

**ASSESSMENT OF SOIL QUALITY AND CARBON  
STOCK UNDER DIFFERENT CROPPING PATTERN OF  
AURANGABAD DISTRICT OF MAHARASHTRA**

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**B. Sc. (Agri.)**

**MASTER OF SCIENCE  
IN  
AGRICULTURE  
(SOIL SCIENCE AND AGRICULTURAL CHEMISTRY)**



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PARBHANI - 431402 (M.S.) INDIA**

**2021**

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STOCK UNDER DIFFERENT CROPPING PATTERN OF  
AURANGABAD DISTRICT OF MAHARASHTRA**

**BY**

**TADI RAJASEKHAR**

**B. Sc. (Agri.)**

**A thesis submitted to**

**Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani**

**in partial fulfillment of the requirement for the degree of**

**MASTER OF SCIENCE**

**IN**

**AGRICULTURE**

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**DEPARTMENT OF SOIL SCIENCE AND AGRIL. CHEMISTRY**

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**VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH**

**PARBHANI - 431402 (M.S.) INDIA**

**2021**

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I hereby declare that the thesis entitled, “ASSESSMENTS OF SOIL QUALITY AND CARBON STOCK UNDER DIFFERENT CROPPING PATTERN OF AURANGABAD DISTRICT OF MAHARASHTRA” submitted by me is based on the actual work carried out by me under the guidance and supervision of **Pravin Himmatrao Vaidya**. The extent of information derived from the existing literature have been duly cited and referenced. The existing research work or its any part is not submitted anywhere else for the award of any degree or diploma.

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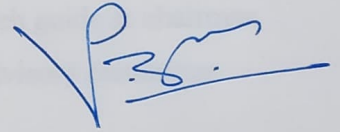
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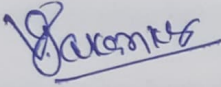


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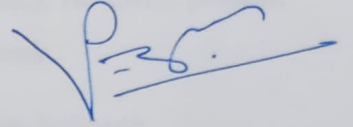
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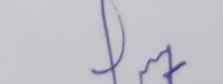
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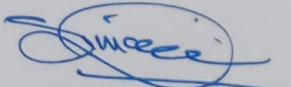
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






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## ABBREVIATIONS

%	-	Percent
ha.	-	Hector
cm.	-	Centi meter
mm.	-	Milli meter
Fig.	-	Figure
i.e.	-	That is
dSm <sup>-1</sup>	-	Decisimens per meter
g kg <sup>-1</sup>	-	Gram per kilogram
kg ha <sup>-1</sup>	-	Kilogram per hector
mg kg <sup>-1</sup>	-	Milligram per kilogram
No.	-	Number (s)
°C	-	Degree celcius
cmol (P <sup>+</sup> ) kg <sup>-1</sup>	-	Cent mol proton per kilogram
Pp	-	Pages
Ppm	-	Parts per million
EC	-	Electrical conductivity
O.C.	-	Organic carbon
CaCO <sub>3</sub>	-	Calcium carbonate
SOC	-	Soil organic carbon
SIC	-	Soil inorganic carbon
CS	-	Carbon Stock
AWC	-	Available water capacity

PAWC	-	Plant available water capacity
HC	-	Hydraulic conductivity
BD	-	Bulk density
Pg	-	Petagram
Tg	-	Teragram

# **THESIS ABSTRACT**

## THESIS ABSTRACT

Title of the thesis	: Assessment of soil quality and carbon stock under different cropping pattern of Aurangabad district of Maharashtra
Name of the student	: Tadi Raja Sekhar
Name of the research Guide	: Pravin Himmatrao Vaidya
Department	: Soil Science and Agricultural Chemistry
College/University	: College of Agriculture.VNMKV, Parbhani
Degree to be awarded	: M.Sc. (Agri.)

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### ABSTRACT

Aurangabad district is located in the north central part of Maharashtra between 19<sup>0</sup> 15' and 20<sup>0</sup> 40' N latitude and 74<sup>0</sup> 37' and 75<sup>0</sup> 52' E Longitude. The mean maximum temperature 39.7<sup>0</sup>C, the mean minimum temperature is 24.6<sup>0</sup>C. The average annual rainfall is 619 mm. The elevation of the district was 500 meters above mean sea level. The length of growing period 145 and humidity period is 101 days. The geographical area is 10,107 Sq.km.

The soils of the study area were shallow to deep, very dark gray (10 YR 1/3) to light brown (10 YR 5/4) in color, loamy to clay in texture and granular to angular blocky in structure, non-sticky non plastic to very sticky to very plastic in nature. The bulk density of the soil varied 1.23 to 1.63 Mg m<sup>-3</sup>. Hydraulic conductivity range between 1.4 to 5.13 cm hr<sup>-1</sup>. Clay content varies from 14.9 to 54.00 per cent, which was significantly correlated with CEC and PAWC (r= 0.96 and r= 0.73) indicating CEC and PAWC closely associated with the clay content in soil. The soils of the study area alkaline in nature and it was varying from 7.8 to 8.8. The electrical conductivity varies from 0.15 to 0.46 dSm<sup>-1</sup>. The maximum CEC was recorded in Typic Haplusterts (31.23 to 60.13 c.mol/ (P<sup>+</sup>) kg<sup>-1</sup>), as compared to Typic Haplustepts, and Lithic Ustorthents. The soil fertility status was found low to high. Taxonomically these soil classified into Lithic Ustorthents ,Typic and Calcic Haplustepts and Typic and Calcic Haplusterts.

The total carbon content in the different cropping pattern and soil profile varies P<sub>1</sub> (*Lithic Ustorthents*) pattern contains 0.973 to 1.26 Pg, C, the maximum TOC under pigeon pea followed by sorghum, cotton and maize. The maximum soil organic carbon stock (SOCS) was noticed at pigeon pea cropping pattern at 100 cm soil depth (13.6 t ha<sup>-1</sup>) and which varies from 7.74 to 13.6 t ha<sup>-1</sup>. The maximum soil inorganic carbon stock (SICS) was noticed at maize cropping pattern at 100 cm soil depth (16.36 t ha<sup>-1</sup>) and which varies from 10.28 to 16.36 t ha<sup>-1</sup>. The Total carbon stock (TCS) was noticed at cotton cropping pattern at 100 cm soil depth ( 26.17 to 59.98 t ha<sup>-1</sup>) and which varies from total profile depth 15.66 to 36.02 t ha<sup>-1</sup>. The correlation between yield of cotton with SOCS (r=0.06), SIC (r=-0.28) and Total Carbon Stock (r=0.052); in Maize SOCS (r=0.42), SIC (r=-0.375) and Total Carbon Stock (r=0.043); and in pigeon pea SOCS (r=0.258), SIC (r=-0.161) and Total Carbon Stock (r=0.051); This indicated that increasing SIC decrease the yield of cotton, maize and pigeon pea under semiarid climate. The correlation between yield of cotton, maize and pigeon pea found positive correlated with SOC (r=0.063, r=0.042 and r=0.258 respectively) indicating the soil organic carbon increased the yield of cotton, maize and pigeon pea increased.

From above result however conclude that the yield of cotton, maize and pigeon pea in Aurangabad district increased with increasing soil organic carbon stock (SOCS) whereas decrease with increasing soil inorganic carbon stock (SICS). Therefore, it's need to control the formation of SIC and its adverse effect for higher yield of commonly grown crop under semiarid climate.

**(Key words:** Carbon stock, Total organic carbon, Soil organic carbon, Soil inorganic Carbon, Soil organic carbon stock, Total carbon stock, Cotton, Pigeon Pea, Maize, Soil Quality)

**CHAPTER-I**  
**INTRODUCTION**

## CHAPTER-I

### INTRODUCTION

Carbon is the basic unit for the development of soil ecosystem functions, it acts as carrier for the lot of chemical reactions in the soil and earth ecosystems. It is an indicator to soil color, soil health and soil microbial activity in the soil. It acts as an energy exchanger between the soil and atmosphere. It can enhance and develop the soil physical properties like bulk density, soil porosity, hydraulic conductivity, plant available water capacity, maintains soil thermal equilibrium and aeration and reduce soil crust formation. It also useful to chemical processes like cation exchange capacity, base saturation, exchange cations and act as a natural chelated agent. Carbon can be increasing the microbial activity and catalyst for the soil enzymatic activities like dehydrogenase (microbial respiration), cellulose, phosphatase, urease, Acyl-Sulphatase. It can develop the soil biodiversity encourages the soil beneficiary organisms, predators and maintains the soil ecological equilibrium. Recently, majority of soil problems like heavy metals toxicity can be reduce by the chelating chain property of carbon and hold the beneficiary trace or obligative minerals. But now a days carbon content in the soil ecosystem decreasing gradually, at the same time carbon emissions in the atmosphere has increasing due to anthropogenic activities. The reduction of soil organic carbon concentration and increasing carbon emissions were burning issue in globally, because it causes lot of changes in weather calamities like global warming, greenhouse gas effect and increase in sea level (Fortunate and Colin, 2004).

The soil organic carbon concentration in most of the Indian soils were less than 10 g/kg and it is generally less than 5 g/kg. (Lal, 2004). The reason behind that was continuous monoculture, high tillage operations, traditional methods of cultivation practices like biomass burning, crop residues burning (Punjab, Haryana), podu method cultivation or jhuming-jhum cultivation (North East Hills), continuous rice cultivation (South India), high grazing in cultivation land, deforestation, cement manufacturing, fossil fuels and industrial pollution. Along with didn't following edaphic conservation method like cover crops, mulching, green manuring, ignoring soil health card results and enormously used plenty of or high doses of commercial fertilizer application causes the soil organic carbon decrease and soil health damage (Lal, 2004). The environmental issue high ozone (O<sub>3</sub> strong oxidizer) concentration in the soil

atmosphere causes lot of oxidations of soil organic carbon in the surface layer of soil (Taiji and Wang, 2014). Recent methodologies like bio-char production, carbon sequestration, carbon stock or pool, crop residue, legume crop rotation, following forestry, Agro-forestry measures and biomass production management was required for restoration of soil health and soil organic carbon management. It is a major concern for the tropical soil.

Soil carbon stock defined as the carbon stored in above biomass below biomass, plant litter dead wood/woody debris and final total soil collectively known as soil carbon stock or pool. The important controlling factors for SOC (Soil Organic Carbon) include climate, hydrology, parent material, soil fertility, biological activity, vegetation pattern and land use (Jenny and Raychaudhuri, 1967). The most of tropical and subtropical Indian soils are low SOC concentration due to high mean annual temperature and low rainfall causes a lot of soil organic carbon decomposition occur and there by SOC level decreases. But humid climatic conditions maintain good SOC content due to vegetation, hydrology and high rainfall. The soil was the largest stock of carbon holding 1500 Pg. C (1pg =  $10^{15}$  g), it was approximately twice the amount held in the atmosphere and thrice the amount held in the terrestrial vegetation. The soil Terrestrial vegetation reported 600 Pg. C and soil inorganic carbon stock contain 750 to 950 Pg. C. It has been estimated that the land use change result in the transfer of 1 to 2 Pg. C  $\text{yr}^{-1}$  from terrestrial ecosystem to the atmosphere of which contributed by decomposition of SOC.

The carbon stock or pool can be divided into two types based on their chemical composition *viz.*, soil organic carbon pool and soil inorganic pool. The soil organic pool or stock estimated that 21 Pg. (Peta-gram =  $1 \times 10^{15}$  g = billion ton) to 30 cm soil depth and inorganic carbon pool estimated that 196 Pg. to 1 m soil depth (Lal *et al.*, 2004), The global soil organic carbon storage corresponded to 615 Gt C to in the top 0.2 m depth 2344 Gt C (Gigatons) depth of up to 3 m. The total of  $\text{CO}_2$  C exchanged annually between the land atmosphere as gross primary productivity is estimated 120 Gt/yr. and about half of it is released by plant respiration. Soil was the largest carbon reservoir of the terrestrial carbon. Soil contains 3.5 per cent earth carbon reserve compared with 1.7 per cent in the atmosphere, 8.9 per cent fossil fuel, 1.0 per cent in biota and 84.9 per cent in the oceans (Lal and Bruce, 1999). The mean residence time of soil organic pool have slowest turnover rate in terrestrial ecosystem and thus

carbon sequestration has potential to mitigate CO<sub>2</sub> emission to the atmosphere, furthermore the higher carbon stabilization in soil is benefiting other soil ecosystem functioning's.

The first comprehensive report of SOC, SIC (Soil Inorganic Carbon) and TC (Total Carbon) was carried out by Velayutham *et al.* (2000) and Bhattacharya *et al.* (2005) later these estimates were made useful for various mapping scheme (Bhattacharya *et al.*, 2008). The SOC stock for India in terms of each order estimated at 1 to 30 cm depths the Inceptisols 22 per cent (4.67 Pg) SOC stock, Entisols 7 per cent (1.36 Pg), Vertisols 13 Per cent (12.5 Pg). Aridisols are low inorganic carbon due to high decomposition but few arid soils belonging to cold (Typic Camotyorthids), hot (Typic Camotruids / Natragids / Calidrids) and arid ecosystem contribute about 37 per cent (7.67 Pg) of the stock. The Indian Mollisols <1 per cent stock due to the fact that only a small portion of the Indian soils. Alfisols 20 per cent (4.22 Pg) SOC stock, Ultisols 0.8 per cent (0.14 Pg), Oxisols (0.9%) (0.19 Pg) SOC stock contributed (Velayutham *et al.*, 2000). The SOC stock concentration increases with high clay and rainfall compared to low clay low rain fall. The SOC content is high in native and non-cultivated soils compared to the cultivated soil. (Jenny and Raychaudhuri, 1967). Forest conditions the SOC stock more in coniferous vegetation compared to ever green and deciduous forest soils. The SOC stock concentration can be increase with inter crop rotation with legumes compared to cereal crops (Shrinivasrao *et al.*, 2012). The SOC stock concentration high in forestry system compared to the other land use system (Surya Prabha *et al.*, 2019). The great potential of increasing soil carbon concentration through adoption of forest land mixed vegetation cover crop, soil microbial cultures bio mixers, bio-inoculants, Organic farming. The recommend management practices (RMPS) (Lal, 2010). The maximum carbon stock and carbon sequestration potential was highest in glyricidia followed Leguminosae crop, cereals and cash crop like cotton and horticultural crop (Wagh, 2018). The amount of SOC under Glyricidia under Leguminosae crop may be due to addition of cash crop. That can increase soil carbon, win-win strategy of increased C storage and fertility soil health.

As per the discussion with farmers and subject matter specialist of the area we find out fact that the soil carbon stock was very less (< 0.1%) under maize and cotton, cropping pattern due to continuous cultivation of these crops. This soil doesn't support to the cotton, farmers were shifted to soyabean crop. With this view of above aspects,

the present investigation was undertaken on “Assessment of soil quality and carbon stock under different cropping pattern of Aurangabad district of Maharashtra” with the following objectives.

**Objectives: -**

1. To know the morphological, physical, chemical properties of soil.
2. To know the carbon stock under different cropping pattern.
3. To establish the cause effect relationship between different soil quality, carbon stock and cropping pattern.

**CHAPTER-II**  
**REVIEW OF LITERATURE**

## CHAPTER-II

### REVIEW OF LITERATURE

A brief review of the literature related to the present investigation has been grouped under following heads.

#### **2.1 Soil characteristics**

##### **2.1.1 Morphological properties**

##### **2.1.2 Physical properties**

##### **2.1.3 Chemical properties**

##### **2.1.4 Soil classification**

##### **2.1.5 Carbon stock under different cropping pattern**

##### **2.1.6 Carbon stock and relationship with cropping pattern.**

#### **2.1 Soil characteristics**

The important soil characteristics which directly or indirectly effect on crop growth and soil characteristics are described as below.

Dhale and Jagdish Prasad (2009) studied on productivity of sweet orange, in Jalna district of Maharashtra and they reported that the soils are shallow to very deep and grouped into Typic Haplusterts to Lithic Ustorthants. The different soil site attribute is responsible for yield of sweet orange.

Ashok and Jagdish (2010) studied on typical sugarcane growing soils of Ahmednagar district of Maharashtra for their characterization and classification. He was reported that the soil under sugarcane is Vertic Haplusterts, Lithic Ustorthants and Sodic Haplusterts.

Patil *et al.* (2013) Studied on soils of Osmanabad district and reported that these soils are classified as Lithic Ustorthent, Typic Ustochrept and Typic Haplusterts. The morphological, chemical and physical properties of soil are differing in relation to topographic position of soil profile. The different soil site attribute responsible for yield difference in soyabean and pigeon pea are PAWC, clay content, soil depth, CEC and stoniness.

Manwar *et al.* (2015) reported on that the sugarcane growing soils of Latur district are shallow to very deep, black (10YR 2.5/1) to yellowish brown (10YR 5/6) in colour, granular to angular blocky in structure, clay loam to clay in texture (37.8 to 64.6 %). These soils were slightly to moderately alkaline in nature (7.25- 8.53), the electrical conductivity is less than  $1 \text{ dsm}^{-1}$ , low to moderately in organic carbon (0.24-0.76%) whereas, low to high calcium carbonate content (0.5 to 15.5 %) and high in cation exchange capacity (26.24 to 74.31  $\text{cmol}(\text{p}^+)(\text{kg}^{-1})$ ). The calcium is dominant and followed by magnesium, sodium and potassium. The base saturation percent is  $> 90$  per cent.

Shinde (2015) studied on soil resources mapping of oil seed research station Latur analyzed that the study area were classified according to us comprehensive system of soil classification (Soil survey staff, 2015) the soil belongs to three orders viz. Entisols, Inceptisols, and Vertisols and sub group level Typic Ustorthent, Typic Haplustepts and Typic Haplusterts.

Aundhkar *et al.* (2018) studied on characterization, classification and evaluation of soils in cotton growing region of Beed district reported that the soil classified Entisols, Inceptisols and Vertisols and at sub group level is Typic Ustorthents, Typic Haplustepts and Haplusterts and Calcic Haplusterts.

Satish (2018) studied on soils of brahmakotkur watershed area in Kurnool district of Andhra Pradesh. They reported that soils were neutral to strongly alkaline (pH 7.01 to 8.86) in reaction, non-saline ( $\text{EC } 0.10 \text{ to } 0.58 \text{ dS m}^{-1}$ ), shallow, deep and very deep in depth and had isohyperthermic temperature and ustic soil moisture regimes. The soil texture, organic carbon (OC), cation exchange capacity (CEC) and base saturation were ranged from gravelly sandy loam to clay, 0.10 to 5.8  $\text{g kg}^{-1}$ , 8.11 to 61.72  $\text{cmol}(\text{p}^+)(\text{kg}^{-1})$  and 69.1 and 99.1 per cent, respectively. Pedon 11 was placed under Entisols due to absence of sub-surface diagnostic horizon and classified as Lithic Ustorthent whereas pedons 4, 8 and 9 were grouped under Inceptisols due to presence of cambic (Bw) sub-surface diagnostic horizon and classified as Lithic Typic Haplustepts and Typic Haplustepts. However, the remaining pedons were placed under Vertisols due to presence of more than 30% clay in all the horizons, slickensides and wedge-shaped aggregates in sub-surface horizons and cracks in surface horizons and were classified as Typic Haplusterts, Sodic Haplusterts, Typic Calciustert.

Sekhar *et al.* (2019) studied on Genesis, characterization and classification of soils from selected part of Prakasam district in Andhra Pradesh. They found that the Pedon 2 and 7 were grouped under Entisols due to absence of subsurface diagnostic horizons and were classified as Typic Ustorthent at sub-group level Pedon 1, 3, 5 and 6 were placed under Inceptisols due to presence of Cambic (BW) sub-surface diagnostic horizon and classified as Typic Haplustepts at sub group level, the Pedon 4 came under Vertisols due to presence of vertic features like slickensides, pressure face, crack and presence of more than 30 per cent clay in all the horizons and was classified as Typic Haplusterts sub group.

Sharma and Raja (2020) studied on pedogenesis and mineralogy of alluvial soil from semiarid part of Rajasthan in Aravalli Range in India. This study reported that the soils were classified as Entisols and Inceptisols. These soils are sandy with more than 50% of fine and medium sand fractions, silt to clay ratio more than 0.45 and little textural variation suggesting more uniform weathering. Mineralogy investigation showed the dominance of mica and smectite and increase of smectite and mica in  $Bw_3$  horizon and high silica activity with limited leaching.

### **2.1.1 Morphological properties**

Kadao *et al.* (2003) reported some typical banana growing soils of Wardha district of Maharashtra and revealed Vertisols developed in basaltic alluvium were deep, calcareous and brown to very dark grayish brown in colour. The texture of pedons ranged from loamy sand to clay (10.7 to 65.4 per cent clay) in different horizons.

Patil *et al.* (2008) studied on soils of college of Agriculture farm Pune, Maharashtra and reported that the soil colour varies from brown (10 YR 4/4) to dark brown (10YR 3/3), clay in texture and medium moderate sub angular blocky in structure.

Dhale and Prasad (2009) found that the sweet orange growing soils of Jalna district, in Maharashtra had their Munsell colour notation in the hue 10YR 5/7 to 5/5 YR with value 3 to 4 and chroma 1 to 4. The surface and subsurface horizon of pedons is associated with sub-angular blocky structure of varying grade and size but angular blocky structure associated with slickenside is a common feature of sub-soils in Vertisols.

Ashok Kumar and Jagdish Prasad (2010) studied and characterized typical sugarcane growing soils of Ahmednagar district of Maharashtra and reported that the soils were very shallow to very deep and have their Munsell color notation in 10YR 7/5 hue with value 3 to 4 and chroma 1 to 4. The dominant structure is a common feature in slicken slide zone of Vertisols.

Kharche and Pharande (2010) studied on Mula command area, Ahmednagar district, Maharashtra and reported that the soil of command is rich in ferromagnesium minerals that weathered into dark-colored soils. The texture of the soils varies from clay-to-clay loam because of fine grained basaltic parent material.

Meena *et al.* (2011) reported that the soils in upper Wardha command area of Maharashtra were clayey in texture and surface horizons had sub angular blocky structure and sub-surface horizons had moderate angular blocky structure. These soils were slightly hard to hard in dry condition, friable to firm in moist condition. The wet consistency of all pedons was sticky and plastic to very sticky and very plastic in nature. Pressure faces were common in Bw horizon of all pedons.

Patil *et al.* (2013) reported that the soils of Osmanabad tahsil were yellowish brown (10YR 5/6) to black (10 YR 2.5/1) in colour, very shallow to very deep, granular to angular blocky in structure sandy clay loam to clay in texture.

Nasre *et al.* (2013) evaluated the soils of Karanji watershed, Yavatmal district and reported that the soils were very shallow to shallow with lower clay content and AWC at upper reaches and deep to very deep with higher clay content AWC at lower reaches of the watershed.

Vaidya and Dhawan (2014) noted that the soils of farm at college of Agriculture Osmanabad, Maharashtra, were developed on gently (1 to 3 per cent) to moderate sloping (3 to 5 per cent) over weathered basalt underlined by saprolites layer and are very shallow to moderately shallow in depth. Soils were reddish brown (5YR 5/4) to yellowish brown (10YR 5/8) in colour, having weak moderate granular to moderate medium subangular blocky structure.

Sayamber (2015) reported that the soils of Tungi watershed are shallow to deep, black (10YR 2.5/1) to light brownish gray (10YR 6/2) in colour, granular to

angular blocky in structure with well-developed intersecting slickensides, clay loam to clay in texture, non-sticky non-plastic to very sticky very plastic in nature.

Pawar *et al.* (2015) studied on the soils of Osmanabad district Maharashtra and observed that the soil was very shallow to very deep, black (10 YR 2.5/1) to dark yellowish brown in colour (10YR 4/4), clay to sandy loam in texture and granular to angular blocky in structure.

Manwar *et al.* (2015) studied the sugarcane growing soils of Latur district in Maharashtra and reported that these soils were shallow to very deep in depth, black (10YR 2.5/1) to brownish yellow (10YR 6/6) in color and granular to subangular blocky in structure. These soils were sandy loam to clay in texture and soil consistency varied from soft to hard in dry condition, friable to firm in moist condition and non-sticky non-plastic to very sticky very plastic in wet condition. The high clay content was attributed to basaltic parent material

Shinde (2015) studied the soils of Oilseed Research Station, Latur of Maharashtra and reported that soil of the area was shallow to moderately deep in depth, very dark gray (10YR 3/1) to brown (10YR 5/3) in colour, granular to sub angular blocky in structure and clay to silty clay in texture. Soil consistency varied from soft to hard in dry condition, friable to firm in moist condition and non-sticky, non-plastic to very sticky very plastic in wet condition.

Adkine *et al.* (2016) studied soils of Krishna valley of Marathwada region, Maharashtra and reported that the soils were very shallow to very deep in depth, black (10YR 2.5/1) to very pale brown (10YR 7/4) in colour, silty clay loam to clayey in texture, granular blocky in structure.

Ghode (2016) studied the cotton growing soils of Nanded district and reported that these soils were shallow to deep, black (10YR 2.5/1) to very pale brown (10YR7/4) in colour, granular to angular blocky in structure, loam to clay in texture.

Prakash (2017) studied on shrinkage swell soils of Chandrabagha in semi-arid region of central India. They reported the all the soils except pedon 1 and pedon 2 were deep brown to very dark grey, the subsurface horizons of all the soil are generally subangular blocky structure and hard (dry) friable (moist) consistency, the Vertisols properties like intersecting slickensides, forming parallel epipedon with the long axe

tilted at 30 to 45°C from horizontally, shiny pressure faces and cracks penetrated to > 50 cm.

Aundhakar *et al.* (2018) studied on the soil of Beed district of Maharashtra and reported that the soil was shallow to deep black (10YR 2.5/1) to light yellowish (10YR 6/4) in colour granular to angular blocky in structure, loam to clay in texture.

Nawkhare (2019) studied on morphological properties of soil of babhulgon village of latur district of Maharashtra and found that the soil of babhulgon shallow to black (10YR 2.5/1) to light brownish gray colour. The soil structure granular to angular blocky in structure with well- developed intersecting slicken slides.

### **2.1.2 Physical properties**

Kadu *et al.* (2003) reported that the hydraulic conductivity is to be the most important limiting factor in controlling the yield of cotton in Vertisols. They also reported that evaluation of Vertisols for deep rooted crops on the basis of hydraulic conductivity alone may help in planning and management of soil under semi- arid climate in India.

Thangasamy *et al.* (2005) studied characterization, classification and evaluation of soil resource in sivigiri micro- watershed area of Chittoor district of Andra Pradesh. He reported that the clay content varied from 2.50 to 58.39 per cent and silt content of all the profiles exhibited an irregular trend with depth. Coarse fraction (sand) constitutes the bulk of mechanical fraction, which could be attributed to the bulk density varied from 1.32 to 1.90 Mg m<sup>-3</sup> and increased with depth which might be due to more compaction in deeper layer caused by over-head weight of the surface soil.

Kharche *et al.* (2009) studied on Godavari command area semi-arid Agro-Eco-Region. The major soils in the command area were Entisols (42.4%), Inceptisols (37.6%) and Vertisols (20%) clay content varies from 45.5 per cent to 74.5 per cent. The Bulky density 1.39 to 1.52 Mg m<sup>-3</sup> saturated Hydraulic conductivity 0.04 to 1.50 cm hr<sup>-1</sup>.

Kharche and Pharande (2010) observed that the soil of mula command area of Ahmednagar district Maharashtra and reported that the clay content in different horizons varied from 36.2 to 57.2 per cent. bulk density of soil varied from 1.32 to 1.65 g cc<sup>-1</sup>.

Meena *et al.* (2011) studied the soils in upper Wardha command area of Maharashtra and observed that the clay content ranged from 52.2 to 60.9 per cent and increased with depth. Silt content was low to medium but it was found almost uniform with depth. Sand content ranged from 7.9 to 16.2 per cent and it decreased with depth. Water holding capacity of studied soils varied from 67.98 to 80.40 per cent and followed an increasing trend with depth in all the pedons.

Selvaraj and Naidu (2012) studied on characteristics, classification and evaluation of soils different land uses in Renugunta mandal of Chittoor district of Andrapradesh. They observed that the bulk density of different pedons varied from 1.13 to 1.96 Mg m<sup>-3</sup> and increased with increase in depth, which might be due to their coarse texture and low organic matter content. Water holding capacity varied from 29.3 to 55.6 per cent.

Satish Kumar and Naidu (2012) studied on the soils of Chittoor district in Andhra Pradesh and reported that clay content varied from 2.74 to 43.84 per cent. The increase in clay content in Bt horizon could be attributed to vertical migration or translocation of clay (Sarkar *et al.*, 2002). The bulk density varied from 1.10 to 1.70 Mg m<sup>-3</sup> and increased with depth.

Malode (2013) studied the soils of Marathwada region in Maharashtra and found that the clay content in Entisols, Inceptisols and Vertisols varied from 43.3 to 58.7, 47.0 to 56.1 and 50.1 to 62.1 per cent, respectively. The bulk density of soils ranged from 1.27 to 1.57 Mg m<sup>-3</sup> and it was increased with depth of soil profiles. The saturated hydraulic conductivity varied from 0.1 to 7.0 cm hr<sup>-1</sup>.

Malode and Patil (2013) studied on characterization of some Vertisols of drought prone zone of Marathwada region (M.S., India) and reported that the soils were clayey in texture and clay per cent ranged from 50.1 to 58.9 per cent sand per cent 10.1 to 21.6 per cent and silt per cent ranged from 25.1 to 32.9 per cent, the clay content significantly and positively correlated with moisture retention at 33 kPa, 1500 kPa and available water content. The bulk density in general, increased with depth.

Patil *et al.* (2013) studies on soils of Osmanabad district of Marathwada region Maharashtra and reported that the soils are sandy clay loam to clayey in texture. The

AWC of soils varies from 7.5 to 20.8 per cent and the PAWC of the soils are varies from 59 to 259 mm.

Vaidya and Dhawan (2014) studied the soil of farm at College of Agriculture Osmanabad in Maharashtra and found that coarse fragments range from 7.33 to 93.6 per cent and sand is the dominant fraction in Pedon located on elevated topography where as clay dominant in surface horizons situated in depress topography. The bulk density of these soils varied from 1.3 to 2.1 Mg m<sup>-3</sup> and high bulk density was noticed in saprolite layer. The available water capacity of these soils ranged from 7.5 to 15.8 per cent, this variation attributed to textural variation.

Nagaraju and Gajbhiye (2014) evaluated the soils of Kukadi command in Ahmednagar district of Maharashtra and revealed that the soils of the area were loamy to clayey in texture with sand, silt and clay content ranged from 15.8 to 57.3, 14.0 to 25.1 and 28.7 to 64.5 per cent, respectively. The higher clay content in soils was associated with water retention at 33 kPa and 1500 kPa.

Ram and Pramod (2014) reported that the soils of Markapur mandal in Prakasam district of Andhra Pradesh, were clay loam to clay in texture and clay content varied from 23 to 25 per cent in hill side slope, 18 to 37 % in pediplains under Inceptisols and 37 to 53 per cent in Pedi plains under Vertisols. The textural variation might be due to differences in composition of parent material topography, insitu weathering and translocation of clay by eluviations and age of soil.

Patel and Dhanashree (2014) studied on soils of Marathwada region, Maharashtra and analyzed that the soils are sandy clay loam to clay in texture. The AWC of soils varied from 7.5 to 20.8 per cent and the PAWC of the soils are varied from 59 to 259 mm.

Manwar *et al.* (2015) reported that the bulk density of sugarcane growing soils of latur district varies from 1.31 to 1.84 Mg m<sup>-3</sup>, PAWC varies from 57.60 to 377.48 mm and saturated hydraulic conductivity varies from 4.12 to 19.4 cm hr<sup>-1</sup>.

Saymber (2015) studied on Tungi watershed of Latur district and found that the bulk density of the area varies from 1.30 to 1.92 Mg m<sup>-3</sup>, saturated hydraulic conductivity varied from 0.42 to 30.00 cm hr<sup>-1</sup>.

Dharmendra (2016) studied on seven soil series of Thiruvananthapuram district of Kerala. He reported that the soil texture was sandy loam to sandy clay loam, Bulk density of soil varied from 1.10 to 1.59 Mg m<sup>-3</sup>.

Ghode (2016) reported that the bulk density of cotton growing soils of Nanded district varied 1.29 to 1.88 Mg m<sup>-3</sup>, PAWC varied from 101.3 to 366.2 mm and saturated hydraulic conductivity varied from 1.30 to 23.10 cm hr<sup>-1</sup> and clayey in soil texture.

Prakash (2017) studied on shrinkage-swell soils of Chandrabhaga valley in central India. They reported that the soils were mostly clay (30.1 to 75.5%) whereas fine clay varied from 13.6 to 57.4 per cent and bulk density at field capacity was 1.23 to 1.7 Mg m<sup>-3</sup> the saturated hydraulic conductivity ranged from 0.01 to 27.4 mm hr<sup>-1</sup>. The plant available water capacity (PAWC) of soils ranged from 40 to 198 mm.

Nawkhare (2019) studied on morphological properties of soils of Babhulgaon Village of Latur found that the soil texture is sandy to clay texture and soil consistency varies nonstick non-plastic to very sticky very plastic in nature the bulk density of soil is 1.42 to 1.79 gr cc<sup>-1</sup> the saturated hydraulic conductivity of the soil varies from 2.42 to 29.25 cm hr<sup>-1</sup>. This variation attributed to textural difference.

### **2.1.3 Chemical properties**

Bhatnagar *et al.* (2003) studied that the CaCO<sub>3</sub> content in Vertosols and Inceptisols of Shivpuri district of Madhya Pradesh ranged between 0.85 to 7.16 per cent and 1.25 to 4.87 per cent with the mean of 2.90 to 2.93 per cent, respectively.

Gabhane *et al.* (2006) studied that the Belura watershed Akola district is neutral to moderately alkaline in reaction (pH 7.5 to 8.03) in general pH of the soil increase with depth. The organic carbon content of the soils varied from 0.32 to 0.72 per cent and it was decreased with depth. The CEC of soil varied from 51.1 to 62.9 cmol (P<sup>+</sup>) Kg<sup>-1</sup>.

Waghmare *et al.* (2007) studied the chemical properties and micronutrient status of some soils of AUSA and Nilanga tahsils of Latur district in Maharashtra and reported that the available P content of these soils are ranged from 4.22 to 24.98 kg ha<sup>-1</sup> and 4.22 to 28.13 kg ha<sup>-1</sup> respectively.

Patil *et al.* (2008) reported that the soils of college of Agriculture, Pune farm are moderately alkaline in reaction (pH 8.0 to 8.7) low to medium organic carbon 0.14

to 0.42 per cent). The soil is moderately calcareous in nature. The  $\text{CaCO}_3$  content increased with increasing depth.

Vaidya and Mali (2008) reported that the soils of Kini farm college of Agriculture Osmanabad are low to moderate in organic carbon, neutral to alkaline (6.8 to 7.2) in reaction and calcareous in nature (<5 per cent).

Kharche *et al.* (2009) studied on Godavari command area of semi-arid Agro-Eco-Region. They reported that the soil chemical parameters like pH ranged between 8.1 to 9.1 the EC varies from 0.06 to 4.84  $\text{dSm}^{-1}$  while organic carbon 1.5 -6.8  $\text{g kg}^{-1}$ , the free calcium carbonate ranged from 5.4 to 20.3 per cent the CEC of the soils varies from 32.6 to 58.4  $\text{cmol (P}^+) \text{kg}^{-1}$ .

Kharche and Pharande (2010) reported the soils of Mula command area of irrigated agro ecosystem of Maharashtra and reported that these soils were moderately to strongly alkaline in reaction, the exchange complex of the soils was dominantly saturated with calcium followed by magnesium, sodium and potassium. ESP of soils varied from 3.9 to 27.0 in different horizon and showed increasing trend with depth. Most of the soils were calcareous with free calcium carbonate content varying from 88 to 205  $\text{g kg}^{-1}$ .

Raut *et al.* (2012) reported that the soils of the Babhulgaon region of Yavatmal district are slightly alkaline in nature, EC ranged between 0.28 to 0.93  $\text{dSm}^{-1}$ , organic carbon ranged between 4.8 to 8.1  $\text{g kg}^{-1}$  calcium carbonate ranged between 5.59 to 15.19 per cent and CEC ranged between 41.32 to 64.60  $\text{cmol (P}^+) \text{kg}^{-1}$ .

Hirey *et al.* (2013) studied the soils of Tuljapur tehsil of Osmanabad district and reported pH of Vertisols, Inceptisols and Entisols ranged from 7.10 to 9.00, 7.00 to 8.90 and 6.10 to 8.90, 2.15 to 12.77, 1.69 to 11.85 and 2.15 to 11.23  $\text{g Kg}^{-1}$ ,  $\text{CaCO}_3$  content 5.00 to 81.00, 10.50 to 81.00 and 20.00 to 79.50  $\text{g kg}^{-1}$  respectively.

Patil *et al.* (2013) studied on soils of Osmanabad district, Maharashtra and reported that the soils are slightly acidic to moderately alkaline in nature. The CEC varies from 23.19 to 44.8  $\text{c.mol (p}^+) \text{kg}^{-1}$ . Low to moderately high in organic carbon. The base saturation per cent is greater than 90 per cent.

Malode and Patil (2013) studied on characterization of some Vertisols of drought prone zone Marathwada region (M.S., India) and reported that pH of soils was moderately to strongly alkaline in reaction, organic carbon ranged from 0.29 to 1 per

cent,  $\text{CaCO}_3$  ranged from 2.8 to 19.0 per cent and CEC ranged from 40.3  $\text{cmol (P}^+) \text{ kg}^{-1}$  to 78.2  $\text{cmol (P}^+) \text{ kg}^{-1}$ .

Nasre *et al.* (2013) assessed the soil of Karanji watershed Yavatmal district and reported that the pH of surface soil was neutral to slightly alkaline however, higher pH and ESP in sub soil of Dhana ( $\text{P}_{12}$ ) and kongara ( $\text{P}_{14}$ ) in alluvium plains indicated the development of sub soil acidity which has resulted in the rapid decrease in hydraulic conductivity.

Patil and Dhanashree (2014) reported that the changes in soil organic carbon stock under different land use system in Gondia district of Maharashtra the land uses included Forest, Paddy more than 10 years, Paddy more than 50 years and paddy more than 100 years. The forest was considered as control. The study on C stock and C potential was 10-year paddy (SOC) less than 50 year followed by 100 years. Estimated soil carbon stock at 0-30 cm depth varied between 13.5 to 50.2  $\text{tons ha}^{-1}$  in Gondia forest, 8.2 to 9.5  $\text{tons ha}^{-1}$  in 10 years paddy cultivated area, 12.3 to 12.6  $\text{tons ha}^{-1}$  in 50 years paddy cultivated area and 11.6 to 13.3  $\text{tons ha}^{-1}$  in 100 years paddy cultivated area, which is being lowest soil carbon stock in 10-year paddy cultivated area and soil highest in forest.

Vaidya and Dhawan (2014) reported that soils of farm at College of Agriculture, Osmanabad were neutral to alkaline in reaction, EC values ranged from 0.1 to 0.3  $\text{dSm}^{-1}$ . The organic carbon content was low to high, the CEC of this soils varied from 17.78 to 48.21  $\text{c.mol (p}^+) \text{ kg}^{-1}$ . The exchangeable complex was dominated by  $\text{Ca}^{++}$  followed by  $\text{Mg}^{++}$ ,  $\text{K}^+$  and  $\text{Na}^+$ . The base saturation percentage was more than 88 per cent.

Cheke *et al.* (2014) studied the soils of Lohara tahsil in Osmanabad district of Maharashtra and reported that soils were alkaline in reaction and within safer limits of electrical conductivity; these soils were calcareous in nature, low to medium in organic carbon content.

Sayamber (2015) reported that the soils of Tungi watershed in Latur district of Maharashtra are slightly to strongly alkaline in reaction with pH range from 7.01 to 8.87. The electrical conductivity of the studied soils ranged from 0.13 to 0.67  $\text{dSm}^{-1}$ , which is well within the safe limit. The organic carbon content varied from 0.04 to 0.81

per cent. It was observed that as depth increase, per cent organic carbon decreased. The soil was low to high in organic carbon content. The calcium carbonate content varied from 4.4 to 37 per cent in different horizons of pedons indicates that soils were highly calcareous in nature. The CEC of soils ranged from 27.50 to 63.58 c.mol (p<sup>+</sup>) kg<sup>-1</sup>. The highest CEC was observed in Typic Haplusterts as compared to Typic Haplustepts and Typic Ustorthents. The calcium was the dominant cation followed by the magnesium, sodium and potassium in all profiles. The base saturation per cent varied from 88.82 to 113.42 per cent.

Mane *et al.* (2015) revealed that the grape growing soils of Osmanabad district were slightly to moderately alkaline in reaction with pH ranged from 7.1 to 8.3. The electrical conductivity ranged between 0.10 to 0.68 dSm<sup>-1</sup>. The organic carbon content in these soils varied from 0.10 to 2.07 per cent and calcium carbonate ranged between 1 to 42.9 per cent, indicating that soil was calcareous in nature. The CEC of soils varied from 18.20 to 62.0 cmol (P<sup>+</sup>) kg<sup>-1</sup>. The exchange site was the dominance of calcium followed by magnesium, sodium and potassium in all profiles. The base saturation per cent varied from 90.21 to 97.9 per cent.

Adkine *et al.* (2016) reported that the soils of Krishna valley were slightly to moderately alkaline (7.10-8.27), low to medium in organic carbon and CaCO<sub>3</sub> and CEC varied from 24.56 to 78.18 c.mol (p<sup>+</sup>) kg<sup>-1</sup>.

Ghode (2016) reported that cotton growing soils of Nanded district are slightly too moderately alkaline in nature (7.2 to 8.5), the electrical conductivity varied from 0.1 to 0.4 dSm<sup>-1</sup>. Low to high in organic carbon (0.1 to 0.95 per cent) whereas low to very high in calcium carbonate content (5.3 to 36.1 per cent) and high in cation exchange capacity 35.40 to 66.30 c.mol (p<sup>+</sup>) kg<sup>-1</sup>. The calcium was the dominant cation followed by magnesium, sodium and potassium.

Chadar *et al.* (2017) studied on the soils of farm college of agriculture Latur and reported that the soils are slightly to moderately alkaline in reaction 7.6 to 8.51, electrical conductivity of the soil ranged from 0.19 to 0.63 dSm<sup>-1</sup>. The organic carbon content in soils was low to moderate and varied from 0.12 to 0.80 per cent, the calcium carbonate content varied from 7.5 to 45.6 per cent and which was increased with depth, CEC of soil varied from 31.30 to 63.30 cmol (p<sup>+</sup>) kg<sup>-1</sup> and the base saturation per cent varied from 93.47 to 98.89 per cent.

Rehman *et al.* (2017) studied on soils of Pulwama district of Kashmir valley. They found that the soils were neutral to alkaline in reaction with p<sup>H</sup> variation from 6.49 to 8.42 the EC of the soil variation from 0.2 to 1.72 dSm<sup>-1</sup>.

Sekhar *et al.* (2019) studied on chemical properties of soils from some parts of Prakasam district of Andhra Pradesh. They found that soils were moderately deep to very deep, slightly alkaline to alkali (pH 7.24 to 10.35), soil moisture regime was ustic, iso-hyperthermic soil temperature regime., soil texture loamy sandy to clay, organic carbon 0.18 to 0.70%, CEC (8.65 to 51.48 cmol (P<sup>+</sup>) kg<sup>-1</sup>), and base saturation (62.87 to 90.92 %).

Supriya *et al.* (2019) studied on soils of semiarid region of Mahanadi mandal Kurnool district in A.P. They reported that the soils were deep to very deep neutral to alkaline (pH 7.3 to 8.3) EC varies from 0.19 to 1.00 dSm<sup>-1</sup>, organic carbon 0.2 to 7.5mg kg<sup>-1</sup>. nitrogen medium 62.7 to 595.7 kg ha<sup>-1</sup> high in available phosphorus 14.9 to 122.5 kg ha<sup>-1</sup> sulfur 1.2 to 79.2 mg kg<sup>-1</sup>, the micro nutrients zinc 0.02 to 4.97 mg kg<sup>-1</sup>, iron 0.40 to 22.5 mg kg<sup>-1</sup>, copper 0.45 to 22.5 mg kg<sup>-1</sup>, Mn 0.27 to 30.80 mg kg<sup>-1</sup>.

#### **2.1.4 Classification of soil**

Gabhane *et al.* (2006) reported that the studies of Belura watershed Akola district. They classified the soils of study area into Typic Haplusterts, Vertic Haplustepts, Typic Haplustepts, Typic Ustorthents.

Ashok and Jagdish (2010) studied typical sugarcane growing soils of Ahmednagar district of Maharashtra for their characterization and classification. They reported that the soils under sugarcane are Vertic Haplustepts, Lithic Ustorthents and Sodic Haplusterts.

Malode and Patil (2013) studied characterization of some Vertisols of drought prone zone of Marathwada region and they classified the soils of study area into Typic Haplusterts.

Patil *et al.* (2013) studied evaluation of soil and ground water quality in basaltic area Osmanabad tahsil and they classified the soils of study area into Lithic Ustorthents, Typic Ustochrepts and Typic Haplusterts.

Manwar *et al.* (2015) studied characterization and evaluation of land resource for sugarcane growing soils of Latur district in Maharashtra and they classified the soils of study area into Typic Ustorthents, Typic Haplustepts and Typic Haplusterts.

Mane *et al.* (2015) studied assessment of quality of grape growing soils in Osmanabad and classified the soils of study area into Lithic Ustorthents, Typic Ustochrepts, Calcic Ustochrepts and Typic Haplusterts.

Sekhar *et al.* (2017) studied on genesis and classification of soils from selected parts of Prakasham district of Andrapradesh. They Reported that the Pedon 2 and 7 were grouped under Entisols due to absence of sub-surface horizons and classified as Typic Ustorthents, at sub group level Pedon 1,3,5 and 6 were place under Inceptisols due to cambic horizon classified as Typic Haplustepts the Pedon 4 was under Vertisols due to presence of slickensides in horizons classified as a Typic Haplusterts at sub group level.

Mahesh *et al.* (2018) studied on genesis classification and evaluation of some sugarcane growing black soils in semi-arid tropical regions of Telangana. They reported that soils have been classified as Typic Haplusterts, and Vertic Haplustepts.

Ramalaxmi *et al.* (2020) studied on characterization and classification of sugarcane growing soils of North Coastal District of Andrapradesh. They Reported that the soils fall under Ustic Moisture and Iso hyper thermic Temperature regime, The pedons of Vishakhapatnam district was classified as fine loamy, mixed Isothermic, Typic Haplustepts and coarse loamy mixed Iso thermic, Typic Haplustepts.

Wagh *et al.* (2020) studied on characterization and classification of Zari-Naam River watershed of Parbhani by GIS, GPS and Remote sensing. They Reported that the soils of Naam River watershed are Typic Haplusterts, and Vertic Haplusterts, these soils have brown black and clay texture, Typic Haplusterts have higher alkalinity than Vertic Haplusterts. Two Pedons of Naam River watershed Representing Typic Haplusterts and vertic Haplusterts.

Srivastava *et al.* (2020) studied on characteristics, Minerology and spectral properties of some typical vertisols of Vidarbha, Maharashtra. They Reported that the soils were classified as chromic Haplusterts (P<sub>1</sub>, P<sub>3</sub>) Leptic Haplusterts (P<sub>2</sub>) and sodic Haplusterts (P<sub>4</sub>).

### **2.1.5 Carbon Stock under cropping pattern**

Schlesinger *et al.* (1983) the first comprehensive study of SOC in Indian soils was conducted using data from different cultivated fields and forests with variable rainfall and temperature patterns (Jenny and Raychaudhuri, 1967). The study confirmed the effect of climate on C reserves in the soil. However; this study did not estimate total C stock in Indian soil. Using ecosystem areas from different sources and representative global average C densities (Ajay *et.al.*, 1979; Schlesinger, 1983), organic C in Indian soils was estimated as 23.4 to 27.1 Pg. (Dadhwal and Nayak, 1993).

Dixon and Turner (1991) current global carbon budget suggest that as much as 2000 Pg of carbon exists in soil systems. There is considerable disagreement, however, over pool size and flux (e.g., CO<sub>2</sub>, & CH<sub>4</sub>) for various ecosystems. An equilibrium analysis of changes in global below ground carbon storage due to a doubled-CO<sub>2</sub> climate suggests a range a possible sink of 41 Pg to a possible source of 101 Pg. Components of the terrestrial biosphere could be managed to sequester or conserve carbon and mitigate accumulation of greenhouse gases in the atmosphere.

Gupta and Rao (1994) The first ever estimation of organic carbon (OC) stock in Indian soils was reported 24.3 Pg (1Pg =10<sup>15</sup>g). They found that Indian soils are largely carbon- depleted out can be brought back to their native carbon carrying capacity by reforestation. The current stocks of organic carbon in Indian soils (24.3 Pg) can be increased to 34.9 Pg, the difference representing the potential for sequestering additional carbon in soils. Reforestation of 35 mha of wasteland with suitable tree and grass species can sequester 0.84 and 1.06 Pg of carbon in vegetation and soil respectively. Reforestation, maintenance and enlarging the carbon stocks of Indian soils are an urgent development priority.

Batjes (1996) total soil C pools for the entire land area of the world are estimated to be 2157 to 2293 Pg of C in the upper 100 cm, whereas soil organic C is estimated to be 684 to 724 Pg of C in the upper 30 cm, 1462 to 1548 Pg of C in the upper 100 cm, and 2376 to 2456 Pg of C in the upper 200 cm.

Chhabra *et al.* (2003) estimated the organic C stocks of Indian forests soils as 6.8 Pg C in top 1m, using estimated the organic SOC densities and remote sensing-based area at forest types. Another attempt to estimate SOC stock was made by Gupta and Rao (1994) who reported SOC stock in Indian soils with depths ranging from surface to an average depth of 44-186 cm. The study used a report of SOC stock in

India was carried out by Bhattacharyya *et al.* (2000) who estimated 9.5 Pg SOC at a depth of 0-0.3 m.

Lal (2004) soil carbon stocks in India the total land area of 329 million hectares (Mha), 297 Mha is the land area comprising 162 Mha of arable land, 69 Mha of forest and woodland, 11 Mha of permanent pasture, 8 Mha of permanent pasture, 8 Mha of permanent crops and 58 Mha is other land uses. The soil organic carbon (SOC) pool is estimated at 21 Pg (peta-gram= $\text{Pg}=1 \times 10^{15} \text{ g}=\text{billion ton}$ ) to 30-cm depth and 63 Pg to 150-cm depth. The soil organic carbon (SOC) concentration in most cultivated soils is less than  $5 \text{ g kg}^{-1}$  compared with 15 to  $20 \text{ g kg}^{-1}$  in uncultivated soils. Low SOC concentration is attributed to ploughing, removal of crop residue and other biosolids, and mining of soil fertility. Accelerated soil erosion by water leads to emission of  $6 \text{ Tg C y}^{-1}$ . Important strategies of soil C sequestration include restoration of degraded soils, and adaptation of recommended management practices (RMPs) of agricultural and forestry soils. Potential of soils C sequestration in India is estimated at 7 to  $10 \text{ Tg C y}^{-1}$  for adoption of RMPs on agricultural soils, and 22 to  $26 \text{ Tg C y}^{-1}$  for secondary carbonates. Thus, total potential of soil C sequestration is 39 to 49 ( $44 \pm 5$ )  $\text{Tg C y}^{-1}$ .

Lal (2004) studied the soil carbon sequestration in India concluded that the soil organic carbon (SOC) pool was estimated at 21 Pg (peta-gram =  $\text{Pg} = 1 \times 10^{15} \text{ g} = \text{billion ton}$ ) to 30-cm depth and 63 Pg to 150-cm depth. The soil inorganic carbon (SIC) pool is estimated at 196 Pg to 1m depth. The SOC concentration in most cultivated soils was ( $5 \text{ g kg}^{-1}$ ) less than uncultivated soils and SOC ( $15 \text{ to } 20 \text{ g kg}^{-1}$ ).

Bhattacharyya *et al.* (2005) studied on land use, clay mineral type and organic carbon content in two Mollisols- Alfisols and Vertisols catenary sequences of tropical India reported that the Vertisols dominated by smectite clay was usually under agriculture and has SOC of  $\sim 8 \text{ g kg}^{-1}$  in the top 30 cm of soils.

Lal (2005) concluded the carbon sequestration in forest soils had the potential to decrease the rate of enrichment of atmospheric concentration of  $\text{CO}_2$ . He also suggested that the increase in C stock of forest soils could be achieved through forest management including site preparation, fire management, afforestation, and species management selection, use of fertilizers and soils amendments. Forest harvesting might be decrease C stock, at least temporarily. The projected climate change may also affect soils C stock through positive impact because of the  $\text{CO}_2$  fertilization effect, increased

availability of N caused by mineralization, and reduction in soil C stock because of increase in soil temperature and the attendant oxidation. While several techniques of monitoring soil C stock and fluxes exist, and rapid advances are being made in measuring and scaling procedures, challenges remain to our ability to assess carbon dynamic in forest soils. None the less, the global potential of C sequestration by forests is high, about 0.4 Pg. C y<sup>-1</sup> in forest soils, and 1-3 Pg. C y<sup>-1</sup> total in forest biomass.

Singh *et al.* (2007) studied on carbon stock and organic carbon dynamics in soils of Rajasthan, they estimated the soil carbon stock was 0-25 and 0-100 cm soil depth of arid and semi-arid region of Rajasthan, carbon stock as 2.13 Pg in the 0-100 cm soil depth, of which 1.23 Pg was soil organic carbon and 0.90 Pg was soil inorganic carbon, the surface horizons (0-25cm) stored 31 per cent of the soil carbon stock. Soil carbon stock were higher in Entisols (0.72 Pg or 33.6 per cent of CS 43.6 per cent of the land area) and Aridisols (0.70 Pg or 32.7% of CS on 28.9% of the area), Alfisols (0.015 Pg or 0.005 per cent of the CS on the 3.2 per cent of the on 0.76 per cent of the land area) and Vertisols (0.105 Pg or 0.005 per cent of the CS on the land area. Soil organic carbon density (SOC) ranged from 4000 to 7000 kg/km<sup>2</sup> in Haplustalfs, Haplusterts, Haplustepts, and Torripsamments, while SIC was of high range (10,000-19,000 kg /km<sup>2</sup>) in Petrocalcids, Haplocalcids, Aloysius and Torrifluents.

Wilkson (2007) studied the long- term impact of a gliricidia- maize intercropping system on carbon sequestration in southern Malawi and reported that the two field plots 7-year and 10-year and also two production systems first sole-maize and second was glyricidia-maize simultaneous intercropping systems. The amount of organic C recycled varied from 0.8 to 4.8 Mg C ha<sup>-1</sup> in gliricidia-maize and from 0.4 to 1.0 Mg C ha<sup>-1</sup> in sole-maize. After 10 years of continuous application of glyricidia tree pruning C was sequestered in the topsoil (0–20 cm) in gliricidia-maize was 1.6 times more than in sole-maize.

Bhattacharya *et al.* (2009) observed the soil carbon stock in India Issue and priorities reported that SOC stock in 48 soil series was 24.3 Pg. The first comprehensive report of SOC, SIC (Soil inorganic carbon) and TC (Total carbon) was carried out by Velayutham *et al.* (2000) and Bhattacharyya *et al.* (2000).

Dadhwal *et al.* (2011) studied on Indian carbon cycle assessment. They Reported that an increase of the country's forest carbon stocks from 6244.8 to 6621.6

Mt with annual increment of 37.7 Mt of the carbon from 1995 to 2005. In national scale, CASA model based average annual NPP is estimated to be 1.5 Pg. C yr<sup>-1</sup> and increasing at the rate 0.005 Pg C Yr<sup>-1</sup>.

Shrinivasrao *et al.* (2012) studied on long-term effects of soil fertility management on carbon sequestration. They reported that soils having poor fertility and little organic matter is the candidate for carbon sequestration. Carbon storage in soil profile not only improves fertility but also abates global warming. Organic carbon stock the in the soil profile showed wide variations and followed the order vertisol> Inceptisol> Gistosol> Alfisol> Aridisols. Inorganic carbon and total carbon stock were large in vertisols than in other soil type. Soil organic carbon stock decreases with depth and inorganic carbon stock increased with depth of profile. Greatest contribution of organic carbon to total carbon stock was under upland rice system. Organic carbon stock in the surface layer of the soil increased with rainfall where as inorganic carbon stock in the soils were found in the regions with less than 550 mm rainfall, CEC had better correlation with the organic carbon stock than clay content.

Saha *et al.* (2012) studied on soil organic carbon stock and fraction in relation to land use and soil depth in degraded lower Himalaya the SOC stock in the 1 m soil profile was highest (83.5 Mg ha<sup>-1</sup>) in forest and lowest (55.6 Mg ha<sup>-1</sup>) in eroded lands. The SOC stock at the surface (0–15 cm) soil constituted 6.95, 27.6, 27 and 42.4 per cent of the total stock in the 1m profile of eroded, cultivated, forest and grassland soils, respectively. The forest soils could sequester 22.4 Mg ha<sup>-1</sup> higher SOC than the cultivated soils in the 1 m soil profile depth.

Venkanna and Uttam (2014) reported the soil organic and inorganic carbon in major soil types and different land use system, the Vertisols and associated soils contained greater total C stocks, followed by Inceptisols and Alfisols. The soil organic carbon (SOC) stock was highest in Alfisols (52.84 Mg ha<sup>-1</sup>) followed by Inceptisols (51.26 Mg ha<sup>-1</sup>) and Vertisols and associated soils (49.33 Mg ha<sup>-1</sup>), whereas soil inorganic carbon (SIC) stock was highest in Vertisols and associated soil (22.9 Mg ha<sup>-1</sup>) followed by Inceptisols (17.5 Mg ha<sup>-1</sup>) and Alfisols (12.4 Mg ha<sup>-1</sup>). Among the different land-use systems, total C stock was highest in forest soils followed by fodder system, paddy, maize, cotton, red gram, intercrop, chili, permanent fallow and lowest in castor system.

Patil and Dhanashree (2014) reported that the changes in soil organic carbon stock under different land use system in Gondia district of Maharashtra the land use included Forest, Paddy more than 10 years, Paddy more than 50 years and paddy more than 100 years. The forest was considered as control. The study on C stock and C potential was 10-year paddy (SOC) less than 50 year followed by 100 years. Estimated soil carbon stock at 0-30 cm depth varied between 13.5 to 50.2 tons  $\text{ha}^{-1}$  in Gondia forest, 8.2 to 9.5 tons  $\text{ha}^{-1}$  in 10 years paddy cultivated area, 12.3 to 12.6 tons  $\text{ha}^{-1}$  in 50 years paddy cultivated area and 11.6 to 13.3 tons  $\text{ha}^{-1}$  in 100 years paddy cultivated area, which is being lowest soil carbon stock in 10-year paddy cultivated area and soil highest in forest.

Kamaljit *et al.* (2015) studied-on Magnitude, Spatiotemporal pattern, and control for soil organic carbon stock in India during 1901-2010. They found that the DLEM simulation have shown that SOC increased by 2.9 Pg. C from 20.5 to 23.4 Pg. C. of the environmental factors studied, elevated atmospheric  $\text{CO}_2$  concentration that stimulates plant biomass production has increased stock over the country by 1.29 Pg .C during 1901-2010. Land cover and land use change has increased by 1.7 Pg .C Primarily in crop lands, Atmospheric N deposition has played smaller positive role that increased SOC 0.45 Pg.C, climate was most important factor that decreased SOC stock by 0.78 Pg .C due to increase heterotrophic respiration as well as due to frequent occurrence of drought year that reduced biomass production over the country. The tropospheric  $\text{O}_3$  (Ozone) pollution decreased plant biomass production has decreased SOC stock by 0.2 Pg C though majority of the decline has occurred during 1901-2010.

Koppad and Pavan (2016) reported that the assessment of carbon sequestration in soils of different land use, dense forest, sparse forest, agriculture and open land were identified. The soil samples at 1 m depth were drawn at grid point in flat land and along the profile in sloppy land in different land use system. Among the different land use classes, higher SOC was sequestered in dense forest (200.10  $\text{t ha}^{-1}$ ) followed by sparse forest (166.89  $\text{t ha}^{-1}$ ). The SOC in open land and agriculture land is 145.78 and 82.79  $\text{t ha}^{-1}$ , respectively. The carbon mitigation potential of dense forest is 2.42 times higher compared agricultural land, followed by sparse forest (2.02 times) lands.

Iqbal and Tiwari (2017) studied that the comparative analysis of soil organic carbon storage under different land use, soil carbon sequestration potential of four land uses i.e., forestland, grassland, agricultural land and wasteland and five land covers i.e.

sal, teak, bamboo, mixed, open and scrub. The highest soil carbon storage potential was found in forest land ( $118.14 \text{ t ha}^{-1}$ ) followed by grassland ( $95.54 \text{ t ha}^{-1}$ ), agricultural land ( $75.70 \text{ t ha}^{-1}$ ) and least was found in the wasteland ( $57.05 \text{ t ha}^{-1}$ ). Among the different land covers, maximum soil carbon storage potential was found in the soils under mixed land cover ( $118.18 \text{ t ha}^{-1}$ ) followed by teak ( $76.64 \text{ t ha}^{-1}$ ), bamboo ( $67.21 \text{ t ha}^{-1}$ ), sal ( $64.28 \text{ t ha}^{-1}$ ) and least under soils of open and scrub ( $48.72 \text{ t ha}^{-1}$ ) land cover.

### **2.1.6 Cropping systems relation with carbon stock**

Bhattacharya *et al.* (2004) studied on organic carbon stock in Indian soils and their distribution. They estimated that organic carbon stock in Indian soils was 24 Pg (1 Pg =  $10^{15}$  g) depth 150 cm based on 48 soil series taking into account of few major soils.

Wani *et al.* (2010) studied on Assessment of agriculture crop and carbon pool in Madhyapradeh at AESR soils, they revealed that the total estimated crop biomass carbon and soil carbon stock of Madhya Pradesh was 34.94 Tg, and 790.6 Tg respectively soils carbon stock was approximately 25 times higher than biomass carbon stock.

Benbi, *et al.* (2011) studied on soil carbon pools under Agro-forestry, rice, wheat, and maize-wheat cropping systems in semi-arid India. They found that agroforestry and maize- wheat system higher concentration and greater stock than rice-wheat system. A majority of organic carbon in soils of Agro-forestry and maize-wheat system was in an easily oxidizable labile form, suggesting that the accumulated carbon should be easily loss of following the land use change, conversely preponderance of less labile.

Srinivas Rao *et al.* (2012) studied on critical input to Maintain soil organic carbon stocks under long term finger millet cropping on Alfisols in semiarid tropical India. They found that to maintain soil organic carbon at equilibrium it was estimated that a critical carbon input of  $1.13 \text{ Mg ha yr}^{-1}$ . was needed.

Das (2014) Studied on effect of long-term manuring on carbon stock and some and some properties of soil under Rice-Rice cropping system in an Inceptisols. He reported that the total stubble incorporated in soil varied from 2998.9 to 6330.85  $\text{kg ha}^{-1}$  and carbon present was from 1223.5 to 2571.5  $\text{kg ha}^{-1}$ , surface soil carbon stock varied from 7.41 to 12.50  $\text{Mg ha}^{-1}$  and 7.14 to 11.76  $\text{Mg ha}^{-1}$  after kharif and rabi respectively.

Soil organic carbon (SOC) of surface soil after kharif varied from 3.48 to 6.51 g kg<sup>-1</sup> and 3.35 to 6.13 g kg<sup>-1</sup>, less amount of total carbon observed in subsurface soil compared to surface soil.

Dharmendra (2016) Studied on Impact of Agriculture land use system on soil carbon pool in soil series of Thiruvananthapuram district of Kerala. He reported that the soil organic carbon (SOC) content in various soil series under different land use system varied from 2.96 to 11.67 g kg<sup>-1</sup>. The agricultural land use like vegetable (8.76 g kg<sup>-1</sup>), coconut (7.96 g kg<sup>-1</sup>), homestead (7.30 g kg<sup>-1</sup>), rice (9.96 g kg<sup>-1</sup>) and tea (11.97 g kg<sup>-1</sup>), hot water-soluble carbon land use varied from 20.6 to 76.45 mg kg<sup>-1</sup>. The highest value recorded in rice land use system in Kazhukuttam series, with respected to labile carbon vegetable (1997 mg kg<sup>-1</sup>), coconut (2541 mg kg<sup>-1</sup>), rubber (2211 and 1349 mg kg<sup>-1</sup>), rice (2187 mg kg<sup>-1</sup>), and tea (1241 mg kg<sup>-1</sup>). The Particulate Organic Carbon (POC) in various soil series varied from 1130 to 3980 mg kg<sup>-1</sup>, the mineralizable carbon concentration was found to the highest under rice land use of Kazhakuttam series (6.39 mg kg<sup>-1</sup>) and the lowest coconut land use of kallar series (2.86 mg kg<sup>-1</sup>).

kar *et al.* (2017) studied on soil organic carbon stock and water retention properties of some uplands they found that the SOC was low in croplands among the field crops legumes hold promise for greater accumulation of SOC in the long-term soil water retention was found be significantly correlated with SOC 0-0.15 m depths only rather than SOC whole profile.

Sarita (2017) studied on quantification of soil organic stock of agricultural land use in Solan , they revealed that among all the agricultural land use systems high SOC stock was recorded under cereal based cropping system ( 38.62 Gt C ) , the order of SOC stock distribution was cereal > fruits > vegetables based cropping system , out of the total SOC stock the dominant agriculture land use of solan 44.77 per cent contributed by cereal based cropping system 26.24 per cent, and 28.09 per cent by fruit and vegetable.

Sushant *et al.* (2017) soil organic carbon stocks and fractions in different orchards of eastern plateau and hill region of India. Their result confirmed that the mango orchard registered highest total soil carbon (62.5 Mg ha<sup>-1</sup>) among the different orchard. The active and passive pool was highest in mango orchard and resulted in 17.8

and 16.4 per cent over control. among the orchards had greater amount of soil organic carbon, active carbon pool, passive carbon higher carbon management index.

Damare *et al.* (2018) studied on soil organic carbon pools under different land use management practices in swell-shrink soils their results revealed that the physical properties like bulk density were improved under long term use of FYM integrated with fertilizer recorded in increase in soil carbon stocks also with in the soil attributes indicating more carbon sequestration for soil health. The total TOC content varied from 4.32 to 8.64 g kg<sup>-1</sup>, the soil under sorghum–wheat cropping system recorded highest TOC (8.64 g kg<sup>-1</sup>).

Kenya *et al.* (2019) studied on soil organic stock of different land use of Mizoram, North east India. They studied on to asses soil organic carbon (SOC) concentration and stock under eight major land uses, shifting cultivation, wet rice cultivation, home gardens, forest grassland and bamboo plantation. Forest recorded the highest mean SOC concentration with 2.74 per cent at 0-45 cm and lowest in the bamboo plantation (1.09 %), Mean SOC stock for 0-45 cm soil depth ranged from 27.68 to 52.74 Mg C ha<sup>-1</sup> agricultural and forest respectively, both SOC concentration and SOC stock decreasing with increasing soil depth.

Bhardwaj *et al.* (2019) studied on impact of carbon inputs on soil carbon fractionation, sequestration and biological response under major nutrient management practices for rice–wheat cropping system, they revealed that the fractionation of incorporation carbon (c) under an integrated nutrient management practice for the rice –wheat system. (LE Vigna as opportunity crop between rice and wheat and its biomass incorporation, into the soil.

Garima *et al.* (2019) studied on assessment of land use change and its effect on soil carbon stock using satellite data in semi-arid region of Rajasthan. They found that the three was continuous decrease forest area and increase in cultivated area in each time period land use change led to alteration in carbon equality in soil due to change or loss in vegetation overall, they concluded that internal trading of land use area during 10 years period (1993-2003) led to net loss of SOC stock by 8. 29 Mt. C, similarly land use change in 11-year period (2003-2014) caused net loss of soil organic carbon by 2.76 Mt. C.

Patel *et al.* (2019) studied on influence of different cropping systems on soil organic carbon stocks after eight years in loamy sand soils, they revealed that significantly the higher SOC stock at 0-15 cm soil depth (9.23 Mg /ha) was recorded under CS<sub>3</sub> (Green gram – mustard – Pearl millet), among the all the treatments the low SOC stock (8.70 Mg ha<sup>-1</sup>) at 0-15 cm soil depth recorded under horticulture system.

Chakrabarti *et al.* (2019) studied on soil carbon stock in Mewat and Phar under cereals and legumes-based cropping systems, they observed SOC stock surface layer decreased from 0.42 to 0.39 per cent in pearl millet –mustard cropping system, but soyabean–wheat cropping system it increased 1.14 per cent to 1.24 per cent legume-based cropping system showed enhanced soil carbon stock.

Sikandar *et al.* (2019) studied on soil carbon sequestration through agronomic management, they revealed that the adoption of different agronomic practice can be helpful in the sequestration carbon such as practices includes no-tillage, reduced tillage, nutrient management, cover crop, crop rotation, green manuring application animal manure agroforestry etc.

Tonde (2019) studied on soil organic fractions under major cropping systems of Agro-Ecological region 6.0, They revealed that six pedons from Agro-ecological region 6.0, comprising three systems (sugarcane, sorghum, cotton), they have been found that the trend of total organic carbon (SOC) content decrease with depth in available of the cropping systems, the stratification ratio of active and passive pool of the carbon under different cropping systems found that the ratio was better for sorghum-based system followed by cotton and sugarcane.

Sahoo *et al.* (2019) studied on Active and Passive soil organic pools as affected by land use types in Mizoram, North East India. They quantified active and passive pool from total soil organic carbon (TOC) in seven different land use systems in north east India. TOC was highest in (2.75%) in natural forest and lowest in grassland (1.31%) and it decreased with increasing depth in different pool of lability. Very labile carbon (VLC) fraction ranged from 36.11 per cent to 42.74 per cent of TOC across different land use system. Active carbon pool was highest in wet rice cultivation (58.71%) and lowest (58.71%) in natural forest.

Pant and Chayan (2020) studied on carbon pools and carbon stocks under multipurpose tree species in mollisol of Tarai region of Uttarakhand. they are

experiment comprised of ten agroforestry tree species, soil samples were collected at - 0-15 cm and 15-30 cm depth, all soil properties were significantly affected by tree plantation bulk density was lower under agroforestry system as compared to control. under MTP based agroforestry soil microbial biomass carbon, soil organic carbon content, SOC stock were 286.59 to 255.06  $\mu\text{g g}^{-1}$  of soil, 0.81 to 0.92 per cent 15.46 to 17.10  $\text{Mg C ha}^{-1}$ , respectively.

**CHAPTER-III**  
**MATERIAL AND METHODS**

## CHAPTER-III

### MATERIAL AND METHODS

The research has been conducted on “Assessment of soil quality and carbon stock under different cropping pattern of Aurangabad district of Maharashtra”. In This chapter we have discussed about the details like the location, research conducted location, geology and parent material, natural vegetation, land use, land cover and climate. Sample collection procedure from different profiles, and finally methodology of conducted research work.

#### 3.1 Location

Aurangabad district is located in the north central part of Maharashtra between North Latitude 19<sup>0</sup> 15' and 20<sup>0</sup> 40' and East Longitude 74<sup>0</sup> 37' and 75<sup>0</sup> 52'. This district is surrounded by Jalgaon district of North, Nashik district in west, Ahmednagar and Beed district in south and Parbhani and Buldhana district in east. Aurangabad district has been divided in 9 talukas viz. Aurangabad, Kannad, Soyagaon, Sillod, Phulambri, Khuladabad, Vaijapur, Gangapur, and Paithan talukas. The district has geographical area of 10,107 sq.km., out of which 726 sq.km is occupied by forest while cultivated area is 8135.57 sq.km and net area sown is 6540 sq.km. Figure 3.1 shown the location sites of different cropping pattern under Aurangabad district.

#### 3.2 Geology and parent material

The entire area is covered by the Deccan trap lava flows of upper cretaceous to lower Eocene age. The lava flows are overlain by thin alluvial deposits along the kham and sukhana river. The basaltic lava flows belonging to the Deccan Trap is the only major geological formation occurring in Aurangabad.

#### 3.3 Natural vegetation and land use

The most of the area they cultivating cotton (*Gossypium hirsutum*) tur or red gram (*Cajanus cajana*), Maize (*Zea mays*), Wheat (*Triticum aestivum*) jowar (*Sorghum halopens*), bajra (Pennisetum Americanum) Bengal gram (*Cicer aritinium*), Sugarcane (*Saccharum officinalis*), Ginger (*zingiber officinales*), Onion (*Allium sativum*) and fruit crops like Guava (*Psidium guajava*), mosambi (*Citrus limetta*), Pomegranate (*Punica*

*granitium*) and mulberry (*Morus rubra*) Production unit. we have commonly observed weeds are Mexican Prickly poppy (*Argemona Mexicana*), nut grass (*Cyperus rotundus*), garika (*Cynodon dactylon*) congress weed (*Parthenium hysterophorus*) celosia (*Celosia argemtea*), we have been found out that vegetation and plantation trees are Babul (*Acacia nilotica*), neem (*Azadirachta indica*), Tamarinds (*Tamarindus indicas*), Ber (*Ziziphus zizube*), Mango (*Mangifera indica*), Sapota (*Acharus zapota*), and moringa (*Moringa oleifera*).

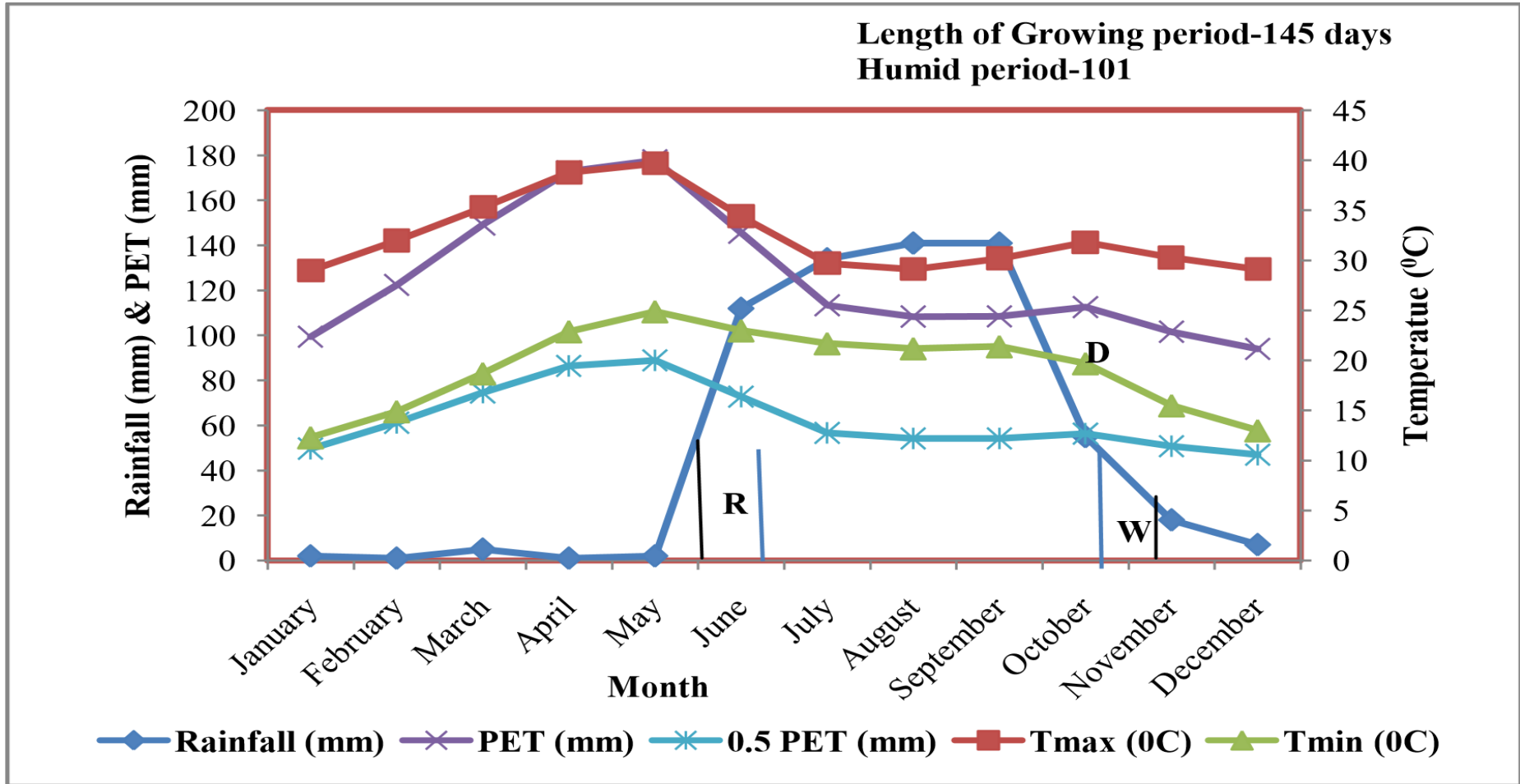
### 3.4 Climate

The climate of the research conduct area was coming under the hot semi-arid Tropical condition. The mean maximum temperature of 32.45<sup>0</sup> C, whereas the mean minimum temperature is 19.10<sup>0</sup>C May is the hottest month with the mean maximum temperature 39.7<sup>0</sup>C the mean minimum temperature of 24.6 <sup>0</sup>C. The average annual rainfall of the district 619 mm. The elevation of the district was 500 meters above mean sea level. The length of growing period 145 and humidity period is 101 days. Fig 3.2 shown the climatic data and water balance of Aurangabad district of Maharashtra.

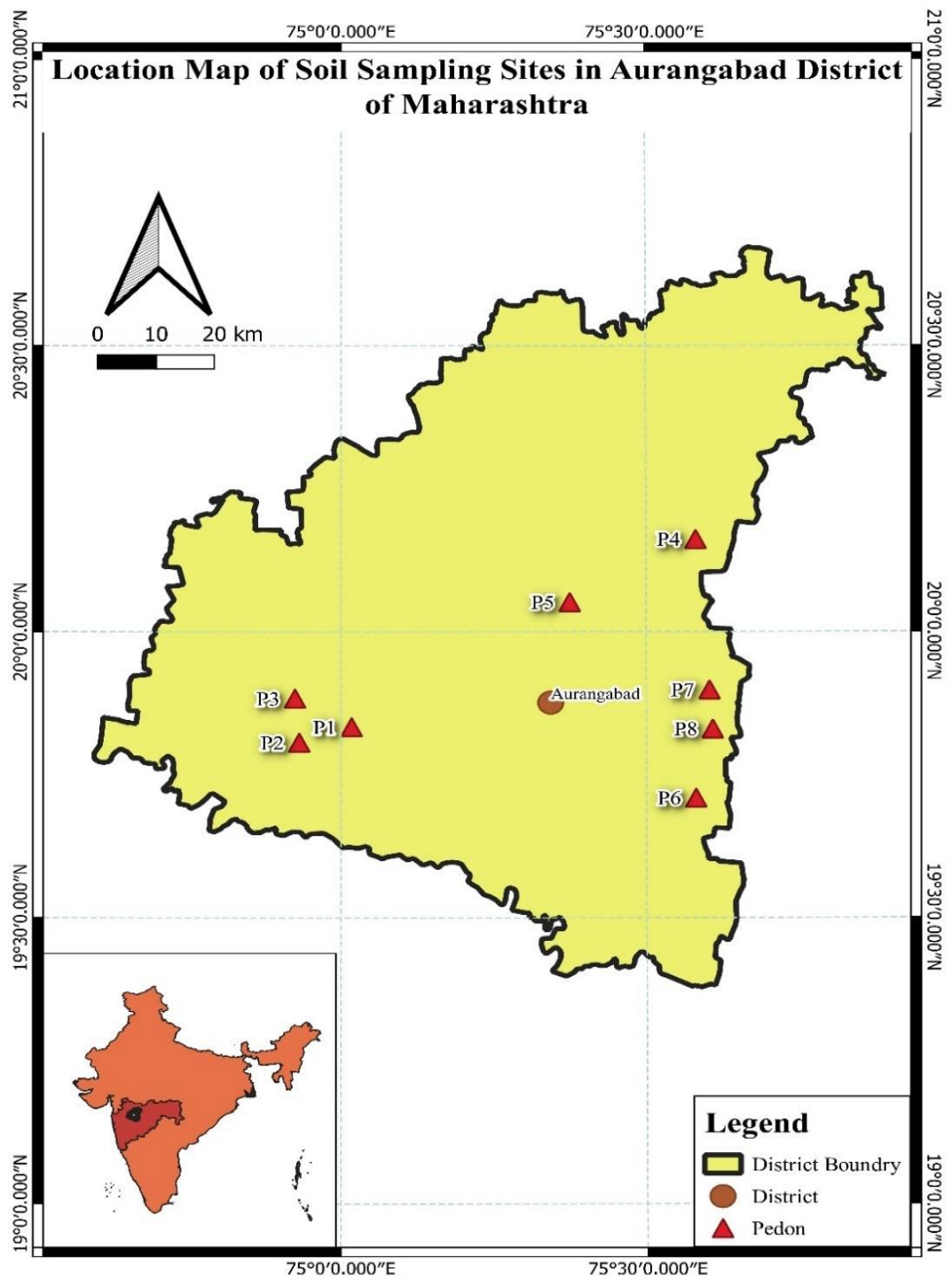
#### 3.1 Climatic data and water balance of Aurangabad district (30 Years)

Month	Rainfall (mm)	Relative humidity (%)		Monthly temperature (Mean of daily)	
		AM	PM	MAX °C	MIN °C
January	2	70	40	29.0	12.3
February	1	64	36	32.0	14.9
March	5	57	31	35.3	18.7
April	1	56	28	38.8	22.9
May	2	67	31	39.7	24.9
June	112	81	44	34.4	23.0
July	134	87	59	29.7	21.7
August	141	89	61	29.1	21.2
September	141	88	58	30.2	21.4
October	55	78	45	31.8	19.7
November	18	72	41	30.3	15.5
December	7	70	40	29.1	13.0
	Total rainfall	Mean max. RH	Mean min. RH	Mean max. temp.	Mean min. Temp.
	<b>619</b>	<b>73.25</b>	<b>42.83</b>	<b>32.45</b>	<b>19.10</b>

Source- Dakore et al. (2021)- Agroclimatic Atlas Maharashtra (Book), VNMKV, Parbhani.



**Fig. 3.2 Last 30-year climatic data and water balance of Aurangabad district of Maharashtra**



**Fig. 3.1** Location sites of different cropping and soil profiles of Aurangabad

### 3.5 Collection of soil samples

The studied research places were selected that adopted village of KVK Aurangabad. Total seven village were selected for soil survey and profile examination. The village names were following this 1. Shekta (Gangapur Thaluk), 2. Gopal wadi (Gangapur Thaluk), 3. Shankarapur (Gangapur Thaluk), 4. Borgav Arj (Phulambri Thaluk), 5. Murshidabad wadi (Aurangabad Thaluk), 6. Devgaeon (Python Thaluk), 7. Hasanbad wadi (Aurangabad Thaluk). the selected village were under different crops like cotton, red gram, maize, jowar, bajra, sugarcane by using GPS and SOI topo-sheet (Table 3.2) as per the (Soil Survey Staff, 1975). Examine soil profile and horizon wise samples were collected for laboratory analysis as wells as determination of final total carbon content and soil SIC and SOC, determination of carbon pool. The yield data were collected from adjoining area at soil profile (mean of five farmers field).

### 3.2 GPS based soil sampling data under different cropping pattern

Name of the farmer	Village name	Thaluk	Latitude and longitude	Elevation MSL
Santhosh Jadhav	Shekta	Gangapur	19° 50' N to 75° 1' E	492
Chadrsekhar Jagtap	Gopal wadi	Gangapur	19° 50' 16" N to 74° 57' 22" E	490.35
Manish pol	Shankarapur	Gangapur	19° 86' 21" N to 74° 94' 31" E	495.25
Amole Bolande	Borgav Arj	Phulambri	20° 16' 19" N to 75° 58' 15" E	601.00
Sanjay Pawar	Murshidabad wadi	Aurangabad	20° 05' N to 75° 37' 5" E	680.55
Sadhasiv Githe	Devgaon	Phythan	19° 70' 96" N to 75° 58' 1" E	540.24
Kacharusingh Golawal	Hasnabadwadi	Aurangabad	19° 87' 11" N to 75° 60' 32" E	554.47

### 3.6 Methodology

#### 3.6.1 Preparation of soil samples

The soil samples collected during the profile survey was initially air dried in laboratory at room temperature, grinded by using wooden mortar and pestle, screened

through 2 mm sieve, properly labeled and stored in polythene bags for laboratory analysis. For certain soil characters like organic carbon, samples were further ground with 80 mm mesh sieve. the following determination were made on processed sample by adopting the standard procedures (Jackson, 1967 and Black *et al.*, 1965).

### **3.6.1 Morphological properties**

Morphological properties of soil were studied in the field and profile descriptions were made as per the procedure suggested by USDA and soil survey staff (1975) and field guide for soil survey NBSS and LUP (2009).

### **3.6.2 Physical properties of soil**

#### **3.6.2.1 Particle size distribution analysis**

The particle size distribution analysis was carried out as per the international pipette method (Jackson, 1979). The particle size distribution was done by international pipette method. The method was based on difference in sedimentation velocity between large and small particles the sedimentation of soil particles is the result of two opposite forces, gravity and friction as a result of movement in a liquid medium. The sample was pipetted from a suspension graduated measuring cylinder at various time interval and 10 cm depths. Time and depths were determined with stokes law. the pipettes suspension is evaporated down and dehydrated and the mass percentage of pipetted fraction is determined by weight. The sand fraction separated by 0.56  $\mu\text{m}$  sieve.

#### **3.6.2.2 Bulk Density**

The bulk density was determined by clod coating method (Piper and Black, 1966). The basis for this method was the measurement of the volume of a clod by utilizing the buoyancy principle. when a clod material is immersed in water is exerted upon it. Thus, if solid objects weight first in air and then water, the difference between two weights of displaced water. the weight displaced water in grams equals its volume in  $\text{cm}^3$ . when measuring the volume of soil clod, the clod is coated with paraffin wax to keep in water out of the pores. The volume of displaced by the clod was equal to the volume of the paraffin coated minus the volume of paraffin.

### 3.6.2.3 Hydraulic conductivity

Disturbed soil sample was fully saturated and then leached with deionized water and hydraulic conductivity of soil was determined by constant head method as described by Richard (1954). the hydraulic conductivity was conducted with help of constant head method. in this method the soil sample saturated over night with deionized water. In beaker. Next day started collection water from the hydraulic conductivity tubes before starting 30 minutes didn't collected water. After we taken collection water from hydraulic tubes with help of beakers at every one hour. After three similar reading when we collect that time stops the experiment and calculated the hydraulic conductivity of samples with help of given formula.

$$K = QL/hAT$$

Were,

Q= Quantity of water

L= Soil specimen length

h= Head of the water

A=Cross section area

T= Time

### 3.6.2.4 Soil moisture retention

The soil moisture retention and release behavior within the available range of 33 K Pa to 1500 K Pa will be based on less than 2 mm sample using pressure plate membrane apparatus (Richard, 1954).

### 3.6.2.5 Available water capacity

Available water capacity (AWC) and plant available water capacity (PAWC) will be determined using the expression suggested by Gardner *et al.* (1984) and latter modified by Coughlan *et al.* (1986).

$$1. AWC = \frac{(W_{max} - W_{dry}) \times BD \times 10}{DW}$$

$$Z = RD$$

$$2. PAWC = \sum AWC \times \Delta Z$$

$$Z = 0$$

Where,  $W_{max}$  = gravimetric water content ( $g\ g^{-1}$ ) at the upper soil water storage limit (0.33 bar).  $W_{dry}$  = gravimetric water content after the plant water extraction i.e., lower soil water limit (15 bar)

BD = bulk density of  $W_{max}$  (0.33 bar)

RD = Root depth

$\Delta Z$  = depth increment

DW = Density of water

### **3.6.3 Chemical properties of soil**

#### **3.6.3.1 Soil reaction (pH Ratio of soil & water 1:2.5)**

Soil: water suspension was determined electrometrically using pH meter as per method described by Jackson (1979). The pH was extracted by with the help of pH meter. 10 gm 2 mm soil taken and filled with 25 ml distilled water continuously stirring the soil water suspension with help of glass rod. Switch on the pH meter and calibration of buffer solutions 4, 7 and 9. Then taken the pH reading of the soil samples.

#### **3.6.3.2 Electrical conductivity (EC Ratio of soil & water 1:2.5)**

1: 2.5 soil: water suspension as per the method described by Jackson (1979). The soil sample which are used for pH which were used for EC after 30 minutes after we taken the reading by using electrical conductivity meter.

#### **3.6.3.3 Calcium Carbonate**

The calcium carbonate was estimated by rapid titration method as described by Piper (1950). The calcium carbonate of the soil sample was extracted by the soil sample is dissolved in the excess of hydrochloric acid. The remainder of the acid was titrated against sodium hydroxide (NaOH). however, a given weight of soil is reacted with an excess of acid. In this reaction,  $CO_2$  gas released and the acid not used in the dissolution of carbonates back titration with NaOH solution. In the titration method,

two equivalents of acid are assumed to react with one mole of  $\text{CaCO}_3$ . Hence one equivalent of acid is assumed to be one-mole of  $\text{CaCO}_3$ .

#### **3.6.3.4 Organic carbon**

Modified Walkley and Black's rapid titration procedure was followed for estimating the organic carbon content (Jackson, 1958). The soil organic matter was oxidized under saturated condition with potassium dichromate in sulphuric acid solution. A measured amount of potassium dichromate is used in excess to what is required for destruction of organic matter, and this excess dichromate is determined by titration with ferrous ammonium sulphate solution using Ferron indicator.

#### **3.6.3.5 Cation exchange capacity**

It will be estimated by soil screened through 2 mm sieve it will be saturated with 1N Sodium acetate (pH 8.2). After removal of excess sodium acetate by washing with alcohol, the adsorbed sodium will be extracted by washing with 1N ammonium acetate (pH 7.0) and the leachate will be made up to known volume.  $\text{Na}^+$  present in the leachate will be determined with flame emission spectrophotometer (Richard, 1954).

#### **3.6.3.6 Exchangeable cations**

Exchangeable calcium and magnesium were determined on less than 2 mm samples by leaching with 1N NaCl solution (piper) and titrating the leachate with standard EDTA solution as per the method of (Richards, 1965). Exchangeable sodium and potassium were determined on less than 2 mm soil 1 N Ammonium acetate (pH 7.0) solution. Na and K from the leachates were estimated by flame emission spectrophotometer (Jackson, 1958).

#### **3.6.3.7 Available nitrogen**

The available nitrogen was determined by alkaline permanganate method by using Kel-plus distillation unit (Subbiah and Asija, 1956). The soil sample is oxidized with alkaline  $\text{KMnO}_4$  solution, the ammonia evolved during oxidation is distilled and trapped in boric acid mixed indicator solution, the amount of trapped is estimated by titrating with standard acid (0.02 N  $\text{H}_2\text{SO}_4$ ).

### **3.6.3.8 Available phosphorus**

The available phosphorus was determined by Olsen's method (pH 8.5), reading will be calibrated by using spectrophotometer (Jackson, 1967). The available phosphorus from soil sample was extracted with help of Olsen reagent (0.5 M NaHCO<sub>3</sub> Adjusted pH 8.5). The method has been found widely applicable in slightly acid, neutral and calcareous soil. In the filtered extract phosphorus is complexed by adding ammonium molybdate and there after reducing the phospho- molybdate complex in acidic medium. The intensity of the blue color reduction provides a measure for the concentration of the P in the sample.

### **3.6.3.9 Available potassium**

The available potassium was be extracted by flame photometer using 1N Neutral ammonium acetate method pH 7.0 as excreted by described by (Jackson, 1967). the available potassium from the soil sample was extracted by neutral 1normal ammonium acetate method pH 7.0 with help of flame photometer. the soil was saturated with 1Normal ammonium acetate after shake the soil solution 30 minutes and filter the solution and prepare K standards and calibrate the in-flame photometer then take the reading of soil sample and prepare the graph.

### **3.6.3.10 Available Sulphur**

The available sulphur was be extracted by turbidity (Turbidimetric) method with help of Spectrophotometer outlined by William and Steinberg (1969). The available sulfur from the soil sample extracted with the help of 0.15% CaCl<sub>2</sub> based on turbidity method, in this method soil saturated with 0.15% CaCl<sub>2</sub> solution shake the soil sample 30 minutes then filter the sample and pour BaCl<sub>2</sub> solution then when white color turbidity was developed take the reading of soil sample after calibration of standards.

### **3.6.3.11 Available micronutrient**

The available micronutrient was be determined by (DTPA (0.005 M) extractable Fe, Mn, Zn, Cu, will be determined by as the procedure outlined by Lindsay and Novell (1978) using atomic adsorption spectrophotometer. The micronutrients from the soil sample were estimated with help of 0.005 M DTPA, 0.01M CaCl<sub>2</sub>, 0.1 M TEA) mixed solution pH (7.3) solution pour in 10 gm soil and shake it 2 hours then filter with Whatman NO-45. Prepare standard solution separately each element and

calibrate the standard in AAS After calibration take the soil sample reading by using Atomic Absorption Spectro photometer. (AAS)

### **3.7 Available boron**

The available boron (non-metal) was determined by as per the standard procedure by Berger and Trough (1939). The available Boron from the soil sample extracted help of hot water method by Berger and Trough. The available boron and water-soluble boron in soil extracted is measured calorimetrically by using reagent Azomethine and carmine. most recently by inductively coupled plasma and atomic emission spectrometry. Soil sample boil at hot pan and filter with Whatman No-40 then add buffer and azomethine. Calibrate standards with colorimeter and then take reading of soil sample.

### **3.8 Total organic carbon**

The Total organic carbon content at soil was calculated with help of the oxidizable carbon content value in walkey black method multiplied 1.334. the value 1.334 was obtained from 77 per cent carbon value divided 100 percent carbon (George *et al.*, 2013).

$$\text{Total organic carbon} = 1.334 \times \text{Oxidizable organic carbon (\%)}$$

$$\text{Organic matter (\%)} = 1.724 \times \text{total organic carbon}$$

### **3.9 Soil Inorganic carbon**

The soil inorganic carbon (SIC) the calculation carried out by using 12 % carbon value in  $\text{CaCO}_3$ . The sum of SOC and SIC stock provides total carbon stock in soil (Bhattacharya *et al.*, 2008).

### **3.10 Calcium Carbonates ( $\text{CaCO}_3$ ) Equivalent**

For the determination of  $\text{CaCO}_3$  equivalent, the soil was first treated with excess hydrochloric acid at known volume and the known strength (0.5 N) HCL to neutralize the whole carbonate. The soils were heated on hot plate on about 30 minutes the bring to condition closed to boiling cool and titrated with std. NaOH solution by using phenolphthalein as an Indicator.

### **3.11 Estimation of carbon stock / pool**

The soil carbon stocks were estimated by mass, volume, and density relationship (Batjes, 1996) and reported in the SOC pool (Mg ha<sup>-1</sup> for a specific depth) was calculated by multiplying the SOC concentration g kg<sup>-1</sup> with bulk density (Mg m<sup>-3</sup>) and depth (m)

$$\text{C Stock Depth} = \text{TC (i)} * \text{BD (i)} * \text{TH (i)} * 10^{-3} \text{ Mg kg}^{-1} * 10^4 \text{ m}^2 \text{ ha}^{-1} \text{ eqn}^1$$

Where, C stock Depth = Cumulative Soil carbon Stock (Mg ha<sup>-1</sup>)

TC (i) = Total soil C concentration in the layer (g C kg<sup>-1</sup>)

BD (i) = Total soil C concentration in the layer (Mg m<sup>-3</sup>)

TH (i) = thickness of the I th layer (m)

Another method for soil carbon stocks calculation given below (Datta *et al.*, 2015) is most appropriate method than above

$$\text{C stock depth} = \text{TC} * \text{BD} * \text{TH}$$

TC = total carbon (g C kg<sup>-1</sup>), BD = bulk density (Mg m<sup>-3</sup>), TH = Thickness of the I th layer (m)

Above method also used for the soil carbon stock calculation carbon stock for each layer of the dominant land use was calculated by multiplying the C stock obtained by equation 1 by the total area covered by a particular land use. Subsequently, C stock in each layer thickness was summed up to determine total C stock contained depth in cm for each land-use type. Difference in soil bulk density caused due to difference in land use or cover affects the calculation of carbon stock by influencing the amount of soil sample from the soil depth.

### 3.12 Computation of weighted mean

The computation weighted mean soil properties were taken 100 cm soil depth. each property calculated with soil horizon depth multiplied with each property and sum of value divided by 100 cm soil depth. (Sys *et al.*, 1993)

$$\text{Weighted mean} = \frac{[ ((x) * (y) + (x)*(y)+(x)*(y).) ]}{\text{Soil depth}}$$

X = soil horizon depth

Y = soil properties  
soil depth = 100cm.

### **3.13 Statistical analysis**

Correlation was carried out maize, cotton, tur, and chemical properties as per procedure described by Panse and Sukhatme (1985)

**CHAPTER-IV**  
**RESULTS AND DISCUSSION**

## **CHAPTER-IV**

### **RESULTS AND DISCUSSION**

The present research study object was conducted to find out the fact that the organic carbon content is very low (<0.1%) under maize and cotton, cropping patterns due to the continuous cultivation of these crop. we this view we have select the soil profile location under different land use and examine soil profile for morphological and analyzed the physical and chemical characteristics, however assessed and calculated the SOC, SIC, and carbon stock under different cropping pattern and established cause effect relationship. It has been presented and discussed in this chapter under following head

#### **4.1 Soil characteristics**

##### **4.1.1 Morphological properties**

##### **4.1.2 Physical properties**

##### **4.1.3 Chemical properties**

#### **4.2 Soil classification**

#### **4.3 Fertility status**

##### **4.3.1 Available macronutrients**

##### **4.3.2 Available micro-nutrients**

#### **4.4 Carbon stock under different cropping pattern**

#### **4.5 Establish the cause effect between different soil quality and cropping pattern**

#### **4.1 Soil characteristics**

Soil site character are essential for the description to a comprehensive soil description. Whereas the profile description describes the internal organization of the soil, site description describes the physiographic condition, topography, vegetation of the soil. Soil distribution describes some of the site characteristics important to a soil description is determined by landscape features. Some of the site characteristics important to soil description are landform, relief, microrelief, elevation, parent

material, slope gradient, length aspect, surface configuration, vegetation, erosion, drainage condition, depth. All the above morphological characteristics were reviewed herein.

The soil site characteristics under different cropping pattern of Aurangabad district of Maharashtra showed in table 4.1

#### 4.1.1 Morphological properties of soil

Soil morphology is the study of soil and their characteristics under field condition. Soils are studied only in the field and best evaluated from the insitu examination of soil profile. However, in laboratory soil samples were analyzed for further interpretation. Soil description is based on classifying soil in defined categories in the soil profile. Various soil horizons were studied. Each horizon was observed and described in respect of various characteristics such as depth, color, texture, consistency. Brief description of soil is given below.

The soil morphological properties under different cropping pattern Aurangabad shown in Table 4.2.

#### Pedon-1

Location	:	Shekta (v), Ta. Gangapur, Dist. (Aurangabad)
Landform and slope	:	1-3% (very gently sloping)
Drainage	:	Well drained
Vegetation	:	Ber, Babul, Neem, Tamarindus
Parent material	:	Weathered basalt
Climate	:	Semi -Arid
Classification	:	Lithic Ustorthents

Horizon	Description
---------	-------------

Ap	0-28 cm, ----very dark grey (10YR 1/3); silty, clay loam, fine, weak, sub angular blocky structure; soft, friable, very sticky and very plastic, porosity; very fine many, fine many pores; very fine many, coarse few roots; slightly effervescences; mildly alkaline (pH 7.7); Clear wavy boundary
----	--

**Table 4.1 Soil site characteristics under different cropping pattern under Aurangabad district of Maharashtra**

<b>Location</b>	<b>Elevation</b>	<b>Landform</b>	<b>Parent material</b>	<b>Slope (%)</b>	<b>Runoff</b>	<b>Drainage</b>	<b>Erosion</b>
<b>Pedon 1</b> – Shekta village, Gangapur tq. Aurangabad district .19° 50' N to 75° 1'E	492 MSL	very gently sloping	Sandstone	1-3%	Medium	Well drained	Moderate
<b>Pedon -2. Gopalwadi</b> village, Gangapur tq. Aurangabad district., 19° 50'16 "Nto74° 57'22" E	490.35 MSL	level to nearly level)	Weathered basalt	0-1%	Medium	Well drained	Moderate
<b>Pedon – 3</b> Shankarpur village, Gangapur tq. Aurangabad district. 19° 86'21" N to 74° 94'31" E	495.25 MSL	level to nearly level	Weathered basalt	0-1%	Medium	Well drained	Moderate
<b>Pedon- 4 Borgavarj</b> village, Pulambritq. Aurangabad, district .20° 16' 19 " N TO 75° 58' 15" E	601 MSL	very gently sloping	Weathered basalt	1-3%	Medium	Well drained	Moderate
<b>Pedon-5</b> murshidabadwadi village, tq. & District Aurangabad. 20° 05' N to 75° 37'5" E	680.55 MSL	very gently sloping	Weathered sandstone	1-3 %	Medium	Well drained	Moderate
<b>Pedon-6</b> Devgaon village,Phythantq . Aurangabad district .19° 70'96"N to 75° 58'1"E	540.24 MSL	very gently sloping	Weathered sandstone	1-3%	Medium	Well drained	Moderate
<b>Pedon- 7, Hassanbadwadi</b> village,tq& district Aurangabad .19° 87' 11" N to 75° 0' 60' 32" E	554.47MSL	very gently sloping	Weathered basalt	1-3%	Medium	Well drained	Moderate
<b>Pedon- 8, Hassanbadwadi</b> village,tq& district Aurangabad .19° 86' 32" N to 75° 60' 58" E	558.5 MSL	Very gently sloping	Weathered basalt	1-3%,	Medium	Well drained	Moderate

**Table 4.2 Morphological properties of different cropping pattern and soil profiles of Aurangabad district of Maharashtra**

Horizon	Depth (cm)	Boundary	Matrix colour	Texture	Structure	Consistency	Pores	Root	Effervescences
<b>Pedon1 Shekta, Tq. Gangapur, Dist. Aurangabad (<i>Lithic Ustorthents</i>) Pigeon pea Cropping pattern</b>									
Ap	0-28	Cw	10YR1/3	sic	f,1,sbk	S,fr,vsvp	vfm, fm	vfm, cf	es
AC	28-50	Cw	10YR6/3	cl	f,1,gr	l,fr,nsnp	cm	cf	ev
Cr	50-60	-	10YR 6/4	cl	m,2,gr	l,fr,nsnp	cf	cf	ev
----- (Weather basalt) -----									
<b>Pedon 2 Gopal wadi, Tq Gangapur, Dist, Aurangabad (<i>Calcic Haplusterts</i>) maize cropping pattern</b>									
Ap	0-22	Cs	10YR 3/2	c	m,2, sbk	sh,fr,vsvp	vfm	vfm	ev
Bw <sub>1</sub>	22-40	Cs	10YR 3/1	c	m,2, sbk	sh,fr,vsvp	vfm	vfm	ev
Bw <sub>2</sub>	40-54	Cs	10YR3/1	cl	m,2, sbk	sh,fr,vsvp	vfm	vfm	ev
Bss <sub>1</sub>	54-72	Cs	10YR3/1	cl	m,2, sbk	sh,fr,vsvp	vfm	vfm	ev
Bss <sub>2</sub>	72-100	Cs	10 YR3/1	cl	m,2, sbk	sh,fr,vsvp	vfm	vfm	ev
Bss <sub>3</sub>	100+	Cs	10YR3/1	cl	m,2, sbk	h,fr,vsvp	vfm	vfm	ev
----- (Weather basalt) -----									
<b>Pedon 3 shakarapur, Tq. Gangapur, Dist. Aurangabad (<i>Typic Haplusterts</i>) sorghum cropping pattern</b>									
Ap	0-28	Cs	10YR3/2	sic	m,2, sbk	sh,fi,vsvp	vfm,fm,	vfm,fm,cf	ev
Bw <sub>1</sub>	28-48	Cs	10YR 3/2	sic	m, 2.sbk	h,fi,vsvp	vfm,fm,	vfm,fm,cf	ev
Bw <sub>2</sub>	48 -60	Cs	10YR3/2	sic	m,3,abk	h,fi,vsvp	vfm,fm	vfm,fm	ev
Bss <sub>1</sub>	68-102	Cs	10YR3/2	c	m,3, abk	h,fi,vsvp	vfm,fm	vfm,fm	ev
Bss <sub>2</sub>	102-132	Cs	10 YR3/2	cl	m,3, abk	h,fi,vsvp	vfm,fm	vfm,fm	ev
Bss <sub>3</sub>	132-150	Cs	10YR3/2	cl	m,3, abk	h,fi,vsvp	Vfm,fm	vfm,fm	ev
----- (Weather basalt) -----									
<b>Pedon 4 Borgav. Arj, Tq, Phulambri, Dist, Aurangabad (<i>Calcic Haplusterts</i>) maize crop cropping pattern</b>									
Ap	0-18	Cs	10 YR3/2	sic	m,3, sbk	sh,fi,vsvp	vfm	ff, cf,vfm	ev
Bw <sub>1</sub>	18-46	Cs	10 YR 3/2	sic	m,3, abk	h,fi,vsvp	vfm	ff,vfm	es
Bw <sub>2</sub>	46-56	Cs	10 YR2.5/1	sic	m,3, abk	h,fi,vsvp	vfm	ff	es

Continue....

Horizon	Depth (cm)	Boundary	Matrix colour	Texture	Structure	Consistency	Pores	Root	Effervescences
Bss <sub>1</sub>	56-75	Cs	10 YR 2.5/1	sic	m, 3.abk	h,fi,vsvp	vfm	ff	es
Bss <sub>2</sub>	75-94	Cs	10 YR 2.5/1	cl	m,3, abk	h,fi,vsvp	vfm	ff	es
Cr	94+	-	10 YR 4/4	cl	m,3, abk	sh,fr,sssp	cf,fm	vf	ev
<b>Pedon 5 Murshidabad wadi, Tq. Phulambri, Dist. Aurangabad (<i>Typic Haplusterts</i>) maize cropping pattern</b>									
Ap	0-23	Cs	10YR3/2	sic	m,1, sbk	sv, fr,sssp	vfm	Vfm,fm,cf	es
Bw <sub>1</sub>	23-42	Cw	10YR3/3	sicl	m,2, sbk	sv, fs, sssp	vfm	Vfm, fm,cf	ev
Cr	42- 130	-	- 10 YR 6/4	cl	f,1, gr	S,1, nsnp	vfm	ff,cm	ev
<b>Pedon 6 Devgaon, Tq,Phythan,Dist. Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>									
Ap	0-15	cs	10YR4/3	c	f,1, sbk	s,fr,sssp	vfm, fm	vfm, cf	ev
Bw <sub>1</sub>	15-30	cw	10YR4/2	cl	f,1, sbk	s,fr,sssp	fm	vfm, cf	ev
Cr	30-60			cl	F,0, gr	l,fr,nsnp	cm	cf	ev
<b>Pedon 7 Hasnabadwadi, Tq. &amp;Dist, Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>									
Ap	0-21	cs	10YR3/2	sic	m,2, sbk	sh,fr,vsvp	vfm	vfm,fm,cf	ev
Bw <sub>1</sub>	21-42	cw	10YR3/3	sic	m,2, sbk	sh,fr,vsvp	vfm	vfm,fm,cf,	ev
Bw <sub>2</sub>	42-71	cw	10YR3/3	cl	m,2, sbk	sh,fr,vsvp	vfm	vfm,fm,cf	ev
Cr <sub>1</sub>	71-85	cw	10YR5/3	cl	m,2, sbk	sh,fr,sssp	vfm	vfm,fm,cf	ev
Cr <sub>2</sub>	85-100	cw	10YR5/4	cl	f, 1, gr	s,fr,nsnp	fm	ff, cf	ev
<b>Pedon 8, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>									
Ap	0-23	cs	10 YR3/2	sic	m,1, sbk	Sv, fr,sssp	vfm	vfm,fm,cf	es
Bw <sub>1</sub>	20-42	cw	10 YR3/3	sic	m,2, sbk	sv, fr,sssp	vfm,	vfm,fm,cf	ev
Cr	42-130	-	10 YR6/4	cl	f,1, gr	s,1nsnp	cm	ff,cm	ev

Ac 28-50 cm, --pale brown(10YR6/3); clay loamy texture; fine, weak, granular structure; loose, friable, nonstick and non-plastic; coarse many pores; coarse few roots; violent effervescence; mildly alkaline (pH 7.8); clear wavy boundary.

Cr 50-60cm--light yellowish brown (10YR 6/4); clay loam, very coarse, moderate, medium granular structure; loose, friable, non-sticky, non-plastic; coarse few pores; coarse few roots; mildly alkaline (pH 7.8); violent effervescence.

Plate 4.2 – show overall view of Pedon -1

### **Pedon-2**

Location : Gopal wadi(v), Ta. Gangapur, Dist. (Aurangabad)

Landform and slope : 0-1% (level to nearly level)

Drainage : Well drained

Vegetation : Neem, Acacia, Tamarindus, Guava

Parent material : Weathered basalt

Climate : Semi -Arid

Classification : Calcic Haplusterts

### **Horizon Description**

Ap 0-22cm---Very dark brown (10YR 3/2); clay; medium, moderate, subangular blocky structure; slightly hard, friable, very sticky and very plastic; very fine many pores: very fine many roots; violent effervescence; moderately alkaline (pH 8.2); clear smooth boundary.

Bw<sub>1</sub> 22-40 cm --- Very dark brown(10YR3/2) clay; medium, moderate, sub angular blocky structure; slightly hard, friable, very sticky, very plastic; very fine many pores; very fine many roots; violent effervescence; moderately alkaline (pH 8.4); clear smooth boundary.

Bw<sub>2</sub> 40-54 cm, ---Very dark grey (10 YR 3/1) clay loam; moderate medium sub angular blocky structure; slightly hard, very sticky, very plastic, very



**Plate 4.1: show overall view of Pedon-1**



**Plate 4.2: show overall view of Pedon-2**



**Plate 4.3: show overall view of Pedon-3**



**Plate 4.4: show overall view of Pedon-4**



**Plate 4.5: show overall view of Pedon-5**



**Plate 4.6: show overall view of Pedon-6**



**Plate 4.7: show overall view of Pedon-7**



**Plate 4.8: show overall view of Pedon-8**



**Plate 4.9 Landscape around pedon-2**



**Plate 4.10 Landscape around pedon-3**



**4.11 Landscape around pedon-4**



**Plate 4.12: Landscape around pedon-6**

fine many pores; very fine many roots, violent effervescence; strong Alkaline (pH 8.5).; clear smooth boundary.

Bss<sub>1</sub> 54-72 cm, -- Very dark grey (10YR3/1); clay loam; medium, moderate, sub angular blocky structure; slightly hard, friable, very sticky, very plastic; very fine many pores; very fine many roots; violent effervescence; strong alkaline (pH 8.6); clear smooth boundary.

Bss<sub>2</sub> 72-100cm, ----Very dark grey (10YR 3/1), clay loam; medium, moderate, sub angular blocky structure; slightly hard, friable, very sticky, very plastic; very fine many pores; very fine many roots, violent effervescence; strong alkaline (pH 8.8); clear smooth boundary.

Bss<sub>3</sub> 100+, ---very dark grey (10YR3/1); clay loam; medium, moderate, sub angular blocky structure; hard, friable, very sticky and very plastic, very fine many pores; very fine many roots; violent effervescence; strong alkaline (pH 8.8); clear smooth boundary.

Plate 4.3– show overall view of Pedon -2

Plate 4.9 – show land scape around Pedon 2

### **Pedon-3**

Location : Shankarpur (v), Ta. Gangapur, Dist. (Aurangabad)  
Landform and slope : 0-1%, (level to nearly -level)  
Drainage : Well drained  
Vegetation : Babul, Ber Drumstick, Guava, Neem, Tamarindus  
Parent material : Weathered basalt  
Climate : Semi-Arid  
Classification : Typic Haplusterts

### **Horizon Description**

Ap 0-28cm, ---very dark grey (10 YR 3/1); silty clay; medium, moderate, sub angular blocky; slightly hard, friable, very sticky and very plastic; very

fine many, fine many pores; very fine many, fine many, coarse few roots; violent effervescence; strongly alkaline (pH 8.4); clear smooth boundary.

Bw<sub>1</sub> 28-48cm—very dark greyish brown (10YR3/2) silty clay; medium, strong, sub angular blocky structure; hard, firm, very sticky and very plastic; very fine many, fine many pores; very fine many, fine many, coarse few roots; violent effervescence; moderately alkaline (pH 8.4); clear smooth boundary.

Bw<sub>2</sub> 48-60 cm-- very dark greyish brown (10YR 3/2) silty clay; medium, strong, sub angular blocky structure; hard, firm, very sticky and very plastic; very fine many fine many, pores; very fine many, fine many, coarse few roots; violent effervescence; strongly alkaline (pH 8.5); clear smooth boundary.

Bss<sub>1</sub> 60 -102 cm—very dark greyish brown (10YR 3/2); clay loam; medium, strong angular blocky structure; hard, firm, very sticky and very plastic; very fine many, fine many pores; very fine many, fine many roots; violent effervescence; strongly alkaline (pH 8.6). Boundary; clear smooth.

Bss<sub>2</sub> 102- 132cm----very dark greyish brown (10 YR 3/2); clay loam, medium, strong Angular blocky; hard, firm, very sticky and very plastic, very fine medium, fine medium pores; very fine many, fine many roots; violent effervescence; strongly alkaline (pH 8.7); clear smooth Boundary;

Bss<sub>3</sub> 132-150 cm –very dark greyish brown (10 YR 3/2), clay loam; medium, strong angular blocky structure; hard, firm, very sticky and very plastic; very fine many, fine many, pores; very fine many, fine many roots; violent effervescence; strongly alkaline (pH 8.7); clear smooth boundary.

Plate 4.4— show overall view of Pedon -3

#### **Pedon-4**

Location : Borgav.arj, Ta. Phulambri, Dist. (Aurangabad)  
Landform and slope : 1-3% (very gently sloping)  
Drainage : Well drained

Vegetation : Ber, Neem, Mango, Moringa, Rampal, Sapota, Citrus  
 Parent material : Weathered basalt  
 Climate : Semi-Arid  
 Classification : Calcic Haplusterts

**Horizon Description**

Ap 0-18 cm — very dark greyish brown (10 YR 3/2); silty clay; medium, strong, sub angular blocky structure; medium, strong angular blocky structure; hard, firm, very sticky and very plastic; very fine many pores; very fine many, fine many roots; violent effervescence; moderately alkaline (pH 8.1); clear smooth. boundary.

Bw<sub>1</sub> 18- 46 cm—black (10YR2.5/1) silty clay; medium, strong, angular blocky structure; hard, firm, very sticky, very plastic; very fine many, fine many pores; very fine many, fine many roots; strong effervescence; moderately alkaline (pH 8.3); clear smooth boundary.

Bw<sub>2</sub> 46-56 cm ---black (10YR2.5/1) silty clay; medium, strong, angular blocky structure; hard, firm, very sticky and very plastic; very fine many pores; fine few roots; strong effervescence; moderately alkaline (pH 8.4), clear smooth boundary.

Bss<sub>1</sub> 56-75 cm ---black (10 YR 2.5 /1); silty clay; medium, strong, angular blocky structure; very hard, firm, very sticky and very plastic; very fine many pores; fine few roots; strong effervescence; moderately alkaline (pH 8.4). clear smooth. boundary.

Bss<sub>2</sub> 75-94 cm—black (10 YR 2.5/1) clay loam; medium, strong, angular blocky structure; hard, very sticky and very plastic, very fine many pores; fine few roots; strong effervescence; moderately alkaline (pH 8.4), clear smooth boundary.

Cr 94+---dark yellowish brown (10 YR 4/4) clay loam; medium, strong, angular blocky; slightly hard, friable, slightly sticky, slightly plastic, coarse few, fine many pores; very fine roots, violent effervescence; strongly alkaline (pH 8.5).

Plate 4.5– show overall view of Pedon -4

Plate 4.10 – show Land scape around Pedon-4

### **Pedon-5**

Location : Murshidabadwadi, Ta. phulambri, Dist. Aurangabad  
Landform and slope : 1-3 % (very gently sloping)  
Drainage : Well drained  
Vegetation : Neem, Subabul  
Parent material : weathered sand stone  
Climate : Semi-Arid  
Classification : Typic Haplustepts

#### **Horizon Description**

Ap 0-23 cm ---brown (10 YR 4/3); silty clay loam; medium, weak, sub angular blocky structure; soft, very friable, slightly sticky, sticky plastic; very fine many, pores; very fine many, fine many, coarse few roots; violent effervescence; strongly alkaline (pH 8.5); clear smooth boundary.

Bw<sub>1</sub> 23-42 cm ---very dark greyish brown (10YR 3/2); silty clay loam; medium, moderate, sub angular blocky structure; soft, very friable, slightly sticky, sticky plastic; very fine many pores; very fine many, fine many, coarse few roots, strong effervescence; moderately alkaline (pH 8.3), clear wavy boundary

Cr 42-130 cm— light yellow brown (10YR 6/4,) clay loam; very fine, weak, granular structure; soft, loose, non-sticky, non-plastic; fine many pores; fine few, coarse many, roots violent effervescence; moderately alkaline (pH 8.2).

Plate 4.6– show overall view of Pedon -5

### **Pedon-6**

Location : Devgaon (v), Ta. Phythan, Dist. (Aurangabad)  
Landform and slope : 1-3%, (very gently sloping,)

Drainage	:	Well drained
Vegetation	:	Ber, Babul Guava, Neem,
Parent material	:	Weathered sand stone
Climate	:	Semi -Arid
Classification	:	Calcic Haplustepts

<b>Horizon</b>	<b>Description</b>
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Ap	0-15 cm— brown (10 YR 4/3); silty clay; fine, weak, sub angular blocky, soft, friable, slightly sticky, slightly plastic; very fine many, fine many pores; very fine many, coarse few roots; violent effervescence, moderately alkaline (pH 8.2). clear smooth boundary
Bw <sub>1</sub>	15-30 cm – dark greyish brown (10 YR 4/2); clay loam; fine, weak, sub angular blocky structure; soft, friable, slightly sticky and slightly plastic; fine many pores; very fine many, coarse few roots; violent effervescence; moderately alkaline (pH 8.2), clear wavy boundary.
Cr	30-60 cm – (10 YR 6/4 ) clay loam; friable, structureless, granular structure; loose, friable, non-sticky, non-plastic; coarse many pores; coarse few roots; violent effervescence; moderately alkaline (pH 8.4).

Plate 4.7– show overall view of Pedon -6

Plate 4.11 show landscape around Pedon-6

### **Pedon-7**

Location	:	Hasnabadwadi, Ta. Dist. (Aurangabad)
Landform and slope	:	1-3%, (very gently sloping,)
Drainage	:	well drained
Vegetation	:	Babul, Coconut, Neem, Mango, Tamarindus
Parent material	:	Weathered basalt
Climate	:	Semi- Arid
Classification	:	Calcic Haplusterts

<b>Horizon</b>	<b>Description</b>
Ap	0-12 cm – very dark greyish brown (10 YR 3/2); silty clay; medium, moderate, sub angular blocky structure; slightly hard, friable, very sticky, very plastic; very fine many pores; very fine many, fine many, coarse few roots; violent effervescence; moderately alkaline (pH 8.2); clear smooth boundary
Bw <sub>1</sub>	21-42 cm –dark greyish brown (10 YR 3/3); silty clay; medium, moderate. sub angular blocky structure; slightly hard, friable, very sticky, very plastic; fine many pores; very fine many, coarse few roots; violent effervescence; moderately alkaline (pH 8.4); clear wavy boundary.
Bw <sub>2</sub>	42- 71cm – dark greyish brown (10YR 3/3); clay loam, medium, moderate. sub angular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; very fine many pores; very fine many, fine many, coarse few roots, violent effervescence; strongly alkaline (pH 8.7); clear wavy boundary.
Cr <sub>1</sub>	71- 85 cm—brown (10 YR 5/3); clay loam; medium, moderate sub angular blocky structure; slightly hard, friable very sticky, very plastic; very fine many roots; very fine many, fine many, coarse few roots; violent effervescence; strongly alkaline (pH 8.7) ,clear wavy boundary.
Cr <sub>2</sub>	85- 100 cm—light brown (10 YR 5/4); clay loam, fine, loose, granular structure; soft, friable, non-sticky, non-plastic; fine many pores; fine few, coarse few roots; violent effervescence; strongly alkaline (pH 8.8); clear wavy boundary.

Plate 4.8– show overall view of Pedon -7

### **Pedon-8**

Location	:	Hasnabadwadi, Ta. Dist. (Aurangabad)
Landform and slope	:	1-3%, (Very gently sloping)
Drainage	:	well drained

Vegetation	:	Ber, Babul, Mango, Tamarindus
Parent material	:	Weathered basalt
Climate	:	Semi-Arid
Classification	:	Calcic Haplusterts

<b>Horizon</b>	<b>Description</b>
Ap	0-23 cm – Very dark greyish brown (10 YR 3/2); silty clay; medium, weak, sub angular blocky structure; soft, friable, slightly sticky, slightly plastic; very fine many pores; very fine many, fine many, coarse few roots; violent effervescence; moderately alkaline (pH 7.9) clear smooth boundary.
Bw <sub>1</sub>	23- 42 – Dark greyish brown (10YR 3/3), silty clay; medium, moderate, sub angular blocky structure; soft, friable, slightly sticky, slightly plastic; very fine many pores, fine many, coarse few roots; violent effervescence; moderately alkaline (pH 8.1); clear wavy boundary.
Cr	42- 130 cm – light yellow brown (10YR6/4) clay loamy; friable, weak, granular structure; soft, loose, nonstick, non-plastic; coarse many pores; fine few, coarse many roots; violent effervescence; moderately alkaline (pH 8.2).

Plate 4.9 Show overall view of Pedon -8

Plate 4.12 Land scape around Pedon-8

#### **4.1.1.1 Soil depth**

The soil depth is an important role in the crop production and crop yield. The soil depth shows the water level in the soil and rainfall, available water capacity and nutrient status of the soil naturally (Fig. 4.1). It is also indicated the available nutrient around the rhizosphere of the plant root and phyllo sphere of the plant. The depth of the soil varies according soil type and to cropping pattern. (P<sub>1</sub>), Entisols, *Lithic Ustorthents* under pigeon pea and maize and soil depth is 50 cm. Pedon P<sub>2</sub>, P<sub>4</sub> and P<sub>7</sub>, Vertisols, Calcic Haplusterts commonly under cotton maize and pigeon pea sorghum crop and soil depth is 94 to 150cm. Pedon P<sub>3</sub>, *Vertisols*, Typic Haplusterts comes under cotton pigeon pea and maize Pedon and soil depth >150 cm. (Fig.4.4 )Pedon P<sub>5</sub>

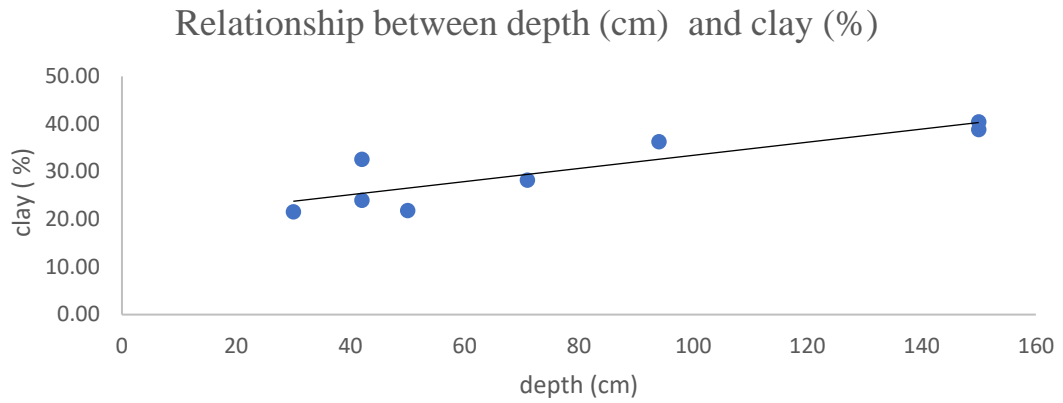
Inceptisols, Typic Haplustepts comes under cotton, pigeon pea, and maize and soil depth 91 cm. Pedon P6 and P8 Inceptisols, Calcic Haplustepts comes under cotton maize pigeon crop soil depth varies from 42 to 70 cm. Depth of the soil varied from 30 to 150 cm. the selection of the crop not as per soil site suitability in this area. Deep rooted crop is also commonly grown on Typic Ustorthent. Therefore, the variation of soil depth is not as per the cropping patterns. Soil depth is also a predictor of soil development. Soil depth had an effect on both organic and inorganic carbon stocks in the soil. In comparison to shallow depth soils, deep soils contain more organic stocks than high depth soils, but inorganic carbon stocks are higher in deep soils than in shallow soils, and inorganic carbon stocks increase with depth (Lal, 2010).

#### **4.1.1.2 Soil horizons**

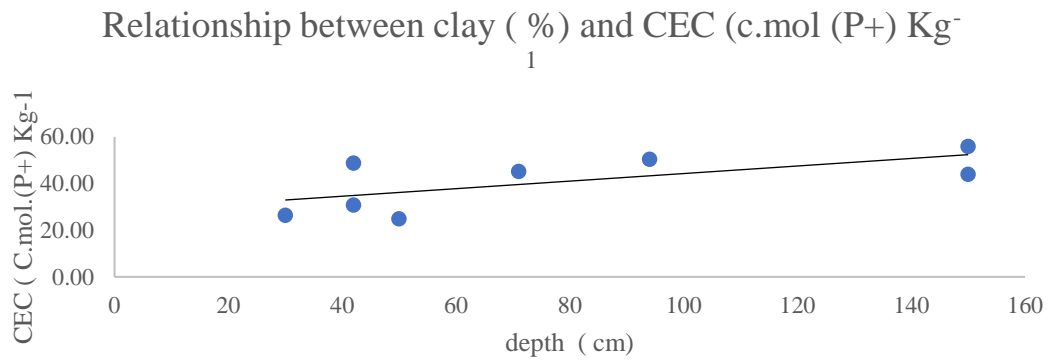
The soil horizon was a layer of soil which is approximately parallel to adjoining layer of the soil that are produced by pedogenic soil forming process. These properties vary from those of the adjacent horizon in respect of characteristics of such as color, texture, structure, consistency, plasticity, aeration capacity, drainage, water and nutrient holding capacity, nutrient leaching and fixation.

#### **4.1.1.3 Soil color**

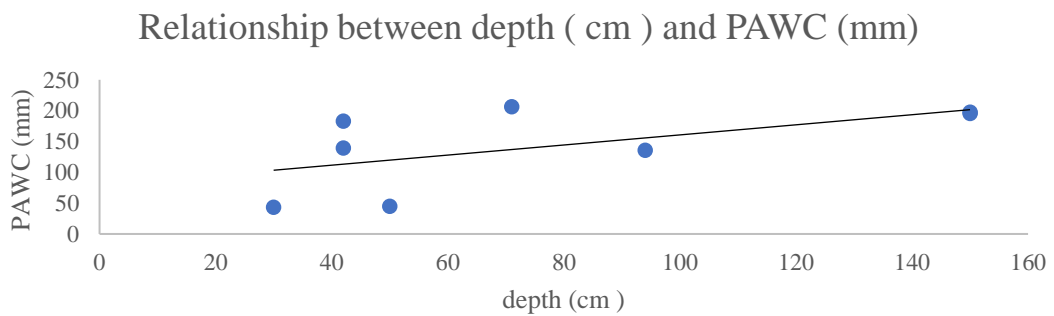
Soil colour is a primary and fundamental indicator of soil health and the pedogenic and morphogenic soil formation processes. Soil colour can also reveal information about topography, vegetation, biosphere, parent material, rainfall, temperature, nutrient status, and mineralogical properties. One of the most notable morphological characteristics used for soil identification is soil colour. The soil colour of the current investigated soil profiles, was primarily influenced by relief, drainage, time, weathering intensity, and parent material. (Table No. 4.1). The soil color presented in Table 4.1. Pedon (P<sub>1</sub>), Entisols, Lithic Ustorthents very dark grey 10 YR 1/3 to light yellow brown 10YR6/4. Pedon P<sub>2</sub>, P<sub>4</sub> & P<sub>7</sub>) Vertisols, Calcic Haplusterts very dark brown 10YR3/2 to 10YR5/4 light brown in color. Pedon P<sub>3</sub>, Vertisols, Typic Haplusterts dark grey 10 YR 3/1 to 10YR3/2 very dark brown. Whereas Pedon P<sub>5</sub>, Inceptisols, Typic Haplustepts brown 10YR4/3 to light brown 10YR5/4. Pedon P<sub>6</sub>, & P<sub>8</sub> Vertisols, Calcic Haplustepts, very dark greyish brown 10YR 3/2 to light brown 10YR5/4. Soil color originated from parent material called as lithochromic. But soil color develops from soil development process known as pedochromic. soil varies



**Fig.4.1** Represent the relationship between depth (cm) and clay (%) under different soil type of Aurangabad



**Fig.4.2** Represent the relationship between clay (%) and CEC under different soil type of Aurangabad



**Fig.4.3** Represent the relationship between depth (cm) and PAWC (mm) under different soil type of Aurangabad

with based on climate. parent material, organic carbon, inorganic carbon, irrigation, cropping pattern and cultivation methods.

#### **4.1.1.4 Soil Structure**

The soil structure was defined as the arrangement sand, silt, clay at certain pattern of aggregation known as soil structure. The soil natural aggregates called as peds and the broken parts of peds called as fragments. the aggregates developed by tillage action called as clods. The soil structures classified as 4 parts 1. size ,2. Classes, 3. Type and 4. grade. The soil structure (Table No. 4.1) of pedon P<sub>1</sub>, Entisols, Lithic Ustorthent was granular to sub angular blocky, (P<sub>2</sub>, P<sub>4</sub> and P<sub>7</sub>, P<sub>3</sub>), Vertisols, Calcic Typic Haplusterts was sub angular blocky (P<sub>3</sub>) was sub angular blocky (P<sub>5</sub>), Inceptisols, Typic Haplustepts) was granular to sub angular blocky. Pedon P<sub>6</sub> and P<sub>7</sub> Inceptisols, Calcic Haplustepts fine granular to sub angular blocky in structure. The structural arrangement of the soil is closely associated with clay content and carbon stock.

#### **4.1.1.5 Soil consistency**

The consistency was a dynamic physical property of the soil the soil consistency refers to the manifestation of the physical forces of cohesion and adhesion acting with in the soil moisture constants. The pedon P<sub>1</sub>, Entisols, Lithic Ustorthents soil consistency was very sticky very plastic to non-sticky to non-plastic. Pedon P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub>, Vertisols, *Calcic Haplusterts* varied from slightly hard, very sticky and very plastic. (P<sub>3</sub>), Vertisols (*Typic Haplusterts*) varies from slightly hard, very sticky and very plastic to hard, firm, very sticky to very plastic. Pedon P<sub>5</sub>, Inceptisols (*Typic Haplustepts*) soft, friable to non-sticky non-plastic . Pedon P<sub>6</sub> and P<sub>8</sub>, Inceptisols, Calcic Haplustepts varies from soft, friable, very sticky, very plastic. The soil consistency is varying with the soil type. The Typic Haplusters soils have high sticky and plasticity as compare to other type of soil. This may be due to high amount of clay content. The content of organic carbon reduces the stickiness.

### **4.1.2 Physical properties of soil**

#### **4.1.2.1 Coarse fragment**

The size of the soil particles more than 2mm called as coarse fragments. It was index for the weathering status of soil method of soil cultivation. The Pedon P<sub>1</sub>, Entisols, Lithic Ustorthents coarse fragment was content 17.12 to 50 per cent, Pedon

P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub>, Vertisols, *Calcic Haplusterts* was content 14.2 to 46.71 per cent, (P<sub>3</sub>), Vertisols (*Typic Haplusterts*) was contains 13.5 to 46.29 per cent. Pedon P<sub>5</sub>, Inceptisols (*Typic Haplustepts*) was contains 19.5 to 44.19 per cent (Table No. 4.1). Pedon P<sub>6</sub> and P<sub>8</sub>, Inceptisols, *Calcic Haplustepts* 21.7 to 45.02 per cent. The soil coarse fragments were associate with the slope and type of soil. The Entisols soil have high amount of coarse fragment as compare to other type of soil.

#### **4.1.2.2 Bulk density**

Bulk density was one of the crucial physical parameters of the soil. Bulk density denoted that the mass of soil per unit volume, includes pore space. it is simply mass per unit volume of dry soil (volume of solid and pore space) it was implies the type of soil. soil drainage, soil strength, plasticity, compaction, crust formation, soil aeration, water holding capacity, and infiltration, permeability, percolation, leaching organic matter also, this physical property very useful for crop production purpose.

The Bulk density of Pedon P<sub>1</sub> Entisols, lithic Ustorthents was varies from 1.44 to 1.6 Mg m<sup>-3</sup> (P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub>) Vertisols, *Calcic Haplusterts* was ranged from 1.2 to 1.63 Mg m<sup>-3</sup>, Pedon P<sub>3</sub> Vertisols (*Typic Haplusterts*) varies from 1.2 to 1.53 Mg m<sup>-3</sup>, Pedon P<sub>6</sub>, P<sub>8</sub>, Inceptisol (*Calcic Haplustepts*) varies from 1.23 to 1.62 Mg m<sup>-3</sup>, pedon P<sub>5</sub> Inceptisols, (*Typic Haplustepts*) was varies from 1.2 to 1.4 Mg m<sup>-3</sup>.

The bulk density generally high compacted soil order Vertisols compared to the shallow soil orders Entisols and Inceptisols. the bulk density increases with the depths because high compaction of soil. The bulk density reduced by high organic matter, and addition of high plant residues and good microbial activity. Bulk density closely associated with porosity of soil, it gives water status of field capacity, available water capacity, permeant wilting co-efficient of the soil. Vertisols soil have high value of bulk density in subsurface layer may be due to high smectite clay and burden leading to compaction and formation of slicken slides, leading to strong structural aggregation formation and high bulk density. Difference in bulk density caused due to in land use or land cover affects the calculation of carbon stock by influencing the amount of soil sampled from the same depth (Solomon *et al.*, 2002).

#### **4.1.2.3 Hydraulic conductivity**

Hydraulic conductivity is one of the important physical parameters of the soil. generally, the hydraulic conductivity talks about the movement water through the soil pores. It shows the permeability, intrinsic permeability, aeration, pore space, drainage conditions, soil strength, soil compaction, water holding capacity of the soil. The coarse texture soil which are loose good aeration capacity which are high hydraulic conductivity compared to clay, compact soils. The hydraulic conductivity under different soil and cropping pattern varies from 1.53 to 5.45 cm ha<sup>-1</sup>. The pedon P<sub>1</sub>Entisols (Lithic Ustorhents) HC was 2.2 to 3.44 cm hr<sup>-1</sup>., Pedon P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> Vertisols, (Calcic Haplusterts) was hydraulic conductivity varies from 1.4 to 5.13cm hr<sup>-1</sup>. Pedon P<sub>3</sub>Vertisols, (*Typic Haplusterts*) HC was varies from 1.21 to 3.84cm hr<sup>-1</sup>., whereas P<sub>5</sub>, Inceptisols (Typic Haplustepts) was hydraulic conductivity 1.2 to 1.48 cm hr<sup>-1</sup> and Pedon P<sub>6</sub> and P<sub>8</sub>, Inceptisols (Calcic Haplustepts) HC varies with 2.8 to 3.90 cm hr<sup>-1</sup>. The hydraulic conductivity of soil is closely associated with the clay content and coarse fragment increase the coarse fragment increase the HC where as increase the clay content decreases the hydraulic conductivity of soil. However, the high hydraulic conductivity in lower horizon may be due to high number of coarse fragments (Table 4.2.)

#### **4.1.2.4 Particle size distribution**

Particle size distribution is the relatively portion of sand, silt, clay content in the soil. It is assumed that the soil textural analysis, indirectly given the amount of organic matter, calcium carbonate content, iron, chloride, percentage in the soil. because this property we can enquire the soil aeration, drainage, infiltration, leaching, permeability, oxygen diffusion rate, soil strength, compaction hydraulic conductivity, porosity. the particle size distribution generally estimated by two methods 1. Hydrometer method, 2. International pipette method. The hydrometer method was simple and its suitable for low calcium carbonate gypsum content soil. The internal pipette method most accurate difficult method it is suitable for calciferous soils, we have followed international pipette method.

The particle size distribution Table No. 4.2 under different soil and cropping pattern and soil P<sub>1</sub> Lithic Ustorhents sand, silt and clay varies from 14.9 to 27 per cent, 49.5 to 52 per cent and 21 to 35 per cent respectively. Pedon P<sub>2</sub>, P<sub>4</sub>, and P<sub>7</sub> Calcic Haplusterts sand, silt and clay, varies from 6 to 29, 28.8 to 54.00 and 22.6 to

40.2 per cent. Pedon P<sub>3</sub>), Vertisols, (Typic Haplusterts) sand, silt and clay varies from 13.24 to 30.2, 28.8 to 48.8 and 20.2 to 40.2 per cent respectively. Pedon P<sub>5</sub> Inceptisols, (Typic Haplustepts) sand, silt and clay varies from 15.6 to 33, 40 to 47.1 and 27 to 37 per cent respectively, Pedon P<sub>6</sub>, and P<sub>8</sub> Calcic Haplustepts, sand, silt and clay vary from 12 to 32, 34 to 49 and 25 to 35.5 per cent respectively (Fig. 4.2).

The maximum clay content was noticed under vertisols comparatively than other type of soil. Moreover, the clay content in soil was found significantly positive correlated with total carbon stock and soil depth ( $r=0.1585$  and  $r= 0.777$ ). The soil total carbon stock increase with clay content in soil and clay content increase with increasing depth.

**Table -4.3 Physical properties of different cropping pattern and soil profiles of Aurangabad district of Maharashtra**

Horizon	Depth (cm)	Coarse Fragment (%)	B D (Mg m <sup>-3</sup> )	H C (Cm hr <sup>-1</sup> )	Particle size analysis (%)			Moisture retention (%)		AWC (%)	PAWC (mm)
					Sand	Silt	Clay	33kPa	1500kPa		
<b>Pedon 1 Shekta, Tq Gangapur, Aurangabad district (<i>Lithic Ustorthents</i>) Pigeon pea cropping pattern</b>											
Ap	0-28	17.12	1.4	2.2	14.9	49.5	35.6	22.28	12.24	10.04	44.82
Ac	28-50	40.19	1.44	2.3	21.1	47.4	31.5	17.82	9.41	8.41	
Cr	50-60	50	1.6	3.44	27	52	21	8.63	4.35	4.28	
<b>Pedon 2 Gopalwadi, Tq Gangapur, Aurangabad district (<i>Calcic Haplusterts</i>) Maize cropping pattern</b>											
AP	0-22	14.74	1.3	1.53	27.2	28.8	44	32.48	16.24	16.24	195.54
Bw <sub>1</sub>	22-40	33.07	1.34	3.43	24	39.6	36.9	29.88	18.44	11.44	
Bw <sub>2</sub>	40-64	34.75	1.43	4.91	30.6	35.9	33.5	21.93	10.83	11.1	
Bss <sub>1</sub>	64-72	35.5	1.46	4.13	21.7	48.8	29.5	17.77	8.43	9.27	
Bss <sub>2</sub>	72-100	40.59	1.46	5.0	27	49	24	14.09	7.03	7.06	
Bss <sub>3</sub>	100+	46.29	1.50	5.13	29	48.4	22.6	12.68	6.38	6.3	
<b>Pedon 3 shankarpur Tq Gangapur, Aurangabad district (<i>Typic Haplusterts</i>) sorghum cropping pattern</b>											
Ap	0-23	13.5	1.2	1.89	13.24	46	40.2	33.25	23.14	10.11	197.59
Bw <sub>1</sub>	23-48	29.60	1.23	2.21	15	47	38	22.02	12.01	10.11	
Bw <sub>2</sub>	48-68	33.5	1.24	2.46	16.20	45.9	37.9	19.2	9.1	10.1	
Bss <sub>1</sub>	68-102	37.42	1.33	2.90	20.4	42.8	36.8	12.7	6.2	6.5	
Bss <sub>2</sub>	102-132	40.59	1.52	3.00	21.2	44.4	34.4	11.05	5.2	6.3	
Bss <sub>3</sub>	132-150	46.29	1.53	3.84	30.2	49.6	20.2	7.69	3.1	4.59	
<b>Pedon 4 Borgav ARJ, Tq, phulambri, Aurangabad district (<i>Calcic Haplusterts</i>) maize cropping pattern</b>											
Ap	0-18	19.72	1.2	4.28	6.0	54	40	32.74	14.32	18.42	135.26
Bw <sub>1</sub>	18-40	21.5	1.29	4.18	12.8	48	39.2	23.4	11.2	12.2	
Bw <sub>2</sub>	40-56	22.6	1.3	4.16	13.5	49	37.5	19.3	8.1	11.2	

Continue....

Horizon	Depth (cm)	Coarse Fragment (%)	B D (Mg m <sup>-3</sup> )	H C (Cm hr <sup>-1</sup> )	Particle size analysis (%)			Moisture retention (%)		AWC (%)	PAWC (mm)
					Sand	Silt	Clay	33kPa	1500kPa		
BSS <sub>1</sub>	56- 75	28.43	1.35	3.2	15	49	36	14.2	7.1	7.1	
BSS <sub>2</sub>	75- 94	34.75	1.40	2.83	21.6	46.4	32	13.6	6.91	6.69	
Cr	94 +	36.85	1.46	2.79	27	46	27	10.1	5.01	5.09	
<b>Pedon 5 Murshidabadwadi, Tqphulambri, Aurangabad district (Typic Haplustepts) maize cropping pattern</b>											
Ap	0-26	19.5	1.2	3.56	15.6	47.1	37	38.35	24.15	14.2	183
Bw <sub>1</sub>	26-50	27.8	1.3	4.01	17	49	34	29.04	18.02	11.02	
Bw <sub>2</sub>	50-91	28.01	1.4	4.032	25	44	31	18.65	8.32	10.33	
Cr	91 – 150	44.19	1.48	3.35	33	40	27	10.94	5.52	5.42	
<b>Pedon 6 Devgaon, Tq. Python, district Aurangabad ( Calcic Haplustepts ) cotton cropping pattern</b>											
Ap	0-15	25.4	1.23	3.90	21	42	37	20.43	10.22	10.21	43.45
Bw <sub>1</sub>	15- 30	28.9	1.35	3.63	32	34	34.	20.06	10.03	10.57	
Cr	30-60	45.4	1.57	2.8	31	40	29	7.46	4.23	3.23	
<b>Pedon 7 Hassanbadwadi, Tq&amp; district Aurangabad (Calcic Haplusterts ) cotton cropping pattern</b>											
Ap	0-21	14.2	1.31	1.95	19	45	35.5	32.29	16.18	16.11	206.12
Bw <sub>1</sub>	21-42	27.8	1.34	2.6	20	46	34	23.5	12.51	10.99	
Bw <sub>2</sub>	42-71	28.6	1.5	3.6	22	47	31	21.5	11.25	10.25	
Cr	71-83	34.7	1.57	5.1	27	46	27	21.4	11.22	10.2	
Cr <sub>2</sub>	83-100	41.9	1.63	5.45	29	46	25	14.5	7.41	7.09	
<b>Pedon 8, Hasnabadwadi. Tq. And district Aurangabad (Calcic Haplustepts) cotton – cropping pattern</b>											
Ap	0-23	21.7	1.4	3.08	12	49	39	26.98	18.44	8.54	139.15
Bw <sub>1</sub>	23-42	30.9	1.6	2.97	18	47	34.5	24.21	16.15	8.06	
Cr	42-130	45.02	1.62	2.92	26	46	28	19.22	11.25	7.97	

#### 4.1.2.5 Moisture retention

The water retention by soil is important for plants and act as chief source of moisture for it in almost all functions. soil moisture can be reduced due to percolation through the soil, evaporation from the soil, evapotranspiration, by the plants amount of clay minerals are mainly responsible for moisture retention. Moisture retention (Table No. 4.2) under different cropping pattern of Aurangabad district viz. (P<sub>1</sub>), Entisols (*Lithic Ustorthents*) showed 8.63 to 22.28 at 33kpa and 4.35 to 12.24 at 1500 kpa, P<sub>2</sub>, P<sub>4</sub> and P<sub>7</sub> (*Calcic Haplusterts*) showed 10.1 to 34.48 per cent at 33kpa and 5.01to 18.44 per cent at 1500 kpa. P<sub>3</sub> (*Typic Haplusterts*) showed 7.69 to 33.25 per cent at 33 kpa, whereas 3.1 to 23.14 per cent at 1500 kpa. Pedon P<sub>5</sub>(*Calcic Haplusterts*) showed 10.94 to 38. 35 per cent at 33 kpa and 5.52 to 24.15 per cent at 1500 kpa. Whereas, P 6 and P8 (*Calcic Haplustepts*) noted 7.46 to 26.98 per cent at 33 kpa and 4.23 to 18.44 per cent at 1500kpa. In general, the maximum moisture content in soil was noted in Vertisols Typic Haplusterts comparatively than other type of soil. This may be due to high amount of clay and organic matter content in soil.

#### 4.1.2.6 Plant available water capacity

Plant available water capacity (Table No. 4.3) under different type of soil and cropping pattern under Aurangabad viz. (P<sub>1</sub>), Entisols (*Lithic Ustorthents*) showed PAWC 44.82 mm, P<sub>2</sub>, P<sub>4</sub> and P<sub>7</sub> (*Calcic Haplusterts*) varies from 135.26 to 206.12 mm. P<sub>3</sub> (*Typic Haplusterts*) showed 197.59 mm Pedon P<sub>5</sub> (*Calcic Haplusterts*) showed 183mm whereas, P 6 and P8 (*Calcic Haplustepts*) noted 43.45 to 139.15 mm. (Fig.4.3)

The maximum PAWC was noticed in Typic and Calcic Haplusterts and lowest at *Lithic Ustorthents*. This may be due to soil depth and clay content. Moreover, significant positive correlation between PAWC with clay content, ( $r = 0.733$ ). (Fig. 4.6) This indicates that PAWC increased with increasing soil depth and clay content in soil. Similar result was also reported by Wagh (2018).

#### 4.1.3 Chemical properties

##### 4.1.3.1 Soil Reaction (pH)

The pH was indicators for the nature of the soil reaction like acidity, alkalinity, neutral condition of the soil. Soil reaction indicate biological reaction of the like acidic reaction fungi grown more, basic reaction bacterial growth, alkaline

condition actinomycetes more. The soil reaction of different soil profiles in cropping pattern like these the soil. Soil reaction tells soil problems salinity, alkalinity, soil submerging. The aeration capacity of the soil oxidation, reduction condition easily understands with help of soil reaction. P<sub>1</sub> (*lithic Ustorthents*) showed 7.7 to 7.8, P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) showed 8.1 to 8.7, P<sub>3</sub> (*Typic Haplusterts*) was varies 8.4 to 8.7, P<sub>5</sub> (*Typic Haplustepts*) was containing (8.2 to 8.5). P<sub>6</sub> and P<sub>8</sub> (*Calcic Haplustepts*) varies 7.9 to 8.4.

The soil reaction all above pedons alkaline in nature. the pedons under soil evapo-transpiration of water need to accumulation salts cause the soil reaction changes alkaline in nature. (Mali *et al.*, 2001). Most of the crops are commercial crops the application high fertilizers improve uses cause the soil reaction change in to alkaline. Calcium carbonate high accumulation also given soil alkalinity. (Salim *et al.*, 2015)

#### **4.1.3.2 Electrical conductivity**

The Electrical conductivity (Table No. 4.2) directly indicated that the total soluble solids and salts present in the soil and soil water nature. The Electrical conductivity of the P<sub>1</sub>(*lithic Ustorthents*) varies from 0.173 to 0.27dSm<sup>-1</sup>. P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was found 0.17 to 0.46 dS m<sup>-1</sup>. P<sub>3</sub> (*Typic Haplusterts*) was varies form 0.15-0.19 dSm<sup>-1</sup>. P<sub>5</sub> (*Typic Haplustepts*) was electrical conductivity showed 0.15 to 0.17dSm<sup>-1</sup>and P<sub>6</sub> and P<sub>8</sub> electrical conductivity found 0.15 to 0.37dSm<sup>-1</sup>. Which is well within safe limit of electrical conductivity range, designated for normal soil (Richard, 1954) and all soils comes under non-saline soils class. The EC value of surface layer is relatively less as compared to murrum layer as (0.08 to 0.38 dSm<sup>-1</sup>). Irregular variation in EC could presently due to leaching of salt from surface to down level through the percolation of water, followed by accumulation at places during evapotranspiration resulting in differential salt accumulation along the pedon. Similar observation recorded by Rajkumar (1990), Vaidya *et al.* (2002).

#### **4.1.3.3 Organic carbon**

The soil organic carbon is an index for the soil health and soil microbial action and enzyme activity. It is one of the soil aggregates formation soil structural

development agents. It stimulating the base saturation, cation exchange capacity and buffering capacity. soil organic carbon as improve the soil physical properties like bulk density, infiltration, hydraulic conductivity nutrient storage, reduce soil erosion and extracted the harmful heavy metals. The soil organic carbon (Table No. 4.2) The P<sub>1</sub> (*lithic Ustorthents*) varies from 0.73 to 0.945 per cent. Pedon P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was varies from 0.16 to 0.79 per cent , P<sub>3</sub> (*Typic Haplusterts*) was varies 0.28 to 0.965 per cent , P<sub>5</sub> (*Typic Haplustepts*) was found 0.10 to 0.645 per cent and P<sub>6</sub> ,P<sub>8</sub> (*Calcic Haplustepts*) was found 0.13 to 0.79 per cent. The surface soil content high amount of soil organic carbon may be due to addition of organic matter, green manuring, bio fertilizers, litter management soil surfaces cause the organic carbon in the soil maintain very well. (Lal, 2010)

#### **4.1.3.4 Calcium carbonate**

The calcium carbonate in the soil plays key role for soil aggregation cementing agent, soil structure development. The calcium in soil act as flocculation capacity of soil. The calcium carbonate in the soil indicates the inorganic carbon status of the soil. Calcium carbonate enhance the important soil chemical parameters like base saturation, buffering capacity, CEC, exchangeable cations of the soil. But high calcium carbonate creates some adverse effect like deficiency of micronutrient Fe and Zn except Mo. The status of calcium carbonate in pedon P<sub>1</sub> (*Lithic Ustorthents*) showed 5.5 to 19.5 per cent, P<sub>2</sub> P<sub>4</sub> and P<sub>7</sub> (*Calcic Haplusterts*) showed 7 to 18.7 per cent, P<sub>3</sub> (*Typic Haplusterts*) showed 8 to 11.5 per cent, P<sub>5</sub> (*Typic Haplustepts*) showed 10.25 to 15.0 per cent and P<sub>6</sub> and P<sub>8</sub> (*Calcic Haplustepts*) showed 9.75 to 18.75 per cent. The calcium carbonate content in Lithic Ustorthents very low value than the Typic Haplustepts and Calcic Haplusterts it may be due to the leaching of (HCO<sub>3</sub>)<sub>2</sub> which get precipitated down to slope as well as at lower horizon (Patil *et al.*, 2014)

#### **4.1.3.5 Calcium carbonate equivalent**

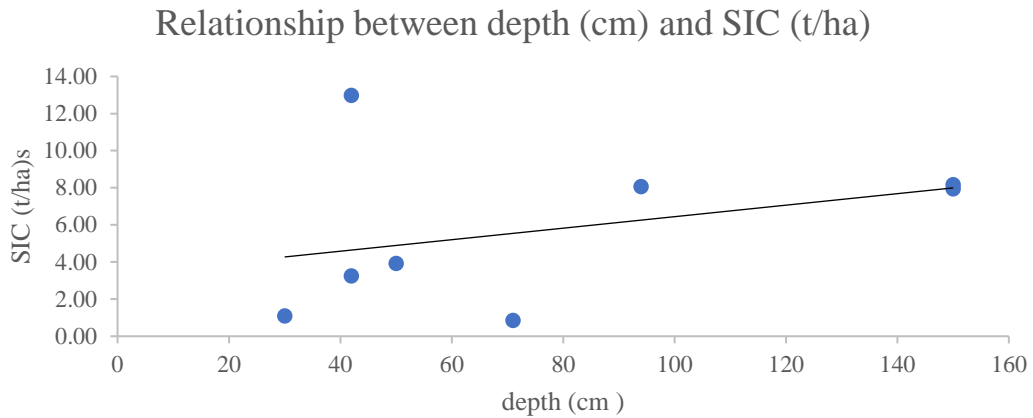
The inorganic carbon in the soil is represented by carbonates of calcium and magnesium. The major component of the SIC is represented by the calcium carbonate. The rapid titration method of Piper (1950 ) also called as acid neutralization method in generally used for estimation of SIC. The sample is treated with dilute acid and the residual unreacted acid is titrated with alkali the results are expressed as calcium carbonate.

The calcium carbonate equivalent (Table No. 4.3) under different cropping pattern of Aurangabad follows this p<sub>1</sub> (*Lithic Ustorthents*) contains 7.6 to 20.1 per cent. p<sub>2</sub>, p<sub>4</sub>, p<sub>7</sub> (*Calcic Haplusterts*) contains 9.9 to 19.9 per cent. P<sub>3</sub> contains (*Typic Haplusterts*) which content 8.8 to 19.9 per cent, P<sub>5</sub>(*Typic Haplustepts*) contains 11.1 to 16.1per cent and P<sub>6</sub>, P<sub>8</sub>(*Calcic Haplusterts*) contains 7.8 to 18.9 per cent and which was increased with depth except in pedon 5.

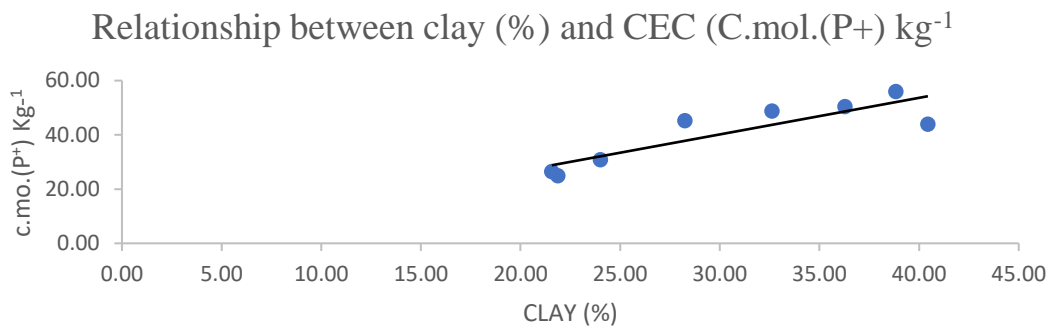
#### 4.1.3.6 Cation exchange capacity

The CEC is the second most important chemical process after photosynthesis. The CEC tells the capacity nutrients present in the soil. The CEC shows edaphic properties, fertility capacity of the soil. The CEC encourages the chemical properties like base saturation, buffering capacity, exchangeable cations, ESP, and it given the clay, organic status and type of soil. Cation exchange capacity (Table No. 4.3) under different soils and cropping pattern Aurangabad viz., P<sub>1</sub> (*Lithic Ustorthents*) varies from 23.65 to 44.23 cmol (P<sup>+</sup>) kg<sup>-1</sup>, Pedon P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was contains 31.23 to 60.85 cmol (p<sup>+</sup>) kg<sup>-1</sup>, P<sub>3</sub> (*Typic Haplusterts*) was varies 31.23 to 60.13 c.mol(p<sup>+</sup>) Kg<sup>-1</sup>, P<sub>5</sub> (*Typic Haplustepts*) was found 35.56 to 60.96 c.mol(p<sup>+</sup>) Kg<sup>-1</sup> where as P<sub>6</sub> and P<sub>8</sub>CEC varies from 39.68 to 55.68 c.mol(p<sup>+</sup>) Kg<sup>-1</sup>.

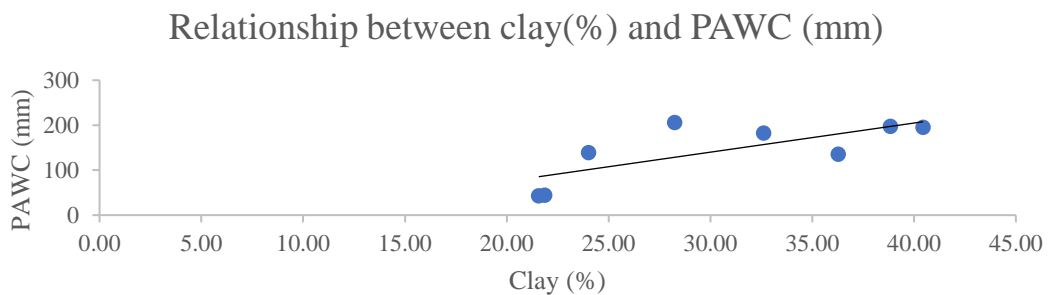
The cation exchange capacity always positive relation with clay, organic matter. The Calcic and Typic Haplusterts soil has high cation exchange capacity and These soils contained good amount of clay, high calcium carbonate, good organic carbon content causes the soil cation exchange capacity given good value. But Pedon -1 *Lithic Ustorthents* contained low cation exchange capacity among the all pedons due to low soil depth. High sand content low water availability, low clay causes the cation exchange capacity decreased. (Fig,4.5) Moreover, significant positive correlation between CEC with soil depth, clay content and carbon stock, (r=0.77722 r=0.96018 and r=0.15895). This indicates that CEC increased with increasing soil depth and. clay content and total carbon stock in soil. Similar result was also reported by Wagh (2018).



**Fig.4.4** Represent the relationship between depth (cm) and SIC (t/ha) under different soil type of Aurangabad



**Fig.4.5** Represent the relationship between clay (%) and CEC (c.mol (P<sup>+</sup>) Kg<sup>-1</sup>) under different cropping pattern of Aurangabad



**Fig.4.6** Represent the relationship between clay (%) and PAWC (mm) under different cropping pattern of Aurangabad

**Table 4.4 Chemical Properties Under Different Cropping Pattern and Soil Profiles Under Aurangabad District of Maharashtra**

Horizon	Depth (cm)	pH	EC (dSm <sup>-1</sup> )	O.C (%)	CaCO <sub>3</sub> (%)	CEC [cmol (p <sup>+</sup> ) Kg <sup>-1</sup> ]	Calcium carbonate equivalent (%)	Cation [cmol (p <sup>+</sup> ) Kg <sup>-1</sup> ]				Sum of cation	BS (%)
								Ca <sup>++</sup>	Mg <sup>++</sup>	Na <sup>++</sup>	K <sup>+</sup>		
<b>Pedon1 shekta,tq. Gangapur, districtAurangabad (<i>LithicUstorthents</i>) pigeon pea cropping pattern</b>													
Ap	0-28	7.7	0.27	0.945	5.5	44.23	7.6	22	14.4	0.61	0.88	39.08	88.3
Ac	28-50	7.8	0.27	0.78	13.75	34.45	14.6	18.8	8.9	0.97	0.73	29.3	85.05
Cr	50-60	7.8	0.173	0.73	19.5	23.65	20.1	10.8	6.8	1.08	0.72	18.94	80.0
<b>Pedon 2 Gopal wadi, tq Gangapur, district Aurangabad (<i>Calcic Haplusterts</i>) maize cropping pattern</b>													
Ap	0-22	8.2	0.33	0.79	7	59.56	9.9	30.8	22.4	0.44	0.92	54.88	92.12
Bw <sub>1</sub>	22-40	8.4	0.30	0.55	7.5	56.12	8.8	28.8	20.4	0.54	0.87	50.69	90.3
Bw <sub>2</sub>	40-64	8.5	0.27	0.43	10.25	54.25	11.5	28	19.3	0.59	0.83	48.75	89.8
Bss <sub>1</sub>	64-72	8.6	0.34	0.44	12.5	50.32	13.3	27.2	16.1	0.65	0.77	44.66	88.7
Bss <sub>2</sub>	72-100	8.8	0.47	0.38	13	45.32	14.9	23.61	13.1	0.67	0.72	37.99	83.8
Bss <sub>3</sub>	100+	8.8	0.46	0.24	13	37.56	14.6	9.6	10.1	0.76	0.65	30.79	82.5
<b>Pedon 3 shankarpur, tq. Gangapur, district, Aurangabad (<i>Typic Haplusterts</i>) sorghum cropping pattern</b>													
Ap	0-23	8.4	0.19	0.965	8	60.13	8.8	34.8	19.8	0.77	0.96	56.63	94.14
Bw <sub>1</sub>	23-48	8.4	0.19	0.718	8.5	57.13	9.9	32.8	18	0.70	0.87	52.66	92.1
Bw <sub>2</sub>	48-68	8.5	0.18	0.73	9.5	51.89	10.8	32.8	15.6	0.65	0.83	47.53	91.5
Bss <sub>1</sub>	68-102	8.5	0.22	0.36	10	51.35	11.2	31.8	13	0.53	0.78	46.4	90.03
Bss <sub>2</sub>	102-132	8,6	0.17	0.32	10.25	50.13	10.25	28.2	12.5	0.41	0.67	42.8	85.3
Bss <sub>3</sub>	132-150	8.7	0.15	0.28	11.75	31.23	12.5	15.6	8.8	0.39	0.57	25.74	82.4
<b>Pedon 4 Borgavarj ,tq. Phulambri, District, Aurangabad (<i>Calcic Haplusterts</i>) Maize cropping pattern</b>													
Ap	0-18	8.1	0.15	0.66	8.5	59.07	9.6	32.8	20.8	0.73	1.13	55.46	93.08
Bw <sub>1</sub>	18-40	8.3	0.15	0.63	11.5	57.23	12.9	31.2	19.2	0.70	1.09	52.19	91.1
Bw <sub>2</sub>	40-50	8.4	0.17	0.60	12.25	56.56	12.8	29.6	19.8	0.65	0.98	51.03	90.2

Continue....

Horizon	Depth (cm)	pH	EC (dSm <sup>-1</sup> )	O.C (%)	CaCO <sub>3</sub> (%)	CEC [cmol (p <sup>+</sup> ) Kg <sup>-1</sup> ]	Calcium carbonate equivalent (%)	Cation [cmol (p <sup>+</sup> ) Kg <sup>-1</sup> ]				Sum of cation	BS (%)
								Ca <sup>++</sup>	Mg <sup>++</sup>	Na <sup>++</sup>	K <sup>+</sup>		
BSS <sub>1</sub>	50-75	8.4	0.14	0.52	13.25	48.12	13.8	25	16.1	0.53	0.92	42.85	89.0
BSS <sub>2</sub>	75-94	8.4	0.15	0.51	14.5	38.45	15.1	21.6	11.1	0.41	0.91	34.02	88.4
BSS <sub>3</sub>	94+	8.5	0.16	0.19	17	36.98	18.9	20	9.6	0.39	0.88	30.87	83.4
<b>Pedon 5 Murshidabadwadi, tq. Phulumbri, district Aurangabad (<i>Typic Haplustepts</i>) maize cropping pattern</b>													
Ap	0-26	8.5	0.17	0.645	14.9	60.96	16.1	32.8	23.6	0.71	0.98	58.09	95.2
Bw <sub>1</sub>	26-50	8.3	0.14	0.34	13.25	50.12	14.3	30.72	14.4	0.70	0.98	46.37	92.5
Bw <sub>2</sub>	50-91	8.2	0.16	0.135	13.25	44.15	13.8	28.1	10.4	0.64	0.87	40.02	90.6
Cr	91-150	8.2	0.15	0.10	10.25	35.56	11.9	23.1	6.2	0.61	0.83	30.63	85.3
<b>Pedon 6, Devgaon, tq. Phythan , district Aurangabad (<i>Calcic Haplustepts</i>) Cotton cropping pattern</b>													
Ap	0-15	8.2	0.15	0.635	13.25	50.68	14.1	32	12.2	1.15	0.84	46.19	91.1
Bw <sub>1</sub>	15-30	8.2	0.22	0.34	13.75	46.56	14.3	26.4	14	1.13	0.73	42.26	90.76
Cr	30-60	8.4	0.24	0.135	15.75	39.68	16.1	21.5	11	1.09	0.64	34.08	85.8
<b>Pedon 7, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplusterts</i>) cotton cropping pattern</b>													
Ap	0-21	8.2	0.20	0.795	9.75	60.85	9.9	34.8	22	0.93	0.99	58.72	96.4
Bw <sub>1</sub>	21-42	8.4	0.24	0.295	11.5	57.78	12.7	32.83	20.1	0.88	0.92	54.7	94.6
Bw <sub>2</sub>	42-71	8.7	0.25	0.265	16.25	53.56	17.8	31.2	16	0.83	0.90	48.93	91.3
Cr <sub>1</sub>	71-82	8.7	0.27	0.235	17.25	45.13	18.9	28	11	0.75	0.84	40.59	89.9
Cr <sub>2</sub>	82-100	8.8	0.37	0.16	18.75	39.45	19.9	26.4	9	0.63	0.72	34.48	87.4
<b>Pedon 8, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>													
Ap	0-23	7.9	0.17	0.72	6.25	55.68	7.8	31	19	1.17	0.90	52.07	93.5
Bw <sub>1</sub>	23-42	8.1	0.22	0.49	11	54.23	12.9	30.4	14	1.07	0.80	50.19	92.5
Cr	42-130	8.2	0.22	0.39	17.25	42.56	18.9	26	6.8	0.96	0.70	36.59	85.9

#### **4.1.3.7 Exchangeable bases**

The exchangeable bases deals with cation exchange capacity, base saturation of the soil. The extent to which the adsorption complex of a soil is saturated with bases (Ca, Mg, Na and K) is frequently used as an indicator of soil fertility and in soil classification (FAO-UNESCO,1970). The exchange complex of the soil in the present study was observed to be dominated by calcium followed by magnesium, sodium and then potassium in general, these soils were found high exchangeable bases.

#### **4.1.3.8 Base saturation percentage**

The high base saturation in black soils is attributed to its smectite clay mineral (Pal and Deshpande, 1987). In general, it was also observed that base saturation percentage increase with increasing soil pH (Tan, 1989) exchangeable calcium followed by magnesium is main source of the base saturation. The base saturation of different soils of Aurangabad viz. P<sub>1</sub> (*Lithic Ustorthents*) varies from 80.00 to 88.8 per cent. P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was contains 82.5 to 96.4 per cent, P<sub>3</sub> (*Typic Haplusterts*) was varies 82.4 to 94.14 per cent, P<sub>5</sub> (*Typic Haplustepts*) was base saturation per centage range from 85.3 to 95.2 per cent and P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) was base saturation per centage range from 85.8 to 93.5 per cent. High base saturation of soil under study may be due to basaltic parent material which is basic in nature. The high base saturation in black soils is attributed to its smectite clay mineral (Pal and Deshpande, 1987). In general, it is also observed that base saturation percentage increase with increasing soil pH (Tan, 1989) exchangeable calcium followed by magnesium is main source of the base saturation.

## **4.2 Soil classification**

Based on field morphology and Laboratory characterization the soils on different cropping pattern of soil profiles Aurangabad have been classified according to U.S comprehensive system of soil classification (Soil Survey Staff (2015)). The dominant soil of the study area belonging to three orders (Table No. 4.5) viz., Entisols, Inceptisols and Vertisols.

#### **4.2.1 Entisols**

The soil developed on moderately sloping nearly level plain at elevated area of the Aurangabad district Pedon P<sub>1</sub> were lack of diagnostic subsurface horizons. they qualify for the order Entisols and due to presence of ustic moisture regime, the soil was grouped into Ustorthents. Further in view of Lithic contact with in 50 cm of the subsurface this soil belongs to the sub group level, as Ustorthents.

#### **4.2.2 Inceptisols**

The pedon P<sub>5</sub>, P<sub>6</sub> and P<sub>8</sub> were possessed ochric epipedons followed by cambic subsurface diagnostic horizons and hence grouped under Inceptisols. Due to Ustic moisture regime these Pedon were qualify for Ustepts suborder. These pedons do not have duripan horizon and hence are classified under Haplustepts greate group. At subgroup level this soil classified as Typic Haplustepts and the calcium carbonate content >15 per cent within 100 cm soil depth qualified as Calcic Haplustepts.

#### **4.2.3 Vertisols**

The Pedon P<sub>2</sub>, P<sub>3</sub>, P<sub>4</sub> and P<sub>7</sub> soil have well developed diagnostic subsurface horizon were deep to very deep, black colored, clayey (>30 percent) and characterized by deep and wide cracks, well developed slickenside and pressure faces. Thus, these soils were classified under the order Vertisol and the subgroup level Typic Haplusterts. The calcium carbonate content >15 per cent within 100 cm soil depth qualified as Calcic Haplusterts.

#### **4.3.1 Available macronutrients and secondary nutrients**

The available macronutrients Table No. 4.6 were the main constituents of organic carbon. These were needed in huge quantity for crop vegetative growth and quality parameters. Secondary nutrients were required in moderate quantity and secondary development of crop. The data presented table in table 4.6 indicated that the availability of nutrient decreased with depth.

**Table 4.5 Soil classification of studied different cropping patten and soil profiles of Aurangabad district of Maharashtra**

<b>Sr. No</b>	<b>Profile &amp; cropping pattern</b>	<b>Order</b>	<b>Suborder</b>	<b>Great group</b>	<b>Sub group</b>	<b>Family</b>
P <sub>1</sub>	Shekta, pigeon pea cropping pattern	Entisols	Orthents	Ustorthents	Lithic Ustorthents	Loam, Montmorilonitic, Hyperthermic
P <sub>2</sub>	Gopal wadi, maize cropping pattern	Vertisols	Usterts	Haplusterts	Typic Haplusterts	Clayey, Montmorilnitic, Hyperthermic
P <sub>3</sub>	Shankarpur, sorghum cropping pattern	Vertisols	Usterts	Haplusterts	Typic Haplusterts	Clayey, Montmorilnitic, Hyperthermic
P <sub>4</sub>	Borgavarj. maize cropping pattern	Vertisols	Usterts	Haplusterts	Typic Haplusterts	Clayey, Montmorilonitic, Hyperthermic
P <sub>5</sub>	Murshidabad, maize cropping pattern	Inceptisols	Ustepts	Haplustepts	Typic Haplustepts	Silty Clay, Montmorilnitic, Hyperthremic
P <sub>6</sub>	Devgaon, cotton cropping pattern	Inceptisols	Ustepts	Haplustepts	Calcic Haplustepts	Loam, Montmorilonitic, Hyperthermic
P <sub>7</sub>	Hassanabadwadi, cotton cropping pattern	Vertisols	Usterts	Haplusterts	Typic Haplusterts	Clayey, Montmorilnitic, Hyperthermic
P <sub>8</sub>	Hassanabadwadi, cotton cropping pattern	Inceptisols	Ustepts	Haplustepts	Calcic Haplustepts	Silty Clay, Montmorilonitic, Hyperthremic

#### 4.3.1.1 Available Nitrogen

The nitrogen is primary nutrient. its available both organic, inorganic form. Nitrogen very highly required for the vegetative growth of the crops, development of protein in plant bodies. The available nitrogen Lithic Ustorthents P<sub>1</sub> varies from 169 to 224 kg ha<sup>-1</sup>, Pedon P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> Calcic Haplusterts was varied from 260 to 297.8 kg ha<sup>-1</sup>. P<sub>3</sub> (*Typic Haplusterts*) was varies 188.6 to 246.00 kg ha<sup>-1</sup>) P<sub>5</sub> (*Typic Haplustepts*) was 169 to 272 kg ha<sup>-1</sup> and P<sub>6</sub> and P<sub>8</sub> (*Calcic Haplusterts*) was found 191 to 275 kg ha<sup>-1</sup>. The lowest nitrogen content in Lithic Ustorthents may be due to continuous cultivation, tillage operation, high temperature cause soil nitrogen volatilization and high erosion occurred in very shallow soil as compare to deep soil. At the same time sandy soil high leaching occur in the soil. The legume crop rotation causes high mineralization loose done by microbes. Soil nitrogen content good in native uncultivated soils as compared to the cultivated soil due to low disturbances of soil. (Lal, 2004).

#### 4.3.1.2 Available phosphorus

The phosphorus is a plant energy exchange in the plant body and useful for root growth and maturity crop. The data presented in Table 4.6 indicated that the available phosphorus content in different soils of Aurangabad district. P<sub>1</sub> (*lithic Ustorthents*) varies from 5.82 to 7.82 kg ha<sup>-1</sup>, pedon P<sub>2</sub>, P<sub>4</sub>, and P<sub>7</sub> (*Calcic Haplusterts*) was contains 2.13 to 9.5 kg ha<sup>-1</sup>, P<sub>3</sub> (*Typic Haplusterts*) was varies 4.92 to 11.4 kg ha<sup>-1</sup>. P<sub>5</sub> (*Typic Haplustepts*) was contains 2.38 to 2.84 kg ha<sup>-1</sup> and P<sub>6</sub> P<sub>8</sub> (*Calcic Haplusterts*) contains 2.475 to 6.21 kg ha<sup>-1</sup>. The surface soils were found to contain more phosphorus than sub surface soil. The presence of phosphorus in murrum layers of all soil profiles may be attributed to leaching of top soil to the subsurface. (Vaidya *et al.*, 2014).

#### 4.3.1.3 Available potassium

The potassium is one of the important quality parameter nutrients to the plants. It imparts the disease resistance to crops and lodging resistance. It can be improving the seed development, water absorbed capacity of the plants. it can be directly involved in starch synthesis reaction, co-factor for > 60 enzyme reaction in the plant. The data in shown table P<sub>1</sub> (*Lithic Ustorthents*) varies from 320 to 385.28

kg ha<sup>-1</sup>, P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub>, (*Calcic Haplusterts*) was contains 280.72 to 495 kg ha<sup>-1</sup>. P<sub>3</sub> (*Typic Haplusterts*) was varies from 250 to 432.32 kgha<sup>-1</sup>, P<sub>5</sub> (*Typic Haplustepts*) was contains 315 to 430.8 kgha<sup>-1</sup>, P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains 282.24 to 396.24 kg ha<sup>-1</sup>. Which was not very with soil type and cropping pattern.

#### **4.3.1.4 Available Sulphur**

The secondary nutrient Sulphur is the compound of organic matter, Sulphur is component of nucleic acids. Its quality parameter for oil development in the oil seed crops. it imparts the cold hard ness in the soil. Sulfur used for to reduce alkalinity of the soil. P<sub>1</sub> (*lithic Ustorthents*) varies from 2.01to 3.048 kgha<sup>-1</sup>, P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was contains 0.495 to 6.6 kgha<sup>-1</sup>, P<sub>3</sub> (*Typic Haplusterts*) was varies 0.55 to 2.73 kgha<sup>-1</sup>, P<sub>5</sub> (*Typic Haplustepts*) was contains 1.5 to 3.15 kgha<sup>-1</sup>, P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains 1.24 to 4.39 kgha<sup>-1</sup>. Which was not found vary with soil type and cropping pattern.

#### **4.3.2 Available micronutrients status of the different cropping pattern and soil profiles under Aurangabad district of Maharashtra**

The micro nutrients Table No. 4.7 were the trace element these are essential for plant but required small amount. Micronutrients are constituting of enzymes and co-enzymes. The main source of micronutrients was parent material. The data indicated that the availability of the micronutrient does not vary with soil type and cropping pattern and it was decreased with depth.

##### **4.3.2.1 Zinc**

Zinc is a constituent of Alcoholic dehydrogenase, carbonic anhydrase, super oxide dismutase it develops the reproductive life of plants. it was key role play IAA, GA, RNA, synthesis. P<sub>1</sub> (*lithic Ustorthents*) varies from 0.208 to 0.523 ppm, P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was contains 0.997 to 2.8 ppm, P<sub>3</sub> (*Typic Haplusterts*) was varies 0.209 to 0.507ppm, P<sub>5</sub> (*Typic Haplustepts*) was contains 0.368 to 0.821ppm and P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains around 0.401 to 0.714 ppm. The zinc content in soil were found low to medium.

**Table.4.6 Available macronutrient and secondary nutrient status of the different cropping pattern and soil profiles under Aurangabad district of Maharashtra**

Horizon	Depth (cm)	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	K <sub>2</sub> O (kg ha <sup>-1</sup> )	Sulphur (kg ha <sup>-1</sup> )
<b>Pedon1 Shekta, tq. Gangapur, district Aurangabad (<i>Lithic Ustorthents</i>) pigeon pea cropping pattern</b>					
Ap	0-28	244	7.82	385.28	3.048
Ac	28-50	194.4	6.26	344.96	2.73
Cr	50-60	169	5.28	320.32	2.01
<b>Pedon 2 Gopalwadi, tq Gangapur, district Aurangabad (<i>Calcic Haplusterts</i>) maize cropping pattern</b>					
Ap	0-22	260.2	5.86	405.4	3.18
Bw <sub>1</sub>	22-40	222.6	5.541	400.96	1.902
Bw <sub>2</sub>	40-64	219.52	5.27	365.12	1.32
Bss <sub>1</sub>	64-72	200.7	4.92	338.24	0.88
Bss <sub>2</sub>	72-100	192.7	3.76	318.08	0.759
Bss <sub>3</sub>	100+	188.16	3.33	286.72	0.606
<b>Pedon 3 Shankarpur, tq. Gangapur, district, Aurangabad (<i>Typic Haplusterts</i>) sorghum cropping pattern</b>					
AP	0-23	272.83	11.4	432.32	2.73
Bw <sub>1</sub>	23-48	235.2	9.29	405.44	2.42
Bw <sub>2</sub>	48-68	228.9	7.54	387.52	1.46
Bss <sub>1</sub>	68-102	206.1	7.35	340.48	1.03
Bss <sub>2</sub>	102-132	192.7	5.27	293.44	0.71
Bss <sub>3</sub>	132-150	188.16	4.92	250.88	0.551
<b>Pedon 4 Borgav arj, tq. Phulambri, District, Aurangabad (<i>Calcic Haplusterts</i>) maize cropping pattern</b>					
Ap	0-18	291.64	9.5	495.04	2.04
Bw <sub>1</sub>	18-40	285.3	7.7	477.12	1.84
Bw <sub>2</sub>	40-56	263.4	5.7	430.08	1.2
Bss <sub>1</sub>	56-75	219.5	4.4	405.44	1
Bss <sub>2</sub>	75-94	194.4	2.3	398.72	0.80
Cr	94+	156.8	2.13	387.52	0.495

Continue....

Horizon	Depth (cm)	N (Kg ha <sup>-1</sup> )	P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> )	K <sub>2</sub> O (kg ha <sup>-1</sup> )	Sulphur (kg ha <sup>-1</sup> )
<b>Pedon 5 Murshidabadwadi, tq. Phulmbri, district Aurangabad (<i>Typic Haplustepts</i>) maize cropping pattern</b>					
Ap	0-26	272	2.84	430.8	3.15
Bw <sub>1</sub>	26-50	219	2.82	383.04	2.84
Bw <sub>2</sub>	50-91	203	2.44	365.12	2.62
Cr	91-150	169	2.38	315.84	1.518
<b>Pedon 6, Devgaon, tq. Phythan, district Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>					
Ap	0-15	250	6.79	367.36	4.39
Bw <sub>1</sub>	15-30	232	5.84	320.32	3.7
Cr	30-60	191	3.23	282.24	2.2
<b>Pedon 7, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplusterts</i>) cotton cropping pattern</b>					
Ap	0-21	297.9	6.52	434.56	6.6
Bw <sub>1</sub>	21-42	269.6	5.22	405.44	5.72
Bw <sub>2</sub>	42-77	250.8	4.3	394.24	1.85
Cr <sub>1</sub>	77-83	222.65	3.08	367.36	1.35
Cr <sub>2</sub>	83-100	200.7	2.88	318	1.21
<b>Pedon 8, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>					
Ap	0-23	275.9	6.2	396.24	3.01
Bw <sub>1</sub>	23-42	235.2	4.87	351.68	2.4
Cr	42-130	191.2	2.75	295.68	1.24

#### 4.3.2.2 Iron

Iron comprises about 5 per cent of the earth crust and is the fourth most abundant element. Most of hematite, goethite's are majors' source of iron. The red color of red soil due granite parent material and ferrous cankers. P<sub>1</sub> (*lithic Ustorthents*) varies from 1.6 to 2.6 ppm, P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was contains 1.7 to 4.08 ppm, P<sub>3</sub> (*Typic Haplusterts*) was varies 2.1 to 3.31 ppm, P<sub>5</sub> (*Typic Haplustepts*) was contains 0.801 to 0.821 ppm and P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains around 2.14 to 3.4 ppm. The iron low to medium content in the soil due to the high calcium carbonate causes lime induced chlorosis fixation, and the soil reaction also one of the factors for decreasing level of in iron in the soil.

#### 4.3.2.3 Copper

Copper concentration in earth crust 55 to 70 ppm. Copper imparting disease resistance, always reduce fungal propagation. P<sub>1</sub> (*lithic Ustorthents*) varies from 0.30 to 0.79 ppm, P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was contains 0.801 to 1.27 ppm, P<sub>3</sub> (*Typic Haplusterts*) was varies from 1.37 to 2.04 ppm, P<sub>5</sub> (*Typic Haplustepts*) was contains (0.801 to 1.33 ppm) and P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains around 2.61 to 6.52 ppm. The low to medium Cu content in *Lithic Ustorthent*, whereas all other content medium to high amount of Cu and found closely associated with clay content.

#### 4.3.2.4 Manganese

Manganese concentration in the earth crust averages 100 ppm. major source for Mn was pyrolusite (MnO<sub>2</sub>), manganite (MnO (OH), and hausmannite (Mn<sub>3</sub>O<sub>4</sub>). Manganese is very important biological nitrogen fixation, photosynthesis, detoxication of free radicles. P<sub>1</sub> (*lithic Ustorthents*) varies from 2.17 to 5 ppm, P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was contains 1.15 to 8.76 ppm, P<sub>3</sub> (*Typic Haplusterts*) was varies from 2.47 to 3.98 ppm, P<sub>5</sub> (*Typic Haplustepts*) was contains (2.6 to 3.24 ppm) and P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains 2.6 to to6.5 ppm. The most of the Pedon content high amount of Mn and which was decreased with depth.

#### 4.3.2.5 Boron

Boron was nonmetal trace element. It was very important for drought tolerance and pollen germination in the plants. The concentration of boron Indian

**Table: 4.7 Micronutrient status of the different cropping pattern and soil profiles of Aurangabad district of Maharashtra**

HORIZON	Depth (cm)	Zn (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)	B(ppm)
<b>Pedon1 Shekta,tq. Gangapur, district Aurangabad (<i>Lithic Ustorthents</i>) Pigeon pea cropping pattern</b>						
Ap	0-28	0.523	2.6	0.79	5	1.03
Ac	28-50	0.321	1.8	0.30	2.3	0.81
Cr	50-60	0.208	1.6	0.30	2.17	0.5
<b>Pedon 2 Gopalwadi, tq Gangapur, district Aurangabad (<i>Calcic Haplusterts</i>) Maize cropping pattern</b>						
Ap	0-22	0.628	3.5	1.35	3.98	2.7
Bw <sub>1</sub>	22-40	0.421	2.8	1.65	3.98	2.3
Bw <sub>2</sub>	40-64	0.321	2.7	1.58	3.12	2.1
Bss <sub>1</sub>	64-72	0.218	2.1	1.18	3.00	2.1
Bss <sub>2</sub>	72-100	0.202	2.1	1.16	2.8	1.98
Bss <sub>3</sub>	100+	0.173	1.7	1.15	2.4	1.7
<b>Pedon 3 Shankarpur, tq. Gangapur, district, Aurangabad (<i>Typic Haplusterts</i>) sorghum cropping pattern</b>						
AP	0-23	0.507	3.31	2.047	3.676	2.4
Bw <sub>1</sub>	23-48	0.434	3.47	2.048	3.29	2.01
Bw <sub>2</sub>	48-68	0.401	3.2	1.97	2.95	1.93
Bss <sub>1</sub>	68-102	0.373	3.0	1.90	2.91	1.74
Bss <sub>2</sub>	102-132	0.273	2.7	1.65	2.72	1.61
Bss <sub>3</sub>	132-150	0.209	2.1	1.37	2.47	1.52
<b>Pedon 4 Borgavarj, tq. Phulambri, District, Aurangabad (<i>Calcic Haplusterts</i>) maize cropping pattern</b>						
Ap	0-18	0.681	4.08	1.56	5.21	2.0
Bw <sub>1</sub>	18-40	0.442	3.78	1.562	3.58	1,8
Bw <sub>2</sub>	40-56	0.378	3.44	1.553	3.63	1.67
Bss <sub>1</sub>	56-75	0.351	3.15	1.531	3.30	1.53
Bss <sub>2</sub>	75-94	0.298	2.45	1.514	2.89	1.42
Cr	94+	0.198	2.14	0.918	2.745	1.2

Continue....

HORIZON	Depth (cm)	Zn (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)	B(ppm)
<b>Pedon 5 Murshidabadwadi, tq. Phulmbri, district Aurangabad ((<i>Typic Haplustepts</i>) maize cropping pattern</b>						
Ap	0-26	0.821	3.1	1.33	3.24	2.5
Bw <sub>1</sub>	26-50	0.631	2.08	1.12	2.8	2.1
Bw <sub>2</sub>	50-91	0.473	2.02	0.902	2.7	1.71
Cr	91-150	0.368	2.14	0.801	2.614	1.07
<b>Pedon 6, Devgaon, tq. Paithan, district Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>						
Ap	0-15	0.714	2.93	1.274	5.87	2.1
Bw <sub>1</sub>	15-30	0.512	2.21	1.16	4.85	1.6
Cr	30-60	0.408	2.14	0.801	2.61	1.0
<b>Pedon 7, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplusterts</i>) cotton cropping pattern</b>						
Ap	0-21	0.537	3.5	2.8	8.76	2.4
Bw <sub>1</sub>	21-42	0.481	2.8	2.4	6.06	2.3
Bw <sub>2</sub>	42-77	0.464	2.6	2.2	3.36	2.1
Cr <sub>1</sub>	77-83	0.421	2.4	1.4	2.47	1.8
Cr <sub>2</sub>	83-100	0.371	2.16	0.997	2.35	1.4
<b>Pedon 8, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>						
Ap	0-23	0.564	3.4	2.21	6.52	1.98
Bw <sub>1</sub>	23-42	0.438	2.8	2.5	5.91	1.75
Cr	42-130	0.401	2.2	1.5	4.53	1.42

soils vary from 7 to 630 ppm. In Aurangabad district P<sub>1</sub> (*Lithic Ustorthents*) varies from 0.5 to 1.03 ppm. P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) was contains 1.5 to 2.7 ppm, P<sub>3</sub> (*Typic Haplusterts*) was varies from 1.52 to 2.4 ppm, P<sub>5</sub> (*Typic Haplustepts*) was contains 1.07 to 2.5 ppm and P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains 1.0 to 2.1 ppm

#### 4.4 Total carbon content soil (TOC)

The total carbon content (Table No. 4.8) in the different cropping pattern and soil profile varies p<sub>1</sub> (*Lithic Ustorthents*) pattern contains 0.96 to 1.26 Pg, C, P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) contains 0.21 to 1. 6 Pg.C, P<sub>3</sub> (*Typic Haplusterts*) contains 0.84 to 1.21 Pg.C, P<sub>5</sub> (*Typic Haplustepts*) contained 0.54 to 0.86 Pg.C.and P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains 0.13 to 0.960 Pg.C

The total organic carbon P<sub>1</sub> (*Lithic Ustorthents*) (0.96-1.26 Pg. C), has highest total carbon as compared to the other pedons because the cropping pattern in the pigeonpea it gives high leaf litter around the year, it fix the atmospheric nitrogen it enhance the microbial population increased and increased the decomposition rate of soil organic matter. P<sub>3</sub>, (*Typic Haplusterts*) contains (0.37 to 1.22 Pg.C) second highest carbon stock compares to the other soil pedons, it under sorghum. These soil years around maintaining plant litter (Dharmendra, 2016). Pedon P<sub>6</sub>, P<sub>7</sub> and P<sub>8</sub> (*Calcic Haplusterts* and *Haplustepts*) which having total carbon content varies from 0.21 to 1.06 pg. C it under cotton it having third largest total carbon content. P<sub>2</sub>, P<sub>4</sub> and P<sub>5</sub> (*Calcic Haplusterts*, *Typic Haplustepts*) contained (0.13 to 1.05 Pg.C) under maize cropping pattern maintaining very low carbon stock compare to other pedons, because the crop is more exhaustive in nature, it absorbs lot of nutrients from the soil, but it maintains low soil litter content. Pedon P<sub>6</sub>, P<sub>7</sub> and P<sub>8</sub> (*Calcic Haplusterts* and *Haplustepts*) which having total carbon content varies from 0.21 to 1.06 Pg. C. Above the data describes that, the total carbon content highest in red gram, followed by sorghum, cotton, maize. Similar result supported by Wagh, 2018 and Thonde , 2019.

**Table 4.8 Total organic carbon under different cropping pattern and soil profiles of Aurangabad district**

<b>Horizon</b>	<b>soil depth (cm)</b>	<b>Soil organic carbon (%)</b>	<b>Total organic carbon (TOC) Pg. C(1.334×oxidizable carbon)</b>
<b>Pedon1 Shekta, tq. Gangapur, district Aurangabad (<i>Lithic Ustorthents</i>) Pigeon pea</b>			
Ap	0-28	0.945	1.26
Ac	28-50	0.78	1.04
Cr	50-60	0.73	0.973
<b>Pedon 2 Gopalwadi, tq Gangapur, district Aurangabad (<i>Calcic Haplusterts</i>) Maize</b>			
Ap	0-22	0.79	1.05
Bw <sub>1</sub>	22-40	0.55	0.73
Bw <sub>2</sub>	40-64	0.43	0.57
Bss <sub>1</sub>	64-72	0.44	0.58
Bss <sub>2</sub>	72-100	0.38	0.50
Bss <sub>3</sub>	100-120	0.24	0.32
<b>Pedon 3 Shankarpur, tq. Gangapur, district, Aurangabad (<i>Typic Haplusterts</i>) sorghum</b>			
AP	0-23	0.915	1.22
Bw <sub>1</sub>	23-48	0.718	0.95
Bw <sub>2</sub>	48-68	0.63	0.84
Bss <sub>1</sub>	68-102	0.36	0.45
Bss <sub>2</sub>	102-132	0.32	0.42
Bss <sub>3</sub>	132-150	0.28	0.37
<b>Pedon 4 Borgav arj, tq. Phulambri, District, Aurangabad (<i>Calcic Haplusterts</i>) Maize</b>			
Ap	0-18	0.66	0.88
Bw <sub>1</sub>	18-40	0.63	0.84
Bw <sub>2</sub>	40-56	0.60	0.80
Bss <sub>1</sub>	56-75	0.52	0.69
Bss <sub>2</sub>	75-94	0.51	0.68
Cr	94-140	0.19	0.25

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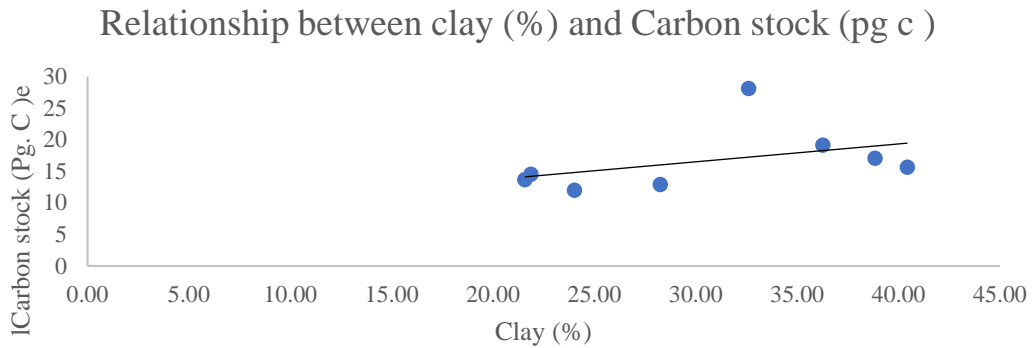
Horizon	soil depth (cm)	Soil organic carbon (%)	Total organic carbon (TOC) pg. (1.334×oxidizable carbon)
<b>Pedon 5 Murshidabadwadi, tq. Phulmbri, district Aurangabad ((<i>Typic Haplustepts</i>) Maize</b>			
Ap	0-26	0.645	0.86
Bw <sub>1</sub>	26-50	0.34	0.45
Bw <sub>2</sub>	50-91	0.135	0.18
Cr	91-150	0.10	0.13
<b>Pedon 6, Devgaon, tq. Phythan, district Aurangabad (<i>Calcic Haplustepts</i>) Cotton</b>			
Ap	0-15	0.635	0.84
Bw <sub>1</sub>	15-30	0.34	0.45
Cr	30-60	0.135	0.18
<b>Pedon 7, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplusterts</i>) Cotton</b>			
Ap	0-21	0.795	1.06
Bw <sub>1</sub>	21-42	0.295	0.39
Bw <sub>2</sub>	42-77	0.265	0.35
Cr <sub>1</sub>	77-83	0.235	0.31
Cr <sub>2</sub>	83-100	0.16	0.213
<b>Pedon 8, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplustepts</i>) Cotton</b>			
Ap	0-23	0.720	0.960
Bw <sub>1</sub>	23-42	0.495	0.660
Cr	42-62	0.391	0.521

#### 4.4.1 Soil organic carbon stock

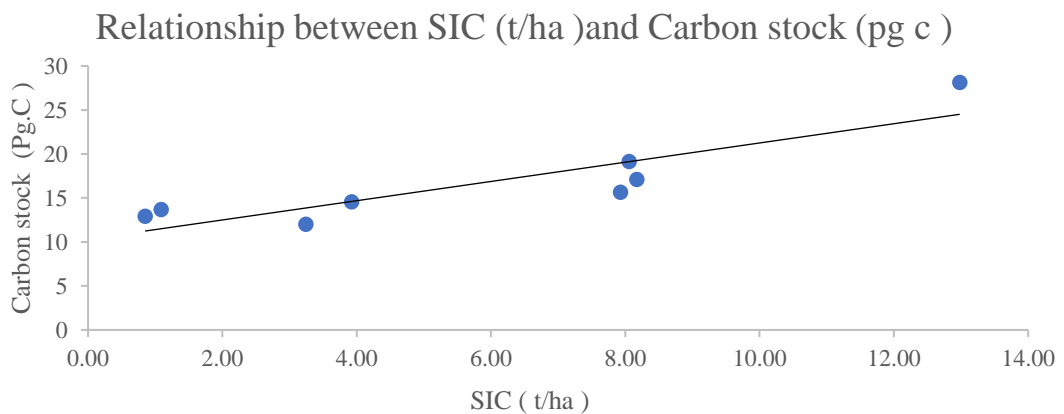
The soil organic stock was estimated by mass, volume and density relationship (Batjes, 1996) and Datta method (2015). The soils under different cropping pattern and soil profiles of Aurangabad were mostly developed from basaltic parent material, few are originated sand stone with deep medium deep, very shallow fine textured soils and few were coarse sandy soils. Soil carbon stocks (Table 4.9) under different cropping pattern and profiles viz. P<sub>1</sub> (*Lithic Ustorthents*) contains 1.16 to 3.81 t ha<sup>-1</sup>. P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) contains 0.48 to 2.25 t ha<sup>-1</sup>. P<sub>3</sub> (*Typic Haplusterts*) contains 0.78 to 2.5 Pg.c. P<sub>5</sub> (*Typic Haplustepts*) contained 4.66 to 10.57 t ha<sup>-1</sup>. Whereas Pedon P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains around 1.26 to 2.31 t ha<sup>-1</sup>. This indicated that the maximum SOC at Lithic Ustorthent (Entisol) soil this may be due to low clay content as compare to organic residue. The soil organic carbon stock under sorghum cropping pattern shows P<sub>1</sub>, were showed 1.16 to 3.81 t ha<sup>-1</sup>, which was decreased with depth SOCS at 15, 100cm found 2.04 and 13.6 t ha<sup>-1</sup> respectively. among all cropping pattern pigeon pea having maximum SOC this may be due to addition of high amount of organic carbon and fixation of nitrogen. The maize cropping pattern P<sub>3</sub> showed the 0.78 to 2.5 t ha<sup>-1</sup> and decreased with depth, SOCS at 15, 100cm found 1.06 and 10.98 t ha<sup>-1</sup> respectively. Maize cropping pattern showed second high carbon stock due to cover crop practices. The cropping pattern under maize P<sub>2</sub>, P<sub>4</sub>, P<sub>6</sub> showed carbon stock 0.78 to 2.5 t ha<sup>-1</sup>. SOCS at 15, 100 cm varies from 1.18 to 1.54 and 7.92 to 10.27 t ha<sup>-1</sup> respectively. The cropping pattern cotton showed 0.45 to 2.18 t ha<sup>-1</sup> and found increased with depth. SOCS at 15, 100 cm varies from 1.46 to 1.56 and 9.77 to 10.41 t ha<sup>-1</sup> respectively. From above result indicated that the maximum SOCS was noticed at pigeon pea followed by sorghum, cotton and maize.

#### 4.4.3 Soil inorganic carbon stock (SIC)

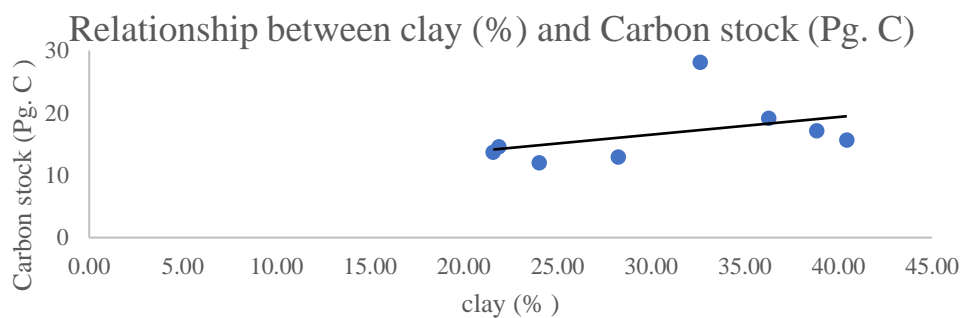
Soil inorganic carbon (SIC) in the soil in the form of precipitation of calcium carbonate which responsible for increasing SIC in soil. The soil inorganic carbon (SIC), the calculation was made using 12 per cent C value in CaCO<sub>3</sub> (Bhattacharya *et al.*, 2009). The primary source of inorganic carbon in soil is carbonate of calcium and magnesium. Soil inorganic carbon could pedogenic in the nature of their origin (Fig. 4.4).



**Fig.4.7** Represent the relationship between CLAY (%) and carbon stock (Pg.C) under different cropping pattern of Aurangabad



**Fig.4.8** Represent the relationship between SIC (t/ha) and carbon stock (Pg.C) under different cropping pattern of Aurangabad



**Fig.4.9** Represent the relationship between Clay (%) and carbon stock (Pg.C) under different cropping pattern of Aurangabad

Formation of pedogenic carbonate through dissolved CO<sub>2</sub> (carbonic acid) in presence at Ca<sup>++</sup> and Mg<sup>++</sup> ions are common in semi-arid and arid climate. however, pedogenic carbonate formation may also take place in sub humid climate depending on soil pH. The formation of pedogenic carbonate in the soils under study is pronounced as evidenced by considerable presence of SIC in the formation of CaCO<sub>3</sub> (Vaidya and Pal, 2002).

The soil inorganic carbon stock (Table 4.10) under different cropping and soil profiles of Aurangabad viz. p<sub>1</sub>(*Lithic Ustorthents*) contains (5.53 to 10.8 t ha<sup>-1</sup>). P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) contains (3.6 to 47.4 t ha<sup>-1</sup>). P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains around (5.02 to 21.7 t ha<sup>-1</sup>). The maximum SICS was noticed at Calcic Haplusterts as compare to other soil. This may be due to precipitation of calcium carbonate under semiarid environment Vaidya and Pal 2002 and Zade, 2007.

The soil inorganic carbon stock cropping Aurangabad district were cotton cropping pattern showed P<sub>6</sub>, P<sub>7</sub>, P<sub>8</sub> varies between 5.02 to 21.7 t ha<sup>-1</sup> and which was found increased with depth, SICS at 15, 100 cm varies from 0.98 to 1.29 and 13.6 to 49.9 t ha<sup>-1</sup> respectively. The maize cropping pattern showed P<sub>3</sub> varies from soil inorganic carbon stock 5.46 to 12.8 t ha<sup>-1</sup>, SICS at 15, 100 cm has 0.98 and 12.41 t ha<sup>-1</sup> respectively. The maize cropping pattern showed soil inorganic carbon 4.07 to 47.4 t ha<sup>-1</sup>. SICS at 15, 100 cm varies from 0.79 to 2.01 and 10.28 to 16.36 t ha<sup>-1</sup> respectively. Under sorghum pattern shows soil inorganic carbon 5.46 to 12.8 t ha<sup>-1</sup> SICS at 15, 100 cm has 0.98 and 12.41 t ha<sup>-1</sup> respectively. (Fig. 4.8). The data indicated that the maximum SICS was noticed in cotton and maize as compare to pigeon pea this may be due to reduce the formation of pedogenic calcium carbonate under semiarid climate due to addition plant residue and it support to control the aired environment is soil (Balpande *et al.*, 1997 and Vaidya and Pal, 2002). (Fig.4.11) P<sub>3</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) contains (4.58 to 47.4 t ha) the soils exhibits high soil inorganic carbon due to high soil depth and lower availability of water causes the accumulation of calcium carbonate increases gradually and it is directly proportional to soil inorganic carbon (Bhattacharya *et al.*, 2004).

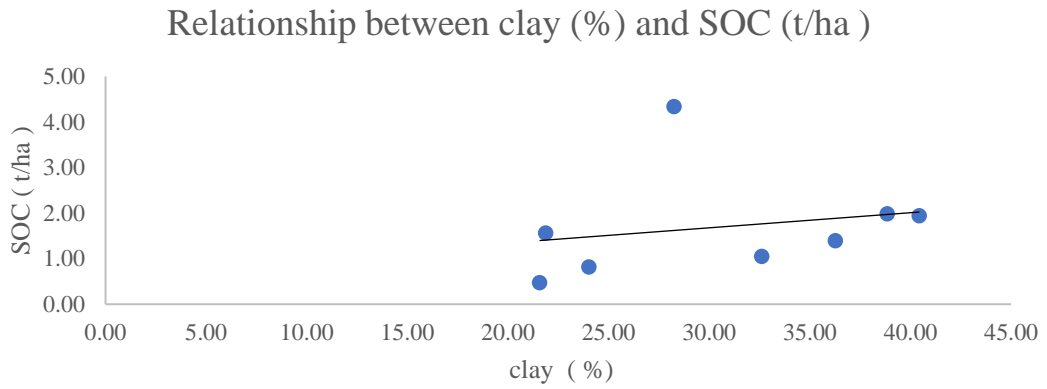
#### 4.4.4 Total soil carbon stock

Total soil carbon stock referred as a sum of SOC stock and SIC stock gave the total carbon (TC) stock in soil (Bhattacharya *et al.*, 2008.)

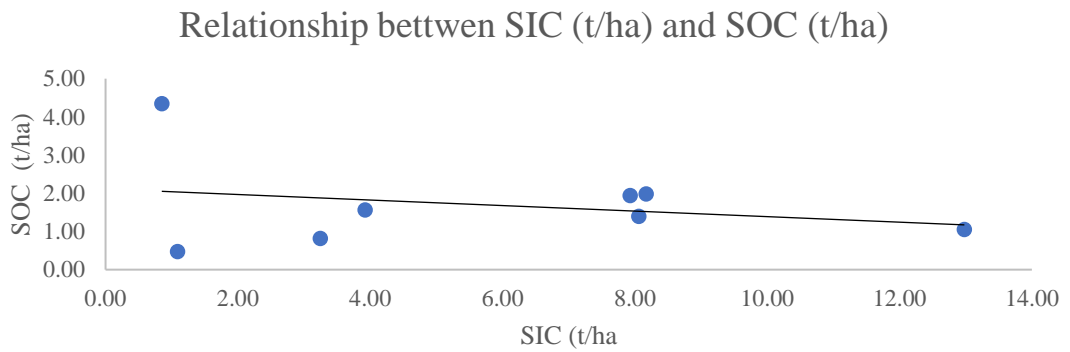
There is change in soil organic carbon pools when natural ecosystem is converted into agro-ecosystem and or land use changed over time, the magnitude of changes depends on land use, management, and ecological factors, such as, temperature, precipitation, soil types and native vegetation. Quantification of changes in the SOC pool as a results of agricultural land use provides a reference point regarding sequestration potential of SOC stock estimation, most of the carbon stocks more in high rainfall, high vegetation, humid climates compared to arid climates. (Fig.4.10) The total carbon under P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub>, Calcic Haplusterts showed soil total carbon varies from 14.56 to 24.91 t ha<sup>-1</sup>. The soil total carbon stock under (*Lithic Ustorthents*) P<sub>1</sub> at 15, 100 cm and total profile depth was found 3.23, 25.57 and 14.56 t ha<sup>-1</sup> respectively, the soil total carbon stock under *Calcic Haplusterts* P<sub>2</sub>, P<sub>4</sub> and P<sub>7</sub> at 15, 100 cm and total profile depth was varying from 2.00 to 2.85, 18.2 to 24.07 and 17.13 to 24.91 t ha<sup>-1</sup> respectively. The soil total carbon stock under *Typic Haplusterts* P<sub>3</sub>, at 15, 100 cm and total profile depth was found 2.58, 23.39 and 35.09 t ha<sup>-1</sup> respectively (Fig 4.7). The soil total carbon stock under P<sub>6</sub>, P<sub>8</sub> *Calcic Haplustepts* was found at 15, 100 cm and total profile depth was varying from 2.48 to 2.58, 26.17 to 59.98 and 15.66 to 78.00 t ha<sup>-1</sup> respectively. The cropping pattern wise total carbon stock under different cropping pattern were cotton P<sub>6</sub>, P<sub>7</sub>, P<sub>8</sub> at 15,100 cm and profile depth varies from 2.48 to 2.85, 24.07 to 59.98 and 15.66 to 36.02 t ha<sup>-1</sup> respectively. Whereas under maize TCS at 15,100 cm and profile depth varies from 2.33 to 3.26, 18.2 to 24.1 and 17.13 to 36.11 tha<sup>-1</sup>respectively. The cropping pattern pigeon pea TCS were found at 15,100 cm and profile depth was 3.23,25.57 and 14.56 tha<sup>-1</sup>respectively. The maize cropping pattern P3 Showed total soil carbon stocks were found at 15,100 cm and profile depth was 2.58 ,23.39 and 35.09 tha<sup>-1</sup>respectively. (Fig. 4.9) This indicated that the maximum TOC was noticed at calcic Haplusterts. This may be due to high amount of SIC. Similar observation also noticed by Wagh, 2018.

#### 4.5 Establish the cause effect between soil quality and cropping pattern

The carbon stock in the soil dependent on the climate, rainfall, temperature, soil types and vegetation, land scape, and soil conservation practices, edaphic soil



**Fig.4.10** Represent the relationship between Clay (%) and SOC (t/ha) under different cropping pattern of Aurangabad



**Fig.4.11** Represent the relationship between SIC (t/ha) and SOC (t/ha) under different cropping pattern of Aurangabad

features imposed by agriculture practices. (Carter, 1996) reduction in soil organic carbon has commonly been attributes to traditional agricultural practices in cropping soils that have left the vulnerable to the effect of wind and water erosion. The production potential of soils of Aurangabad district was vary with soil type. Entisols soils. Pedon P1 (Lithic Ustorthent) has the greatest limitation of these soils is its low water retention capacity, excessive drainage and consequently high leaching. High hydraulic conductivity, low clay content and CEC was directly influenced on the yield of commonly grown crop where as in Calcic Haplusterts and Haplustepts has high amount of  $\text{CaCO}_3$  is yield reducing factor (Vaidya *et al.*, 2014), However, it was observed that in table 4.11, the correlation between soil depth with clay, CEC and PAWC was found highly significant ( $r=0.77^{**}$ ,  $r=0.96^{**}$  and  $r=0.73^*$ ) indicated that the soil depth increased the clay content, CEC and PAWC was increased.

#### **4.5 Establish the cause effect between soil quality and cropping pattern**

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**Table 4.9 Soil organic carbon, soil inorganic stock of soils under different cropping pattern and profiles of Aurangabad district of Maharashtra.**

Horizon	Depth (cm)	SOCS (t ha <sup>-1</sup> )	SOCS (tha <sup>-1</sup> ) 15 cm depth	SOCS (tha <sup>-1</sup> ) 100 cm depth	SOCS (t /ha <sup>-1</sup> ) Total profile depth	SIC (t ha <sup>-1</sup> )	SICS (t /ha <sup>-1</sup> ) 15 cm depth	SICS 100 cm depth (t ha <sup>-1</sup> )	Total SICS total profile depth (t ha <sup>-1</sup> )	Total Carbon stock throughout profile (t ha <sup>-1</sup> )		
										15 cm	100 cm	Profile depth
<b>Pedon1 shekta, tq. Gangapur, district Aurangabad (<i>Lithic Ustorthents</i>) pigeon pea cropping pattern</b>												
Ap	0-28	3.81	2.04	13.6	8.16	5.53	1.19	11.97	6.4	3.23	25.57	14.56
Ac	28-50	2.24				10.8						
cr	50-60	1.16				7.8						
<b>Pedon 2 Gopalwadi, tq Gangapur, district Aurangabad (<i>Calcic Haplusterts</i>) maize cropping pattern</b>												
Ap	0-22	2.24	1.54	10.27	10.27	4.07	0.793	12.36	12.36	2.33	22.68	22.63
Bw <sub>1</sub>	22-40	1.36				4.6						
Bw <sub>2</sub>	40-64	1.47				8.7						
Bss <sub>1</sub>	64-72	5.13				3.6						
Bss <sub>2</sub>	72-100	1.6				13.7						
Bss <sub>3</sub>	100-120	0.074				28.8						
<b>Pedon 3 shankarpur, tq. Gangapur, district, Aurangabad (<i>Typic Haplusterts</i>) sorghum cropping pattern</b>												
Ap	0-28	2.5	1.6	10.98	16.47	5.46	0.98	12.41	18.62	2.58	23.39	35.09
Bw <sub>1</sub>	28-48	2.2				7.1						
Bw <sub>2</sub>	48-60	1.56				6.17						
Bss <sub>1</sub>	60-102	1.62				11.5						
Bss <sub>2</sub>	102-132	1.45				12.8						
Bss <sub>3</sub>	132-150	0.78				8.08						
<b>Pedon 4 Borgav arj, tq. Phulambri, District, Aurangabad (<i>Calcic Haplusterts</i>) maize cropping pattern</b>												
Ap	0-18	1.42	1.18	7.92	7.44	4.58	0.82	10.28	9.69	2	18.2	17.13
Bw <sub>1</sub>	18-46	1.71				7.84						
Bw <sub>2</sub>	46-56	0.78				10.21						
Bss <sub>1</sub>	56-75	1.72				9.41						
Bss <sub>2</sub>	75-94	1.35				11.29						
Cr	94 -140	1.27				47.4						

Continue....

Horizon	Depth (cm)	SOC (t ha <sup>-1</sup> )	SOC (t ha <sup>-1</sup> ) 15 cm depth	SOC (t ha <sup>-1</sup> ) 100 cm depth	SOC (t /ha <sup>-1</sup> ) Total profile depth	SIC (t ha <sup>-1</sup> )	SIC (t /ha <sup>-1</sup> ) 15 cm depth	SIC 100 cm depth (t ha <sup>-1</sup> )	Total sic total profile depth (t ha <sup>-1</sup> )	Total Carbon stock throughout profile (t ha <sup>-1</sup> )		
										15 cm	100 cm	Total profile depth
<b>Pedon 5 Murshidabadwadi, tq. Phulmbri, district Aurangabad ((<i>Typic Haplustepts</i>) maize cropping pattern</b>												
Ap	0-26	2.01	1.16	7.74	11.61	11.7	2.1	16.36	24.5	3.26	24.1	36.11
Bw <sub>1</sub>	26-50	0.979				9.5						
Bw <sub>2</sub>	50-91	0.75				19.15						
Cr	91-150	0.87				15.37						
<b>Pedon 6, Devgaon, tq. Phythan, district Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>												
Ap	0-15	2.05	1.46	9.77	5.86	6.1	1.12	16.4	9.8	2.58	26.17	15.66
Bw <sub>1</sub>	15-30	1.09				6.6						
Cr	30-60	0.635				18.51						
<b>Pedon 7, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplusterts</i>) cotton cropping pattern</b>												
Ap	0-21	2.18	1.56	10.41	10.41	6.6	1.29	13.6	14.5	2.85	24.07	24.91
Bw <sub>1</sub>	21-42	0.83				6.83						
Bw <sub>2</sub>	42-77	1.15				8.01						
Cr <sub>1</sub>	77-83	0.47				8.75						
Cr <sub>2</sub>	83-100	0.45				12.94						
<b>Pedon 8, Hasnabadwadi. Tq. And district Aurangabad (<i>Calcic Haplustepts</i>) cotton cropping pattern</b>												
Ap	0-22	2.31	1.5	10.08	13.1	5.02	0.98	49.9	64.9	2.48	59.98	36.02
Bw <sub>1</sub>	23-42	1.50				8.2						
cr	42-62	1.26				21.7						

**Table 4.10 Weighted means of soil characteristics of typing pedons**

<b>Sl. No.</b>	<b>Depth (cm)</b>	<b>Clay (%)</b>	<b>CEC [cmol (p<sup>+</sup>) Kg<sup>-1</sup>]</b>	<b>PAWC (mm)</b>	<b>O.C (%)</b>	<b>CaCO<sub>3</sub> (%)</b>	<b>SIC (t/ha)</b>	<b>SOC(t/ha)</b>	<b>Carbon stock (pg c)</b>	<b>Cotton yield (q/ha)</b>	<b>Tur yield (q/ha)</b>	<b>Maize yield (q/ha)</b>
<b>Pedon 1</b>	50	21.86	24.93	44.82	0.66	6.52	3.92	1.56	14.56	12.50	22.00	50.00
<b>Pedon 2</b>	150	40.44	43.94	195.54	0.52	9.99	7.93	1.94	15.63	25.00	25.00	65.00
<b>Pedon 3</b>	150	38.84	55.95	197.59	0.67	9.27	8.17	1.98	17.09	33.25	22.50	62.00
<b>Pedon 4</b>	94	36.27	50.43	135.60	0.55	12.37	8.06	1.39	19.13	22.20	20.50	55.00
<b>Pedon 5</b>	42	32.61	48.74	183.00	0.31	13.30	12.98	1.05	28.11	21.00	18.00	40.00
<b>Pedon 6</b>	30	21.57	26.49	43.45	0.53	8.78	1.09	0.47	13.66	10.50	12.50	32.00
<b>Pedon 7</b>	71	28.25	45.21	206.12	0.34	12.90	0.85	4.34	12.91	15.20	20.00	45.25
<b>Pedon 8</b>	42	24.02	30.77	139.15	0.33	6.63	3.24	0.82	12	14.00	16.00	45.00

**Table 4.11 correlation coefficient between parameter x and parameter y**

Parameter X	Parameter Y	r
Depth	Clay	0.77722
Clay	CEC	0.96018
Clay	TCS	0.1585
Clay	PAWC	0.7333
Clay	SIC	-0.396
Clay	SOC	-0.432
SOC	SIC	-0.046

The correlation between yield of Cotton, Maize and Pigeon pea with Soil Depth, CEC and PAWC was found highly significant (Table 4.12) This indicated that soil depth, clay content and PAWC was found yield reducing factor in Aurangabad district.

<b>Table 4.12 Correlation coefficient between yield of cotton, maize and pigeon pea and carbon parameters</b>		
Crop X	Soil parameter y	r
Cotton	Depth	0.952
	Clay	0.799
	PAWC	0.565
	TCS	0.052
	SOC	0.063
	SIC	-0.280
	CaCO <sub>3</sub>	0.052
Maize	Depth	0.899
	Clay	0.475
	PAWC	0.342
	TCS	0.043
	SOC	0.424
	SIC	-0.375
	CaCO <sub>3</sub>	-0.043
Pigeon pea	Depth	0.804
	Clay	0.604
	PAWC	0.291
	TCS	0.051
	SOC	0.258
	SIC	-0.616
	CaCO <sub>3</sub>	0.051

The correlation between yield of cotton with SOCS (r=0.06), SIC (r=-0.28) and Calcium Carbonate (r=0.052); in Maize SOCS (r=0.42), SIC (r=-0.375) and Calcium Carbonate (r=-0.043), total carbon stock (r= 0.052); and in pigeon pea SOCS (r=0.258), total carbon stock (r= 0.051), SIC (r=-0.161) Calcium carbonate (r=0.051); This indicated that increasing SIC decrease the yield of cotton, maize and pigeon pea

under semi - arid climate. This may be due to precipitation of calcium carbonate, the loss of calcium ion in soil induces the sodicity and decrease PAWC and HC which adversely effect on yield of cotton, maize and pigeon pea. Similar observation was also reported by Vaidya and Pal, 2002 under semiarid climate. Whereas, the correlation between yield of cotton, maize and pigeon pea found positive correlated with SOC ( $r=0.063$ ,  $r=0.042$  and  $r=0.258$  respectively) indicating the soil organic carbon increased the yield of cotton, maize and pigeon pea increased.

**CHAPTER-V**  
**SUMMARY AND CONCLUSION**

## CHAPTER-5

### SUMMARY AND CONCLUSION

Most of the Indian soils contains very low carbons stocks because uneven rainfall, high soil temperature, poor vegetation management, improper method of edaphic conservation practice and also high temperature leads to lot of carbon losses due to decomposition. As per the discussion with farmers and subject matter specialist of the study area we find out fact that the soil carbon was very less (< 0.1%) under maize, cotton, pigeon pea due to continuous cultivation of these crops. This soil doesn't support to the cotton, farmers were shifted to soyabean crop. With this view of above aspects, the present investigation was undertaken on "Assessment of soil quality and carbon stock under different cropping pattern of Aurangabad district of Maharashtra" was carried out at the department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during the year 2020-21.

Aurangabad district is located in the north central part of Maharashtra between North Latitude 19<sup>0</sup> 15' and 20<sup>0</sup> 40' and East Longitude 74<sup>0</sup> 37' and 75<sup>0</sup> 52'. This district is surrounded by Jalgaon district of North, Nashik district in west, Ahmednagar and Beed district in south and Parbhani and Buldhana district in east. Aurangabad district has been divided in 9 talukas viz. Aurangabad, Kannad, Soyagaon, Sillod, Phulambri, Khuladabad, Vaijapur, Gangapur, and Paithan talukas. The district has geographical area of 10,107 sq.km., out of which 726 sq.km is occupied by forest while cultivated area is 8135.57 sq.km and net area sown is 6540 sq.km. The present study was undertaken eight soil profiles under different cropping pattern viz. red gram, maize, and cotton, in Aurangabad district of Maharashtra, we collected soil sample from soil profile horizon wise for laboratory analysis and yield data were collected from adjoining area.

The depth of the soil varies according soil type and cropping pattern. (P<sub>1</sub>), Entisols, *Lithic Ustorthents* under pigeon pea and maize and soil depth is 50 cm. Pedon P<sub>2</sub>, P<sub>4</sub> and P<sub>7</sub>, Vertisols, Calcic Haplusterts commonly under cotton maize and pigeon pea sorghum crop and soil depth is 94 to 150cm. Pedon P<sub>3</sub>, *Vertisols*, Typic Haplusterts comes under cotton, pigeon pea and maize Pedon and soil depth >150 cm. Pedon P<sub>5</sub> Inceptisols, Typic Haplustepts comes under cotton, pigeon pea and maize and soil depth 91 cm. Pedon P<sub>6</sub> and P<sub>8</sub> Inceptisols, Calcic Haplustepts comes under cotton, maize

pigeon and bajra crop soil depth varies from 42 to 70 cm. Depth of the soil varied from 30 to 150cm. The selection of the crop not as per soil site suitability in this area.

The soil color Pedon (P<sub>1</sub>), Lithic Ustorthents very dark grey to light yellow brown, Pedon P<sub>2</sub>, P<sub>4</sub> & P<sub>7</sub> Calcic Haplusterts very dark brown to light brown in colour. Pedon P<sub>3</sub>, Typic Haplusterts very dark grey to very dark brown. Whereas Pedon P<sub>5</sub>, Inceptisols, Typic Haplustepts brown to light brown. Pedon P<sub>6</sub>, & P<sub>8</sub> Calcic Haplustepts, very dark greyish brown to light brown. The soil colour does not vary with cropping pattern. The soil structure varies from angularly blocky to granular in structure. Whereas soil texture varies from clay silty loamy to sandy loam clay in texture.

The Bulk density of Pedon P<sub>1</sub> Entisols, lithic Ustorthents was varies from 1.44 to 1.6 Mg m<sup>-3</sup> (P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub>) Vertisols, Calcic Haplusterts was ranged from 1.2 to 1.63 Mg m<sup>-3</sup>, Pedon P<sub>3</sub> Vertisols (Typic Haplusterts) varies from 1.2 to 1.53 Mg m<sup>-3</sup>, Pedon P<sub>6</sub>, P<sub>8</sub>, Inceptisol (Calcic Haplustepts) varies from 1.23 to 1.62 Mg m<sup>-3</sup>, Pedon P<sub>5</sub> Inceptisols, (Typic Haplustepts) was varies from 1.2 to 1.4 Mg m<sup>-3</sup>. The bulk density does not vary with cropping patterns. Surface soil has low bulk density and sub surface soil increases the bulk density with soil depth because compaction and presence of murrum layer.

The hydraulic conductivity under different soil and cropping pattern varies from 1.53 to 5.45 cm ha<sup>-1</sup>. The Pedon P<sub>1</sub> Lithic Ustorthents HC was 2.2 to 3.44 cm hr<sup>-1</sup>. Pedon P<sub>2</sub>, P<sub>4</sub>, Calcic Haplusterts was hydraulic conductivity varies from 1.4 to 5.13 cm hr<sup>-1</sup>. Pedon P<sub>3</sub> *Typic Haplusterts* HC was varying from 1.21 to 3.84 cm hr<sup>-1</sup>, whereas P<sub>5</sub>, Typic Haplustepts was hydraulic conductivity 1.2 to 1.48 cm hr<sup>-1</sup> and Pedon P<sub>6</sub> and P<sub>8</sub> Calcic Haplustepts HC varies with 2.8 to 3.90 cm hr<sup>-1</sup>. The hydraulic conductivity of soil is closely associated with the clay content and coarse fragment increase the coarse fragment increase the HC whereas, increase the clay content decrease the hydraulic conductivity of soil. However, the high hydraulic conductivity in in lower horizon this may be due to high amount of coarse fragments.

The particle size distribution under different soil and cropping pattern and soil P<sub>1</sub> Lithic Us orthents sand, silt and clay varies from 14.9 to 27, 49.5 to 52 and 21 to 35.6 per cent respectively. Pedon P<sub>2</sub>, P<sub>4</sub>, and P<sub>7</sub> Calcic Haplusterts sand, silt and clay, varies from 6 to 29, 28.8 to 54.00 and 22.6 to 40.2 percent. Pedon P<sub>3</sub>, Typic Haplusterts) sand, silt and clay varies from 13.24 to 30.2, 28.8 to 48.8 and 20.2 to 40.2 per cent

respectively. Pedon P<sub>5</sub> Typic Haplustepts sand, silt and clay varies from 15.6 to 33, 40 to 47.1 and 27 to 37 per cent respectively, Pedon P<sub>6</sub>, and P<sub>8</sub> Calcic Haplustepts, sand, silt and clay vary from 12 to 32, 34 to 49 and 25 to 35.5 per cent respectively. The maximum clay content was noticed under Vertisols (under maize and cotton) comparatively than other type of soil. Moreover, the clay content in soil was found significantly positive correlated with soil total carbon stock and soil depth ( $r=0.1585$ ). The soil total carbon stock increase with clay content in soil and clay content increase with increasing depth.

Plant available water capacity under different type of soil and cropping pattern under Aurangabad viz. P<sub>1</sub> *Lithic Ustorthents* showed PAWC 44.82 mm, P<sub>2</sub>, P<sub>4</sub> and P<sub>7</sub> *Calcic Haplusterts* varies from 135.26 to 206.12 mm. P<sub>3</sub> *Typic Haplusterts* showed 197.59 mm Pedon P<sub>5</sub> *Calcic Haplusterts* showed 183 mm whereas, P<sub>6</sub> and P<sub>8</sub> *Calcic Haplustepts* noted 43.45 to 139.15 mm. The maximum PAWC was noticed in Typic and Calcic Haplusterts and lowest at *Lithic Ustorthents*. This may be due to soil depth and clay content. Moreover, significant positive correlation between PAWC with s clay content, ( $r=0.73$ ). This indicates that PAWC increased with increasing soil depth and clay content in soil.

The soil reaction all pedons alkaline in nature. P<sub>1</sub> *lithic Ustorthents* showed 7.7 to 7.8., P<sub>2</sub>., P<sub>4</sub>, P<sub>7</sub> *Calcic Haplusterts* showed 8.1 to 8.7, P<sub>3</sub> *Typic Haplusterts* was varies 8.4 to 8.7, P<sub>5</sub> *Typic Haplustepts* was containing 8.2 to 8.5 and P<sub>6</sub> and P<sub>8</sub> *Calcic Haplustepts* varies 7.9 to 8.4. The Electrical conductivity of the varies from 0.15 to 0.37 dSm<sup>-1</sup> and which was found well within safe limit.

The soil organic carbon does not vary with cropping pattern, most of the surface soil of all Pedon organic carbon is greater than 0.5 per cent. The organic carbon 0.1 percent found in surface layer below 100 cm soil depth. The P<sub>1</sub> *lithic Ustorthents* varies from 0.73 to 0.945 per cent, Pedon P<sub>2</sub>., P<sub>4</sub>, P<sub>7</sub> *Calcic Haplusterts* was varies from 0.16-0.79 percent, P<sub>3</sub> *Typic Haplusterts* was varies 0.28 to 0.965 percent, P<sub>5</sub> *Typic Haplustepts* was found 0.10 to 0.645 per cent and P<sub>6</sub>, P<sub>8</sub> *Calcic Haplustepts* was found 0.13 to 0.79 per cent. The surface soil content high amount of soil organic carbon may be due to addition of organic matter.

The status of calcium carbonate in Pedon P<sub>1</sub> *Lithic Ustorthents* showed 5.5 to 19.5 per cent, P<sub>2</sub>, P<sub>4</sub> and P<sub>7</sub> *Calcic Haplusterts* showed 7 to 18.7 per cent, P<sub>3</sub> *Typic*

*Haplusterts* showed 8 to 11.5 per cent, *P<sub>5</sub> Typic Haplustepts* showed 10.25-15.0 per cent and *P<sub>6</sub>* and *P<sub>8</sub> Calcic Haplustepts* showed 9.75-18.75 per cent. The calcium carbonate content in Lithic Ustorthent was very low value than the Typic Haplustepts and Typic Haplusterts it may be due to the leaching of  $(\text{HCO}_3)_2$  which get precipitated down to slope as well as at lower horizon.

Cation exchange capacity under different soils and cropping pattern Aurangabad viz., *P<sub>1</sub> (lithic Ustorthents)* varies from 23.65 to 44.23 c.mol (p<sup>+</sup>) kg<sup>-1</sup>, Pedon *P<sub>2</sub>*, *P<sub>4</sub>*, *P<sub>7</sub> (Calcic Haplusterts)* was contains 31.23 to 60.85 c.mol (p<sup>+</sup>) kg<sup>-1</sup>, *P<sub>3</sub> (Typic Haplusterts)* was varies 31.23 to 60.13 c.mol (p<sup>+</sup>) Kg<sup>-1</sup>, *P<sub>5</sub> (Typic Haplustepts)* was found 35.56 to 60.96 c.mol(p<sup>+</sup>) Kg<sup>-1</sup> where as *P<sub>6</sub>* and *P<sub>8</sub>* CEC varies from 39.68 to 55.68 c.mol(p<sup>+</sup>) Kg<sup>-1</sup>. The maximum cation exchange capacity found in Typic Haplusterts under cotton crop and lowest was observed in Lithic Ustorthent This variation is not of cropping pattern This is due to soil and landform variation. Moreover, significant positive correlation between CEC with soil clay content ( $r= 0.96018^{**}$ ) This indicates that CEC increased with increasing soil depth and clay content and total carbon stock in soil. The exchange complex of the soil in the present study was observed to the dominated by calcium fallowed by magnesium, sodium and then potassium in general, these soils were found high exchangeable bases. The high CEC value in surface due to high microbial activity and good plant litter contain carbon.

The soils of Aurangabad have been classified according to U. S comprehensive system of soil classification (soil survey staff (2015) were belonging to three orders viz., Entisols, Inceptisols and Vertisols and at subgroup level Typic Ustorthents, Typic Haplustepts, calcic Haplustepts, Typic Haplusterts and calcic Haplusterts. The maize cropping pattern show lowest total carbon stock as compared the other pedons.

The total organic carbon content *P<sub>1</sub> (Lithic Ustorthents)* (0.96-1.26 pg, c), highest as among the all-soil Pedon's under different cropping pattern of Aurangabad district. the reason behind that was high legumes plant litter in the soil.

The soils were very low to medium in available nitrogen and phosphorus content and moderate to very high in available potassium content. The available sulphur was low in these soils. The soils of the study area were low to medium in available Fe, Mn and Cu, and Zn content in these soils.

The total organic carbon content P<sub>1</sub> (*Lithic Ustorthents*) (0.96-1.26 Pg.C), highest as among the all-soil Pedon's under different cropping pattern of Aurangabad district. the reason behind that was high legumes plant litter in the soil. The sorghum (*Calcic Haplusterts*) P<sub>2</sub> 0.35 to 1.05 Pg.C. Cropping pattern shows lowest total carbon as compared all the other Pedons. The total carbon cropping pattern viz red gram, cotton, maize, sorghum.

The total carbon stock was high in P<sub>6</sub>, P<sub>7</sub>, P<sub>8</sub> cotton cropping pattern 15.66 to 36.02 t ha<sup>-1</sup>. The total carbon stock lowest showed P<sub>1</sub> red gram cropping pattern 14.56 t ha<sup>-1</sup>. The cropping pattern wise total carbon stock under different cropping pattern viz. cotton, maize, sorghum, red gram.

The soil inorganic carbon stock was low in showed P<sub>1</sub> red gram cropping pattern 5.53 to 10.8 t ha<sup>-1</sup> as compared to the among the cropping pattern Pedon's. The highest soil inorganic carbon stock was found in cotton cropping pattern compared to the other Pedons 5.02 to 21.7 t ha<sup>-1</sup>. The soil inorganic stocks cropping patten wise cotton, maize, sorghum.

The soil organic carbon stock was highest in cotton cropping pattern, showed 0.45 to 2.31 t ha<sup>-1</sup> and lowest soil organic carbon stock observed in maize cropping pattern 0.78 to 2.24 t ha<sup>-1</sup>. soil organic carbon stock cropping pattern wise cotton, red gram, sorghum, maize.

The soil organic carbon under different cropping and soil profiles of Aurangabad viz. p<sub>1</sub> (*Lithic Ustorthents*) contains 1.16 to 3.81 t ha<sup>-1</sup>. P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) contains 0.48 to 5.13 t ha<sup>-1</sup> P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains around 0.638 to 5.8 t ha<sup>-1</sup>.

The soil inorganic carbon under different cropping and soil profiles of Aurangabad viz. P<sub>1</sub> (*Lithic Ustorthents*) contains (5.53 to 10.8 t ha<sup>-1</sup>). P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub> (*Calcic Haplusterts*) contains (3.6 to 47.4 t ha<sup>-1</sup>). P<sub>6</sub>, P<sub>8</sub> (*Calcic Haplusterts*) contains around (5.02 to 21.7 t ha<sup>-1</sup>).

The total carbon under P<sub>2</sub>, P<sub>4</sub>, P<sub>7</sub>, (*Calcic Haplusterts*) showed soil total carbon were 17.13 to 24.91 t ha<sup>-1</sup>. The soil total carbon stock under (*Lithic Ustorthents*) P<sub>1</sub> was 14.56 t ha<sup>-1</sup>. The soil total carbon stock under P<sub>6</sub>, P<sub>8</sub> were 15.66 to 36.02 ha<sup>-1</sup>.

From the above results following conclusion were drawn

- The soils of the study area were shallow to deep, dark brown (10 YR 3/3) to light brown (10 YR 5/4) in color, loamy to clay in texture and granular to angular blocky in structure,
- The bulk density of the studied soil varied from (1.2- 1.62Mg/m<sup>3</sup>), the soil moisture retention at 33kpa varied from (8-38%).
- The coarse fragments under studied are maximum contains Lithic Ustorthents red gram cropping pattern (17.12-50%), minimum coarse fragment observed sugarcane cropping pattern Typic Haplusterts (19.7.5-36.85 %).
- The lithic Ustorthents soils place we observed sandstone parent material, the Typic Haplusterts soils places we observed Basalt parent material, lithic ustorthents soil places we observed cambic surface and k bearing illite.
- The plant available water capacity under different cropping pattern of Aurangabad viz. P<sub>7</sub> cotton cropping pattern recorded high plant available water (206.12mm), lowest plant available water recorded in P<sub>6</sub> bajra cropping pattern (43.45mm). soil moisture retention highest recorded P<sub>5</sub> maize cropping pattern (10.94-35) at 15kpa, (5.54-24.15) at 1500 kpa. Lowest soil moisture retention recorded in P<sub>6</sub> bajra cropping pattern (7.46-20.43) at 33kpa, (4.23-10.22) at 1500kpa.
- The pH of the soils was neutral to alkaline (7.7-8.8) in nature, electrical conductivity varies (0.15-0.37 dSm<sup>-1</sup>) normal. the soil organic carbon content varies from low to high (0.19 -0.99%), the calcium carbonate percentage varies from (5.5-18.75%) medium to very high.
- The calcium carbonate equivalent under the studied area varies (17-23 %). The calcium carbonate equivalent present sorghum cropping pattern Typic Haplusterts (19.6-23 %), The minimum calcium carbonate equivalents observed in Lithic Ustorthents red gram cropping pattern (17.6-20.1 %)
- The maximum CEC was recorded in Typic Haplusterts (31.23-60.13 c.mol/ (P<sup>+</sup>) kg<sup>-1</sup>), as compared to Typic Haplusteps, and lithic Ustorthents. Minimum CEC was observed lithic Ustorthents (22.65 – 44.23 c.mol/ (P<sup>+</sup>) kg<sup>-1</sup>).
- The taxonomically the soils of the studied area classified as Typic Haplusterts, Typic Haplusteps, lithic Ustorthents.

- The soil fertility of different cropping pattern of soil was macronutrient nitrogen low; phosphorus maintains low to medium; potassium maintains in high, but secondary nutrient sulphur also contains low in content.
- The micronutrient content on the studied area the zinc, iron, maintains low concentration. The manganese content in the soil good amount, trace non-metal boron concentration maintains low to medium.
- The cropping pattern red gram P1 (*Lithic Ustorthents*) (0.96-1.26 Pg.C), total organic carbon as compared the other soil Pedons.
- Soil classification wise total carbon stock was highest in calcic Haplusterts, calcic Haplustepts, *Lithic Ustorthents*.
- The cropping pattern wise total carbon stock were viz.cotton, maize, sorghum, red gram.

From the above results the soil carbon stock under different cropping pattern of Aurangabad. The soil carbon total stock highest found in the cotton cropping pattern (calcic Haplusterts), lowest total carbon stock was under red gram cropping pattern P1 (*Lithic Ustorthents*). After cotton cropping maize, sorghum cropping pattern. For the improvement carbon status, soil carbon stocks (RMP Lal 2010). Maintain good surface plant litter, good drainage facilities, application of organic manures farm yard manure, vermicompost, green manure, biofertilizers, improve the soil carbon status. Low tillage and zero tillage operation, cover crop, inter crop, crop rotation with legumes causes the soil organic carbon increases. The better vegetation, agroforestry measures, shelter bed leads to the soil carbon level enhanced. soil water conserve by surface mulches, application of sand silt to the soil improves the carbon status in the soil. By the above strategic management methods, we can improve the soil carbon pools status and improve the soil health.

**LITERATURE  
CITED**

## LITERATURE CITED

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# **APPENDIX**

## APPENDIX 1

### Rating of Soil Organic Carbon and Available Macro Nutrients

Particular	Soil organic Carbon (g kg <sup>-1</sup> )	Available N (Kg ha <sup>-1</sup> )	Available P (Kg ha <sup>-1</sup> )	Available K (Kg ha <sup>-1</sup> )
Very low	<2	<140	<7.0	<100
Low	2.1 to 4.0	141 to 280	7.1 to 14.0	101 to 150
Moderate	4.1 to 6.0	281 to 420	14.1 to 21.0	151 to 200
Moderately High	6.1 to 8.0	421 to 560	21.2 to 28	201 to 250
High	8.1 to 10.0	561 to 700	28 to 35.0	251 to 300
Very high	>10.0	>700	>35	>300

Anonymous (2000)

### Critical Limits for Soil Nutrients

Particular	Critical limit	References
Sulphur	10 mg kg <sup>-1</sup>	Williams and Steinbergs (1969)
Copper	0.2 mg kg <sup>-1</sup>	Lindsay Norwell (1978)
Iron	4.5 mg kg <sup>-1</sup>	Lindsay Norwell (1978)
Zinc	0.6 mg kg <sup>-1</sup>	Lindsay Norwell (1978)
Manganese	2.0 mg kg <sup>-1</sup>	Lindsay Norwell (1978)

Anonymous (2000)

# **CURRICULUM VITAE**

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### Academic qualification

Course/ Degree	Name of the college /Institute	University/ Board	Year of passing	Percentage (%) CGPA	Class/ grade
SSC	Z. P. High School kothapenta	Board of Secondary Education Andhra Pradesh	2011	73.5	1 <sup>st</sup>
Intermediate	Punyagiri Junior College, S. Kota	Board of Intermediate Education, A. P.	2013	89.8%	1 <sup>st</sup>
B.Sc. (Agri.)	Agricultural College, Naira	ANGRAU, Guntur	2018	7.64	1 st

Place: Parbhani

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