnataka ranged from 2.25 to 108.00, 2.25 to 94.50 in surface (0-22.5 cm depth) and sub surface (22.5-45 cm depth) soils, respectively in 1986 and in 2004 ranged from 1.35 to 112.50, 1.35 to 146.25 kg ha⁻¹ in surface and sub surface soil samples, respectively.

The available phosphorus content of the soils in Chittoor district, Andhra Pradesh varied from 9.29 to 23.96 kg ha⁻¹ (Varaprasad Rao *et al.*, 2008). The available phosphorus content in sandy clay loam to clay soils of Jaunpur district, Uttar Pradesh and sandy soils of Amritsar district, Punjab varied from 5.4 to 14.2 and 9.38 to 84.9 kg P₂O₅ ha⁻¹ with a mean value of 9.76 and 37.3 kg P₂O₅ ha⁻¹, respectively (Raghubanshi and Singh, 2008 and Sharma *et al.*, 2008). Jamuna *et al.* (2008) studied the fertility status of coastal soils of Visakhapatnam, Vizianagaram and Srikakulam districts in North coastal Andhra Pradesh and reported that the available phosphorus content was low in 40.0, 25.0 and 36.25 per cent samples, medium in 22.7, 32.0 and 25.8 per cent samples and high in 37.3, 42.0 and 38.0 per cent samples, respectively.

The black cotton soils of Ghataprabha left canal command area of north Karnataka recorded medium to high available phosphorus content and it ranged from 12.0 to 38.0 kg P₂O₅ ha⁻¹ with mean value of 22.3 kg P₂O₅ ha⁻¹ (Binita *et al.*, 2009). In coastal sandy soils of Srikakulam, Nalgonda and Nellore districts of Andhra Pradesh the phosphorus values ranged from 8.38 to 18.69 kg P₂O₅ ha⁻¹ with a mean value of 12.79 kg P₂O₅ ha⁻¹ (Laxminarayana and Rajagopal, 2009).

Dhale and Jagdish Prasad (2009) reported the available phosphorus content in black soils of Jalna district, Maharashtra which ranged from 0.9 to 27.0 kg ha⁻¹.

Waghmare *et al.* (2009) reported that the available phosphorus content in black soils of AUSA tahsil of Latur district, Maharashtra varied from 4.22 to 24.98 kg P₂O₅ ha⁻¹ with mean value of 14.29 kg P₂O₅ ha⁻¹ while, in black soils of Krishna western delta, Andhra Pradesh, Srinivas *et al.* (2011) reported that it varied from 30.6 to 69.4 with an average of 48.2 kg P₂O₅ ha⁻¹.

The available phosphorus content in sandy soils of Churu district of western Rajasthan ranged from 7 to 80 kg P₂O₅ ha⁻¹ with a mean value of 18.6 kg P₂O₅ ha⁻¹ (Maheshkumar *et al.*, 2011).

Ram *et al.* (2014a) reported that the phosphorus (P) content of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 10.0 to 28.1 kg ha⁻¹. Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that the phosphorus (P) content of these soils varied from 12.0 to 28.1 kg ha⁻¹.

2.3.3.3 Potassium

Sekhon and MahatimSingh (1982) analysed the Indian soils and reported that the available potassium status was low in 20 per cent soils, medium in 42 per cent soils and high in the remaining 38 per cent of the soils.

According to Subba Rao *et al.* (1986) the potassium supplying power of clayey and loamy soils is more than silty clay loams and clay loams.

Chowdhury and Rahman (1990) reported that the exchangeable potassium in Gangetic river flood plain soils of Bangladesh was 0.22 cmol (p⁺) kg⁻¹ soil. Hebsur and Satyanarayana (2001) studied the transformation of added potassium in soils under sugarcane based cropping system and found that the total potassium status of soils ranged from 0.575 to 3.3 ppm. Anitha *et al.* (2001) reported that the available potassium was high in soils of Marturu mandal of Prakasam district.

According to the findings of Krishnamurthy and Chandra (2002) the average available potassium (K) content of tobacco growing soils in northern light soils was 193 kg ha⁻¹. Vertic Haplustepts and Typic Haplusterts of central India recorded the available potassium values varying from 116.8 to 369.5 kg ha⁻¹ (Hajare and Mandal, 2003).

Out of 278 soil samples analysed, 68 (<140 kg ha⁻¹), 95 (140-280 kg ha⁻¹) and 115 (>280 kg ha⁻¹) samples were low, medium and high in available potassium (K₂O), respectively in tobacco growing soils of middle Gujarat region (Ghelani *et al.*, 2004).

Thangasamy *et al.* (2005) reported that the available potassium content of the soils in Sivagiri micro watershed in Chittoor district of Andhra Pradesh varied from 22.0 to 212.0 kg ha⁻¹.

Krishnamurthy *et al.* (2007) surveyed tobacco growing soils of Periyapatna in Mysore district, Karnataka and reported that the available potassium (K₂O) content ranged from 154 to 1610, 154 to 1638 in surface (0-22.5 cm depth) and sub surface (22.5-45 cm depth) soils, respectively in 1986 and in 2004 it ranged from 48 to 1652 and 97 to 1400 kg ha⁻¹ in surface soil and sub-surface soil samples, respectively. Varaprasad Rao *et al.* (2008) reported that the available potassium content in soils of Chittoor district, Andhra Pradesh varied from 135.0 to 320.0 kg ha⁻¹.

The available potassium content in black soils of Jalna district, Maharashtra varied from 195.0 to 1287.0 kg ha⁻¹ (Dhale and Jagdish Prasad, 2009). Gurumurthy *et al.* (2010) found that the available potassium content ranged from 16 to 25 mg kg⁻¹ in FCV tobacco growing soils of southern transition zone of Karnataka.

The mean value of available potassium content in surface soils under tobacco growing soils at Zonal Agricultural Research Station, Shimoga was 13.67 mg kg⁻¹ (Gurumurthy *et al.*, 2011).

Ram *et al.* (2014a) also reported that the potassium (K) content of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 99.7 to 255.4 kg ha⁻¹. Similarly Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that the potassium (K) content of these soils varied from 67.2 to 255.4 kg ha⁻¹.

2.3.3.4 Sulphur

Ahmed and Jha (1969) reported that the water soluble sulphur in Bihar ranged from 5.7 to 36.0 ppm with an average of 14.8 ppm. Joshi *et al.* (1973) reported that the soils of Rajasthan contained sulphates from 20 to 90 ppm. They also observed that high rainfall areas had low amounts of sulphur, which might be due to leaching losses of sulphate sulphur.

Chandrababu and Tripathi (1973) found that the sulphate sulphur varied from 9.0 to 52.0 ppm with an average of 18.2 ppm in Uttar Pradesh soils. Palaniappan *et al.* (1978) reported that the available sulphur in Tamil Nadu soils on an average was 105 ppm. They observed lower values (3 ppm) in plains and higher values in the higher elevation (191 ppm).

Jamuna *et al.* (1984) reported that the mean value of available sulphur content in soils of Prakasam district was 34.9 kg ha⁻¹. Similarly Ramesh *et al.* (1998) surveyed Kandukuru and Jarugumali mandals of Prakasam district and found that the mean available sulphur of these soils were 37.5 and 31.2 mg kg⁻¹, respectively.

Muntasir *et al.* (2000) surveyed soils of Belabothana of Narsingdi and Harirampurthana of Manikgonj district, Bangladesh and reported that the sulphur content ranged from 10 to 27 kg ha⁻¹ in these soils. Rai *et al.* (2000) collected samples of various soil associations from the agricultural areas of Allahabad district and reported that the sulphur (SO₄-S) of these soils varied from 4.00 to 22.38 ppm.

Pandey *et al.* (2000) studied some Inceptisols of central Uttar Pradesh and reported that the available sulphur content varied from 5.8 to 53.4 mg kg⁻¹. They also reported that about 41 and 49% soil samples recorded low and high sulphur status respectively.

Trivedi *et al.* (2000) reported that the available sulphur content in Alfisols and Inceptisols of Madhya Pradesh varied from 8 to 54 mg kg⁻¹. Pramanik and Dolui (2001) studied the sulphur distribution in Alfisols of West Bengal and reported that available sulphur ranged from 13.1 to 29.3mg kg⁻¹ with a mean value of 16.8 mg kg⁻¹.

Bhatnagar *et al.* (1999) observed that available sulphur in Shivapuri soils ranged from 11.25 to 13.25 and 9.87 to 16.25 with a mean value of 12.27 and 12.40 mg kg⁻¹ in surface layers of Inceptisols and Vertisols, respectively.

Surendra *et al.* (2003) reported that available sulphur status in rice growing soils of upland and medium lowlands varied from traces to 47.6 and 7.7 to 105.8 mg kg⁻¹ with a mean of 12.1 and 26.7 mg kg⁻¹, respectively. Out of 278 samples analysed, 139, 17, 122 samples were low (<12.5 ppm), medium (12.5-15 ppm) and high (>15 ppm) available sulphur, respectively in tobacco growing soils of middle Gujarat region (Ghelani *et al.*, 2004).

Thangasamy *et al.* (2005) reported that the sulphur content of the soils in Sivagiri micro watershed in Chittoor district of Andhra Pradesh varied from 12.5 to 35.2 mg ha⁻¹. Jat and Yadav (2006) observed that available sulphur in Entisols of Jaipur ranged from 4.1 to 39.9 mg kg⁻¹ with a mean value of 14.52 mg kg⁻¹.

Shankaraiah *et al.* (2006) studied the distribution of sulphur in black soils of Karimnagar district of Andhra Pradesh and reported that the available sulphur content varied from 11.0 to 24.0 ppm with a mean value of 17.6 ppm.

Mishra and Singh (2008) recorded available sulphur content in soils of Araziline block of Varanasi which varied from 4.7 to 14 ppm. Raghubanshi and Singh (2008) reported that available sulphur content in black soils of Jaunpur district of Jalalpur that ranged from 7.4 to 13.5 ppm.

Sathish *et al.* (2008) observed the available sulphur status of soils in Guntur district and reported that the black soils were in sufficient range, whereas the red soils were in deficient range. Sharma *et al.* (2008) studied the soils of Amritsar district, Punjab and reported that the available sulphur content was varying from 24.6 to 60 kg ha⁻¹ with an average value of 37.6 kg ha⁻¹

According to Rajput and Polara (2012), the soils of coastal Bhavnagar district of Gujarat had 1.1 to 39.2 mg kg⁻¹ of available sulphur. Selvaraj and Naidu (2012) studied the soils of different land uses in Renigunta mandal of Chittoor district in Andhra Pradesh and reported that the available sulphur content varied from 10.0 to 65.0 mg kg⁻¹.

From the studies on black soils of Varanasi, Surendrasingh and Pramodkumar (2012) recorded the available sulphur content varying from 4.37 to 23.75 kg ha⁻¹.

Sharma *et al.* (2013) studied the soils of rice land use systems of Mokokchung district of Nagaland and reported that the available sulphur content ranged from 8.0 to 36.0 kg ha⁻¹.

According to Ram *et al.* (2014a) also reported that the sulphur content of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 5.2 to 12.7 mg kg⁻¹. Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that the sulphur content of these soils varied from 3.3 to 12.3 mg kg⁻¹.

2.3.4 Available Micronutrients

2.3.4.1 Zinc

Lal *et al.* (1960) reported that the available zinc status of Indian soils ranged from 4.5 to 6.0 ppm in fertile alluvial soils, 1.3 to 3.8 ppm in black calcareous soils and around 1.3 ppm in laterite soils. Alluvial, terai Bundelkharid and Vindhyan soils of Uttar Pradesh contained available Zn ranging from 0.9 to 8.8 ppm (Thripathi *et al.*, 1969). The eastern districts of Uttar Pradesh contained 0.02 to 1.82 ppm of available Zn (Agarwala *et al.*, 1970). Mathan (1974) observed 3.5 to 14.0 ppm of available Zn in Nilgiri soils.

Available Zn in the vineyard soils of Rajasthan ranged from 0.52 to 2.11 ppm (Khetawat and Vashishtha, 1977). Krishnamurthy *et al.* (1979b) surveyed southern red soil zone (Nellore and Prakasam), northern light soils zone (East and

West Godavari) and traditional black soils zone (Guntur, East Godavari and Prakasam) and reported that the average available zinc content of these soils were 1.86, 8.93 and 1.06 ppm, respectively.

Sakal *et al.* (1988) found that the available Zn content in rice growing old alluvial soils ranged from 0.04 to 5.80 ppm. The DTPA extractable Zn content in alluvial soils of Haryana ranged from 0.1 to 0.4 ppm (Kuldeep *et al.*, 1990). Venkateswarlu *et al.* (1995) reported that micronutrients *i.e* Zn, Fe, Mn and Cu status in black soils of Kandukuru division were 0.09 to 0.58, 2.36 to 5.44, 28.68 to 72.10 and 1.22 to 2.40 ppm, respectively. According to Jagannadham *et al.* (1995) the cationic micronutrients *i.e* Zn, Fe, Mn and Cu in red soils of Kandukuru division ranged from 0.34 to 0.84, 7.20 to 19.80, 4.80 to 26.30 and 1.10 to 1.74 ppm, respectively.

The available zinc content varied from 0.20 to 1.44 mg kg⁻¹ in tobacco growing soils of Karnataka light soils region (Shetty *et al.*, 2001). Ratnam *et al.* (2001) found that the micronutrients *i.e* Zn, Fe, Mn and Cu varied from 0.52 to 0.60, 12.70 to 25.90, 17.20 to 27.10 and 0.70 to 1.20 ppm in Ulavapadu mandal, Prakasam district. The black soils of Vatticherukuru mandal, Guntur district were sufficient in available Zn, Mn and Cu status except for Fe (Madhuvani *et al.*, 2001).

Kadao *et al.* (2002) reported that the DTPA- extractable Zn, Fe, Mn and Cu contents in black soils of Wardha district of Maharashtra varied from 0.15 to 0.58, 6.28 to 12.87, 1.35 to 16.98 and 1.05 to 5.24, mg kg⁻¹, respectively. Sharma *et al.* (2002) in sandy soils of Punjab reported that the contents varied from 0.08 to 1.88, 0.50 to 23.0, 0.20 to 27.7 and 0.04 to 2.40, mg kg⁻¹, respectively.

Kumari *et al.* (2005) stated that the available zinc in cotton growing soils of Guntur district was sufficient and it ranged from 0.6 to 3.4 ppm with an average of 1.7 ppm, while it was insufficient (0.28 to 0.44 ppm) in black soils of Jammu district of Jammu and Kashmir (Najar *et al.*, 2005).

Viswasarao *et al.* (2005) reported that the available Zn, Mn and Cu were fairly rich, whereas, Fe was deficient in Tiruvur mandal of Krishna district, Andhra Pradesh.

Waghmare *et al.* (2009) reported that the available Zn, Fe, Mn and Cu contents in black soils of Nilanga Tahsil of Latur district of Maharashtra varied from 0.29 to 1.96, 3.40 to 22.04, 2.37 to 14.74 and 1.05 to 7.08 mg kg⁻¹ with the mean values of 0.61, 7.60, 8.82 and 2.84 mg kg⁻¹, respectively.

2.3.4.2 Iron

The available Fe content in the alluvial soils of Uttar Pradesh ranged from 0.6 to 21.7 ppm (Agarwala, 1963 and Agarwala *et al.*, 1964). The available Fe content in alluvial soils of Uttar Pradesh ranged from 0.35 to 14.65 ppm (Pathak *et al.*, 1979). In India, the deficiency of Fe was second only to Zn and has been reported from Punjab, Haryana, Uttar Pradesh and Andhra Pradesh (Katiyal and Sharma, 1979).

Pillai *et al.* (1982) reported that the soils of Ananthapur district of Andhra Pradesh were adequate in available Fe content. Kuldeep Singh *et al.* (1990) reported that the available Fe content in alluvial soils of Haryana ranged from 2.5 to 22.2 ppm. Srivastava and Srivastava (1993) reported that the available Fe decreased at the rate of 0.7 ppm per unit increase in soil pH in soils of Uttar Pradesh.

Yadav and Meena (2009) and Maheshkumar *et al.* (2011) studied the sandy soils of Degana district and Churu district of Rajasthan and reported that the available Zn, Fe, Mn and Cu contents varied from 0.21 to 2.18, 0.20 to 18.73, 0.43 to 7.75 and 0.09 to 3.05 mg kg⁻¹ and from 0.18 to 4.6, 2.7 to 32.0, 4.0 to 35.0 and 0.14 to 2.8 mg kg⁻¹, respectively.

2.3.4.3 Manganese

Tembhare and Rai (1967) found that the available Mn in soil decreased with increasing in clay content, increasing in pH and also with increasing CaCO₃ content of the soil. They also reported that there exists a positive relationship between organic matter and available manganese content.

The studies of Baser and Sexena (1970) revealed that when the texture of the soils changed from coarse to fine the exchangeable Mn decreased, while reducible Mn increased. Mahapatra and Kibe (1972) reported that the available

Mn content in Maharashtra soils ranged from 1.5 to 67.0 ppm. Available Mn content of soils of Sikkim region ranged from 0.05 to 6.10 ppm (Khera and Pradhan, 1980). The available Mn content in black and associated soils of Vatticherukur mandal, Andhra Pradesh varied from 4.1 to 26.94 mg kg⁻¹ (Madhuvani *et al.*, 2001).

The soils of Amreli district, Gujarat were high in available Mn and Cu and medium in Fe and Zn and the contents of Zn, Fe, Mn and Cu varied from 0.20 to 2.94, 1.10 to 16.34, 0.54 to 23.02 and 0.20 to 2.94 with mean values of 0.64, 7.84, 12.63 and 0.64 mg kg⁻¹, respectively (Polara and Kabaria, 2006), while in loamy and clay soils of Tonk district Rajasthan recorded from 0.19 to 1.93, 2.23 to 14.16, 0.21 to 1.87 and 6.85 to 45.25 with mean values of 0.83, 5.38, 0.61 and 21.56 mg kg⁻¹, respectively (Meena *et al.*, 2006). As per the reports given by Raj *et al.* (2006) the mean of micronutrients *i.e* Zn, Fe, Mn and Cu in Prakasam district were 0.77, 14.20, 15.20 and 1.20 mg kg⁻¹.

2.3.4.4 Copper

The available copper content in alluvial soils of Uttar Pradesh ranged from 0.1 to 16.2 ppm (Agarwala *et al.*, 1964). Available copper content in Madhya Pradesh soils ranged from 0.45 to 12.34 ppm (Agarwala and Motiramani, 1966) and traces to 5.5 ppm (Rai and Mishra, 1967). Pande (1969) reported that the available Cu content in soils of Orissa ranged from 1.46 to 2.14 ppm. Available Cu content in the soils of Assam ranged from 0.87 to 2.5 ppm (Chakraborty *et al.*, 1979).

Jamuna *et al.* (1984) reported that the mean values of cationic micronutrients *i.e* Zn, Fe, Mn and Cu content in soils of Prakasam district were 1.13, 143, 33.2 and 1.6 ppm, respectively. Available copper content in old alluvial soils of Bihar ranged from 0.3 to 11.7 ppm (Sakal *et al.*, 1988). Sahu *et al.* (1990) reported that the available copper content in rice growing soils of Orissa ranged from 0.5 to 11.1 ppm. Kuldeep Singh *et al.* (1990) found that the DTPA extractable copper content in alluvial soils of Haryana ranged from 0.46 to 0.68

ppm. Gajanan *et al.* (1993) reported that the ranges of micronutrients *i.e* Zn, Fe, Mn, and Cu were 0.38 to 2.08, 2.00 to 71.30, 4.40 to 87.60 and 0.17 to 7.50 ppm, respectively in tobacco growing soils of Shimoga area, Karnataka.

Nayak *et al.* (2000) studied the alluvial soils of Arunachal Pradesh and found that the DTPA extractable copper content ranged from 0.50 to 3.57 mg kg⁻¹ in surface soils and 0.14 to 4.07 mg kg⁻¹ soil in sub surface horizons.

The available copper content in black and associated soils of Vatticherukur mandal, Andhra Pradesh varied from 0.45 to 1.67 mg kg⁻¹ soil (Madhuvani *et al.*, 2001). Ramesh *et al.* (2003) stated that available copper and manganese were sufficient but zinc and iron were deficient. In Singarayakonda mandal of Prakasam district, Andhra Pradesh, Ramesh *et al.* (2003) stated that available copper and manganese contents were sufficient but zinc and iron were deficient.

Laxminarayana and Rajagopal (2009) reported that in rice growing soils of Andhra Pradesh the mean values of Zn, Fe, Mn and Cu were 0.83, 2.14, 13.7 and 1.56 mg kg⁻¹, respectively while the contents in red and black soils of Naira village of Srikakulam district were 1.20, 38.87, 28.47 and 2.36 ppm (Jayaramarao *et al.*, 2013) and in Vertisols of Chittoor district were 1.01, 5.15, 2.44 and 0.67 mg kg⁻¹, respectively (Reddy *et al.*, 2013).

Ram *et al.* (2014a) reported that the cationic micronutrients *i.e* Zn, Fe, Mn and Cu of different physiographic divisions in soils of Markapur mandal, Prakasam district ranged from 0.3 to 0.7, 4.5 to 30.9, 0.8 to 11.5 and 1.3 to 4.2 mg kg⁻¹. Similarly Ram *et al.* (2014b) surveyed soils at different physiographic divisions in selected mandals of Prakasam district, Andhra Pradesh and reported that the cationic micronutrient content *i.e* Zn, Fe, Mn and Cu varied from 0.2 to 0.7, 2.7 to 20.3, 0.7 to 32.6 and 1.7 to 5.4 mg kg⁻¹.

Chapter – III

Material and Methods

Chapter - III

MATERIAL AND METHODS

The details pertaining to basic information of the study area, methodology adopted and the materials used in the present investigation are presented in this chapter.

3.1 GENERAL DESCRIPTION OF STUDY AREA

The present study was taken up in Vijayawada and Nuzivedu revenue divisions of Krishna district, Andhra Pradesh which consists of alluvial and associated soils. Places were selected and soils were dug vertically down at two different depths (0-15 & 15-30 cm). Depthwise soil samples were collected for analysis from farmers fields (table 3.1) in study area divisions of Krishna District (fig.1). The coordinates at each location were recorded by using GPS equipment.

3.1.1 Location and Climate

Krishna District is located on the East coast of India between 15°43'N latitude and 17°10'N. latitude and between 80°00' E longitude and 81°33'E longitude, covering an area of about 8,727 Sq.Km. It accounts for 3.17% of the total geographical area of the state. The climatic conditions of the district consist of extremely hot summers and moderately cold winters and may be classified as tropical. The period starting from April to June is the hottest. The annual rainfall in the region is about 1028 mm and is contributed mostly by the South-West monsoon. Frequent cyclones of different intensities and tidal storms are natural calamities affecting the central tracts of Krishna particularly causing deterioration of ground water quality in the coastal aquifers.

3.1.2 Soils

There are two types of soils in the study area viz., black cotton soils (57.6%), sandy clay loams (22.3%). The black cotton soil is the most extensive and occurs in all most all mandals. The sandy clay loams formed along with rivers and streams.

3.1.3 Crops

The principle crops grown are paddy, cotton, chilli, sugarcane and red gram.

3.2 PROCESSING OF SOIL SAMPLES

The soil samples collected from 212 places (counts to 424 including surface and sub-surface) were air dried under shade, grounded with wooden hammer, sieved through 2 mm sieve and were preserved in polythene bags for laboratory analysis.

3.3 METHODS OF SOIL ANALYSIS

The methods followed for the analysis of soil samples are listed here under.

3.3.1 Laboratory Analysis

3.3.2 Physical Properties

3.3.2.1 Soil texture

The particle size analysis was carried out by the Bouyoucos hydrometer method. (Bouyoucos, 1962).

3.3.3 Physico - Chemical Properties

3.3.3.1 Soil Reaction (pH)

Soil reaction of the samples was determined in 1:2.5 (soil: water) soil water suspension using a glass electrode pH meter (Jackson, 1973).

3.3.3.2 Electrical Conductivity (EC)

Electrical conductivity of the soil samples was determined in 1:2.5 soil water suspension using a conductivity bridge and expressed as dS m^{-1} (Jackson, 1973).

3.3.3.3 Organic Carbon (OC)

Organic carbon content of the soils was determined by Walkley and Black's wet digestion method (Jackson, 1973).

3.3.4 Chemical Properties

3.3.4.1 Cation exchange capacity (CEC)

A known weight of the soil sample was saturated with one normal sodium acetate (pH 8.2). The excess sodium acetate was leached out by washing with 95% ethanol. Then the adsorbed sodium was displaced with neutral normal ammonium acetate and the concentration of sodium in the leachate was estimated flame photometrically. The CEC was calculated and expressed as cmol (p+) kg^{-1} soil (Bower *et al.*, 1952).

3.3.4.2 Exchangeable cations

Exchangeable cations were extracted by centrifuge extraction procedure using neutral normal ammonium acetate as described by Bower *et al.* (1952). The sodium (Na^+) and potassium ions (K^+) were determined in the extract by aspirating directly into flame photometer, where as calcium (Ca^{+2}) and magnesium (Mg^{+2}) ions were determined by Versenate method (Kanwar and Chopra, 1976).

3.3.5 Available Nutrients of Soils

3.3.5.1 Primary nutrients

3.3.5.1.1 Available Nitrogen

Available nitrogen content of the soils was determined by alkaline potassium permanganate method as developed by Subbiah and Asija (1956).

3.3.5.1.2 Available Phosphorus

Available phosphorus in soils was extracted using Olsen's extractant as described by Olsen *et al.* (1954) and phosphorus content in the extract was estimated by Murphy and Riley method (using ascorbic acid as reducing agent) as described by Watanabe and Olsen (1965) using spectrophotometer at 660 nm wavelength. The available phosphorus was expressed as kg P₂O₅ ha⁻¹ by multiplying the percent P with 2.29.

3.3.5.1.3 Available Potassium

Available potassium of the soils was extracted with neutral normal ammonium acetate and the potassium content in the extract was determined flame photometrically (Jackson, 1973). The available potassium was expressed as kg K₂O ha⁻¹ by multiplying the percent K with 1.2.

3.3.5.2 Available Sulphur

Surface and subsurface soil samples were analyzed for sulphate sulphur (SO₄-S). The available sulphur in the soil samples was extracted with 0.15 per cent CaCl₂.2H₂O as described by Williams and Steinbergs (1959) and estimated by turbidimetric method (Cottenie *et al.*, 1979).

3.3.6 Available Micronutrients

The Available micronutrients *viz.*, Fe, Mn, Cu and Zn of the soils were extracted with DTPA extractant (pH 7.3) (Lindsay and Norvell, 1978) and the extracted micronutrients were determined by using atomic absorption spectrophotometer.

3.4 PREPARATION OF SOIL TEST SUMMARIES

The analytical data of surface and subsurface soil samples were summarized to evaluate the fertility status of the soils.

Table 3.1. Details of soil sampling sites

S.No.	Name of the village	Mandal	Latitude & Longitude
1	A.konduru	A.konduru	N- 17°04'78" E-80 °09 '82"
2	Gollamandala	A.konduru	N -16°58'44.5" E-80°40'52.8"
3	Khambampadu	A.konduru	N-16°58'55.4" E-80°39'15.1"
4	Cheemalapadu	A.konduru	N-16°53'31.4" E-80°38'5.1"
5	Koduru	A.konduru	N-16°00'08" E-80°02'30"
6	Madhavaram	A.konduru	N-16°54'2.2" E-80°41'31.9"
7	Repudi	A.konduru	N-16°16'4.8" E-80°14'20.4"
8	Reddigudem	Reddigudem	N-16°52'8.5" E-80°44'12.1"
9	Reddigudem	Reddigudem	N-16°52'8.5" E-80°44'12.1"
10	Naguluru	Reddigudem	N-16°48'6.8" E-80°42'17.3"
11	Kudapa	Reddigudem	N-16°53'46" E-80°41'22.4"
12	Rudravaram	Reddigudem	N- 16°52'28.3" E-80°39'52.6"
13	Rudravram	Reddigudem	N- 16°52'22.6" E-80°39'57.1"
14	Rangapuram	Reddigudem	N- 16°51'17.2" E-80°43'39.7"
15	Mylavaram	Mylavaram	N- 16°45'49.7" E-80°38'17.6"
16	Chandrala	Mylavaram	N- 16°45'55.1" E-80°42'12.2"

Contd.

S.No.	Name of the village	Mandal	Latitude & Longitude
17	Mylavaram	Mylavaram	N- 16°45'49.7" E-80°38'17.6"
18	Velvadam	Mylavaram	N- 16°45'43.4" E-80°39.47.6"
19	Pulluru	Mylavaram	N- 16°50'0.2" E-80°38'17.5"
20	Morusumilli	Mylavaram	N- 16°52'37.4" E-80°35'4.1"
21	Kanimerla	Mylavaram	N- 16°46'49.9" E-80°44'56.9"
22	Vissanapeta	Vissanapeta	N- 16°56'33.2" E-80°46'46.7"
23	Putrela	Vissanapeta	N- 17°1'27.1" E-80°43'1.9"
24	Kondaparva	Vissanapeta	N- 17°7'36.1" E-80°44'6.2"
25	Korlamanda	Vissanapeta	N- 17°2'3.5" E-80°46'21.7"
26	Tatakuntla	Vissanapeta	N- 16°56'7.4" E-80°48'56.3"
27	Narsapuram	Vissanapeta	N- 17°10'15.5" E-80°49'21.2"
28	Kalagara	Vissanapeta	N- 17°0'38.5" E-80°46'21.7"
29	Nuzivedu	Nuzivedu	N- 16°47'5.9" E-80°50'55.9"
30	Digavalli	Nuzivedu	N- 16°52'5.9" E-80°49'6.2"
31	Morsapudi	Nuzivedu	N- 16°44'24.8" E-80°53'35.2"
32	Boravancha	Nuzivedu	N- 16°45'4.2" E-80°50'37.7"
33	Sunkollu	Nuzivedu	N- 16°48'17.9 E-80°8'8.6

Contd.

S.No.	Name of the village	Mandal	Latitude & Longitude
34	Vempadu	Nuzivedu	N- 16°46'22.7 E-80°50'12.5
35	Gollapalle	Nuzivedu	N- 16°44'42 E-80°52'20.3
36	Chatrai	Chatrai	N- 16°59'40.6 E-80°51'50.4
37	Chatrai	Chatrai	N- 16°59'53.2 E-80°51'66.8
38	Chittapur	Chatrai	N- 16°55'55.7 E-80°51'36.0
39	Mankollu	Chatrai	N- 17°0'34.7 E-80°56'48.1
40	Polavaram	Chatrai	N- 16°58'55.9 E-80°54'44.9
41	Kothapadu	Chatrai	N- 17°3'30.5 E-80°55'9.8
42	Chinnampet	Chatrai	N- 17°3'55.9 E-80°52'50.4
43	Jaggaypeta	Jaggaypeta	N- 16°54'41 E-80°9'52.6
44	Balusupadu	Jaggaypeta	N- 16°53'42 E-80°10'50
45	Garikipadu	Jaggaypeta	N- 16°56'994 E-80°3'8.6
46	Ravirala	Jaggaypeta	N- 16°49'19.2 E-80°8'13.9
47	Vedadri	Jaggaypeta	N- 16°47'57.2 E-80°8'54.2
48	Takkalapadu	Jaggaypeta	N- 16°48'52 E-80°8'56.7
49	West gandrai	Jaggaypeta	N- 16°58'14.5 E-80°7'2.3
50	Ravirala	Jaggaypeta	N- 16°49'19.2 E-80°8'13.9

Contd.

S.No.	Name of the village	Mandal	Latitude & Longitude
51	Jaggaypeta	Jaggaypeta	N- 16°54'7.6 E-80°6'13.3
52	East gandrai	Jaggaypeta	N- 16°58'56.5 E-80°7'22.5
53	Chillakallu	Jaggaypeta	N- 16°53'36.9 E-80°8'19.2
54	Ibbrahimpatnam	Ibbrahimpatnam	N- 16°35'33.7 E-80°31'19.2
55	Ibbrahimpatnam	Ibbrahimpatnam	N- 16°35'56 E-80°32'22.7
56	Elaprolu	Ibbrahimpatnam	N- 16°36'6.8 E-80°33'28.8
57	Damuluru	Ibbrahimpatnam	N- 16°35'26.9 E-80°33'17.6
58	Kotikalapudi	Ibbrahimpatnam	N- 16°36'2.5 E-80°27'46.8
59	Jupudi	Ibbrahimpatnam	N- 16°36'15.1 E-80°29'49.2
60	Tummalapalem	Ibbrahimpatnam	N- 16°34'17 E-80°31'50.2
61	Mullapadu	Ibbrahimpatnam	N- 16°36'31.7 E-80°28'12.4
62	Gampalagudem	Gampalagudem	N- 16°53'32.4 E-80°31'37.8
63	Arlapadu	Gampalagudem	N- 17°1'32.9 E-80°29'37.7
64	Gullapudi	Gampalagudem	N- 17°2'59.0 E-80°30'17.8
65	Kanumuru	Gampalagudem	N- 16°59'57.5 E-80°31'12.7
66	Lingala	Gampalagudem	N- 16°56'29.8 E-80°13'41.5
67	Meduru	Gampalagudem	N- 17°1'56 E-80°30'22.5

Contd.

S.No.	Name of the village	Mandal	Latitude & Longitude
68	Utukuru	Gampalagudem	N- 17°0'57.9 E-80°25'55.0
69	Utukuru	Gampalagudem	N- 17°0'22.5 E-80°26'12.7
70	Pamidimukkala	Pamidimukkala	N- 16°16'44.4 E-80°52'0.6
71	Inampudi	Pamidimukkala	N- 16°17'44.9 E-80°54'20
72	Meduru	Pamidimukkala	N- 16°16'12.2 E-80°54'12
73	Mantada	Pamidimukkala	N- 16°15'17.6 E-80°52'22.8
74	Mullapudi	Pamidimukkala	N- 16°18'15.1 E-80°53'49.9
75	Choragudi	Pamidimukkala	N- 16°14'31.6 E-80°52'30.4
76	Inapuru	Pamidimukkala	N- 16°15'38.9 E-80°52'15.2
77	Musunuru	Musunuru	N- 16°49'37.6 E-80°56'0.6
78	Surepalli	Musunuru	N- 16°53'33.4 E-80°54'14.8
79	Gullapudi	Musunuru	N- 17°2'58.9 E-80°30'17.6
80	Musunuru	Musunuru	N- 16°49'37.6 E-80°56'0.6
81	Ellapuram	Musunuru	N- 16°52'22 E-80°54'16.2
82	Chintalvalli	Musunuru	N- 16°50'0.2 E-80°54'59.4
83	Lopudi	Musunuru	N- 16°53'50.3 E-80°56'44.2
84	Tiruvuru	Tiruvuru	N- 17°6'35.8 E-80°36'33.5

Contd.

S.No.	Name of the village	Mandal	Latitude & Longitude
85	Chittela	Tiruvuru	N- 17°2'44.5 E-80°36'27.7
86	Rajupeta	Tiruvuru	N- 17°5'36.7 E-80°36'29.8
87	Mallela	Tiruvuru	N- 17°2'25.6 E-80°36'29.8
88	Munukulla	Tiruvuru	N- 17°6'54.4 E-80°34'30
89	Vavilala	Tiruvuru	N- 17°5'5.3 E-80°32'10.3
90	Vavilala	Tiruvuru	N- 17°5'30.9 E-80°32'12.5
91	Nandigama	Nandigama	N- 16°46'23.9 E-80°17'10.1
92	Damuluru	Nandigama	N- 16°44'10.9 E-80°10'26.5
93	Lingalapadu	Nandigama	N- 16°44'10.4 E-80°10'27
94	Satyavaram	Nandigama	N- 16°45'46.4 E-80°14'35.4
95	Pallagiri	Nandigama	N- 16°45'25.2 E-80°14'42
96	Gollamudi	Nandigama	N- 16°45'26 E-80°14'42.6
97	Kanchela	Nandigama	N- 16°54'12.2 E-80°9'3.6
98	Penuganchiprolu	Penuganchiprolu	N- 16°54'6.1 E-80°14'50.6
99	Thotacherla	Penuganchiprolu	N- 16°55'12.7 E-80°15'27.3
100	Mullapadu	Penuganchiprolu	N- 16°53'25.3 E-80°12'22.3
101	Konakanchi	Penuganchiprolu	N- 16°49'38.3 E-80°11'54.6

Contd.

S.No.	Name of the village	Mandal	Latitude & Longitude
102	Sanagapadu	Penuganchiprolu	N- 16°49'5.3 E-80°17'78.6
103	Sanagapadu	Penuganchiprolu	N- 16°49'22.9 E-80°17'19.3
104	Kollikulla	Penuganchiprolu	N- 16°52'16.3 E-80°15'21
105	Anigandlapadu	Penuganchiprolu	N- 16°53'8.6 E-80°12'28.1
106	Vatsvai	Vatsvai	N- 16°58'49.4 E-80°14'40.6
107	Chittela	Vatsvai	N- 17°2'44.5 E-80°36'27.8
108	Lingala	Vatsvai	N- 16°56'46.3 E-80°14'43.4
109	Allurupadu	Vatsvai	N- 16°58'26.9 E-80°14'6.3
110	Makkapeta	Vatsvai	N- 16°55'33.2 E-80°11'22.2
111	Gangavalli	Vatsvai	N- 16°57'51.0 E-80°14'25.4
112	Dechupalem	Vatsvai	N- 16°56'21 E-80°13'32.6
113	Chandarlapadu	Chandarlapadu	N- 16°41'38.1 E-80°12'35.3
114	Eturu	Chandarlapadu	N- 16°42'10.8 E-80°12'35.3
115	Konayapalem	Chandarlapadu	N- 16°45'22.7 E-80°13'35.4
116	Pokkunuru	Chandarlapadu	N- 16°39'27.7 E-80°9'37.1
117	Gudimetla	Chandarlapadu	N- 16°42'10.8 E-80°12'35.3
118	Chintalpadu	Chandarlapadu	N- 16°39'21.2 E-80°16'38.6

Contd.

S.No.	Name of the village	Mandal	Latitude & Longitude
119	Mungalapalli	Chandarlapadu	N- 16°41'12.3 E-80°9'22.1
120	Kanchikacherla	Kanchikacherla	N- 16°40'59.9 E-80°23'25.4
121	Chevitikallu	Kanchikacherla	N- 16°31'42.6 E-80°14'20.8
122	Keesara	Kanchikacherla	N- 16°43'4.4 E-80°21'7.9
123	Paritala	Kanchikacherla	N- 16°39'30.2 E-80°24'32.4
124	Singapuram	Kanchikacherla	N- 16°31'35 E-80°21'12.5
125	Vemulapalli	Kanchikacherla	N- 16°41'56.4 E-80°22'37.2
126	Gandepalli	Kanchikacherla	N- 16°43'29.6 E-80°22'28.2
127	Verullapadu	Verullapadu	N- 16°49'11.3 E-80°23'52.8
128	Jammavaram	Verullapadu	N- 16°44'9.2 E-80°21'59.4
129	Nadaluru	Verullapadu	N- 16°44'46.4 E-80°20'38.4
130	Pallampalle	Verullapadu	N- 16°48'39.6 E-80°22'48
131	Peddapuram	Verullapadu	N- 16°43'11.3 E-80°27'12.6
132	Vellanki	Verullapadu	N- 16°45'58.4 E-80°22'17.8
133	Vellanki	Verullapadu	N- 16°45'42.5 E-80°22'9.2
134	Penamaluru	Penamaluru	N- 16°26'20.8 E-80°42'36
135	Penamaluru	Penamaluru	N- 16°26'57.88 E-80°42'33.5

Contd.

S.No.	Name of the village	Mandal	Latitude & Longitude
136	Penamaluru	Penamaluru	N- 16°27'47.5 E-80°42'29.9
137	Vanukuru	Penamaluru	N- 16°26'34.7 E-80°44'11.8
138	Chodavaram	Penamaluru	N- 16°25'13.1 E-80°42'58.3
139	Gosala	Penamaluru	N- 16°26'45.6 E-80°44'50.3
140	Gosala	Penamaluru	N- 16°26'22.2 E-80°44'12.2
141	Kankipadu	Kankipadu	N- 16°26'2.4 E-80°46'4.1
142	Davuluru	Kankipadu	N- 16°25'4.8 E-80°47'27.6
143	Kunderu	Kankipadu	N- 16°25'24.3 E-80°50'30.8
144	Tanneru	Kankipadu	N- 16°29'0.2 E-80°48'49.7
145	Velpuru	Kankipadu	N- 16°29'43.4 E-80°45'28.8
146	Kandalampadu	Kankipadu	N- 16°26'33.4 E-80°49'45.8
147	Edpugallu	Kankipadu	N- 16°27'32.4 E-80°45'10.8
148	Vuyyuru	Vuyyuru	N- 16°21'32.4 E-80°50'24
149	Akunuru	Vuyyuru	N- 16°23'42 E-80°49'3
150	Akunuru	Vuyyuru	N- 16°23'35.2 E-80°49'24.2
151	Mudunuru	Vuyyuru	N- 16°23'11.8 E-80°48'54
152	Katuru	Vuyyuru	N- 16°22'4.8 E-80°50'39.5

Contd.

S. No.	Name of the village	Mandal	Latitude & Longitude
153	Chinnaogirala	Vuyyuru	N- 16°22'34.7 E-80°49'28.6
154	Saipuram	Vuyyuru	N- 16°21'12.5 E-80°48'9.6
155	Unguturu	Unguturu	N- 16°31'34.7 E-80°52'45.1
156	Bokkinala	Unguturu	N- 16°27'46.8 E-80°50'42
157	Mukkapadu	Unguturu	N- 16°29'13.2 E-80°54'13.7
158	Mukkapadu	Unguturu	N- 16°29'20.4 E-80°54'43.2
159	Indupalli	Unguturu	N- 16°29'36.2 E-80°52'55.2
160	Manikonda	Unguturu	N- 16°29'16.8 E-80°49'51.6
161	Atkuru	Unguturu	N- 16°32'38.4 E-80°51'10.8
162	Gannavaram	Gannavaram	N- 16°32'8.5 E-80°47'55.3
163	Balliparru	Gannavaram	N- 16°16'42.6 E-80°46'2.5
164	Gollanapalle	Gannavaram	N- 16°36'12.6 E-80°4'45.1
165	Mettapalle	Gannavaram	N- 16°33'15.1 E-80°49'33.8
166	Savirigudem	Gannavaram	N- 16°32'4.2 E-80°43'37.2
167	Allapuram	Gannavaram	N- 16°32'26.5 E-80°50'6.4
168	Chinavautupalli	Gannavaram	N- 16°33'23 E-80°49'28.6
169	Agiripalle	Agiripalle	N- 16°40'54 E-80°47'2

Contd.

S. No.	Name of the village	Mandal	Latitude & Longitude
170	Agiripalle	Agiripalle	N- 16°40'57.2 E-80°47'13.2
171	Sagguru	Agiripalle	N- 16°39'31.7 E-80°50'6
172	Saravaram	Agiripalle	N- 16°37'59.2 E-80°51'35.6
173	Edara	Agiripalle	16°43'27.5 E-80°45'15.8
174	Kalaturu	Agiripalle	N- 16°41'12.6 E-80°50'18.9
175	Kalaturu	Agiripalle	N- 16°41'24.6 E-80°50'49.3
176	Bapulapadu	Bapulapadu	N- 16°22'52 E-80°34'32.9
177	Ampapuram	Bapulapadu	N- 16°24'39.6 E-80°55'17.5
178	Chirivada	Bapulapadu	N- 16°33'28.8 E-80°56'4.2
179	Kanumollu	Bapulapadu	N- 16°36'19.4 E-80°57'56.2
180	Madicherla	Bapulapadu	N- 16°44'10.3 E-80°58'59.5
181	Veleru	Bapulapadu	N- 16°45'07 E-80°12'23
182	Ramalle	Bapulapadu	N- 16°44'22.3 E-80°58'11
183	G.konduru	G.konduru	N- 16°40'55.6 E-80°34'27.5
184	Koduru	G.konduru	N- 16°39'2 E-80°39'12.1
185	Chevuturu	G.konduru	N- 16°41'34.8 E-80°35'48.8
186	Pinapaka	G.konduru	N- 16°39'29.5 E-80°34'35.8

Contd.

S. No.	Name of the village	Mandal	Latitude & Longitude
187	Vellaturu	G.konduru	N- 16°42'51.5 E-80°34'24.2
188	Gaddamanugu	G.konduru	N- 16°40'49.8 E-80°34'33.2
189	Kavuluru	G.konduru	N- 16°37'34.7 E-80°35'3.1
190	Thotlavalluru	Thotlavalluru	N- 16°21'37.1 E-80°50'40.6
191	Devarapalli	Thotlavalluru	N- 16°17'47.4 E-80°49'32.2
192	Penamakuru	Thotlavalluru	N- 16°19'39 E-80°49'19.9
193	Royyuru	Thotlavalluru	N- 16°23'34.4 E-80°45'1.4
194	Yakamuru	Thotlavalluru	N- 16°21'37.4 E-80°49'50.2
195	Chagantipadu	Thotlavalluru	N- 16°29'30.8 E-80°51'20.5
196	Iluru	Thotlavalluru	N- 16°15'56.5 E-80°49'56.3
197	Kummamuru	Thotlavalluru	N- 16°20'44.2 E-80°49'33.6
198	Garikaparru	Thotlavalluru	N- 16°20'50.6 E-80°49'57
199	Kanakavalli	Thotlavalluru	N- 16°23'10.4 E-80°49'40.8
200	Guruvindapalli	Thotlavalluru	N- 16°17'14.1 E-80°49'28.66
201	South valluru	Thotlavalluru	N- 16°21'59.49 E-80°45'16.91
202	North valluru	Thotlavalluru	N- 16°22'26.61 E-80°47'36.58
203	Royyuru	Thotlavalluru	N- 16°23'28.99 E-80°44'24.54

Contd.

S. No.	Name of the village	Mandal	Latitude & Longitude
204	Vijayawada (rural)	Vijayawada (rural)	N- 16°30'48.42 E-80°37'22.11
205	Kotturu	Vijayawada (rural)	N- 16°30'12.2 E-80°36'2.4
206	Enikipadu	Vijayawada (rural)	N- 16°30'46.32 E-80°42'7.32
207	Tadepalle	Vijayawada (rural)	N- 16°29'24.5 E-80°41'29.8
208	Gudavalli	Vijayawada (rural)	N- 16°30'22.1 E-80°42'12.9
209	Vijayawada(urban)	Vijayawada(urban)	N- 16°31'29.51 E-80°36'14.33
210	Vijayawada(urban)	Vijayawada(urban)	N- 16°31'2.1 E-80°35'32.5
211	Vijayawada(urban)	Vijayawada(urban)	N- 16°33'15.6 E-80°36'18.7
212	Vijayawada(urban)	Vijayawada(urban)	N- 16°31'26.7 E-80°35'26

Table 3.2 : Soil sampling details in different mandals of Vijayawada and Nuzivedu divisions of Krishna district

S. No.	Mandal	No. of samples collected
1	A.Konduru	7
2	Reddigudem	7
3	Mylavaram	7
4	Vissanapeta	7
5	Nuzivedu	7
6	Chatrai	7
7	Jaggaypeta	11
8	Ibbrahimpatnam	8
9	Gampalagudem	8
10	Pamidimukkala	7
11	Musunuru	7
12	Tiruvuru	7
13	Nandigama	7
14	Penuganchiprolu	8
15	Vatsvai	7
16	Chandarlapadu	7
17	Kanchikacherla	7
18	Verullapadu	7
19	Penamaluru	7
20	Kankipadu	7
21	Vuyyuru	7
22	Unguturu	7
23	Gannavaram	7
24	Agiripalli	7
25	Bapulapadu	7
26	G.Konduru	7
27	Thotlavalluru	14
28	Vijayawada(Rural)	5
29	Vijayawada(Urban)	4
	Total	212

Table: 3.3 Details of farmers and cultivating crops in study area during past five years (2012-2017)

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, 2012-2017									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
1	P.Venkateswara Rao	Chilli	5800	Cotton	620	Chilli	5781	Chilli	4933	Cotton	559
2	K.Ramulu	Cotton	701	Chilli	5700	Cotton	820	Cotton	600	Chilli	5000
3	Chimata.Gopayya	Chilli	5850	Cotton	650	Chilli	5700	Cotton	650	Chilli	5655
4	Velugu.Lakshmi Narayana	Cotton	756	Chilli	5500	Cotton	850	Chilli	5600	Cotton	565
5	Barothu.Ramu	Chilli	5899	Cotton	648	Chilli	5857	Cotton	600	Chilli	4900
6	Kukalakuntla.V.Rama Krishna Rao	Cotton	760	Chilli	5789	Chilli	5400	Cotton	620	Chilli	5423
7	Kothapalli.Seshaiah	Chilli	5653	Cotton	600	Cotton	800	Chilli	5587	Chilli	5768
8	Pidaparathi.Appireddy	Chilli	5055	Cotton	610	Maize	6300	Cotton	580	Chilli	5897
9	Chata.China Venkata Ratnam	Cotton	700	Maize	6412	Cotton	790	Cotton	597	Chilli	5543
10	Polisetty.Venkata Srinivasa Rao	Maize	6288	Chilli	5107	Cotton	785	Cotton	600	Cotton	500
11	Gampaneni.Rama Devi	Chilli	5238	Cotton	620	Chilli	5337	Cotton	620	Maize	6921
12	Regella.Ananta Reddy	Cotton	710	Maize	6489	Cotton	810	Cotton	575	Chilli	5632
13	Bommareddy.Markendeya Reddy	Maize	6325	Chilli	5347	Maize	6534	Maize	6921	Chilli	5780
14	Bondada.Rambabu	Cotton	690	Maize	6356	Cotton	800	maize	6800	Cotton	500
15	Chanumolu.Srinivasa Rao	Cotton	720	Cotton	690	Cotton	850	Cotton	600	Cotton	525
16	Ch.Ramarao	Cotton	685	Cotton	685	Cotton	780	Cotton	600	Cotton	542
17	Thalla.Kondal Rao	Cotton	720	Cotton	692	Cotton	780	Cotton	600	Cotton	500
18	Vellanki.Ramayya	Cotton	700	Cotton	600	Cotton	800	Cotton	600	Cotton	550
19	Bolagani.Raghavamma	Cotton	725	Cotton	650	Cotton	850	Cotton	620	Cotton	590
20	S.Ramu	Cotton	750	Cotton	600	Cotton	872	Cotton	650	Cotton	575

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
21	J.Ravi Kumar	Cotton	765	Cotton	600	Cotton	842	Cotton	600	Cotton	565
22	Ramineni.Narasimha Swamy	Maize	6319	Maize	6389	Cotton	865	Cotton	600	Maize	6821
23	Vanama.Seetha Ramayya	Cotton	789	Maize	6414	Maize	6731	Cotton	500	Cotton	525
24	V.Ibrahim	Maize	6390	Cotton	650	Maize	6643	Cotton	550	Maize	6790
25	Maddireddy.Jaggareddy	Cotton	750	Maize	6975	Cotton	800	Maize	6810	Maize	6980
26	Ch.Sambha Siva	Maize	6910	Cotton	625	Maize	6543	Maize	6700	Cotton	520
27	J.Koteswara Rao	Cotton	750	Maize	6291	Cotton	815	Maize	6890	Cotton	525
28	Pagutla.Krishna	Maize	6750	Cotton	620	Cotton	825	Maize	6930	Maize	6690
29	P.Sesha Ratnam	Mango	9000	Mango	8150	Mango	9500	Mango	9000	Cotton	500
30	Ponnuru.Venkateswara Rao	Mango	9000	Mango	8150	Mango	9500	Mango	9000	Mango	8650
31	Gogineni Surya Narayana	Mango	9500	Mango	8450	Mango	9555	Cotton	625	Mango	8500
32	B.Nageswara Rao	Cotton	700	Cotton	655	Cotton	620	Cotton	825	Mango	9200
33	Kovuri.Ramadasu	Mango	9200	Mango	8400	Mango	9555	Cotton	650	Mango	9250
34	Maganti.Venkateswara Rao	Mango	9500	Mango	8450	Mango	9555	Mango	9350	Cotton	575
35	P.Yesu	Mango	9500	Mango	8000	Mango	9500	Mango	8450	Mango	9555
36	P.Chinna Reddy	Cotton	725	Chilli	5809	Cotton	800	Chilli	4933	Bhendi	13750
37	Mandapati.Surendara Reddy	Chilli	5689	Bhendi	13500	Chilli	5000	Chilli	5308	Cotton	555
38	B.Chitti Babu	Bhendi	13000	Chilli	5509	Bhendi	13000	Chilli	5290	Cotton	565
39	M.Raga Ratnam	Cotton	765	Bhendi	13000	Chilli	5600	Cotton	650	Chilli	5290

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
40	Yerra.Manoharamma	Chilli	4907	Cotton	650	Chilli	5080	Chilli	5208	Bhendi	13750
41	Balaji	Bhendi	13500	Chilli	4700	Cotton	825	Chilli	5480	Bhendi	13800
42	Kurram.Panakalu	Cotton	710	Bhendi	13400	Chilli	5809	Cotton	600	Chilli	5409
43	Sk.Jaan Hamen	Chilli	5666	Cotton	620	Chilli	5035	Cotton	680	Chilli	5100
44	P.Krishna Prasad	Cotton	725	Chilli	5600	Cotton	850	Cotton	650	Chilli	4933
45	Pasula.Harinadam	Chilli	4950	Cotton	600	Chilli	5108	Cotton	600	Chilli	5009
46	Ch.Subba Rao	Cotton	710	Chilli	4952	Cotton	800	Chilli	5075	Cotton	525
47	Yalagaala.Narayana	Chilli	5723	Cotton	600	Chilli	5438	Cotton	650	Chilli	5289
48	Myla.Srilatha	Cotton	730	Chilli	4969	Cotton	760	Cotton	680	Chilli	5300
49	Kakanaboyina.Kotayya	Chilli	5689	Cotton	625	Chilli	5200	Chilli	5198	Cotton	565
50	Myla.Venkateswarlu	Cotton	700	Chilli	5090	Cotton	750	Cotton	600	Cotton	500
51	L.Budhamma	Chilli	5381	Cotton	650	Chilli	5375	Cotton	600	Chilli	5312
52	Alla.Krishna	Cotton	735	Chilli	5512	Cotton	780	Chilli	5476	Cotton	525
53	Karupati.Suresh Babu	Chilli	5198	Cotton	600	Cotton	750	Cotton	600	Chilli	4908
54	K.Ramarao	Bhendi	14000	Sugarcane	98590	Bhendi	13500	Bhendi	12950	Bhendi	14650
55	Vemparala.Anjamma	Cotton	750	Bhendi	14000	Sugarcane	80000	Bhendi	14200	Cotton	500
56	Kakarla.Venkateswara Rao	Sugarcane	90500	Cotton	675	Bhendi	13250	Bhendi	14500	Sugarcane	87750
57	Uppuleti.Narsayya	Bhendi	15750	Sugarcane	100750	Bhendi	14200	Cotton	625	Bhendi	13650
58	Gude.Narsimha Rao	Bhendi	14250	Cotton	650	Sugarcane	82250	Bhendi	13950	Bhendi	14650

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
59	P.Mani	Cotton	715	Bhendi	14250	Cotton	825	Bhendi	14000	Sugarcane	89950
60	Komiti.Ratayya	Sugarcane	90250	Sugarcane	99850	Bhendi	14500	Bhendi	14200	Cotton	525
61	Nimmagadda.Srihari	Bhendi	15000	Cotton	600	Sugarcane	87550	Bhendi	13500	Bhendi	14500
62	Panneru.Srinivasa Rao	Cotton	725	Maize	6050	Cotton	850	Bhendi	14350	Bhendi	14700
63	D.Nagireddy	Maize	6100	Cotton	625	Maize	6490	Bhendi	14800	Maize	6800
64	Tammisetty China Venkayya	Bhendi	14200	Maize	6380	Cotton	800	Maize	6865	Bhendi	14750
65	B.Venkateswara Rao	Cotton	760	Bhendi	14000	Maize	6550	Cotton	675	Maize	6900
66	E.Krishnayya	Maize	6169	Cotton	650	Maize	6400	Maize	6660	Bhendi	14500
67	K.Venkateswar Rao	Bhendi	14500	Maize	6200	Bhendi	13900	Cotton	665	Maize	6831
68	Mudhigonda.Srinivasarao	Cotton	700	Maize	6487	Maize	6500	Bhendi	14500	Cotton	500
69	Guntupalli.Narsimha Rao	Maize	6259	Bhendi	14500	Maize	6498	Cotton	675	Bhendi	14800
70	E.Satyanarayana	Turmeric	8500	Brinjal	18650	Turmeric	8950	Sugarcane	85500	Sugarcane	89900
71	Murala.Ankayya	Brinjal	18500	Turmeric	8250	Brinjal	18950	Sugarcane	87750	Sugarcane	85750
72	Bhimavarapu.Kotireddy	Sugarcane	90000	Brinjal	18950	Turmeric	8550	Sugarcane	91200	Sugarcane	90120
73	Dhara.Ranganayakamma	Turmeric	8750	Sugarcane	107500	Brinjal	18250	Turmeric	8750	Sugarcane	89650
74	P.Anjibabu	Brinjal	18250	Brinjal	18500	Sugarcane	80120	Brinjal	18220	Turmeric	8125
75	A.Durga Prasad	Sugarcane	91200	Brinjal	18250	Sugarcane	85750	Turmeric	8250	Brinjal	18750
76	Konda.Chinnapareddy	Turmeric	8250	Brinjal	18550	Turmeric	8800	Sugarcane	86750	Turmeric	8215
77	S.S.Sai Krishna	Cotton	700	Maize	6500	Cotton	825	Maize	6015	Cotton	755

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
78	Guntru.Veera Swamy	Maize	6590	Cotton	325	Cotton	800	Maize	6168	Maize	6895
79	Vempati.Srinivasa Rao	Cotton	750	Maize	6341	Cotton	795	Cotton	825	Maize	6732
80	L.K.Subba Rao	Maize	6290	Cotton	655	Maize	6300	Cotton	855	Maize	6599
81	Ch.Rajayya	Cotton	775	Maize	6438	Cotton	825	Maize	6642	Cotton	785
82	Gorrapati.Lakshmi Narayana	Maize	6900	Cotton	625	Cotton	775	Maize	6168	Cotton	790
83	P.Kondala Rao	Cotton	720	Maize	6989	Cotton	850	Cotton	870	Maize	6389
84	Kunchem.Prabhakar Rao	Cotton	775	Chilli	5700	Pesara	725	Yam	12500	Pesara	525
85	Kolli.V.Lella Prasad	Yam	11000	Cotton	625	Yam	12500	Chilli	4985	Pesara	525
86	S.Murali	Maize	6345	Chilli	5512	Cotton	750	Yam	12000	Pesara	550
87	G.Bhanu Teja	Chilli	5123	Yam	12500	Pesara	525	Cotton	660	Chilli	4977
88	Mungala.Apayya	Pesara	965	Chilli	5328	Pesara	555	Yam	6000	Cotton	500
89	P.Venkata Ramayya	Cotton	750	Pesara	500	Yam	12000	Cotton	625	Chilli	5058
90	K.Venkateswara Rao	Yam	12000	Chilli	5489	Cotton	840	Pesara	500	Yam	10200
91	Ch.Anand Vasudev	Chilli	5497	Cotton	600	Chilli	5328	Cotton	650	Chilli	4987
92	S.Murali Krishna	Cotton	710	Chilli	5732	Cotton	855	Cotton	650	Chilli	5036
93	M.Ganesh	Chilli	5423	Cotton	685	Cotton	825	Chilli	5915	Cotton	525
94	K.Nagaraju	Cotton	695	Chilli	5169	Cotton	800	Cotton	620	Chilli	4955
95	Kolluri.Nageswara Rao	Chilli	5674	Cotton	600	Chilli	5421	Chilli	5508	Cotton	510
96	T.Konda	Cotton	725	Chilli	5387	Cotton	810	Chilli	5109	Cotton	575

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
97	M.Ratayya	Chilli	5648	Cotton	650	Chilli	5128	Cotton	625	Chilli	5548
98	Yesebhu	Cotton	765	Bhendi	14550	Cotton	865	Bhendi	14220	Cotton	550
99	Balusupati.Haribabu	Bhendi	14250	Cotton	625	Bhendi	14250	Bhendi	14850	Cotton	585
100	Y.Prakash Rao	Cotton	750	Bhendi	14120	Cotton	870	Bhendi	14770	Cotton	550
101	K.Venkat Rao	Bhendi	14550	Cotton	610	Bhendi	14750	Cotton	600	Bhendi	14110
102	Bonava.Venkayya	Cotton	750	Bhendi	14750	Cotton	800	Cotton	650	Bhendi	14250
103	A.Nagaraju	Bhendi	14000	Cotton	685	Bhendi	14550	Bhendi	14250	Cotton	575
104	Kuchi.Rambabu	Cotton	765	Bhendi	14850	Cotton	850	Bhendi	14000	Cotton	520
106	N.Pulla Rao	Cotton	750	Chilli	5678	Cotton	750	Chilli	4920	Cotton	700
107	Avula.Kasayya	Chilli	5489	Cotton	625	Cotton	825	Chilli	5368	Cotton	525
108	M.Narasimha Rao	Cotton	750	Chilli	5873	Cotton	855	Cotton	625	Chilli	4925
109	Mattapalli.Nageswara Rao	Chilli	5468	Cotton	625	Chilli	5008	Cotton	650	Chilli	5109
110	V.Venkateswarlu	Cotton	725	Chilli	5614	Cotton	820	Chilli	4933	Cotton	500
111	L.Bethala Reddy	Chilli	5213	Cotton	650	Chilli	4900	Cotton	660	Chilli	4985
112	K.Rama Rao	Cotton	700	Chilli	5682	Cotton	780	Cotton	600	Chilli	4984
113	Gudipudi.Venkateswarlu	Chilli	5782	Cotton	550	Chilli	5512	Cotton	610	Chilli	4915
114	M.Srikumar	Cotton	712	Chilli	5782	Cotton	765	Chilli	4800	Cotton	565
115	E.Krishnayya	Chilli	5520	Chilli	5583	Cotton	810	Chilli	4978	Cotton	570
116	K.Venkateswara Rao	Cotton	690	Cotton	580	Chilli	5785	Chilli	5368	Cotton	500

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
117	Ch.Seethayya	Chilli	5700	Cotton	595	Chilli	5632	Cotton	590	Chilli	5126
118	Kadiyala.Subba Rao	Cotton	655	Chilli	5648	Cotton	750	Chilli	5245	Cotton	575
119	Konakanchi.Srinivasa Rao	Chilli	4978	Cotton	600	Chilli	5845	Cotton	555	Chilli	5543
120	S.Surya Narayana	Cotton	750	Chilli	4975	Cotton	855	Chilli	5004	Cotton	525
121	P.Koteswara Rao	Chilli	5643	Cotton	675	Chilli	5249	Cotton	580	Chilli	5618
122	M.Jamala Reddy	Cotton	765	Chilli	5721	Cotton	785	Cotton	625	Chilli	4972
123	Chintala.Ram Mohana Rao	Chilli	5723	Cotton	665	Cotton	850	Chilli	5285	Chilli	4998
124	M.Satish	Cotton	700	Chilli	5546	Cotton	800	Cotton	600	Chilli	5328
125	Damini.Hari Babu	chilli	5528	Chilli	5865	Chilli	5439	Cotton	600	Cotton	500
126	B.Srihari Reddy	Cotton	700	Chilli	5249	Cotton	825	Chilli	4985	Cotton	555
127	V.Nageswar Rao	Gourds	13500	Yam	12500	Turmeric	8000	Sugarcane	88500	Sugarcane	85000
128	D.Siva Rama Krishna Prasad	Sugarcane	82500	Turmeric	7500	Sugarcane	80125	Turmeric	8250	Sugarcane	80125
129	Elurri.Satyanarayana	Turmeric	8250	Sugarcane	80150	Turmeric	8120	Sugarcane	90120	Turmeric	8120
130	Ch.Venkatareddy	Sugarcane	80125	Turmeric	8500	Sugarcane	89900	Sugarcane	80125	Turmeric	7500
131	Maddala.Srinivasa Rao	Turmeric	8120	Turmeric	7500	Sugarcane	85750	Turmeric	8120	Sugarcane	80150
132	Sk.Meera Vali	Sugarcane	80000	Sugarcane	80150	Turmeric	7500	Turmeric	7500	Sugarcane	80125
133	R.Poornachandar Rao	Turmeric	7500	Turmeric	8250	Sugarcane	80150	Sugarcane	80150	Turmeric	8120
134	Chekuri.Subba Rao	Sugarcane	80150	Turmeric	8550	Sugarcane	90120	Turmeric	7500	Sugarcane	85650
135	N.Pichayya	Gourds	11500	Sugarcane	92500	Gourds	11500	Sugarcane	80150	Gourds	12000

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
136	K.Srinivasa Rao	Sugarcane	92500	Gourds	11500	Sugarcane	85750	Sugarcane	85650	Gourds	11500
137	K.Bucchi Babu	Gourds	13500	Sugarcane	90500	Sugarcane	90120	Gourds	10000	Gourds	13500
138	M.Chennayya	Sugarcane	85650	Gourds	12500	Sugarcane	89650	Gourds	11250	Sugarcane	85650
139	Parvathaneni.Kutumba Rao	Gourds	12500	Sugarcane	85650	Gourds	12500	Sugarcane	85650	Gourds	11500
140	Anamololu.Sai Prasad	Sugarcane	85750	Gourds	11500	Sugarcane	85650	Gourds	12000	Sugarcane	89900
141	B.Mutha Reddy	Maize	6855	Baby corn	5250	Maize	6250	Gourds	11500	Sugarcane	85750
142	Vallabhaneni.Venkata Reddy	Baby corn	5500	Maize	6750	Gourds	12000	Maize	6900	Sugarcane	90120
143	Kuppala.Prasad	Maize	6500	Baby corn	4500	Maize	6700	Gourds	11500	Sugarcane	89650
144	S.Satya Prasad	Gourds	11250	Maize	6976	Sugarcane	85650	Maize	6855	Baby corn	3000
145	Valluri.Siva Kumar	Sugarcane	92500	Gourds	11000	Baby corn	5250	Maize	6490	Maize	6950
146	J.Anjaneyulu	Maize	6250	Baby corn	4500	Maize	6900	Gourds	13000	Sugarcane	85650
147	Md.Ismael	Baby corn	3500	Gourds	11555	Maize	6250	Sugarcane	92500	Maize	6865
148	V.Lakshmana Rao	Turmeric	8000	Yam	12000	Gourds	12000	Sugarcane	102500	Sugarcane	92510
149	Kakani.Rambabu	Yam	11500	Turmeric	8210	Sugarcane	85000	Sugarcane	88520	Gourds	11000
150	Ch.Chalapathi Rao	Gourds	12500	Yam	11250	Turmeric	8000	Sugarcane	89250	Sugarcane	80000
151	K.Narayana Rao	Sugarcane	85500	Gourds	11500	Yam	11220	Turmeric	8000	Sugarcane	82500
152	Chinda.Srinivasa Rao	Turmeric	8500	Sugarcane	80000	Gourds	11500	Sugarcane	80000	Yam	12500
153	K.Veera Raghavayya	Yam	12000	Sugarcane	82500	Sugarcane	82500	Gourds	12500	Turmeric	8750
154	Katta.Srinivasa Rao	Gourds	12000	Yam	10000	Turmeric	7950	Sugarcane	87500	Sugarcane	91250

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
155	Adusumilli.Murali Krishna	Sugarcane	82500	Turmeric	8750	Sugarcane	85500	Turmeric	8250	Sugarcane	90120
156	Badugu.Venkateswarlu	Turmeric	8250	Sugarcane	85000	Turmeric	8550	Sugarcane	82500	Turmeric	8600
157	N.Venkateswara Rao	Sugarcane	80125	Turmeric	8000	Sugarcane	80000	Sugarcane	85000	Turmeric	8000
158	Mekala.Nageswara Rao	Turmeric	8120	Turmeric	8250	Sugarcane	92500	Turmeric	8650	Sugarcane	80150
159	Ch.Siva	Sugarcane	80000	Sugarcane	87500	Turmeric	8125	Turmeric	8120	Sugarcane	88500
160	Tummala.Venkata Ravi	Turmeric	7500	Turmeric	7000	Sugarcane	90000	Sugarcane	85500	Turmeric	8125
161	Batthina.Samyelu	Sugarcane	80150	Turmeric	7250	Sugarcane	85650	Turmeric	7560	Sugarcane	89500
162	A.Ranga Rao	Mango	8500	Mango	7750	Mango	8350	Mango	8125	Mango	7900
163	Talam.Venkateswara Rao	Mango	7000	Mango	8000	Mango	8125	Mango	7950	Mango	8000
164	K.Rambabu	Mango	8125	Groundnut	2150	Mango	7805	Mango	7000	Ground nut	2650
165	Kosaraju.Pichayya Chowdary	Mango	8000	Mango	8250	Mango	7500	Mango	8250	Mango	8125
166	B.Siva Ram Prasad	Mango	7000	Mango	8000	Mango	8125	Mango	7950	Mango	8000
167	A.Ramarao	Ground nut	2000	Groundnut	2250	Gourds	12000	Ground nut	1950	Mango	7000
168	Venkataratnam	Mango	8500	Mango	7550	Mango	8350	Mango	8125	Mango	7900
169	P.Durga Rao	Mango	7200	Mango	8500	Mango	8125	Mango	7950	Mango	8000
170	Ramababu	Mango	8500	Mango	7750	Mango	8350	Mango	8125	Mango	7900
171	Kota.Babu Rao	Mango	7000	Mango	8000	Mango	8125	Mango	7950	Mango	8000
172	I.Srinivasa Rao	Mango	8000	Groundnut	2125	Mango	8550	Ground nut	1900	Ground nut	2200
173	P.Narasimha Rao	Ground nut	2450	Groundnut	2200	Ground nut	1890	Ground nut	2200	Mango	7950

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
174	Pamarthi.Subba Rao	Mango	8500	Mango	7750	Mango	8350	Mango	8125	Mango	7900
175	A.Sambayya	Mango	7000	Mango	8000	Mango	8125	Mango	7950	Mango	8000
176	Katragadda.Srinivasa Rao	Bhendi	14250	Cotton	625	Bhendi	14250	Bhendi	14850	Cotton	585
177	Guddeti.Sudhakar	Cotton	750	Bhendi	14120	Cotton	870	Bhendi	14770	Cotton	550
178	G.Satyanarayana	Bhendi	14550	Cotton	610	Bhendi	14750	Cotton	600	Bhendi	14110
179	Katta.Venkatesh	Cotton	750	Bhendi	14750	Cotton	800	Cotton	650	Bhendi	14250
180	Konasani.Venkateswara Rao	Bhendi	14000	Cotton	685	Bhendi	14550	Bhendi	14250	Cotton	575
181	A.Pedha Kotayya	Cotton	765	Bhendi	14850	Cotton	850	Bhendi	14000	Cotton	520
182	Dondapati.Krishnayya	Cotton	750	Chilli	5678	Cotton	750	Chilli	4920	Cotton	700
183	P.Vasu	Cotton	725	Cotton	650	Cotton	825	Cotton	680	Cotton	610
184	Kandula.Ramesh	Cotton	755	Cotton	655	Cotton	800	Cotton	650	Cotton	600
185	M.Seetha Ramulu	Cotton	680	Cotton	610	Cotton	795	Cotton	700	Cotton	590
186	Sola.Subrahmanyam	Cotton	650	Cotton	600	Cotton	755	Cotton	725	Cotton	500
187	V.Venkateswara Rao	Cotton	700	Cotton	590	Cotton	820	Cotton	755	Cotton	525
188	Puppala.Sambasiva Rao	Cotton	700	Cotton	675	Cotton	850	Cotton	680	Cotton	575
189	Avuluri.Vekata Narayana Reddy	Cotton	725	Cotton	600	Cotton	820	Cotton	650	Cotton	510
190	Kallam.Yogeswara Reddy	Turmeric	8555	Yam	620	Chilli	5423	Sugarcane	85650	Sugarcane	86470
191	A.Vema Reddy	Yam	11000	Turmeric	7950	Sugarcane	79500	Chilli	4925	Sugarcane	85650
192	Alla.Satya Narayana	Sugarcane	88950	Yam	10000	Turmeric	7500	Sugarcane	85650	Chilli	5036

Contd.

S. No.	Name of the cultivator	Crops grown & yield (kg ha ⁻¹) in past five years, (2012-2017)									
		2016-17	Yield	2015-16	Yield	2014-15	Yield	2013-14	Yield	2012-13	Yield
193	K.Koteswara Rao	Chilli	5872	Sugarcane	102500	Yam	11250	Turmeric	8250	Sugarcane	89900
194	Bommareddy.Venkata Reddy	Turmeric	8850	Chilli	5563	Sugarcane	90120	Yam	12050	Sugarcane	85750
195	Changanti.Kotireddy	Yam	12500	Sugarcane	90250	Sugarcane	89650	Chilli	5491	Turmeric	8000
196	Kunapareddy.Durga Rao	Sugarcane	85650	Turmeric	8500	Yam	13220	Chilli	5782	Sugarcane	90120
197	P.Dharma Rao	Chilli	5276	Yam	13500	Turmeric	8250	Sugarcane	89000	Sugarcane	89650
198	Myneni.Prabhakar Rao	Turmeric	8000	Chilli	5925	Sugarcane	90120	Yam	13200	Sugarcane	87500
199	Surapaneni.Sambhasiva Rao	Yam	11200	Sugarcane	90000	Sugarcane	89650	Turmeric	8125	Chilli	4987
200	K.Achutha Ramireddy	Sugarcane	85500	Yam	10000	Chilli	5258	Sugarcane	85550	Turmeric	8000
201	Chigurapati.Apparao	Chilli	5746	Sugarcane	85650	Sugarcane	80000	Turmeric	8000	Yam	11220
202	B.Rama Swamy	Turmeric	8250	Chilli	5232	Yam	12120	Sugarcane	89900	Sugarcane	85500
203	K.Anjaneyulu	Chilli	5469	Turmeric	8500	Sugarcane	82500	Sugarcane	85750	Yam	10500
204	Movva.Radha Krishna Murthy	Maize	4250	Maize	5500	Turmeric	8000	Sugarcane	90120	Sugarcane	80000
205	B.Subha Rao	Cucumber	15000	Maize	5000	Turmeric	8100	Sugarcane	89650	Sugarcane	80000
206	E.Rama Krishna	Turmeric	8150	Turmeric	8250	Turmeric	8000	Turmeric	7590	Turmeric	8125
207	Garimella.Ramesh	Turmeric	8000	Sugarcane	89900	Maize	5200	Sugarcane	88000	Maize	4900
208	Kanumuri.Venkata Rama	Maize	4000	Sugarcane	85750	Maize	5000	Turmeric	7250	Maize	5250
209	Manmada Rao	Cucumber	14500	Sugarcane	90120	Maize	4950	Sugarcane	89900	Maize	4500
210	Venkata Krishnayya	Maize	4250	Sugarcane	89650	Maize	6000	Sugarcane	85750	Maize	4000
211	P.Venkatappaya	Cucumber	15250	Sugarcane	100550	cucumber	15200	Sugarcane	90120	Sugarcane	82500
212	Tammala.Chinnayya	Maize	4250	Sugarcane	105500	Turmeric	8520	Sugarcane	89650	Sugarcane	81250

Table 3.3.1: Average yield (kg ha⁻¹) of major crops grown in different mandals of Krishna district

S. No.	Name of the crop	Yield (kg ha ⁻¹)				
		2016-17	2015-16	2014-15	2013-14	2012-13
1	Cotton	726	647	800	644	550
2	Chilles	5465	5500	5781	4933	3500
3	Sugarcane	90468	102508	83791	89795	88159
4	Maize	4338	4037	4282	4148	4738
5	Turmeric	8898	8850	8663	8524	8500
6	Mango	9312	8267	9849	9296	9000
7	Bhendi	14333	13250	13000	14120	12500
8	Groundnut	4411	3412	2693	1925	2847

3.4.1 Ratings for Soil Samples

Ratings for soil sample were given as low, medium and high categories as per the limits suggested by Ramamoorthy and Bajaj (1969) for available nitrogen. The ratings for organic carbon, soil reaction, electrical conductivity available nitrogen, phosphorus and potassium were followed as given by the Department of Agriculture, Andhra Pradesh (1989).

The ratings adopted for different parameters are given below.

Table 3.4: SOIL REACTION

S. No.	Category	pH	Classes given by
1	Acidic	< 6.5	(Department of Agriculture, AP, 2007)
2	Neutral	6.6 - 7.3	
3	Slightly alkaline	7.4 - 7.8	
4	Moderately alkaline	7.9 - 8.4	
5	Highly alkaline	> 8.4	

Table 3.5: ELECTRICAL CONDUCTIVITY (dS m⁻¹)

S. No.	Category	Sandy soil	Loamy soil	Clayey soils	Classes given by
1.	Normal	0.1- 1.0	0.1 - 1.5	0.1-2.0	(Department of Agriculture, AP, 2007)
2.	Critical for germination	1.0 - 3.0	1.6 - 3.0	2.0 - 6.0	
3.	Injurious to most of the crops	> 3.0	> 3.0	> 6.0	

Table 3.6: Rating chart for organic carbon, available N, P₂O₅ and K₂O (Kgha⁻¹)

S. No.	Nutrient	Low	Medium	High	Classes given by
1	Available N	<280	280-560	>560	Ramamoorthy and Bajaj (1969)
2	Available P ₂ O ₅	<22.4	22.4-56.0	>56.0	Muhr <i>et al.</i> (1965)
3	Available K ₂ O	<125	125-250	>250	
4	Organic carbon (%)	<0.5	0.5-0.75	>0.75	Ramamoorthy and Bajaj (1969)

Table 3.7 : Rating chart for available sulphur (SO₄⁻²)

Available secondary nutrient	Deficient	Sufficient	Limits proposed by
Available sulphur (ppm)	< 10	>10	(Tandon, 1991).

Table 3.8: Critical Limits for Available Micronutrients

S.No.	Available micronutrient	Critical limit (ppm)	Limits proposed by
1	Copper	0.2	(Lindsay and Norvell, 1978)
2	Iron	4.5	
3	Manganese	1.0	
4	Zinc	0.8	

Computation and Classification of Nutrient Index

Nutrient indices for soils were worked out as per the following formula given by Parker *et al.* (1951).

$$NI = \left[\frac{\text{No. of samples under low category} \times 1 + \text{No. of samples under medium category} \times 2 + \text{No. of sample under high category} \times 3}{\text{Total number of samples}} \right]$$

The nutrient indices so computed were classified as low, medium and high as per the ratings proposed by Ramamoorthy and Bajaj (1969).

Table 3.9: Nutrient indices for organic carbon, available N, P₂O₅ and K₂O

S. No.	Nutrient index	Category
1	<1.67	Low
2	1.67-2.33	Medium
3	>2.33	High

3.5 PREPARATION OF MAPS

Soil fertility maps for surface and subsurface soils were prepared by using Arc GIS 9.3 soft ware.

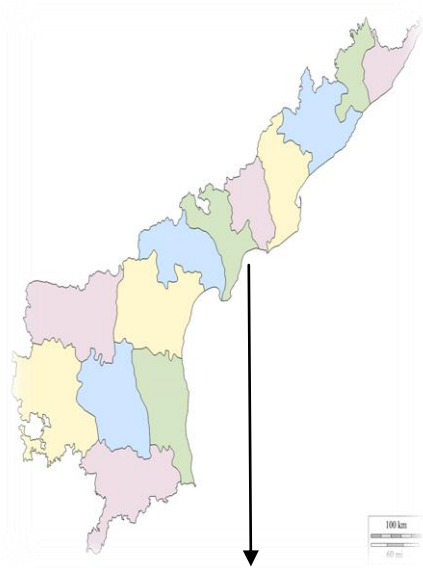
3.6 STATISTICAL ANALYSIS

Various soil properties were tested for their correlation with crop yield as per the procedure outlined by Snedecor and Cochran (1980).

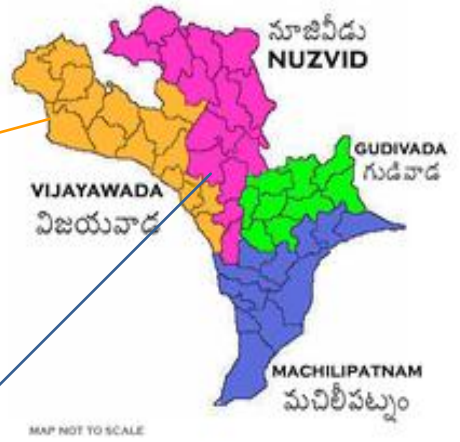
CROP YIELD DATA :

The data pertaining to productivity of different crops during the past 5 years, 2012-2017 (Table 3.3 and 3.3.1) was collected during survey and it was observed that there was gradual increase in yield 550 kg ha⁻¹ to 726 kg ha⁻¹ in

cotton, 3500 kg ha⁻¹ to 5465 kg ha⁻¹ in chillies, 88159 to 90468 kg ha⁻¹ in sugarcane, 8500 to 8898 kg ha⁻¹ in turmeric, 9000 to 9312 kg ha⁻¹ in mango, 12000 to 14333 kg ha⁻¹ in bhendi and 2847 to 4411 kg ha⁻¹ in groundnut. While slight decrease in yield from 4738 to 4338 kg ha⁻¹ was observed in maize in 2012-13 and 2016-17 years respectively.



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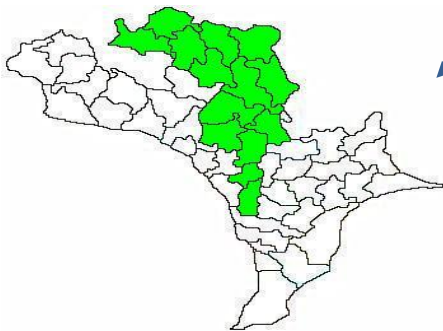


Fig 1: Location of study area

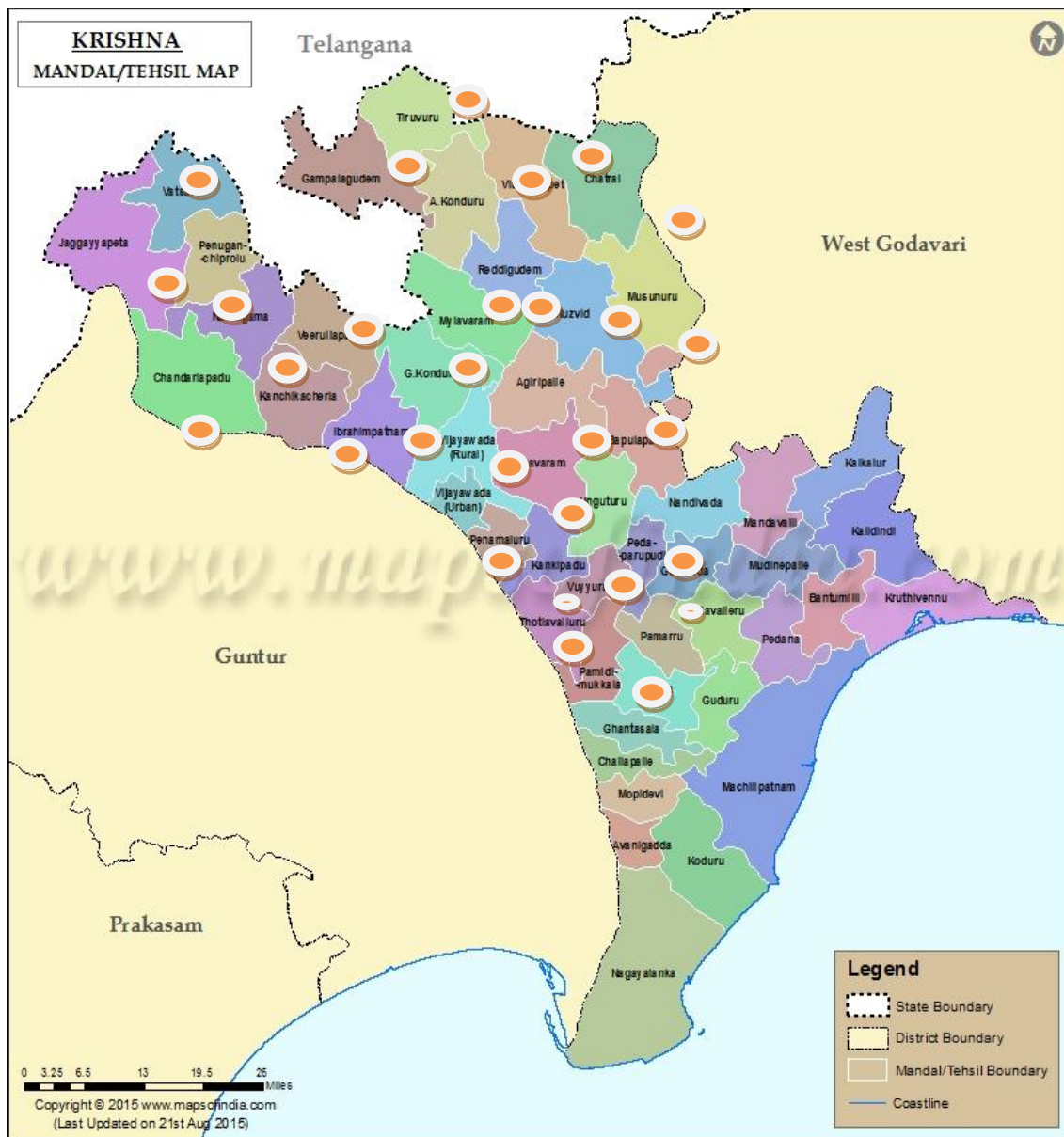


Fig. 2: Sampling Sites of Krishna District

Chapter – IV

Results and Discussion

Chapter - IV

RESULTS AND DISCUSSION

The present investigation entitled 'Fertility evaluation of upland soils of Krishna district, Andhra Pradesh' was carried out by collecting surface & subsurface samples at two hundred twelve locations. The samples were processed and analysed for physical, physico-chemical and available nutrient status of the soil. The results of the present investigation are presented under the following major sections with appropriate sub-sections as

4.1 Physical properties of soils

4.2 Physico-chemical properties of soils

4.3 Available nutrient status of soils

4.1 PHYSICAL PROPERTIES OF SOILS

The data on physical properties of soils are presented in tables 4.1 and 4.2 and depicted in figures 4.1, 4.2, 4.3 and 4.4.

4.1.1 Particle Size Distribution and Texture

The soils of study area comprised of two different textural classes, viz. sandy clay loam and clay for both surface and subsurface soil samples (Table 4.1). Critical analysis of data indicated that 25 per cent of surface and subsurface samples were found to be sandy clay loam, whereas 75 per cent of soils were clay in texture at both the depths. As a whole clay texture is the dominant textural class of the study area. Similar type of texture was observed by Ratnam *et al.* (2001) in coastal soils of Prakasam district, Andhra Pradesh. The soil texture became finer with depth. Similar textural classes were observed by Sharma (2002) in soils of Gohana, Haryana.

Table 4.1: Physical properties of the upland soils of Krishna district

S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
1	A.konduru	A.konduru	56.7	55.9	9.7	10.0	33.6	34.1	scl	Scl
2	Gollamandala	A.konduru	25.0	23.0	10.0	11.0	65.0	66.0	c	C
3	Khambampadu	A.konduru	26.0	25.0	11.0	10.0	63.0	65.0	c	C
4	Cheemalapadu	A.konduru	25.8	21.3	9.5	9.5	65.5	69.2	c	C
5	Koduru	A.konduru	25.6	25.0	11.0	10.0	63.4	65.0	c	C
6	Madhavaram	A.konduru	26.0	24.9	10.0	10.0	64.0	65.1	c	C
7	Repudi	A.konduru	28.0	22.7	9.0	11.0	63.0	66.3	c	C
8	Reddigudem	Reddigudem	26.0	23.0	10.0	12.0	64.0	65.0	c	C
9	Reddigudem	Reddigudem	27.0	25.1	9.0	12.0	62.0	62.9	c	C
10	Naguluru	Reddigudem	26.0	23.8	9.0	10.0	65.0	66.2	c	C
11	Kudapa	Reddigudem	25.0	25.5	11.0	11.0	64.0	63.5	c	C
12	Rudravaram	Reddigudem	28.0	20.2	10.0	16.0	62.0	63.8	c	C
13	Rudravram	Reddigudem	66.0	65.5	12.0	12.0	22.0	22.5	scl	Scl
14	Rangapuram	Reddigudem	43.3	38.9	10.0	13.0	46.7	48.1	c	C
15	Mylavaram	Mylavaram	55.0	54.5	11.0	10.0	34.0	35.5	scl	Scl
16	Chandrala	Mylavaram	42.6	39.8	10.0	12.0	47.4	48.2	c	C
17	Mylavaram	Mylavaram	55.6	55.2	10.0	10.0	34.4	34.8	scl	Scl
18	Velvadam	Mylavaram	35.6	35.1	9.0	8.5	55.4	56.4	c	c

Contd.

S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
19	Pulluru	Mylavaram	28.6	31.1	15.0	12.0	56.4	56.9	c	C
20	Morusumilli	Mylavaram	26.6	24.9	10.0	10.0	64.4	65.1	c	C
21	Kanimerla	Mylavaram	35.6	32.7	8.5	10.0	55.9	57.3	c	C
22	Vissanapeta	Vissanapeta	40.6	42.8	10.0	6.0	49.4	51.2	c	C
23	Putrela	Vissanapeta	35.6	36.1	11.0	10.0	53.4	53.9	c	C
24	Kondaparva	Vissanapeta	28.6	28.7	14.0	12.0	57.4	59.3	c	C
25	Korlamanda	Vissanapeta	25.6	21.7	11.0	13.0	64.4	65.3	c	C
26	Tatakuntla	Vissanapeta	55.6	53.9	10.0	11.0	34.4	35.1	scl	ScI
27	Narsapuram	Vissanapeta	70.0	63.6	5.0	10.0	25.0	26.4	scl	ScI
28	Kalagara	Vissanapeta	35.6	32.1	9.0	12.0	55.4	55.9	c	C
29	Nuzivedu	Nuzivedu	30.0	30.0	11.0	10.0	59.0	60.0	c	C
30	Digavalli	Nuzivedu	22.6	26.2	15.0	11.0	62.4	62.8	c	C
31	Morsapudi	Nuzivedu	22.6	23.7	15.0	10.0	62.4	66.3	c	C
32	Boravancha	Nuzivedu	25.6	19.8	9.0	14.0	65.4	66.2	c	C
33	Sunkollu	Nuzivedu	35.6	29.0	11.0	16.0	53.4	55.0	c	C
34	Vempadu	Nuzivedu	43.3	41.8	10.0	10.0	46.7	48.2	scl	ScI
35	Gollapalle	Nuzivedu	28.0	25.0	9.0	10.0	63.0	65.0	c	C
36	Chatrai	Chatrai	55.6	53.4	10.0	11.0	34.4	35.6	scl	ScI
37	Chatrai	Chatrai	55.6	56.8	11.0	6.0	33.4	37.2	scl	ScI

Contd.

S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
38	Chittapur	Chatrai	25.6	24.5	10.0	9.0	64.4	66.5	c	C
39	Mankollu	Chatrai	35.6	33.1	9.5	11.0	54.9	55.9	c	C
40	Polavaram	Chatrai	25.6	23.2	10.0	10.0	64.4	66.8	c	C
41	Kothapadu	Chatrai	65.7	59.7	6.0	11.0	28.3	29.4	scl	ScI
42	Chinnampet	Chatrai	26.0	24.7	10.0	9.0	64.0	66.3	c	C
43	Jaggaypeta	Jaggaypeta	25.0	24.1	11.0	11.0	64.0	64.9	c	C
44	Balusupadu	Jaggaypeta	43.3	42.7	10.0	10.0	46.7	47.3	c	C
45	Garikipadu	Jaggaypeta	55.6	55.3	11.0	9.5	33.4	35.2	scl	ScI
46	Ravirala	Jaggaypeta	26.0	22.5	10.0	11.0	64.0	66.5	c	C
47	Vedadri	Jaggaypeta	55.6	54.7	11.0	10.0	33.4	35.3	scl	ScI
48	Takkalapadu	Jaggaypeta	40.6	39.0	11.0	12.0	48.4	49.0	c	C
49	West gandrai	Jaggaypeta	56.6	61.5	15.0	9.0	28.4	29.5	scl	ScI
50	Ravirala	Jaggaypeta	55.0	53.9	11.0	9.5	34.0	36.7	scl	ScI
51	Jaggaypeta	Jaggaypeta	35.6	32.8	9.5	10.0	54.9	57.2	c	C
52	East gandrai	Jaggaypeta	25.6	22.6	10.0	8.5	64.4	69.0	c	C
53	Chillakallu	Jaggaypeta	35.6	30.7	9.5	11.0	54.9	58.3	c	C
54	Ibbrahimpatnam	Ibbrahimpatnam	25.6	18.3	10.0	12.0	64.4	69.7	c	C
55	Ibbrahimpatnam	Ibbrahimpatnam	25.6	17.4	10.0	13.0	64.4	69.6	c	C
56	Elaprolu	Ibbrahimpatnam	60.6	51.9	10.0	13.0	29.4	35.1	scl	ScI

Contd.

S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
57	Damuluru	Ibbrahimpatnam	62.0	64.4	16.0	10.0	22.0	25.6	scl	ScI
58	Kotikalapudi	Ibbrahimpatnam	60.0	55.9	9.8	12.0	30.2	32.2	scl	ScI
59	Jupudi	Ibbrahimpatnam	26.0	21.4	10.0	10.0	64.0	68.6	c	C
60	Tummalapalem	Ibbrahimpatnam	40.6	39.0	11.0	12.0	48.4	49.0	c	C
61	Mullapadu	Ibbrahimpatnam	22.6	26.4	15.0	10.0	62.4	63.6	c	C
62	Gampalagudem	Gampalagudem	40.6	34.9	11.0	15.0	48.4	50.1	c	C
63	Arlapadu	Gampalagudem	62.5	59.4	10.0	11.0	27.5	29.7	scl	ScI
64	Gullapudi	Gampalagudem	35.6	34.1	9.5	10.0	54.9	55.9	c	C
65	Kanumuru	Gampalagudem	25.6	22.5	10.0	10.0	64.4	67.5	c	C
66	Lingala	Gampalagudem	25.6	24.2	10.0	10.0	64.4	65.8	c	C
67	Meduru	Gampalagudem	30.0	29.9	11.0	10.0	59.0	60.1	c	C
68	Utukuru	Gampalagudem	26.0	22.8	12.0	14.0	62.0	63.3	c	C
69	Utukuru	Gampalagudem	30.6	28.9	12.0	11.0	57.4	60.2	c	C
70	Pamidimukkala	Pamidimukkala	62.5	60.4	10.0	10.0	27.5	29.7	scl	ScI
71	Inampudi	Pamidimukkala	30.6	30.1	11.0	10.0	58.4	59.9	c	C
72	Meduru	Pamidimukkala	62.0	63.3	16.0	11.0	22.0	25.7	scl	ScI
73	Mantada	Pamidimukkala	66.0	65.9	12.0	11.0	22.0	23.1	scl	ScI
74	Mullapudi	Pamidimukkala	60.0	62.9	13.0	8.5	27.0	28.6	scl	ScI
75	Choragudi	Pamidimukkala	26.0	22.7	10.0	12.0	64.0	65.4	c	C

Contd.

S.No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
76	Inapuru	Pamidimukkala	35.6	34.3	12.0	10.0	52.4	55.7	c	C
77	Musunuru	Musunuru	30.0	27.5	10.0	10.0	60.0	62.5	c	C
78	Surepalli	Musunuru	65.0	65.0	13.0	6.0	22.0	29.0	scl	ScI
79	Gullapudi	Musunuru	28.0	29.8	14.0	10.0	58.0	60.2	c	C
80	Musunuru	Musunuru	35.6	34.7	12.0	12.0	52.4	53.3	c	C
81	Ellapuram	Musunuru	26.0	21.5	12.0	13.0	62.0	65.5	c	C
82	Chintalvalli	Musunuru	66.0	65.1	12.0	11.0	22.0	24.0	scl	ScI
83	Lopudi	Musunuru	70.0	62.5	5.0	10.0	25.0	27.5	scl	ScI
84	Tiruvuru	Tiruvuru	40.6	35.9	10.0	12.0	49.4	52.1	c	C
85	Chittela	Tiruvuru	28.0	26.8	10.0	10.0	62.0	63.3	c	C
86	Rajupeta	Tiruvuru	26.0	19.8	10.0	11.0	64.0	69.3	c	C
87	Mallela	Tiruvuru	31.0	25.9	10.0	10.0	59.0	64.2	c	C
88	Munukulla	Tiruvuru	35.6	27.6	9.5	14.0	54.9	58.4	c	C
89	Vavilala	Tiruvuru	66.0	58.3	12.0	16.0	22.0	25.7	c	C
90	Vavilala	Tiruvuru	60.6	57.6	10.0	10.0	29.4	32.5	scl	ScI
91	Nandigama	Nandigama	28.0	28.2	14.0	10.0	58.0	61.8	scl	ScI
92	Damuluru	Nandigama	30.6	28.8	11.0	11.0	58.4	60.2	c	C
93	Lingalapadu	Nandigama	40.4	44.7	12.0	6.0	47.6	49.3	c	C
94	Satyavaram	Nandigama	62.5	60.4	10.0	10.0	27.5	29.7	scl	ScI

Contd.

S.No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
95	Pallagiri	Nandigama	40.4	35.9	12.0	12.0	47.6	52.2	c	C
96	Gollamudi	Nandigama	60.0	60.4	13.0	10.0	27.0	29.6	scl	ScI
97	Kanchela	Nandigama	65.0	64.0	13.0	13.0	22.0	23.0	scl	ScI
98	Penuganchiprolu	Penuganchiprolu	40.4	37.9	12.0	14.0	47.6	48.1	c	C
99	Thotacherla	Penuganchiprolu	43.6	35.9	8.5	12.0	47.9	52.1	c	C
100	Mullapadu	Penuganchiprolu	43.3	37.9	10.0	12.0	46.7	50.1	c	C
101	Konakanchi	Penuganchiprolu	30.6	28.6	11.0	12.0	58.4	59.4	c	C
102	Sanagapadu	Penuganchiprolu	63.0	62.9	10.0	5.0	27.0	32.2	scl	ScI
103	Sanagapadu	Penuganchiprolu	40.4	40.3	12.0	10.0	47.6	49.7	c	C
104	Kollikulla	Penuganchiprolu	43.6	35.5	8.5	11.0	47.9	53.5	c	C
105	Anigandlapadu	Penuganchiprolu	60.0	59.8	12.0	10.0	28.0	30.2	scl	ScI
106	Vatsvai	Vatsvai	40.6	33.0	10.0	10.0	49.4	57.0	c	C
107	Chittela	Vatsvai	28.0	23.5	10.0	11.0	62.0	65.5	c	C
108	Lingala	Vatsvai	65.7	55.7	6.0	9.0	28.3	35.3	scl	ScI
109	Allurupadu	Vatsvai	25.6	23.3	10.0	11.0	64.4	65.7	c	C
110	Makkapeta	Vatsvai	30.6	30.3	12.0	10.0	57.4	59.7	c	C
111	Gangavalli	Vatsvai	60.0	59.4	13.0	11.0	27.0	29.6	scl	ScI
112	Dechupalem	Vatsvai	30.6	30.0	11.0	9.0	58.4	61.0	c	C
113	Chandarlapadu	Chandarlapadu	26.0	21.4	10.0	11.0	64.0	67.6	c	C

Contd.

S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
114	Eturu	Chandarlpadu	35.6	34.3	12.0	10.0	52.4	55.7	c	C
115	Konayapalem	Chandarlpadu	30.0	26.4	10.0	9.5	60.0	64.2	c	C
116	Pokkunuru	Chandarlpadu	30.0	26.9	11.0	11.0	59.0	62.1	c	C
117	Gudimetla	Chandarlpadu	25.6	21.1	10.0	10.0	64.4	69.0	c	C
118	Chintalpadu	Chandarlpadu	288.0	28.0	14.0	12.0	58.0	60.0	c	C
119	Mungalapalli	Chandarlpadu	62.0	60.5	16.0	11.0	22.0	28.5	scl	ScI
120	Kanchikacherla	Kanchikacherla	62.5	61.4	10.0	10.0	27.5	28.6	scl	ScI
121	Chevitikallu	Kanchikacherla	40.6	39.8	10.0	10.0	49.4	50.2	c	C
122	Keesara	Kanchikacherla	30.6	29.4	11.0	11.0	58.4	59.6	c	C
123	Paritala	Kanchikacherla	65.7	61.4	6.0	9.0	28.3	29.7	scl	ScI
124	Singapuram	Kanchikacherla	26.0	23.1	10.0	11.0	64.0	65.9	c	C
125	Vemulapalli	Kanchikacherla	30.0	28.8	10.0	10.0	60.0	61.3	c	C
126	Gandepalli	Kanchikacherla	25.6	22.7	10.0	11.0	64.4	66.4	c	C
127	Verullapadu	Verullapadu	25.0	21.4	10.0	9.0	65.0	69.6	c	C
128	Jammavaram	Verullapadu	28.0	19.4	9.0	11.0	63.0	69.6	c	C
129	Nadaluru	Verullapadu	66.0	62.5	12.0	10.0	22.0	27.5	scl	ScI
130	Pallampalle	Verullapadu	55.0	53.9	11.0	9.5	34.0	36.6	scl	ScI
131	Peddapuram	Verullapadu	26.0	22.4	10.0	11.0	64.0	66.6	c	C
132	Vellanki	Verullapadu	28.0	20.4	9.0	10.0	63.0	69.6	c	C

Contd.

S. No	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
133	Vellanki	Verullapadu	25.0	20.7	10.0	12.0	65.0	67.3	c	C
134	Penamaluru	Penamaluru	25.6	24.8	9.0	9.0	65.4	66.2	c	C
135	Penamaluru	Penamaluru	35.6	30.5	9.0	10.0	55.4	59.5	c	C
136	Penamaluru	Penamaluru	43.3	40.2	10.0	12.0	46.7	47.8	c	C
137	Vanukuru	Penamaluru	25.6	23.7	10.0	11.0	64.4	65.4	c	C
138	Chodavaram	Penamaluru	25.6	21.3	10.0	9.5	64.4	69.2	c	C
139	Gosala	Penamaluru	28.0	22.6	10.0	11.0	62.0	66.4	c	C
140	Gosala	Penamaluru	55.6	50.2	11.0	10.0	33.4	39.8	c	C
141	Kankipadu	Kankipadu	26.0	24.5	10.0	9.5	64.0	66.0	c	C
142	Davuluru	Kankipadu	35.6	34.3	9.5	10.0	54.9	55.7	c	C
143	Kunderu	Kankipadu	25.6	23.7	10.0	11.0	64.4	65.3	c	C
144	Tanneru	Kankipadu	22.6	25.1	15.0	10.0	62.4	64.9	c	C
145	Velpuru	Kankipadu	25.6	20.2	9.0	10.0	65.4	69.9	c	C
146	Kandalampadu	Kankipadu	65.7	59.0	6.0	11.0	28.3	30.0	c	C
147	Edpugallu	Kankipadu	288.0	19.7	9.0	15.0	63.0	65.3	c	C
148	Vuyyuru	Vuyyuru	55.6	54.4	11.0	10.0	33.4	35.6	c	C
149	Akunuru	Vuyyuru	55.0	53.4	11.0	10.0	34.0	36.6	c	C
150	Akunuru	Vuyyuru	25.6	20.1	10.0	14.0	64.4	65.9	c	C
151	Mudunuru	Vuyyuru	43.3	40.4	10.0	11.0	46.7	48.6	c	C

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S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
152	Katuru	Vuyyuru	25.0	21.7	11.0	12.0	64.0	66.4	c	C
153	Chinnaogirala	Vuyyuru	27.0	27.1	9.0	10.0	62.0	62.9	c	C
154	Saipuram	Vuyyuru	25.6	19.1	11.0	12.0	64.4	69.0	c	C
155	Unguturu	Unguturu	55.6	51.3	10.0	13.0	34.4	35.7	scl	ScI
156	Bokkinala	Unguturu	30.0	23.5	11.0	13.0	59.0	63.5	c	C
157	Mukkapadu	Unguturu	35.6	28.3	9.0	12.0	55.4	59.7	c	C
158	Mukkapadu	Unguturu	40.6	35.2	11.0	8.5	48.4	56.3	c	C
159	Indupalli	Unguturu	25.6	19.7	10.0	11.0	64.4	69.4	c	C
160	Manikonda	Unguturu	35.6	34.3	9.5	10.0	54.9	55.7	c	C
161	Atkuru	Unguturu	28.6	28.8	11.0	14.0	53.4	57.2	c	C
162	Gannavaram	Gannavaram	55.6	52.5	10.0	11.0	34.4	36.5	scl	ScI
163	Balliparru	Gannavaram	66.0	66.8	12.0	10.0	22.0	23.3	scl	ScI
164	Gollanapalle	Gannavaram	28.0	22.4	9.0	11.0	63.0	66.6	c	C
165	Mettapalle	Gannavaram	25.0	23.3	9.5	10.0	65.5	66.7	c	C
166	Savirigudem	Gannavaram	43.3	42.4	10.0	9.0	46.7	48.6	c	C
167	Allapuram	Gannavaram	30.6	30.3	11.0	10.0	58.4	59.7	c	C
168	Chinavautupalli	Gannavaram	43.6	42.1	8.5	9.7	47.9	48.2	c	C
169	Agiripalle	Agiripalle	30.6	32.8	11.0	8.5	58.4	58.7	c	C
170	Agiripalle	Agiripalle	40.4	39.4	12.0	11.0	47.6	49.6	c	C

Contd.

S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
171	Sagguru	Agiripalle	65.0	73.7	13.0		22.0	26.4	scl	ScI
172	Saravaram	Agiripalle	60.0	58.0	13.0	13.0	27.0	29.0	scl	ScI
173	Edara	Agiripalle	31.0	29.0	10.0	11.0	59.0	60.0	c	C
174	Kalaturu	Agiripalle	26.0	24.6	12.0	10.0	62.0	65.5	c	C
175	Kalaturu	Agiripalle	62.5	58.4	10.0	12.0	27.5	29.6	scl	ScI
176	Bapulapadu	Bapulapadu	66.0	63.5	12.0	10.0	22.0	26.5	scl	ScI
177	Ampapuram	Bapulapadu	26.0	22.4	10.0	11.0	64.0	66.6	c	C
178	Chirivada	Bapulapadu	22.6	23.7	15.0	10.0	62.4	66.3	c	C
179	Kanumollu	Bapulapadu	40.6	37.0	11.0	14.0	48.4	49.0	c	C
180	Madicherla	Bapulapadu	25.6	18.6	10.0	16.0	64.4	65.4	c	C
181	Veleru	Bapulapadu	62.5	60.4	10.0	10.0	27.5	29.7	scl	ScI
182	Ramalle	Bapulapadu	26.0	23.4	10.0	10.0	64.0	66.6	c	C
183	G.konduru	G.konduru	30.0	26.0	10.0	11.0	60.0	63.0	c	C
184	Koduru	G.konduru	28.6	35.3	14.0	6.0	57.4	58.7	c	C
185	Chevuturu	G.konduru	25.6	22.3	11.0	10.0	64.4	67.7	c	C
186	Pinapaka	G.konduru	26.6	24.7	10.0	10.0	64.4	65.3	c	C
187	Vellaturu	G.konduru	55.6	54.7	11.0	10.0	33.4	35.3	scl	ScI
188	Gaddamanugu	G.konduru	26.0	22.0	10.0	12.0	64.0	66.0	c	C
189	Kavuluru	G.konduru	28.0	24.7	9.0	10.0	63.0	65.3	c	C

Contd.

S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
190	Thotlavalluru	Thotlavalluru	28.0	15.2	10.0	15.0	62.0	69.8	c	C
191	Devarapalli	Thotlavalluru	56.7	52.5	9.7	11.0	33.6	36.5	scl	ScI
192	Penamakuru	Thotlavalluru	35.6	30.3	8.5	10.0	55.9	59.7	c	C
193	Royyuru	Thotlavalluru	30.6	30.3	11.0	10.0	58.4	59.7	c	C
194	Yakamuru	Thotlavalluru	35.6	37.1	12.0	10.0	52.4	52.9	c	C
195	Chagantipadu	Thotlavalluru	30.0	21.8	10.0	10.0	60.0	68.2	c	C
196	Iluru	Thotlavalluru	66.0	64.4	12.0	11.0	22.0	24.6	scl	ScI
197	Kummamuru	Thotlavalluru	30.6	29.6	12.0	11.0	57.4	59.4	c	C
198	Garikaparru	Thotlavalluru	26.0	22.4	12.0	11.0	62.0	66.6	c	C
199	Kanakavalli	Thotlavalluru	30.0	30.1	11.0	10.0	59.0	59.9	c	C
200	Guruvindapalli	Thotlavalluru	35.6	33.7	9.5	10.0	54.9	56.3	c	C
201	South valluru	Thotlavalluru	40.6	39.2	11.0	11.0	48.4	49.8	c	C
202	North valluru	Thotlavalluru	25.6	21.3	10.0	9.0	64.4	69.7	c	C
203	Royyuru	Thotlavalluru	35.6	33.3	9.5	11.0	54.9	55.7	c	C
204	Vijayawada (rural)	Vijayawada (rural)	26.0	24.6	10.0	10.0	64.0	65.4	c	C
205	Kotturu	Vijayawada (rural)	25.0	22.1	11.0	11.0	64.0	66.9	c	C
206	Enikipadu	Vijayawada (rural)	25.6	26.0	10.0	9.0	64.4	65.0	c	C
207	Tadepalle	Vijayawada (rural)	26.0	21.0	10.0	10.0	64.0	69.0	c	C
208	Gudavalli	Vijayawada (rural)	55.0	54.5	11.0	9.0	34.0	36.5	scl	ScI

Contd.

S. No.	Name of the village	Mandal	sand(%)		silt(%)		clay(%)		textural class	
			surface	subsurface	surface	subsurface	surface	subsurface	surface	Subsurface
209	Vijayawada(urban)	Vijayawada(urban)	56.6	61.4	15.0	9.0	28.4	29.6	scl	ScI
210	Vijayawada(urban)	Vijayawada(urban)	25.6	21.7	10.0	10.0	64.4	68.3	c	C
211	Vijayawada(urban)	Vijayawada(urban)	28.6	33.0	15.0	10.0	56.4	57.0	c	C
212	Vijayawada(urban)	Vijayawada(urban)	28.0	24.8	10.0	10.0	62.0	65.2	c	C

The sand, silt and clay contents and the textural classes were widely ranging. Parent material was one of the factors responsible for soil formation and variation in soil properties. The black soils and sandy soils of Andhra Pradesh were derived from deltaic alluvium and marine sediments, respectively (Rao *et al.*, 1995). State of weathering of parent material and lateral translocation of finer particles might have played an important role in further modifying the texture of soils (Tiwari *et al.*, 1983).

Black soils are most dominant group in the study area. All the surface and subsurface black soil samples exhibited clay in texture. Uniformity in texture in both surface and subsurface soils might be due to the pedogenic process of argillo-pedoturbation operating in these soils. Similar textural class and uniformity with depth in black soils were noticed by Jejenaik (2009) and Tantujanandy (2010).

It was observed that wide variation in texture of sandy and black soils of the study area. This abrupt change in texture from light to heavy might be due to variation in parent material.

4.2 PHYSICO-CHEMICAL PROPERTIES

4.2.1 Soil Reaction (Soil pH)

Results pertaining to the pH of upland soils of Krishna district presented in table 4.2, 4.21, 4.22 and 4.23.

The pH of surface and subsurface soils was found to be neutral to highly alkaline. The data presented in table 4.2 revealed that the pH values of 212 surface soil samples varied from 6.81-8.42 with a mean value of 7.61. Out of which 56.60% were found to be neutral (pH 6.5- 7.3), 41.50% were slightly alkaline (pH 7.4-7.8) and 1.90% were moderately alkaline (pH 7.9-8.4) in soil reaction.

The pH values of 212 subsurface soil samples varied from 6.81-8.62 with a mean value of 7.70. Out of which 49.05% were found to be neutral (pH 6.5 -7.3), 44.81% were found to be slightly alkaline (pH 7.4-7.8) and 5.66% were found to

be moderately alkaline (7.9-8.4) in reaction, while the remaining 0.48% is found highly alkaline in nature (pH 8.5-9.2). These results were in conformation with the findings of Ramesh and Hari Prasada Rao (2005), Jamuna *et al.* (2008) and Tantujanandy (2010) for coastal soils of Prakasam, Vizianagaram and Guntur district of Andhra Pradesh, respectively. The development of alkalinity in these soils might be due to reaction of applied fertilizers with soil colloids which resulted in the retention of basic cations on the exchange complex of soil. The high pH (8.6) in these soils might be due to hydrolysis of sodium bicarbonate and carbonates leading to release of OH⁻ ions.

The results also indicated that subsurface soil samples recorded high mean pH value (7.70) as compared to surface (7.61) soil samples. The higher pH in subsurface could be due to accumulation of basic cations with depth and another possible reason for this trend might be due to release of organic acids during decomposition of organic matter. These released acids might have bring down the pH values at the surface. Similar trend of soil reaction with depth was observed by Sathish Babu *et al.* (2010) and Mydhili (2006) in coastal soils of Guntur district.

Further, it was observed that clay soils had relatively higher pH values than sandy clay loam soils because of imperfect drainage of black soils and also might be due to efficient recycling of basic cations in black soils (Rama Krishna Prasad *et al.*, 1998). Gabhane *et al.* (2006) and Radha Krishna (2007) reported similar trend of soil reaction in black soils of Vidarbha region of Maharashtra and Guntur district of Andhra Pradesh, respectively.

The pH values of the entire study area indicated that about 70 per cent of soils were neutral to slightly alkaline in nature.

4.2.2 Electrical Conductivity

The data presented in table 4.1,4.21,4.22 and 4.24 indicated that electrical conductivity (EC) of the surface and subsurface samples varied from 0.12 to 0.72 dS m⁻¹ and from 0.11 to 0.83 dS m⁻¹ with mean values of 0.42 dS m⁻¹ and 0.47 dS m⁻¹, respectively. The results revealed that 100 % surface and subsurface samples

were found under normal category while none of the samples were found to be injurious to most crops (Table 4.2 and 4.24). Similar results were reported by Sathish Babu *et al.* (2010) and Mahesh Kumar *et al.* (2011) in coastal soils of Guntur district of Andhra Pradesh and Churu district of Rajasthan.

The low electrical conductivity of the surface soils might be due to the leaching of the soluble salts from the surface soils to subsurface as the study area experienced good amount of rainfall. Similar results were reported by Mandal and Sharma (2013) and Anil Sood *et al.* (2003) in sandy soils of Indira Gandhi Nahar Pariyojana Command area, Rajasthan and Kandi area of Punjab, respectively.

Sandy clay loam soils recorded comparatively lower EC values than black soils. This might be due to more leaching and less accumulation of soluble salts in deeper layers in sandy soils. Similar observations were made by Iqbal Khan (1990), Ramalakshmi *et al.* (2002) and Ramarao (2003) in sandy and black soils of Ganapavaram village of Karlapalem mandal, Bapatla-Karlapalem region of Guntur district and Chirala mandal, Prakasam district of Andhra Pradesh, respectively.

An overall review of the study area showed that about 100 per cent of the soils were normal ($<1 \text{ dS m}^{-1}$). As the area is under irrigated condition, some of the fine textured locations which are presently free from salinity hazard may become saline if precautions are not taken. Therefore, salt accumulation should be prevented by improving the drainage of soils by suitable management.

4.2.3 Organic Carbon

The range, mean and nutrient index values of organic carbon are presented in table 4.2, 4.21, 4.22, 4.25 and 4.6 and depicted in figure 3a and 3b. The organic carbon content of surface and subsurface soils ranged from 0.15-0.72 and 0.11-0.65 with a mean value of 0.43 and 0.38 per cent, respectively. According to criteria given by Ramamoorthy and Bajaj (1969), the surface and subsurface soils of the present study area were found to be low to medium in organic carbon content.

Out of 424 soil samples (surface and subsurface), 80.18% surface and 90.56% subsurface samples were found to be low whereas, 19.34 % samples of surface and 9.44% of subsurface samples were medium, respectively. Only 0.48% of surface samples fall under high category. Average nutrient index of the study area as a whole with respect to organic carbon was 1.20 for surface and 1.09 for subsurface soils which indicated that soils are low in fertility status. Low organic carbon content in these soils might be due to rapid decomposition of organic matter in semi-arid climatic conditions and poor management of soils. These results were similar with the findings of Waghmare *et al.* (2009) and Venu Madhav and Prasada Rao (2003) in black soils of Latur district, Maharashtra and Krishna western delta of Andhra Pradesh, respectively.

The surface soil samples had relatively high mean organic carbon content (0.43%) compared to subsurface soil samples (0.38%) irrespective of the soil type. The higher organic carbon content at surface might be due to the addition of FYM or accumulation of crop residues as leaf litter on the surface and biological activity. Similar findings were reported by Rajeshwar and Khan (2007) and Rajeshwar *et al.* (2009) in Garikapadu soils of Krishna district and in sandy loam soils of Nalgonda district of Andhra Pradesh, respectively. Mini *et al.* (2007) stated that the organic carbon content in surface soils was higher than subsurface soils due to high amount of plant residues at the surface.

It was observed that organic carbon content of black soils was higher than that of the sandy clay loam soils. The nutrient index in respect of organic carbon for the sandy soils was low for both surface (1.08) and subsurface (1.07) samples while in case of black soils it was medium (1.85) for the surface and subsurface samples. The black soils on account of inherent higher fertility status and moisture retention capacity support dense vegetation and the remnants of which are also likely to contribute for the high organic carbon content. Similarly, lower organic carbon content in sandy soils when compared to black soils of Chirala mandal of Prakasam was reported by Ramarao (2003), which was ascribed due to scanty vegetation, less clay content and high rate of decomposition in sandy soils.

Table 4.2 : Physico-chemical properties of upland soils of Krishna district

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
1	A.konduru	A.konduru	7.53	7.54	0.40	0.32	0.29	0.26
2	Gollamandala	A.konduru	7.68	7.70	0.50	0.34	0.31	0.22
3	Khambampadu	A.konduru	7.36	7.42	0.42	0.31	0.26	0.23
4	Cheemalapadu	A.konduru	7.17	7.28	0.12	0.42	0.22	0.18
5	Koduru	A.konduru	7.45	7.51	0.24	0.26	0.40	0.38
6	Madhavaram	A.konduru	7.78	7.79	0.42	0.46	0.28	0.21
7	Repudi	A.konduru	7.32	7.33	0.41	0.28	0.31	0.26
		Mandal range	7.17-7.78	7.28-7.79	0.12-0.50	0.26-0.46	0.22-0.40	0.18-0.38
8	Reddigudem	Reddigudem	7.02	7.09	0.23	0.31	0.46	0.40
9	Reddigudem	Reddigudem	7.59	7.62	0.47	0.32	0.36	0.28
10	Naguluru	Reddigudem	7.72	7.79	0.30	0.30	0.29	0.20
11	Kudapa	Reddigudem	7.63	7.60	0.36	0.38	0.32	0.25
12	Rudravaram	Reddigudem	7.49	7.42	0.41	0.28	0.15	0.10
13	Rudravram	Reddigudem	6.82	7.00	0.52	0.31	0.50	0.41
14	Rangapuram	Reddigudem	7.61	7.62	0.31	0.42	0.39	0.32
		Mandal range	6.82-7.72	7.00-7.79	0.23-0.52	0.28-0.42	0.15-0.50	0.10-0.41
15	Mylavaram	Mylavaram	7.46	7.59	0.39	0.39	0.21	0.17
16	Chandrala	Mylavaram	7.71	7.82	0.53	0.38	0.25	0.18
17	Mylavaram	Mylavaram	7.39	7.79	0.24	0.31	0.41	0.33

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
18	Velvadam	Mylavaram	7.23	7.68	0.26	0.36	0.22	0.16
19	Pulluru	Mylavaram	7.49	7.40	0.31	0.35	0.19	0.11
20	Morusumilli	Mylavaram	7.46	7.39	0.31	0.45	0.52	0.43
21	Kanimerla	Mylavaram	7.21	7.40	0.30	0.35	0.31	0.28
		Mandal range	7.21-7.71	7.39-7.82	0.24-0.53	0.31-0.45	0.19-0.52	0.11-0.43
22	Vissanapeta	Vissanapeta	7.68	7.67	0.39	0.34	0.18	0.11
23	Putrela	Vissanapeta	7.69	7.89	0.31	0.43	0.21	0.15
24	Kondaparva	Vissanapeta	7.67	7.70	0.36	0.46	0.36	0.30
25	Korlamanda	Vissanapeta	7.57	7.67	0.55	0.57	0.33	0.30
26	Tatakuntla	Vissanapeta	7.67	7.80	0.30	0.44	0.31	0.25
27	Narsapuram	Vissanapeta	7.83	7.80	0.22	0.28	0.28	0.21
28	Kalagara	Vissanapeta	7.79	7.49	0.42	0.49	0.42	0.34
		Mandal range	7.57-7.83	7.49-7.89	0.22-0.55	0.28-0.57	0.18-0.42	0.11-0.34
29	Nuzivedu	Nuzivedu	7.38	7.79	0.37	0.63	0.39	0.30
30	Digavalli	Nuzivedu	7.61	7.28	0.52	0.61	0.36	0.31
31	Morsapudi	Nuzivedu	7.29	7.23	0.33	0.50	0.32	0.27
32	Boravancha	Nuzivedu	7.19	7.21	0.46	0.60	0.32	0.25
33	Sunkollu	Nuzivedu	7.65	7.69	0.28	0.39	0.32	0.23
34	Vempadu	Nuzivedu	7.81	7.87	0.32	0.50	0.19	0.11

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
35	Gollapalle	Nuzivedu	7.64	7.68	0.42	0.69	0.15	0.12
		Mandal range	7.19-7.81	7.21-7.87	0.32-0.52	0.39-0.69	0.15-0.39	0.11-0.31
36	Chatrai	Chatrai	6.88	7.00	0.68	1.04	0.64	0.56
37	Chatrai	Chatrai	7.41	7.49	0.62	0.64	0.61	0.54
38	Chittapur	Chatrai	7.58	7.62	0.36	0.51	0.49	0.47
39	Mankollu	Chatrai	7.79	7.00	0.24	0.24	0.59	0.52
40	Polavaram	Chatrai	7.86	7.86	0.49	0.35	0.61	0.56
41	Kothapadu	Chatrai	7.43	7.56	0.65	0.31	0.64	0.58
42	Chinnampet	Chatrai	7.39	7.41	0.27	0.38	0.59	0.51
		Mandal range	6.88-7.86	7.00-7.86	0.24-0.68	0.24-1.04	0.49-0.64	0.47-0.58
43	Jaggaypeta	Jaggaypeta	7.78	7.86	0.29	0.37	0.52	0.48
44	Balusupadu	Jaggaypeta	7.62	7.68	0.21	0.38	0.57	0.52
45	Garikipadu	Jaggaypeta	7.64	7.60	0.26	0.27	0.58	0.52
46	Ravirala	Jaggaypeta	7.89	7.98	0.33	0.44	0.41	0.35
47	Vedadri	Jaggaypeta	7.73	8.62	0.30	0.36	0.36	0.31
48	Takkalapadu	Jaggaypeta	7.83	8.09	0.42	0.31	0.22	0.16
49	West gandrai	Jaggaypeta	7.73	7.81	0.24	0.45	0.26	0.19
50	Ravirala	Jaggaypeta	7.61	7.77	0.33	0.34	0.37	0.29
51	Jaggaypeta	Jaggaypeta	7.61	7.01	0.61	0.36	0.40	0.32

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
52	East gandrai	Jaggaypeta	7.23	7.23	0.72	0.41	0.38	0.30
53	Chillakallu	Jaggaypeta	7.42	7.26	0.14	0.36	0.27	0.18
		Mandal range	7.23-7.89	7.01-8.62	0.14-0.72	0.27-0.45	0.22-0.58	0.18-0.52
54	Ibbrahimpatnam	Ibbrahimpatnam	7.21	7.41	0.21	0.51	0.38	0.29
55	Ibbrahimpatnam	Ibbrahimpatnam	7.24	8.01	0.23	0.56	0.21	0.16
56	Elaprolu	Ibbrahimpatnam	7.12	7.26	0.49	0.32	0.31	0.25
57	Damuluru	Ibbrahimpatnam	7.68	7.44	0.62	0.21	0.34	0.27
58	Kotikalapudi	Ibbrahimpatnam	7.91	7.32	0.64	0.23	0.39	0.30
59	Jupudi	Ibbrahimpatnam	7.46	7.09	0.39	0.29	0.32	0.23
60	Tummalapalem	Ibbrahimpatnam	7.21	6.89	0.32	0.16	0.23	0.18
61	Mullapadu	Ibbrahimpatnam	7.32	7.61	0.41	0.31	0.28	0.21
		Mandal range	7.12-7.91	6.89-8.01	0.21-0.64	0.16-0.56	0.21-0.39	0.16-0.30
62	Gampalagudem	Gampalagudem	7.64	8.03	0.19	0.26	0.41	0.33
63	Arlapadu	Gampalagudem	7.82	8.09	0.12	0.24	0.33	0.31
64	Gullapudi	Gampalagudem	7.19	8.36	0.31	0.52	0.24	0.20
65	Kanumuru	Gampalagudem	7.21	7.92	0.39	0.49	0.35	0.26
66	Lingala	Gampalagudem	7.21	7.89	0.24	0.81	0.30	0.26
67	Meduru	Gampalagudem	7.63	7.76	0.29	0.64	0.42	0.36
68	Utukuru	Gampalagudem	7.71	8.03	0.27	0.32	0.25	0.19

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
69	Utukuru	Gampalagudem	7.29	7.06	0.27	0.31	0.29	0.20
		Mandal range	7.19-7.82	7.06-8.36	0.12-0.39	0.24-0.81	0.24-0.42	0.19-0.36
70	Pamidimukkala	Pamidimukkala	7.48	7.21	0.32	0.29	0.36	0.31
71	Inampudi	Pamidimukkala	7.43	7.32	0.39	0.26	0.43	0.38
72	Meduru	Pamidimukkala	7.86	7.43	0.36	0.34	0.26	0.18
73	Mantada	Pamidimukkala	6.98	7.46	0.37	0.21	0.47	0.38
74	Mullapudi	Pamidimukkala	7.21	7.52	0.64	0.32	0.21	0.17
75	Choragudi	Pamidimukkala	7.46	7.29	0.63	0.11	0.33	0.23
76	Inapuru	Pamidimukkala	7.39	7.09	0.13	0.19	0.36	0.29
		Mandal range	6.98-7.86	7.09-7.52	0.13-0.64	0.11-0.34	0.21-0.47	0.17-0.38
77	Musunuru	Musunuru	7.72	7.36	0.24	0.21	0.22	0.19
78	Surepalli	Musunuru	7.79	7.42	0.26	0.36	0.44	0.38
79	Gullapudi	Musunuru	7.31	7.31	0.27	0.43	0.31	0.26
80	Musunuru	Musunuru	7.32	7.39	0.39	0.52	0.21	0.15
81	Ellapuram	Musunuru	7.41	7.32	0.62	0.52	0.46	0.38
82	Chintalvalli	Musunuru	7.49	7.31	0.58	0.64	0.23	0.17
83	Lopudi	Musunuru	7.31	7.26	0.51	0.69	0.30	0.25
		Mandal range	7.31-7.79	7.60-7.42	0.24-0.62	0.21-0.69	0.21-0.46	0.17-0.38
84	Tiruvuru	Tiruvuru	7.63	7.21	0.22	0.31	0.24	0.21

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
85	Chittela	Tiruvuru	7.71	7.24	0.24	0.21	0.45	0.33
86	Rajupeta	Tiruvuru	7.79	7.26	0.69	0.32	0.26	0.20
87	Mallela	Tiruvuru	7.39	7.2	0.31	0.64	0.34	0.26
88	Munukulla	Tiruvuru	7.61	6.81	0.29	0.31	0.29	0.22
89	Vavilala	Tiruvuru	7.62	8.06	0.27	1.21	0.48	0.41
90	Vavilala	Tiruvuru	7.69	7.92	0.63	0.24	0.25	0.19
		Mandal range	7.39-7.79	6.81-8.06	0.22-0.69	0.21-1.21	0.24-0.48	0.19-0.41
91	Nandigama	Nandigama	7.84	7.03	0.69	0.32	0.29	0.21
92	Damuluru	Nandigama	7.89	7.23	0.43	0.21	0.35	0.27
93	Lingalapadu	Nandigama	7.72	7.27	0.22	0.19	0.41	0.35
94	Satyavaram	Nandigama	7.72	7.03	0.24	0.42	0.26	0.20
95	Pallagiri	Nandigama	7.78	7.14	0.60	0.64	0.36	0.29
96	Gollamudi	Nandigama	7.21	7.32	0.51	0.32	0.45	0.36
97	Kanchela	Nandigama	7.32	7.26	0.47	0.31	0.51	0.42
		Mandal range	7.21-7.89	7.03-7.32	0.22-0.69	0.19-0.64	0.26-0.51	0.20-0.42
98	Penuganchiprolu	Penuganchiprolu	7.48	7.31	0.32	0.26	0.41	0.36
99	Thotacherla	Penuganchiprolu	7.42	7.46	0.21	0.24	0.27	0.19
100	Mullapadu	Penuganchiprolu	7.31	7.52	0.29	0.31	0.38	0.32
101	Konakanchi	Penuganchiprolu	7.63	7.64	0.32	0.13	0.31	0.24

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
102	Sanagapadu	Penuganchiprolu	7.43	7.51	0.21	0.27	0.32	0.22
103	Sanagapadu	Penuganchiprolu	7.29	7.42	0.43	0.32	0.29	0.21
104	Kollikulla	Penuganchiprolu	7.51	7.64	0.19	0.21	0.46	0.39
105	Anigandlapadu	Penuganchiprolu	7.28	7.39	0.27	0.26	0.43	0.32
		Mandal range	7.29-7.63	7.31-7.64	0.19-0.43	0.13-0.32	0.27-0.46	0.19-0.39
106	Vatsvai	Vatsvai	7.39	7.41	0.23	0.23	0.45	0.36
107	Chittela	Vatsvai	7.02	7.26	0.39	0.39	0.36	0.32
108	Lingala	Vatsvai	7.27	7.24	0.41	0.22	0.21	0.13
109	Allurupadu	Vatsvai	6.81	7.00	0.34	0.26	0.28	0.21
110	Makkapeta	Vatsvai	6.99	7.09	0.51	0.21	0.31	0.26
111	Gangavalli	Vatsvai	7.36	7.22	0.29	0.41	0.40	0.32
112	Dechupalem	Vatsvai	7.49	7.49	0.23	0.54	0.26	0.20
		Mandal range	6.81-7.49	7.00-7.49	0.23-0.51	0.21-0.54	0.21-0.45	0.13-0.36
113	Chandarlapadu	Chandarlapadu	7.71	7.82	0.38	0.26	0.25	0.18
114	Eturu	Chandarlapadu	7.29	7.36	0.27	0.27	0.42	0.32
115	Konayapalem	Chandarlapadu	7.63	7.31	0.24	0.31	0.39	0.30
116	Pokkunuru	Chandarlapadu	7.79	7.92	0.20	0.20	0.22	0.17
117	Gudimetla	Chandarlapadu	7.27	7.32	0.19	0.15	0.29	0.19
118	Chintalpadu	Chandarlapadu	7.36	7.46	0.42	0.20	0.41	0.33

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
119	Mungalapalli	Chandarlapadu	7.09	7.21	0.21	0.27	0.24	0.16
		Mandal range	7.09-7.79	7.21-7.92	0.19-0.42	0.15-0.31	0.22-0.42	0.17-0.33
120	Kanchikacherla	Kanchikacherla	7.39	7.41	0.22	0.39	0.45	0.41
121	Chevitikallu	Kanchikacherla	6.98	7.01	0.24	0.34	0.37	0.32
122	Keesara	Kanchikacherla	7.07	7.01	0.29	0.21	0.23	0.18
123	Paritala	Kanchikacherla	7.86	7.26	0.31	0.54	0.30	0.23
124	Singapuram	Kanchikacherla	7.63	7.21	0.29	0.38	0.43	0.38
125	Vemulapalli	Kanchikacherla	7.01	7.22	0.26	0.26	0.23	0.17
126	Gandepalli	Kanchikacherla	6.87	7.41	0.27	0.24	0.44	0.37
		Mandal range	6.87-7.86	7.01-7.41	0.22-0.31	0.21-0.54	0.23-0.45	0.17-0.41
127	Verullapadu	Verullapadu	7.38	7.23	0.23	0.27	0.38	0.32
128	Jammavaram	Verullapadu	7.24	7.26	0.31	0.59	0.24	0.15
129	Nadaluru	Verullapadu	7.29	7.32	0.19	0.39	0.32	0.28
130	Pallampalle	Verullapadu	7.39	7.54	0.43	0.46	0.46	0.41
131	Peddapuram	Verullapadu	7.01	7.61	0.52	0.21	0.27	0.23
132	Vellanki	Verullapadu	7.43	7.51	0.40	0.19	0.36	0.29
133	Vellanki	Verullapadu	7.24	7.49	0.31	0.12	0.25	0.19
		Mandal range	7.01-7.43	7.23-7.61	0.19-0.52	0.12-0.59	0.24-0.46	0.15-0.41
134	Penamaluru	Penamaluru	7.32	7.36	0.17	0.29	0.33	0.27

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
135	Penamaluru	Penamaluru	7.46	7.51	0.41	0.22	0.36	0.30
136	Penamaluru	Penamaluru	7.69	7.70	0.52	0.31	0.51	0.42
137	Vanukuru	Penamaluru	8.02	7.81	0.39	0.36	0.49	0.43
138	Chodavaram	Penamaluru	7.69	7.72	0.22	0.41	0.26	0.19
139	Gosala	Penamaluru	7.21	7.83	0.33	0.48	0.35	0.28
140	Gosala	Penamaluru	7.39	7.42	0.42	0.52	0.28	0.20
		Mandal range	7.21-8.02	7.36-7.83	0.17-0.52	0.22-0.48	0.26-0.51	0.19-0.42
141	Kankipadu	Kankipadu	8.42	7.51	0.24	0.29	0.34	0.29
142	Davuluru	Kankipadu	7.89	8.01	0.21	0.31	0.27	0.17
143	Kunderu	Kankipadu	7.63	7.23	0.27	0.29	0.41	0.32
144	Tanneru	Kankipadu	7.21	7.09	0.27	0.27	0.36	0.27
145	Velpuru	Kankipadu	7.09	7.31	0.29	0.22	0.41	0.33
146	Kandalampadu	Kankipadu	7.38	7.29	0.22	0.36	0.47	0.29
147	Edpugallu	Kankipadu	7.61	7.63	0.39	0.51	0.43	0.37
		Mandal range	7.09-8.42	7.09-8.01	0.21-0.39	0.22-0.51	0.27-0.47	0.17-0.37
148	Vuyyuru	Vuyyuru	7.42	7.56	0.50	0.54	0.53	0.48
149	Akunuru	Vuyyuru	8.04	7.71	0.49	0.49	0.61	0.53
150	Akunuru	Vuyyuru	7.63	7.79	0.27	0.21	0.52	0.46

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
151	Mudunuru	Vuyyuru	7.21	7.63	0.23	0.38	0.49	0.42
152	Katuru	Vuyyuru	7.36	7.43	0.27	0.27	0.56	0.48
153	Chinnaogirala	Vuyyuru	7.01	7.29	0.22	0.23	0.55	0.45
154	Saipuram	Vuyyuru	7.12	7.59	0.22	0.29	0.63	0.52
		Mandal range	7.01-8.04	7.29-7.79	0.22-0.50	0.21-0.54	0.49-0.63	0.42-0.53
155	Unguturu	Unguturu	7.21	7.29	0.19	0.51	0.51	0.43
156	Bokkinala	Unguturu	7.39	7.40	0.30	0.41	0.42	0.39
157	Mukkapadu	Unguturu	7.19	7.22	0.29	0.39	0.35	0.27
158	Mukkapadu	Unguturu	7.23	7.27	0.31	0.51	0.31	0.23
159	Indupalli	Unguturu	7.26	7.32	0.22	0.23	0.29	0.19
160	Manikonda	Unguturu	7.05	7.13	0.26	0.31	0.23	0.20
161	Atkuru	Unguturu	6.90	7.01	0.21	0.26	0.34	0.26
		Mandal range	6.90-7.39	7.01-7.40	0.19-0.31	0.23-0.51	0.23-0.51	0.19-0.43
162	Gannavaram	Gannavaram	7.36	7.42	0.21	0.29	0.44	0.36
163	Balliparru	Gannavaram	7.03	7.46	0.36	0.24	0.32	0.25
164	Gollanapalle	Gannavaram	7.31	6.87	0.27	0.22	0.40	0.31
165	Mettapalle	Gannavaram	7.21	7.24	0.17	0.42	0.38	0.30
166	Savirigudem	Gannavaram	7.27	7.29	0.20	0.18	0.45	0.37
167	Allapuram	Gannavaram	7.23	7.27	0.33	0.52	0.33	0.26

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
168	Chinavautupalli	Gannavaram	7.23	7.36	0.29	0.59	0.28	0.22
		Mandal range	7.03-7.36	6.87-7.46	0.17-0.36	0.18-0.59	0.28-0.45	0.22-0.37
169	Agiripalle	Agiripalle	7.36	7.09	0.22	0.83	0.28	0.19
170	Agiripalle	Agiripalle	7.09	7.31	0.26	0.39	0.46	0.32
171	Sagguru	Agiripalle	7.11	7.01	0.28	0.22	0.37	0.30
172	Saravaram	Agiripalle	7.28	7.43	0.21	0.27	0.26	0.17
173	Edara	Agiripalle	7.24	7.21	0.27	0.29	0.31	0.23
174	Kalaturu	Agiripalle	7.13	7.01	0.27	0.21	0.36	0.27
175	Kalaturu	Agiripalle	7.07	7.32	0.19	0.29	0.23	0.19
		Mandal range	7.07-7.36	7.01-7.43	0.19-0.28	0.21-0.83	0.23-0.46	0.17-0.32
176	Bapulapadu	Bapulapadu	7.43	7.36	0.22	0.22	0.39	0.29
177	Ampapuram	Bapulapadu	7.31	7.41	0.27	0.39	0.48	0.38
178	Chirivada	Bapulapadu	7.21	7.39	0.29	0.50	0.46	0.39
179	Kanumollu	Bapulapadu	7.23	6.98	0.42	0.49	0.39	0.37
180	Madicherla	Bapulapadu	7.10	7.26	0.38	0.27	0.23	0.19
181	Veleru	Bapulapadu	7.19	7.27	0.37	0.21	0.21	0.15
182	Ramalle	Bapulapadu	7.03	7.19	0.19	0.39	0.53	0.43
		Mandal range	7.03-7.43	6.98-7.41	0.19-0.42	0.21-0.50	0.21-0.53	0.15-0.43
183	G.konduru	G.konduru	7.63	7.71	0.29	0.52	0.49	0.41

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
184	Koduru	G.konduru	7.34	7.37	0.24	0.41	0.39	0.32
185	Chevuturu	G.konduru	7.08	7.39	0.23	0.31	0.31	0.24
186	Pinapaka	G.konduru	7.16	7.01	0.23	0.17	0.27	0.22
187	Vellaturu	G.konduru	7.14	7.43	0.18	0.29	0.42	0.34
188	Gaddamanugu	G.konduru	7.20	7.33	0.52	0.39	0.29	0.21
189	Kavuluru	G.konduru	7.00	7.19	0.61	0.50	0.49	0.38
		Mandal range	7.00-7.63	7.01-7.71	0.18-0.61	0.17-0.52	0.27-0.49	0.21-0.41
190	Thotlavalluru	Thotlavalluru	7.32	7.49	0.22	0.49	0.63	0.55
191	Devarapalli	Thotlavalluru	7.28	7.36	0.26	0.27	0.54	0.48
192	Penamakuru	Thotlavalluru	7.22	7.49	0.24	0.36	0.39	0.31
193	Royyuru	Thotlavalluru	7.21	7.29	0.21	0.31	0.66	0.57
194	Royyuru	Thotlavalluru	7.24	7.28	0.32	0.45	0.72	0.65
195	Chagantipadu	Thotlavalluru	7.38	7.43	0.26	0.34	0.59	0.50
196	Iluru	Thotlavalluru	7.03	7.63	0.24	0.27	0.51	0.43
197	Kummamuru	Thotlavalluru	7.09	7.29	0.21	0.24	0.60	0.54
198	Garikaparru	Thotlavalluru	7.26	7.36	0.29	0.32	0.63	0.55
199	Kanakavalli	Thotlavalluru	7.24	7.63	0.21	0.25	0.54	0.47
200	Guruvindapalli	Thotlavalluru	7.09	7.01	0.26	0.21	0.50	0.42
201	South valluru	Thotlavalluru	6.82	6.87	0.39	0.43	0.49	0.40

Contd.

S. No.	Name of the village	Mandal	pH		EC (dS m ⁻¹)		OC(%)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
202	North valluru	Thotlavalluru	6.89	7.09	0.26	0.31	0.52	0.43
203	Yakamuru	Thotlavalluru	7.07	7.32	0.21	0.27	0.50	0.39
		Mandal range	6.82-7.38	6.87-7.63	0.21-0.39	0.21-0.49	0.39-0.72	0.31-0.65
204	Vijayawada (rural)	Vijayawada (rural)	7.13	7.61	0.20	0.39	0.63	0.53
205	Kotturu	Vijayawada (rural)	7.26	7.64	0.23	0.23	0.55	0.47
206	Enikipadu	Vijayawada (rural)	7.21	7.36	0.36	0.41	0.71	0.62
207	Tadepalle	Vijayawada (rural)	7.06	7.82	0.21	0.24	0.65	0.56
208	Gudavalli	Vijayawada (rural)	6.98	8.02	0.21	0.22	0.51	0.48
		Mandal range	6.98-7.26	7.36-8.02	0.20-0.36	0.22-0.41	0.51-0.71	0.47-0.62
209	Vijayawada(urban)	Vijayawada(urban)	7.31	8.11	0.26	0.32	0.56	0.47
210	Vijayawada(urban)	Vijayawada(urban)	7.28	7.26	0.25	0.29	0.64	0.59
211	Vijayawada(urban)	Vijayawada(urban)	7.07	7.31	0.25	0.31	0.57	0.49
212	Vijayawada(urban)	Vijayawada(urban)	7.27	7.63	0.21	0.21	0.38	0.32
		Mandal Range	7.07-7.31	7.26-8.11	0.21-0.26	0.21-0.32	0.38-0.64	0.32-0.59
		Overall range	6.81-8.42	6.81-8.62	0.12-0.72	0.11-0.83	0.15-0.72	0.11-0.65
		Overall mean	7.61	7.70	0.42	0.47	0.43	0.38

Table 4.21: Range and mean \pm standard deviation of pH, EC, OC and CEC of surface soils (0-15cm) of different mandals of Krishna district

S. No.	Name of the Mandal	pH	EC(dS m ⁻¹)	OC(%)	CEC(cmol (p+)kg ⁻¹ soil)
1	A.konduru	7.17-7.78 (7.47 \pm 0.21)	0.12-0.50 (0.36 \pm 0.13)	0.22-0.40 (0.30 \pm 0.06)	32.6-49.2 (44.56 \pm 5.61)
2	Reddigudem	6.82-7.72 (7.41 \pm 0.35)	0.23-0.52 (0.37 \pm 0.10)	0.15-0.50 (0.35 \pm 0.12)	26.2-55.0 (47.17 \pm 9.93)
3	Mylavaram	7.21-7.71 (7.42 \pm 0.17)	0.24-0.53 (0.33 \pm 0.10)	0.19-0.52 (0.30 \pm 0.12)	13.0-50.0 (34.59 \pm 14.02)
4	Vissanapeta	7.57-7.83 (7.70 \pm 0.09)	0.22-0.55 (0.36 \pm 0.11)	0.18-0.42 (0.30 \pm 0.08)	13.0-47.8 (37.47 \pm 11.65)
5	Nuzivedu	7.19-7.81 (7.51 \pm 0.23)	0.28-0.52 (0.39 \pm 0.09)	0.15-0.39 (0.29 \pm 0.09)	32.6-50.0 (40.69 \pm 6.12)
6	Chatrai	6.88-7.86 (7.48 \pm 0.32)	0.24-0.68 (0.47 \pm 0.18)	0.49-0.64 (0.60 \pm 0.05)	13.0-54.4 (37.37 \pm 16.15)
7	Jaggaypeta	7.23-7.89 (7.64 \pm 0.19)	0.14-0.72 (0.35 \pm 0.17)	0.22-0.58 (0.39 \pm 0.12)	13.0-60.9 (42.22 \pm 14.47)
8	Ibhrahimpatnam	7.12-7.91 (7.39 \pm 0.27)	0.21-0.64 (0.41 \pm 0.16)	0.21-0.39 (0.31 \pm 0.06)	25.2-52.2 (39.74 \pm 9.16)
9	Gampalagudem	7.19-7.82 (7.46 \pm 0.26)	0.12-0.39 (0.26 \pm 0.08)	0.24-0.42 (0.32 \pm 0.07)	14.3-56.5 (47.44 \pm 14.60)
10	Pamidimukkala	6.98-7.86 (7.40 \pm 0.27)	0.13-0.64 (0.41 \pm 0.18)	0.21-0.47 (0.35 \pm 0.09)	13.0-58.7 (38.71 \pm 15.12)

Contd.

S. No.	Name of the Mandal	pH	EC(dS m ⁻¹)	OC(%)	CEC(cmol (p+)kg ⁻¹ soil)
11	Musunuru	7.31-7.79 (7.48 ± 0.20)	0.24-0.62 (0.41 ± 0.16)	0.21-0.46 (0.31 ± 0.10)	32.6-52.2 (42.03 ± 7.18)
12	Tiruvuru	7.39-7.79 (7.63 ± 0.12)	0.22-0.69 (0.38 ± 0.20)	0.24-0.48 (0.33 ± 0.10)	13.0-45.7 (34.69 ±10.35)
13	Nandigama	7.21-7.89 (7.64 ± 0.27)	0.22-0.69 (0.45 ± 0.17)	0.26-0.51 (0.38 ± 0.09)	25.2-45.7 (37.04 ± 6.73)
14	Penuganchiprolu	7.29-7.63 (7.42 ± 0.12)	0.19-0.43 (0.28 ± 0.08)	0.27-0.46 (0.36 ± 0.07)	25.2-56.5 (44.38 ± 11.14)
15	Vatsvai	6.81-7.49 (7.19 ± 0.25)	0.23-0.51 (0.34 ± 0.10)	0.21-0.45 (0.32 ± 0.08)	13.0-50.0 (39.33 ± 12.56)
16	Chandarlapadu	7.09-7.79 (7.45 ± 0.26)	0.19-0.42 (0.27 ± 0.09)	0.22-0.42 (0.32 ± 0.09)	32.6-50.0 (41.16 ±5.98)
17	Kanchikacherla	6.87-7.86 (7.26 ±0.37)	0.22-0.31 (0.27 ± 0.03)	0.23-0.45 (0.35 ± 0.10)	25.2-56.5 (43.23 ± 10.38)
18	Verullapadu	7.01-7.43 (7.28 ±0.14)	0.19-0.52 (0.34 ± 0.12)	0.24-0.46 (0.33 ± 0.08)	25.2-50.0 (39 ± 8.83)
19	Penamaluru	7.21-8.02 (7.54 ±0.28)	0.17-0.52 (0.35 ± 0.12)	0.26-0.51 (0.37 ± 0.10)	13.0-58.7 (40.99 ± 15.65)
20	Kankipadu	7.09-8.42 (7.60 ± 0.45)	0.21-0.39 (0.27 ± 0.06)	0.27-0.47 (0.38 ± 0.07)	28.3-58.7 (44.94 ± 12.17)

Contd.

S. No.	Mandal	pH	EC(dS m ⁻¹)	OC(%)	CEC(cmol (p+)kg ⁻¹ soil)
21	Vuyyuru	7.01-8.04 (7.40 ± 0.35)	0.22-0.50 (0.31 ± 0.13)	0.49-0.63 (0.56 ± 0.05)	25.2-60.9 (50.19 ± 14.81)
22	Unguturu	6.90-7.39 (7.18 ± 0.16)	0.19-0.31 (0.25 ± 0.05)	0.23-0.51 (0.35 ± 0.09)	32.6-60.9 (50.94 ± 9.63)
23	Gannavaram	7.03-7.36 (7.23 ± 0.10)	0.17-0.36 (0.26± 0.07)	0.28-0.45 (0.37 ± 0.06)	13.0-58.7 (44.61 ± 15.90)
24	Agiripalli	7.07-7.36 (7.18 ± 0.11)	0.19-0.28 (0.24 ± 0.04)	0.23-0.46 (0.32 ± 0.08)	25.2-56.5 (42.00 ± 11.21)
25	Bapulapadu	7.03-7.43 (7.21 ± 0.13)	0.19-0.42 (0.31 ± 0.09)	0.21-0.53 (0.38 ± 0.12)	13.0-58.7 (41.79 ± 16.88)
26	G.konduru	7.00-7.63 (7.22 ± 0.21)	0.18-0.61 (0.33 ± 0.17)	0.27-0.49 (0.38 ± 0.09)	36.2-60.9 (47.81 ± 8.77)
27	Thotlavalluru	6.82-7.38 (7.15 ± 0.16)	0.21-0.39 (0.26 ± 0.05)	0.39-0.72 (0.56 ± 0.08)	25.2-58.7 (45.39 ± 9.13)
28	Vijayawada(rural)	6.98-7.26 (7.13 ± 0.11)	0.20-0.36 (0.24 ± 0.07)	0.51-0.71 (0.61 ± 0.08)	25.2-56.5 (44.60 ± 13.14)
29	Vijayawada(urban)	7.07-7.31 (7.23 ± 0.11)	0.21-0.26 (0.24 ± 0.02)	0.38-0.64 (0.54 ± 0.11)	36.2-60.9 (47.65 ± 10.17)

Table 4.22 : Range and mean \pm standard deviation of pH, EC, OC and CEC of subsurface soils (15-30cm) of different mandals of Krishna district

S. No.	Name of the Mandal	pH	EC (dS m ⁻¹)	OC (%)	CEC
1	A.konduru	7.28-7.79 (7.51 \pm 0.19)	0.26-0.46 (0.34 \pm 0.07)	0.18-0.38 (0.25 \pm 0.06)	35.2-50.9 (46.16 \pm 5.28)
2	Reddigudem	7.00-7.79 (7.45 \pm 0.30)	0.28-0.42 (0.33 \pm 0.05)	0.10-0.41 (0.28 \pm 0.11)	28.7-56.3 (49.03 \pm 9.77)
3	Mylavaram	7.39-7.82 (7.58 \pm 0.19)	0.31-0.45 (0.37 \pm 0.04)	0.11-0.43 (0.25 \pm 0.14)	15.2-51.3 (36.27 \pm 13.70)
4	Vissanapeta	7.49-7.89 (7.72\pm 0.13)	0.28-0.57 (0.43 \pm 0.10)	0.11-0.34 (0.24 \pm 0.08)	15.2-49.7 (37.87 \pm 12.66)
5	Nuzivedu	7.21-7.87 (7.54 \pm 0.28)	0.39-0.69 (0.56 \pm 0.10)	0.11-0.31 (0.23 \pm 0.08)	35.2-51.2 (43.13 \pm 5.53)
6	Chatrai	7.00-7.86 (7.42 \pm 0.32)	0.24-1.04 (0.50 \pm 0.27)	0.47-0.58 (0.53 \pm 0.04)	15.2-55.2 (39.31 \pm 15.88)
7	Jaggaypeta	7.01-8.62 (7.72 \pm 0.45)	0.27-0.45 (0.37 \pm 0.05)	0.18-0.52 (0.33 \pm 0.13)	15.2-62.4 (44.15 \pm 13.94)
8	Ibbrahimpatnam	6.89-8.01 (7.38 \pm 0.34)	0.16-0.56 (0.32 \pm 0.14)	0.16-0.30 (0.24 \pm 0.05)	26.9-53.0 (41.04 \pm 8.95)
9	Gampalagudem	7.06-8.36 (7.89 \pm 0.38)	0.24-0.81 (0.45 \pm 0.20)	0.19-0.36 (0.26 \pm 0.06)	18.2-60.4 (51.34 \pm 14.60)

Contd.

S. No.	Name of the Mandal	pH	EC (dS m ⁻¹)	OC (%)	CEC
10	Pamidimukkala	7.09-7.52 (7.33 ± 0.15)	0.11-0.34 (0.25 ± 0.08)	0.17-0.38 (0.28 ± 0.09)	15.2-62.6 (41.61 ± 15.87)
11	Musunuru	7.6-7.42 (7.34 ± 0.05)	0.21-0.69 (0.48 ± 0.16)	0.17-0.38 (0.25 ± 0.09)	35.2-56.1 (44.97 ± 8.23)
12	Tiruvuru	6.81-8.06 (7.39 ± 0.04)	0.21-1.21 (0.46 ± 0.36)	0.19-0.41 (0.26 ± 0.08)	15.2-49.6 (37.96 ± 10.92)
13	Nandigama	7.03-7.32 (7.18 ± 0.12)	0.19-0.64 (0.34 ± 0.15)	0.20-0.42 (0.30 ± 0.08)	26.9-49.6 (40.06 ± 7.62)
14	Penuganchiprolu	7.31-7.64 (7.49 ± 0.12)	0.13-0.32 (0.25 ± 0.06)	0.19-0.39 (0.28 ± 0.08)	26.9-60.4 (47.66 ± 11.99)
15	Vatsvai	7.00-7.49 (7.24 ± 0.17)	0.21-0.54 (0.32 ± 0.13)	0.13-0.36 (0.26 ± 0.08)	15.2-53.9 (42.60 ± 13.29)
16	Chandarlapadu	7.21-7.92 (7.49 ± 0.27)	0.15-0.31 (0.24 ± 0.06)	0.17-0.33 (0.24 ± 0.08)	35.2-53.9 (44.87 ± 6.30)
17	Kanchikacherla	7.01-7.41 (7.22 ± 0.16)	0.21-0.54 (0.34 ± 0.11)	0.17-0.41 (0.29 ± 0.10)	26.9-60.4 (46.43 ± 11.34)
18	Verullapadu	7.23-7.61 (7.42 ± 0.15)	0.12-0.59 (0.32 ± 0.17)	0.15-0.41 (0.27 ± 0.09)	26.9-53.9 (42.40 ± 9.57)
19	Penamaluru	7.36-7.83 (7.62 ± 0.19)	0.22-0.48 (0.37 ± 0.11)	0.19-0.42 (0.30 ± 0.10)	15.2-62.6 (44.46 ± 16.28)

Contd.

S. No.	Name of the Mandal	pH	EC (dS m ⁻¹)	OC (%)	CEC
20	Kankipadu	7.09-8.01 (7.44 ± 0.31)	0.22-0.51 (0.32 ± 0.09)	0.17-0.37 (0.29 ± 0.06)	32.2-62.6 (48.46 ± 12.53)
21	Vuyyuru	7.29-7.79 (7.57 ± 0.17)	0.21-0.54 (0.34 ± 0.13)	0.42-0.53 (0.48 ± 0.04)	26.9-64.8 (53.59 ± 15.68)
22	Unguturu	7.01-7.40 (7.23 ± 0.13)	0.23-0.51 (0.37 ± 0.11)	0.19-0.43 (0.28 ± 0.09)	35.2-64.8 (54.66 ± 10.05)
23	Gannavaram	6.87-7.46 (7.27 ± 0.19)	0.18-0.59 (0.35 ± 0.16)	0.22-0.37 (0.30 ± 0.06)	15.2-62.5 (47.89 ± 16.72)
24	Agiripalli	7.01-7.43 (7.20 ± 0.17)	0.21-0.83 (0.36 ± 0.22)	0.17-0.32 (0.24 ± 0.06)	26.9-60.4 (45.01 ± 12.20)
25	Bapulapadu	6.98-7.41 (7.27 ± 0.15)	0.21-0.50 (0.35 ± 0.12)	0.15-0.43 (0.31 ± 0.11)	15.2-62.6 (45.13 ± 17.73)
26	G.konduru	7.01-7.71 (7.35 ± 0.22)	0.17-0.52 (0.37 ± 0.12)	0.21-0.41 (0.30 ± 0.08)	37.4-64.8 (51.33 ± 9.41)
27	Thotlavalluru	6.87-7.63 (7.32 ± 0.22)	0.21-0.49 (0.32 ± 0.08)	0.31-0.65 (0.48 ± 0.09)	26.9-62.6 (48.78 ± 9.62)
28	Vijayawada(rural)	7.36-8.02 (7.69 ± 0.25)	0.22-0.41 (0.30 ± 0.09)	0.47-0.62 (0.53 ± 0.06)	26.9-60.4 (48.06 ± 13.97)
29	Vijayawada(urban)	7.26-8.11 (7.58 ± 0.39)	0.21-0.32 (0.28 ± 0.05)	0.32-0.59 (0.47 ± 0.11)	37.4-64.8 (50.88 ± 11.22)

Table 4.23 : Soil test summary for soil reaction (pH)

S. No.	Number of samples	pH		Number of samples in each category			
		Range	Mean	Neutral	Slightly alkaline	Moderately alkaline	Highly alkaline
Surface							
1	212	6.81-8.42	7.61	120(56.60%)	88(41.50%)	4(1.90%)	NIL
Subsurface							
2	212	6.81-8.62	7.70	104(49.05%)	95(44.81%)	12(5.66%)	1(0.48%)

Table 4.24: Soil test summary for electrical conductivity (dS m⁻¹)

S. No.	Number of samples	EC(dSm ⁻¹)		Number of samples in each category		
		Range	Mean	Normal	Critical for Germination	Injurious to crops
Surface						
1	212	0.12-0.72	0.42	212(100%)	NIL	NIL
Subsurface						
2	212	0.11-0.83	0.47	212(100%)	NIL	NIL

Table 4.25: Soil test summary for organic carbon (OC%)

S. No.	Number of samples	Organic carbon (oc%)		Number of samples in each category		
		Range	Mean	Low	Medium	High
Surface						
1	212	0.15-0.72	0.43	170(80.18%)	41(19.34%)	1(0.48%)
Subsurface						
2	212	0.11-0.65	0.38	192(90.56%)	20(9.44%)	NIL

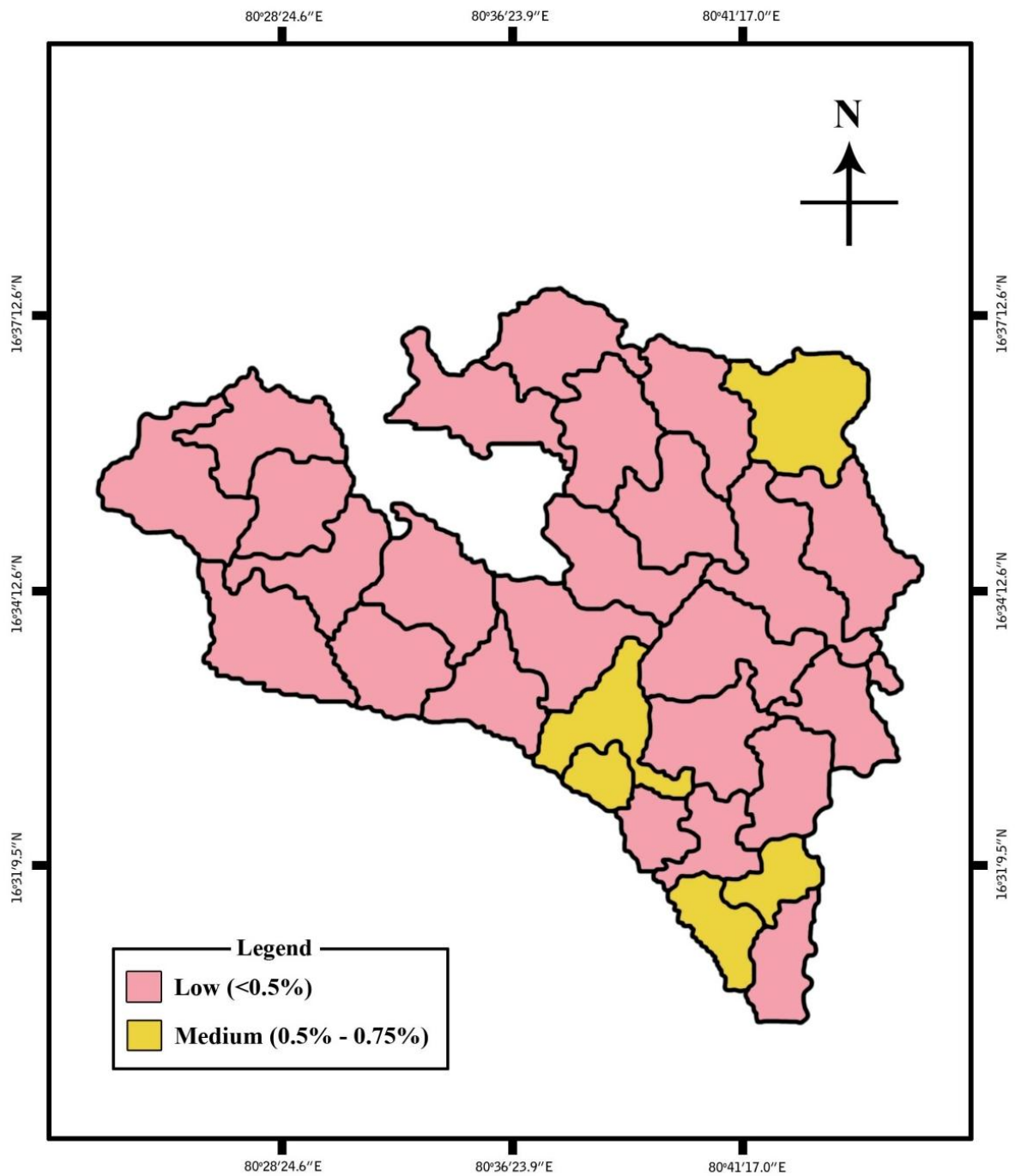


Fig. 3a Organic carbon status of surface soil samples of Krishna district

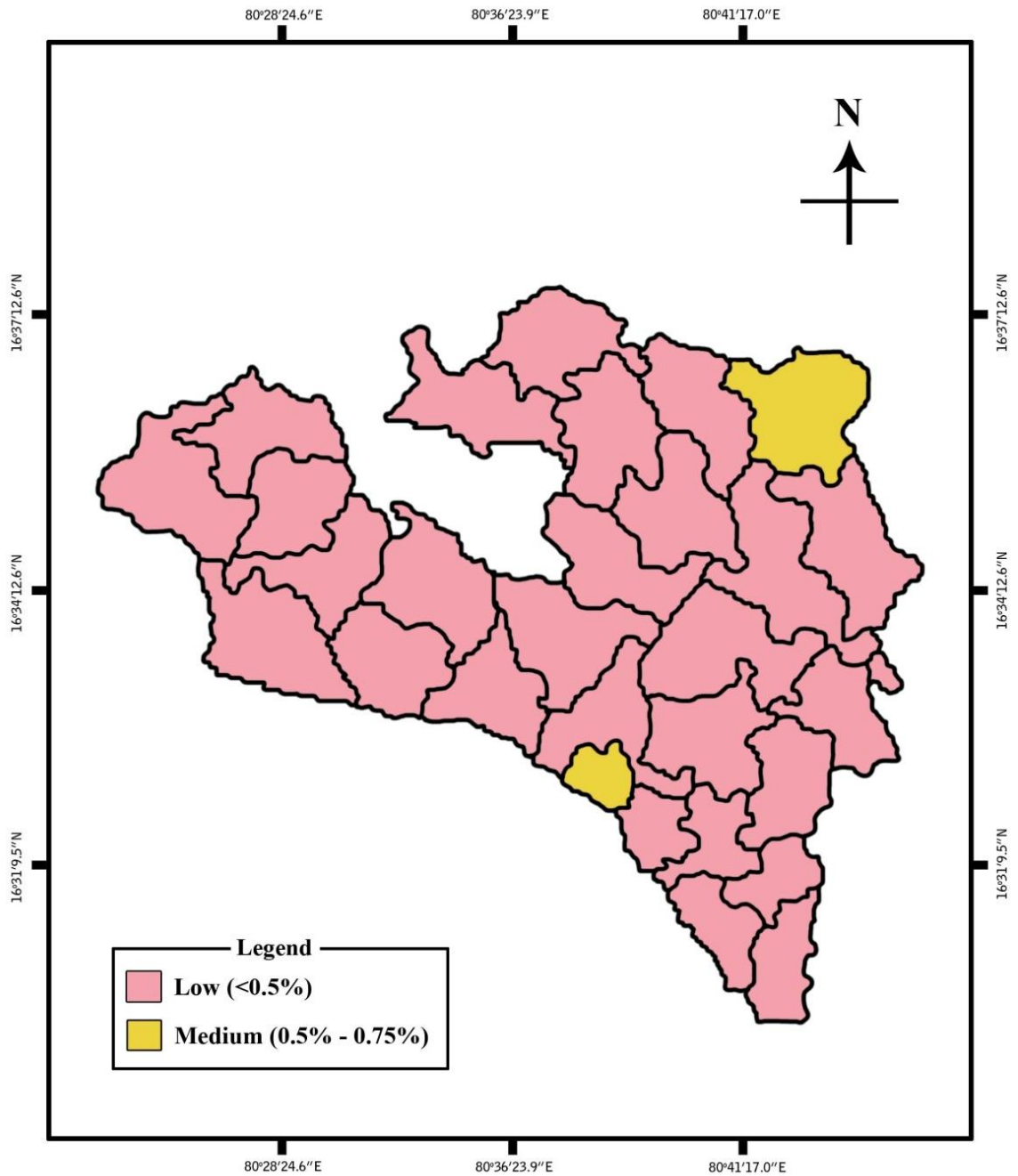


Fig. 3b Organic carbon status of subsurface soil samples of Krishna district

Among the mandals, the soils of Chatrai mandal recorded highest mean soil organic carbon (0.60%) content while, the lowest (0.29%) was recorded in Nuzivedu mandal. The variation among the mandals with respect to carbon content might be due to diversified cropping pattern followed in the study area. Similarly, wide variation in organic carbon under different land use systems has also been reported by Sharma *et al.* (2013).

The available organic carbon content showed significant and positive correlation with yield of crops like sugarcane ($r=0.747^*$), turmeric (0.694^*), groundnut ($r=0.749^*$), cotton ($r=0.698^*$), chilli (0.684^*), maize ($r=0.673^*$) and mango ($r=0.717^*$) and highly significant positive correlation with bhendi ($r=0.880^{**}$) yield. (Table 4.70, 4.71, 4.72, 4.73, 4.74, 4.75, 4.76 and 4.77)

4.2.4 Cation Exchange Capacity

The data presented in table 4.3 revealed that cation exchange capacity (CEC) of surface soils ranged from 13.0 to 60.9 cmol (p+) kg^{-1} with a mean value of 36.95 cmol (p+) kg^{-1} while it ranged from 15.2 to 64.8 cmol (p+) kg^{-1} with a mean value of 40 cmol (p+) kg^{-1} in subsurface soils.

It was observed that subsurface samples had higher CEC values as compared to surface soil samples. This might be due to finer texture in subsurface samples. These results were in accordance with the findings made by Kaswala *et al.* (1999) and Durga Devi (2011) in coastal soils of South Gujarat and Nellore district of Andhra Pradesh, respectively.

The CEC was more in these soils because of the presence of clay and organic matter and these fractions had a large number of negative charges on their surface, thus they attracted cations and contributed to higher CEC values. Similar results were reported by Mini *et al.* (2007) in coastal soils of Karnataka which ranged from 18.6 to 69.1 cmol (p+) kg^{-1} . Similar findings were reported by Sharma and Kanwar (2010) in soils of Himachal Pradesh, Likhari and Jagdishprasad (2011) in orange growing soils of Nagpur district.

Table 4.3 : Electro-chemical properties of the upland soils of Krishna district

S.No.	NAME OF THE VILLAGE	MANDAL	CEC(c mol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
1	A.Konduru	A.Konduru	32.6	35.2
2	Gollamandala	A.Konduru	47.5	48.7
3	Khambampadu	A.Konduru	48.2	50.0
4	Cheemalapadu	A.Konduru	49.2	50.9
5	Koduru	A.Konduru	45.3	47.3
6	Madhavaram	A.Konduru	45.5	46.4
7	Repudi	A.Konduru	43.6	44.6
		Mandal Range	32.6-49.2	35.2-50.9
8	Reddigudem	Reddigudem	55.0	56.3
9	Reddigudem	Reddigudem	54.1	56.3
10	Naguluru	Reddigudem	52.9	56.0
11	Kudapa	Reddigudem	46.8	47.4
12	Rudravaram	Reddigudem	49.7	50.2
13	Rudravram	Reddigudem	26.2	28.7
14	Rangapuram	Reddigudem	45.5	48.3
		Mandal Range	26.2-55.0	28.7-56.3

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC(c mol (p+) kg-1 soil)	
			Surface	Subsurface
15	Mylavaram	Mylavaram	18.2	20.1
16	Chandrala	Mylavaram	47.8	49.0
17	Mylavaram	Mylavaram	13.0	15.2
18	Velvadam	Mylavaram	37.0	38.2
19	Pulluru	Mylavaram	39.1	40.2
20	Morusumilli	Mylavaram	50.0	51.3
21	Kanimerla	Mylavaram	37.0	39.9
		Mandal Range	13.0-50.0	15.2-51.3
22	Vissanapeta	Vissanapeta	37.0	27.5
23	Putrela	Vissanapeta	43.5	45.7
24	Kondaparva	Vissanapeta	47.8	49.4
25	Korlamanda	Vissanapeta	39.1	40.2
26	Tatakuntla	Vissanapeta	13.0	15.2
27	Narsapuram	Vissanapeta	36.2	37.4
28	Kalagara	Vissanapeta	45.7	49.7
		Mandal Range	13.0-47.8	15.2-49.7
29	Nuzivedu	Nuzivedu	39.1	40.3
30	Digavalli	Nuzivedu	43.5	47.3
31	Morsapudi	Nuzivedu	50.0	51.2

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC(c mol (p+) kg-1 soil)	
			Surface	Subsurface
32	Boravancha	Nuzivedu	39.1	42.3
33	Sunkollu	Nuzivedu	34.8	39.0
34	Vempadu	Nuzivedu	45.7	46.6
35	Gollapalle	Nuzivedu	32.6	35.2
		Mandal Range	32.6-50.0	35.2-51.2
36	Chatrai	Chatrai	30.6	32.7
37	Chatrai	Chatrai	20.1	22.2
38	Chittapur	Chatrai	50.0	51.3
39	Mankollu	Chatrai	47.8	49.7
40	Polavaram	Chatrai	54.4	55.2
41	Kothapadu	Chatrai	13.0	15.2
42	Chinnampet	Chatrai	45.7	48.9
		Mandal Range	13.0-54.4	15.2-55.2
43	Jaggaypeta	Jaggaypeta	47.8	49.4
44	Balusupadu	Jaggaypeta	47.8	50.1
45	Garikipadu	Jaggaypeta	26.1	29.6
46	Ravirala	Jaggaypeta	39.1	42.6
47	Vedadri	Jaggaypeta	36.2	37.4
48	Takkalapadu	Jaggaypeta	60.9	62.4

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
49	West Gandrai	Jaggaypeta	32.6	35.2
50	Ravirala	Jaggaypeta	13.0	15.2
51	Jaggaypeta	Jaggaypeta	52.2	53.0
52	East Gandrai	Jaggaypeta	50.0	51.1
53	Chillakallu	Jaggaypeta	58.7	59.7
		Mandal Range	13.0-60.9	15.2-62.4
54	Ibbrahimpatnam	Ibbrahimpatnam	34.8	35.3
55	Ibbrahimpatnam	Ibbrahimpatnam	52.2	53.0
56	Elaprolu	Ibbrahimpatnam	25.2	26.9
57	Damuluru	Ibbrahimpatnam	36.2	37.4
58	Kotikalapudi	Ibbrahimpatnam	32.6	35.2
59	Jupudi	Ibbrahimpatnam	47.8	43.6
60	Tummalapalem	Ibbrahimpatnam	47.8	51.7
61	Mullapadu	Ibbrahimpatnam	41.3	45.2
		Mandal Range	25.2-52.2	26.9-53.0

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
62	Gampalagudem	Gampalagudem	56.5	60.4
63	Arlapadu	Gampalagudem	14.3	18.2
64	Gullapudi	Gampalagudem	56.5	60.4
65	Kanumuru	Gampalagudem	39.1	43.0
66	Lingala	Gampalagudem	52.2	56.1
67	Meduru	Gampalagudem	50.0	53.9
68	Utukuru	Gampalagudem	56.5	60.4
69	Utukuru	Gampalagudem	54.4	58.3
		Mandal Range	14.3-56.5	18.2-60.4
70	Pamidimukkala	Pamidimukkala	32.6	35.2
71	Inampudi	Pamidimukkala	52.2	56.1
72	Meduru	Pamidimukkala	13.0	15.2
73	Mantada	Pamidimukkala	36.2	37.4
74	Mullapudi	Pamidimukkala	32.6	35.2
75	Choragudi	Pamidimukkala	58.7	62.6
76	Inapuru	Pamidimukkala	45.7	49.6
		Mandal Range	13.0-58.7	15.2-62.6

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
77	Musunuru	Musunuru	52.2	56.1
78	Surepalli	Musunuru	36.2	37.4
79	Gullapudi	Musunuru	43.5	47.4
80	Musunuru	Musunuru	47.8	51.7
81	Ellapuram	Musunuru	45.7	49.6
82	Chintalvalli	Musunuru	32.6	35.2
83	Lopudi	Musunuru	36.2	37.4
		Mandal Range	32.6-52.2	35.2-56.1
84	Tiruvuru	Tiruvuru	34.8	38.7
85	Chittela	Tiruvuru	37.0	40.9
86	Rajupeta	Tiruvuru	41.3	45.2
87	Mallela	Tiruvuru	34.8	38.7
88	Munukulla	Tiruvuru	45.7	49.6
89	Vavilala	Tiruvuru	36.2	37.4
90	Vavilala	Tiruvuru	13.0	15.2
		Mandal Range	13.0-45.7	15.2-49.6

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
91	Nandigama	Nandigama	41.3	45.2
92	Damuluru	Nandigama	41.3	45.2
93	Lingalapadu	Nandigama	37.0	40.9
94	Satyavaram	Nandigama	36.2	37.4
95	Pallagiri	Nandigama	45.7	49.6
96	Gollamudi	Nandigama	25.2	26.9
97	Kanchela	Nandigama	32.6	35.2
		Mandal Range	25.2-45.7	26.9-49.6
98	Penuganchiprolu	Penuganchiprolu	56.5	60.4
99	Thotacherla	Penuganchiprolu	54.4	58.3
100	Mullapadu	Penuganchiprolu	52.2	56.1
101	Konakanchi	Penuganchiprolu	45.7	49.6
102	Sanagapadu	Penuganchiprolu	25.2	26.9
103	Sanagapadu	Penuganchiprolu	34.8	38.7
104	Kollikulla	Penuganchiprolu	50.0	53.9
105	Anigandlapadu	Penuganchiprolu	36.2	37.4
		Mandal Range	25.2-56.5	26.9-60.4

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
106	Vatsvai	Vatsvai	47.8	51.7
107	Chittela	Vatsvai	43.5	47.4
108	Lingala	Vatsvai	13.0	15.2
109	Allurupadu	Vatsvai	39.1	43.0
110	Makkapeta	Vatsvai	50.0	53.9
111	Gangavalli	Vatsvai	36.2	37.4
112	Dechupalem	Vatsvai	45.7	49.6
		Mandal Range	13.0-50.0	15.2-53.9
113	Chandarlapadu	Chandarlapadu	39.1	43.0
114	Eturu	Chandarlapadu	43.5	47.4
115	Konayapalem	Chandarlapadu	50.0	53.9
116	Pokkunuru	Chandarlapadu	46.8	50.7
117	Gudimetla	Chandarlapadu	37.0	40.9
118	Chintalpadu	Chandarlapadu	39.1	43.0
119	Mungalapalli	Chandarlapadu	32.6	35.2
		Mandal Range	32.6-50.0	35.2-53.9

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
120	Kanchikacherla	Kanchikacherla	25.2	26.9
121	Chevitikallu	Kanchikacherla	45.5	49.4
122	Keesara	Kanchikacherla	45.7	49.6
123	Paritala	Kanchikacherla	36.2	37.4
124	Singapuram	Kanchikacherla	52.2	56.1
125	Vemulapalli	Kanchikacherla	56.5	60.4
126	Gandepalli	Kanchikacherla	41.3	45.2
		Mandal Range	25.2-56.5	26.9-60.4
127	Verullapadu	Verullapadu	43.5	47.4
128	Jammavaram	Verullapadu	47.8	51.7
129	Nadaluru	Verullapadu	32.6	35.2
130	Pallampalle	Verullapadu	25.2	26.9
131	Peddapuram	Verullapadu	34.8	38.7
132	Vellanki	Verullapadu	39.1	43.0
133	Vellanki	Verullapadu	50.0	53.9
		Mandal Range	25.2-50.0	26.9-53.9

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
134	Penamaluru	Penamaluru	37.0	40.9
135	Penamaluru	Penamaluru	58.7	62.6
136	Penamaluru	Penamaluru	13.0	15.2
137	Vanukuru	Penamaluru	41.3	45.2
138	Chodavaram	Penamaluru	47.8	51.7
139	Gosala	Penamaluru	56.5	60.4
140	Gosala	Penamaluru	32.6	35.2
		Mandal Range	13.0-58.7	15.2-62.6
141	Kankipadu	Kankipadu	45.7	49.6
142	Davuluru	Kankipadu	34.8	38.7
143	Kunderu	Kankipadu	28.3	32.2
144	Tanneru	Kankipadu	58.7	62.6
145	Velpuru	Kankipadu	52.2	56.1
146	Kandalampadu	Kankipadu	36.2	37.4
147	Edpugallu	Kankipadu	58.7	62.6
		Mandal Range	28.3-58.7	32.2-62.6

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
148	Vuyyuru	Vuyyuru	25.2	26.9
149	Akunuru	Vuyyuru	32.6	35.2
150	Akunuru	Vuyyuru	56.5	60.4
151	Mudunuru	Vuyyuru	60.9	64.8
152	Katuru	Vuyyuru	58.7	62.6
153	Chinnaogirala	Vuyyuru	56.5	60.4
154	Saipuram	Vuyyuru	60.9	64.8
		Mandal Range	25.2-60.9	26.9-64.8
155	Unguturu	Unguturu	32.6	35.2
156	Bokkinala	Unguturu	60.9	64.8
157	Mukkapadu	Unguturu	50.0	53.9
158	Mukkapadu	Unguturu	58.7	62.6
159	Indupalli	Unguturu	56.5	60.4
160	Manikonda	Unguturu	52.2	56.1
161	Atkuru	Unguturu	45.7	49.6
		Mandal Range	32.6-60.9	35.2-64.8

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
162	Gannavaram	Gannavaram	36.2	37.4
163	Balliparru	Gannavaram	13.0	15.2
164	Gollanapalle	Gannavaram	56.5	60.4
165	Mettapalle	Gannavaram	58.7	62.6
166	Savirigudem	Gannavaram	47.8	51.7
167	Allapuram	Gannavaram	45.7	49.6
168	Chinavautupalli	Gannavaram	54.4	58.3
		Mandal Range	13.0-58.7	15.2-62.5
169	Agiripalle	Agiripalle	47.8	51.7
170	Agiripalle	Agiripalle	52.2	56.1
171	Sagguru	Agiripalle	32.6	35.2
172	Saravaram	Agiripalle	25.2	26.9
173	Edara	Agiripalle	56.5	60.4
174	Kalaturu	Agiripalle	43.5	47.4
175	Kalaturu	Agiripalle	36.2	37.4
		Mandal Range	25.2-56.5	26.9-60.4

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
176	Bapulapadu	Bapulapadu	13.0	15.2
177	Ampapuram	Bapulapadu	50.0	53.9
178	Chirivada	Bapulapadu	41.3	45.2
179	Kanumollu	Bapulapadu	47.8	51.7
180	Madicherla	Bapulapadu	58.7	62.6
181	Veleru	Bapulapadu	25.2	26.9
182	Ramalle	Bapulapadu	56.5	60.4
		Mandal Range	13.0-58.7	15.2-62.6
183	G.Konduru	G.Konduru	60.9	64.8
184	Koduru	G.Konduru	55.0	58.9
185	Chevuturu	G.Konduru	50.0	53.9
186	Pinapaka	G.Konduru	39.1	43.0
187	Vellaturu	G.Konduru	36.2	37.4
188	Gaddamanugu	G.Konduru	43.5	47.4
189	Kavuluru	G.Konduru	50.0	53.9
		Mandal Range	36.2-60.9	37.4-64.8

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
190	Thotlavalluru	Thotlavalluru	54.4	58.3
191	Devarapalli	Thotlavalluru	25.2	26.9
192	Penamakuru	Thotlavalluru	47.8	48.1
193	Royyuru	Thotlavalluru	45.7	49.6
194	Yakamuru	Thotlavalluru	49.2	53.1
195	Chagantipadu	Thotlavalluru	37.0	40.9
196	Iluru	Thotlavalluru	32.6	35.2
197	Kummamuru	Thotlavalluru	39.1	43.0
198	Garikaparru	Thotlavalluru	43.5	47.4
199	Kanakavalli	Thotlavalluru	58.7	62.6
200	Guruvindapalli	Thotlavalluru	52.2	56.1
201	South Valluru	Thotlavalluru	47.8	51.7
202	North Valluru	Thotlavalluru	50.0	53.9
203	Royyuru	Thotlavalluru	52.2	56.1
		Mandal Range	25.2-58.7	26.9-62.6

Contd.

S.No.	NAME OF THE VILLAGE	MANDAL	CEC (cmol (p+) kg ⁻¹ soil)	
			Surface	Subsurface
204	Vijayawada (Rural)	Vijayawada (Rural)	45.7	49.6
205	Kotturu	Vijayawada (Rural)	39.1	43.0
206	Enikipadu	Vijayawada (Rural)	56.5	60.4
207	Tadepalle	Vijayawada (Rural)	56.5	60.4
208	Gudavalli	Vijayawada (Rural)	25.2	26.9
		Mandal Range	25.2-56.5	26.9-60.4
209	Vijayawada(Urban)	Vijayawada(Urban)	36.2	37.4
210	Vijayawada(Urban)	Vijayawada(Urban)	47.8	51.7
211	Vijayawada(Urban)	Vijayawada(Urban)	45.7	49.6
212	Vijayawada(Urban)	Vijayawada(Urban)	60.9	64.8
		Mandal Range	36.2-60.9	37.4-64.8
		Overall Range	13.0-60.9	15.2-64.8
		Overall Mean	36.95	40.00

Relatively higher CEC values were recorded in black soils, which might be due to clayey texture of black soils and also indicated contribution of clay towards CEC of soil. Similar observation made by Ramarao (2003) in sandy and black soils of Chirala mandal of Andhra Pradesh. Sharma *et al.* (2008) reported that the CEC of soils was relatively higher in fine textured soils than in medium and coarse textured soils in Amritsar district (Punjab).

4.2.5 Per cent Base Saturation

The data pertaining to per cent base saturation in upland soils of Krishna district were presented in the table 4.31,4.32,4.33 and 4.34. PBS of surface soils ranged from 75-99% with mean of 95.94 % while in subsurface soils it ranged from 74-98% with mean of 94.12%. Relatively lower PBS has been observed in subsurface soils which might be due to less clay content and enhanced leaching of basic cations besides surface soils. The results further revealed that in all the soils the contents of exchangeable cations were found in the order of $\text{Ca}^{2+} > \text{Mg}^{2+} > \text{K}^+ > \text{Na}^+$.

Exchangeable calcium was found to be the most dominant cation on the exchange complex ranging from 13.2 to 48.1 cmol (p^+) kg^{-1} of soil with a mean value of 30.5 cmol (p^+) kg^{-1} , while in subsurface soils, exchangeable calcium varied from 10.6 to 46.5 with a mean value of 28.7 cmol (p^+) kg^{-1} . Calcium usually dominated the exchange complex in soils of Sivagiri micro-watershed in Chittoor district of Andhra Pradesh (Thangasamy *et al.*, 2005). Similar results were reported by Likhari and Jagdishprasad (2011) in soils of Nagpur district, Maharashtra.

Exchangeable magnesium was the second most dominant cation next to exchangeable calcium, but higher than exchangeable sodium and exchangeable potassium. The exchangeable magnesium in surface soils of Krishna district ranged from 1.7 to 25.0 with a mean value of 8.2 cmol (p^+) kg^{-1} , While in subsurface soils, exchangeable magnesium varied from 1.6 to 22.3 with a mean value of 7.0 cmol (p^+) kg^{-1} .

The exchangeable potassium content of surface soils ranged from 0.1 to 8.8 with a mean value of 2.01 cmol (p^+) kg^{-1} and in subsurface it ranged from 0.1 to 7.9 with a mean of 1.7 cmol (p^+) kg^{-1} and was found next to Ca^{+2} and Mg^{+2} . The

Table 4.31 : Percent base saturation of surface soils(0-15cm) of Krishna district

S. No.	Name Of The Village	Exchangeble bases (c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
1	A.konduru	36.1	13.2	2.2	0.6	95
2	Gollamandala	35.1	13.0	2.5	0.5	95
3	Khambampadu	33.9	12.2	2.5	0.3	92
4	Cheemalapadu	34.0	10.3	2.1	0.3	94
5	Koduru	35.8	9.1	0.6	0.3	98
6	Madhavaram	35.3	13.3	4.5	0.5	97
7	Repudi	34.1	12.8	5.1	0.4	95
	Mandal Range	33.9-36.1	9.1-13.3	0.6-5.1	0.3-0.6	92-98
8	Reddigudem	41.8	12.8	3.1	0.4	98
9	Reddigudem	39.0	13.1	3.3	0.4	97
10	Naguluru	37.2	13.8	4.3	0.4	98
11	Kudapa	25.0	11.3	1.4	0.4	97
12	Rudravaram	30.3	9.1	0.9	1.5	97
13	Rudravaram	30.3	10.3	1.0	0.8	98
14	Rangapuram	30.1	10.0	1.2	1.1	97

Contd.

S. No	Name Of The Village	Exchangeble bases (c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
	Mandal Range	25.0-41.8	9.1-13.8	0.9-4.3	0.4-1.5	97-98
15	Mylavaram	34.0	10.5	1.5	0.8	98
16	Chandrala	30.2	10.8	1.2	0.4	98
17	Mylavaram	29.4	11.0	0.8	0.4	98
18	Velvadam	28.1	9.8	1.5	0.4	98
19	Pulluru	40.9	10.0	3.1	0.4	97
20	Morusumilli	36.2	13.5	2.3	0.4	96
21	Kanimerla	30.9	14.3	1.0	0.4	97
	Mandal Range	28.1-40.9	9.8-14.3	0.8-3.1	0.4-0.8	96-98
22	Vissanapeta	30.1	14.0	1.4	0.4	96
23	Putrela	29.2	13.6	1.5	0.4	98
24	Kondaparva	32.4	12.2	1.4	0.5	97
25	Korlamanda	31.2	8.2	1.5	0.4	95
26	Tatakuntla	29.4	11.0	0.8	0.4	98
27	Narsapuram	32.3	7.2	1.7	0.3	96
28	Kalagara	30.0	7.2	0.8	0.3	98
	Mandal Range	29.2-32.4	7.2-14.0	0.8-1.7	0.3-0.5	95-98
29	Nuzivedu	32.2	4.1	1.0	0.3	98
30	Digavalli	29.5	18.0	7.9	0.3	96

S. No.	Name Of The Village	Exchangeble bases (c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
31	Morsapudi	32.7	13.8	7.7	0.5	95
32	Boravancha	31.9	14.8	8.8	0.4	95
33	Sunkollu	33.3	20.0	4.4	0.4	98
34	Vempadu	30.1	10.2	1.0	0.2	98
35	Gollapalle	26.9	8.3	1.9	0.3	97
	Mandal Range	26.9-33.3	4.1-20.0	1.0-8.8	0.2-0.5	95-98
36	Chatrai	26.9	8.5	2.0	0.3	92
37	Chatrai	30.6	13.0	2.5	0.4	96
38	Chittapur	32.2	10.0	2.1	0.4	98
39	Mankollu	29.0	11.7	2.1	0.3	96
40	Polavaram	28.2	9.4	1.7	0.3	94
41	Kothapadu	26.0	9.7	2.1	0.3	97
42	Chinnampet	24.7	9.2	2.3	0.2	92
	Mandal Range	24.7-32.2	8.5-13.0	1.7-2.5	0.2-0.4	92-98
43	Jaggaypeta	24.8	8.2	2.0	0.3	93
44	Balusupadu	22.7	7.9	1.0	0.2	97
45	Garikipadu	23.1	5.1	0.5	0.4	99
46	Ravirala	30.8	11.3	4.2	0.5	94
47	Vedadri	30.0	9.0	5.0	0.4	93

Contd.

S. No.	Name Of The Village	Exchangeble bases (c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
48	Takkalapadu	28.0	9.4	3.4	0.3	95
49	West gandrai	28.0	7.5	3.2	0.4	96
50	Ravirala	27.0	9.3	1.1	0.8	97
51	Jaggaypeta	28.1	10.2	2.0	0.5	99
52	East gandrai	30.2	10.1	1.1	0.1	97
53	Chillakallu	31.1	10.6	1.0	0.4	99
	Mandal Range	22.7-31.1	5.1-11.3	0.5-5.0	0.1-0.8	93-99
54	Ibbrahimpatnam	31.2	11.6	2.1	0.3	95
55	Ibbrahimpatnam	30.7	10.2	1.1	0.7	98
56	Elaprolu	28.1	10.2	1.0	0.4	99
57	Damuluru	32.6	11.9	2.0	0.4	98
58	Kotikalapudi	34.2	7.4	1.0	0.4	98
59	Jupudi	23.9	14.0	2.1	0.4	93
60	Tummalapalem	22.1	14.0	1.8	0.3	95
61	Mullapadu	20.0	13.2	1.6	0.2	92
	Mandal Range	20.0-34.2	7.4-14.0	1.0-2.1	0.2-0.7	92-99
62	Gampalagudem	30.2	13.2	1.0	0.6	98
63	Arlapadu	26.2	12.4	1.2	0.4	99
64	Gullapudi	25.2	12.9	1.9	0.3	96

Contd.

S. No.	Name Of The Village	Exchangeble bases (c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
65	Kanumuru	23.9	11.2	1.7	0.3	97
66	Lingala	24.5	10.3	1.9	0.3	97
67	Meduru	25.0	10.1	0.7	0.5	98
68	Utukuru	25.9	11.0	0.5	0.4	99
69	Utukuru	28.2	11.3	0.7	0.4	98
	Mandal Range	23.9-30.2	10.1-13.2	0.5-1.9	0.3-0.6	96-99
70	Pamidimukkala	27.1	10.9	1.2	0.4	97
71	Inampudi	26.8	11.1	1.5	0.4	98
72	Meduru	31.6	6.2	0.7	0.6	98
73	Mantada	31.2	7.1	0.8	0.4	98
74	Mullapudi	36.1	5.4	1.1	0.4	95
75	Choragudi	33.8	8.2	1.0	0.4	98
76	Inapuru	35.2	8.1	1.1	0.4	93
	Mandal Range	26.8-36.1	5.4-11.1	0.7-1.5	0.4-0.6	93-98
77	Musunuru	38.0	17.7	2.0	0.6	97
78	Surepalli	35.1	20.1	3.2	0.4	97
79	Gullapudi	35.0	22.0	3.7	0.3	98
80	Musunuru	34.9	25.0	3.3	0.2	97
81	Ellapuram	28.0	12.8	0.9	0.6	98

Contd.

S. No.	Name Of The Village	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
82	Chintalvalli	27.2	12.0	1.5	0.5	97
83	Lopudi	26.1	10.2	1.9	0.3	98
	Mandal Range	26.1-38.0	10.2-25.0	0.9-3.7	0.2-0.6	97-98
84	Tiruvuru	24.2	9.1	1.8	0.4	93
85	Chittela	24.1	8.2	2.0	0.4	94
86	Rajupeta	29.3	13.7	1.0	1.2	94
87	Mallela	28.0	10.3	0.5	1.0	99
88	Munukulla	28.5	11.2	1.4	0.5	98
89	Vavilala	29.2	8.5	0.7	1.0	97
90	Vavilala	27.5	10.2	1.0	0.1	97
	Mandal Range	24.1-29.3	8.2-13.7	0.5-2.0	0.1-1.2	93-99
91	Nandigama	26.6	9.5	0.1	0.2	95
92	Damuluru	26.0	8.5	0.8	0.3	97
93	Lingalapadu	24.3	9.3	0.7	0.1	97
94	Satyavaram	31.7	10.0	0.6	0.5	99
95	Pallagiri	30.9	10.2	1.0	0.4	99
96	Gollamudi	29.7	9.3	0.8	0.4	98
97	Kanchela	28.8	8.6	1.0	0.4	98
	Mandal Range	24.3-31.7	8.5-10.2	0.1-1.0	0.1-0.5	95-99

Contd.

S. No.	Name Of The Village	Exchangeble bases (c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
98	Penuganchiprolu	27.6	9.6	0.9	0.4	99
99	Thotacherla	32.5	12.3	6.2	0.4	95
100	Mullapadu	43.6	12.2	3.9	0.3	94
101	Konakanchi	32.2	12.5	4.2	0.3	94
102	Sanagapadu	31.7	12.9	1.9	0.3	98
103	Sanagapadu	30.2	10.8	1.0	0.4	98
104	Kollikulla	32.1	10.2	1.1	0.6	98
105	Anigandlapadu	29.2	9.0	0.2	0.4	99
	Mandal Range	27.6-43.6	9.0-12.9	0.2-6.2	0.3-0.6	94-99
106	Vatsvai	28.7	9.3	0.5	0.4	97
107	Chittela	28.2	9.1	0.6	0.4	97
108	Lingala	26.0	10.4	0.7	0.4	97
109	Allurupadu	29.1	13.1	1.0	0.4	98
110	Makkapeta	29.0	13.0	0.7	0.3	98
111	Gangavalli	28.1	11.3	0.9	0.3	95
112	Dechupalem	28.2	10.1	0.6	0.4	98
	Mandal Range	26.0-29.1	9.1-13.1	0.5-1.0	0.3-0.4	95-98
113	Chandarlapadu	29.5	8.6	0.5	0.4	95
114	Eturu	30.0	10.1	0.9	0.6	98

S. No.	Name Of The Village	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
115	Konayapalem	28.1	9.0	0.8	0.4	99
116	Pokkunuru	28.5	8.1	0.2	0.4	99
117	Gudimetla	24.1	8.2	0.5	0.4	98
118	Chintalpadu	23.2	7.2	0.6	0.4	99
119	Mungalapalli	32.6	10.9	1.0	0.7	96
	Mandal Range	23.2-32.6	7.2-10.9	0.2-1.0	0.4-0.7	95-99
120	Kanchikacherla	30.9	11.5	0.9	0.4	96
121	Chevitikallu	30.1	10.2	0.9	0.4	93
122	Keesara	28.4	11.3	0.7	0.4	93
123	Paritala	30.0	10.1	0.6	0.5	95
124	Singapuram	29.7	14.0	1.5	0.5	94
125	Vemulapalli	30.1	13.3	1.4	0.4	96
126	Gandepalli	27.6	10.1	0.8	0.4	97
	Mandal Range	27.6-30.9	10.1-14.0	0.6-1.5	0.4-0.5	93-97
127	Verullapadu	29.8	11.0	1.7	0.4	98
128	Jammavaram	28.4	11.8	1.8	0.4	98
129	Nadaluru	34.2	9.8	1.3	0.6	98
130	Pallampalle	30.1	8.1	0.6	0.6	97
131	Peddapuram	27.0	10.4	0.9	0.5	97

S. No.	Name Of The Village	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
132	Vellanki	26.4	8.0	0.7	0.5	97
133	Vellanki	23.1	9.5	0.7	0.6	99
	Mandal Range	23.1-34.2	8.0-11.8	0.6-1.8	0.4-0.6	97-99
134	Penamaluru	23.4	4.7	2.5	3.7	99
135	Penamaluru	26.7	5.9	2.2	3.1	97
136	Penamaluru	22.0	3.3	2.0	2.2	98
137	Vanukuru	21.7	2.5	2.1	3.0	98
138	Chodavaram	18.8	2.7	3.0	1.0	94
139	Gosala	19.2	2.0	2.9	1.0	91
140	Gosala	21.8	2.6	2.8	2.0	97
	Mandal Range	18.8-26.7	2.0-5.9	2.0-3.0	1.0-3.7	91-99
141	Kankipadu	13.2	2.0	2.9	1.0	89
142	Davuluru	23.8	3.8	2.2	2.2	98
143	Kunderu	22.0	3.7	2.3	1.4	98
144	Tanneru	27.2	5.5	3.2	2.7	97
145	Velpuru	33.5	7.8	3.2	2.8	99
146	Kandalampadu	27.0	4.0	1.9	1.2	96
147	Edpugallu	24.4	4.0	2.0	2.1	98
	Mandal Range	13.2-33.5	2.0-7.8	1.9-3.2	1.0-2.8	89-99

S. No.	Name Of The Village	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
148	Vuyyuru	30.0	2.5	2.7	1.5	99
149	Akunuru	26.0	2.3	3.0	4.5	97
150	Akunuru	27.4	3.4	2.8	0.8	96
151	Mudunuru	35.8	5.9	3.0	2.7	99
152	Katuru	35.0	6.6	3.0	3.1	98
153	Chinnaogirala	35.0	5.3	2.4	4.1	98
154	Saipuram	34.2	5.3	2.3	4.8	97
	Mandal Range	26.0-35.8	2.3-6.6	2.3-3.0	0.8-4.8	96-99
155	Unguturu	31.0	5.9	2.4	3.1	96
156	Bokkinala	35.0	6.7	3.6	3.4	99
157	Mukkapadu	20.0	2.5	3.3	2.9	94
158	Mukkapadu	23.0	3.9	4.1	3.1	95
159	Indupalli	28.6	6.8	4.9	4.5	97
160	Manikonda	31.2	6.3	2.9	5.0	97
161	Atkuru	23.0	5.3	2.9	4.0	95
	Mandal Range	20.0-35.0	2.5-6.8	2.4-4.9	2.9-5.0	94-99
162	Gannavaram	23.0	6.6	2.1	3.0	98
163	Balliparru	23.5	7.0	1.9	3.2	98
164	Gollanapalle	21.5	6.2	1.9	3.1	96

S. No.	Name Of The Village	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
165	Mettapalle	21.0	8.5	1.1	3.0	96
166	Savirigudem	23.7	6.0	1.2	3.0	97
167	Allapuram	18.4	6.2	1.5	2.7	94
168	Chinavautupalli	29.0	4.8	1.4	4.1	99
	Mandal Range	18.4-29.0	4.8-8.5	1.1-2.1	2.7-4.1	94-99
169	Agiripalle	32.0	2.2	1.8	0.4	99
170	Agiripalle	31.0	3.6	1.7	0.7	95
171	Sagguru	40.0	2.5	3.5	1.9	96
172	Saravaram	38.1	2.4	3.3	0.7	93
173	Edara	35.6	4.1	2.5	0.4	97
174	Kalaturu	36.6	3.2	1.9	0.5	87
175	Kalaturu	38.2	2.3	1.8	0.7	98
	Mandal Range	31.0-40.0	2.2-4.1	1.7-3.5	0.4-1.9	87-99
176	Bapulapadu	30.6	2.8	1.7	0.5	95
177	Ampapuram	28.3	3.4	1.9	0.4	92
178	Chirivada	28.2	3.0	1.7	0.5	84
179	Kanumollu	36.1	2.7	1.7	0.9	87
180	Madicherla	36.9	3.0	1.8	0.8	96
181	Veleru	33.3	4.0	1.9	1.3	88

S. No.	Name Of The Village	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
182	Ramalle	36.6	3.6	2.1	0.5	84
	Mandal Range	28.2-36.9	2.7-4.0	1.7-2.1	0.4-1.3	84-96
183	G.konduru	39.8	3.1	2.1	0.7	94
184	Koduru	36.3	2.1	1.6	1.1	94
185	Chevuturu	32.7	3.1	3.2	0.6	90
186	Pinapaka	30.5	3.2	2.8	0.7	94
187	Vellaturu	40.6	3.8	3.6	0.5	96
188	Gaddamanugu	28.5	2.2	3.0	0.9	98
189	Kavuluru	35.6	3.4	3.6	0.4	93
	Mandal Range	28.5-40.6	2.1-3.8	1.6-3.6	0.4-1.1	90-98
190	Thotlavalluru	28.2	2.0	2.0	2.2	98
191	Devarapalli	41.1	3.6	2.4	0.7	99
192	Penamakuru	30.8	2.8	2.8	0.9	99
193	Royyuru	40.5	2.4	2.8	1.1	97
194	Yakamuru	38.8	2.7	2.4	0.5	95
195	Chagantipadu	39.4	2.9	2.7	1.5	96
196	Iluru	40.9	3.1	2.1	0.5	99
197	Kummamuru	28.6	1.7	1.7	0.5	92
198	Garikaparru	35.2	3.1	1.7	0.6	98

S. No.	Name Of The Village	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
199	Kanakavalli	32.8	3.0	2.7	0.8	98
200	Guruvindapalli	30.1	3.0	1.9	0.7	96
201	South valluru	34.5	4.4	2.5	0.5	77
202	North valluru	44.2	2.4	2.4	0.5	99
203	Royyuru	48.1	3.0	2.1	0.6	95
	Mandal Range	28.2-48.1	1.7-4.4	1.7-2.8	0.5-2.2	77-99
204	Vijayawada (rural)	42.5	2.8	2.2	0.3	99
205	Kotturu	40.8	1.7	1.7	0.5	92
206	Enikipadu	40.1	2.0	1.7	0.9	93
207	Tadepalle	43.6	3.0	2.1	0.7	90
208	Gudavalli	43.3	3.1	2.1	0.4	93
	Mandal Range	40.1-43.6	1.7-3.1	1.7-2.2	0.3-0.9	90-99
209	Vijayawada(urban)	28.5	1.9	1.6	0.8	75
210	Vijayawada(urban)	35.6	3.8	2.4	0.5	76
211	Vijayawada(urban)	43.1	3.2	1.8	0.7	94
212	Vijayawada(urban)	44.8	2.4	2.4	0.5	99
	Mandal Range	28.5-44.8	1.9-3.8	1.6-2.4	0.5-0.8	75-99
	Overall Range	13.2-48.1	1.7-25.0	0.1-8.8	0.1-4.9	75-99
	Overall Mean	30.5	8.2	2.01	0.9	95.94

Table 4.32 : Percent base saturation of subsurface soils(15-30cm) of Krishna district

S. No.	Name Of The Village	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
1	A.konduru	34.8	12.2	2.0	0.4	93
2	Gollamandala	33.9	12.0	2.3	0.4	93
3	Khambampadu	32.6	11.3	2.2	0.2	90
4	Cheemalapadu	32.7	9.3	1.8	0.2	92
5	Koduru	34.5	8.2	0.3	0.2	96
6	Madhavaram	34.0	12.3	4.2	0.3	95
7	Repudi	32.8	11.9	4.8	0.3	93
	Mandal Range	32.6-34.8	8.2-12.3	0.3-4.8	0.2-0.4	90-96
8	Reddigudem	40.5	11.8	2.8	0.2	96
9	Reddigudem	37.7	12.1	3.0	0.2	95
10	Naguluru	35.9	12.9	4.0	0.3	96
11	Kudapa	23.8	10.4	1.1	0.3	95
12	Rudravaram	29.0	8.1	0.6	1.3	95
13	Rudravram	29.0	9.3	0.7	0.7	96
14	Rangapuram	28.8	9.0	1.0	1.0	95

Contd.

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
	Mandal Range	23.8-40.5	8.1-12.9	0.6-4.0	0.2-1.3	95-96
15	Mylavaram	32.7	9.5	1.3	0.6	96
16	Chandrala	28.9	9.9	0.9	0.3	96
17	Mylavaram	28.1	10.0	0.5	0.2	96
18	Velvadam	26.9	8.9	1.3	0.2	96
19	Pulluru	39.7	9.1	2.8	0.3	95
20	Morusumilli	35.2	12.3	1.5	0.3	95
21	Kanimerla	29.9	13.2	0.2	0.2	96
	Mandal Range	26.9-39.7	8.9-13.2	0.2-2.8	0.2-0.6	95-96
22	Vissanapeta	29.1	12.8	0.5	0.3	95
23	Putrela	28.2	12.4	0.6	0.3	97
24	Kondaparva	31.4	11.0	0.5	0.4	96
25	Korlamanda	30.2	7.0	0.7	0.3	94
26	Tatakuntla	28.4	9.8	0.8	0.2	97
27	Narsapuram	31.3	6.0	0.8	0.2	95
28	Kalagara	29.0	6.0	0.4	0.2	97
	Mandal Range	28.2-31.4	6.0-12.8	0.4-0.8	0.2-0.4	94-97
29	Nuzivedu	31.2	2.9	0.1	0.2	97
30	Digavalli	28.5	16.8	7.0	0.2	95

Contd.

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
31	Morsapudi	31.7	12.7	6.9	0.4	94
32	Boravancha	30.9	13.7	7.9	0.3	94
33	Sunkollu	32.3	18.8	3.5	0.3	97
34	Vempadu	29.1	9.0	0.1	0.1	97
35	Gollapalle	25.9	7.2	1.0	0.2	96
	Mandal Range	25.9-32.3	2.9-18.8	0.1-7.9	0.1-0.4	94-97
36	Chatrai	25.9	7.3	1.1	0.2	91
37	Chatrai	29.6	11.8	1.6	0.3	95
38	Chittapur	31.2	8.9	1.2	0.3	97
39	Mankollu	28.0	10.5	1.3	0.2	95
40	Polavaram	27.2	8.2	0.9	0.2	93
41	Kothapadu	25.0	8.5	1.2	0.2	96
42	Chinnampet	23.7	8.0	1.5	0.1	91
	Mandal Range	23.7-31.2	7.3-11.8	0.9-1.6	0.1-0.3	91-97
43	Jaggaypeta	23.1	7.2	1.9	0.3	91
44	Balusupadu	21.0	6.9	0.9	0.2	95
45	Garikipadu	21.4	4.1	0.3	0.4	97
46	Ravirala	29.2	10.3	4.1	0.5	92
47	Vedadri	28.3	8.0	4.9	0.4	91

Contd.

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
48	Takkalapadu	26.4	8.5	3.3	0.3	93
49	West gandrai	26.3	6.5	3.1	0.4	94
50	Ravirala	25.4	8.3	0.9	0.8	95
51	Jaggaypeta	26.5	9.2	1.8	0.5	97
52	East gandrai	28.5	9.1	1.0	0.1	95
53	Chillakallu	29.5	9.6	0.9	0.3	97
	Mandal Range	21.0-29.5	4.1-10.3	0.3-4.9	0.1-0.8	91-97
54	Ibbrahimpatnam	29.5	10.6	2.0	0.3	93
55	Ibbrahimpatnam	29.0	9.2	1.0	0.7	96
56	Elaprolu	26.5	9.2	0.9	0.3	97
57	Damuluru	30.9	10.9	1.9	0.4	96
58	Kotikalapudi	32.5	6.5	0.9	0.3	96
59	Jupudi	22.2	13.0	2.0	0.3	91
60	Tummalapalem	20.5	13.0	1.6	0.3	93
61	Mullapadu	18.4	12.2	1.5	0.2	90
	Mandal Range	18.4-32.5	6.5-13.0	0.9-2.0	0.2-0.7	90-97
62	Gampalagudem	28.5	12.2	0.9	0.6	96
63	Arlapadu	24.5	11.4	1.1	0.3	97
64	Gullapudi	23.5	11.9	1.7	0.3	94

Contd.

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
65	Kanumuru	22.2	10.2	1.6	0.3	95
66	Lingala	22.9	9.3	1.8	0.3	95
67	Meduru	22.8	7.4	0.6	0.4	96
68	Utukuru	23.7	8.3	0.4	0.4	97
69	Utukuru	25.9	8.7	0.6	0.3	96
	Mandal Range	22.2-28.5	7.4-11.9	0.4-1.8	0.3-0.6	94-97
70	Pamidimukkala	24.9	8.2	1.1	0.3	95
71	Inampudi	24.6	8.5	1.4	0.3	96
72	Meduru	29.3	3.5	0.6	0.2	96
73	Mantada	28.9	4.4	0.7	0.3	96
74	Mullapudi	33.9	2.7	1.0	0.3	93
75	Choragudi	31.6	5.5	0.9	0.3	96
76	Inapuru	32.9	5.4	1.0	0.3	91
	Mandal Range	24.6-33.9	2.7-8.5	0.6-1.4	0.2-0.3	91-96
77	Musunuru	35.7	15.0	1.9	0.5	95
78	Surepalli	32.9	17.5	3.1	0.3	95
79	Gullapudi	32.7	19.4	3.6	0.3	96
80	Musunuru	32.6	22.3	3.2	0.1	95
81	Ellapuram	25.7	10.2	0.8	0.5	96

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
82	Chintalvalli	24.9	9.3	1.4	0.4	95
83	Lopudi	23.9	7.5	1.8	0.3	96
	Mandal Range	23.9-35.7	7.5-22.3	0.8-3.6	0.1-0.5	95-96
84	Tiruvuru	21.9	6.4	1.7	0.3	91
85	Chittela	21.8	5.5	1.9	0.3	92
86	Rajupeta	27.0	11.0	0.9	1.1	92
87	Mallela	25.7	7.7	0.4	0.9	97
88	Munukulla	26.3	8.5	1.3	0.4	96
89	Vavilala	26.9	5.9	0.6	0.9	95
90	Vavilala	25.3	7.6	0.9	0.8	95
	Mandal Range	21.8-27.0	5.5-11.0	0.4-1.9	0.3-1.1	91-97
91	Nandigama	23.4	6.9	0.8	0.1	93
92	Damuluru	22.9	5.9	0.7	0.2	95
93	Lingalapadu	21.2	6.6	0.6	0.4	95
94	Satyavaram	28.5	7.4	0.6	0.4	97
95	Pallagiri	27.8	7.6	0.9	0.3	97
96	Gollamudi	26.5	6.6	0.7	0.3	96
97	Kanchela	25.7	5.9	0.9	0.3	96
	Mandal Range	21.2-28.5	5.9-7.6	0.6-0.9	0.1-0.4	93-96

Contd.

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
98	Penuganchiprolu	24.5	6.9	0.8	0.3	97
99	Thotacherla	29.4	9.7	6.1	0.3	93
100	Mullapadu	40.5	9.5	3.8	0.2	92
101	Konakanchi	29.1	9.8	4.1	0.2	92
102	Sanagapadu	28.6	10.2	1.8	0.2	96
103	Sanagapadu	27.1	8.1	0.9	0.3	96
104	Kollikulla	29.0	7.5	1.0	0.5	96
105	Anigandlapadu	26.0	6.4	0.1	0.3	97
	Mandal Range	24.5-40.5	6.4-10.2	0.1-6.1	0.2-0.5	92-97
106	Vatsvai	25.5	6.6	0.4	0.3	95
107	Chittela	25.0	6.5	0.5	0.3	95
108	Lingala	22.9	7.8	0.6	0.3	95
109	Allurupadu	26.0	10.4	0.9	0.3	96
110	Makkapeta	25.9	10.3	0.6	0.2	96
111	Gangavalli	25.0	8.7	0.8	0.2	93
112	Dechupalem	25.1	7.5	0.5	0.3	96
	Mandal Range	22.9-26.0	6.5-10.4	0.4-0.9	0.2-0.3	93-96
113	Chandarlapadu	26.3	5.9	0.4	0.3	93
114	Eturu	26.9	7.5	0.9	0.5	96

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
115	Konayapalem	25.0	6.4	0.7	0.3	97
116	Pokkunuru	25.3	5.5	0.1	0.3	97
117	Gudimetla	21.0	5.5	0.4	0.3	96
118	Chintalpadu	20.1	4.5	0.5	0.3	97
119	Mungalapalli	29.5	8.2	0.9	0.6	94
	Mandal Range	20.1-26.9	4.5-8.2	0.1-0.9	0.3-0.6	93-97
120	Kanchikacherla	27.8	8.9	0.8	0.3	94
121	Chevitikallu	27.0	7.6	0.8	0.3	91
122	Keesara	25.3	8.7	0.7	0.3	91
123	Paritala	26.9	7.5	0.5	0.4	93
124	Singapuram	26.6	11.4	1.4	0.4	92
125	Vemulapalli	28.1	10.6	1.3	0.3	94
126	Gandepalli	25.6	7.5	0.7	0.3	95
	Mandal Range	25.3-28.1	7.5-11.4	0.5-1.4	0.3-0.4	91-95
127	Verullapadu	27.8	8.4	1.6	0.3	96
128	Jammavaram	26.4	9.1	1.7	0.3	96
129	Nadaluru	32.2	7.1	1.2	0.5	96
130	Pallampalle	28.1	5.5	0.5	0.5	95
131	Peddapuram	25.0	7.7	0.8	0.4	95

Contd.

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
132	Vellanki	24.5	5.4	0.6	0.4	95
133	Vellanki	21.1	6.8	0.6	0.5	97
	Mandal Range	21.1-32.2	5.4-9.1	0.5-1.7	0.3-0.5	95-97
134	Penamaluru	21.4	2.0	2.4	3.6	98
135	Penamaluru	24.7	3.2	2.1	3.4	96
136	Penamaluru	20.0	3.2	1.8	2.2	97
137	Vanukuru	19.7	2.4	1.9	3.0	97
138	Chodavaram	16.8	2.6	2.8	2.1	93
139	Gosala	17.2	1.9	2.7	2.9	90
140	Gosala	19.2	2.5	2.6	0.9	96
	Mandal Range	16.8-24.7	1.9-3.2	1.8-2.8	0.9-3.6	90-98
141	Kankipadu	10.6	1.9	2.7	0.9	87
142	Davuluru	21.2	3.7	2.0	1.9	96
143	Kunderu	19.4	3.6	2.1	0.9	96
144	Tanneru	27.0	5.4	3.0	2.1	95
145	Velpuru	32.2	7.7	3.0	1.3	97
146	Kandalampadu	25.7	3.9	1.7	2.6	94
147	Edpugallu	23.1	3.9	1.8	2.7	96
	Mandal Range	10.6-32.2	1.9-7.7	1.7-3.0	0.9-2.7	87-97

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
148	Vuyyuru	28.7	2.4	2.5	1.1	97
149	Akunuru	24.7	2.2	2.8	2.0	96
150	Akunuru	26.1	3.3	2.6	1.4	94
151	Mudunuru	34.5	5.8	2.8	4.4	97
152	Katuru	33.7	6.5	2.8	0.7	97
153	Chinnaogirala	33.7	5.2	2.2	2.6	96
154	Saipuram	32.9	5.2	2.1	3.0	96
	Mandal Range	24.7-34.5	2.2-6.5	2.1-2.8	0.7-4.4	94-97
155	Unguturu	29.7	5.8	2.2	4.0	94
156	Bokkinala	33.7	6.6	3.4	4.7	97
157	Mukkapadu	18.7	2.4	3.1	3.0	93
158	Mukkapadu	21.7	3.8	3.9	3.3	93
159	Indupalli	27.3	6.7	4.7	2.8	96
160	Manikonda	29.5	6.2	2.7	3.0	95
161	Atkuru	21.3	5.2	2.7	4.4	93
	Mandal Range	18.7-33.7	2.4-6.7	2.7-4.7	2.8-4.7	93-97
162	Gannavaram	21.3	6.5	1.9	4.9	97
163	Balliparru	21.8	6.9	1.7	3.9	96
164	Gollanapalle	19.8	6.1	1.7	2.9	95

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
165	Mettapalle	19.3	8.4	0.9	3.1	94
166	Savirigudem	22.0	5.9	1.0	3.0	95
167	Allapuram	16.7	6.1	1.3	2.9	93
168	Chinavautupalli	27.3	4.7	1.2	2.9	97
	Mandal Range	16.7-27.3	4.7-8.4	0.9-1.9	2.9-4.9	93-97
169	Agiripalle	30.3	2.1	1.6	2.6	97
170	Agiripalle	29.3	3.5	1.5	4.0	93
171	Sagguru	38.3	2.4	3.3	0.3	94
172	Saravaram	36.5	2.3	3.1	0.6	91
173	Edara	34.0	4.0	2.3	1.8	95
174	Kalaturu	35.0	3.1	1.7	0.6	85
175	Kalaturu	36.6	2.2	1.6	0.3	97
	Mandal Range	29.3-38.3	2.1-4.0	1.5-3.3	0.3-4.0	85-97
176	Bapulapadu	29.0	2.7	1.5	0.4	93
177	Ampapuram	26.7	3.3	1.7	0.6	91
178	Chirivada	26.6	2.9	1.5	0.4	82
179	Kanumollu	34.5	2.6	1.5	0.3	85
180	Madicherla	35.3	2.9	1.6	0.4	94
181	Veleru	31.7	3.9	1.7	0.8	86

Contd.

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
182	Ramalle	35.0	3.5	1.9	0.7	83
	Mandal Range	26.6-35.3	2.6-3.9	1.5-1.9	0.3-0.8	82-93
183	G.konduru	38.2	3.0	1.9	1.2	92
184	Koduru	34.7	2.0	1.4	0.4	92
185	Chevuturu	31.1	3.0	3.0	0.6	88
186	Pinapaka	28.9	3.1	2.6	1.0	92
187	Vellaturu	39.0	3.7	3.4	0.5	94
188	Gaddamanugu	26.9	2.1	2.8	0.6	96
189	Kavuluru	34.0	3.3	3.4	0.4	91
	Mandal Range	26.9-38.2	2.0-3.7	1.4-3.4	0.4-1.2	88-96
190	Thotlavalluru	26.6	1.9	1.8	0.8	97
191	Devarapalli	39.5	3.5	2.2	0.3	98
192	Penamakuru	29.2	2.7	2.6	2.1	97
193	Royyuru	38.9	2.3	2.6	0.6	95
194	Yakamuru	37.2	2.6	2.2	0.8	94
195	Chagantipadu	37.8	2.8	2.5	1.0	95
196	Iluru	39.3	3.0	1.9	0.4	98
197	Kummamuru	27.0	1.6	1.5	1.4	90
198	Garikaparru	33.6	3.0	1.5	0.4	96

Contd.

S. No.	Name Of The Village	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
199	Kanakavalli	31.2	2.9	2.5	0.4	97
200	Guruvindapalli	28.5	2.9	1.7	0.5	95
201	South valluru	32.9	4.3	2.3	0.7	75
202	North valluru	42.6	2.3	2.2	0.6	97
203	Royyuru	46.5	2.9	1.9	0.4	93
	Mandal Range	26.6-46.5	1.6-4.3	1.5-2.6	0.3-2.1	75-98
204	Vijayawada (rural)	40.9	2.7	2.0	0.4	97
205	Kotturu	39.2	1.6	1.5	0.5	91
206	Enikipadu	38.5	1.9	1.5	0.2	92
207	Tadepalle	42.0	2.9	1.9	0.4	89
208	Gudavalli	41.7	3.0	1.9	0.8	91
	Mandal Range	38.5-42.0	1.6-3.0	1.5-2.0	0.2-0.8	89-97
209	Vijayawada(urban)	26.9	1.8	1.4	0.6	74
210	Vijayawada(urban)	34.0	3.7	2.2	0.3	75
211	Vijayawada(urban)	41.5	3.1	1.6	0.7	92
212	Vijayawada(urban)	43.2	2.3	2.2	0.4	97
	Mandal Range	26.9-43.2	1.8-3.7	1.4-2.2	0.3-0.7	74-97
	Overall Range	10.6-46.5	1.6-22.3	0.1-7.9	0.1-4.8	74-98
	Overall Mean	28.7	7.0	1.7	0.8	94.12

Table 4.33 : Range of percent base saturation of surface soils (0-15cm) of different mandals of Krishna district

S.No.	Mandal	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
1	A.konduru	33.9-36.1	9.1-13.3	0.6-5.1	0.3-0.6	92-98
2	Reddigudem	25.0-41.8	9.1-13.8	0.9-4.3	0.4-1.5	97-98
3	Mylavaram	28.1-40.9	9.8-14.3	0.8-3.1	0.4-0.8	96-98
4	Vissanapeta	29.2-32.4	7.2-14.0	0.8-1.7	0.3-0.5	95-98
5	Nuzivedu	26.9-33.3	4.1-20.0	1.0-8.8	0.2-0.5	95-98
6	Chatrai	24.7-32.2	8.5-13.0	1.7-2.5	0.2-0.4	92-98
7	Jaggaypeta	22.7-31.1	5.1-11.3	0.5-5.0	0.1-0.8	93-99
8	Ibbrahimpatnam	20.0-34.2	7.4-14.0	1.0-2.1	0.2-0.7	92-99
9	Gampalagudem	23.9-30.2	10.1-13.2	0.5-1.9	0.3-0.6	96-99
10	Pamidimukkala	26.8-36.1	5.4-11.1	0.7-1.5	0.4-0.6	93-98
11	Musunuru	26.1-38.0	10.2-25.0	0.9-3.7	0.2-0.6	97-98
12	Tiruvuru	24.1-29.3	8.2-13.7	0.5-2.0	0.1-1.2	93-99
13	Nandigama	24.3-31.7	8.5-10.2	0.1-1.0	0.1-0.5	95-99
14	Penuganchiprolu	27.6-43.6	9.0-12.9	0.2-6.2	0.3-0.6	94-99
15	Vatsvai	26.0-29.1	9.1-13.1	0.5-1.0	0.3-0.4	95-98

Contd.

S.No.	Mandal	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	95-99
17	Kanchikacherla	27.6-30.9	10.1-14.0	0.6-1.5	0.4-0.5	93-97
18	Verullapadu	23.1-34.2	8.0-11.8	0.6-1.8	0.4-0.6	97-99
19	Penamaluru	18.8-26.7	2.0-5.9	2.0-3.0	1.0-3.7	91-99
20	Kankipadu	13.2-33.5	2.0-7.8	1.9-3.2	1.0-2.8	89-99
21	Vuyyuru	26.0-35.8	2.3-6.6	2.3-3.0	0.8-4.8	96-99
22	Unguturu	20.0-35.0	2.5-6.8	2.4-4.9	2.9-5.0	94-99
23	Gannavaram	18.4-29.0	4.8-8.5	1.1-2.1	2.7-4.9	94-99
24	Agiripalli	31.0-40.0	2.2-4.1	1.7-3.5	0.4-1.9	87-99
25	Bapulapadu	28.2-36.9	2.7-4.0	1.7-2.1	0.4-1.3	84-96
26	G.konduru	28.5-40.6	2.1-3.8	1.6-3.6	0.4-1.1	90-98
27	Thotlavalluru	28.2-48.1	1.7-4.4	1.7-2.8	0.5-2.2	77-99
28	Vijayawada(rural)	40.1-43.6	1.7-3.1	1.7-2.2	0.3-0.9	90-99
29	Vijayawada(urban)	28.5-44.8	1.9-3.8	1.6-2.4	0.5-0.8	75-99
	Overall range	13.2 - 48.1	1.7 - 25.0	0.1 - 8.8	0.1-4.9	75-99
	Overall Mean	30.5	8.2	2.01	0.9	95.94

Table 4.34 : Range of percent base saturation of subsurface soils (15-30 cm) of different mandals of Krishna district

S. No.	Mandal	Exchangeable bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
1	A.konduru	32.6-34.8	8.2-12.3	0.3-4.8	0.2-0.4	90-96
2	Reddigudem	23.8-40.5	8.1-12.9	0.6-4.0	0.2-1.3	95-96
3	Mylavaram	26.9-39.7	8.9-13.2	0.2-2.8	0.2-0.6	95-96
4	Vissanapeta	28.2-31.4	6.0-12.8	0.4-0.8	0.2-0.4	94-97
5	Nuzivedu	25.9-32.3	2.9-18.8	0.1-7.9	0.1-0.4	94-97
6	Chatrai	23.7-31.2	7.3-11.8	0.9-1.6	0.1-0.3	91-97
7	Jaggaypeta	21.0-29.5	4.1-10.3	0.3-4.9	0.1-0.8	91-97
8	Ibbrahimpatnam	18.4-32.5	6.5-13.0	0.9-2.0	0.2-0.7	90-97
9	Gampalagudem	22.2-28.5	7.4-11.9	0.4-1.8	0.3-0.6	94-97
10	Pamidimukkala	24.6-33.9	2.7-8.5	0.6-1.4	0.2-0.3	91-96
11	Musunuru	23.9-35.7	7.5-22.3	0.8-3.6	0.1-0.5	95-96
12	Tiruvuru	21.8-27.0	5.5-11.0	0.4-1.9	0.3-1.1	91-97
13	Nandigama	21.2-28.5	5.9-7.6	0.6-0.9	0.1-0.4	93-96
14	Penuganchiprolu	24.5-40.5	6.4-10.2	0.1-6.1	0.2-0.5	92-97
15	Vatsvai	22.9-26.0	6.5-10.4	0.4-0.9	0.2-0.3	93-96

Contd.

S. No.	Mandal	Exchangeble bases(c mol (p ⁺) kg ⁻¹ soil)				Base saturation (%)
		Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	
16	Chandarlapadu	20.1-26.9	4.5-8.2	0.1-0.9	0.3-0.6	93-97
17	Kanchikacherla	25.3-28.1	7.5-11.4	0.5-1.4	0.3-0.4	91-95
18	Verullapadu	21.1-32.2	5.4-9.1	0.5-1.7	0.3-0.5	95-97
19	Penamaluru	16.8-24.7	1.9-3.2	1.8-2.8	0.9-3.6	90-98
20	Kankipadu	10.6-32.2	1.9-7.7	1.7-3.0	0.9-2.7	87-97
21	Vuyyuru	24.7-34.5	2.2-6.5	2.1-2.8	0.7-4.4	94-97
22	Unguturu	18.7-33.7	2.4-6.7	2.7-4.7	2.8-4.7	93-97
23	Gannavaram	16.7-27.3	4.7-8.4	0.9-1.9	2.9-4.8	93-97
24	Agiripalli	29.3-38.3	2.1-4.0	1.5-3.3	0.3-4.0	85-97
25	Bapulapadu	26.6-35.3	2.6-3.9	1.5-1.9	0.3-0.8	82-93
26	G.konduru	26.9-38.2	2.0-3.7	1.4-3.4	0.4-1.2	88-96
27	Thotlavalluru	26.6-46.5	1.6-4.3	1.5-2.6	0.3-2.1	75-98
28	Vijayawada(rural)	38.5-42.0	1.6-3.0	1.5-2.0	0.2-0.8	89-97
29	Vijayawada(urban)	26.9-43.2	1.8-3.7	1.4-2.2	0.3-0.7	74-97
	Overall range	10.6-46.5	1.6-22.3	0.1-7.9	0.1-4.8	74-98
	Overall Mean	28.7	7.0	1.7	0.8	94.12

exchangeable potassium was low compared to Ca^{+2} and Mg^{+2} which might be due to slow weathering of mica and fixation of released potassium (Balpande *et al.*, 2007).

Among the exchangeable cations analysed from the four hundred and twenty four surface and subsurface soil samples, the exchangeable sodium was found least ranging from 0.1 to 4.9 cmol (p+) kg^{-1} and 0.1 to 4.8 cmol (p+) kg^{-1} with a mean value of 0.9 and 0.8 cmol (p+) kg^{-1} respectively. The low values of monovalents compared to divalents were due to dominance of calcium and magnesium in parent materials and also the monovalents can be leached out easily unlike divalents as divalents were strongly bounded.

Among the exchangeable cations, Ca^{+2} was most dominant cation on the exchange complex followed by Mg^{+2} , K^{+} and Na^{+} in surface and subsurface soils of Krishna district. This might be due to reason that the divalent cations, like Ca^{+2} and Mg^{+2} were relatively less mobile yet among the two, Mg^{+2} ions were more mobile than Ca^{+2} ions. As such, Mg^{+2} ions were leached out earlier than the Ca^{+2} ions leading to the dominance of Ca^{+2} on exchange complex (Duranth and Dutil, 1971).

Overall observation showed that high base saturation in these soils might be due to moderately alkaline reaction and high CaCO_3 content, as the exchangeable complex of the soils were dominated by calcium and magnesium, which are main sources for base saturation. The other reason could be due to the presence of base contributing minerals such as smectite in black soils (Pal *et al.*, 2006)

4.3 AVAILABLE NUTRIENT STATUS OF SOILS

4.3.1 Primary Nutrients

Nitrogen

The data pertaining to available nitrogen content of soil samples, range, mean and nutrient index values are presented in tables 4.4, 4.41, 4.42 and 4.43. depicted in figure 4a and 4b.

The available nitrogen content of surface and subsurface soil samples ranged from 185 to 298 kg ha⁻¹ and from 163 to 274 kg ha⁻¹ with mean values of 241.5 and 218.5 kg ha⁻¹, respectively. Out of 424 soil samples (surface and subsurface), 97.16% surface and 100% subsurface samples were found to be low in available nitrogen, whereas, 2.84% surface samples were medium in available nitrogen content. The nutrient index values indicated that the soils under study were low to medium in available nitrogen content as per criteria given by Ramamoorthy and Bajaj (1969) (Table 3.2). This could be attributed due to low organic matter content and semiarid climate. Singaravel *et al.* (1996) stated that poor nitrogen status of coastal soils might be due to poor vegetation cover and high rate of decomposition of organic matter. The low levels of nitrogen might be ascribed to several factors such as lower organic carbon, high pH, favouring ammonia volatilization losses, reduced nitrification and subsided activity of nitrogen fixing microbes (Najar *et al.*, 2005). Average nutrient index of the survey area as a whole with respect to available nitrogen was 1.02 for surface and 1.00 for subsurface soils which indicated that soils are low in fertility status (Table 4.6).

The surface samples showed relatively higher nitrogen content (mean 241.5 kg ha⁻¹) compared to subsurface soils samples (mean 218.5 kg ha⁻¹). This might be due to application of nitrogenous fertilizers and organic manures by the farmers at the surface and also presence of stubbles of the preceding crops. According to Bandyopadhyay *et al.* (2004) decrease of nitrogen availability with depth might be due to the low organic matter in the subsurface and also the semiarid climatic conditions favouring rapid oxidation and lesser accumulation of organic matter which results in low nitrogen content.

The available nitrogen content showed highly significant and positive correlation with yield of crops like sugarcane ($r=0.826^{**}$), turmeric (0.861^{**}) and groundnut ($r=0.799^{**}$) and positively significant with cotton ($r=0.734^{*}$), chilli(0.721^{*}), maize ($r=0.719^{*}$), mango ($r=0.679^{*}$) and bhendi ($r=0.743^{*}$) yield. (Table 4.70, 4.71, 4.72, 4.73, 4.74, 4.75, 4.76 and 4.77).

The highest mean nitrogen content was recorded in A.Konduru mandal (254.43 kg ha⁻¹), while the lowest was noticed in Myalavaram mandal (211.00 kg ha⁻¹). This might be due to variation in cropping pattern and varied application of different nitrogen sources.

Phosphorus (P₂O₅)

The data pertaining to the available phosphorus content of 424 surface and subsurface samples range, mean and nutrient index values are presented in tables 4.4, 4.41, 4.42 and 4.44, depicted in figure 5a and 5b.

The available phosphorus content ranged from 11.2 to 96.3 kg ha⁻¹ (mean 53.75 kg ha⁻¹) in the surface samples, while it ranged from 10.9 to 94.0 kg ha⁻¹ (mean 52.45 kg ha⁻¹) in the subsurface samples. Out of 424 samples, available phosphorus content of 71.22 % samples of surface and 74.52% of subsurface samples were medium, 12.26 % surface and 16.03 % subsurface samples were low and remaining 16.52% of surface and 9.45% of subsurface were found to be high, respectively as per ratings given by Muhr *et al.* (1965) (Table 3.2).

Nutrient indices for surface and subsurface samples were found to be 2.04 and 1.93, respectively, which implied that soils were in medium fertility status (Table 4.61). The medium content of available phosphorus in these soils might be due to regular application of phosphatic fertilizers to realise higher yields. Similar observations were earlier made by Ramesh and Hari Prasada Rao (2005) in coastal soils of Prakasam district.

Surface soil samples recorded higher mean available phosphorus (53.75kg ha⁻¹) compared to subsurface soil samples (52.45 kg ha⁻¹) which might have been due to application of fertilizers to surface soils. Similar trend of phosphorus content from surface to subsurface soils was observed by Sathish *et al.* (2008) and Durga Devi (2011) in Guntur and Nellore districts, respectively of Andhra Pradesh.

The available phosphorus content found to be highly significant and positive correlation with yield of crops like cotton ($r=0.799^{**}$), chilli(0.837^{**}), maize ($r=0.876^{**}$), mango ($r=0.808^{**}$) turmeric (0.856^{**}), groundnut ($r=0.864^{**}$) and bhendi ($r=0.863^{**}$) and slightly significant with yield of crops like Sugarcane ($r=0.693^*$). (Table 4.70, 4.71, 4.72, 4.73, 4.74, 4.75, 4.76 and 4.77).

Among the different mandals, highest (79.06 kg ha^{-1}) mean available phosphorus content was observed in Vijayawada (rural) mandal while the lowest (41.27 kg ha^{-1}) was observed in Nandigama mandal. The variation in available phosphorus content in soils of different mandals of the study area might be due to variation in management practices.

Potassium (K_2O)

The data pertaining to available potassium content of soil samples, range, mean and nutrient index values are presented in tables 4.4, 4.41, 4.42 and 4.45 and depicted in figure 6a and 6b.

The available potassium content of surface and subsurface soil samples ranged from 247 to 866 and from 232 to 783 $\text{kg K}_2\text{O ha}^{-1}$ with mean values of 556.5 and 507.5 $\text{kg K}_2\text{O ha}^{-1}$, respectively. About 97.16 % of surface & 88.67 % of subsurface samples were found to be high, whereas 2.84 per cent of surface and 11.33 per cent of sub surface samples were medium in available potassium content as per rating suggested by Muhr *et al.* (1965). On the whole, the soils of the study area were found to be medium to high in available potassium content in both surface and subsurface soils with nutrient index values of 2.99 and 2.97 respectively. Similarly low to medium content of potassium in coastal soils of Guntur district was observed by Sathish Babu *et al.* (2010). Medium to high available potassium content in these soils might be attributed to the prevalence of potassium rich minerals like illite and potassium feldspars and high fertilizers use. Sharma *et al.* (2008) also reported similar result in soils of Amritsar district (Punjab). Similar ranges of potassium content were observed in coastal soils of Guntur district by Mydhili (2006) and Tantuja nandy (2010).

The surface samples had more available potassium content (mean 556.5 kg K₂O ha⁻¹) when compared with subsurface soil samples (mean 507.5 kg K₂O ha⁻¹). This could be due to more intense weathering of potash bearing minerals, release of potassium from decomposing organic matter added to the surface through natural vegetation and in some cases upward translocation of potassium from lower depths with capillary rise of ground water. These results are corroborated with the findings of Rama Lakshmi *et al.* (2001), Revathi *et al.* (2005), Mydhili (2006) and Vara Prasada Rao *et al.* (2008).

It was observed that the available potassium content of the sandy soils was less than in black soils, which might be due to high leaching losses of applied or native soil potassium, particularly in view its being highly water soluble and mobile. The higher potassium content of black soils might also be due to the presence of potassium bearing minerals like muscovite and orthoclase. Similar observations of high potassium content in black soils were reported by Iqbal Khan (1990) and Rama Rao (2003) in Karlapalem and Chirala mandals of Andhra Pradesh, respectively.

The available potassium content showed positive significant correlation with yield of crops like sugarcane ($r=0.706^*$), turmeric (0.718^*), chilli (0.698^*), maize ($r=0.726^*$), bhendi ($r=0.724^*$) and found highly significant with groundnut ($r=0.896^{**}$), cotton ($r=0.864^{**}$) and mango ($r=0.834^{**}$) yield. (Table 4.70, 4.71, 4.72, 4.73, 4.74, 4.75, 4.76 and 4.77).

Among the different mandals, highest (530.57 kg ha⁻¹) mean available potassium content was observed in Kanchikacherla mandal while the lowest (314.63 kg ha⁻¹) was observed in Penuganchiprolu mandal.

4.3.2 Secondary Nutrients

Sulphur

The data pertaining to available sulphur content of surface and subsurface samples, range and mean are presented in table 4.4,4.41,4.42 and 4.46, depicted in figures 7a and 7b.

The available sulphur content of surface ranged from 15.32 to 82.18 ppm and that of subsurface soils ranged from 10.25 to 57.91 ppm with mean values of 48.75 and 34.08 ppm, respectively. Out of 212 surface soils 11.33% were found to be deficient and 88.67% were sufficient in available sulphur content. While in subsurface, 73.12% were found to be sufficient and 26.88% soils are deficient. It indicated that the soils under study area showed sufficiency as well as deficiency in available sulphur content as per the rating given by Tandon (1991)(Table 3.3).

Presence of sufficient levels of available sulphur in most of these soils might be due to continuous addition of sulphur through inorganic fertilizers like SSP, gypsum besides organic source for higher productivity of crops and also might be due to sea water inundation with sulphide minerals. Similar values with respect to sulphur were observed in groundnut growing soils of Andhra Pradesh by Ramesh and Hari Prasada Rao (2005).

The available sulphur content of all the surface soils (48.75 ppm) was higher than in subsurface soils (34.08 ppm), which might be due to high organic carbon content at the surface and probably due to greater plant and microbial activity in mineralization of organic matter resulting in the accumulation of soluble sulphate-sulphur. Similar trend of higher available sulphur with depth was observed in Inceptisols of Chittoor district, Andhra Pradesh (Basavaraju *et al.*, 2005). Similar trends were observed in black and associated soils of Guntur (Madhuvani *et al.*, 2001), black soils and sandy soils of Prakasam district, Andhra Pradesh (Ramesh *et al.*, 2003) and sandy to clay loam soils of Ramachandrapuram, Chittoor district (Vara Prasad Rao *et al.*, 2008).

Among the different mandals, highest (45.86ppm) mean available sulphur content was observed in A.Konduru mandal while the lowest (17.76ppm) was observed in Vijaywada (rural) mandal.

Table 4.4 : Available Macronutrient status of soils of Krishna district

S. No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
1	A.konduru	A.konduru	235	201	25.3	23.2	363	356	32.31	27.32
2	Gollamandala	A.konduru	298	273	43.2	40.3	392	373	46.12	40.93
3	Khambampadu	A.konduru	223	210	13.2	11.2	374	361	29.52	20.36
4	Cheemalapadu	A.konduru	263	232	42.6	41.3	350	334	63.60	57.31
5	Koduru	A.konduru	251	240	35.2	33.6	303	297	52.72	43.96
6	Madhavaram	A.konduru	295	274	21.2	19.5	313	310	49.93	44.32
7	Repudi	A.konduru	216	208	32.6	30.0	498	487	46.82	39.63
		Mandal range	216-298	201-274	13.2-43.2	11.2-40.3	303-498	297-487	29.52-63.60	20.36-57.31
8	Reddigudem	Reddigudem	204	187	31.6	29.5	487	473	15.93	10.93
9	Reddigudem	Reddigudem	245	210	25.3	22.6	301	293	19.63	15.26
10	Naguluru	Reddigudem	213	206	22.6	15.2	353	342	17.51	16.22
11	Kudapa	Reddigudem	238	226	41.2	38.5	684	680	16.82	11.32
12	Rudravaram	Reddigudem	185	170	48.3	47.9	596	591	19.03	12.46
13	Rudravram	Reddigudem	223	210	26.5	25.5	683	676	52.43	47.39
14	Rangapuram	Reddigudem	232	206	22.1	21.2	347	333	39.20	33.21
		Mandal range	185-245	170-226	22.1-48.3	15.2-47.9	301-684	293-680	15.93-52.43	10.93-47.39

Contd.

S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
15	Mylavaram	Mylavaram	232	224	36.5	33.6	366	358	17.36	13.29
16	Chandrala	Mylavaram	210	196	35.2	34.2	299	294	18.32	11.63
17	Mylavaram	Mylavaram	198	173	24.1	22.5	351	347	19.56	15.26
18	Velvadam	Mylavaram	191	163	31.5	30.1	325	322	82.18	79.83
19	Pulluru	Mylavaram	207	201	48.6	46.8	279	268	63.32	56.43
20	Morusumilli	Mylavaram	216	189	51.8	50.0	498	494	46.41	41.76
21	Kanimerla	Mylavaram	223	196	26.3	24.5	359	352	36.56	28.32
		Mandal range	191-232	163-224	24.1-51.8	22.5-50.0	279-498	268-494	17.36-82.18	11.63-56.43
22	Vissanapeta	Vissanapeta	223	212	21.6	20.3	567	560	40.72	37.92
23	Putrela	Vissanapeta	191	179	19.5	16.5	318	310	32.81	28.41
24	Kondaparva	Vissanapeta	248	203	12.5	11.2	389	384	48.23	41.32
25	Korlamanda	Vissanapeta	216	211	20.2	18.6	479	471	37.32	32.64
26	Tatakuntla	Vissanapeta	191	186	15.6	14.9	661	654	26.41	19.43
27	Narsapuram	Vissanapeta	251	236	11.2	10.9	467	464	39.36	26.93
28	Kalagara	Vissanapeta	273	265	20.9	17.5	389	384	47.26	41.82
		Mandal range	191-273	179-265	11.2-21.6	10.9-20.3	318-661	310-654	26.41-48.23	19.43-41.82
29	Nuzivedu	Nuzivedu	216	198	25.6	24.3	391	387	16.36	12.64

Contd.

S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
30	Digavalli	Nuzivedu	216	211	19.6	17.1	277	268	18.19	11.47
31	Morsapudi	Nuzivedu	198	180	22.3	20.6	286	282	19.68	14.77
32	Boravancha	Nuzivedu	207	180	43.2	38.6	302	297	16.26	10.91
33	Sunkollu	Nuzivedu	232	216	29.6	25.1	296	291	50.19	48.24
34	Vempadu	Nuzivedu	229	219	31.2	29.9	311	310	38.03	33.42
35	Gollapalle	Nuzivedu	254	239	29.6	27.1	383	380	49.73	42.23
		Mandal range	198-254	180-239	19.6-43.2	17.1-38.6	277-391	268-387	16.26-50.19	10.91-48.24
36	Chatrai	Chatrai	210	203	22.5	21.0	343	336	23.63	19.28
37	Chatrai	Chatrai	235	229	21.3	20.3	271	266	47.31	39.32
38	Chittapur	Chatrai	223	214	35.2	34.1	283	275	32.28	27.46
39	Mankollu	Chatrai	241	230	32.6	29.6	304	296	33.63	32.21
40	Polavaram	Chatrai	267	242	30.9	26.1	364	343	41.72	37.43
41	Kothapadu	Chatrai	229	214	41.2	39.5	436	431	33.46	29.52
42	Chinnampet	Chatrai	270	244	55.5	53.2	299	287	43.51	38.92
		Mandal range	210-270	203-244	21.3-55.5	20.3-53.2	271-436	266-431	23.63-47.31	19.28-39.32
43	Jaggaypeta	Jaggaypeta	279	264	54.3	53.6	268	252	30.55	25.32

Contd.

S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
44	Balusupadu	Jaggaypeta	210	174	54.1	53.6	291	287	50.62	43.40
45	Garikipadu	Jaggaypeta	241	231	41.2	35.6	324	319	48.66	41.33
46	Ravirala	Jaggaypeta	248	229	39.6	36.2	366	358	42.31	36.96
47	Vedadri	Jaggaypeta	229	203	35.8	33.0	301	291	31.46	27.12
48	Takkelapadu	Jaggaypeta	263	250	39.9	36.5	297	290	25.93	18.26
49	West gandrai	Jaggaypeta	289	267	43.2	41.3	348	341	38.81	32.46
50	Ravirala	Jaggaypeta	210	203	51.3	49.6	681	677	27.21	25.21
51	Jaggaypeta	Jaggaypeta	248	229	26.9	25.3	526	523	34.30	29.29
52	East gandrai	Jaggaypeta	238	220	43.2	40.6	474	468	43.62	39.22
53	Chillakallu	Jaggaypeta	216	211	55.1	53.2	370	359	49.79	41.76
		Mandal range	210-289	174-267	26.9-55.1	25.3-53.6	268-681	252-677	27.21-50.62	18.26-43.40
54	Ibbrahimpatnam	Ibbrahimpatnam	254	240	21.3	20.6	598	594	19.82	17.41
55	Ibbrahimpatnam	Ibbrahimpatnam	232	212	35.6	33.2	303	300	17.73	15.32
56	Elaprolu	Ibbrahimpatnam	263	243	41.6	40.1	437	429	15.32	10.71
57	Damuluru	Ibbrahimpatnam	279	255	35.5	34.4	388	386	18.62	11.38
58	Kotikalapudi	Ibbrahimpatnam	223	210	28.9	25.2	476	474	16.68	12.46
59	Jupudi	Ibbrahimpatnam	241	227	52.2	50.1	498	482	45.31	39.33

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S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
60	Tummalapalem	Ibbrahimpatnam	251	239	36.8	33.1	389	385	37.26	32.63
61	Mullapadu	Ibbrahimpatnam	263	248	54.1	50.2	347	338	18.23	15.93
		Mandal range	223-279	210-255	21.3-52.2	20.6-50.2	303-598	300-594	15.32-45.31	10.71-39.33
62	Gampalagudem	Gampalagudem	210	198	21.2	19.8	301	296	35.19	29.29
63	Arlapadu	Gampalagudem	201	191	26.5	24.2	481	474	26.51	22.71
64	Gullapudi	Gampalagudem	213	207	28.9	26.8	371	371	29.63	23.43
65	Kanumuru	Gampalagudem	232	211	42.6	40.0	293	288	44.36	38.83
66	Lingala	Gampalagudem	248	239	38.5	35.9	577	570	38.72	31.62
67	Meduru	Gampalagudem	241	227	41.6	40.2	321	318	28.83	22.96
68	Utukuru	Gampalagudem	267	243	38.9	38.1	293	287	23.96	20.83
69	Utukuru	Gampalagudem	296	259	40.6	38.8	327	322	24.26	19.71
		Mandal range	201-296	191-259	21.2-42.6	19.8-40.2	293-577	287-570	23.96-44.36	19.71-38.83
70	Pamidimukkala	Pamidimukkala	273	246	41.2	40.1	350	344	37.46	31.43
71	Inampudi	Pamidimukkala	238	220	29.8	28.9	277	273	46.51	39.24
72	Meduru	Pamidimukkala	248	216	31.6	29.2	298	293	36.39	27.52
73	Mantada	Pamidimukkala	232	211	28.5	26.5	350	335	46.51	39.32
74	Mullapudi	Pamidimukkala	241	227	50.2	47.1	362	344	41.32	37.46

Contd.

S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
75	Choragudi	Pamidimukkala	235	232	40.9	38.5	368	351	33.21	28.46
76	Inapuru	Pamidimukkala	270	236	42.6	38.8	311	301	24.39	19.52
		Mandal range	232-273	211-246	28.5-50.2	26.5-47.1	277-368	273-351	24.39-46.51	19.52-39.32
77	Musunuru	Musunuru	223	214	59.3	57.2	367	359	29.53	22.29
78	Surepalli	Musunuru	245	225	66.2	65.1	413	409	37.62	32.36
79	Gullapudi	Musunuru	232	207	58.1	55.5	294	288	25.86	21.42
80	Musunuru	Musunuru	245	237	46.8	41.3	358	347	34.91	27.63
81	Ellapuram	Musunuru	225	210	48.8	45.5	297	282	49.48	43.76
82	Chintalvalli	Musunuru	248	235	58.2	55.9	358	348	44.53	39.93
83	Lopudi	Musunuru	229	224	60.1	59.4	298	291	26.69	20.89
		Mandal range	223-248	207-237	46.8-66.2	41.3-65.1	294-413	282-409	25.86-49.48	20.89-43.76
84	Tiruvuru	Tiruvuru	251	239	59.1	55.9	351	344	35.36	28.43
85	Chittela	Tiruvuru	213	201	65.3	63.3	289	288	51.42	48.52
86	Rajupeta	Tiruvuru	207	213	49.6	44.4	436	428	44.29	37.26
87	Mallela	Tiruvuru	226	216	53.6	50.2	304	298	27.21	21.19
88	Munukulla	Tiruvuru	260	248	58.8	55.9	481	462	36.19	33.24
89	Vavilala	Tiruvuru	241	229	60.2	58.9	366	361	50.06	48.53

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S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
90	Vavilala	Tiruvuru	238	223	69.1	66.2	559	544	42.36	37.65
		Mandal range	207-260	201-248	49.6-69.1	44.4-66.2	289-559	288-544	27.21-51.42	21.19-48.53
91	Nandigama	Nandigama	223	213	26.3	24.6	314	301	37.23	30.49
92	Damuluru	Nandigama	254	232	22.1	20.9	315	312	23.42	19.23
93	Lingalapadu	Nandigama	238	226	35.5	34.2	512	509	30.93	25.96
94	Satyavaram	Nandigama	210	204	42.9	40.1	483	479	38.76	33.76
95	Pallagiri	Nandigama	220	206	56.0	55.5	390	385	52.98	46.83
96	Gollamudi	Nandigama	257	241	69.3	67.9	291	289	43.38	35.23
97	Kanchela	Nandigama	223	202	50.0	48.7	368	358	36.19	30.25
		Mandal range	210-257	202-241	22.1-69.3	20.9-67.9	291-512	289-509	23.42-52.96	19.23-46.83
98	Penuganchiprolu	Penuganchiprolu	213	184	38.9	33.8	289	283	42.26	34.86
99	Thotacherla	Penuganchiprolu	216	210	48.6	47.5	352	347	22.32	17.54
100	Mullapadu	Penuganchiprolu	263	235	51.2	50.0	299	293	31.93	24.43
101	Konakanchi	Penuganchiprolu	210	201	50.9	48.7	300	299	48.26	42.32
102	Sanagapadu	Penuganchiprolu	248	236	58.8	56.8	314	311	39.63	31.21
103	Sanagapadu	Penuganchiprolu	232	223	37.8	32.2	263	260	21.93	17.36

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S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
104	Kollikulla	Penuganchiprolu	276	207	44.4	41.7	327	324	29.43	24.19
105	Anigandlapadu	Penuganchiprolu	260	241	52.2	50.2	373	367	32.46	29.73
		Mandal range	210-276	184-241	37.8-58.8	32.2-56.8	263-373	260-367	21.93-48.26	17.36-42.32
106	Vatsvai	Vatsvai	235	210	28.9	26.5	462	456	47.32	42.96
107	Chittela	Vatsvai	248	231	21.6	20.1	391	384	41.18	33.90
108	Lingala	Vatsvai	257	236	20.9	19.5	305	301	39.72	32.26
109	Allurupadu	Vatsvai	229	222	32.1	30.6	467	463	44.63	40.29
110	Makkapeta	Vatsvai	276	251	29.3	25.8	866	861	38.42	31.76
111	Gangavalli	Vatsvai	257	236	46.6	45.8	410	402	33.38	27.43
112	Dechupalem	Vatsvai	263	250	21.9	20.1	273	269	40.21	33.52
		Mandal range	229-276	210-251	20.9-46.6	19.5-45.8	273-866	269-861	33.38-47.32	27.43-42.96
113	Chandarlapadu	Chandarlapadu	210	192	67.8	62.8	362	354	16.32	12.65
114	Eturu	Chandarlapadu	207	201	83.0	78.3	504	498	18.26	15.33
115	Konayapalem	Chandarlapadu	251	239	91.3	86.4	346	342	18.39	14.96
116	Pokkunuru	Chandarlapadu	226	221	96.3	94.0	335	329	17.46	12.82
117	Gudimetla	Chandarlapadu	213	202	83.3	76.3	330	326	17.71	10.52
118	Chintalpadu	Chandarlapadu	238	221	61.5	53.3	786	783	20.32	16.96

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S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
119	Mungalapalli	Chandarlpadu	254	248	58.3	51.4	629	626	21.46	18.71
		Mandal range	207-254	192-248	58.3-96.3	51.4-94.0	330-786	326-783	16.32-21.46	10.52-18.71
120	Kanchikacherla	Kanchikacherla	223	214	22.9	20.1	744	740	19.32	13.29
121	Chevitikallu	Kanchikacherla	279	267	43.5	40.8	377	372	18.64	10.25
122	Keesara	Kanchikacherla	263	259	42.6	40.1	629	623	15.92	12.55
123	Paritala	Kanchikacherla	220	216	41.0	38.5	652	647	17.63	15.43
124	Singapuram	Kanchikacherla	276	263	38.8	34.7	431	421	18.32	11.31
125	Vemulapalli	Kanchikacherla	235	229	37.9	36.5	514	510	16.63	14.29
126	Gandepalli	Kanchikacherla	267	251	25.5	20.1	367	358	41.46	36.27
		Mandal range	220-279	214-267	22.9-43.5	20.1-40.8	367-652	358-740	15.92-41.46	10.25-36.27
127	Verullapadu	Verullapadu	216	193	52.2	50.1	629	626	37.52	31.43
128	Jammavaram	Verullapadu	232	223	56.9	54.2	314	309	26.63	22.40
129	Nadaluru	Verullapadu	273	270	55.1	52.2	440	434	46.72	41.68
130	Pallampalle	Verullapadu	213	212	46.8	46.0	629	625	32.79	28.65
131	Peddapuram	Verullapadu	232	223	58.7	52.6	304	300	25.56	21.71
132	Vellanki	Verullapadu	273	260	46.6	40.1	460	453	28.19	23.93

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S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
133	Vellanki	Verullapadu	270	254	39.8	36.2	461	459	27.29	21.42
		Mandal range	213-273	193-270	39.8-58.7	36.2-54.2	304-629	300-626	25.56-46.72	21.42-41.68
134	Penamaluru	Penamaluru	241	238	49.7	42.7	335	330	36.30	29.51
135	Penamaluru	Penamaluru	273	267	54.6	50.5	283	277	42.26	37.29
136	Penamaluru	Penamaluru	238	201	58.4	53.3	498	496	34.49	27.36
137	Vanukuru	Penamaluru	248	221	57.3	55.3	452	443	23.57	19.21
138	Chodavaram	Penamaluru	213	211	33.2	28.2	372	368	29.63	23.19
139	Gosala	Penamaluru	241	216	55.4	53.4	461	453	31.91	24.10
140	Gosala	Penamaluru	245	229	59.5	54.9	274	268	43.86	38.05
		Mandal range	213-273	201-267	33.2-57.3	28.2-55.3	274-498	268-496	23.57-43.86	19.21-38.05
141	Kankipadu	Kankipadu	210	186	49.5	48.7	482	480	35.79	31.19
142	Davuluru	Kankipadu	235	224	28.6	25.4	401	396	21.43	17.29
143	Kunderu	Kankipadu	270	252	34.8	30.1	440	438	28.36	22.71
144	Tanneru	Kankipadu	260	249	37.7	35.9	347	340	35.43	29.36
145	Velpuru	Kankipadu	223	210	48.6	44.9	514	511	40.31	37.33
146	Kandalampadu	Kankipadu	232	209	52.8	50.1	472	468	45.59	38.08

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S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
147	Edpugallu	Kankipadu	257	231	49.8	48.6	467	462	27.72	25.09
		Mandal range	210-270	186-252	28.6-52.8	25.4-50.1	347-514	340-511	21.43-45.59	17.29-38.08
148	Vuyyuru	Vuyyuru	232	216	28.9	25.8	393	386	31.84	23.63
149	Akunuru	Vuyyuru	235	229	20.7	18.9	363	359	44.46	38.59
150	Akunuru	Vuyyuru	229	221	29.6	28.7	388	383	31.58	25.49
151	Mudunuru	Vuyyuru	267	238	19.8	15.8	430	425	30.25	23.73
152	Katuru	Vuyyuru	248	209	31.0	30.7	296	293	21.19	15.16
153	Chinnaogirala	Vuyyuru	276	252	42.3	41.8	274	269	36.83	31.19
154	Saipuram	Vuyyuru	226	216	37.7	35.8	298	292	43.33	40.03
		Mandal range	229-276	209-252	19.8-42.3	15.8-41.8	274-430	269-425	21.19-44.46	15.16-40.03
155	Unguturu	Unguturu	232	211	34.5	30.9	302	297	61.72	57.91
156	Bokkinala	Unguturu	238	229	46.3	42.9	344	338	33.93	26.23
157	Mukkapadu	Unguturu	223	210	39.7	31.3	297	295	22.56	20.33
158	Mukkapadu	Unguturu	263	251	24.1	20.3	494	489	29.55	21.56
159	Indupalli	Unguturu	223	216	53.3	45.3	335	326	42.19	37.61
160	Manikonda	Unguturu	220	210	68.4	63.3	291	284	39.32	31.79

Contd.

S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
161	Atkuru	Unguturu	254	241	70.9	67.6	452	428	32.43	24.52
		Mandal range	220-263	210-251	24.1-70.9	20.3-67.6	291-494	284-489	22.56-61.72	20.33-57.91
162	Gannavaram	Gannavaram	213	196	29.4	23.4	381	372	23.21	18.49
163	Balliparru	Gannavaram	248	242	41.2	38.6	326	323	36.29	33.41
164	Gollanapalle	Gannavaram	216	210	54.0	46.1	320	311	25.19	19.65
165	Mettapalle	Gannavaram	251	229	39.2	31.2	378	374	52.20	48.76
166	Savirigudem	Gannavaram	270	249	46.3	42.6	483	469	37.33	34.93
167	Allapuram	Gannavaram	263	241	43.3	41.7	430	424	24.18	17.51
168	Chinavautupalli	Gannavaram	245	225	40.4	37.5	351	349	41.62	36.33
		Mandal range	213-270	196-249	29.4-54.0	23.4-46.1	320-483	311-469	23.21-52.20	17.51-48.76
169	Agiripalle	Agiripalle	232	223	58.4	52.3	326	320	49.44	43.26
170	Agiripalle	Agiripalle	248	232	48.9	47.6	314	311	32.73	25.49
171	Sagguru	Agiripalle	226	223	55.5	53.3	326	321	29.91	21.53
172	Saravaram	Agiripalle	210	198	54.7	53.2	514	509	25.70	18.09
173	Edara	Agiripalle	213	191	48.9	44.3	283	272	38.64	29.63

Contd.

S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
174	Kalaturu	Agiripalle	251	241	45.5	43.4	284	279	46.55	40.76
175	Kalaturu	Agiripalle	223	216	51.6	46.4	440	439	28.39	21.52
		Mandal range	210-251	191-241	45.5-58.4	43.4-53.3	283-514	272-509	25.70-49.44	18.09-43.26
176	Bapulapadu	Bapulapadu	207	202	68.6	65.9	328	393	34.43	28.29
177	Ampapuram	Bapulapadu	254	248	58.3	52.5	351	388	26.56	19.35
178	Chirivada	Bapulapadu	220	207	74.4	69.8	274	268	36.26	33.83
179	Kanumollu	Bapulapadu	204	183	58.9	52.3	351	344	43.31	36.42
180	Madicherla	Bapulapadu	238	220	69.6	64.0	503	498	33.29	26.29
181	Veleru	Bapulapadu	257	239	81.5	77.3	305	301	27.30	22.19
182	Ramalle	Bapulapadu	216	202	70.1	66.4	440	433	36.41	30.33
		Mandal range	204-257	183-248	58.3-81.5	52.3-77.3	328-503	268-498	26.56-43.31	19.35-36.42
183	G.konduru	G.konduru	201	194	46.4	41.4	607	603	28.39	22.29
184	Koduru	G.konduru	232	221	38.6	33.0	340	330	39.55	31.76
185	Chevuturu	G.konduru	260	249	23.9	20.2	527	522	26.43	20.55
186	Pinapaka	G.konduru	198	163	51.4	47.6	247	232	29.80	19.32
187	Vellaturu	G.konduru	213	206	28.8	22.6	514	511	37.91	33.96
188	Gaddamanugu	G.konduru	263	249	49.2	48.4	472	466	44.42	40.73

Contd.

S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
189	Kavuluru	G.konduru	241	236	55.4	51.4	467	461	31.93	27.52
		Mandal range	198-263	185-249	23.9-55.4	20.2-51.4	247-607	232-603	26.43-44.42	19.32-40.73
190	Thotlavalluru	Thotlavalluru	223	211	51.2	49.5	393	384	36.75	32.63
191	Devarapalli	Thotlavalluru	267	249	48.9	46.5	363	352	23.66	19.71
192	Penamakuru	Thotlavalluru	216	229	61.6	60.2	388	381	34.29	29.56
193	Royyuru	Thotlavalluru	210	202	49.7	48.9	406	402	49.36	42.71
194	Yakamuru	Thotlavalluru	270	249	47.4	46.3	432	430	45.44	37.53
195	Chagantipadu	Thotlavalluru	223	217	36.9	33.1	453	446	24.58	19.64
196	Iluru	Thotlavalluru	248	229	22.1	20.8	398	393	38.49	33.93
197	Kummamuru	Thotlavalluru	273	259	20.9	18.6	359	353	52.72	46.52
198	Garikaparru	Thotlavalluru	238	226	19.5	16.5	430	421	41.45	37.25
199	Kanakavalli	Thotlavalluru	241	231	24.3	23.1	388	384	46.59	42.33
200	Guruvindapalli	Thotlavalluru	254	214	22.1	20.1	297	292	53.63	50.20
201	South valluru	Thotlavalluru	276	236	44.6	42.2	335	349	25.32	18.51
202	North valluru	Thotlavalluru	270	230	21.0	18.4	286	281	21.46	19.76
203	Royyuru	Thotlavalluru	238	227	22.6	20.9	494	484	46.50	41.88
		Mandal range	210-276	202-259	19.5-61.6	16.5-60.2	286-494	281-484	21.46-53.63	18.51-50.20

Contd.

S.No.	Name of the village	Mandal	N(kg ha ⁻¹)		P ₂ O ₅ (kg ha ⁻¹)		K ₂ O(kg ha ⁻¹)		S(ppm)	
			Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
204	Vijayawada (rural)	Vijayawada (rural)	248	220	53.4	50.6	395	390	19.52	13.34
205	Kotturu	Vijayawada (rural)	241	229	46.5	43.4	368	363	16.66	10.31
206	Enikipadu	Vijayawada (rural)	282	264	40.4	39.2	331	328	18.37	11.39
207	Tadepalle	Vijayawada (rural)	251	239	41.3	39.2	336	332	18.31	12.11
208	Gudavalli	Vijayawada (rural)	232	223	52.1	51.8	426	418	15.93	10.56
		Mandal range	232-282	220-264	40.4-53.4	39.2-51.8	331-426	328-418	15.93-19.52	10.31-13.34
209	Vijayawada(urban)	Vijayawada(urban)	235	241	33.9	32.1	441	432	48.40	43.78
210	Vijayawada(urban)	Vijayawada(urban)	244	227	42.7	40.8	399	395	23.47	20.40
211	Vijayawada(urban)	Vijayawada(urban)	254	214	55.1	53.3	436	430	22.19	19.31
212	Vijayawada(urban)	Vijayawada(urban)	270	229	48.9	44.7	299	292	47.08	42.21
		Mandal range	235-270	214-241	33.9-55.1	32.1-53.3	299-441	292-432	22.19-48.40	19.31-43.78
		Overall range	185-298	163-274	11.2-96.3	10.9-94.0	247-866	232-783	15.32-82.18	10.25-57.91
		Overall mean	241.5	218.5	53.75	52.45	556.5	507.5	48.75	34.08

Table 4.41 : Range And Mean \pm Standard deviation of available N, P₂O₅, K₂O and S in surface soils (0-15cm) of different mandals of Krishna district

S. No.	Name of the Mandal	N(Kg ha ⁻¹)	P ₂ O ₅ (Kg ha ⁻¹)	K ₂ O(Kg ha ⁻¹)	S(ppm)
1	A.konduru	216-298 (254.43 \pm 32.84)	13.2-43.2 (30.47 \pm 11.16)	303-498 (370.43 \pm 64.64)	29.52-63.60 (45.86 \pm 11.76)
2	Reddigudem	185-245 (220.0 \pm 19.39)	22.1-48.3 (31.09 \pm 10.05)	301-684 (493 \pm 151.66)	15.93-52.43 (25.79 \pm 13.20)
3	Mylavaram	191-232 (211 \pm 14.12)	24.1-51.8 (36.29 \pm 10.53)	279-498 (353.86 \pm 71.19)	17.36-82.18 (40.53 \pm 25.08)
4	Vissanapeta	191-273 (227.57 \pm 31.25)	11.2-21.6 (17.36 \pm 4.24)	318-661 (467.14 \pm 117.01)	26.41-48.23 (38.87 \pm 7.70)
5	Nuzivedu	198-254 (221.71 \pm 18.46)	19.6-43.2 (28.73 \pm 7.65)	277-391 (320.86 \pm 46.53)	16.26-50.19 (29.8 \pm 15.72)
6	Chatrai	210-270 (239.29 \pm 22.22)	21.3-55.5 (34.17 \pm 11.69)	271-436 (328.57 \pm 57.55)	23.63-47.31 (36.51 \pm 8.11)
7	Jaggaypeta	210-289 (242.82 \pm 26.45)	26.9-55.1 (44.05 \pm 8.89)	268-681 (386 \pm 125.86)	27.21-50.62 (38.48 \pm 9.13)
8	Ibbrahimpatnam	223-279 (250.75 \pm 18.23)	21.3-52.2 (38.25 \pm 11.01)	303-598 (429.50 \pm 93.71)	15.32-45.31 (23.62 \pm 11.19)
9	Gampalagudem	201-296 (238.50 \pm 31.91)	21.2-42.6 (34.85 \pm 8.11)	293-577 (370.50 \pm 104.22)	23.96-44.36 (31.43 \pm 7.33)
10	Pamidimukkala	232-273 (248.14 \pm 16.75)	28.5-50.2 (37.83 \pm 8.03)	277-368 (330.86 \pm 35.25)	24.39-46.51 (37.97 \pm 7.82)

Contd.

S. No.	Name of the Mandal	N(Kg ha ⁻¹)	P ₂ O ₅ (Kg ha ⁻¹)	K ₂ O(Kg ha ⁻¹)	S(ppm)
11	Musunuru	223-248 (235.29 ± 10.47)	46.8-66.2 (56.79 ±6.75)	294-413 (340.71 ± 45.52)	25.86-49.48 (35.52 ± 9.02)
12	Tiruvuru	207-260 (233.71± 19.42)	49.6-69.1 (59.39 ±6.58)	289-559 (398 ± 98.49)	27.21-51.42 (40.98 ±8.65)
13	Nandigama	210-257 (232.14 ± 17.96)	22.1-69.3 (43.16 ±16.74)	291-512 (381.86 ± 86.37)	23.42-52.96 (37.56 ± 9.30)
14	Penuganchiprolu	210-276 (239.75 ± 25.52)	37.8-58.8 (47.85 ±7.10)	263-373 (314.63 ± 35.33)	21.93-48.26 (33.53 ± 9.34)
15	Vatsvai	229-276 (252.14 ±16.23)	20.9-46.6 (28.76±9.04)	273-866 (453.43 ± 196.15)	33.38-47.32 (40.69 ± 4.46)
16	Chandarlapadu	207-254 (228.43 ± 19.57)	58.3-96.3 (77.36±14.87)	330-786 (470.29 ± 178.49)	16.32-21.46 (18.56 ± 1.76)
17	Kanchikacherla	220-279 (251.86 ± 25.18)	22.9-43.5 (36.03 ±8.35)	367-652 (530.57 ± 147.49)	15.92-41.46 (21.13 ± 9.04)
18	Verullapadu	213-273 (244.14 ± 27.05)	39.8-58.7 (50.87 ±6.77)	304-629 (462.43 ± 131.11)	25.56-46.72 (32.10 ± 7.69)
19	Penamaluru	213-273 (242.71 ± 17.61)	33.2-57.3 (52.59 ±9.13)	274-498 (382.14 ± 89.79)	23.57-43.86 (34.57 ± 7.08)
20	Kankipadu	210-270 (241 ± 21.83)	28.6-52.8 (43.11 ±9.30)	347-514 (446.14 ± 56.12)	21.43-45.59 (33.52 ± 8.24)

Contd.

S. No.	Mandal	N(Kg ha ⁻¹)	P ₂ O ₅ (Kg ha ⁻¹)	K ₂ O(Kg ha ⁻¹)	S(ppm)
21	Vuyyuru	229-276 (244.71 ± 19.75)	19.8-42.3 (30.00±8.20)	274-430 (348.46 ± 59.51)	21.19-44.46 (34.21 ± 8.09)
22	Unguturu	220-263 (236.14 ± 16.67)	24.1-70.9 (48.17 ±17.29)	291-494 (359.29 ± 81.03)	22.56-61.72 (37.39 ±12.49)
23	Gannavaram	213-270 (243.71 ± 21.78)	29.4-54.0 (41.97 ±7.46)	320-483 (381.29 ± 58.39)	23.21-52.20 (34.29 ± 10.77)
24	Agiripalli	210-251 (229 ± 15.90)	45.5-58.4 (51.93 ±4.51)	283-514 (355.29 ±87.65)	25.70-49.44 (35.91 ± 9.23)
25	Bapulapadu	204-257 (228 ± 21.76)	58.3-81.5 (68.77 ±8.20)	328-503 (364.57 ± 79.91)	26.56-43.31 (33.94 ± 5.75)
26	G.konduru	113-263 (215.43 ± 51.93)	23.9-55.4 (41.96 ±11.92)	247-607 (453.43 ± 121.57)	26.43-44.42 (34.06 ± 6.65)
27	Thotlavalluru	210-276 (246.21 ± 22.70)	19.5-61.6 (35.20 ±14.84)	286-494 (387.29 ± 57.22)	21.46-53.63 (38.59 ± 11.21)
28	Vijayawada(rural)	232-282 (250.80± 18.91)	40.4-53.4 (46.74 ± 5.98)	331-426 (371.20 ± 40.11)	15.93-19.52 (17.76 ± 1.44)
29	Vijayawada(urban)	235-270 (250.75 ± 15)	33.9-55.1 (45.15 ±9.05)	299-441 (393.75 ± 65.89)	22.19-48.40 (35.29 ± 14.40)

Table 4.42: Range And Mean \pm Standard deviation of available N, P₂O₅, K₂O and S in subsurface soils (15-30cm) of different mandals of Krishna district

S. No.	Name of the Mandal	N(Kg ha ⁻¹)	P ₂ O ₅ (Kg ha ⁻¹)	K ₂ O(Kg ha ⁻¹)	S(ppm)
1	A.konduru	201-274 (234 \pm 30.28)	11.2-40.3 (28.44 \pm 11.10)	297-487 (359.71 \pm 62.53)	20.36-57.31 (39.12 \pm 12.08)
2	Reddigudem	170-226 (202.14 \pm 16.84)	15.2-47.9 (28.63 \pm 11.19)	293-680 (484 \pm 154.13)	10.93-47.39 (20.97 \pm 12.92)
3	Mylavaram	163-224 (191.71 \pm 19.78)	22.5-50.0 (34.53 \pm 10.45)	268-494 (347.86 \pm 72.37)	11.63-56.43 (35.22 \pm 25.71)
4	Vissanapeta	179-265 (213.14 \pm 29.50)	10.9-20.3 (15.70 \pm 3.59)	310-654 (461 \pm 116.77)	19.43-41.82 (32.64 \pm 8.29)
5	Nuzivedu	180-239 (206.14 \pm 21.60)	17.1-38.6 (26.10 \pm 6.92)	268-387 (316.43 \pm 47.64)	10.91-48.24 (24.81 \pm 16.06)
6	Chatrai	203-244 (225.14 \pm 15.37)	20.3-53.2 (31.97 \pm 11.61)	266-431 (319.14 \pm 57.31)	19.28-39.32 (32.02 \pm 7.30)
7	Jaggaypeta	174-267 (225.55 \pm 27.87)	25.3-53.6 (41.68 \pm 9.58)	252-677 (378.64 \pm 127.91)	18.26-43.40 (32.76 \pm 8.33)
8	Ibbrahimpatnam	210-255 (234.25 \pm 16.42)	20.6-50.2 (35.86 \pm 10.62)	300-594 (423.10 \pm 92.99)	10.71-39.33 (19.40 \pm 10.64)
9	Gampalagudem	191-259 (221.88 \pm 23.93)	19.8-40.2 (32.98 \pm 8.10)	287-570 (365.75 \pm 103.35)	19.71-38.83 (26.17 \pm 6.54)
10	Pamidimukkala	211-246 (226.86 \pm 12.20)	26.5-47.1 (35.59 \pm 7.53)	273-351 (320.14 \pm 30.65)	19.52-39.32 (31.85 \pm 7.35)

Contd.

S. No.	Name of the Mandal	N(Kg ha ⁻¹)	P ₂ O ₅ (Kg ha ⁻¹)	K ₂ O(Kg ha ⁻¹)	S(ppm)
11	Musunuru	207-237 (221.71 ± 11.83)	41.3-65.1 (54.27 ±8.18)	282-409 (332 ± 47)	20.89-43.76 (29.75 ± 9.26)
12	Tiruvuru	201-248 (224.14 ± 16.03)	44.4-66.2 (56.40 ± 7.45)	288-544 (389.29 ± 93.24)	21.19-48.53 (36.40 ± 10.01)
13	Nandigama	202-241 (217.71 ± 15.33)	20.9-67.9 (41.70 ±16.88)	289-509 (376.14 ± 87.55)	19.23-46.83 (31.68 ± 8.54)
14	Penuganchiprolu	184-241 (217.13 ± 19.97)	32.2-56.8 (45.11 ±8.55)	260-367 (310.50 ± 34.75)	17.36-42.32 (27.71 ± 8.57)
15	Vatsvai	210-251 (233.71 ± 14.61)	19.5-45.8 (26.91 ±9.31)	269-861 (448 ± 196.10)	27.43-42.96 (34.59 ± 5.31)
16	Chandarlapadu	192-248 (217.71 ± 20.73)	51.4-94.0 (71.79 ±16.37)	326-783 (465.43 ± 179.54)	10.52-18.71 (14.56 ± 2.79)
17	Kanchikacherla	214-267 (242.71 ± 22.59)	20.1-40.8 (32.97 ±9.03)	358-740 (524.43 ± 148.91)	10.25-36.27 (16.20 ± 9.02)
18	Verullapadu	193-270 (233.57 ± 28.22)	36.2-54.2 (47.34 ±6.88)	300-626 (458 ± 131.58)	21.42-41.68 (27.32 ± 7.38)
19	Penamaluru	201-267 (226.14 ± 21.64)	28.2-55.3 (48.33 ±9.86)	268-496 (376.43 ± 89.87)	19.21-38.05 (28.39 ± 7.12)
20	Kankipadu	186-252 (223 ± 23.51)	25.4-50.1 (40.53 ±10.01)	340-511 (442.14 ± 57.47)	17.29-38.08 (28.72 ± 7.62)

Contd.

S. No.	Name of the Mandal	N(Kg ha ⁻¹)	P ₂ O ₅ (Kg ha ⁻¹)	K ₂ O(Kg ha ⁻¹)	S(ppm)
21	Vuyyuru	209-252 (225.86± 14.96)	15.8-41.8 (28.21 ±9.09)	269-425 (343.86 ± 59.16)	15.16-40.03 (28.26 ± 8.90)
22	Unguturu	210-251 (224 ± 16.67)	20.3-67.6 (43.09 ±17.42)	284-489 (351 ± 77.79)	20.33-57.91 (31.42 ± 13.13)
23	Gannavaram	196-249 (227.43 ± 18.98)	23.4-46.1 (37.30 ±7.71)	311-469 (374.57 ± 55.86)	17.51-48.76 (29.87 ± 11.71)
24	Agiripalli	191-241 (217.71 ± 17.83)	43.4-53.3 (48.64 ±4.25)	272-509 (350.14 ± 89.06)	18.09-43.26 (28.61 ± 9.87)
25	Bapulapadu	183-248 (214.43 ± 22.78)	52.3-77.3 (64.03 ±9.03)	268-498 (375 ± 78.39)	19.35-36.42 (28.10 ± 6.08)
26	G.konduru	106-249 (204.43 ± 51.40)	20.2-51.4 (37.80 ±12.72)	232-603 (446.43 ± 125.52)	19.32-40.73 (28.02 ± 7.91)
27	Thotlavalluru	202-259 (229.21 ± 15.66)	16.5-60.2 (33.22 ±15.09)	281-484 (382.29 ± 55.46)	18.51-50.20 (33.73 ± 10.82)
28	Vijayawada(rural)	220-264 (235 ± 17.76)	39.2-51.8 (4.84 ±6.07)	328-418 (366.20 ± 38.37)	10.31-13.34 (11.54 ± 1.23)
29	Vijayawada(urban)	214-241 (227.75 ± 11.06)	32.1-53.3 (42.73 ± 8.80)	292-432 (387.25 ± 65.73)	19.31-43.78 (31.43 ± 13.38)

Table 4.43: Soil Test Summary For Nitrogen (kg ha⁻¹)

S. No.	Number of samples	Available nitrogen(kg ha ⁻¹)		Number of samples in each category		
		Range	Mean	Low	Medium	High
Surface						
1	212	185-298	241.5	206(97.16%)	6(2.84%)	0
Subsurface						
2	212	163-274	218.5	212(100%)	0	0

Table 4.44: Soil Test Summary for phosphorus P₂O₅ (kg ha⁻¹)

S. No.	Number of samples	Available phosphorus (kg ha ⁻¹)		Number of samples in each category		
		Range	Mean	Low	Medium	High
Surface						
1	212	11.2-96.3	53.75	26(12.26%)	151(71.22%)	35(16.52%)
Subsurface						
2	212	10.9-94.0	52.45	33(16.03%)	157(74.52%)	22(9.45%)

Table 4.45 : Soil Test Summary for Potassium K₂O (kg ha⁻¹)

S. No.	Number of samples	Available potassium (kg ha ⁻¹)		Number of samples in each category		
		Range	Mean	Low	Medium	High
Surface						
1	212	247-866	556.5	0	6(2.84%)	206(97.16%)
Subsurface						
2	212	232-783	507.5	0	24(11.33%)	188(88.67%)

Table 4.46 : Soil test summary for sulphur (ppm)

S. No.	Number of samples	Available sulphur (ppm)		Number of samples in each category	
		Range	Mean	Deficient	Sufficient
Surface					
1	212	15.32-82.18	48.75	24(11.33%)	188(88.67%)
Subsurface					
2	212	10.25-57.91	34.08	57(26.88%)	155(73.12%)

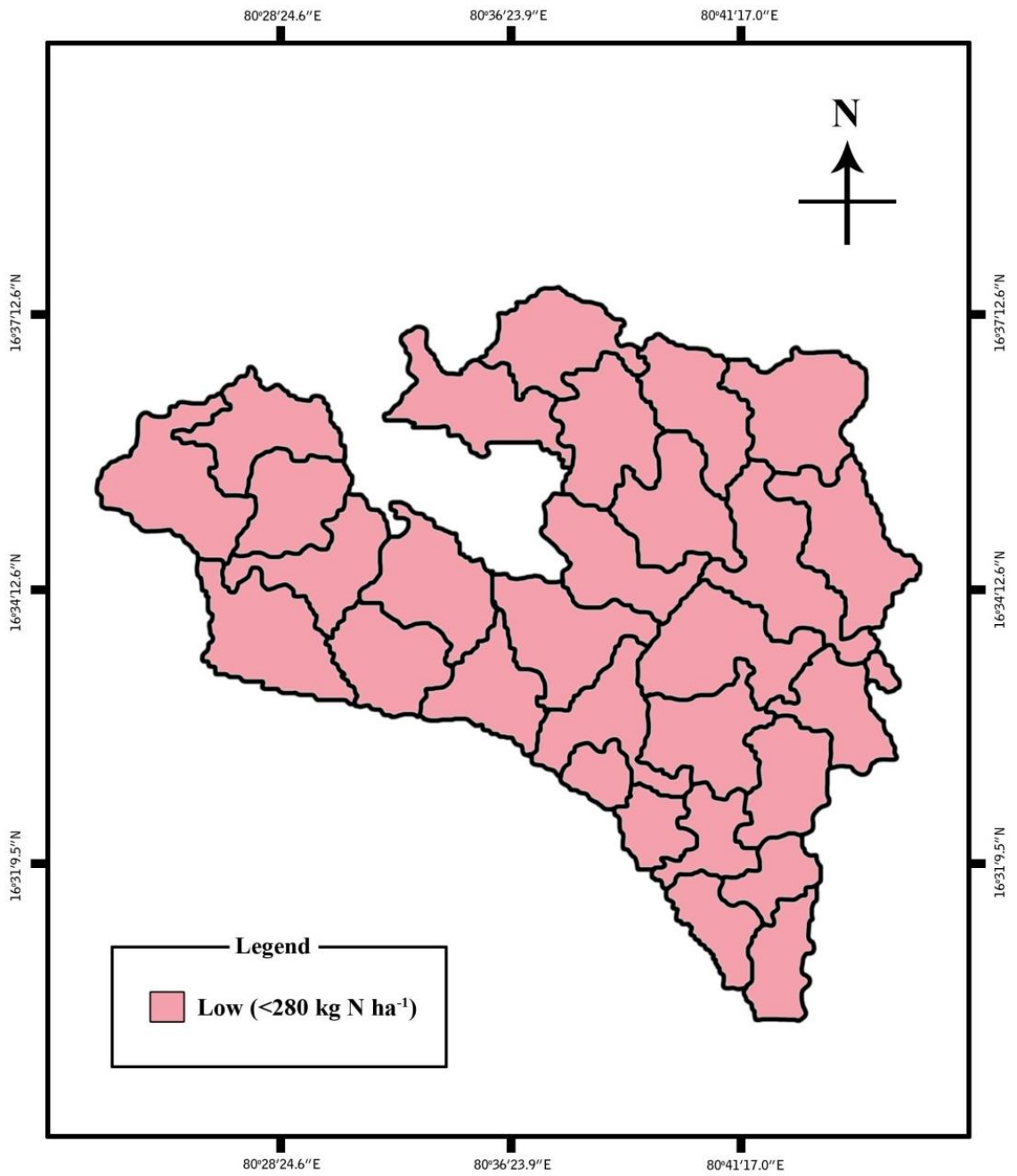


Fig. 4a Available Nitrogen content of surface soil samples of Krishna district

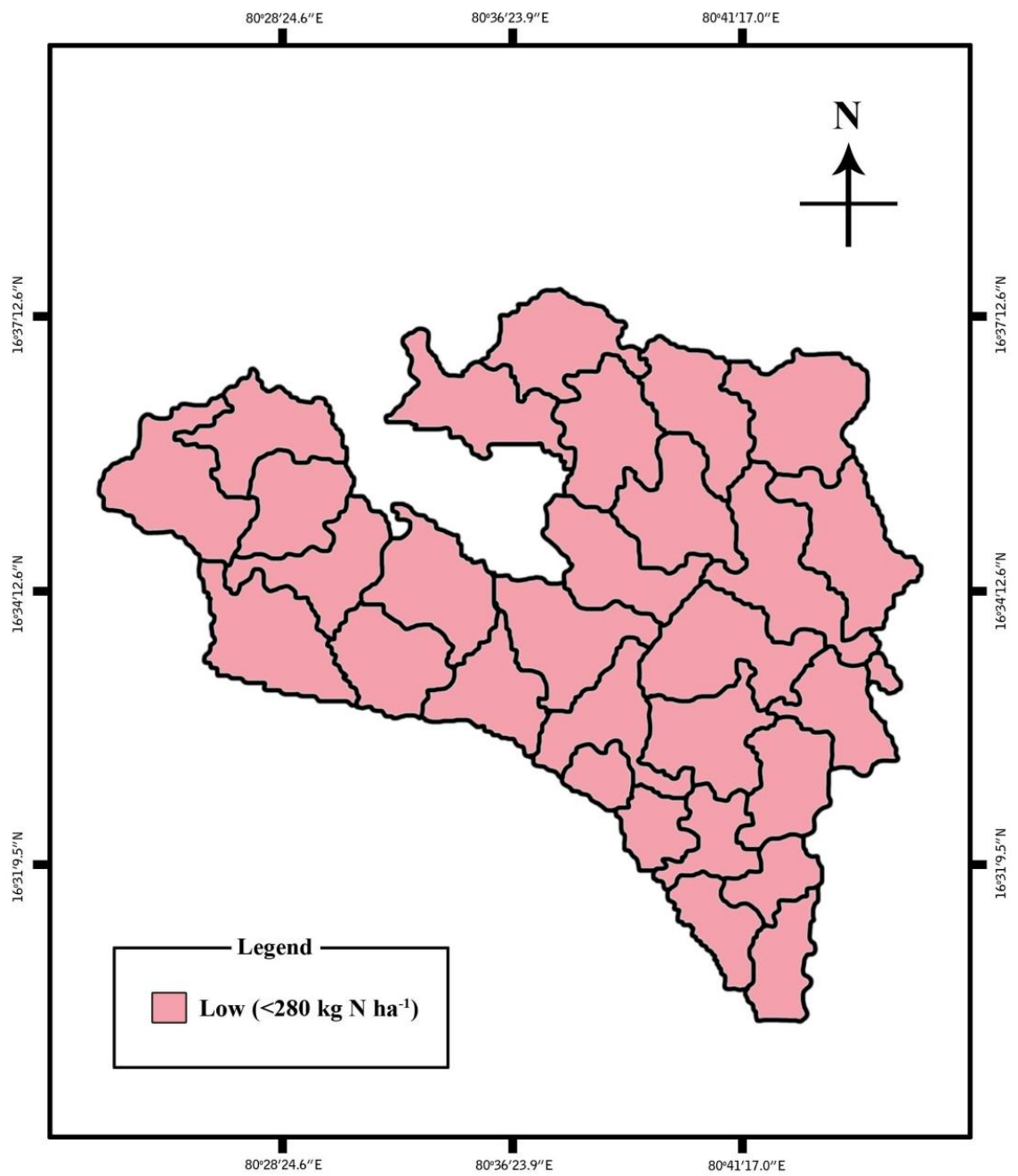


Fig. 4b Available Nitrogen content of subsurface soil samples of Krishna district

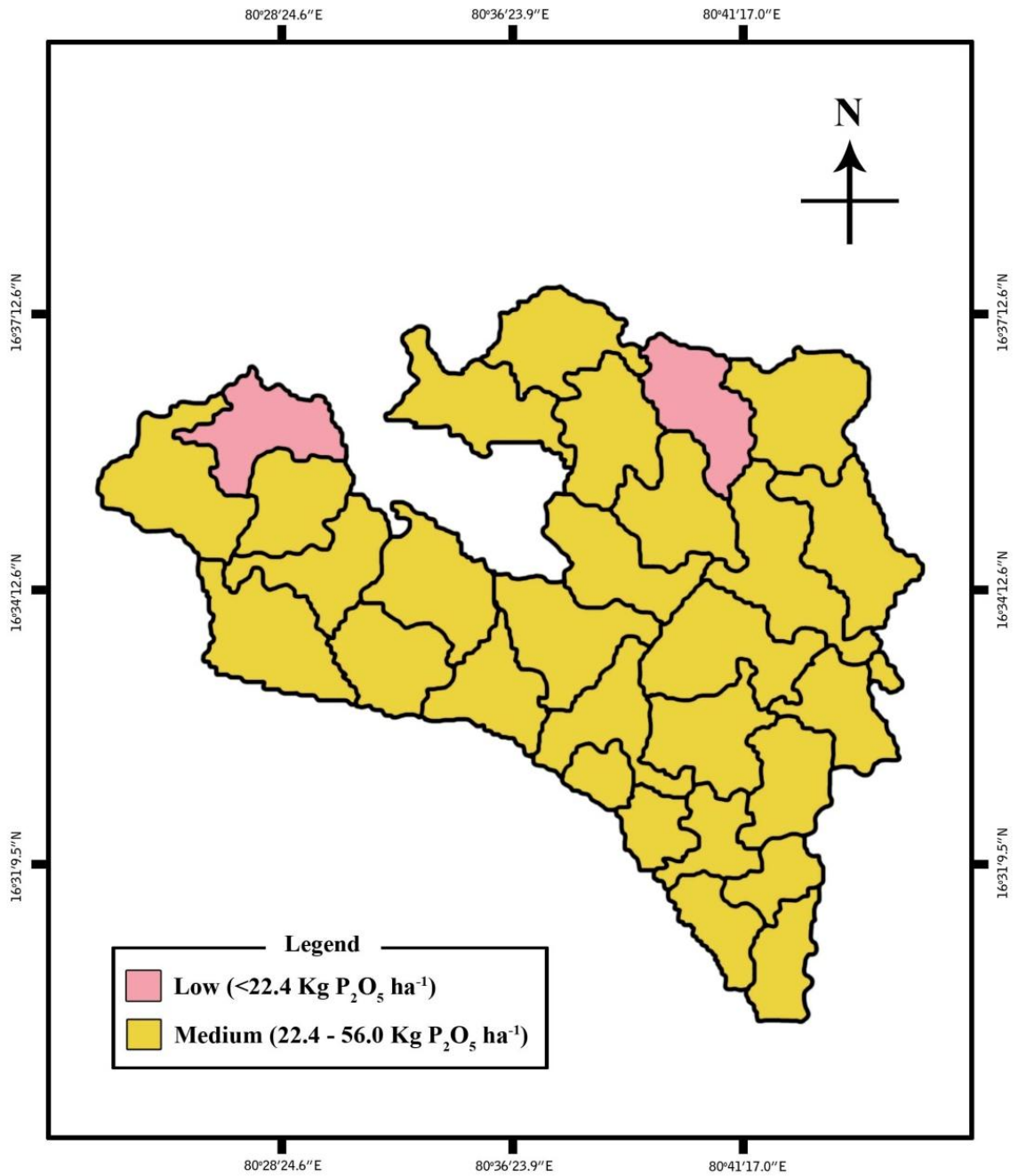


Fig. 5a Available phosphorus content(P₂O₅) of surface soil samples of Krishna district

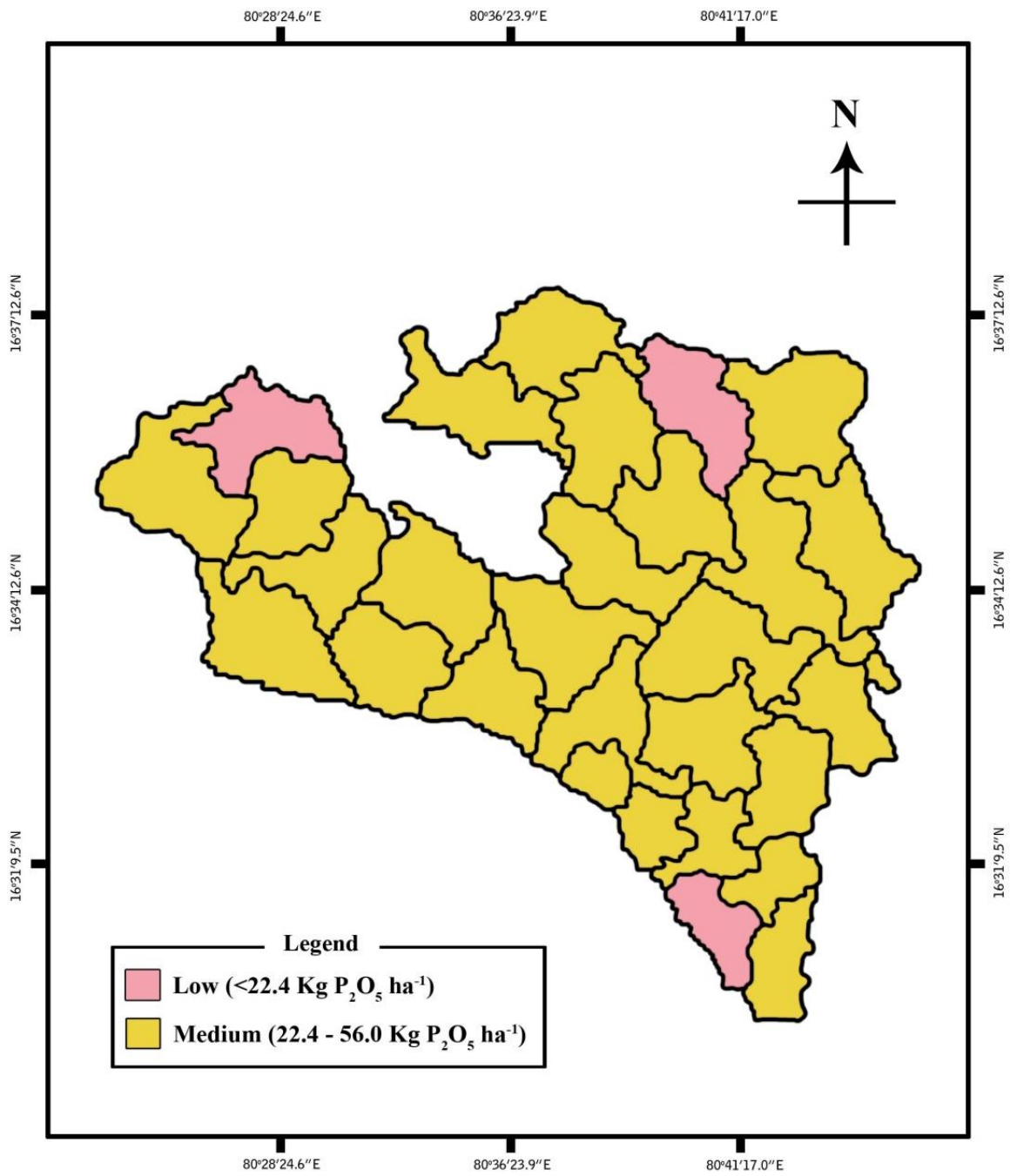


Fig. 5b Available phosphorus content(P_2O_5) of subsurface soil samples of Krishna district

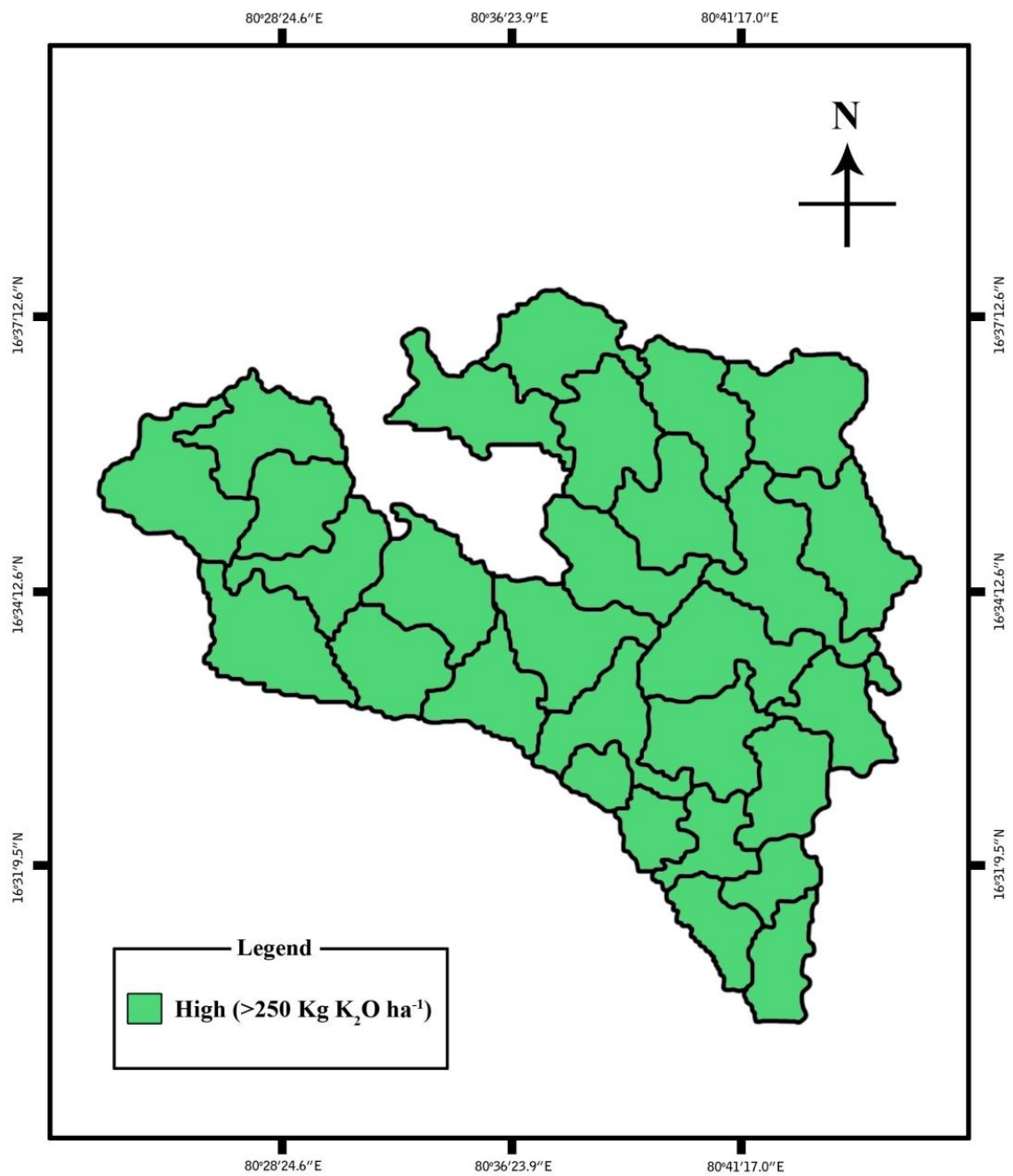


Fig. 6a Available potassium content (K_2O) of surface soil samples of Krishna district

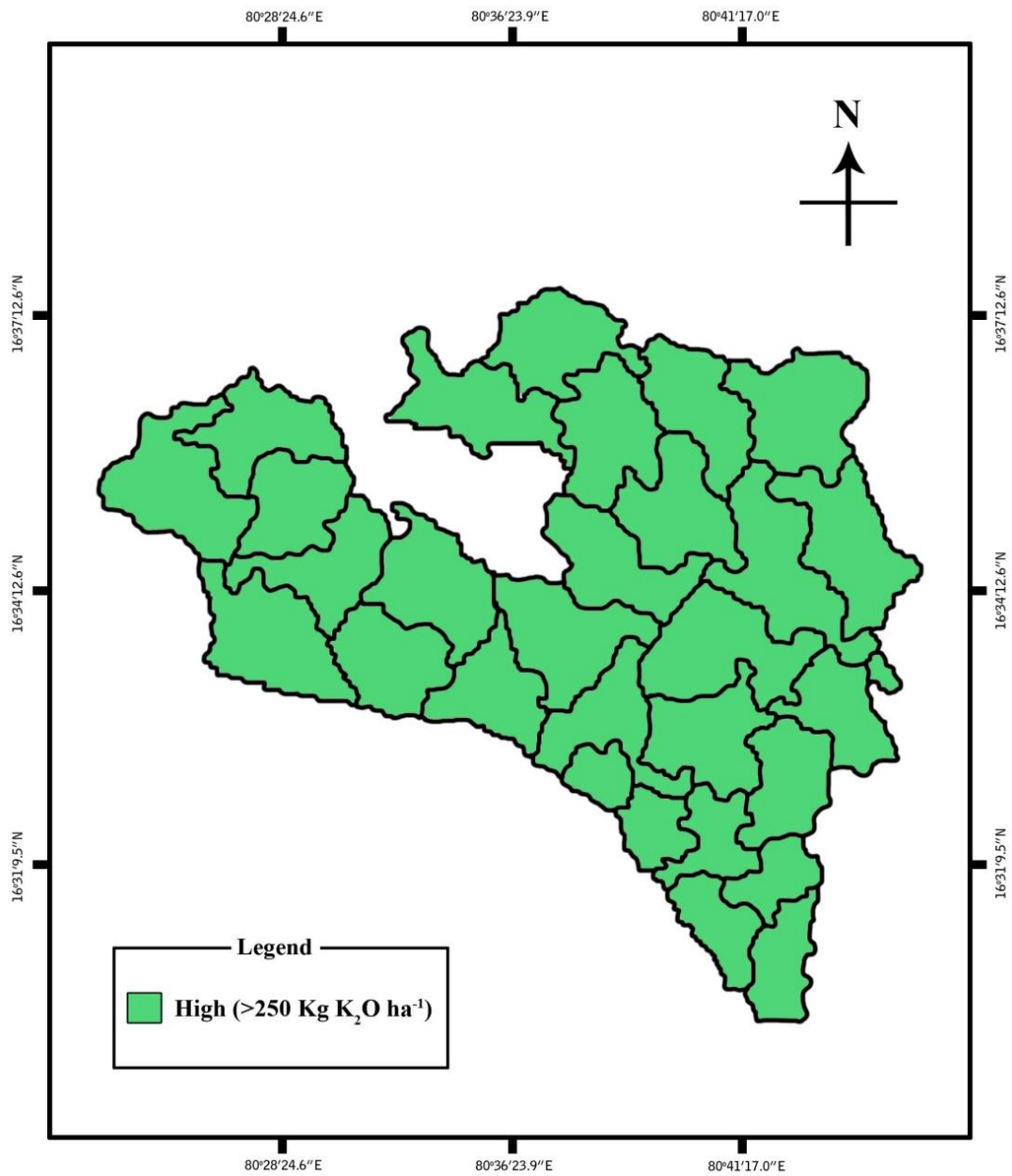


Fig. 6b Available potassium content (K_2O) of subsurface soil samples of Krishna district

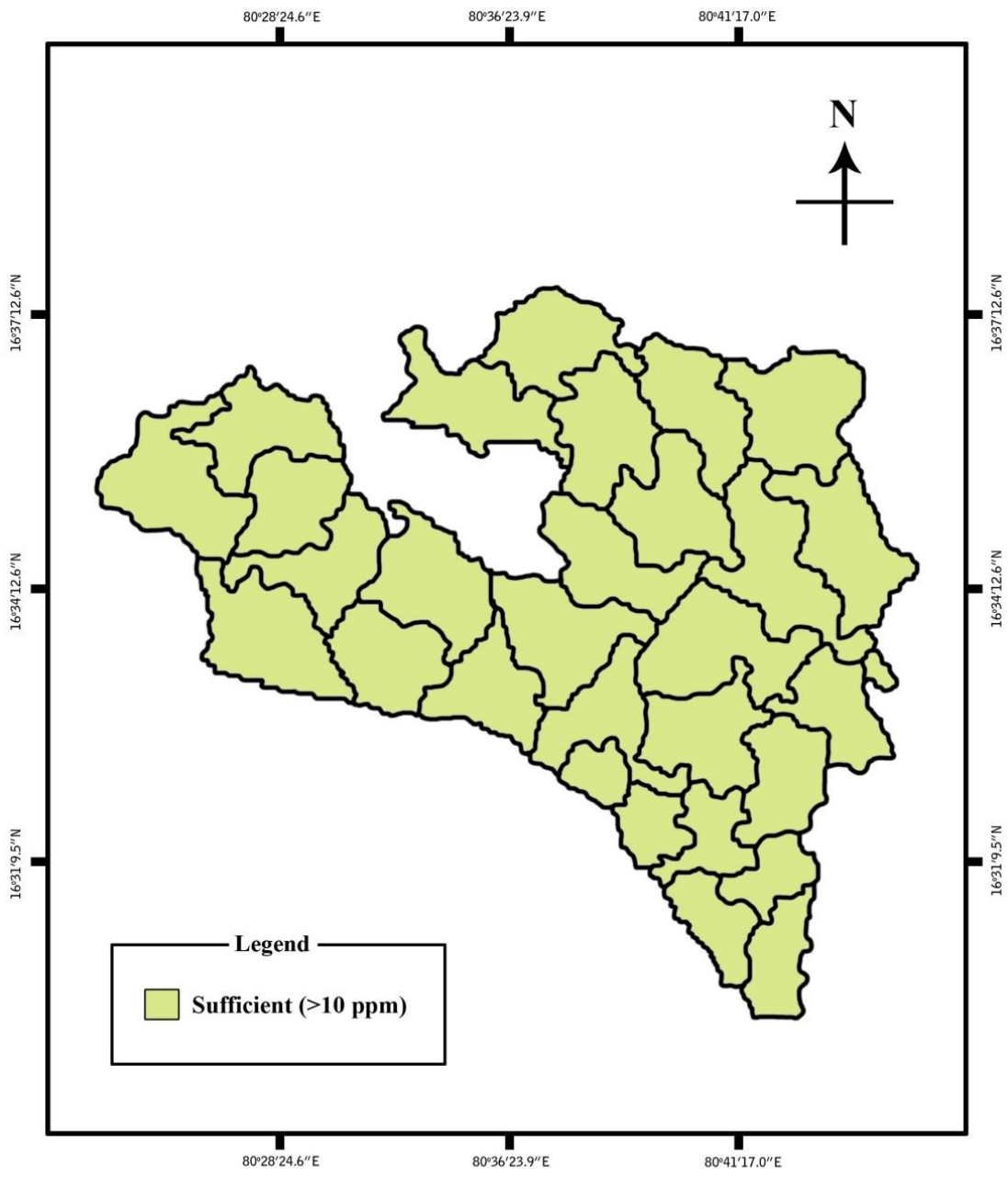


Fig. 7a Available sulphur content of surface soil samples of Krishna district

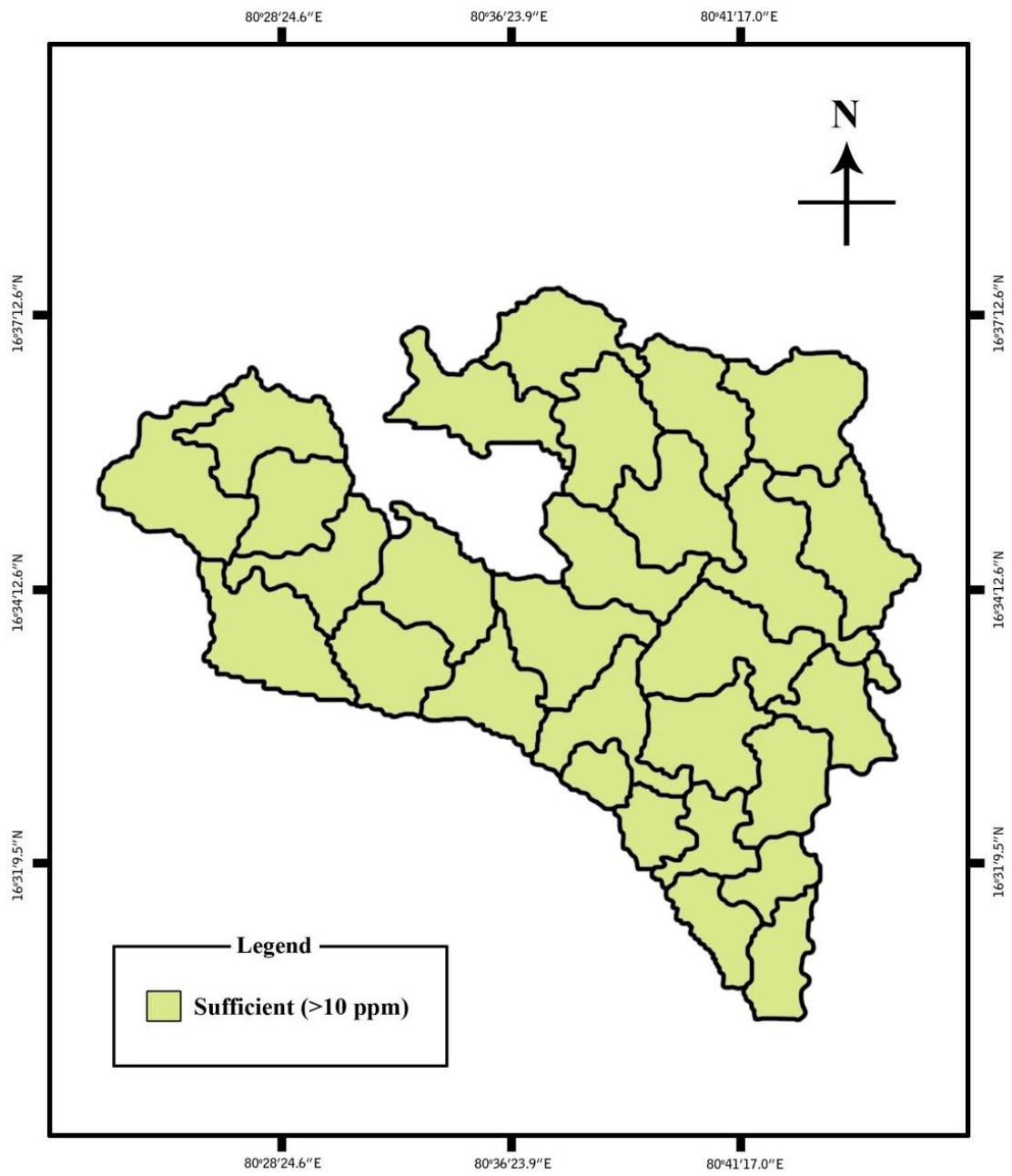


Fig. 7b Available sulphur content of subsurface soil samples of Krishna district

4.4 MICRONUTRIENTS

Zinc

The data pertaining to the available zinc content of surface and subsurface samples, range and mean are presented in table 4.5, 4.51, 4.52 and 4.53 and depicted in figure 8a and 8b.

The available zinc content of surface and subsurface soil samples ranged from 0.09 to 4.37 and from 0.05 to 4.27 with a mean value of 2.23 and 2.16 ppm, respectively. In study area, 66.00% and 73.59 % of surface and subsurface respectively were found to be deficient while other soils are sufficient in available zinc content as per the ratings given by Lindsay and Norwell (1978).

Deficiency of zinc in these soils might be due to basic soil reaction and high iron content of these soils and also due to over application of phosphatic fertilizers by farmers ignoring the native nutrient status in soil inducing deficiency of zinc. Revathi *et al.* (2005) reported that the lower zinc values in black soils might be due to the presence of medium to heavy texture, which favours fixation of zinc in the octahedral layers substituting for magnesium. Similar observations were made by Vara Prasad Rao *et al.* (2008) in wide texturally varied (sandy to clay loam) soils of Ramachadrapuram mandal, Chittoor district, Andhra Pradesh.

Surface samples were found to be comparatively rich (mean 2.23 ppm) in available zinc as compared with subsurface soil samples (mean 2.16 ppm), which might be due to relatively high organic carbon and application of fertilizer zinc at surface. Similar relationship was observed by Mahesh Kumar *et al.* (2011) in soils of Rajasthan.

Comparatively sandy clay loam soils recorded less available zinc content than black soils. This might be due to low organic carbon content of sandy soils. The results are corroborating with findings of Rama Rao (2003) and Rama Lakshmi and Seshagiri Rao (2000) in sandy and black soils of Chirala and Bapatla-Karlapalem mandal, Andhra Pradesh.

Among the different mandals, highest (2.46 ppm) mean available zinc content was observed in Penamaluru mandal while the lowest (0.30 ppm) was observed in Uyyuru mandal.

Iron

The data pertaining to the available iron content of surface and subsurface samples, range and mean are presented in table 4.5,4.51,4.52 and 4.54 and depicted in figure 9a and 9b.

The available iron content ranged from 0.53 to 9.53 and from 0.48 to 9.48 ppm with a mean value of 5.03 and 4.98 ppm in surface and subsurface soil samples, respectively. Out of 424 (surface and subsurface), 86% of surface and 85% of subsurface samples were found to be sufficient and remaining soils are deficient as per rating of Lindsay and Norvell, (1978) (Table 3.4). Similar results were reported by Padmaja *et al.* (2001) in coastal soils of Guntur district, Andhra Pradesh.

The results also indicated that the available iron content was more in surface than in the subsurface soils, which might be due to fixation of ferrous and ferric ions as $\text{Fe}(\text{OH})_2$ and $\text{Fe}(\text{OH})_3$ as the subsurface soils were found to be more alkaline than the surface soils. The results were corroborated with findings of Madhuvani *et al.* (2001) in black and associated soils of Vatticherukur mandal of Guntur district, Andhra Pradesh.

It was observed that the sandy clay loam soils were relatively rich in available iron content compared to the black soils. Lower availability of iron in black soils might be due to precipitation of iron in the form of insoluble iron compounds, particularly so in view of high alkalinity in black soils than the sandy soils. Similar results were reported by Rama Rao (2003) and Ramesh (2000) in sandy and black soils of Chirala and Singarayakonda mandal of Andhra Pradesh, respectively.

Among the different mandals, highest (6.43 ppm) mean Iron content was observed in Reddigudem mandal while the lowest (2.49 ppm) was observed in Pamidimukkala mandal.

Manganese

The data pertaining to the available manganese content of surface and subsurface samples, range and mean are presented in table 4.5, 4.51, 4.52 and 4.55 and depicted in figure 10 a and 10 b.

The available manganese content of the surface and subsurface soil samples ranged from 1.05 to 7.41 and from 0.98 to 7.36 ppm with a mean value of 4.23 and 4.17 ppm, respectively. Both surface and subsurface soils contained above the critical limit of 1.0 ppm as proposed Lindsay and Norvell (1978) (Table 3.4).

Surface soil samples have high (mean 4.23 ppm) concentration of available manganese as compared to subsurface soil samples (mean 4.17 ppm). This might be attributed to Mn bearing minerals in the parent material and also might be less mobility of Mn⁺² in the soils, which might have contributed for the accumulation of reducible and soluble forms of manganese in the surface soils. Similar observations were reported by Mydhili (2006), Rama Lakshmi and Seshagiri Rao (2000) in soils of Guntur district, Pradeep *et al.* (2006) in the (groundnut growing) black soils of upper Krishna command area, Karnataka and Ramesh and Hari Prasada Rao, (2005) in the coastal soils of Prakasam district, Andhra Pradesh.

It was also observed that the available manganese was more in the black soils than in sandy soils. The results are in confirmity with the findings of Rama Lakshmi (1999) and Rama Rao (2003) in soils of Bapatla-Karlapalem and Chirala mandal, Andhra Pradesh.

Among the different mandals, highest (4.23 ppm) mean manganese content was observed in Nuzivedu mandal while the lowest (2.22 ppm) was observed in A.Konduru mandal.

Copper

The data pertaining to the available copper content of surface and subsurface samples, range and mean are presented in table 4.5, 4.51, 4.52 and 4.56 and depicted in figure 11a and 11b.

Available copper content of the surface soils varied from 0.40 to 6.33 ppm with a mean value of 3.36 ppm. In case of subsurface samples it was found to vary from 0.35 to 6.21 pm with an average value of 3.28ppm. Among 424 surface and subsurface samples, 100% surface and subsurface samples were sufficient in available copper content as per the ratings (>0.2 ppm) given by Lindsay and Norvell (1978). The results were in accordance with those of Rama Lakshmi and Seshagiri Rao (2000), Sathish *et al.* (2008) and Vara Prasad Rao *et al.* (2008) in sandy and black soils of Guntur and Chittoor district, Andhra Pradesh, respectively.

Available copper content of surface soil samples recorded high (mean 3.36 ppm) concentration as compared with subsurface soil samples (mean 3.28 ppm) which might be due to the application of copper containing chemicals mostly as fungicides to surface. Similar observation were made by Vijayasekhar *et al.* (2000) and Joshna Priyadarshini (2011) in black soils of UKP command Karnataka and Nellore district, Andhra Pradesh, respectively.

The available copper content of the black soils was found to be high than that of the sandy soils which might be due to higher clay content and organic matter contents of the fine textured soils. The organic matter might promote the availability of copper presumably by supplying soluble complexing and chelating agent, as result of which the loss of soluble copper mainly due to fixation and formation of insoluble hydroxides and carbonates. Similar views were expressed by Venu Madhav and Prasada Rao (2003) in black soils of Krishna western delta region of Andhra Pradesh.

Among the different mandals, highest (3.64 ppm) mean available copper content was observed in Nandigama mandal while the lowest (1.39 ppm) was observed in Ibrahimpatnam mandal.

Table 4.5 : Available micronutrient status of upland soils of Krishna district

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
1	A.konduru	A.konduru	0.32	0.27	4.96	4.82	1.33	1.26	1.43	1.39
2	Gollamandala	A.konduru	0.56	0.54	6.49	6.23	1.37	1.33	1.64	1.56
3	Khambampadu	A.konduru	0.14	0.11	4.76	4.66	1.25	1.21	2.48	2.35
4	Cheemalapadu	A.konduru	0.26	0.25	4.86	4.78	1.22	1.19	0.96	0.88
5	Koduru	A.konduru	0.53	0.52	4.81	4.65	2.76	2.59	1.69	1.61
6	Madhavaram	A.konduru	0.63	0.63	5.11	5.03	2.04	1.99	2.44	2.38
7	Repudi	A.konduru	0.44	0.42	8.37	8.32	5.55	5.51	1.66	1.56
		Mandal range	0.14-0.63	0.11-0.63	4.76-8.37	4.66-8.32	1.22-5.55	1.19-5.51	0.96-2.48	0.88-2.38
8	Reddigudem	Reddigudem	0.63	0.62	7.64	7.59	5.75	5.56	1.72	1.64
9	Reddigudem	Reddigudem	0.25	0.24	6.40	6.38	2.98	2.89	1.04	1.00
10	Naguluru	Reddigudem	0.50	0.45	4.96	4.86	1.27	1.22	1.59	1.48
11	Kudapa	Reddigudem	0.33	0.30	9.53	9.48	5.77	5.65	1.68	1.52
12	Rudravaram	Reddigudem	0.52	0.49	6.20	6.18	1.97	1.81	1.75	1.66
13	Rudravram	Reddigudem	0.40	0.39	5.36	5.26	2.73	2.63	1.55	1.48

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
14	Rangapuram	Reddigudem	0.81	0.76	4.89	4.79	3.24	3.21	2.04	1.96
		Mandal range	0.25-0.81	0.24-0.76	4.89-9.53	4.79-9.48	1.27-5.77	1.21-5.65	1.04-2.01	1.00-1.96
15	Mylavaram	Mylavaram	0.54	0.52	5.64	5.53	2.65	2.54	1.99	1.87
16	Chandrala	Mylavaram	0.30	0.29	2.68	2.54	4.36	4.31	0.77	0.71
17	Mylavaram	Mylavaram	0.34	0.33	3.42	3.40	3.35	3.28	2.35	2.30
18	Velvadam	Mylavaram	0.27	0.25	2.53	2.48	2.47	2.33	1.63	1.59
19	Pulluru	Mylavaram	0.54	0.51	2.12	2.01	4.39	4.31	1.93	1.84
20	Morusumilli	Mylavaram	0.46	0.44	4.33	4.26	4.12	4.09	1.97	1.89
21	Kanimerla	Mylavaram	0.34	0.32	3.65	3.58	5.32	5.26	2.04	1.98
		Mandal range	0.27-0.54	0.25-0.51	2.12-5.64	2.01-5.53	2.47-5.32	2.33-5.26	0.77-2.35	0.71-2.30
22	Vissanapeta	Vissanapeta	0.30	0.23	4.64	4.51	3.70	3.65	1.44	1.33
23	Putrela	Vissanapeta	0.34	0.33	4.84	4.78	2.72	2.69	1.22	1.19
24	Kondaparva	Vissanapeta	0.46	0.45	4.70	4.66	2.92	2.86	1.09	1.02
25	Korlamanda	Vissanapeta	0.37	0.35	5.35	5.24	1.99	1.91	1.42	1.35
26	Tatakuntla	Vissanapeta	0.24	0.22	3.69	3.59	2.43	2.36	1.34	1.29
27	Narsapuram	Vissanapeta	0.20	0.15	4.96	4.82	3.70	3.57	1.55	1.52

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
28	Kalagara	Vissanapeta	0.27	0.23	5.07	4.98	7.41	7.36	2.36	2.29
		Mandal range	0.20-0.46	0.15-0.45	3.69-5.35	3.59-5.24	1.99-7.41	1.91-7.36	1.09-2.36	1.02-2.29
29	Nuzivedu	Nuzivedu	0.93	0.86	6.34	6.38	6.33	6.23	3.05	2.86
30	Digavalli	Nuzivedu	1.07	1.02	5.40	5.32	6.12	6.10	2.27	2.21
31	Morsapudi	Nuzivedu	0.90	0.83	5.25	5.21	3.42	3.37	3.42	3.27
32	Boravancha	Nuzivedu	1.37	1.24	6.56	6.46	3.95	3.55	3.39	3.26
33	Sunkollu	Nuzivedu	1.53	1.50	4.98	4.87	4.83	4.59	2.65	2.58
34	Vempadu	Nuzivedu	1.10	1.02	8.56	8.48	2.67	2.42	2.39	2.24
35	Gollapalle	Nuzivedu	1.53	1.50	4.93	4.75	2.27	2.16	2.15	2.09
		Mandal range	0.90-1.53	0.83-1.50	4.93-8.56	4.75-8.48	2.27-6.33	2.16-6.23	2.15-3.42	2.09-3.26
36	Chatrai	Chatrai	0.53	0.50	3.61	3.55	2.16	2.06	0.43	0.21
37	Chatrai	Chatrai	0.63	0.62	4.33	4.26	1.18	1.10	1.63	1.58
38	Chittapur	Chatrai	0.46	0.32	2.47	2.35	2.32	2.12	2.61	2.55
39	Mankollu	Chatrai	0.42	0.36	2.40	2.28	3.64	3.42	1.52	1.49
40	Polavaram	Chatrai	0.37	0.30	3.70	3.56	3.38	3.25	1.97	1.75
41	Kothapadu	Chatrai	0.25	0.22	4.02	3.98	2.24	2.15	1.24	1.12

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
42	Chinnampet	Chatrai	0.36	0.27	4.85	4.77	3.46	3.46	1.37	1.29
		Mandal range	0.25-0.63	0.12-0.62	2.40-4.85	2.28-4.77	1.18-3.64	1.10-3.46	0.43-2.61	0.21-2.55
43	Jaggaypeta	Jaggaypeta	1.19	1.03	4.97	4.85	6.38	6.25	1.03	0.98
44	Balusupadu	Jaggaypeta	1.05	1.02	5.31	5.26	4.38	4.19	1.43	1.24
45	Garikipadu	Jaggaypeta	0.92	0.85	5.64	5.55	2.98	2.57	1.64	1.58
46	Ravirala	Jaggaypeta	0.40	0.26	5.25	5.19	3.60	3.45	1.37	1.26
47	Vedadri	Jaggaypeta	0.53	0.35	6.32	6.26	2.54	2.49	2.02	1.98
48	Takkalapadu	Jaggaypeta	0.65	0.59	7.70	7.58	2.37	2.12	2.52	2.48
49	West gandrai	Jaggaypeta	1.65	1.45	5.57	5.49	2.56	2.49	2.37	2.17
50	Ravirala	Jaggaypeta	0.94	0.75	5.94	5.87	2.46	2.25	2.52	2.46
51	Jaggaypeta	Jaggaypeta	1.56	1.47	4.56	4.49	3.21	3.10	2.64	2.35
52	East gandrai	Jaggaypeta	1.50	1.33	4.81	4.52	3.33	2.24	1.93	1.85
53	Chillakallu	Jaggaypeta	0.25	0.17	3.65	3.59	4.26	4.17	1.47	1.41
		Mandal range	0.25-1.65	0.17-1.47	3.65-7.70	3.59-7.58	2.37-6.38	2.12-6.25	1.03-2.64	0.98-2.48
54	Ibbrahimpatnm	Ibbrahimpatnam	0.37	0.13	4.10	3.98	3.50	3.49	0.93	0.78
55	Ibbrahimpatnam	Ibbrahimpatnam	0.25	0.20	3.11	3.05	2.64	2.60	1.31	1.28
56	Elaprolu	Ibbrahimpatnam	0.37	0.26	3.52	3.48	4.72	4.53	1.47	1.35

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
57	Damuluru	Ibbrahimpatnam	0.56	0.43	2.70	2.57	3.34	3.11	2.65	2.56
58	Kotikalapudi	Ibbrahimpatnam	0.37	0.26	2.72	2.68	3.69	3.47	1.33	1.24
59	Jupudi	Ibbrahimpatnam	0.25	0.19	2.53	2.39	2.81	2.74	1.41	1.35
60	Tummalapalem	Ibbrahimpatnam	0.20	0.15	4.37	4.26	2.24	2.14	1.10	1.07
61	Mullapadu	Ibbrahimpatnam	0.21	0.18	5.63	5.51	2.48	2.40	0.94	0.61
		Mandal range	0.20-0.56	0.13-0.43	2.53-5.63	2.39-5.51	2.24-4.72	2.14-4.53	0.93-2.65	0.61-2.56
62	Gampalagudem	Gampalagudem	0.32	0.23	6.31	6.26	2.62	2.50	1.65	1.54
63	Arlapadu	Gampalagudem	0.46	0.36	5.97	5.84	3.10	3.06	1.71	1.65
64	Gullapudi	Gampalagudem	0.46	0.36	5.43	5.29	3.46	3.26	1.26	1.22
65	Kanumuru	Gampalagudem	0.57	0.48	5.40	5.31	6.34	6.24	1.54	1.46
66	Lingala	Gampalagudem	0.74	0.66	6.42	6.38	2.25	2.16	2.64	2.58
67	Meduru	Gampalagudem	0.34	0.25	4.64	4.58	4.62	4.62	2.01	1.98
68	Utukuru	Gampalagudem	0.30	0.25	5.14	5.10	4.77	4.66	3.43	3.36
69	Utukuru	Gampalagudem	0.14	0.11	5.30	5.25	3.34	3.24	3.32	3.12
		Mandal range	0.14-0.74	0.11-0.66	4.64-6.42	4.58-6.38	2.25-6.34	2.16-6.24	1.26-3.43	1.22-3.36
70	Pamidimukkala	Pamidimukkala	0.91	0.85	5.07	5.00	2.37	2.37	3.97	3.81
71	Inampudi	Pamidimukkala	0.96	0.76	0.53	0.48	4.32	4.22	1.73	1.65

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
72	Meduru	Pamidimukkala	1.36	1.25	0.69	0.53	3.66	3.57	2.62	2.58
73	Mantada	Pamidimukkala	1.25	1.12	1.35	1.28	2.74	2.59	2.43	2.26
74	Mullapudi	Pamidimukkala	1.62	1.43	2.61	2.54	2.75	2.58	2.73	2.57
75	Choragudi	Pamidimukkala	1.10	1.00	3.72	3.65	3.12	3.10	2.65	2.51
76	Inapuru	Pamidimukkala	1.36	1.15	3.47	3.26	4.32	4.25	6.33	6.21
		Mandal range	0.91-1.62	0.76-1.43	0.53-5.07	0.48-5.00	2.37-4.32	2.37-4.25	1.73-6.33	1.65-6.21
77	Musunuru	Musunuru	0.26	0.12	4.94	4.85	2.24	2.12	1.47	1.32
78	Surepalli	Musunuru	0.53	0.36	5.02	4.95	2.36	2.21	1.40	1.31
79	Gullapudi	Musunuru	0.37	0.29	5.36	5.25	3.38	3.32	1.44	1.32
80	Musunuru	Musunuru	0.64	0.56	4.73	4.61	2.68	2.51	2.64	2.51
81	Ellapuram	Musunuru	0.53	0.36	4.63	4.59	4.35	4.26	3.96	3.84
82	Chintalvalli	Musunuru	0.77	0.52	4.69	4.52	3.57	3.48	2.39	2.32
83	Lopudi	Musunuru	0.65	0.59	4.79	4.61	3.27	3.21	1.33	1.21
		Mandal range	0.26-0.77	0.12-0.59	4.63-5.36	4.52-5.25	2.24-4.35	2.12-4.26	1.33-3.96	1.21-3.84
84	Tiruvuru	Tiruvuru	0.26	0.12	5.63	5.51	2.87	2.78	2.42	2.35
85	Chittela	Tiruvuru	0.36	0.29	5.36	5.32	6.76	6.64	1.65	1.52
86	Rajupeta	Tiruvuru	0.30	0.23	5.94	5.84	3.94	3.85	1.40	1.36

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
87	Mallela	Tiruvuru	0.25	0.20	5.76	5.62	4.30	4.22	2.53	2.48
88	Munukulla	Tiruvuru	0.52	0.48	5.20	5.15	4.61	4.53	2.70	2.51
89	Vavilala	Tiruvuru	0.25	0.20	5.31	5.27	5.38	5.27	1.56	1.48
90	Vavilala	Tiruvuru	0.36	0.27	6.32	6.29	5.37	5.29	2.70	2.59
		Mandal range	0.25-0.52	0.12-0.48	5.20-6.32	5.15-6.29	2.87-6.76	2.78-6.64	1.40-2.70	1.36-2.59
91	Nandigama	Nandigama	0.67	0.52	7.64	7.55	4.62	4.55	4.64	4.52
92	Damuluru	Nandigama	0.56	0.43	5.22	5.16	2.22	2.18	4.44	4.26
93	Lingalapadu	Nandigama	0.51	0.50	4.94	4.86	2.86	2.66	3.70	3.61
94	Satyavaram	Nandigama	0.25	0.17	4.65	4.54	3.04	2.98	4.64	4.58
95	Pallagiri	Nandigama	0.21	0.16	8.21	8.15	3.26	3.12	1.94	1.84
96	Gollamudi	Nandigama	0.36	0.25	6.65	6.54	3.36	3.24	2.72	2.65
97	Kanchela	Nandigama	0.20	0.15	7.37	7.29	2.93	2.54	3.43	3.22
		Mandal range	0.20-0.67	0.15-0.52	4.65-8.21	5.16-8.15	2.22-4.62	2.18-4.55	1.94-4.64	1.84-4.58
98	Penuganchiprolu	Penuganchiprolu	1.54	1.50	5.75	5.66	4.62	4.58	1.92	1.87
99	Thotacherla	Penuganchiprolu	1.50	1.30	5.08	5.00	4.36	4.28	2.52	2.48
100	Mullapadu	Penuganchiprolu	1.69	1.36	5.32	5.21	2.28	2.10	2.37	2.26
101	Konakanchi	Penuganchiprolu	2.26	2.17	5.73	5.65	5.38	5.29	3.42	3.36

Contd.

S. No .	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
102	Sanagapadu	Penuganchiprolu	2.74	2.54	5.24	5.18	6.66	6.57	2.64	2.51
103	Sanagapadu	Penuganchiprolu	1.54	1.43	5.62	5.58	3.39	3.28	1.43	1.29
104	Kollikulla	Penuganchiprolu	2.64	2.47	5.43	5.29	2.83	2.76	2.69	2.58
105	Anigandlapadu	Penuganchiprolu	2.37	2.24	4.94	4.85	3.43	3.24	1.97	1.84
		Mandal range	1.50-2.74	1.30-2.47	4.94-5.75	4.85-5.66	2.28-6.66	2.10-6.57	1.43-3.42	1.29-3.36
106	Vatsvai	Vatsvai	1.53	1.25	4.64	4.52	2.53	2.42	1.73	1.68
107	Chittela	Vatsvai	1.27	1.10	4.72	4.66	4.35	4.29	1.53	1.48
108	Lingala	Vatsvai	1.31	1.33	5.31	5.28	2.27	2.19	1.26	1.19
109	Allurupadu	Vatsvai	0.97	0.89	5.10	5.01	3.05	2.98	1.57	1.46
110	Makkapeta	Vatsvai	2.64	2.45	5.26	5.21	3.34	3.28	1.72	1.68
111	Gangavalli	Vatsvai	2.37	2.13	5.02	4.89	5.75	5.66	2.10	2.01
112	Dechupalem	Vatsvai	2.54	2.43	5.93	5.88	3.72	3.65	2.57	2.47
		Mandal range	0.97-2.64	0.69-2.45	4.64-5.93	4.52-5.88	2.27-5.75	2.19-5.66	1.26-2.57	1.19-2.47
113	Chandarlapadu	Chandarlapadu	0.36	0.24	5.73	5.68	3.08	2.98	2.50	2.39
114	Eturu	Chandarlapadu	0.56	0.43	5.31	5.26	2.06	2.00	1.76	1.58
115	Konayapalem	Chandarlapadu	0.25	0.20	7.65	7.49	1.36	1.29	1.25	1.22
116	Pokkunuru	Chandarlapadu	0.44	0.36	6.39	6.32	2.65	2.58	1.29	1.26

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
117	Gudimetla	Chandarlapadu	0.31	0.17	6.36	6.29	3.22	3.19	1.64	1.58
118	Chintalpadu	Chandarlapadu	0.25	0.17	5.65	5.52	4.31	4.28	2.94	2.84
119	Mungalapalli	Chandarlapadu	0.25	0.17	5.12	5.06	1.05	0.98	1.64	1.59
		Mandal range	0.25-0.56	0.17-0.43	5.12-7.65	5.06-7.49	1.05-4.31	0.98-4.28	1.25-2.94	1.22-2.84
120	Kanchikacherla	Kanchikacherla	0.56	0.48	5.87	5.78	1.38	1.24	1.60	1.55
121	Chevitikallu	Kanchikacherla	0.74	0.56	5.56	5.49	2.24	2.21	2.36	2.27
122	Keesara	Kanchikacherla	0.66	0.49	4.93	4.85	4.23	4.19	2.39	2.30
123	Paritala	Kanchikacherla	0.53	0.47	4.73	4.32	3.64	3.57	2.76	2.69
124	Singapuram	Kanchikacherla	0.25	0.16	5.26	5.23	3.46	3.26	1.93	1.84
125	Vemulapalli	Kanchikacherla	0.37	0.25	5.43	5.26	2.51	2.47	1.34	1.26
126	Gandepalli	Kanchikacherla	0.53	0.36	6.31	6.23	2.95	2.88	2.70	2.54
		Mandal range	0.25-0.74	0.16-0.56	4.73-6.31	4.32-6.23	1.38-4.23	1.24-4.19	1.34-2.76	1.26-2.69
127	Verullapadu	Verullapadu	0.30	0.19	5.69	5.58	2.19	2.11	1.72	1.64
128	Jammavaram	Verullapadu	0.12	0.10	5.26	5.12	2.54	2.48	1.53	1.50
129	Nadaluru	Verullapadu	0.19	0.12	5.25	5.19	1.86	1.73	2.03	1.98
130	Pallampalle	Verullapadu	0.25	0.19	5.36	5.24	2.05	1.89	1.38	1.26
131	Peddapuram	Verullapadu	0.59	0.37	6.03	5.89	4.37	4.26	1.44	1.24

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
132	Vellanki	Verullapadu	0.66	0.43	4.96	4.84	3.16	3.11	1.69	1.61
133	Vellanki	Verullapadu	0.25	0.12	4.83	4.72	2.67	2.58	2.64	2.57
		Mandal range	0.12-0.66	0.10-0.43	4.83-6.03	4.72-5.89	1.86-4.37	1.73-4.26	1.38-2.64	1.24-2.57
134	Penamaluru	Penamaluru	2.69	2.49	5.26	5.19	3.89	3.85	2.77	2.65
135	Penamaluru	Penamaluru	2.65	2.32	5.10	5.03	2.65	2.59	2.36	2.29
136	Penamaluru	Penamaluru	3.46	3.25	5.34	5.32	5.36	5.26	2.53	2.48
137	Vanukuru	Penamaluru	4.37	4.27	5.40	5.32	4.31	4.28	1.37	1.29
138	Chodavaram	Penamaluru	2.12	2.07	5.43	5.26	2.68	2.59	1.54	1.48
139	Gosala	Penamaluru	1.37	1.26	6.26	6.48	2.54	2.48	1.63	1.56
140	Gosala	Penamaluru	0.53	0.37	4.83	4.80	1.91	1.88	1.26	1.21
		Mandal range	0.53-4.37	0.37-4.27	5.10-6.26	4.80-6.48	1.91-5.36	1.88-5.26	1.26-2.77	1.21-2.65
141	Kankipadu	Kankipadu	1.36	1.26	8.46	8.32	2.65	2.59	1.32	1.28
142	Davuluru	Kankipadu	2.46	2.35	7.44	7.39	3.33	3.29	1.46	1.39
143	Kunderu	Kankipadu	1.10	1.05	6.37	6.33	3.13	3.01	1.73	1.66
144	Tanneru	Kankipadu	1.96	1.79	5.63	5.58	4.29	4.22	1.56	1.48
145	Velpuru	Kankipadu	1.26	1.10	5.11	5.03	2.68	2.59	2.31	2.29
146	Kandalampadu	Kankipadu	0.36	0.25	5.20	5.12	2.36	2.22	1.35	1.22

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
147	Edpugallu	Kankipadu	0.26	0.16	5.93	5.87	2.62	2.58	1.21	1.18
		Mandal range	0.26-2.46	0.16-2.35	5.11-8.46	5.03-8.32	2.36-4.29	2.22-4.22	1.21-3.21	1.18-2.29
148	Vuyyuru	Vuyyuru	0.43	0.35	5.64	5.56	3.26	3.16	2.27	2.16
149	Akunuru	Vuyyuru	0.25	0.20	7.36	7.22	3.49	3.38	1.57	1.53
150	Akunuru	Vuyyuru	0.11	0.07	4.64	4.58	3.21	3.18	2.40	2.35
151	Mudunuru	Vuyyuru	0.09	0.05	5.64	5.56	3.62	3.56	2.72	2.68
152	Katuru	Vuyyuru	0.36	0.26	5.10	5.02	3.97	3.92	1.65	1.59
153	Chinnaogirala	Vuyyuru	0.53	0.39	4.36	4.28	2.48	2.44	1.73	1.66
154	Saipuram	Vuyyuru	0.36	0.30	4.93	4.86	2.39	2.31	1.93	1.89
		Mandal range	0.09-0.53	0.05-0.39	4.36-7.36	4.58-7.22	2.39-3.97	2.31-3.92	1.57-2.72	1.53-2.68
155	Unguturu	Unguturu	0.56	0.29	5.03	5.00	4.39	4.26	1.04	0.95
156	Bokkinala	Unguturu	0.43	0.40	5.96	5.83	4.09	3.96	1.10	1.06
157	Mukkapadu	Unguturu	0.64	0.43	5.74	5.68	4.37	4.25	2.44	2.38
158	Mukkapadu	Unguturu	0.72	0.53	5.42	5.22	5.65	5.58	2.37	2.33
159	Indupalli	Unguturu	0.80	0.37	6.31	6.26	2.44	2.37	1.30	1.26
160	Manikonda	Unguturu	0.63	0.52	6.14	6.11	3.62	3.55	1.52	1.46
161	Atkuru	Unguturu	0.56	0.39	5.94	5.88	1.96	1.88	3.43	3.37

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
		Mandal range	0.43-0.80	0.29-0.53	5.03-6.31	5.00-6.26	1.96-5.65	1.88-5.58	1.04-3.43	0.95-3.37
162	Gannavaram	Gannavaram	0.30	0.17	5.53	5.48	1.25	1.22	2.62	2.55
163	Balliparru	Gannavaram	0.32	0.27	5.09	5.02	2.65	2.59	4.97	4.86
164	Gollanapalle	Gannavaram	1.47	1.26	5.12	5.09	3.32	3.26	4.73	4.69
165	Mettapalle	Gannavaram	1.36	1.25	5.29	5.22	2.90	2.84	2.53	2.48
166	Savirigudem	Gannavaram	1.90	1.70	6.36	6.24	2.36	2.25	2.80	2.71
167	Allapuram	Gannavaram	1.10	1.06	5.70	5.54	2.61	2.54	2.50	2.44
168	Chinavautupalli	Gannavaram	1.43	1.26	5.23	5.12	3.32	3.28	2.40	2.35
		Mandal range	0.30-1.90	0.17-1.70	5.09-6.36	5.02-6.24	1.25-3.32	1.22-3.28	2.53-4.97	2.35-4.86
169	Agiripalle	Agiripalle	1.64	1.32	4.86	4.78	2.46	2.33	2.22	2.14
170	Agiripalle	Agiripalle	1.26	1.13	5.02	4.88	2.66	2.54	2.65	2.57
171	Sagguru	Agiripalle	1.77	1.55	5.40	5.33	3.45	3.36	2.37	2.25
172	Saravaram	Agiripalle	1.90	1.66	5.44	5.28	3.21	3.18	4.40	4.34
173	Edara	Agiripalle	0.21	0.17	5.27	5.18	5.15	5.11	0.96	0.85
174	Kalaturu	Agiripalle	0.36	0.25	4.73	4.65	4.33	4.26	4.34	4.22
175	Kalaturu	Agiripalle	0.56	0.40	4.56	4.47	2.23	2.18	1.67	4.53
		Mandal range	0.21-1.90	0.17-1.66	4.56-5.44	4.47-5.33	2.23-5.15	2.18-5.11	0.96-4.40	0.85-4.53

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
176	Bapulapadu	Bapulapadu	1.34	1.26	5.32	5.24	3.41	3.37	2.43	2.37
177	Ampapuram	Bapulapadu	1.26	1.14	4.64	4.58	2.65	2.58	2.03	1.95
178	Chirivada	Bapulapadu	0.36	0.27	4.69	4.66	2.74	2.69	2.65	2.54
179	Kanumollu	Bapulapadu	0.54	0.47	5.32	5.22	2.51	5.44	2.42	2.36
180	Madicherla	Bapulapadu	0.26	0.14	5.50	5.47	2.38	2.29	2.37	2.25
181	Veleru	Bapulapadu	0.39	0.27	5.69	5.52	3.49	3.44	1.92	1.78
182	Ramalle	Bapulapadu	0.65	0.57	5.54	5.48	3.05	2.95	1.09	0.98
		Mandal range	0.26-1.34	0.14-1.26	4.64-5.69	4.58-5.52	2.51-3.49	2.29-5.44	1.09-2.65	0.98-2.54
183	G.konduru	G.konduru	0.36	0.16	4.98	4.87	4.45	4.41	1.54	1.48
184	Koduru	G.konduru	0.25	0.14	4.86	4.72	2.61	3.58	1.69	1.62
185	Chevuturu	G.konduru	0.27	0.20	5.63	5.58	3.48	3.39	1.52	1.48
186	Pinapaka	G.konduru	0.47	0.37	5.95	5.95	2.66	2.57	1.70	1.62
187	Vellaturu	G.konduru	0.57	0.24	7.53	7.48	2.36	2.28	1.13	1.08
188	Gaddamanugu	G.konduru	0.73	0.57	5.64	5.49	3.43	3.36	1.52	1.47
189	Kavuluru	G.konduru	0.55	0.26	6.66	6.55	3.53	3.48	0.87	0.85
		Mandal range	0.25-0.73	0.14-0.57	4.86-7.53	4.72-7.48	2.36-4.45	2.28-4.41	0.87-1.70	0.85-1.62
190	Thotlavalluru	Thotlavalluru	0.64	0.36	4.84	4.75	2.63	2.61	0.40	0.35

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
191	Devarapalli	Thotlavalluru	1.56	1.35	4.76	4.68	1.12	1.04	0.93	0.84
192	Penamakuru	Thotlavalluru	1.63	1.52	5.04	4.98	1.36	1.28	0.57	0.52
193	Royyuru	Thotlavalluru	1.56	1.46	5.34	5.28	3.63	3.54	1.37	1.26
194	Royyuru	Thotlavalluru	1.10	1.03	3.43	3.39	3.86	3.79	1.50	1.48
195	Chagantipadu	Thotlavalluru	0.32	0.27	3.69	3.61	4.35	4.28	1.52	1.47
196	Iluru	Thotlavalluru	0.25	0.16	5.24	5.19	2.66	2.57	2.44	2.35
197	Kummamuru	Thotlavalluru	0.36	0.25	5.96	5.88	3.35	3.31	2.62	2.59
198	Garikaparru	Thotlavalluru	0.69	0.50	6.42	6.35	3.65	3.58	2.70	2.64
199	Kanakavalli	Thotlavalluru	0.51	0.31	6.37	6.28	3.76	3.70	2.52	2.47
200	Guruvindapalli	Thotlavalluru	1.53	1.46	4.93	4.89	2.14	2.09	1.40	1.35
201	South valluru	Thotlavalluru	1.77	1.49	5.12	5.02	2.43	2.28	2.65	2.55
202	North valluru	Thotlavalluru	2.64	2.49	5.01	4.96	2.23	2.16	2.96	2.87
203	Yakamuru	Thotlavalluru	2.54	2.37	4.69	4.55	2.33	2.27	2.73	2.75
		Mandal range	0.25-2.64	0.16-2.49	3.43-6.42	3.39-6.35	1.12-4.35	1.04-4.28	0.40-2.96	0.35-2.87
204	Vijayawada (rural)	Vijayawada (rural)	0.63	0.54	7.51	7.45	2.76	2.65	1.55	1.48
205	Kotturu	Vijayawada (rural)	0.36	0.13	6.27	6.22	3.47	3.44	1.40	1.36
206	Enikipadu	Vijayawada (rural)	0.25	0.10	4.86	4.75	3.68	3.62	1.33	1.28

Contd.

S. No.	Name of the village	Mandal	Zn(ppm)		Fe(ppm)		Mn(ppm)		Cu(ppm)	
			Surface	Subsurfae	Surface	Subsurfae	Surface	Subsurface	Surface	Subsurface
207	Tadepalle	Vijayawada (rural)	0.57	0.49	4.74	4.66	3.41	3.38	1.97	1.92
208	Gudavalli	Vijayawada (rural)	0.37	0.25	6.26	6.20	2.63	2.57	1.21	1.17
		Mandal range	0.25-0.63	0.10-0.54	4.74-7.51	4.66-7.45	2.63-3.68	2.65-3.62	1.21-1.97	1.28-1.92
209	Vijayawada(urban)	Vijayawada(urban)	1.63	1.33	5.30	5.24	2.66	2.57	1.53	1.48
210	Vijayawada(urban)	Vijayawada(urban)	1.56	1.49	5.43	5.37	3.20	3.15	2.61	2.55
211	Vijayawada(urban)	Vijayawada(urban)	0.43	0.37	5.09	4.86	4.63	4.49	1.29	1.21
212	Vijayawada(urban)	Vijayawada(urban)	0.31	0.13	4.90	4.88	5.02	4.95	0.84	0.77
		Mandal range	0.31-1.63	0.13-1.49	4.90-5.43	4.86-5.37	2.66-5.02	2.57-4.95	0.84-2.61	0.77-2.55
		Overall range	0.09-4.37	0.05-4.27	0.53-9.53	0.48-9.48	1.05-7.41	0.98-7.36	0.40-6.33	0.35-6.21
		Overall mean	2.23	2.16	5.03	4.98	4.23	4.17	3.36	3.28

Table 4.51: Range And Mean \pm Standard deviation of Zn, Fe, Mn and Cu in surface soils (0-15cm) of different mandals of Krishna district

S. No.	Mandal	Zn(ppm)	Fe(ppm)	Mn(ppm)	Cu(ppm)
1	A.konduru	0.14-0.63 (0.41 \pm 0.18)	4.76-8.37 (5.62 \pm 1.35)	1.22-5.55 (2.22 \pm 1.57)	0.96-2.48 (1.76 \pm 0.54)
2	Reddigudem	0.25-0.81 (0.49 \pm 0.19)	4.89-9.53 (6.43 \pm 1.67)	1.27-5.77 (3.39 \pm 1.75)	1.04-2.01 (1.62 \pm 0.30)
3	Mylavaram	0.27-0.54 (0.40 \pm 0.11)	2.12-5.64 (3.48 \pm 1.21)	2.47-5.32 (3.81 \pm 1.03)	0.77-2.35 (1.81 \pm 0.51)
4	Vissanapeta	0.20-0.46 (0.31 \pm 0.09)	3.69-5.35 (4.75 \pm 0.52)	1.99-7.41 (3.55 \pm 1.81)	1.09-2.36 (1.49 \pm 0.41)
5	Nuzivedu	0.90-1.53 (1.20 \pm 0.27)	4.93-8.56 (6.00 \pm 1.30)	2.27-6.33 (4.23 \pm 1.60)	2.15-3.42 (2.76 \pm 0.53)
6	Chatrai	0.25-0.63 (0.43 \pm 0.12)	2.40-4.85 (3.63 \pm 0.91)	1.18-3.64 (2.63 \pm 0.90)	0.43-2.61 (1.54 \pm 0.67)
7	Jaggaypeta	0.25-1.65 (0.97 \pm 0.48)	3.65-7.70 (5.43 \pm 1.04)	2.37-6.38 (3.46 \pm 1.19)	1.03-2.64 (1.90 \pm 0.55)
8	Ibbrahimpatnam	0.20-0.56 (0.32 \pm 0.12)	2.53-5.63 (3.59 \pm 1.06)	2.24-4.72 (3.18 \pm 0.81)	0.93-2.65 (1.39 \pm 0.55)
9	Gampalagudem	0.14-0.74 (0.42 \pm 0.18)	4.64-6.42 (5.58 \pm 0.61)	2.25-6.34 (3.81 \pm 1.35)	1.26-3.43 (2.20 \pm 0.83)
10	Pamidimukkala	0.91-1.62 (1.22 \pm 0.25)	0.53-5.07 (2.49 \pm 1.71)	2.37-4.32 (3.33 \pm 0.79)	1.73-6.33 (3.21 \pm 1.53)

Contd.

S. No.	Mandal	Zn(ppm)	Fe(ppm)	Mn(ppm)	Cu(ppm)
11	Musunuru	0.26-0.77 (0.54 ± 0.17)	4.63-5.36 (4.88 ± 0.25)	2.24-4.35 (3.12 ± 0.75)	1.33-3.96 (2.09 ±0.98)
12	Tiruvuru	0.25-0.52 (0.33 ± 0.10)	5.20-6.32 (5.65 ± 0.40)	2.87-6.76 (4.75 ± 1.24)	1.40-2.70 (2.14 ± 0.57)
13	Nandigama	0.20-0.67 (0.39 ± 0.19)	4.65-3.21 (6.38± 1.44)	2.22-4.62 (3.18 ±0.73)	1.94-4.64 (3.64 ± 1.03)
14	Penuganchiprolu	1.50-2.74 (2.04 ± 0.52)	4.94-5.75 (5.39 ±0.30)	2.28-6.66 (4.12 ± 1.43)	1.43-3.42 (2.37 ±0.60)
15	Vatsvai	0.97-2.64 (1.80 ± 0.69)	4.64-5.93 (5.14 ± 0.43)	2.27-5.75 (3.57 ±1.19)	1.26-2.57 (1.78 ± 0.43)
16	Chandarlapadu	0.25-0.56 (0.35 ± 0.12)	5.12-7.65 (6.03 ±0.86)	1.05-4.31 (2.53 ± 1.14)	1.25-2.94 (1.86 ± 0.63)
17	Kanchikacherla	0.25-0.74 (0.52 ±0.17)	4.73-6.31 (5.44± 0.54)	1.38-4.23 (2.92 ± 0.96)	1.34-2.76 (2.15 ± 0.55)
18	Verullapadu	0.12-0.66 (0.34 ± 0.21)	4.83-6.03 (5.34±0.41)	1.86-4.37 (2.69 ± 0.86)	1.38-2.64 (1.78 ± 0.44)
19	Penamaluru	0.53-4.37 (2.46 ± 1.28)	5.10-6.26 (5.37 ± 0.44)	1.91-5.36 (3.33 ± 1.22)	1.26-2.77 (1.92 ± 0.61)
20	Kankipadu	0.26-2.46 (1.25 ± 0.79)	5.11-8.46 (6.31 ± 1.24)	2.36-4.29 (3.01 ±0.65)	1.21-3.21 (1.56 ± 0.37)

Contd.

S. No.	Mandal	Zn(ppm)	Fe(ppm)	Mn(ppm)	Cu(ppm)
21	Vuyyuru	0.09-0.53 (0.30 ± 0.16)	4.36-7.36 (5.38 ± 0.99)	2.39-3.97 (3.20 ± 0.58)	1.57-2.72 (2.04 ± 0.43)
22	Unguturu	0.43-0.80 (0.62 ± 0.12)	5.03-6.31 (5.79 ± 0.44)	1.96-5.65 (3.79 ± 1.25)	1.04-3.43 (1.89 ± 0.89)
23	Gannavaram	0.30-1.90 (1.13 ± 0.61)	5.09-6.36 (5.47 ± 0.45)	1.25-3.32 (2.63 ± 0.71)	2.53-4.97 (3.22 ± 1.12)
24	Agiripalli	0.21-1.90 (1.10 ± 0.71)	4.56-5.44 (5.04 ± 0.34)	2.23-5.15 (3.36 ± 1.06)	0.96-4.40 (2.66 ± 1.29)
25	Bapulapadu	0.26-1.34 (0.69 ± 0.44)	4.64-5.69 (5.24 ± 0.42)	2.51-3.49 (2.89 ± 0.44)	1.09-2.65 (2.13 ± 0.52)
26	G.konduru	0.25-0.73 (0.46 ± 0.17)	4.86-7.53 (5.89 ± 0.94)	2.36-4.45 (3.22 ± 0.72)	0.87-1.70 (1.42 ± 0.31)
27	Thotlavalluru	0.25-2.64 (1.22 ± 0.79)	3.43-6.42 (5.06 ± 0.85)	1.12-4.35 (2.82 ± 0.97)	0.40-2.96 (1.88 ± 0.88)
28	Vijayawada(rural)	0.25-0.63 (0.44 ± 0.16)	4.74-7.51 (5.93 ± 1.15)	2.63-3.68 (3.19 ± 0.47)	1.21-1.97 (1.49 ± 0.29)
29	Vijayawada(urban)	0.31-1.63 (0.98 ± 0.71)	4.90-5.43 (5.18 ± 0.23)	2.66-5.02 (3.88 ± 1.13)	0.84-2.61 (1.57 ± 0.75)

Table 4.52: Range And Mean \pm Standard deviation of Zn, Fe, Mn and Cu in subsurface soils (15-30cm) of different mandals of Krishna district

S. No.	Name of the Mandal	Zn(ppm)	Fe(ppm)	Mn(ppm)	Cu(ppm)
1	A.Konduru	0.11-0.63 (0.39 \pm 0.19)	4.66-8.32 (5.50 \pm 1.36)	1.19-5.51 (2.15 \pm 1.57)	0.88-2.38 (1.68 \pm 0.53)
2	Reddigudem	0.24-0.76 (0.46 \pm 0.18)	4.79-9.48 (6.36 \pm 1.69)	1.21-5.65 (3.28 \pm 1.72)	1.00-1.96 (1.53 \pm 0.29)
3	Mylavaram	0.25-0.51 (0.38 \pm 0.11)	2.01-5.53 (3.40 \pm 1.21)	2.33-5.26 (3.73 \pm 1.06)	0.71-2.30 (1.74 \pm 0.50)
4	Vissanapeta	0.15-0.45 (0.28 \pm 0.10)	3.59-5.24 (4.65 \pm 0.52)	1.91-7.36 (3.49 \pm 1.82)	1.02-2.29 (1.43 \pm 0.41)
5	Nuzivedu	0.83-1.50 (1.14 \pm 0.28)	4.75-8.48 (5.92 \pm 1.32)	2.16-6.23 (4.06 \pm 1.64)	2.09-3.26 (2.64 \pm 0.50)
6	Chatrai	0.12-0.62 (0.37 \pm 0.14)	2.28-4.77 (3.54 \pm 0.93)	1.10-3.46 (2.51 \pm 0.89)	0.21-2.55 (1.43 \pm 0.71)
7	Jaggaypeta	0.17-1.47 (0.84 \pm 0.47)	3.59-7.58 (5.33 \pm 1.05)	2.12-6.25 (3.21 \pm 1.25)	0.98-2.48 (1.80 \pm 0.53)
8	Ibbrahimpatnam	0.13-0.43 (0.23 \pm 0.09)	2.39-5.51 (3.49 \pm 1.06)	2.14-4.53 (3.06 \pm 0.77)	0.61-2.56 (1.28 \pm 0.58)
9	Gampalagudem	0.11-0.66 (0.34 \pm 0.17)	4.58-6.38 (5.50 \pm 0.61)	2.16-6.24 (3.72 \pm 1.35)	1.22-3.36 (2.11 \pm 0.81)
10	Pamidimukkala	0.76-1.43 (1.08 \pm 0.23)	0.48-5.00 (2.39 \pm 1.71)	2.37-4.25 (3.24 \pm 0.79)	1.65-6.21 (3.08 \pm 1.52)

Contd.

S. No.	Mandal	Zn(ppm)	Fe(ppm)	Mn(ppm)	Cu(ppm)
11	Musunuru	0.12-0.59 (0.40 ± 0.17)	4.52-5.25 (4.77 ± 0.26)	2.12-4.26 (3.02 ± 0.77)	1.21-3.84 (1.98 ± 0.98)
12	Tiruvuru	0.12-0.48 (0.26 ± 0.11)	5.15-6.29 (5.57 ± 0.39)	2.78-6.64 (4.65 ± 1.23)	1.36-2.59 (2.04 ± 0.56)
13	Nandigama	0.15-0.52 (0.31 ± 0.17)	5.16-8.15 (6.30 ± 1.44)	2.18-4.55 (3.04 ± 0.76)	1.84-4.58 (3.53 ± 1.03)
14	Penuganchiprolu	1.30-2.47 (1.88 ± 0.53)	4.85-5.66 (5.30 ± 0.30)	2.10-6.57 (4.01 ± 1.46)	1.29-3.36 (2.27 ± 0.62)
15	Vatsvai	0.69-2.45 (1.63 ± 0.70)	4.52-5.88 (5.06 ± 0.45)	2.19-5.66 (3.50 ± 1.19)	1.19-2.47 (1.71 ± 0.42)
16	Chandarlapadu	0.17-0.43 (0.25 ± 0.11)	5.06-7.49 (5.95 ± 0.83)	0.98-4.28 (2.47 ± 1.15)	1.22-2.84 (1.78 ± 0.60)
17	Kanchikacherla	0.16-0.56 (0.40 ± 0.15)	4.32-6.23 (5.31 ± 0.62)	1.24-4.19 (2.83 ± 0.97)	1.26-2.69 (2.06 ± 0.53)
18	Verullapadu	0.10-0.43 (0.22 ± 0.13)	4.72-5.89 (5.23 ± 0.40)	1.73-4.26 (2.59 ± 0.87)	1.24-2.57 (1.69 ± 0.46)
19	Penamaluru	0.37-4.27 (2.29 ± 1.27)	4.80-6.48 (5.34 ± 0.53)	1.88-5.26 (3.28 ± 1.21)	1.21-2.65 (1.85 ± 0.60)
20	Kankipadu	0.16-2.35 (1.14 ± 0.78)	5.03-8.32 (6.23 ± 1.22)	2.22-4.22 (2.93 ± 0.67)	1.18-2.29 (1.50 ± 0.39)

Contd.

S. No.	Mandal	Zn(ppm)	Fe(ppm)	Mn(ppm)	Cu(ppm)
21	Vuyyuru	0.05-0.39 (0.23 ± 0.13)	4.58-7.22 (5.30 ± 0.97)	2.31-3.92 (3.14 ± 0.58)	1.53-2.68 (1.98 ± 0.43)
22	Unguturu	0.29-0.53 (0.42 ± 0.08)	5.00-6.26 (5.71 ± 0.46)	1.88-5.58 (3.69 ± 1.25)	0.95-3.37 (1.83 ± 0.89)
23	Gannavaram	0.17-1.70 (1.00 ± 0.56)	5.02-6.24 (5.39 ± 0.42)	1.22-3.28 (2.57 ± 0.70)	2.35-4.86 (3.15 ± 1.11)
24	Agiripalli	0.17-1.66 (0.93 ± 0.64)	4.47-5.33 (4.94 ± 0.33)	2.18-5.11 (3.28 ± 1.08)	0.85-4.53 (2.99 ± 1.40)
25	Bapulapadu	0.14-1.26 (0.59 ± 0.44)	4.58-5.52 (5.17 ± 0.39)	2.29-5.44 (3.25 ± 1.05)	0.98-2.54 (2.03 ± 0.53)
26	G.Konduru	0.14-0.57 (0.28 ± 0.15)	4.72-7.48 (5.81 ± 0.96)	2.28-4.41 (3.30 ± 0.70)	0.85-1.62 (1.37 ± 0.29)
27	Thotlavalluru	0.16-2.49 (1.07 ± 0.79)	3.39-6.35 (4.99 ± 0.84)	1.04-4.28 (2.75 ± 0.97)	0.35-2.87 (1.82 ± 0.88)
28	Vijayawada(Rural)	0.10-0.54 (0.30 ± 0.20)	4.66-7.45 (5.86 ± 1.17)	2.65-3.62 (3.13 ± 0.49)	1.28-1.92 (1.44 ± 0.29)
29	Vijayawada(Urban)	0.13-1.49 (0.83 ± 0.68)	4.86-5.37 (5.09 ± 0.26)	2.57-4.95 (3.79 ± 1.12)	0.77-2.55 (1.50 ± 0.76)

Table 4.53: Soil test summary for zinc (ppm)

S. No.	Number of samples	Available zinc (ppm)		Number of samples in each category	
		Range	Mean	Sufficient	Deficient
Surface					
1	212	0.09-4.37	2.23	70 (34.00%)	142(66.00%)
Subsurface					
2	212	0.05-4.27	2.16	58 (26.41%)	154(73.59 %)

Table 4.54: Soil test summary for Iron (ppm)

S. No.	Number of samples	Available iron (ppm)		Number of samples in each category	
		Range	Mean	Sufficient	Deficient
Surface					
1	212	0.53-9.53	5.03	182 (86%)	29(14%)
Subsurface					
2	212	0.48-9.48	4.98	180(85%)	31(15%)

Table 4.55 : Soil test summary for manganese(ppm)

S. No.	Number of samples	Available manganese(ppm)		Number of samples in each category	
		Range	Mean	Sufficient	Deficient
Surface					
1	212	1.05-7.41	4.23	212 (100 %)	NIL
Subsurface					
2	212	0.98-7.36	4.17	212 (100 %)	NIL

Table 4.56: Soil test summary for copper(ppm)

S. No.	Number of samples	Available copper(ppm)		Number of samples in each category	
		Range	Mean	Sufficient	Deficient
Surface					
1	212	0.40-6.33	3.36	212 (100 %)	NIL
Subsurface					
2	212	0.35-6.21	3.28	212 (100 %)	NIL

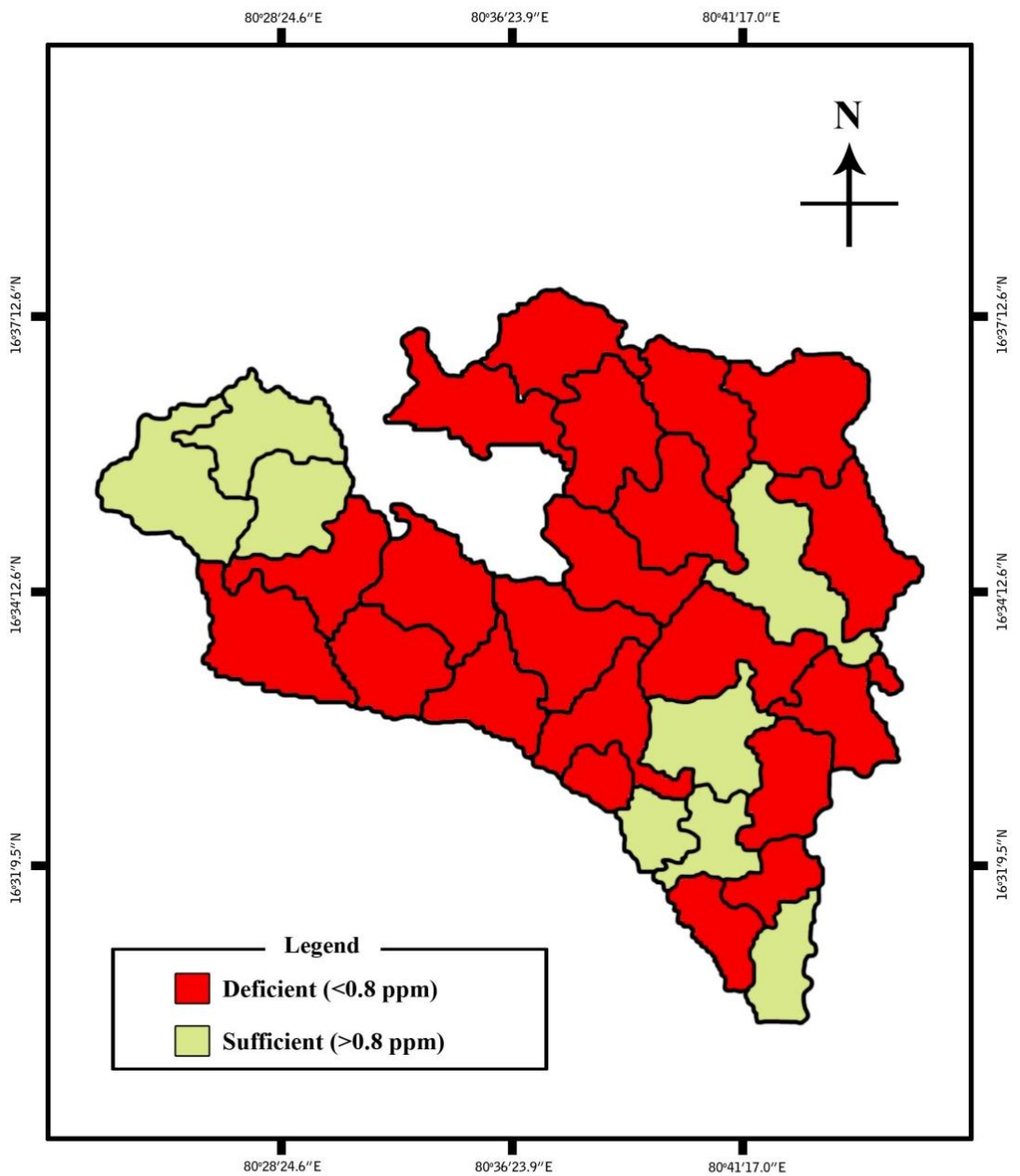


Fig. 8a Available zinc content of surface soil samples of Krishna district

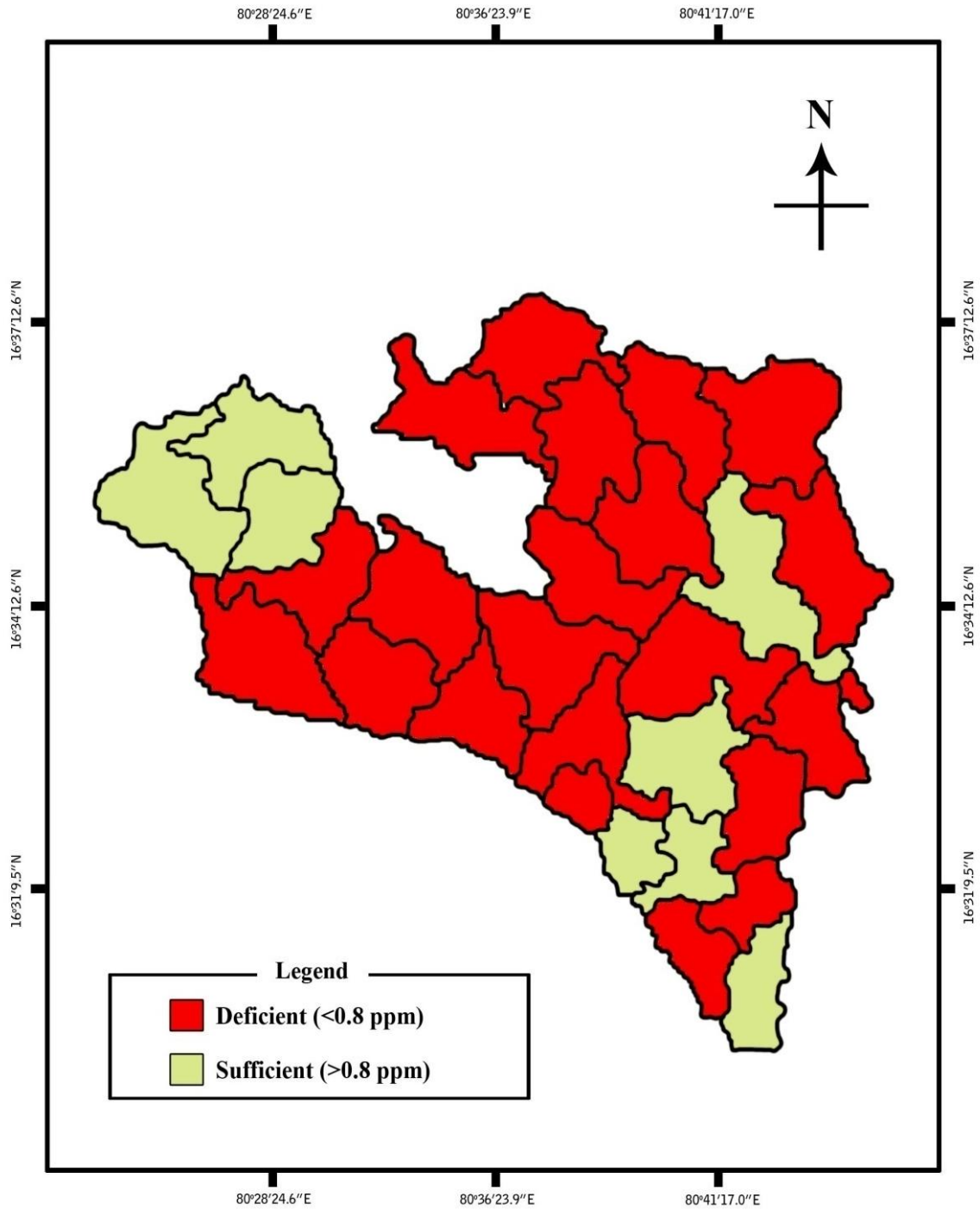


Fig. 8b Available zinc content of subsurface soil samples of Krishna district

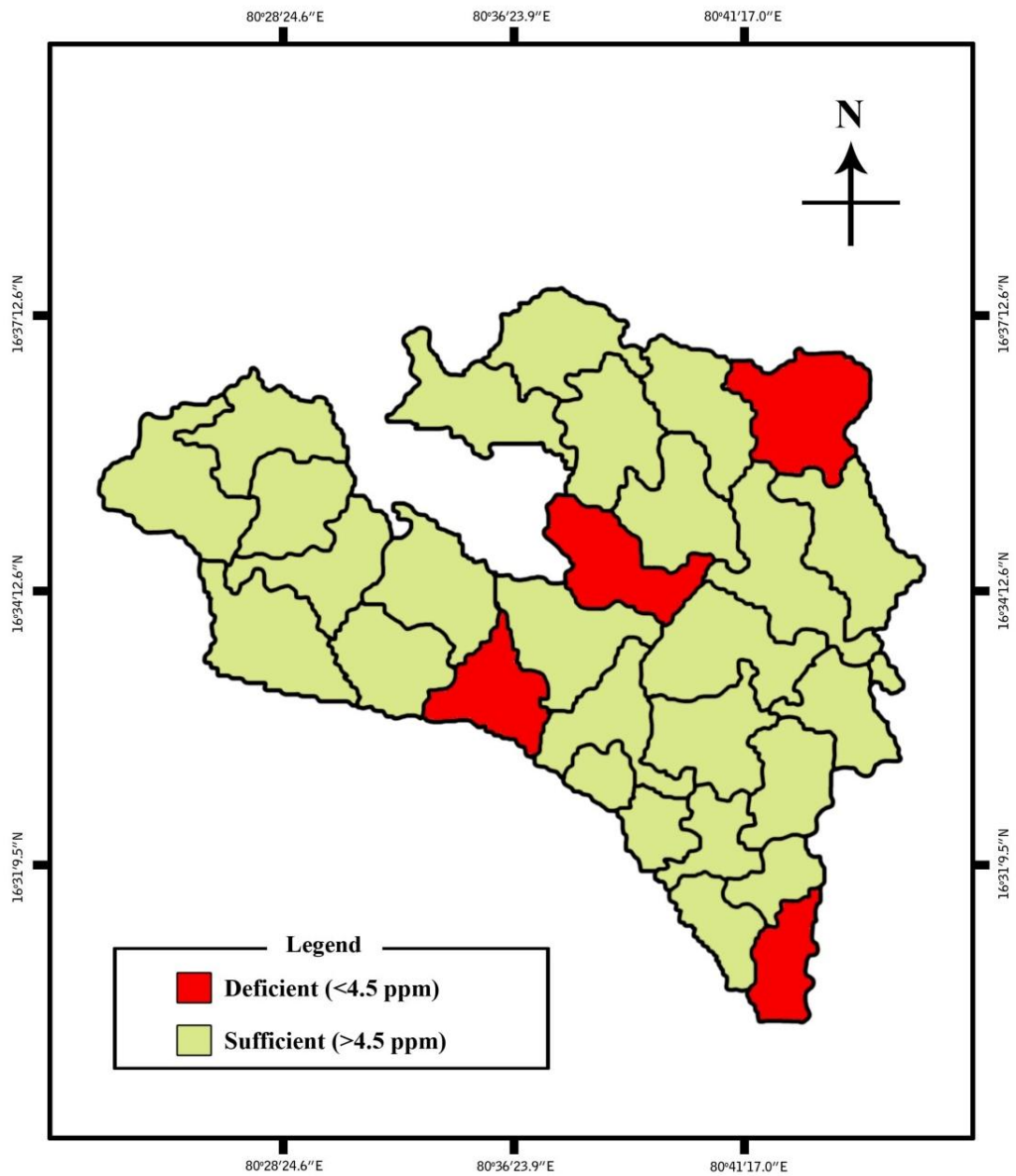


Fig. 9a Available iron content of surface soil samples of Krishna district

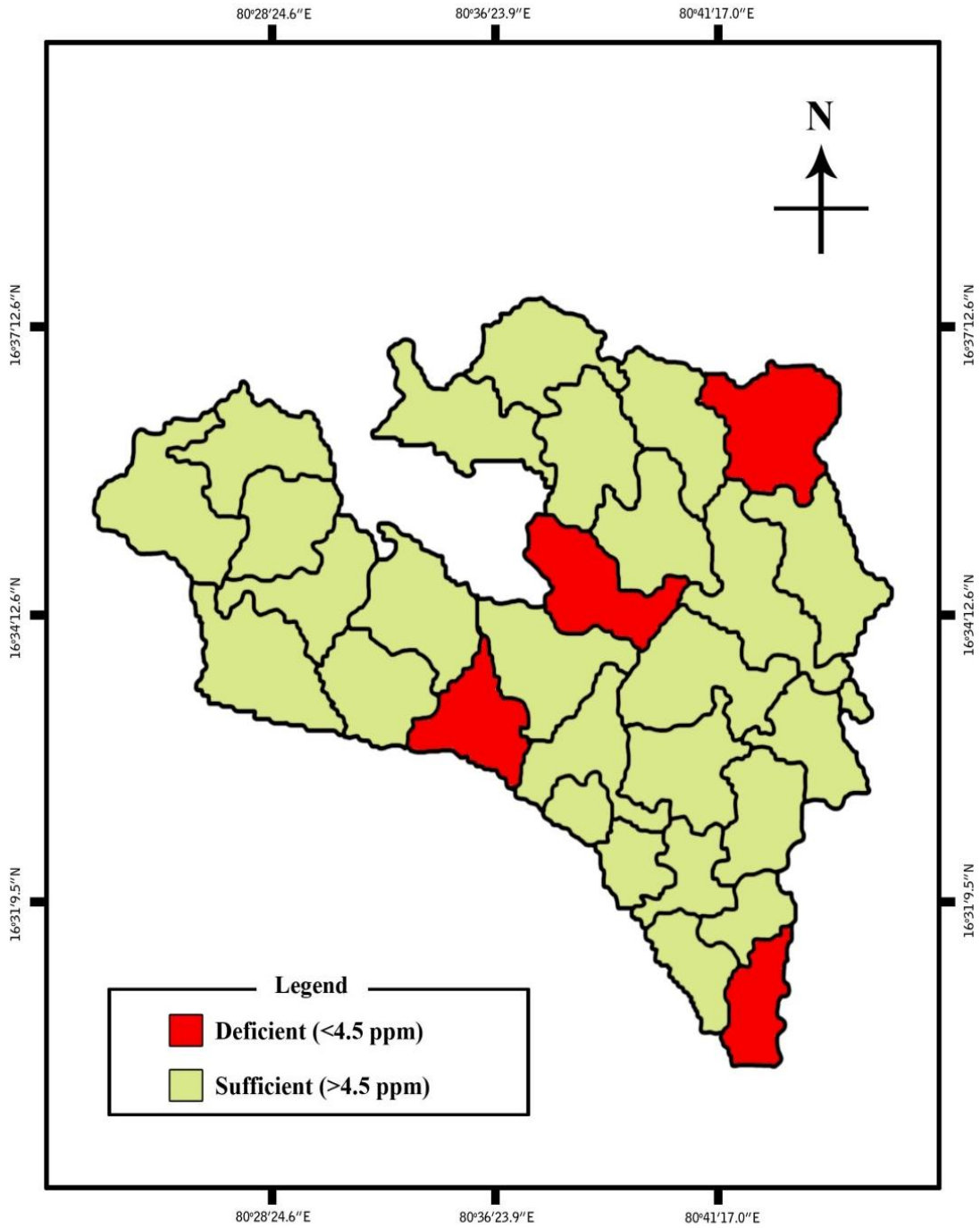


Fig. 9b Available iron content of subsurface soil samples of Krishna district

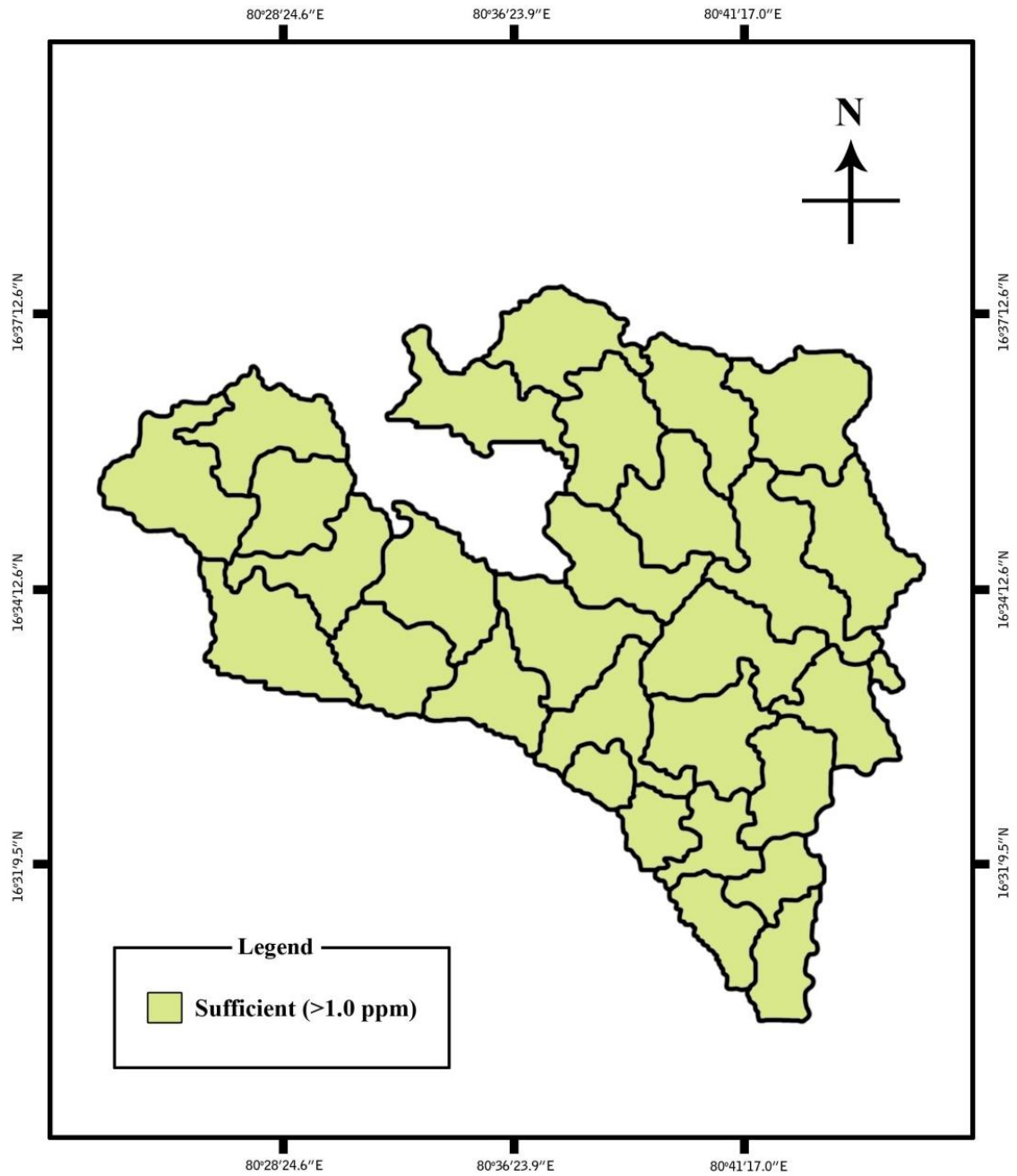


Fig. 10a Available Manganese content of surface soil samples of Krishna district

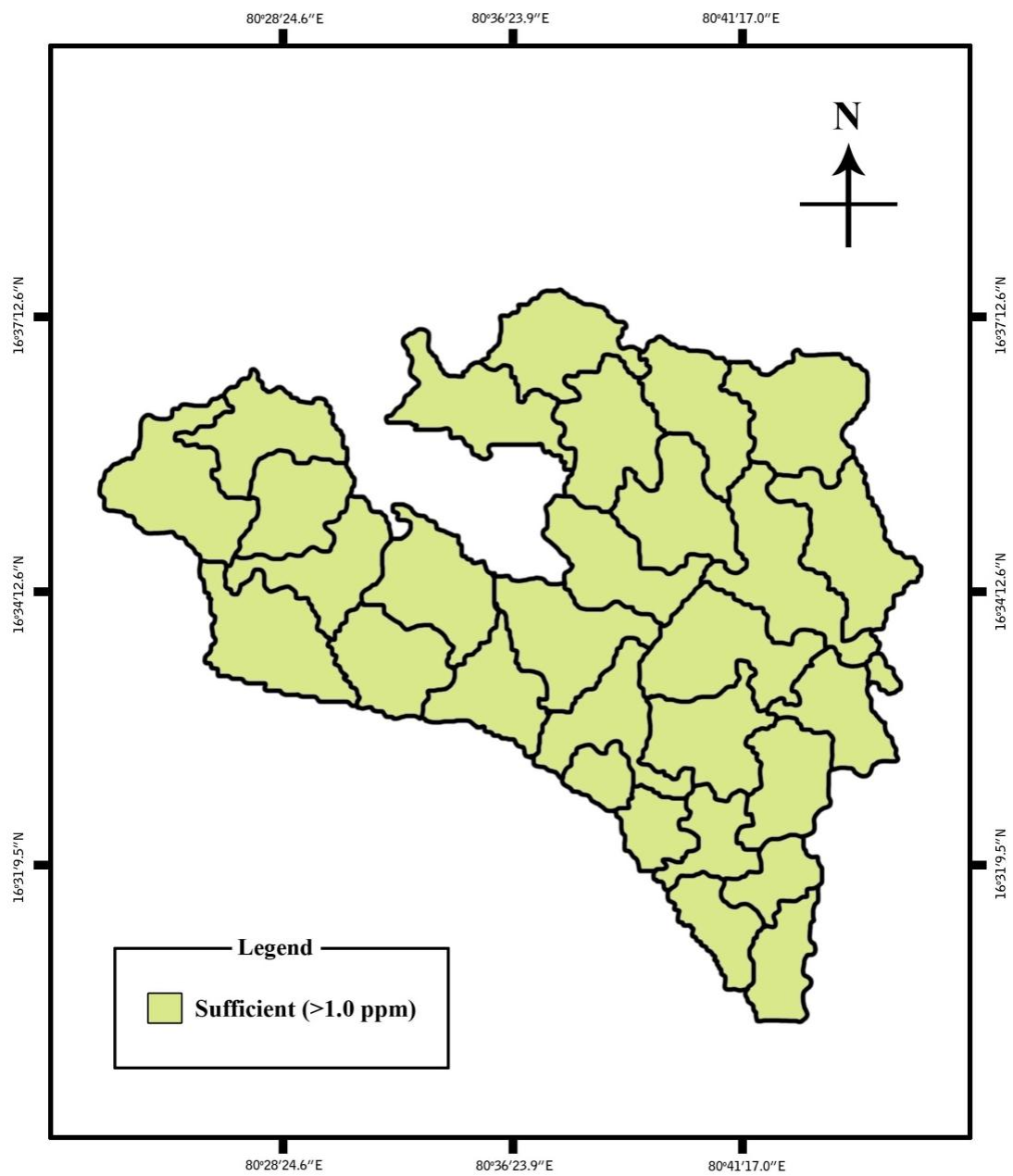


Fig. 10b Available Manganese content of subsurface soil samples of Krishna district

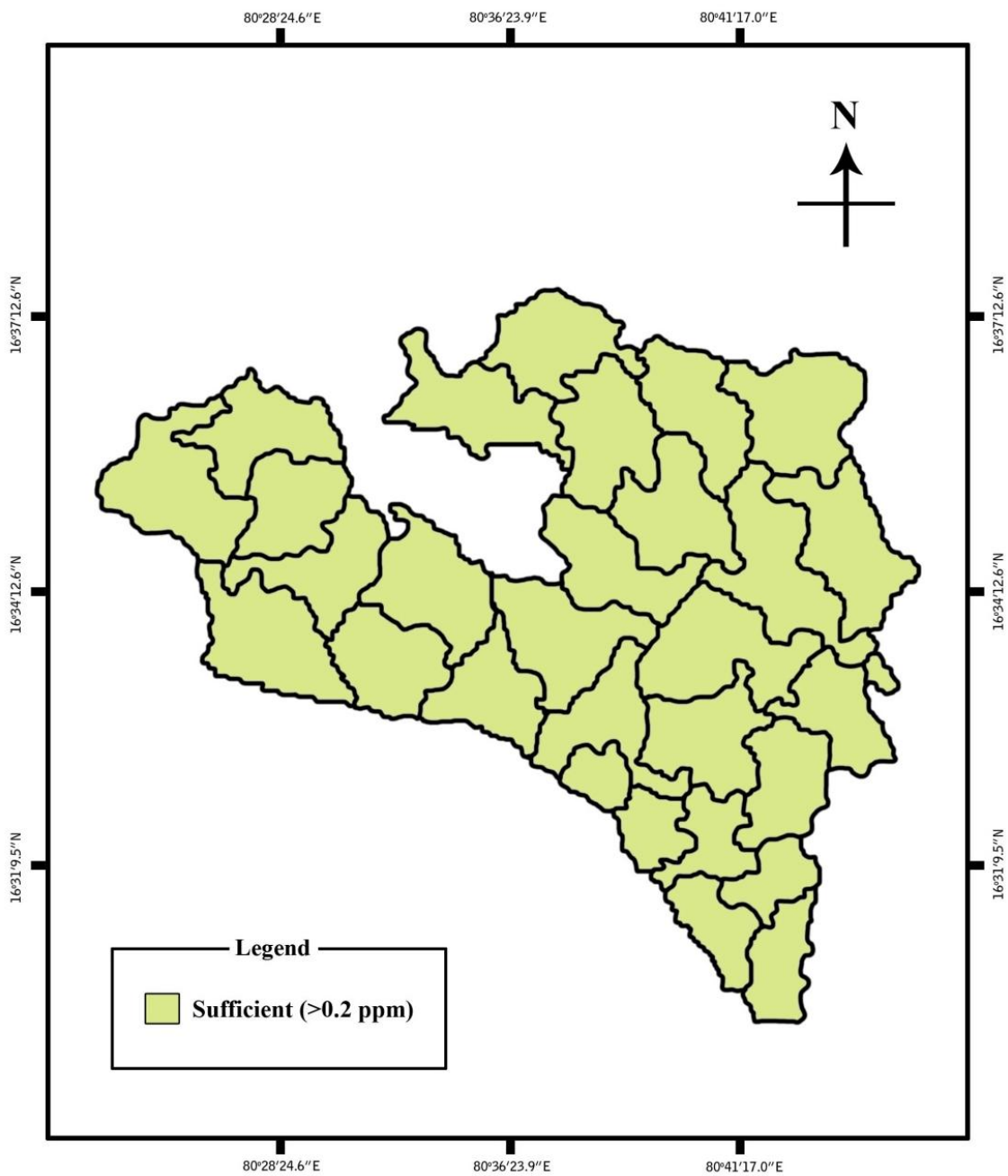


Fig. 11a Available copper content of surface soil samples of Krishna district

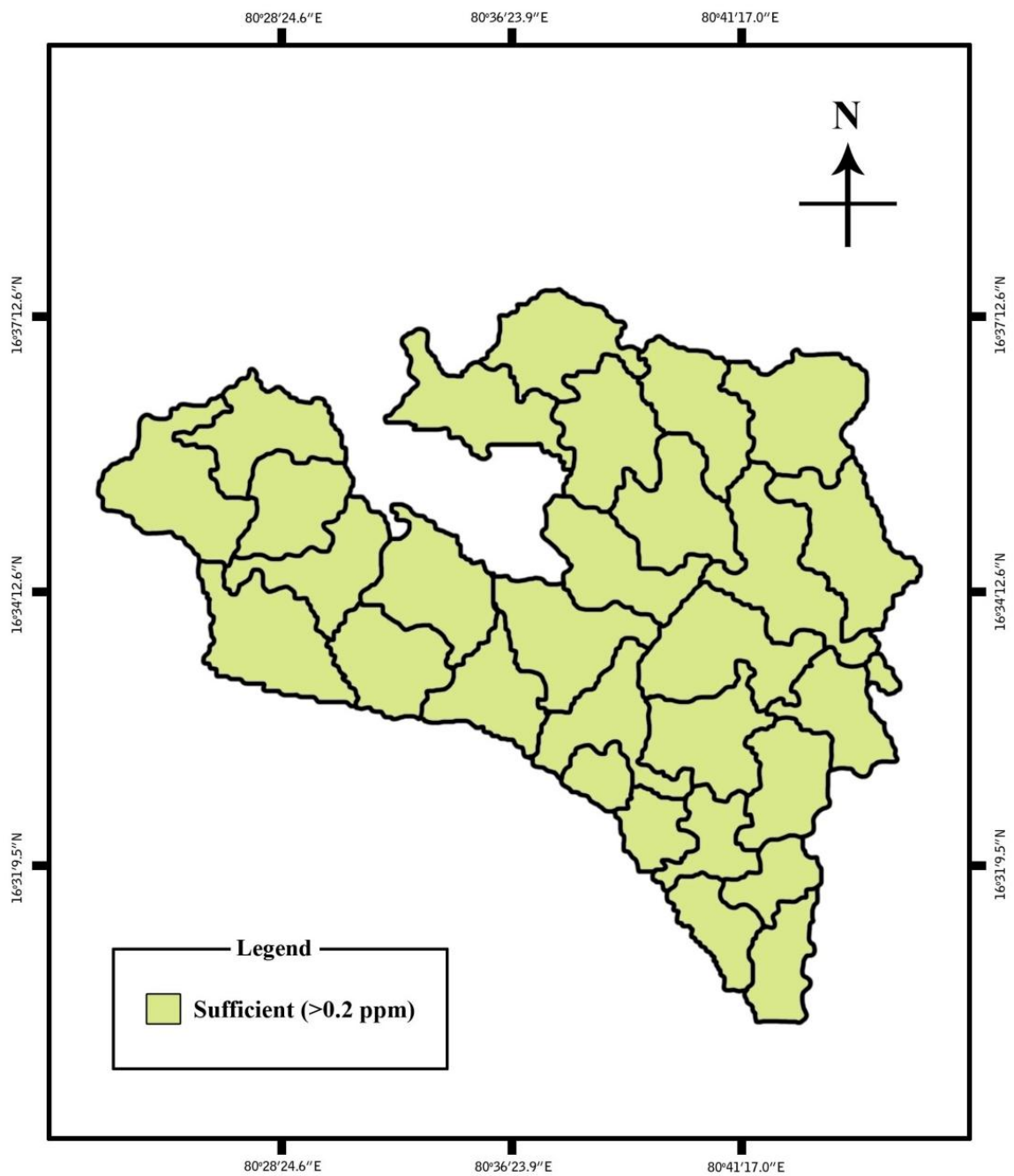


Fig. 11b Available copper content of subsurface soil samples of Krishna district

Table 4.6: Nutrient Index values of organic carbon and available nitrogen and fertility status in upland soils of Krishna district

S.No.	Mandal	OC				N			
		Surface	Rating	Subsurface	Rating	Surface	Rating	Subsurface	Rating
1	A.konduru	1.00	Low	1.00	Low	1.28	Low	1.00	Low
2	Reddigudem	1.14	Low	1.00	Low	1.00	Low	1.00	Low
3	Mylavaram	1.14	Low	1.00	Low	1.00	Low	1.00	Low
4	Vissanapeta	1.00	Low	1.00	Low	1.00	Low	1.00	Low
5	Nuzivedu	1.00	Low	1.00	Low	1.00	Low	1.00	Low
6	Chatrai	2.71	Medium	1.85	Medium	1.00	Low	1.00	Low
7	Jaggaypeta	1.27	Low	1.18	Low	1.09	Low	1.00	Low
8	Ibbrahimpatnam	1.00	Low	1.00	Low	1.00	Low	1.00	Low
9	Gampalagudem	1.00	Low	1.00	Low	1.12	Low	1.00	Low
10	Pamidimukkala	1.00	Low	1.00	Low	1.00	Low	1.00	Low
11	Musunuru	1.00	Low	1.00	Low	1.00	Low	1.00	Low
12	Tiruvuru	1.00	Low	1.00	Low	1.00	Low	1.00	Low
13	Nandigama	1.14	Low	1.00	Low	1.00	Low	1.00	Low
14	Penuganchiprolu	1.00	Low	1.00	Low	1.00	Low	1.00	Low
15	Vatsvai	1.00	Low	1.00	Low	1.00	Low	1.00	Low
16	Chandarlapadu	1.00	Low	1.00	Low	1.00	Low	1.00	Low
17	Kanchikacherla	1.00	Low	1.00	Low	1.00	Low	1.00	Low

Contd.

S.No.	Mandal	OC				N			
		Surface	Rating	Subsurface	Rating	Surface	Rating	Subsurface	Rating
18	Verullapadu	1.00	Low	1.00	Low	1.00	Low	1.00	Low
19	Penamaluru	1.14	Low	1.00	Low	1.00	Low	1.00	Low
20	Kankipadu	1.00	Low	1.00	Low	1.00	Low	1.00	Low
21	Vuyyuru	1.85	Medium	1.57	Low	1.00	Low	1.00	Low
22	Unguturu	1.14	Low	1.00	Low	1.00	Low	1.00	Low
23	Gannavaram	1.00	Low	1.00	Low	1.00	Low	1.00	Low
24	Agiripalli	1.00	Low	1.00	Low	1.00	Low	1.00	Low
25	Bapulapadu	1.14	Low	1.00	Low	1.00	Low	1.00	Low
26	G.konduru	1.00	Low	1.00	Low	1.00	Low	1.00	Low
27	Thotlavalluru	1.85	Medium	1.42	Low	1.00	Low	1.00	Low
28	Vijayawada(rural)	2.00	Medium	1.60	Low	1.20	Low	1.00	Low
29	Vijayawada(urban)	1.75	Medium	1.75	Medium	1.00	Low	1.00	Low

Table 4.61: Nutrient Index values of available phosphorus and potassium and fertility status in upland soils of Krishna district

S. No.	Mandal	P ₂ O ₅				K ₂ O			
		Surface	Rating	Subsurface	Rating	Surface	Rating	Subsurface	Rating
1	A.konduru	1.71	Medium	1.71	Medium	3.00	High	3.00	High
2	Reddigudem	1.85	Medium	1.71	Medium	3.00	High	3.00	High
3	Mylavaram	2.00	Medium	2.00	Medium	3.00	High	3.00	High
4	Vissanapeta	1.00	Low	1.00	Low	3.00	High	3.00	High
5	Nuzivedu	1.71	Medium	1.71	Medium	3.00	High	3.00	High
6	Chatrai	1.85	Medium	1.71	Medium	3.00	High	3.00	High
7	Jaggaypeta	2.00	Medium	2.00	Medium	3.00	High	3.00	High
8	Ibbrahimpatnam	1.87	Medium	1.87	Medium	3.00	High	3.00	High
9	Gampalagudem	1.87	Medium	1.75	Medium	3.00	High	3.00	High
10	Pamidimukkala	2.00	Medium	2.00	Medium	3.00	High	3.00	High
11	Musunuru	2.71	Medium	2.42	Medium	3.00	High	3.00	High
12	Tiruvuru	2.71	Medium	2.42	Medium	3.00	High	3.00	High
13	Nandigama	2.00	Medium	2.00	Medium	3.00	High	3.00	High

Contd.

S.No.	Mandal	P ₂ O ₅				K ₂ O			
		Surface	Rating	Subsurface	Rating	Surface	Rating	Subsurface	Rating
14	Penuganchiprolu	2.12	Medium	2.12	Medium	3.00	High	3.00	High
15	Vatsvai	1.57	Low	1.57	Low	3.00	High	3.00	High
16	Chandarlapadu	3.00	Medium	2.71	Medium	3.00	High	3.00	High
17	Kanchikacherla	2.00	Medium	1.71	Medium	3.00	High	3.00	High
18	Verullapadu	2.28	Medium	2.00	Medium	3.00	High	3.00	High
19	Penamaluru	2.42	Medium	2.00	Medium	3.00	High	3.00	High
20	Kankipadu	2.00	Medium	2.00	Medium	3.00	High	3.00	High
21	Vuyyuru	1.71	Medium	1.71	Medium	3.00	High	3.00	High
22	Unguturu	2.28	Medium	2.14	Medium	3.00	High	3.00	High
23	Gannavaram	2.00	Medium	2.00	Medium	3.00	High	3.00	High
24	Agiripalli	2.14	Medium	2.00	Medium	3.00	High	3.00	High
25	Bapulapadu	3.00	Medium	2.71	Medium	3.00	High	3.00	High
26	G.konduru	2.00	Medium	1.85	Medium	2.85	High	2.87	High
27	Thotlavalluru	1.71	Medium	1.64	Low	3.00	High	3.00	High
28	Vijayawada(rural)	2.00	Medium	2.00	Medium	3.00	High	3.00	High
29	Vijayawada(urban)	2.00	Medium	2.00	Medium	3.00	High	3.00	High

Table 4.62: Fertility status of Zinc, Iron, Manganese and Copper in upland soils of Krishna district

S.No.	MANDAL	Zinc		Iron		Manganese		Copper	
		Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
1	A.konduru	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
2	Reddigudem	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
3	Mylavaram	Deficient	Deficient	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient
4	Vissanapeta	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
5	Nuzivedu	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
6	Chatrai	Deficient	Deficient	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient
7	Jaggaypeta	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
8	Ibhrahimpatnam	Deficient	Deficient	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient
9	Gampalagudem	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
10	Pamidimukkala	Sufficient	Sufficient	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient
11	Musunuru	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
12	Tiruvuru	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
13	Nandigama	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
14	Penuganchiprolu	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
15	Vatsvai	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient

Contd.

S.No.	Mandal	Zinc		Iron		Manganese		Copper	
		Surface	Subsurface	Surface	Subsurface	Surface	Subsurface	Surface	Subsurface
16	Chandarlapadu	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
17	Kanchikacherla	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
18	Verullapadu	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
19	Penamaluru	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
20	Kankipadu	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
21	Vuyyuru	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
22	Unguturu	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
23	Gannavaram	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
24	Agiripalli	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
25	Bapulapadu	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
26	G.konduru	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
27	Thotlavalluru	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
28	Vijayawada(rural)	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
29	Vijayawada(urban)	Deficient	Deficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient

Table 4.70: correlation (r-value) among cotton yield and soil properties

Soil property	r-value
Organic carbon (%)	0.698*
Nitrogen (kg ha ⁻¹)	0.734*
Phosphorus (kg ha ⁻¹)	0.799**
Potassium (kg ha ⁻¹)	0.864**

Table 4.71: correlation (r-value) among chilli yield and soil properties

Soil property	r-value
Organic carbon (%)	0.684*
Nitrogen (kg ha ⁻¹)	0.721*
Phosphorus (kg ha ⁻¹)	0.837**
Potassium (kg ha ⁻¹)	0.698*

Table 4.72: correlation (r-value) among sugarcane yield and soil properties

Soil property	r-value
Organic carbon (%)	0.747*
Nitrogen(kg ha ⁻¹)	0.826**
Phosphorus (kg ha ⁻¹)	0.693*
Potassium (kg ha ⁻¹)	0.706*

Table 4.73: correlation (r-value) among turmeric yield and soil properties

Soil property	r-value
Organic carbon (%)	0.694*
Nitrogen (kg ha ⁻¹)	0.861**
Phosphorus (kg ha ⁻¹)	0.856**
Potassium(kg ha ⁻¹)	0.718*

Table 4.74: correlation (r-value) among maize yield and soil properties

Soil property	yield
Organic carbon (%)	0.673*
Nitrogen (kg ha ⁻¹)	0.719**
Phosphorus (kg ha ⁻¹)	0.913*
Potassium (kg ha ⁻¹)	0.906*

Table 4.75: correlation (r-value) among mango yield and soil properties

Soil property	r-value
Organic carbon (%)	0.717*
Nitrogen (kg ha ⁻¹)	0.679*
Phosphorus (kg ha ⁻¹)	0.808**
Potassium (kg ha ⁻¹)	0.834**

Table 4.76: correlation (r-value) among bhendi yield and soil properties

Soil property	r-value
Organic carbon (%)	0.880**
Nitrogen (kg ha ⁻¹)	0.743*
Phosphorus (kg ha ⁻¹)	0.863**
Potassium (kg ha ⁻¹)	0.724*

Table 4.77: correlation (r-value) among groundnut yield and soil properties

Soil property	r-value
Organic carbon (%)	0.749*
Nitrogen (kg ha ⁻¹)	0.799**
Phosphorus (kg ha ⁻¹)	0.864**
Potassium (kg ha ⁻¹)	0.896**

Chapter – V

Summary and Conclusions

Chapter - V

SUMMARY AND CONCLUSIONS

The present investigation entitled “Fertility evaluation of upland soils of Krishna district, Andhra Pradesh” was conducted for assessing the fertility status of soils as it is one of the important factor controlling yields of the crops.

Representative surface soil samples collected from 212 places (counts to 424 including surface and sub-surface) from different mandals of Krishna district by following random sampling technique. The soil samples were processed and analysed for their physical properties (mechanical composition), physico-chemical properties (pH, EC, organic carbon), available macronutrients (nitrogen, phosphorus and potassium), available secondary nutrient (sulphur) and micronutrients (zinc, iron, manganese and copper).

Critical examination of the data revealed that soils of the study area in general were dominantly fine textured clay followed by sandy loam, sandy clay loam. The surface and subsurface soils were found to be neutral to highly alkaline (about 70%). subsurface soil samples recorded high mean pH value (7.7) as compared to surface (7.6) soil samples. EC of the surface and subsurface samples varied from 0.12 to 0.72 dSm^{-1} and from 0.11 to 0.83 dS m^{-1} with mean values of 0.42 dS m^{-1} and 0.47 dS m^{-1} , respectively. The results revealed that 100 % surface and subsurface samples were found under normal ($<1\text{dS m}^{-1}$).

CEC of surface soils ranged from 13.0 to 60.9 cmol (p+) kg^{-1} with a mean value of 36.95 cmol (p+) kg^{-1} , while it ranged from 15.2 to 64.8 cmol (p+) kg^{-1} with a mean value of 40 cmol (p+) kg^{-1} in subsurface soils. It was observed that subsurface soils had higher CEC values as compared to surface soil. PBS of surface soils ranged from 75-99% with mean of 95.94 % .while in subsurface soils it ranged from 74-98% with mean of 94.12%. Relatively lower PBS has been observed in subsurface soils which might be due to less clay content and enhanced leaching of basic cations besides surface soils.

The organic carbon content of surface and subsurface soils ranged from 0.15-0.72 and 0.11-0.65 with a mean value of 0.43 and 0.38 per cent, respectively. Average nutrient index of the study area as a whole with respect to organic carbon was 1.20 for surface and 1.09 for subsurface soils which indicated that soils are low in organic carbon status. The available nitrogen content of surface and subsurface soil samples ranged from 185 to 298 kg ha⁻¹ and from 163 to 274 kg ha⁻¹ with mean values of 241.5 and 218.5 kg ha⁻¹, respectively. The nutrient index values indicated that the soils under study were low to medium and the surface samples showed relatively higher nitrogen content (mean 241.5 kg ha⁻¹) compared to subsurface soils samples (mean 218.5 kg ha⁻¹).

The available phosphorus content ranged from 11.2 to 96.3 kg ha⁻¹ (mean 53.75 kg ha⁻¹) in the surface samples, while it ranged from 10.9 to 94.0 kg ha⁻¹ (mean 52.45 kg ha⁻¹) in the subsurface samples. The available potassium content of soil samples ranged from 247 to 866 and from 232 to 783 kg K₂O ha⁻¹ with mean values of 556.5 and 507.5 kg K₂O ha⁻¹, respectively. The available sulphur content of surface and subsurface soil samples ranged from 15.32 to 82.18 ppm and from 10.25 to 57.91 ppm with mean values of 48.75 and 34.08 ppm, respectively and were found medium to sufficient.

Among micro nutrients copper and manganese were sufficient at both depths, while zinc was sufficient in 34 per cent and deficient in 66 per cent of surface soils where as in subsurface soils 73.59 percent are deficient and remaining soils are sufficient. Iron was sufficient in 86 percent soils and deficient in 14 per cent of surface soil and in subsurface soils, 85 percent are sufficient and 15 percent are found to be deficient.

The present investigation revealed that the physico-chemical and nutrient problems, which are likely to hinder the productivity of these soils. It prompted to arrive with certain recommendations, which are to be adopted by the farmers, to overcome the problems and to realise maximum yields.

- ❖ Organic matter was found to be low, which needs much concern for regulating and increasing the availability of all nutrients, besides creating congenial atmosphere for the same, for this purpose addition of organics in the form of FYM/compost/green manure is to be considered as indispensable. Besides every nitrogen chemical fertilizer has to be applied/used in conjunction with any concentrated organic sources. Also the bulky organics are to be incorporated and rate of decomposition is hastened by using the consortium of micro organisms.
- ❖ In almost all soils the available nitrogen content was low, which might be attributed to the climatic conditions and agronomical practices being adopted by the local farmers. In view of this nitrogenous fertilizers are to be applied carefully in more splits following the recommended methods and time of application.
- ❖ Phosphorus and potassium status of the soils under study was found fatty, which may be attributed to the dumping of high analyzing NPK complex fertilizers at all crop growth stages. This is very expensive and may have some detrimental effect on the availability of other nutrients, particularly micro nutrients. This fattiness of nutrients can be cleverly managed by using some biological organisms.
- ❖ To mitigate the problem of zinc deficiency, it should be supplied in the form of chemical fertilizer either as soil application or through foliar spray and should be included in the fertilizer schedule of various crops grown in the study area. Adoption of soil test based fertilizer recommendations is highly essential for achieving the desired crop productivity without deteriorating soil health.

It can be concluded from the available data, the soils were deficient in some nutrients while others were very high due to imbalanced fertilization coupled with intensive cultivation of nutritive exhaustive crops.

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***Original not seen**

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