CHARACTERIZATION AND CLASSIFICATION OF SOILS OF RANGA REDDY DISTRICT FOR LANDUSE PLANNING

By

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B. Sc. (Ag.)

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CERTIFICATE

This is to certify that the thesis entitled **"CHARACTERIZATION AND CLASSIFICATION OF SOILS OF RANGA REDDY DISTRICT FOR LANDUSE PLANNING"** submitted in partial fulfillment 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 **Mrs. V.V. SRUJANA** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All the assistance and help received during the course of the investigation have been duly acknowledged by the author of the thesis.

(Dr. V. GOVARDHAN)
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CERTIFICATE

MrS. V.V. SRUJANA has satisfactorily prosecuted the course of research and that the thesis entitled **"CHARACTERIZATION AND CLASSIFICATION OF SOILS OF RANGA REDDY DISTRICT FOR LANDUSE PLANNING"** 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 the thesis or part there of has not been previously submitted by her for a degree of any University.

Date : **(V. GOVARDHAN)**
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DECLARATION

I, **V.V. SRUJANA,** hereby declare that the thesis entitled **"CHARACTERIZATION AND CLASSIFICATION OF SOILS OF RANGA REDDY DISTRICT FOR LANDUSE PLANNING"** submitted to Acharya N.G. Ranga Agricultural University for the degree of **'MASTER OF SCIENCE IN AGRICULTURE'** is the result of original research work done by me. I further declare that the thesis or any part thereof has not been published earlier in any manner.

Date : **(*V.V. SRUJANA*)**

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ABSTRACT

In the present study fifteen representative pedons were selected from Ranga Reddy district of Andhra Pradesh. The Pedons selected were in the locations of (1) Basashirabad (2) Chevella (3) Moinabad (4) Uppal (5) Kisara (6) Saroornagar (7) Ibrahimpatan (8) Medchal (9) Shamirpet (10) Doma (11) Tandur (12) Shamshabad (13) Pargi (14) Mominpet (15) Virkarabad. All the pedons were described for their morphological features and horizonwise samples were processed for laboratory analysis on physical, physico-chemical and chemical characteristics. Based on the morphology and analytical data all the pedons were characterised and classified.

The climate of the study area was semi arid. The pedons selected were confined to plains of cultivated lands. These pedons were shallow to very deep and have angular to sub angular blocky structure in surface horizons and sub angular blocky or angular blocky structure in sub surface horizons. Pedons at Moinabad, Uppal and Kisara had developed argillic horizons in sub surface layers. Cambic horizons were recognized in pedons at Ibrahimpatan, Medchal, Pargi and Shamshabad.

The analytical data revealed that these soils are sandy clay to sandy clay loam to clay in texture and showed an increasing trend of clay content with increase in depth, slightly acidic to alkaline and low in organic carbon. The dominance of exchangeable bases on exchange complex was in the order of Ca^{2+} > Mg^{2+} > K^{+} > Na^{+}. The soils were low in available nitrogen and phosphorus and medium to high in available potassium with sufficient available copper, iron and manganese content but deficient in zinc.

Based on morphology, physical, physico-chemical and chemical characteristics of soils, the pedons were classified as Vertisols, Alfisols, Inceptisols and Entisols.

The soil and land resource inventory for assessing the soil related constraints has been prepared based on field survey and laboratory investigations and improved inter cropping systems of cereals and legumes are suggested based on the degree of suitability. Soil erosion, crusting, compaction, low organic content and poor nutrient availability were identified as prominent soil related constraints.

CHAPTER-I

INTRODUCTION

Soils is the most valuable natural resource but is finite and non renewable. Any progress and development in agriculture depends largely on the basic resource of soil and manner in which this invaluable resource is managed. In order to meet the ever increasing food requirement of the growing population there has been compulsion to produce more and more from each unit area of land; this process is leading to depletion of natural resources.

Under these conditions clear and intimate knowledge of the kind of soil, their extent, distribution characteristics and potential gain prominence in optimizing land use on sustainable basis. Soil survey not only helps in expanding our knowledge and understanding different soil and, it also helps to make practical recommendations for the management of degraded soils, soil and water conservation measures etc.

Andhra Pradesh state is endowed with a wide variety of soils, ranging from less fertile coastal sands to highly fertile and highly productive deltaic alluviums of the Godavari, Krishna and Pennar rivers, through the red and black soils, developed from different parent materials.

Ranga Reddy district is located in Southern Telangana region of Andhra Pradesh extending over an area of 7493 km^2 between $16^o30'$ and $18^o20'$ North latitudes and $77^o30'$ and $79^o30'$ East longitudes. It is bounded by the districts of Medak on North Nalgonda on East, Mahaboobnagar on South and Gulbarga of Karnataka state on the West. The district is located in the geographic centre of the subcontinent and situated at on elevation of 500-600 meters above mean sea level in the Deccan plateau. The district is mostly hilly with some woods. Scattered hillocks and outcrops of black stone are ubiquitous in the district. The general slope of the land is from west to east and south-east.

The district comprises of plains crisscrossed with some rivers, several rivulets and small streams. The chief river, Musi rises in the Ananthagiri hills (Vikarabad) and flows west to east. Rivers Bhima and Manjira, a tributary of Godavari, are also dominant and have great bearing and influence in the soil and land resource development.

The district experiences hot summers and is dry except during the south-west monsoon season. The average rainfall is 750 mm which is received mostly from south-west monsoon.

Land and water are the two basic fundamental natural resources for agricultural production. For sustainable development, efficient management of natural resources is important. Detailed information on soils of the district are not available.

Soil characterization helps in determining the potential of the soil identifying constraints for crop production besides giving a detailed information about different soil properties. Lack of soil characterization becomes an obstacle in exploiting the production potential of soils. Soil classification helps in suggesting suitable management practices for increasing the productivity of the soil. Since, the information available on the above aspects is limited in the district of Ranga Reddy the present study was undertaken with the following specific objectives;

1. Characterization and classification of soils of Ranga Reddy district.
2. Assessing the pedogenic features and developmental relationship of soils of various land forms and land use categories.
3. Identification of soil related constraints for crops production.

CHAPTER II

REVIEW OF LITERATURE

2.1 NOMENCLATURE

According to Krishna and Perumal (1948) the typical black (cotton), shrink-swell soils, have developed on basaltic parent material under semi-arid to sub-humid climatic conditions which are called as regur or black cotton soils in India. Black and associated soils in India were commonly known as black cotton soils or regurs. They were designated by different names in different parts of the country viz., Nallaregada in Andhra Pradesh, Karail in Uttar Pradesh, Mar and Kabar in Madhya Pradesh, Morand, Kalikasadar and Bhal in Gujarat, Yere or Kari in Karnataka (Murthy *et al*., 1982).

The red and associated soils in India have developed under varying physiographic and climatic conditions. Red sandy soils are locally called as “Chalka soils” in Andhra Pradesh (Singa Rao *et al*., 1993). According to Sehgal (1993) `lateritic’ is a term used for soils that do not necessarily have laterite as a sub soil horizon but reflect its occurrence in their morphological features.

2.2 PEDOGENESIS

Dokuchaiev (1898) was the first person to show that soils usually form as a result of the interplay of soil forming factors viz., parent material, climate, organisms, topography and time. The soil forming factors were independent variables, each of them would change and vary from place to place without the influence of the other (Jenny, 1941).

According to Diwakar and Singh (1994) absence of distinct horizonation in Vertisols and associated soils of Bihar, might be due to haploidization by argillopedoturbation. Besides the shrink-swell phenomenon several other processes were also recongnised in the genesis of Vertisols viz., dissolution and accumulation of silica, carbonates, gypsum, sodium and other soluble salts (Soil Survey Staff, 1994).

Murthy *et al*. (1994) noticed the tendency of salinization in Vertisols derived from limestone and granodiorite. Leaching and illuviation was more pronounced in the Inceptisols of middle Siwaliks (Sanjay *et al*., 1996). Srinivasa Rao *et al*. (1997) noticed that pedoturbation was responsible for the uniformity in the levels of exchangeable potassium in Vertisols occurring near Bhopal.

Gleying (gleization) was found to be predominant pedogenic process operating in flood plain soils of Assam valley (Battacharyya *et al*., 1997) and in Bangladesh (Khan *et al*., 1997). According to Mahapatra *et al*. (2000) the sub-humid soils of Kashmir region show varying degree of profile development from A-C to A-B-C profiles on steep slopes to piedmont plains, kariwas and broad valleys and the major soils belong to Entisols followed by Inceptisols, Alfisols and Mollisols.

Rainfall and ground water level were found to enhance the development of soil acidity, release of basic cations and increase of acidic cations in the soils, suggesting that the soil acidity can be enhanced through leaching losses of basic cations (Khan and Adachi, 2000).

Gangopadhyay *et al*. (2001) stated that the translocation of free ion oxides was prominant in rubber growing soils of Tripura as evidenced by the increase of the ion oxides with the increase in soil depth.

2.2.1 Parent material

Red soils were developed from sand stones, micaceous schists, basalts, quartzites, shales and gneisses. According to Digar and Barde (1982) the fine textured red soils were related to the weathering products of gneisses, charnockites and diorite that are richer in clay forming minerals such as feldspars, micas and hornblende. The profiles developed on granite-gneiss were classified as Alfisols in Northern Kerala by Sahu and Krishna Murti (1984).

Subbaiah and Manickam (1992) reported that the black soils of Andhra Pradesh were developed over a wide variety of parent material like granite-gneiss, granite, yellow shale, pink shale limestone and charnockite. In coastal districts of Andhra Pradesh laterites were formed from feldspars, sillimanite, pyroxenes, garnet and quartz (Suryanarayana, 1992). Shyampura *et al*. (1993) reported that red soils formed from schist showed greater clay content due to difference in weatherability and also showed high total iron compared with quartizite-derived soils.

The variation in content of $CaCO_3$ (47.6 to 726 kg m^{-3}) showed increasing trend with depth, absence of peak concentration, presence of micro crystallized, calcite in voids, channels and as coating of skeleton grains. Presence of *in situ* formed segregates suggest that lime was present in the parental material inherited during aggradational processes (Choudhari 1994).

Vijay Kumar *et al*. (1994) stated that the soils of northern Telangana region of Andhra Pradesh had granite-gneisses parentage and the soils were Entisols, Inceptisols and Vertisols. Vertisols in the coastal plains of Gujarat were developed from alluvium (Battacharyya *et al*., 1994) and red soils were developed under alluvium in Indogangetic plain of Bihar (Singh and Mishra, 1994).

According to Murthy *et al*. (1994) Vertisols derived from basaltic rocks have high clay content, CEC, water holding capacity, lower pH and EC while black soils of Kandukur division of Andhra Pradesh developed on granite-gneiss (Venkateswarlu *et al*., 1995).

According to Sen *et al*. (1996) the Inceptisols on hill slopes of Manipur were derived from sand stone, old sedimentary or sandy shale, silt stone, tertiary sedimentary rocks. Vertisols derived from basaltic and lime stone have high phosphorus adsorption capacities compared with those of grey shale, granodiorite and granitic - granodiorite parent material (Murthy *et al*., 1996).

Surekha *et al*. (1997) noticed that Vertisols of Andhra Pradesh owe their parentage to shale, limestone, granite, gneiss, charnockite and granite. The Vertisols of Nandyal in Andhra Pradesh were developed from shale parent material derived from the Kurnool-Cuddapah formation (Sreenivasulu Reddy, 1997).

According to Tamgadge *et al*. (1999) the parent material for the soils of Madhya Pradesh was a variety of rocks amongst which basalt, sandstone, granite and laterites dominate.

Much of amorphous forms of iron and aluminium in the acid Alfisols of Bihar plateau have been transformed to crystalline forms more in Debatoli than in Pusarao series and the former is relatively older than the later (Mathur *et al*., 2000). Rudra Murthy and Dasog (2001) stated that the dithionite iron (fed) content was lowest in red and black soils developed from basalt and chlorite – schist.

2.2.2 Climate

Semiarid climate with moderate rainfall ranging from 575 to 905 mm per annum was conducive for the formation of black soils in coastal Andhra Pradesh (Subbaiah and Manickam, 1992).

Vijay Kumar *et al*. (1994) reported that the northern Telangana zone of Andhra Pradesh had semiarid climate with mean annual rainfall varying from 900-1150 mm, hyper thermic soil temperature regime and Udic soil moisture regime.

Jagdish Prasad *et al*. (1995) observed the development of Typic Rhodustalfs under hot humid climate, Typic Ustropepts under sub-humid zone and Chromic Haplusterts in semiarid climate of Maharashtra.

Vertisols of Kurnool district of Andhra Pradesh had semiarid climate with a mean annual rainfall of about 780 mm and mean annual maximum and minimum temperature of 35.5°C and 22°C respectively (Sreenivasulu Reddy 1997).

Battacharyya *et al*. (1997) classified Brahmaputra flood plains of Assam as Inceptisols and Entisols under humid tropical climate with 1160 mm average rainfall per annum. In Alfisols of Punjab region the depth of Bt horizons, organic matter content and root distribution was increased with rainfall and decreased with temperature where the concavity of the land surface and heavy rainfall events during monsoon months facilitated agrillic horizon development (Sharma *et al*., 1998).

Jagdish Prasad and Gajbhiye (1999) reported that the semiarid ecosystem provided more Zn, Cu and Mn than sub-humid zone, while the lowest available Fe was observed in the soils of semiarid regions.

Rudra Murthy and Dasog (2001) stated that the differences in genessis and occurrence of associated red and black soils in close proximity developed from the same parent material was mainly related to influence of drainage as conditioned by relief in North Karnataka.

2.2.3 Topography

Arunaprasad *et al*. (1987) studied the profile development in relation of topography and found that undulating landscape, excessive hummocky, poor vegetal cover resulted in Entisols formation. Soils of Mizoram showed very dark grey to dark brown in surface horizon and yellowish brown to brown at higher altitudes whereas it was olive brown in lower altitudes. This increase in value and chroma with decreasing in altitude was due to the decrease in organic matter content (Singh *et al*., 1991). Gentle slope profiles had thicker 'A' horizon and better profile differentiation compared to profiles on steeper slopes (Ramana Murthy and Sharma, 1992). The Vertisols of Andhra Pradesh were confined to the plains of Rayalaseema and Telangana regions while they were confined to lower elements of topography in coastal Andhra Pradesh (Subbaiah and Manickam, 1992).

Shyampura *et al*. (1994) reported that the soils on very steeply sloping side slopes are shallow, excessively drained and coarser in nature, whereas the soils of gently sloping pediment and undulating plains are deep, finer in texture and have better structural development. The soils of Somasila and Telugu Ganga project area in Nellore district of Andhra Pradesh were located on gently rolling plains with hard and compact laterite or ferrugenous layer (Bhaskar and Subbaiah, 1995).

Chamuah *et al*. (1996) stated that topography appears to be the dominant soil-forming factor in southern bank of Brahmaputra valley of Assam and noticed that base saturation decreased with depth in upland soils, while reverse was seen in the low land soils. Sharma *et al*. (1996) reported that the soils at higher topography were more weathered than the soils at lower topography. Topographical variations were responsible for the heterogeneity of soils since hydrological conditions might have modified the soil climate, which in turn had influenced the pedogenic processes (Battacharyya *et al*., 1997).

The land form-soil relationship was studied by Yadav *et al*. (1998) and was found that the development of deep soils on summit flank slopes and shallow soils on shoulder, foot and toe slopes.

Some Alfisols in Andhra Pradesh on gently sloping uplands showed greater pedogenic development by virtue of their comparatively higher index values than the soils in the undulating uplands (Dipak Dutta *et al*., 1999).

Tamgadge *et al*. (2000) have classified the Satpura range as Lithic/ Typic Ustorthents in hilly terrain; Typic Vertic Ustochrepts in sloping beds and Typic Haplusterts in valleys. The variations are due to various land form setting, elevation differences and slope gradient, which influence the soil development process. The soils of different physiological units in the sub-humid ecosystems of Kashmir region soils of summits were studied and the side reposed slope are shallow to medium in depth, severely eroded and occur on steep to very steep slopes whereas soils on piedmont plains and Karewas are deep, well drained and occur on very gentle to moderate slope. Slope of fluvial valleys are also deep and moderately well developed (Mahapatra *et al*., 2000).

2.2.4 Vegetation

Prasuna Rani *et al*. (1991) stated that grasses and xerophytic plants were the natural vegetation on red and associated soils of Somasila project of Andhra Pradesh.

The replacement of tropical rainforest with high value plantation crops resulted in an increases of bulk density due to decline in organic matter (Mongia and Bhandhyopadhyay, 1992). In well-drained soils termites and earthworms had the greatest influence on soil micro morphology (Venugopal, 1993). Bhaskara and Subbaiah (1995) reported that xerophytic luxuriant vegetation was found in laterite and associated soils along east coast of Andhra Pradesh. Plantation of trees (Tectona grandis, Dalbergia sissoo and Acasia catechu) on red loam soil

(Iceptisol) of Dharwad showed a decrease in bulk density and pH whereas soil aggregation, organic matter and exchangeable Ca of the soils increased (Hosur and Dasog, 1955).

Coulombe *et al*. (1996) reported that Vertisols under native grasslands and pateurs would develop a polygonal cracking pattern while with row crops such as maize and sorghum a linear cracking pattern. Vertisols of Kurnool district in Andhra Pradesh were deep to very deep due to cultivation of crops like cotton, jowar, bengalgram and setaria (Sreenivasulu Reddy, 1997).

West *et al*. (1998) reported that destructive impact of termites activity was much in Ultisol formation since the transport of clay to the surface counters the downward movement of clay in the soil solution. Pannu *et al*. (1999) observed the presence of low chroma in rice growing soils as compared to non-rice growing soils. The increase or decrease of soil properties due to the influence of *Eucalyptus citriodora* was more in surface than in sub surface soil layers (Balamurugass *et al*., 2000). Ratnam *et al*., (2001) observed soil colour variation from dark greyish brown to very dark greyish brown in rice growing soils and from very dark gray to very dark greyish brown in non rice growing Vertisols of Andhra Pradesh

2.3 SOIL MORPHOMETRIC CHARACTERISTICS

2.3.1 Horizons

Red soils of Mahananda alluvium had an argillic horizon ochric epipedon and showed 4 or higher colours values which were classified as Haplustalfs (Singh *et al*., 1993) B_{11}, B_{12} and B_{13} horizons and B_1, B_{21t}, B_{22t} horizons in Inceptisols and Alfisols of northern Telangana, respectively were observed by Vijay Kumar *et al*. (1994).

Battacharyya *et al*. (1994) reported that the Vertisols of coastal plains of Gujarat showed A_1, B_{21}, B_{22ca}, B_{23ca} and C_{ca} horizon by the presence of calcic horizon, slicken slides etc. only A_c profiles were observed in Vertisols of Mahaboobnagar district of Andhra Pradesh (Murthy *et al*., 1996).

Bhaskar and Nagaraju (1998) noticed the A_p, B_w, B_{ss1}, B_{ss2}, B_{s3} in sodic Haplusterts of Chitravathi River basin of Andhra Pradesh. A_{p1g}, A_{p2g}, B_{21g}, B_{22g}, B_{23g}, B_{3g}, C_{1g} and C_{2g} in Aeric Haplaquepts and A_{pg}, B_{21g}, B_{22g}, B_{23g}, 11Abg, 11_{c1g} and 11_{c2g} in Typic Haplaquepts were reported by Khan *et al*. (1998) in the flood plains of Bangladesh. Pannu *et al*. (1999) observed the ochric epipedon underlaid by an altered - B (cambic horizon) in Khirandwa rice soil of Haryana which was classified under Inceptisol.

Tamgadge *et al*. (1999) observed the Ap, ABs, Bss and C horizon in Vertisols developed on basaltic terrain of Madhya Pradesh.

2.3.2 Soil colour

Soil colour is probably the most obvious feature of the soil that can be easily determined at field level. Soil colour is related to specific physical, chemical and biological properties of the soil. It indicates many soil features varies among different kinds as well as within the soil profile of the same kind of soil. Its an important soil property through which its description and classification can be made.

Palaskar *et al*. (1981) reported that alteration of parent material with different degree of weathering induces variation of soil colour in the soils possessing genetic similarity. Karan Singh *et al*. (1993) reported that gleization process was responsible for low chroma ranging from 0-1 in low land soils of central Himalayas. Coarse loamy soils of Punjab under rice-wheat rotation have darker hues (Sawhney and Rajkumar, 1993). Alfisols and Inceptisols with red colour and the soils of low lands are recent Entisols with grey colours (Shiva Prasad *et al*., 1994). According to Bhaskar and Subbaiah (1995) the colour of the laterites and associated soils along the east coast of Andhra Pradesh varied from dark yellowish brown to red.

Elahi *et al*. (1996) reported that the colour of Inceptisols on Madhupur clay in Bangladesh varied from light yellowish brown to dark grey under different hydrological conditions. The soils associated with elevated topography were redder (7.5 YR) in colour, which gradually became greyish (10 YR) down the slope (Sharma *et al*., 1996).

The colour of Vertisols of Andhra Pradesh was brown to very dark grey under dry conditions and greyish brown to black under moist conditions (Surekha *et al*., 1997).

Dipak Sarkar *et al*. (1997) observed that the colour of the surface horizons was dark in some profiles of Ultisols and Alfisols except in lower altitudes (5 YR 3/4 to 2.5 YR 3/6). Bench mark acid soils of North eastern India (Inceptisols and Vertisols) were characterised by low chroma at surface and high chroma at the sub-surface with colour ranging from very dark gray brown (10 YR 3/2) to strong brown (7.5 YR 4/6) and dark yellowish brown (10 YR 4/3) to dark red (2.5 YR 3/6) respectively (Sen *et al*., 1997).

Anitha *et al*. (1998) reported that colour of black soils in Gurazala mandal of Guntur district, Andhra Pradesh varied from very dark grayish brown to dark grayish brown. The colour of vertic Ustropepts and Sodic Haplusterts of Andhra Pradesh varied from yellowish brown (10 YR) to light grey (2.5 YR) (Bhaskar and Nagaraju, 1998).

Khan and Chatterjee (2001) reported that the moist matrix colour of all the horizons in uncultivated filed was strong brown (hue 7.5 YR) and mottle colour of the lower horizon was dark red (Hue 2.5 YR) but in rice cultivated soils it was brown (10 YR) and yellowish red (5 YR) respectively in West Bengal. These differences were mainly due to fluctuations of water table in rice growing pedon.

2.3.3 Soil texture

Soil texture is a very important and relatively a permanent property and it depends upon various factors like parent material, climate, topography, stage of weathering etc. Sahu *et al*. (1990) reported that the texture of Alfisols varied from gravelly silty clay loam to gravelly clay with more than 20% gravel in all the horizons. The texture of the deep Vertisols in Jayakwadi command area of Marathwada was clay-to-clay loam (Bharambe *et al*., 1990).

Krishnasamy and Krishnamoorthy (1991) reported that the sand, silt and clay contents of Vertisols varied from 24.6 to 67.4, 6.3 to 23.3 and 23.8 to 56.8 per cent, respectively. The clay content of Vertisols of Andhra Pradesh ranged from 36.7 to 73.1 per cent (Subbaiah and Manickam, 1992).

Murthy *et al*. (1994) stated that modifying affects of topography influenced the texture by bringing all the weathered products into low lying areas. The soils of northern Telangana zone of Andhra Pradesh were sandy loam to clay loams. The clay contents of soils varied from 17.4 to 54.1 per cent at surface layers (Vijay Kumar *et al*., 1994).

The texture of red soils in topo sequence as clay-to-clay loam is due to the translocation of finer sediments (Singh and Mishra, 1995). The texture of red soils of Kandukur division in Andhra Pradesh varied from sandy loam, sandy clay loam to clay loam (Jagannadham *et al*., 1995). Walia and Rao (1996) reported that the red soils derived from different parent materials showed wide textural variations from sandy loam to clay due to physiography, parent material, in situ weathering and translocation of clay. The texture of Inceptisols of north-west India were sandy loam to loam in Udic and loam to clay in Ustic moisture regime (Sharma and Gangwara, 1997). Khan *et al*. (1998) reported that the soils developed on Gangetic alluvium exhibited silty clay-to-clay texture, while those developed on Tista and Brahmaputra alluvium were silty loams.

Ravindhra Singh and Nayak (1999) reported clayey texture in Vertic Haplaquepts, Typic Haplaquepts and Vertic Ustochrepts whereas it is clay loam in Typic Ustochrepts in Mahi right bank canal command area of Gujarat. Ray Choudhary and Sanyal (1999) identified the clay texture in Inceptisols and clay loam texture in Entisols. Gangopadhyay *at al*. (2001) reported that the texure of the sub - surface horizons of rubber growing soils of Tripura varied from sandy loam to sandy clay loam, due to translocation of the final particles from the upper layer.

2.3.4 Soil structure

Swell shrink soils of semiarid tropics in India had developed sub angular blocky to angular blocky structure (Rajeev Srivastava and Jagdish Prasad, 1992). Inceptisols showed crumby to sub angular blocky structure and Vertisols showed blocky to sub-angular blocky structure in command area of Karnataka (Mruthunjaya and Kenchenna Gowda, 1993).

Vijay Kumar *et al*. (1994) reported that in Northern Telangana region of Andhra Pradesh, Inceptisols expressed granular to sub-angular blocky structure, whereas Vertisols had sub-angular blocky structure. Sub-angular blocky to prismatic structure in lower horizons of Vertisols, massive to moderate sub-angular blocky and single grained to moderate sub-angular blocky in Inceptisols and moderate blocky to sub-angular blocky structures in Alfisols of Kamarajan district of Tamil Nadu (Mahendran and Mathan, 1994).

The Vertisols of Andhra Pradesh had surface crumb structure followed by sub-angular blocky structure in deeper layers (Subbaiah, 1984) and the same was given for black soils of Kandukur division of Andhra Pradesh by Venkateswarlu *et al*. (1995). Singh *et al*. (1995) reported that the black soils developed from basalt and basaltic alluvium in Rajasthan had granular to angular blocky to massive structure. The structure of Vertisols of Andhra Pradesh was massive or granular at the surface layer, whereas blocky structure existed in lower layers (Surekha *et al*., 1997).

Patil *et al*. (1999) observed the structures of Entisols and Inceptisols of Akola as moderate sub-angular blocky at surface horizon and angular blocky in sub-surface horizons. But in Vertisols coarse, strong angular blocky was observed in Bssk horizon.

2.3.5 Cracks and slickensides

Subbaiah and Manickam (1992) observed prominent intersecting slickensides in Vertisols developed on different parent material in Andhra Pradesh. The black soils of Kandukur division in Andhra Pradesh showed cracks greater than 1 cm width and gilgai micro relief on the surface (Venkateswarlu *et al*., 1995).

Rao *et al*. (1995) reported that the black soils of Telugu Ganga project showed cracks extending down to a depth of 50 cm, which are classified under Vertisols. Surekha *et al*. (1997) observed the cracks of varying width (0.5 - 3.5 cm) in hot summer with prominent slickensides formation at lower depth in Vertisols of Andhra Pradesh. Well development slickensides in the sub-surface horizon (at 50 cm or below) and prominent cracks at the surface were observed in the salt affected soils of Purna valley of Vidarbha, Maharashtra (Padole and Deshmukh, 1998). The soils of Montagane in North Karnataka showed prominent slickensides and pressure faces indicating significant swell – shrink activity (Rudra Murthy and Dasog, 2001).

2.4 PHYSICAL PROPERTIES

2.4.1 Moisture retention characteristics

Singh *et al*. (1988) found high water retention capacity in silt loam and clay loam soils compared to the sand and loamy sand soils.

Ghajbhiye (1990) reported significant positive correlation of water retention at 15 bar with clay, silt and clay plus silt. Vertisols developed on basalt showed higher values of water holding capacity than the other soils developed on granite or metamorphic parent material (Murthy *et al*., 1994).

Bhaskar and Subbaiah (1995) reported that the water holding capacity of laterites and associated soils along the east coast of Andhra Pradesh ranged from 21.4 to 35.8 per cent and water holding capacity increased with increase in soil depth. Water holding capacity values varied from 23.31 to 56.97 per cent and the range of sticky point was 16.30 to 38.37 per cent in the black and associated soils of Pedakurapadu mandal in Guntur district of Andhra Pradesh (Ramana Kumar, 1997).

Anantwar *et al*. (2000) reported that the variability of liquid limit and plastic limit was high in B horizon and was positively correlated with clay CEC and organic carbon content. The variation in available water capacity in different soil groups may be attributed to difference in quantity, nature of colloidal materials present, pH and salt content (Ravender Singh *et al*., 2000).

Ravender Singh and Nayak (1999) studied the water retention characteristics of Mahi right bank canal command area of Gujarat. They concluded that the water retention capacity was in the order of Vertic Haplaquept > Typic Haplaquept > Fluventic Ustochrept > Typic Ustorthent. Higher water reterntion was noticed in Sodic Haplusterts than Calcic, Petrocalcic Haplusterts this may be due to the accumulation of Exchangeble sodium and lime at 0.03MPa (Singh et al., 2001)

2.4.2 Bulk density

The bulk density of Entisols of Tamil Nadu was as high as 1.78 g cm^{-3} (Kumaresan and Romanathan, 1989).

The Vertisols of Andhra Pradesh had bulk density varying from 1.75 to 2.08 g cc^{-1} (Subbaiah and Manickam, 1992). Prasuna Rani *et al*. (1992) reported that the bulk density of Alfisols and associated soils of Kavali canal area under Somasila project in Andhra Pradesh increased with depth (1.40 to 1.79 Mg m^{-3}).

Increase of bulk density in Alfisols was due to compaction caused by cementing agents (Suresh Kumar and Suman Kumar, 1993). Inceptisols under rice-wheat rotation had higher bulk density in plough layer, which was due to mechanical compaction caused by dynamic loading (Sawhney and Raj Kumar, 1993).

The soils of northern Telangana zone of Andhra Pradesh showed the bulk density ranging form 1.3 to 1.68 g cc^{-1} (Vijay Kumar *et al*., 1994). Jagannadham *et al*. (1995) reported that the red soils of Kandukur division in Prakasam district of Andhra Pradesh showed an increasing trend of bulk density (1.35 to 1.54 mg m^{-3}) with depth.

Gurumurthy *et al*. (1996) reported that the bulk density of soils ranged from 1.25 to 1.67 g cc^{-1} in the soils of Giddalur mandal of Prakasam district of Andhra Pradesh. Low bulk density of surface horizon was associated with relatively high organic mater content but its progressive increase with depth was probably due to increase in coarse fraction and/or filling up of pores by alluvial material leading to compaction (Walia and Rao, 1996). Sharma *et al*. (1997) stated that the bulk density was positively and significantly correlated with clay content.

High bulk density values of 1.79 to 1.81 mg m^{-3} in shallow Vertisols of central India where the bulk density values were increased with depth (Shashi Yadav *et al*., 1997).

Ram Prakash (1998) reported that the bulk density varied between 1.3 and 1.63 mg m^{-3} and showed increasing trend with depth and the range of particle density was 2.31 - 2.56 mg m^{-3} and no particular trend with depth was observed in soils of Gampalagudem mandal of Krishna district of Andhra Pradesh.The same was observed by Gupta et al .,(2001) in the Kandi Belt soils of Jammu region. Lower bulk density of 1.30 mg m^{-3} in Ustipsamments and higher bulk density values in Rhodic Paleustalfs in red sand dunes of Tamil Nadu (Jawahar *et al*., 1999).

Anantwar *et al*. (2000) reported that the bulk density was negatively correlated with organic matter and porosity showed increasing trends with decrease inorganic carbon content and soil porosity. The bulk density of Inceptisols and vertisols in Nagpur district of Maharashtra ranged from 1.52 to 1.72 gcm $^{-3}$ (Jagdish Prasad et al., 2001). Bulk density of red soils were higher (1.63 Mg m $^{-3}$) than black soils (1.57 Mg m $^{-3}$) due to their coarser texture associated with lesser porespace (Ram Prakash and Seshgiri Rao, 2002)

2.5 CHEMICAL PROPERTIES

2.5.1 Soil pH

The pH of surface soils of Northern Telangana zone ranged from 6.4 to 8.1 (Vijay Kumar *et al*., 1994), Maji and Bandyopadhyay (1995) studied the coastal soils of Sundarbans with various pH values which were acidic and varied greatly, despite the nearly similar physiographic situations.

The pH of black soils was higher than associated and red soils of Giddalur mandal of Guntur district, Andhra Pradesh (Gurumurthy *et al*., 1996). Patil and Dasog (1996) reported that the pH of lateritic soils of North Karnataka were slightly acidic (pH 5.5 to 6.6). The soil pH in 1N KCl followed the trend similar to the pH in water. The pH of surface horizon ranged from neutral (pH 7.3) to alkaline (pH 8.6) whereas in the sub-surface horizons it was neutral (pH 7.1) to strongly alkaline (pH 9.1) in the Inceptisols of North West India (Sharma *et al*., 1997).

Meena and Singh (1998)reported that the pH of Inceptisols from IARI, New Delhi was 7.7 and Vertisols from Indira Gandhi Vishwa Vidyalaya, Raipur was 7.6. The pH of Vertisols of Central India ranged from 7.1 to 8.4 (Biswas *et al*., 1999).

Rudramurthy and Dasog (2001) reported that the red soil pedons showed pH range from strognly acdic to neutral and from neutral to strognly alkaline in black soils of northern Karnataka.

2.5.2 Cation exchange capacity

Rao *et al*. (1984) reported that semiarid regions of Andhra Pradesh showed CEC of clay fractions ranged from as low as 13.6 mg/ 100 g clay in AP horizon of Vertisols. CEC showed significant positive correlation with soil pH and it varied at the rate of 3.7 cmol (p^+) kg^{-1} soil per unit increase in soil pH (Srivastava and Srivastava, 1991).

According to Subbaiah and Manickam (1992) Vertisols of Andhra Pradesh were having CEC within the range of 46.3 to 67.8 cmol(p^+) kg^{-1}. In red soils CEC of surface horizons was high and those of C horizon low (Maji and Bandyopadhyay, 1995). Mishra and Ghosh (1995) reported higher CEC values in Inceptisols than the expected values when the clay content was very low which would be attributed to genesis of larger particles of Vermiculite and possible of chlorite.

The CEC value of black soils of Telugu Ganga project area tend to increase with depth with high base saturation (86-97 %) reflecting restricted internal water movement (Rao *et al*., 1995). Sreenivasulu Reddy (1997) reported that the CEC of Vertisols in Kurnool district of Andhra Pradesh was very high which ranged between 50.5 and 60.6 cmol (p^+) kg^{-1} soil. The Inceptisols of Sagar Island showed CEC 18.5-21.6 cmol (p^+) kg^{-1} did not show definite trend with depth due to variable clay and organic carbon content (Maji *et al*., 1998).

Trivedi *et al*. (1998) noticed higher CEC values in Vertisols ranging from 31.6 to 38.9 c mol (p^+) kg^{-1} in comparison to Entisols having 11.2 to 37.9 cmol (p^+) kg^{-1}. The CEC of Paleosols in Anantapur district was lower than 1.5 to 11.7 C mol (p^+) kg^{-1} suggesting that the soils were highly leached (Dutta *et al*., 2001)

2.5.3 Electrical conductivity

Yadav *et al*. (1989) observed the EC values of 1.2 and 1.4 dSm^{-1} for Inceptisols and Vertisols respectively. The EC of soils of Northern Telangana zone ranged from 0.01 to 0.7 dSm^{-1} (Vijay Kumar *et al*., 1994). Sidhu *et al*. (1994) reported that the Entisols of Punjab were low in EC ranging from 0.16 to 0.51 dSm^{-1}. The EC values of red soils of Kandukur division of Prakasam district in Andhra Pradesh varied from 0.06 to 0.98 dSm^{-1} (Jagannadham *et al*., 1995).

Maji and Bandyopadhyay (1995) found that the amount of salt accumulation as indicated by EC was higher in heavy textured soils than light textured soils but the EC of Vertisols did not vary much it was around 0.1 dSm^{-1} in Basaltic alluvium of Rajasthan.

EC of black soils of Kandukur mandal showed 0.16 to 0.39 dSm^{-1} and increased with depth (Venkateswarlu *et al*., 1996). Sreenivasulu Reddy (1997) reported that the Vertisols of Nandyal farm showed EC 0.5-3.1 dSm^{-1} with mean value of 1.5 dSm^{-1} and increased with depth. EC values of Gurazala mandal in Guntur district of Andhra Pradesh ranged from 0.238 to 1.237 dSm^{-1} (Anitha *et al*., 1998).

2.5.4 Exchangeable cations

Exchangeable calcium, magnesium and sodium increased with depth and exchangeable potassium was distributed uniformly due to potassium equilibrium in soils (Karale *et al*., 1969). Black soils have greater amount of total exchangeable cations than alluvial or laterite soils and the black soils were richer in exchangeable calcium than the other two (Daji, 1970).

According to Boul *et al*. (1980). the soils formed from limestone, dolomites, shales, basalt and diorites were high in base saturation. Soils developed from sand stones, granites, granitic- gneiss and the unconsolidated coastal plain sediments of alluvial - colluvial - deltaic origin were low in base saturation.

2.5.5 Organic carbon

Rao and Krishna Murthy (1982) found that the organic matter content varied form 0.15 to 0.7 per cent in red soils and 0.1 to 1.05 per cent in black soils of Hyderabad region. Singh *et al*. (1994) reported 0.36 - 1.54 per cent organic carbon showing maximum value in plateau and decreasing topographically from gently sloping plain of alluvial plains. Lateritic soils showed 0.51 to 0.56 per cent organic carbon in crest and 0.87 per cent in valley, due to deposition of eroded materials from upland soils into valley (Kudrat *et al*., 1995).

The surface soils of valleys in Arunachal Pradesh were rich in organic carbon decreasing regularly with depth but the colluvium derived soils at piedmont slopes showed reverse trend due to inherent nature of deposited materials (Walia and Chamuah, 1990).

Anil *et al*. (1998) stated that the organic carbon content of the basaltic derived soils were higher than sandstone derived soils. In the upland of Tamil Nadu Alfisols showed accumulation of organic carbon at surface soils due to downward movement and Vertisols showed distribution of organic carbon throughout the profile due to pedoturbation (Thiyagarajan, 1998). Dipak Dutta *et al*. (2000) found that the parent material had influence on the organic carbon storage through its control on soil texture. The mean soil organic carbon storage in five land forms is in the order of Basalt > alluvial > laterite > sand stone > granite - gneiss. Gangopadhyay et al., (2001 found that the organic carbon varied from 1.0 to 14 .4 g kg^{-1} in the rubber growing soils of Tripura and also reported that the organic carbon content was high in the surface layers and it decreased with the depth.The organic carbon content was low (1.5 to 11.5g kg^{-1}) and decreased with depth in the Nagpur Mandarin orchard (Marathe et al, 2003)

2.5.6 Calcium carbonate

Subbaiah and Manickam (1987) reported that parent material rich in $CaCO_3$ gave rise to shallow profiles and the profiles derived from granite were not calcareous where the size and abundance of $CaCO_3$ concentrations increased with depth imparting brown to pale brown colour in deeper horizons. They also concluded that Entic Chromustert and Typic Chromusterts were weak in $CaCO_3$ content whereas Typic and Entic Paleusterts were strong in $CaCO_3$ content (> 5% $CaCO_3$) Balanagoudar and Satyanarayana (1990) in their study found that all the Vertisols were alkaline and high $CaCO_3$ (4.4-22.25 %) and the Alfisols were slightly acidic and low in $CaCO_3$ (Traces to 1.6%).

Red soils of Northern Karnataka were devoid of $CaCO_3$ (Rudra Murthy *et al*., 1996). Sharma *et al*. (1996) observed that the zone of $CaCO_3$ accumulation was between 0.56 and 0.80 m and 0.12 and 0.156 m depth in Typic Ustochrepts indicating that pedoturbation was not sufficient to erase out the effect of old pedogenic activities. Surekha *et al*. (1997) noticed that the $CaCO_3$ content varied from 45 to 228 g kg^{-1} in Vertisols of Andhra Pradesh. Haplusterts occurring in Chitravathi river basin of Andhra Pradesh had the $CaCO_3$ values ranging from 7.4 to 148 g kg^{-1} and this content was positively correlated (r = +0.42) with silt fraction (Bhaskar and Nagaraju, 1998).

Sahrawat (1999) reproted that Vertiols of Patancheru, Andhra Pradesh had the $CaCO_3$ value varying from 93 to 152 g kg^{-1}

2.5.7 Available NPK content

Jenny (1941) stated that the nitrogen content of the soil increased with increase of rainfall. The nitrogen content of the black soils of Andhra Pradesh was low. Red soils were poor in all the major plant nutrients while alluvial soils were rich in phosphorus and potassium (Raychoudhuri *et al*., 1963).

Jamuna *et al*. (1984) reported that the available potassium status of coastal sandy soils of Andhra Pradesh was in the range of 40.7 to 201.6 kg ha^{-1}. In Andhra Pradesh about 57 per cent of soils are low in available nitrogen, 80 per cent were low in available phosphorus and only 3 per cent were low in available potassium (NBSS and LUP, 1997). Contents of available phosphorus ranged from 7.7 to 55.4 kg ha^{-1} in different soil associations of Kanpur district in central Uttar Pradesh. Correlation studies reveal that availability of phosphorus in all the soil associations in general was significantly and positively influenced by organic matter and finer soil particles (Pandey *et al*., 2000).

2.5.8 Total Micronutrients

According to Nipunage *et al*. (1996) the Inceptisol soils of Maharashtra were having total Fe, Mn, Zn and Cu in the ranges from 6.4 to 14.4%, 800 to 2880 ppm, 48 to 240 ppm and 140 to 520 ppm respectively. The total Fe and Mn was higher when compared to Zn and Cu.

The total Zn, Cu and Mn contents were significantly and positively associated with clay content where as pH and EC excercised significant negative effect (Murthy *et al*., 1997).

2.5.9 Available micro nutrients

The DTPA extractable Zn, Cu and Fe in Alfisols of Ananthapur district of Andhra Pradesh ranged from 0.2-1.8 and 2.31-19.5 ppm respectively (Pillai *et al*., 1982). Prabhu Prasadini and Singa Rao (1995) reported that in Srikakulam soils the available micro nutrients were above critical limits. According to NBSS and LUP and ICAR (1997) in Andhra Pradesh 49 and 22 per cent of soils were deficient or marginal in Zn and Fe, respectively. The Vertisols were well supplied with respect to available Fe, Mn and Cu.

According to Patiram *et al*. (2000) soil pH had negative correlation with available Fe and Mn and positive with Zn and Cu. The distribution of available micro nutrients is relatively low in Inceptisols of piedmont and soils of active flood plains than the soils of upland, gently sloping plains and recent flood plains (Nayak *et al*., 2000).

Dipak Sarkar *et al*. (2000) reported that the soils of Madhubani district, Bihar were fairly rich in available Cu, Fe and Mn but were low in Zn. The available Zn contents varied from 0.4 to 1.0 ppm in these soils. In acid Alfisols of Bihar plateaus, different forms of Fe occurred in the following decreasing order : Crystalline > Amorphous > Organic

> Exchangeable (Mathur *et al*., 2000). Jassal *et al*., (2000) and Venkatesh *et al*., (2003) reported that the organic carbon content was positively correlated with available Zn and Cu.

2.6 CLASSIFICATION

Venkateswarlu *et al*. (1995) classified the black soils of Kandukur division, Andhra Pradesh developed on granite gneiss under Vertisols or vertic subgroup of Inceptisols. Red, black and associated soils of Giddalur mandal in Andhra Pradesh were classified as Calcic Ustochrepts, Typic Haplustalfs, Chromic Calciusterts, Typic Rhodustalfs and Vertic Ustochrepts (Gurumurthy *et al*., 1996).

Sreenivasulu Reddy (1997) classified the soils in Kurnool district of Andhra Pradesh into very fine montmorillonitic hyper thermic, Palleustollic Chomusterts at family level. The deep black soils of Andhra Pradesh were grouped under the order Vetisols sub-order Usterts, great group Haplusterts, sub groups Typic and Chromic Haplusterts (Surekha *et al*., 1997).

Red soils of south-west Nigeria were classified by Okusami *et al*. (1997) into Rhodic Kandiudalfs and Rhodic Kandiudults by the presence of kandic horizons. The soils at the slope, hummocks, sand dunes and inter demal depression were placed under the order Entisols and demal base and plains under Aridisol. The Aridisol was due to the presence of cambic sub surface horizons and aridic soil moisture regime whereas

Entisol was due to lack of pedogenic activity and absence of diagnostic horizons in pedons of these areas (Ahuja *et al*., 1997).

The soils of Andhra Pradesh mainly come under four orders, namely Entisols, Inceptisols, Vertisols and Alfisols as per soil Taxonomy. The genesis of red and black soils lying in between the Krishna and Pennar river catchment areas of the state were studied by Vijay Kumar *et al*. (1997).

According to Turton *et al*. (1998) red soils in the eastern hills of Nepal were classified as Rhodustalf, which were showing Bt horizon of clay accumulation. The black soils of Gurazala mandal in Guntur district of Andhra Pradesh were classified as Petrocalcic Usterts, Typic calciusterts, Chromic Haplusterts, Chromic Calciusterts, Vertic Ustropepts (Anitha *et al*., 1998).

Singh *et al*. (1998) classified soils of Goa and placed some soils in Alfisols based on eluvial-illuvial horizons, higher fine clay to total clay coupled with argillans. Further, placed under Ultic Rhodustalf based on colour concept, Ultic Haplustalfs with base saturation <75% and lesser-illuviated profiles into Oxic Dystropepts.

The black soils of Bidar and Mantagani areas of North Karnataka were studied by Rudramurthy and Dasog (2001) and classified them as Typic Haplusterts, Typic Calciusterts and Typic Haplusterts respectively.

2.7 CROP PRODUCTION CONSTRAINTS

Toposequential occurrence of soil texture, CEC, K actvity, depth and slope gradient determine the soil potassium status (Gajbhiye *et al*., 1993).

Crop production constraints in the soils of Srikakulam district were studied by Prabhu Prasadini and Singa Rao (1995). The constraints included were very rapid permeability, poor permeability in some of the soils with high clay content, high bulk density in lower layers, low organic carbon and poor nitrogen contents. Suitable management practices for improving the productivity of the soils were suggested.

According to NBSS and LUP (1997) in Andhra Pradesh about 54 per cent of soils are degraded by water erosion, crusting and compaction, salinity and sodicity and flooding. About 28 per cent soils are calcareous and 5 per cent of soils are affected by frequent flooding and water logging.

Reddy *et al*. (1998) reported that water erosion is the major degradation problem causing loss of top soil and terrain deformation in about 45.5 per cent area. Chemical deterioration in the form of loss of nutrients and organic matter, soil salinisation and sodification account for about 2.1 per cent area. Physical deterioration due to the formation of sealing crusts and compaction and water logging and flooding have affected about 6.8 per cent land area in the state.

2.8 LAND USE PLANNING

The Vertisols are well or moderately well suited to improved inter cropping systems using cereals and legumes, but unsuited to improved sequential cropping systems unless supplementary irrigation is provided (ICRISAT, 1991).

According to FAO (1993) systematic assessment of physical, social and economic factors in such a way as to encourage and assist land uses in selecting options that increase their productivity are sustainable and meet the needs of the society.

The delineation of agro-ecological units that provide complete information on the edaphic situation when used, in conjunction with soil resource maps, provides a sound basis for optimising land use (Sehgal, 1995). Janakiraman *et al*. (1997) conducted a study for land use planning in the soils of Tamil Nadu and the potentials and constraints were assessed and interpreted for better land use planning. Based on soil properties and land capability classes, a suitable land use plan was suggested for the soils of Manipur by Dipak Sarkar *et al*., (2002)

CHAPTER III

MATERIALS AND METHODS

For this study soil samples were collected from fifteen profiles of Ranga Reddy district in Andhra Pradesh. Profiles were opened up to the parent material or greater than 1.2 m depth and described for their morphological characteristics as per the procedure given in the USDA soil survey manual (Soil Survey Staff, 1967).

3.1 LOCATION OF THE DISTRICT

Ranga Reddy district extends over an area of about 7493 km^2 and is bounded by 16°30' and 18°20' North latitude and 77°30' and 79°30' East longitudes. It is surrounded by Medak district in the North, Mahaboobnagar district in the South, Nalgonda district in the East and Gulbarga district of Karnataka state in the West.

3.2 PHYSIOGRAPHY

The district is mostly hilly with some woods. The general slope of the land is from west to east and south-east. The Rajkonda hill reins in a south-east direction up to Devarakonda mandal in Nalgonda district. The Ananthagiri hills Traverse the district from the south in Mahaboobnagar district to the north upto Dharur. A large portion of this range is compared of high grade latitude and isolated granite hills are also found.

3.3 RIVERS

Ranga Reddy district comprises of plains criss crossed with some rivers, several rivulets and small streams. The chief river is Musi, which rises in the Ananthagiri hills near Sivareddipet village (Vikarabad mandal) and flows from west to east.

River Bhima also called as Knaga flows through Vikarabad and Tandur. Manjira, tributary of Godavari, also drains in the district.

3.4 CLIMATE

The average rainfall of the district is about 750 mm, 60 per cent of which is recorded during south-west monsoon. The maximum and minimum temperatures vary between 27°C to 45.5°C.

Collection of soil samples

Profile samples

The profiles were studied in selected locations by digging pits upto the required depth. There was maximum sunshine on the face of the profile at the time of sampling. The faces of the pits were cleaned carefully with wooden plank and the depths of each layer was marked depending on variations. The soil samples were collected in cloth bags for the purpose of characterisation and classification of Ranga Reddy district soils.

Surface samples

Two samples from each mandal were collected at random from a depth of 10-20 cm (60 surface samples).

3.5 PROCESSING OF SOIL SAMPLES

Horizon wise soil samples were collected from fifteen profiles which were air dried under shade and pounded with wooden pestle and passed through 2 mm sieve. The soil so collected was used for determining their physical, physico-chemical and chemical properties.

3.5.1 Physical properties

3.5.1.1 Particle size distribution

Particle size distribution of the soils was determined by hydrometer method as described by Gee *et al*. (1986). Textural classes of the soils were interpreted from the textural triangle diagram given for the international system of classification of particle sizes.

3.5.1.2 Bulk density

Core method on dry weight basis was used to determine the bulk density of soils and were expressed in g cm^{-3} (Blake and Hartge, 1986).

3.5.1.3 Soil colour

Munsellis colour notation of hue, value and chroma were evaluated both for dry and moist samples (Soil Survey Staff, 1975).

3.5.1.4 Water retention

Water retention capacity of the soil samples at 0.33 and 15 bar tensions was determined using pressure plate apparatus (Klute, 1986) and expressed interms of percentage on dry weight basis.

3.5.2 Physico-chemical properties

3.5.2.1 Soil reaction

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

3.5.2.2 Electrical conductivity (EC)

The electrical conductivity was determined in 1:2.5 soil water extract using digital conductivity meter (Jackson, 1973) and the results were expressed in dSm^{-1}.

3.5.2.3 Cation exchange capacity

Sodium saturation method was used to determine the CEC of the soil samples (Chapman, 1965) and the results were expressed in cmol (p^{+}) kg^{-1} soil.

3.5.3 Chemical properties

3.5.3.1 Free calcium carbonate

The free calcium carbonate content was determined by rapid titration method as described by Piper (1966).

3.5.3.2 Exchangeable cations

The exchangeable cations Ca^{2+}, Mg^{2+}, Na^{+} and K^{+} were determined by extracting the soil with neutral normal ammonium acetate (Jackson, 1973) and the results were expressed in cmol (p^{+}) kg^{-1} soil.

3.5.3.3 Available secondary nutrients

Calcium and magnesium were determined in the sodium acetate leachate by versenate (Jackson, 1973).

3.5.3.4 Exchangeable sodium percentage

ESP is calculated by using the formula (Soil Science Society of America, 1984) :

$$ESP = \frac{\text{Exchangeable sodium}}{\text{CEC}} \times 100$$

3.5.3.5 Organic carbon

Walkley and Black (1934) method was used to determine the organic carbon content of the soils and the results were expressed in percentage.

3.5.3.6 Available nitrogen

The available nitrogen in soils was determined by alkali permanganate method given by Subbaiah and Asija (1956) and the results were expressed in kg ha^{-1}.

3.5.3.7 Available phosphorus

The available phosphorus content was determined by extracting the soil with 0.5 M $NaHCO_3$ (Olsen *et al*., 1954) and estimating the phosphorus colorimetrically in the extract by ascorbic acid method (Watanabe and Olsen, 1965).

3.5.3.8 Available potassium

The available potassium content was determined in neutral normal ammonium acetate extract using a flame photometer (Jackson, 1973).

3.5.3.9 Total micro nutrients

Total micro nutrients, Zn, Cu, Fe and Mn were determined by aspirating the diacid mixture extract directly in the Atomic Absorption Spectrophotometer. The results were expressed as mg kg^{-1} (Hesse, 1971).

3.5.3.10 Available micro nutrients

The available micro nutrients (Zn, Cu, Fe and Mn) were determined in the DTPA extract of soil using Atomic Absorption Spectrophotometer (Lindsay and Norwell, 1978).

3.5.3.11 Soil classification

The soils were classified as per the soil taxonomy of USDA (Soil Survey Staff, 1975).

3.5.3.11 Identification of constraints

Soil constraints for crop production were identified based on the laboratory and field analysis of the soils.

CHAPTER IV

RESULTS

The selected soil profiles(15) in Ranga Reddy district were studied for their morphological features and described horizon wise. The surface samples (60) were also analysed. Soil samples collected from these profiles were analysed for physical properties viz., particle size distribution, bulk density and moisture retention at 1/3 and 15 bars, physico-chemical properties viz., soil reaction (pH), electrical conductivity (EC) and cation exchange capacity (CEC) and chemical properties viz., organic carbon, exchangeable cations, available nitrogen, available phosphorus, available potassium. Total and available micro nutrients (Fe, Mn, Cu and Zn) were also determined. The results are presented in this chapter.

4.1 MORPHOLOGICAL PROPERTIES

4.1.1 Soil depth

The profile of Bashirabad (114 cm), Doma (118 cm), Tandur (136 cm) and Vikarabad (115 cm) pedons were deep, whereas other pedons were shallow and the depth ranged from 32-78 cm.

4.1.2 Soil horizons

Bashirabad and Doma showed six horizons and Vikarabad five horizons, while the rest showed three to four horizons. The thickness of the surface horizons ranged from 13 to 19 cm and the sub surface horizons ranged from 13 to 53 cm.

4.1.3 Horizon boundary

The change in properties with depth was gradual in all the pedons studied. Distinction between the horizons in all the pedons studied has been generally clear and smooth boundaries. Except for Bashirabad and Doma Pedons which showed diffuse and smooth.

4.1.4 Soil colour

The Bashirabad, Uppal, Kisara, Medchal, Doma, Tandur, Shamshabad, and Vikarabad pedons had the hue of 10 YR with values 2 to 5 and chroma 2 to 6. The other pedons had hue of 5 YR with values of 3 to 5 and chroma 2 to 6.

4.1.5 Soil structure

Pedons of Chevella and Saroornagar showed subangular blocky structure throughout the depth whereas Bashirabad, Doma and Tandur showed subangular blocky structure at surface and angular blocky at lower depths, Moinabad, Uppal, Ibrahimpatan, Shamirpet, Shamshabad and Mominpet showed granular to subangular blocky structure in the surface and subangular block in subsurface layers. The remaining pedons Kisara, Medchal and Vikarabad had granular structure in surface and angular blocky in the subsurface layers.

4.1.6 Soil texture

The texture of pedons varied widely as sandy loam, sandy clay loam, sandy clay and clay.

4.1.7 Soil consistence

The consistence varied from non sticky and non plastic to very sticky and very plastic.

4.1.8 Cracks

Bashirabad, Kisara, Medchal, Shamirpet, Doma, Tandur and Shamshabad pedons had wide surface cracks with width varying from 1-2.5 cm and extending upto a maximum depth of 89 cm.

4.1.9 Slicken Sides

Bashirabad, Doma, Tandur and Vikarabad pedons had shown indistinct to distinct and prominent slicken sides in deeper layers.

4.1.10 Pores

The pores ranged from few (less than one per unit area) to many (more than 5 per unit area), fine (1 mm) to medium (2.5 mm) pores are seen in the pedons.

4.1.11 Roots

The roots were common and many to few in all the pedons studied. Very fine (less than 0.5 mm) to medium (2.5 mm) roots are seen in the pedons.

4.2 PHYSICAL AND PHYSICO-CHEMICAL PROPERTIES

The data pertaining to the physical and physico-chemical properties of the profile samples are presented in Table 2.

4.2.1 Soil texture

Clay: The results of the particle size analysis revealed that the clay content increased with depth in Bashirabad, Chevella, Moinabad, Kisera, Saroornagar and Doma and a reverse trend was observed in Kisara, Shamirpet and Mominpet. Among the rest no particular trend was followed. Bashirabad recorded higher clay content ranging from 51.9 to 57 per cent while Saroornagar recorded lower clay content varying from 17.9 to 31.8 per cent.

Silt : The silt content decreased with depth in Moinabad, Uppal, Kisara, Medchal, Pargi and Mominpet pedons while in remaining pedons it followed an irregular trend. Vikarabad pedon recorded higher silt content ranging from 13 to 21.9 per cent while Medchal pedon recorded lower silt content ranging from 4.9 to 5.7 per cent.

Sand : The sand content decreased with increase in depth in Chevella, Moinabad, Saroornagar, Doma and Shamshabad pedons while the reverse was observed in Shamirpet and Mominpet pedons, while the other pedons showed an irregular trend, higher values are recorded by Saroornagar 58.9 to 73.5 per cent while Bashirabad recorded the lower values ranging in between 27.8 and 29.4 per cent.

4.2.2 Bulk density

The bulk density values ranged from 1.16 to 1.69 gcc^{-1}. These values increased with depth in most of the pedons, whereas Shamirpet, Shamshabad showed an irregular trend. Tandur pedon showed lower values ranging from 1.16 to 1.39 gcc^{-1} while the Saroornagar pedon showed higher values varying from 1.43 to 1.69 gcc^{-1}.

4.2.3 $CaCO_3$

The results revealed that the $CaCO_3$ content increased with decrease in depth in all the pedons. The $CaCO_3$ content in different pedons ranged from 0.6 to 7.8 per cent. Bashirabad and Doma, Tandur and Vikarabad pedons showed greater than five per cent $CaCO_3$ indicating as medium while the remaining pedons are having less than five per cent and low in $CaCO_3$.

4.2.4 Moisture retention

All the pedons showed an increase in the moisture retention along with the increase in the depth. The moisture retention in different pedons ranged from 6.9 to 31.5 with highest retention being recorded in Doma and the lowest in Mominpet.

4.2.5 Soil reaction

All the soil samples studied were slightly acidic to alkaline in reaction. The pH values ranged from 6.1 to 9.1. Higher values were observed in Bashirabad, Kisara, Medchal, Shamirpet, Doma, Tandur, Shamshabad and Vikarabad pedons from 7.7 to 9.1. Relatively lower values were observed in Chevella, Moinabad, Uppal, Saroornagar, Pargi and Mominpet, pedons ranging from 6.1 to 7.39.

4.2.6 Electrical conductivity

The results revealed that the electrical conductivity is less varied among the pedons ranging from 0.05 to 0.71 dSm^{-1}. All the pedons showed an increasing trend with depth whereas Chevella, Saroornagar and Mominpet had not shown any particular trend with depth. Higher values were observed in Bashirabad and Doma pedons ranging from 0.37 to 0.71 dSm^{-1}, while lower values of 0.05 to 0.43 dSm^{-1} were recorded in the remaining pedons.

4.2.7 Cation exchange capacity

The results revealed that there was a wide variation in CEC values varying from 6.95 to 52.17 cmol$(p^+)^{-1}$ kg soil Kisara, Saroornagar and Shamshabad pedons showed an irregular trend with depth whereas the remaining pedons showed an increasing trend with depth.

4.2.8 Organic carbon

The organic carbon content in different pedons ranged from 0.08 to 0.77 per cent. The organic carbon content was found to be invariably high in surface horizons than subsurface horizons. Bashirabad, Chevella, Uppal, Kisara, Saroornagar, Ibrahimpatan, Medchal, Shamirpet, Doma, Tandur, Shamshabad, Pargi, Mominpet and Vikarabad pedons showed a decreasing trend with depth.

4.2.9 Exchangeable sodium percentage

The exchangeable sodium percentage values ranged from 0.02 to 8.10 per cent. The highest value (8.10) was recorded in Mominpet pedon and the lowest (0.02) was recorded in Kerara.

4.3 CHEMICAL PROPERTIES

The data pertaining to the chemical properties of the profile samples are presented in Table 3.

4.3.1 Exchangeable bases

Calcium

The exchangeable calcium was found to be the dominant cation on the exchange complex and the values varied from 6.1 to 31.6 cmol kg^{-1} soil. Saroor Nagar, Shamirpet, Shamshabad and Mominpet pedons showed an irregular trend with depth while in the remaining pedons.an increase with depth was observed.

Magnesium

Next to calcium, magnesium was the dominant cation on the exchange complex and the values ranged from 2.1 to 16.7 cmol kg^{-1} soil. Pedons of Bashirabad, Moinabad, Uppal, Kisara, Saroornagar, Ibrahimpatan, Doma, Tandur, Mominpet, Vikarabad and Shamirpet showed an increasing trend with depth and Chevella, Medchal, Shamirpet, Shamshabad and Pargi pedons had shown an irregular trend with depth.

Sodium

The exchangeable sodium varied from 0.01 to 1.02 cmol kg^{-1} soil. Kisara Medchal and Vikarabad pedons showed an increasing trend with depth and the reverse was observed in the pedons of Moinabad, Uppal, Medchal and Mominpet. The remaining pedons showed an irregular trend with depth.

Potassium

The surface horizons of all the pedons invariably recorded higher values than the subsurface horizons and all the pedons showed a decreasing trend with depth.

4.3.2 Available nitrogen

The results of the available nitrogen content indicated that all pedons were found low to medium in available nitrogen in the surface horizons. The available nitrogen content varied from 49 to 317 kg ha^{-1} in all the pedons. The highest value of 317 kg ha^{-1} was observed in the surface horizon of Medchal pedon and the minimum value of 49 kg ha^{-1} was noticed in the lowest horizon of Shamshabad pedon. All the pedons showed a decreasing trend with depth.

4.3.3 Available phosphorus

The results of the available 'P' content indicated that all the pedons were found to be low to medium in available phosphorus content in the surface horizons. The available phosphorus content varied more 3.1 to 28.1 kg ha^{-1}. The highest value of 28.1 kg ha^{-1} was observed in the Tandur pedon surface horizon and the minimum value of 3.1 kg ha^{-1} was noticed in the lower horizon of Kisara. All the pedons showed a decreasing trend with depth except Bashirabad and Shamshabad which showed no regular trend.

4.3.4 Available potassium

The available K content varied from 132.7 to 648.6 kg ha^{-1}. Higher values were observed in Tandur pedon ranging from 309.4 to 648.6 kg ha^{-1} and lower values were observed in Shamshabad pedon ranging from 132.7 to 221.4 kg ha^{-1}. All the pedons showed a decreasing trend with depth.

4.3.5 Total zinc

The total zinc content varied from 27.06 to 93 ppm. Highest values ranging from 75 to 93 mg kg^{-1} were recorded by Ibrahimpatan pedon, lowest values were recorded by Kisara pedon (27.06 to 31.23). Moinabad, Uppal, Ibrahimpatan and Vikarabad pedons showed decreasing trend with depth while the rest of the pedons did not show any particular trend with depth.

4.3.6 Total copper

The total copper content varied from 17.09 to 121 mg kg^{-1}. The highest value of 121 mg kg^{-1} was recorded in Ibrahimpatan pedon in which the values ranged form 102.8 to 121 mg kg^{-1} while the lowest value of 17.09 mg kg^{-1} was registered by Vikarabad in which the values ranged from 17.09 to 21.76 ppm. All the pedons showed an irregular trend with depth except Ibrahimpatan, Chevella, Moinabad and Uppal which showed a decreasing trend with depth.

4.3.7 Total iron

The total iron content varied from 1.01 to 7.5 mg kg^{-1}. The highest being recorded in the lower horizon of Saroornagar pedon while the lowest value of 1.01 ppm was recorded in the lower layer of Pargi pedon. All the pedons showed an irregular trend with depth except Moinabad, Uppal, Kisara, Ibrahimpatan, Pargi, Mominpet and Vikarabad which showed a decreasing trend with depth. Most of the profiles recorded higher total Fe content in the surface layer than in the subsurface layer.

4.3.8 Total manganese

The total manganese content ranging from 256 to 1506 mg kg^{-1}. The highest value of 1506 mg kg^{-1} was registered in Shamirpet pedon while the lowest value of 256 mg kg^{-1} was recorded in lower horizon of Kisara pedon. The pedons of Uppal, Ibrahimpatan, Medchal, Shamirpet, Tandur, Pargi, Mominpet and Vikarabad showed a decreasing trend with depth and remaining pedons showed an irregular trend with depth.

4.3.9 Available zinc

The available zinc content varied from 0.07 to 1.8 mg kg^{-1} highest values ranging from 0.9 to 1.8 mg kg^{-1} were recorded in

Chevella pedon and lowest values were recorded in Mominpet pedon ranging from 0.07 to 0.15 mg kg^{-1}. A decreasing trend with depth was noticed in all the pedons except Kisara, Ibrahimpatan, Medchal, Tandur and Pargi pedons which were showing an irregular trend with depth.

4.3.10 Available copper

The available copper content varied from 0.19 to 1.87 mg kg^{-1}. Highest values ranging from 1.21 to 1.87 mg kg^{-1} were recorded by Chevella pedon and lowest values were recorded in Medchal pedon (0.19 to 0.49 mg kg^{-1}). A decreasing trend which depth was noticed in Bashirabad, Chevella, Moinabad, Uppal, Saroornagar, Medchal, Shamirpet, Doma, Tandur, Shamshabad, Pargi and Vikarabad. The remaining pedons showed an irregular trend with depth.

4.3.11 Available iron

The available iron content varied from 4.09 to 22.4 mg kg^{-1}. Highest values were recorded in Chevella pedon ranging from 17.6 to 22.4 mg kg^{-1} while lowest values were recorded in Mominpet pedon ranging from 4.09 to 4.76 mg kg^{-1}. A decreasing trend with depth was noticed in Bashirabad, Moinabad, Uppal, Kisara, Saroornagar, Ibrahimpatan, Medchal, Shamirpet, Doma, Tandur, Pargi, Mominpet and Vikarabad pedons. The remaining pedons did not show any particular trend with depth.

4.3.12 Available manganese

The available manganese content varied from 11.2 to 59.18 mg kg^{-1}. Highest values ranging from 21.09 to 59.18 were recorded by Shamirpet pedon while lowest values were recorded in Doma pedon ranging from 11.2 to 18.16 mg kg^{-1}. A decreasing trend with depth was noticed in Ibrahimpatan, Shamirpet, Doma, Bashirabad, Chevella, Moinabad, Uppal, Pargi, Mominpet and Vikarabad pedons while the remaining pedons did not show any particular trend with depth.

4.4 CHARACTERISTICS OF SURFACE SOILS

The results of characteristics of surface soils are presented in Table 4.

4.4.1 Particle size distribution

The texture of the soils varied from sandy loam to clayey. The maximum clay content of 54.8 per cent was recorded in Timmaipalle surface soil while minimum clay content of 18 per cent was recorded in Antireddigudam surface soil. The silt content was more in Malkaram surface soil and was low in Railapuram surface soil. The sand content varied more 27.6 to 73.4 per cent. Minimum sand was observed in surface of Timmaipalle soil while maximum was noticed in surface soil of Antireddigudam.

4.4.2 Soil reaction (pH)

The soil pH in surface soils ranged from slightly acidic to strongly alkaline with pH values of 6.13 to 8.91. The lowest (pH 6.13) was recorded in Khudawandpur surface soil while highest (pH 8.91) was noticed in Chintakunta surface soil.

4.4.3 Electrical conductivity (EC)

The EC of the soils ranged from 0.04 to 0.63 dSm^{-1}. The maximum EC of 0.63 dSm^{-1} was recorded in Nancherlapeta surface soil while lowest EC of 0.04 dSm^{-1} was observed in surface soil of Kankal.

4.4.4 Organic carbon

The organic carbon content of soils ranged from 0.19 to 4.11 per cent. The highest organic carbon content (4.11 %) was noticed in surface soil of Kothaguda whereas lowest organic carbon content (0.19 %) was seen in surface soil of Sirpuram.

4.4.5 Free calcium carbonate

The free $CaCO_3$ was found to vary from nil to 4.2 per cent. The $CaCO_3$ was found absent in some surface soils. The highest $CaCO_3$ content (4.2 %) was found in surface soil of Thimmayapalli.

4.4.6 Available phosphorus

The available phosphorus status was low to medium varying from 5.6 to 28.7 kg ha^{-1}. The highest (28.7 kg ha^{-1}) being observed in Indur surface soil, while the lower (5.6 kg ha^{-1}) was seen in Thimmayapalli surface soil. Almost all the surface soils were low to medium in available phosphorus content.

4.4.7 Available potassium

The available potassium status was medium to high varying from 164.9 to 586.7 kg ha^{-1}. The maximum content of available K (586.7 kg ha^{-1}) was recorded in Buragpalli surface soil while the minimum (164.9 kg ha^{-1}) was observed in Antireddigudem surface soil.

4.4.8 Exchangeable calcium

The exchangeable Ca^{++} content was found to vary from 6.3 to 27.8 c mol (p^+) kg^{-1}. The lowest Ca^{2+} content [6.3 c mol (p^+) kg^{-1}] was recorded in Buchanpalli surface soil while the highest [27.8 c mol (p^+) kg^{-1}] in Railapuram surface soil. Taking 1.5 meq. 100 g^{-1} soil as critical limit (Tandon, 1989) all the soils were found sufficient in exchangeable Ca.

4.4.9 Exchangeable magnesium

The exchangeable Mg^{++} showed a variation from 2.7 to 17.6 c mol (p^+) kg^{-1}. The higher content of Mg^{2+} [17.6 c mol (p^+) kg^{-1}] was recorded at Mantatti surface soil while the lowest content [2.7 c mol (p^+) kg^{-1}] was recorded in Rampalli surface soil. Taking 1.5 meq. 100 g^{-1} soil as critical limit (Tandon, 1989) all the soils were found rich in available magnesium.

Table 2 : Morphological properties of soils

Location	Horizon	Depth (cm)	Colour		Texture	Structure	Consistency			Cracks width	Pores	Roots	Boun-dary
			Moist	Dry			Dry	Moist	Wet				
Bashirabad	AP	0-14	10YR 4/2 Dark greyish brown	10 YR 4/2 Dark greyish brown	C	f 2 sbk	sh	fi	s&p	2	many med.	few med.	DS
	A_{12}	14-29	"	"	C	f 2 sbk	h	fi	vs&vp	2	many fine	few med.	DS
	A_{13}	29-57	"	"	C	f 2 sbk	h	fi	vs&vp	2	many fine	few med.	DS
	A_{14}	57-79	"	"	C	f 3 abk	h	vfi	vs&vp	1	many fine	few fine	DS
	A_{15}	79-114	10 YR 3/2 Very dark greyish brown	10YR 4/2 Very Dark greyish brown	C	f 3 abk	vh	vfi	vs&vp	-	many fine	-	GW
	AC	114+	"	"	C	f 3 abk	vh	vfi	vs&vp	-	many fine	-	
Chevella	AP	0-19	2.5 YR 4/4 Reddish brown	2.5 YR 4/6 Red	SL	m 2 sbk	sh	fi	ss&sp	2-Jan	few fine	few med.	CS
	B_{1t}	19-43	5 YR 3/4 Dark reddish brown	5 Y/R 3/4 Dark reddish brown	SCL	m2sbk	sh	fi	S&P	-	few fine	few fine	CS
	B_{21}	43-71	5 YR 3/3 Dark reddish brown	5 Y/R 3/3 Dark reddish brown	SCL	m2sbk	sh	fi	S&P	-	few fine	few fine	CS
Moinabad	AP	0-18	5 YR 5/3 Reddish brown	5 YR 5/6 Yellowish red	SCL	f 1 gr-sbk	L	fr	ss&sp	-	few fine	few fine	CS
	B_1	18-32	5 YR 3/2 Dark reddish brown	5 YR 4/3 Reddish brown	SC	f 2 sbk	L	fi	ss&sp	-	few fine	few fine	CS
	C	32+	5 YR 4/3 Reddish brown	5 YR 5/6 Yellowish red	SC	f 2 sbk	sh	fi	ss&sp	-	few fine	-	CS
Uppal	A	0-16	10 YR 5/6 Yellowish brown	10 YR 5/8 Yellowish brown	SCL	f 1 gr-sbk	L	fr	ss&sp	-	few fine	few fine	CS
	B_1	16-45	10 YR 5/6 Yellowish brown	10 YR 5/8 Yellowish brown	SC	f 2 sbk	sh	fr	ss&sp	-	few fine	few fine	CS
	C	45+	10 YR 5/8 Yellowish brown	10 YR 5/8 Yellowish brown	SCL	f 2 sbk	sh	fr	ss&sp	-	few fine	few fine	CS
Kisara	A	0-19	10 YR 4/3 Dark	10 YR 5/3 Brown	C	f 1 gr-abk	L	fr	ss&sp	1-2	few fine	few fine	CS
	B_{1t}	19-31	10 YR 2/2 Very dark brown	10 YR 4/2 Dark greyish brown	C	f 2 gr-abk	sh	fi	s&p	1	few fine	few fine	CW
	B_{2t}	31-55	10 YR 4/3 Dark	10 YR 4/3 Dark brown	C	f 2 abk	sh	fi	s&p	-	few fine	few fine	CW
	C	55+	10 YR 4/3 Dark brown	10 YR 4/4 Dark yellowish brown	SC	f 2 abk	sh	fi	s&p		few fine	-	CS

Contd..

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Horizon	Horizon	Depth (cm)	Colour		Texture	Structure	Consistency			Cracks width	Pores	Roots	Boun-dary
			Moist	Dry			Dry	Moist	Wet				
Saroornagar	A	0-14	5 YR 4/4 Reddish brown	5 YR 4/4 Reddish brown	SL	f 1 sbk	sh	fi	ss&sp	-	few fine	fine med.	CS
	B_{1t}	14-29	5 YR 5/4 Reddish brown	5 YR 5/4 Reddish brown	SCL	f 1 sbk	sh	fi	ss&sp	-	few fine	few med.	CS
	B_{21t}	29-43	2.5 YR 3/6 Red	2.5 YR 4/6 Red	SCL	m 2 sbk	h	fi	s&p	-	few fine	fine med.	CS
	C	43-61	2.5 YR 3/4 Dark reddish brown	2.5 YR 3/4 Dark reddish brown	SCL	m 2 sbk	h	fi	s&p	-	few fine	fine med.	CS
Ibrahimpatan	A	0-18	5 YR 4/4 Redddish brown	5 YR 4/3 Reddish brown	SCL	f 1 gr-sbk	L	fr	ns&np	-	few fine	few fine	CS
	B_{11}	18-53	5 YR 3/3 Reddish brown	5 YR 4/4 Reddish brown	SCL	f 1 sbk	L	fr	ss&sp	-	few fine	few, fine med.	CS
	B_{12}	53-78	5 YR 4/4 Reddish brown	5 YR 4/6 Yellowish red	SCL	f 1 sbk	L	fr	ss&sp	-	few fine	fine med.	CS
	C	78+	5 YR 4/4 Reddish brown	5 YR 4/6 Yellowish red	SCL	m 2 sbk	sh	fi	ss&sp	-	few fine	few coarse	CS
Medchal	A	0-13	10 YR 2/2 Very dark brown	10 YR 4/3 Dark brown	SC	f 1 gr-abk	L	fr	s&p	1-2	few fine	few fine	CS
	B_1	13-38	10 YR 2/2 Very dark brown	10 YR 4/3 Dark brown	SCL	f 2 abk	sh	fi	s&p	-	few fine	few fine	CW
	C	38+	10 YR 3/2 Very dark grey brown	10 YR 4/3 Dark brown	SCL	f 2 abk	h	fi	s&p	-	few fine	few med.	CS
Shamirpet	A	0-16	5 YR 3/4 Dark reddish brown	5 YR 4/6 Yellowish red	SCL	f 1 gr-sbk	L	fr	ss&sp	1-Jan	few fine	few fine	CS
	B_1	16-42	5 YR 5/4 Rreddish brown	5 YR 6/4 Light reddish brown	SCL	f 2 sbk	L	fr	ss&sp	-	few fine	few med.	CS
	C	42+	5 YR 5/6 Yellowish	5 YR 5/6 Yellowish red	SCL	f 2 sbk	sh	fi	ss&sp	-	few fine	few med.	CS
Doma	AP	0-16	10 YR 4/4 Dark yellowish brown	10 YR 4/4 Dark yellowish brown	C	f 2 sbk	sh	fi	s&p	2.5	few med.	few med.	DS
	A_{12}	16-28	10 YR 4/3 Dark .	10 YR 6/3 Dark brown	C	m 2 abk	vh	fi	VS&VP	2.5	many fine	few med.	DS
	A_{13}	28-54	10 YR 4/3 Dark brown	10 YR 4/2 Dark greyish brown	C	m 2 abk	vh	fi	VS&VP	1	fine	few med.	DS
	A_{14}	54-88	10 YR 4/3 Dark brown	"	C	m 3 abk	vh	fi	VS&VP	1	fine	few fine	DS
	A_{15}	88-118	10 YR 4/3 Dark brown	10 YR 4/3 Dark brown	C	m 3 abk	vh	fi	VS&VP	-	fine	few fine	DS
	AC	118+	10 YR 3/2 Very dark greyish brown	10 YR 3/2 Very dark greyish brown	C	m 3 abk	vh	fi	VS&VP	-	fine	few fine	DS

Contd..

Contd..

Horizon	Horizon	Depth (cm)	Colour		Texture	Structure	Consistency			Cracks width	Pores	Roots	Boun-dary
			Moist	Dry			Dry	Moist	Wet				
Tandur	AP	0-17	10 YR 4/3 Dark	10 YR 6/3 Dark brown	C	m 2 sbk	h	fi	s&p	2	few fine	medium fine	CS
	C_1	17-47	10 YR 3/3 Dark	10 YR 6/3 Dark brown	C	m 2 sbk	h	fi	s&p	2	few fine	few fine	CS
	C_2	47-89	10 YR 3/2 Very dark greyish brown	10 YR 3/2 Very dark greyish brown	C	m 2 abk	h	vfi	s&p	1	few fine	few fine	CS
	C_3	89-136	"	"	C	m 2 abk	h	vfi	s&p	-	few fine	-	GS
Shamshabad	AP	0-15	10 YR 3/2 Very dark greyish brown	10 YR 4/2 Grey brown	SC	f 1 gr-sbk	L	fr	ss&sp	1-2	few fine	few fine	CS
	B_{1t}	15-37	10 YR 4/2 Dark greyish brown	10 YR 4/3 Dark brown	SC	f 2 gr-sbk	L	fr	ss&sp	1	few fine	few fine	CW
	B_{2t}	37-55	10 YR 4/3 Dark	10 YR 4/3 Dark brown	SC	f 2 sbk	sh	fr	s&p	-	few fine	few medium	CW
	C	55+	10 YR 4/2 Dark grey brown	10 YR 4/2 Dark grey brown	SC	f 2 sbk	sh	fr	s&p	-	few fine	fem medium	CS
Pargi	A	0-15	5 YR 3/3 Dark reddish brown	5 YR 4/4 Reddish brown	SCL	f 1 gr-sbk	L	fr	ss&sp		few fine	few fine	CS
	B_{11}	15-41	5 YR 3/4 Dark reddish brown	5 YR 4/4 Reddish brown	SCL	f 1 sbk	sh	L	ss&sp		few fine	few medium	CS
	B_{12}	41-59	5 YR 5/4 Reddish brown	5 YR 6/4 Light reddish brown	SCL	f 1 sbk	sh	L	ss&sp		few fine	few medium	CS
	C	59+	5 YR 4/4 Reddish brown	5 YR Yellowish red	SCL	f 2 sbk	sh	L	ss&sp		few fine	-	CS
Mominpet	A	0-18	5 YR 4/2 Dark reddish brown	5 YR 4/2 Dark reddish brown	SCL	f 1 gr-sbk	L	fr	ss&sp		few fine	few fine	CS
	B_1	18-34	5 YR 3/2 Reddish brown	5 YR 3/3 Dark reddish brown	SCL	f 1 sbk	L	fr	s&p		few fine	few fine	CS
	B_2	34-57	5 YR 4/4 Reddish brown	5 YR 4/6 Yellowish red	SCL	f 1 sbk	sh	fr	s&p		few fine	few medium	CS
Vikarabad	A	0-17	10 YR 3/1 Very dark grey	10 YR 4/1 Dark grey	SC	f 2 gr	L	fr	ss&sp	1	few fine	few fine	CS
	B_{11}	17-42	10 YR 3/2 Very dark grey brown	10 YR 4/2 Dark grey brown	SC	f 3 abk	sh	fr	s&p	1	few fine	few fine	CW
	B_{21}	42-84	10 YR 3/1 Very dark grey	10 YR 4/1 Dark grey	SC	f 3 abk	h	fi	vs&vp		few fine	few fine	CW
	$B_{21\ CW}$	84-115	10 YR 2/2 Very dark brown	10 YR 4/3 Dark brown	SC	f 3 abk	h	vfi	s&p		few fine	-	CS
	CC	115+	10 YR 5/2 Grey brown	10 YR 5/3 Brown	SC	f 3 abk	h	vfi	ss&sp		few fine		CS

CHAPTER V

DISCUSSION

The present investigation was carried out to know the physical, physico-chemical and chemical properties of soils of Ranga Reddy district. Based on the results of the study the soils were classified as per USDA soil taxonomy and the soil constraints for crop production were also identified. The results obtained are discussed in this chapter.

Bashirabad, Doma, Tandur, Pargi, Mominpet, Shamshabad and Vikarabad pedons were recognised as black and associated black soils while Chevella, Moinabad,Uppal, Kisara, Saroornagar, Ibrahimpatan, Medchal and Shamirpet were recognised as red and associated red soils. The profile morphology and the laboratory analysis results are discussed below.

5.1 GENESIS

5.1.1 Parent Material

The soils of the study area are developed on granite gneiss and basaltic parent material. In some places, the parent material was mixed with calcareous murrum. The development of Vertisols on granite-gneiss and limestone parent material was reported by Dasog and Hadimani (1980) and by Subbaiah and Manickam (1992). Sehgal *et al*. (1993) recognised the parent materials of Alfisols, Ultisols and Oxisols as granite, gneiss and sandstone. The parent materials of Vertisols, Inceptisols and Entisols was recognised as sand stone, basalt and alluvium by Shrikant *et al*. (1993).

5.1.2 Climate

The climate of the study area was semi-arid monsoonic type the average annual rainfall of the district is 750 mm, out of which 60 per cent was received during south-west monsoon. The temperature ranged between 27°C to 45.5°C. Dasog and Hadimani (1980) reported that semi-arid climatic conditions favour the formation of black soils. Subbaiah and Manickam (1992) reported the same i.e., semi-arid climate with moderate rainfall favours the formation of black soils in coastal Andhra Pradesh.

5.1.3 Topography

Topographically the Ranga Reddy district is mostly hilly. The red and associated soils developed on undulating and gentle slopes whereas the black soils and their associated soils confined to nearly level to gently undulating plains.

Bhattacharjee *et al*. (1971) reported that the topographical variations were responsible for soil heterogeneity as they regulate the hydrological conditions and this was further justified by Tiwari *et al*. (1989) that the different moisture and drainage conditions also brought about changes in the soils. Yadav *et al*. (1977) reported the occurrence of deep red soils in the uplands, pale brown soils in the terraces and dark grey soils in the low lands.

Krishnamoorthy and Govindarajan (1977) generalised that the associated red and brown soils occupied higher relief positions and the black soils were confined to level plateaus, valley depressions and sites at lower elevations.

At hilly land form, young soils (Entisols), at intermediate land form, immature soils (Inceptisols) and at lower elevation mature soils (Vertisols and Alfisols) are developed (Tamgadge *et al*., 2000).

5.1.4 Vegetation

The natural vegetation of the study area comprised grasses, Prosopis sp, Celoria sp, Acacia sp, Leucas sp, Tamarind and neem. The observations were similar to that of Bhaskar and Subbaiah (1995) in laterites and associated soils of Andhra Pradesh and Srinivas (1990) in black soils of Somasila project area of Andhra Pradesh. The soils under deciduous forest ecosystem had developed a mollic epipedon underlined by a cambic horizon (Sehgal *et al*., 1985). A less developed Haplustalfs was found under mixed vegetation in Doon valley (Singhal and Sharma, 1985).

5.2 PHYSICAL PROPERTIES

5.2.1 Colour

Most of the pedons under study showed uniform colour. Such uniform colour throughout could be due to after churning process occurred in these pedons. Chevella, Moinabad, Uppal, Kisara and Saroornagar pedons are Alfisols, where the reddening of hematite was two times higher than in moderately weathered soils (Kampf and Schwertman, 1983).Bashirabad, Doma, Tandur, Vikarabad and Shamshabad pedons showed dark colour where as the Kisara, Ibrahimpatan, Shamirpet, Pargi, Mominpet and Vikarabad pedons showed colour, which was lightened with depth which could be due to decreasing trend of organic carbon content in the soil and more accumulation of lime in deeper layers and dark colour in other pedons might be due to formation of clay humus complex (Dasog and Hadimani, 1980). The dark colour could be due to the adsorption of dispersed organic matter on the surface of the clay forming clay humus complex. The observations were similar to the observations reported by Subbaiah and Manickam (1992). Singh *et al*. (1993) found that the colour of sedimentary soils developed on granite gneiss varied from yellowish red (5 YR 4/6) to strong brown (7.5 YR 7/6). The soils on the hill tops and foot hill uplands were reddish brown whereas the soils in depression had dark brown to very dark greyish brown (Aruna Prasad *et al*., 1989).

5.2.2 Soil texture

Soil texture is one of the most important diagnostic morphological character and had been found to change with depth. In the present study, the texture of all the profiles varied from sandy loam to clayey.

The clay content decreased with depth in Shamirpet and Mominpet pedons and increased in the remaining pedons. In Saroornagar, Shamirpet, Shamshabad and Vikarabad pedons the silt content increased with depth while sand content decreased with depth in Bashirabad, Chevella, Moinabad, Saroornagar, Doma, Shamshabad and Vikarabad pedons. The increase in clay with depth is due to vertical migration of the clay, intensive weathering and improvement of finer particles from surface horizons (Subbaiah and Manickam, 1987).

The decrease in clay content and increase of sand with depth could be due to transporation of clay and deposited by river waters (Krishnamoorthy and Govindarajan, 1977). The uniformity in texture of Bashirabad, Moinabad, Ibrahimpatan, Shamirpet Tandur and Parigi pedons is due to pedoturbation, operating in soils (Ahmed, 1983; Boul *et al*., 1998). The higher percentage of clay in surface horizons indicated more advanced weathering than in surface horizons (Egide Nizeyimana, 1997). The Vertisols showing a decrease in clay content with depth was observed by Vijay Kumar *et al*., (1994) and Jagannadham *et al*., (1995).

5.2.3 Soil structure

All the pedons showed well developed structural variations and exhibited granular to sub-angular blocky in surface and sub angular to angular blocky structures in sub surface horizons. These features were in accordance with the features recorded by Subbaiah (1984) and Venkateswarlu *et al*. (1995). The Inceptisols had subangular blocky structure (Kaistha and Gupta 1994). The black soils developed from Basalt and Basaltic alluvium had granular to angular blocking or subangular to angular structure (Singh *et al*., 1995).

5.2.4 Cracks

Bashirabad, Chevella, Kisara, Medchal, Doma, Tandur Shamshabad and Vikarabad pedons showed cracks while the other pedons had not shown any cracks. Subbaiah (1984) reported that the Vertisols of Andhra Pradesh showed 2-7 cm wide cracks extending upto a depth of 1 m. Similar observations were made by Surekha *et al*. (1997). Surface cracks were the unique feature of Vertisols. The width of surface cracks is more in Chromousterts as compared to Ustochrepts and the width of cracks found to decrease with depth (Bhattacharjee *et al*., 1981). Singh *et al*. (1995) noticed that the soils of *in situ* origin have higher intensity of cracks than the soils of alluvial origin. The variation in the width of surface cracks is due to the variation in cementing materials like humus substance, iron and aluminum hydroxides and exchangeable sodium (Subbaiah and Manickam, 1992).

5.2.5 Bulk density

All the pedons had recorded invariably high bulk density in subsurface horizons than the surface horizons. Similar observations were made by Prasuna Rani *et al*. (1992), Vijay Kumar *et al*. (1994), Gurumurthy (1995) and Gupta *et al*. (2001). Lower bulk density values was caused by high organic carbon content in surface horizons (Walia and Rao, 1996; Egide Nizeyimmana, 1997).

5.3 CHEMICAL PROPERTIES

5.3.1 Soil reaction

All the soil samples studied were slightly acidic to alkaline in reaction and the pH increased with depth. This trend could be due to increase in accumulation of exchangeable Na^+ and $CaCO_3$. As mobility of Ca^{+2} was more than other elements, the calcium which had been translocated to lower depths might have led to higher pH values. Similar observations were made by Subbaiah and Manickam (1992), Maji and Bandyopadhyay (1995). The soil pH is generally lower in surface horizons than sub surface horizons in the soils at higher elevations (Egide Nizeyimmana, 1997).

5.3.2 Electrical conductivity

The electrical conductivity varied from 0.05 to 0.71 dSm^{-1}. Chevella, Saroornagar and Mominpet pedons showed no regular trend. Non accumulation of salts even in deeper horizons may be due to less drained condition of the pedons (Gurumurthy, 1995). Bashirabad, Moinabad, Uppal Kisara, Ibrahimpatan, Medchal, Shamirpet, Doma, Tandur, Shamshabad, Pargi and Vikarabad pedons showed an increasing trend with depth which could be due to translocation of soils from surface horizons (Subbaiah and Manickam, 1992). In Vertisols the EC values increased with depth (Dasog and Hadimani, 1980). Similar observations were made by Sreenivasulu Reddy (1997) and for Inceptisols (Yadav *et al*., 1989).

5.3.3 Organic carbon

All the pedons showed a decreasing trend with depth. The surface horizons of all the pedons invariably recorded higher values than the subsurface horizons and the contents were found to be decreasing with increasing depth. Similar results were reported by Gangopadhyay *et al*., (2001), Madhumita Das *et al*. (1997), Prasuna Rani (1991). Most of the black soils of India contained less than one per cent organic carbon (Gawande and Biswas, 1967). The organic carbon content will be more in black soils compared to red soils (Thiyagarajan, 1998). The order of organic carbon content was Vertisols > Inceptisols > Alfisols and Entisols (Dipak Dutta *et al*., 2000).

5.3.4 Calcium carbonate

The results revealed that the surface horizons of the pedons were weakly calcareous than the deeper horizons. The greater amount of $CaCO_3$ at lower depths of the soil profiles clearly illustrates that the $CaCO_3$ moved from surface to sub surface layers. Dasog and Hadimani (1980) also reported that higher content of $CaCO_3$ in black soils, might be due to the translocation and limited leaching within the profile. The $CaCO_3$ present increases with depth in soils on different land forms and is influenced by topography within the land form (Choudhari, 1994).

5.3.5 CEC

Bashirabad, Chevella, Moinabad, Uppal, Ibrahimpatan, Medchal, Shamirpet, Doma, Tandur, Pargi, Mominpet and Vikarabad pedons showed an increasing trend with increase in the depth which was attributed to the variation in nature and amount of clay. The CEC of the black soils will be high (Subbaiah and Manickam, 1992). CEC variations are similar to organic carbon (Egide Nizeyimana, 1997). Similar results were obtained by Vijay Kumar *et al*. (1994), Singh *et al*. (1995), Maji and Bandyopadhyaya (1995).

5.3.6 Exchangeable bases

The results of exchangeable bases revealed that calcium was the dominant exchangeable cation followed by magnesium and potassium ($Ca^{++} > Mg^{++} > K^{+} > Na^{+}$). Similar observations were earlier made by Diwakar and Singh (1994) in Vertisols of Bihar and Balpande *et al*. (1997) in black soils of Purna valley and Singh *et al*. (2001) in old alluvial soils. Maji *et al*. (1998) recorded higher exchangeable bases with increase in depth in black soils of Sagar islands.

5.3.7 Available nitrogen

The available N content of the pedons in general was more in surface than sub surface layers. This might be primarily due to the presence of organic matter as also reported by Tapesh Lahri and Chakravarthy (1989). The available N content showed decrease with increase in depth in all pedons. Similar results were reported by Kuldeep Singh and Ahuja (1990), Mandal *et al*. (1990) and Kaistha *et al*. (1990) and Singh *et al*. (1992) and Sreenivasulu Reddy (1997).

5.3.8 Available phosphorus

All the pedons shoed a decreasing trend with depth while Bashirabad and Shamshabad showed no regular trend. The decrease in available phosphorus is attributed to decrease in organic matter with increase in depth. Similar results were reported by NBSS and LUP (1997) and also on clay content (Pandey *et al*., 2000).

5.3.9 Available potassium

All the pedons showed a decreasing trend with depth. The availability of potassium is medium to high in most of the pedons.

Higher availability of potassium status in the surface horizons than in the sub surface horizons could be ascribed to more weathering of potassium bearing minerals. Similar observations were also made by Kumara Sastry and Balakran Mathur (1972) and NBSS and LUP (1997) and Kuldeep and Ahuja (1990).

5.3.10 Total and available micronutrients

Zinc

The total zinc content varied from 27.06 to 93 mg kg^{-1}. Such variation due to the chemical composition of the parent material, organic carbon and clay contents of the soils were observed by Diwakar and Singh (1992). Similar results were observed by Patiram *et al*. (2000). The available zinc content varied form 0.07 to 1.8 ppm it decreased with depth. Diwakar and Singh (1992) also reported similar findings.

The available zinc content was maximum in surface layers of all the profiles and it decreased with increase in the depth. Similar results were obtained by Dipak Sarkar *et al*. (2000) and Nipunageetal (1996)

The depth wise distribution of available zinc content was more or less in line with organic carbon status which might be due to accumulation of comparatively more amount of organic matter in surface and sub surface layers as reported by Jalali *et al*. (1989) and Nayak *et al*. (2000). The total Zn content was significantly and positively associated with clay content where as pH and EC exercised significant negative effect (Murthy *et al*., (1997). According to Khan *et al*., (1997) there exist a positive correlation between the Zn and Mn in soil.

Copper

The total copper content varied from 17.09 to 121 mg kg^{-1}. All the pedons showed an irregular trend with depth except the pedons of Chevella, Moinabad, Uppal and Ibrahimpatan in which a decreasing trend was observed with increase in depth. Similar results were given by Dipak Sarkar *et al*. (2000) and Patiram *et al*. (2000).

The available copper content varied from 0.19 to 1.87 mg kg^{-1}. Similar results were given by Vijay Kumar *et al*. (1996) and Dipak Sarkar *et al*. (2000). The available copper was more in surface layers and decreased with depth, which might be due to its association with organic carbon affecting its availability in sub surface layers. The soils formed from basalt had higher values of total Cu than those of costal plains which had least amount (Khan et al 1997)

Iron

The total iron content varied from 1.01 to 7.5 per cent. The highest content 7.5 per cent was recorded in lowest horizon of Saroornagar pedon while the lowest value 1.01 per cent was recorded in surface layer of Pargi pedon. All the pedons showed an irregular trend with depth except Moinabad, Uppal, Kisara, Ibrahimpatan, Pargi, Mominpet and Vikarabad pedons in which decreasing trend was observed with depth. In most of the pedons the total Fe content was higher in the surface layer than in the subsurface layer similar results were observed by Nipunage *et al*., (1996)

It might be due to accumulation of humic material in the surface layers besides prevalence of reduced conditions in sub surface layers. The availability of Fe depends on clay content and soil reaction (Sharma and Yadav, 1986) and Diwakar and Singh (1992).

Manganese

The total manganese content ranged from 256 to 1506 mg kg^{-1}. The highest content of 1506 ppm was observed in Shamirpet pedon while the lowest (256 ppm) was noticed in the lower horizon of Kisara pedon. Almost similar results were observed by Patiram *et al*. (2000). The available manganese content varied from 11.2 to 59.18 mg kg^{-1}.

The available manganese content, in general, decreased with the depth, which might be due to its presence of the reduced forms in surface and sub surface layers and also due to higher amount of organic carbon as reported by Ranganayakulu *et al*. (1981) and also by Kannan and Mathan (1994) and Nayak *et al*. (2000) and Dipak Sarkar *et al*. (2000).

5.4 CLASSIFICATION

Based on morphological, physical, physico-chemical and chemical characteristics of the pedons and climate of the area, the Ranga Reddy district soils were classified upto family level (Table 5) as per the specifications made by Soil Survey Staff (1998).

5.4.1 Vertisols

At order level

Bashirabad, Doma, Tandur and Vikarabad pedons were classified under Vertisols because they exhibited the following features :

- Clay texture, more than 30% clay in fine earth fraction of all the horizons and gradual increase in clay content with depth.
- Depth of the pedons extended for more than 1 m showing strong granular structure in upper 15 cm.
- Cracks that open and close periodically.

- Dark colours of low chroma, higher organic carbon content, surface cracks, Ca^{2+} and Mg^{2+} occur as dominant exchangeable cations.

Based on the above features, these pedons were classified as Vertisols (Boul *et al*., 1998).

At sub order level

These soils have cracks which are 5 mm or more wide, through a thickness of 25 cm or more within 50 cm of the surface for 90 or more cumulative days per year. And the soil moisture regime was Ustic. Hence, they were keyed out as Usterts. Diwakar and Singh (1994), Sehgal (1993), Sreenviasulu Reddy (1997), Thakre *et al*., (1998) and Ram Prakash and Seshagiri Rao (2002)classified the Vertisols of Bihar, black cotton soils of Hyderabad, Vertisols of Nandyal farm and black soils of Maharashtra, Black soils of Krishna District as Usterts respectively.

At great group level

The Bashirabad and Doma pedons had EC less than 4 dS m^{-1} and pH more than 4.5. Salic, gypsic and petrocalcic horizons were not found within 100 cm depth in these pedons. Hence, they were included under great group Haplusterts.

Tandur and Vikarabad pedons had chroma moist of 1-5 or more dominant in the matrix in more than half of each pedon. Hence, they were included under great group Chromusterts.

At sub group level

The Bashirabad and Doma pedons were further placed under the subgroup level chromic Haplusterts as the pedons had a colour value of 4 in moist condition and also all the subsurface horizons had a chroma more than 1.5 in moist conditions (Madhuvani *et al*., 2001).

The Tandur and Vikarabad pedons were further placed under the sub group level Typic Chromusterts as the pedons had deep cracks that remained open for more than 150 cumulative days most years (Krishnasamy and Krishnamoorthy, 1991).

5.4.2 Alfisols

The Chevella, Moinabad, Uppal, Kisara and Saroornagar pedons were classified under Alfisols because of the presence of argillic horizon. The Argillic horizon was identified by the following features :

- The elluvial horizon remains and there is no lithological discontinuity between it and the underlying argillic horizon, the argillic horizon contains, within 30 cm of its upper boundary, higher percentages of total clay than the elluvial horizon and as the overlying elluvial horizon, has 15.40 per cent total clay. The total clay content in the argillic horizon is 20 per cent or more higher than the elluvial horizon. Similar results wee reported by Mahapatra *et al*. (2000).

- The thickness of argillic horizon is 15 cm or more, as the horizon is loamy sand.

At sub order level

As the climate is semi arid monsoonic type with distinct rainy and dry seasons. The moisture regime of the pedons was Ustic as the soils were moist for 210-270 days in a year. Hence, they were placed under Ustalfs at sub order level.

At great group level

The Chevella, Moinabad, Uppal and Kisara pedons were classified as Haplustalfs because of the following reasons :

- Presence of an argillic horizon.
- Absence of natric horizon, petrocalcic horizon, duripan and plinthite.

The hue is redder than 10 YR and the chroma is more than 4 Saroornagar pedon was classified under Rhodustalfs because of the following reasons :

- Presence of an Argillic horizon.
- Absence of natric horizon or petrocalcic horizon and plinthite.

- Has colour hue redder than 5 YR and a value moist less than 4.

At sub group level

Chevella and Moinabad pedons showed hyperthermic or warmer soil temperature regimes which were dry in some or all parts for less than 120 cumulative days per year and the temperature at a depth of 50 cm below the soil surface is higher than 8°C. Hence they were placed under Udic Haplustalf at sub group level (Banerjee *et al*., 1990; Prasuna Rani *et al*., 1991).

Uppal pedon had texture finer than loamy fine sand, absence of lithic contact and have CEC of 24 meq. per 100 g clay, had soft powdery secondary lime within 1.25 m of soil surface. Hence, planed under sub group Typic Haplustalfs. Kisara pedon was placed under Vertic Haplustalfs sub group level because of clayey texture and expanding clay in Argillic horizon, it also shows wide cracks in most years. Saroornagar pedon was classified under Udic Rhodustalfs as the horizon doe snot contain soft, powdery secondary lime.

5.4.3 Inceptisols

Ibrahimpatnam, Medchal and Shamshabad pedons were classified under the order Inceptisols because of the presence of

- A cambic horizon

- An ochric epipedon is seen.

In these pedons the subsurface horizons were recognised as cambic horizons. Sharma *et al*. (1993) and Walia and Chamuah (1996) and Tamgadge *et al*. (2000) also observed similar type of features in black soils of Himachal Pradesh and Arunachal hills and keyed them out as Inceptisols. Similar results were noted by Dipak Sarkar *et al*., (2002) in the soils of Loktak Catchment area of Manipur. The soils of Etawah district of Uttar Pradesh were also placed under Inceptisols because of the presence of cambic horizon by Verma et al., (2001).

At sub order level

As the Ibrahimpatnam, Medchal and Shamshabad pedons had either an ochric epipedon or a mollic epipedon, they are included under the suborder Ochrepts.

At great group level

The soils of study area were under the influence of semi arid monsoon type climate with distinct rainy and dry seasons. The soils were moist for 210-270 days in a year. hence, the moisture regimes of these pedons was Udic-Ustic. Hence, they were placed under great group Ustochrepts.

At sub group level

The Ibrahimpatan pedon had a warmer soil temperature regime and was dry in some or all parts for less than 120 cumulative days per year then the temperature at a depth of 50 cm below the soil surface is higher than 8°C, so they are placed under sub group Udic Ustochrepts.

The Medchal pedon has soft powdery secondary lime with in a depth of 70 cm below the soil surface and a lithic contact at a depth of 60 cm from soil surface. Hence it is placed under sub group, Typic Ustochrepts.

The Shamshabad pedon showed cracks within soil surface that are 5.mm wide through thickness of 30 cm or more for some time in most years and slickensides in a layer of 15 cm or thick and a lithic contact is seen with in 50 cm of mineral soil surface. So it has been placed under the subgroup Vertic Ustochrepts. Similar results were obtained by Venkateswarlu *et al*. (1995) and Saxena (1992).

5.4.4 Entisols

Shamirpet, Pargi and Mominpet pedons were classified under order Entisols because of the slight degree of soil formation and presence of less than 30 per cent clay in some sub horizons with in a depth of 50 cm and do not have gilgai microrelief, wedge shaped natural aggregates and slickensides close enough to intersect (Ahuja *et al*., 1997).

At sub order level

The presence of lithic contact that is shallower than 25 cm and above 1 m, having an organic carbon content that decreases with increasing depth and reaches a level of 0.2 per cent or less at a depth of 1.25 m, not permanently saturated with water and do not have characteristics associated with wetness, hence placed under the Orthents sub order level.

At great group level

At great group level the pedons were classified under Ustorthents because of the warmer soil temperature regime and had an Ustic soil moisture regime and have conductivity of saturation extract less than 2 m mhos cm^{-1} in all sub horizons. They also had lithic contact within 50 cm of the mineral soil surface.

At sub group level

The Shamirpet pedon has a warmer soil temperature regime and is dry in some or all parts for less than 120 cumulative days per year when the temperature at a depth of 50 cm below the soil surface is higher than 8 ^{0}C, so it is placed under subgroup Udic Ustor thents.

The Pargi and Mominpet pedon was placed under Typic Ustorthents at sub group level because of no appreciable cementation with silica, low biological activity and absence of clayey texture and swelling type of clay and it also show ochric epipedon (Saxena, 1992).

5.5 PEDOGENESIS

The pedogenic processes are extremely complex and dynamic involving many chemical and biological reactions and usually operate simultaneously in a given area. The Bashirabad, Doma, Tandur and Vikarabad were Classified under the order Vertisols; Chevella, Moinabad, Uppal, Kisara and Saroornagar pedons under Alfisols; Ibrahimpatan, Medchal and Shamshabad pedons under Inceptisols and Shamirpet, Pargi and Mominpet under Entisols.

The Bashirabad, Doma, Tandur and Vikarabad pedons were classified under Vertisols these soils were developed from the weathering of sedimentary and metamorphic rocks, lime stone and shale (Dasog and Hadimani, 1980). They are also developed from weathered products of granite-gneiss complex both *in situ* and transported materials.

The smectite group of minerals, particularly smectite have a basic character of expansion and contraction. Evidently the cracks of atleast 1 cm width are found. During the pedogenesis process, three dimensional volume changes might set in with a cyclic movement of soil materials to cause a vertical mixing in pedoturbation (Sehgal, 1998).

The slickensides though present are not predominant, the common features of all these pedons is the presence of vertical cracks upto a depth of 50 cm or more.

The Alfisols, Inceptisols and Entisols are mostly developed from granite - gneiss complex and at times from quartzites and coarse grain sand stones. These are very shallow to moderate depending upon the topography processed (Sehgal *et al.*, 1993).

The Chevella, Moinabad, Uppal, Kisara and Saroornagar pedons were classified under Alfisols and are developed on granite, gneiss of archaean period and Dharwaras. They show the process of eluviation where mobilization and translocation of mobile constituents resulting in textural difference in seen which is followed by the process of deposition of soil material in the lower layer termed as illuviation, the process lead to the textural contrast between horizons and higher clay ratio in the B horizon. Ibrahimpatan, Medchal and Shamshabad pedons were classified under order Inceptisols. The landscape is quite undulating as a result of which the area is eroded extensively showing a consistent influence on the soil development. Typically the soils are having an ochric epipedon over a cambic horizon. The ochric epipedon, which is present in these pedons is generally light coloured, the sub surface cambic horizon is showing the clear evidence of pedogenesis.

The Shamirpet, Pargi and Mominpet pedons were classified under order Entisols, which are having little or no evidence of development of pedogenic horizons (Soil Survey Staff, 1998). These soils are developed on land surfaces which are prone for erosion either with rainfall or runoff. These pedons are categorized under the suborder orthents. These are formed on the hill surfaces and are subjected to regular erosion rather than deposition.

5.6 SOIL CONSTRAINTS AND LAND USE PLANNING

The constraints of crop production in the soils of Ranga Reddy district were identified as soil erosion, crusting, compaction, low organic carbon, poor nutrient availability.

The pedons of Shamirpet, Pargi and Mominpet were classified as Entisols, the soil related constraints were shallow depth, coarse textured soils with low water holding capacity, moderate to severe erosion and runoff acidic conditions (Singh and Gupta, 1991). Low pH accompanied by manganese and iron toxicities, lower availability of major nutrients N, P and K and Zn deficiency (Patiram and Bhaduria, 1995; Mahapatra, 2000).

The main related constraints of Bashirabad, Doma, Tandur and Vikarabad pedons were poor drainage, water logging, slight to moderate erosion and runoff. Nitrogen deficiency is predominant in all the pedons. Vikarabad pedon showed phosphorus deficiency. Similar observations were made by Reddy *et al*. (1998) and Francis Conant *et al*. (1983).

The Chevella, Moinabad, Uppal, Kisara and Saroornagar pedons were classified as Alfisols. Characteristically these pedons showed crusting and compaction. These pedons were moderately deep coarse to fine textural with few fine pores, few fine roots, acidic to neutral in condition, low nitrogen, low phosphorus. medium to high availability of potassium. Availability of zinc was low and higher availability of Cu, Fe and Mn was noticed (Francis Connant *et al.*, 1983).

Constraints in these soils are moderate erosion and runoff besides these, phosphorus and zinc deficiencies were predominant (NBSS and LUP, 1997).

The Ibrahimpatan, Medchal and Shamshabad pedons were classified as Inceptisols. The soil related constraints of the above pedons were slight to severe erosion and runoff. They are mostly deficient in phosphorus and zinc. Similar results were reported by Singh and Gupta (1991) and Patiram and Bhadaria (1995).

Paddy sorghum, chillies, cotton, groundnut pulses and fodder crops are grown extensively followed by vegetables. The flood plain and low land soils are suitable for rice cultivation as these soils remain wet due to flooding and impeded drainage (Lalia *and Chamuah*, 1990). Improved intercropping systems using cereals and legumes are well suited to the Vertisols and associated soils (ICRISAT, 1991; Gajbhiye and Deshmukh, 1992).

CHAPTER VI

SUMMARY

The present study was carried out with specific objectives of characterization and classification of soils of Ranga Reddy district for land use planning. The investigation consisted of study of morphological characteristics of soil profiles in the field and analysis of soil samples in the laboratory. The soils were finally classified as per USDA system of soil taxonomy.

Fifteen representative pedons of the area were chosen for the study. Horizon wise soil samples were collected, analysed for physical, physico-chemical and chemical properties including available macro and total and available micronutrients.

The climate of the study area was semi arid. The pedons selected were confined to gently rolling plains to plains of cultivated lands. These pedons were shallow to very deep and had granular to sub angular blocky structure in surface horizons and sub angular blocky or angular blocky structure in subsurface horizons.

Pedons Moinabad, Uppal and Kisara had developed argillic horizons in sub surface layers. Cambic horizons were recognised in pedons Ibrahimpatan, Medchal, Pargi and Shamshabad.

The analysis revealed that these soils were sandy clay to sandy clay loam to clay in texture and showed an increasing trend of clay with increase in depth. The results of physico-chemical properties indicated that these soils were slightly acidic to alkaline in reaction, low in organic carbon, low to high in cation exchange capacity. The exchangeable bases were in the order of Ca^{+2} > Mg^{2+} > K^{+} > Na^{+}.

The soils in general were low in available phosphorus and medium to high in available potassium. Regarding the availability of micronutrients zinc was found to be the most limiting micronutrient.

Based on the morphology of the pedons and analytical data of the soil samples, the pedons were classified as :

Pedon 1: Fine, clayey, hyperthermic, Chromic Haplusterts.

Pedon 2:Fine, loamy, hyperthermic, Udic Haplustalfs.

Pedon 3:Fine, loamy, hyperthermic, Udic Haplustalfs.

Pedon 4: Fine, loamy, hyperthermic, typic Haplustalfs.

Pedon 5: Fine, loamy, hyperthermic, Vertic Haplustalfs.

Pedon 6: Fine, loamy, hyperthermic, Udic Rhodustalfs.

Pedon 7: Fine, loamy, hyperthermic, Udic Ustochrepts.

Pedon 8: Fine, loamy, mixed, hyperthermic, Typic Ustochrepts.

Pedon 9: Fine, loamy, hyperthermic, Udic Ustorthents.

Pedon 10: Fine, clayey, isohyperthermic, Chromic Udic Haplusterts.

Pedon 11: Fine, clayey, hyperthermic, Chromic Haplusterts.

Pedon 12: Fine, clayey, hyperthermic, Vertic Ustochrepts.

Pedon 13: Fine, loamy, hyperthermic, Typic Ustorthents.

Pedon 14: Fine, loamy, hyperthermic, Typic Ustorthents.

Pedon 15: fine, clayey, hyperthermic, Typic Chromusterts.

The pedons Chevella, Moinabad, Uppal, Kisara and Saroornagar under Alfisols are developed on granite - gneiss of archean period and dhaurwar of the pre cambic period and the pedons Bashirabad, Doma, Tandur and Vikarabad under Vertisols developed from sedimentary and metamorphic rocks, lime stones and shale.

The land use planning has been prepared based on field survey and laboratory investigations. Soil erosion, runoff, water logging low organic carbon and poor nutrient availability were identified as prominent soil related constraints.

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