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## Assessment of physical properties of soil from different blocks of Guntur district, Andhra Pradesh, India

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### Abstract

The objective of this study is to do the physical and chemical analysis of soil samples and to provide information to the farmers due to lack of information in the selected areas. Soil samples were collected from three blocks of Guntur District with three depths viz., 0-15, 15-30 and 30-45 cm. Soil parameters like soil texture, soil colour, Bulk density, particle density and solid space increases with increase in depth, pore space decreases as go deeper, water holding capacity and specific gravity were increases with increasing depths. The soil of the study area varies from dark brown to dark yellowish brown in colour and its texture varies from loam to clay loam. The result of the study area shows that the soil has a very good physical condition and the soil is alkaline in nature. The organic carbon is low in content, low to medium in nitrogen content, high in phosphorous, potassium, Exchangeable calcium and magnesium and available sulphur contents.

**Keywords:** physical properties, chemical properties, soil analysis

### Introduction

Soil is all unconsolidated material of the earth's crust in which land plants can grow, if water and temperature are adequate at least the minimum nutrients are available and toxic substances are in low concentration. Soil sampling is the most vital step for any soil analysis. It is a dynamic natural body developed as a result of pedogenic processes during weathering of rocks. It consists of minerals and organic constituents, exhibits definite physical, chemical and biological properties of variable depth. Over the surface of earth provides a suitable medium for plant growth. Soil mainly consists of 50% pore space (air and water) and 50% solid phase. The soil phase is broadly composed of 45% mineral matter and 5% organic constituents. (Soils and Plant Nutrients). The physical properties of the soil depend upon the amount, shape, structure, size, pore spaces, organic matter and mineral composition of soil. The chemical properties of the soil are the interactions of various chemical constituents among soil particles and the soil solution.

These physical properties are soil texture, bulk density particle density, percent pore space, water holding capacity, soil structure, soil colour. The chemical properties are  $p^H$ , EC, OC, Nitrogen, Phosphorus, Potassium, Extractable Calcium and Magnesium and Sulphur. The state Andhra Pradesh covers geographical area about 16.02 million ha, located at 16091'29" N Latitude and 80074'80" E Longitude. Guntur city lies in 26 m above the mean sea level with a tropical climate. The average annual temperature of city is 28.5 OC / 83.3 OF. In a year the average rainfall is 906 mm. The state endowed with a variety of soils ranging from poor coastal sands to highly fertile deltaic alluviums. Red soils occupy over 66% of the cultivated area and are mostly situated in Rayalaseema districts. These soils have low nutrient status.

### Materials and Methods

#### Study area

The location of Guntur district lies between 15°36'50" N latitude and 79°58'35" E longitude. It covers geographical area of 11,391 sq. kms which is bounded by Krishna district in the North, Prakasam district in the South and Nalgonda district in West.

#### Sampling and Analysis

##### Collection of the soil samples

Soil samples were collected randomly from a site using soil auger and screw auger, khurpi knife at the depth of (a) 0-15cm and (b) 15-30 cm.

All these samples will be mixed and the mixed sample has been divided into four parts and then among them two samples are collected and only half kg sample is being taken for the soil analysis by the conning and quartering method.

### Processing of soil samples

After sampling the samples were air dried in shade and then these samples were processed for various physical and chemical tests. The processing was done as follows: After drying all the unwanted materials like roots, stones, and others were removed. The clods formed were broken by using wooden pallet. Then the samples were sieved with 2 mm sieve Sieved samples were stored in polybags for further estimation of different physical and chemical parameters.

### Analysis of the soil physical and chemical parameters

Soil textural analysis was performed by Hydrometer method (Bouyoucos, 1927) [5]. For soil colour the soil samples were matched against standard Munsell soil colour chart (Munsell, 1971) to obtain hue, value and chroma. Bulk density, particle density, pore space and water holding capacity was determined by 100 ml measuring cylinder (Muthuvel *et al.* 1992) [14]. Specific gravity of soil was determined by relative density bottle or pycnometer (Black, 1965) [4].

Soil pH by Digital P<sup>H</sup> meter (Jackson, 1958) [10]. Soil EC by digital EC meter (Wilcox, 1950) [21]. Organic Carbon by Wet Oxidation Method (Walkey and Black, 1947) [220]. Available Nitrogen by Alkaline Permanganate Method by using Kjeldahl Flask (Subbiah and Asija, 1956) [16]. Available Phosphorus by using Spectrometric method (Olsen *et al.*,

1954) [17]. Available Potassium by Flame Photometer Method using ammonium acetate solution (Toth and Prince, 1949) [18]. Available Sulphur by Turbidimetric Method (Chesnin and Yien, 1950) [7]. Exchangeable calcium and Magnesium by 1N Neutral Ammonium Acetate Saturation / EDTA Method (Cheng and Bray, 1951) [6].

## Results and Discussion

### Physical Properties

As presented in table 1, 2 and 3. The texture of the soil of Guntur district varied from sandy clay loam to clay loam. Soil colour shows brown to very dark greyish brown in dry condition and from dark brown to dark yellowish brown in wet condition. Pore space decreases with increasing in soil depth ranged from 47.77 to 68.72%. Bulk density increase with depth ranged from 1.34 to 1.56 Mg m<sup>-3</sup> and particle density ranged from 2.39 to 2.76 Mg m<sup>-3</sup>. The bulk density and particle density increases with the increase in soil depth this due to presence of organic matter and clay content in surface soils. Higher compaction in the sub surface soils may be due to absence of cultivation. Solid space ranged from 31.28 to 52.23 Water holding capacity ranged from 34.09 to 66.66%. The surface layer has higher percentage of water holding capacity than the sub-surface layer this may due to the mechanical composition and organic matter content in soils and pore space percentage from 44.19 to 62.98%. Pore space decreases with an increase in depth. Decrease in pore space is attributed to increase in compaction in the soil. Specific gravity in soils of different villages range from 1.48 to 2.30.

**Table 1:** Soil texture and Soil Colour of Guntur District

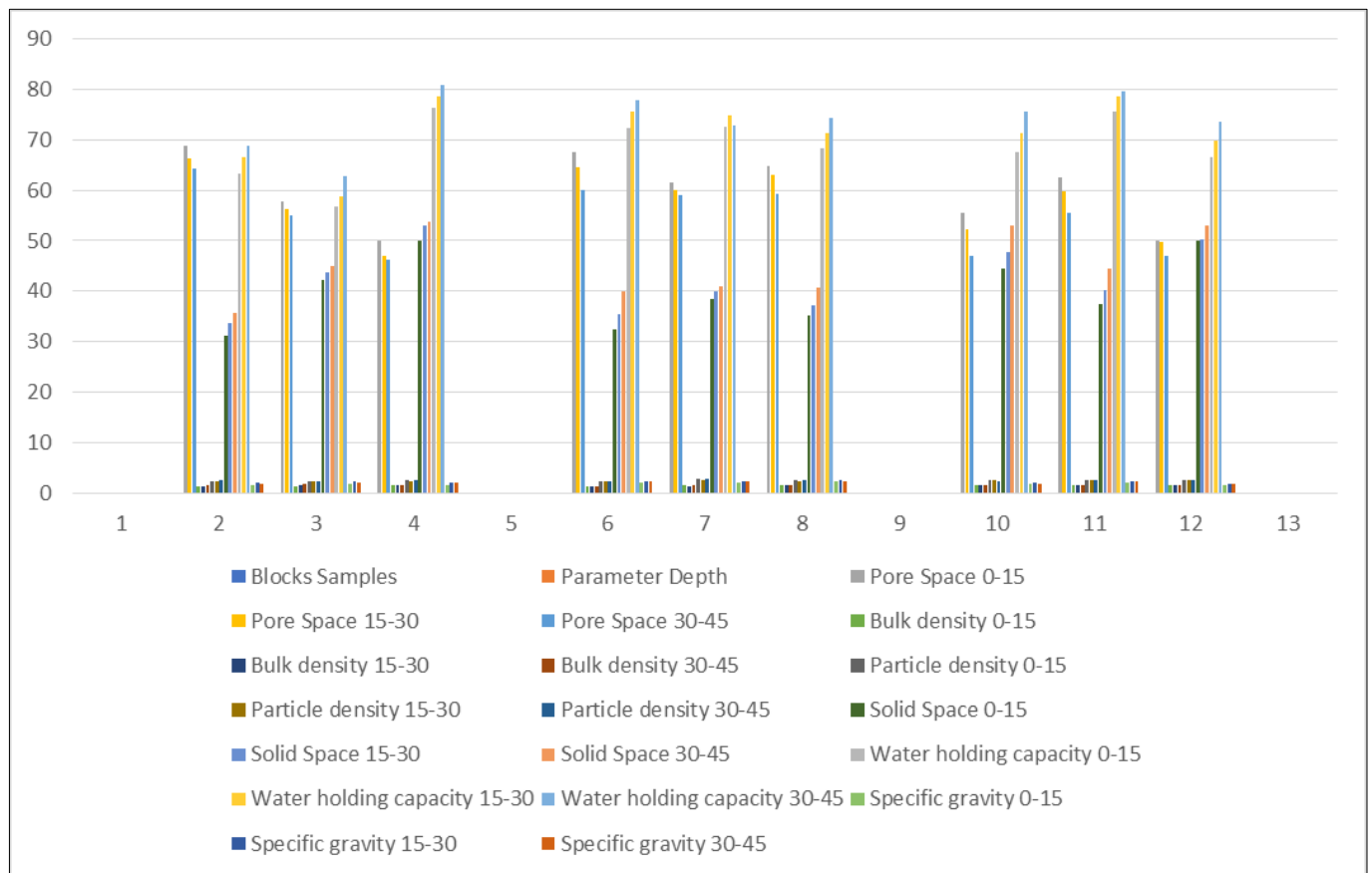
Village Name	Soil Texture	Soil Colour	
		Range (Dry condition)	Range (Wet Condition)
<b>Amaravathi</b>			
S <sub>1</sub>	Sandy clay	Brown - Dark brown	Dark brown
S <sub>2</sub>	Clay	Very Dark grey	Very Dark greyish brown
S <sub>3</sub>	Clay loam	Dark greyish brown	Very Dark greyish brown
<b>Guntur</b>			
S <sub>4</sub>	Clay	Dark brown	Very dark grey – Dark brown
S <sub>5</sub>	Clay	Very Dark grey	Very Dark greyish brown
S <sub>6</sub>	Clay	Very Dark greyish brown	Dark brown
<b>Mangalagiri</b>			
S <sub>7</sub>	Sandy clay loam	Yellowish brown	Dark yellowish brown
S <sub>8</sub>	Sandy clay loam	Very Dark greyish brown	Dark brown
S <sub>9</sub>	Sandy clay loam	Dark brown	Dark brown

**Table 2:** Evaluation of bulk density, particle density and water holding capacity of soils of Guntur District

Village Name	Bulk Density (Mg m <sup>-3</sup> )			Particle Density (Mg m <sup>-3</sup> )			Water Holding Capacity (%)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
<b>Amaravathi</b>									
S <sub>1</sub>	1.37	1.41	1.44	2.41	2.38	2.48	63.32	66.66	68.72
S <sub>2</sub>	1.35	1.52	1.81	2.42	2.35	2.40	56.86	58.91	62.73
S <sub>3</sub>	1.50	1.53	1.55	2.45	2.37	2.46	76.31	78.62	80.91
<b>Guntur</b>									
S <sub>4</sub>	1.35	1.33	1.35	2.32	2.21	2.31	72.42	75.61	77.77
S <sub>5</sub>	1.47	1.42	1.46	2.85	2.62	2.81	72.51	74.76	72.97
S <sub>6</sub>	1.50	1.51	1.57	2.46	2.32	2.46	68.41	71.36	74.47
<b>Mangalagiri</b>									
S <sub>7</sub>	1.50	1.53	1.55	2.47	2.44	2.42	67.56	71.43	75.67
S <sub>8</sub>	1.50	1.51	1.57	2.62	2.53	2.60	75.67	78.72	79.54
S <sub>9</sub>	1.47	1.53	1.55	2.54	2.46	2.52	66.66	69.83	73.52
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to depth	S	0.056	0.118	S	0.029	0.061	S	0.913	1.936

**Table 3:** Estimation of pore space (%), solid space (%) and specific gravity of soils of Guntur District

Village Name	Pore space (%)			Solid space (%)			Specific gravity		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
<b>Amaravathi</b>									
S <sub>1</sub>	68.72	66.23	64.31	31.28	33.77	35.69	1.61	1.98	1.74
S <sub>2</sub>	57.81	56.21	55.01	42.19	43.79	44.99	1.75	2.24	2.16
S <sub>3</sub>	50.09	47.08	46.13	49.91	52.92	53.87	1.64	2.12	1.95
<b>Guntur</b>									
S <sub>4</sub>	67.47	64.44	60.01	32.53	35.56	39.99	2.15	2.34	2.18
S <sub>5</sub>	61.51	60.04	58.92	38.49	39.96	41.08	2.13	2.32	2.24
S <sub>6</sub>	64.83	62.93	59.21	35.17	37.07	40.79	2.32	2.46	2.38
<b>Mangalagiri</b>									
S <sub>7</sub>	55.52	52.21	47.06	44.48	47.79	52.94	1.72	2.14	1.86
S <sub>8</sub>	62.52	59.84	55.55	37.48	40.16	44.45	2.17	2.34	2.22
S <sub>9</sub>	50.12	49.82	47.05	49.88	50.18	52.95	1.65	1.92	1.74
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to depth	S	0.905	1.919	S	0.905	1.919	S	0.064	0.135



**Fig 1:** Physical parameters of soil sample

**Chemical Properties**

As depicted in table 4. The soil pH varies between 7.36 to 8.96. In general, pH decreased with increase in soil depth. The pH of the soil is alkaline in nature. Similar finding were also reported by Kekane (2015) [11], Patel (2015) [11] and Kumar *et al.*, (2005) [3]. Electrical Conductivity (dS m<sup>-1</sup>) range from 0.14 to 0.64 dS m<sup>-1</sup>. It has also been observed that electrical conductivity of soils of the study area is moderately saline and

is good for crop production. These results were in accordance with the findings of Venkateswarlu *et al.*, (1995) [19]. Soil organic carbon (%) of the soil samples are varies from 0.21 to 0.56%. The surface layer had low organic carbon as compared to sub surface layer which could be due to deposition of leaf litter and residues (Dutta *et al.* 2015) [9]. Similar findings were also reported by Krishnamurthy and Chandra (2002) [12].

**Table 4:** Estimation of soil pH (1:2) EC (1:2) (dS m<sup>-1</sup>), OC (%)

Village Name	pH			EC (dS m <sup>-1</sup> )			OC (%)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
<b>Amaravathi</b>									
S <sub>1</sub>	8.18	8.23	8.41	0.29	0.32	0.55	0.30	0.21	0.09
S <sub>2</sub>	7.47	7.51	7.87	0.23	0.36	0.53	0.56	0.42	0.39
S <sub>3</sub>	8.84	8.92	8.96	0.23	0.35	0.53	0.42	0.36	0.33
<b>Guntur</b>									
S <sub>4</sub>	8.26	8.42	8.61	0.14	0.26	0.47	0.47	0.32	0.30
S <sub>5</sub>	8.02	8.14	8.42	0.20	0.44	0.56	0.51	0.42	0.40
S <sub>6</sub>	7.80	8.01	8.24	0.26	0.52	0.64	0.42	0.38	0.35
<b>Mangalagiri</b>									
S <sub>7</sub>	8.23	8.48	8.67	0.19	0.28	0.49	0.31	0.23	0.19
S <sub>8</sub>	8.12	8.31	8.61	0.23	0.46	0.57	0.34	0.21	0.19
S <sub>9</sub>	7.36	7.46	7.67	0.14	0.27	0.62	0.41	0.32	0.26
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to Depth	S	0.052	0.110	S	0.039	0.083	S	0.021	0.044

### Primary Nutrients

As portrayed in table 5. The available nitrogen content in the study area ranged from 76.00 to 276.01 Kg ha<sup>-1</sup> with a mean value of 206.09 Kg ha<sup>-1</sup>. Similar observations of high potassium content were reported by Bandyopadhyay *et al.*, (2004)<sup>[1]</sup> and Dhale and Jagdishprasad (2009)<sup>[8]</sup>. Phosphorous varies from 36.00 to 198.01 Kg ha<sup>-1</sup> with a mean value of

132.00 (Kg ha<sup>-1</sup>). Similar observations of high potassium content were reported by Bandyopadhyay *et al.*, (2004)<sup>[1]</sup> and Dhale and Jagdishprasad (2009)<sup>[8]</sup> and the potassium ranged from 110.00 to 964.33 Kg ha<sup>-1</sup> and with a mean value of 551.67 Kg ha<sup>-1</sup>. Similar observations of high potassium content were reported by Bandyopadhyay *et al.*, (2004)<sup>[1]</sup> and Dhale and Jagdishprasad (2009)<sup>[8]</sup>.

**Table 5:** Evaluation of Available Nitrogen Kg ha<sup>-1</sup>, Available Phosphorous (Kg ha<sup>-1</sup>) and Available Potassium (Kg ha<sup>-1</sup>)

Village Name	N (Kg ha <sup>-1</sup> )			P (Kg ha <sup>-1</sup> )			K (Kg ha <sup>-1</sup> )		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
<b>Amaravathi</b>									
S <sub>1</sub>	166.00	123.00	85.00	68.00	62.00	56.00	672.00	563.00	420.00
S <sub>2</sub>	198.00	156.00	98.00	55.00	53.00	50.00	672.00	576.00	460.00
S <sub>3</sub>	276.00	194.00	150.00	57.00	54.00	52.00	538.00	446.00	360.00
<b>Guntur</b>									
S <sub>4</sub>	154.00	131.00	76.00	55.00	53.00	51.00	739.00	630.00	521.00
S <sub>5</sub>	216.00	182.00	120.00	135.00	132.00	129.00	1075.00	968.00	850.00
S <sub>6</sub>	204.00	162.00	117.00	198.00	193.00	182.00	1008.00	970.00	860.00
<b>Mangalagiri</b>									
S <sub>7</sub>	184.00	147.00	112.00	94.00	90.00	86.00	856.00	742.00	651.00
S <sub>8</sub>	198.00	162.00	110.00	45.00	40.00	36.00	349.00	242.00	110.00
S <sub>9</sub>	194.00	174.00	136.00	119.00	90.00	88.00	976.00	864.00	726.00
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to Depth	S	8.775	18.603	S	3.902	8.272	S	14.409	30.547

### Secondary Nutrients

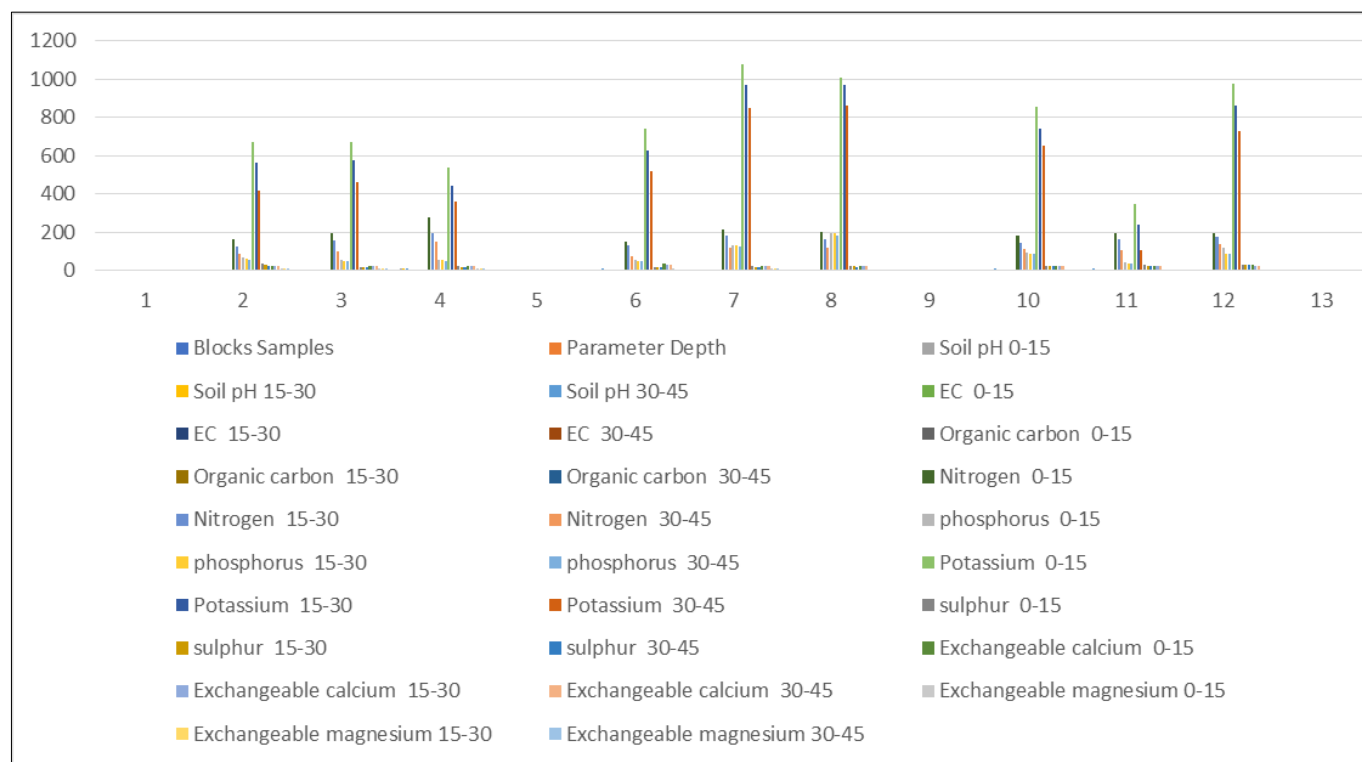
As illustrated in table 6. The Exchangeable Calcium and Magnesium of the soil samples ranges from 21.93 to 34.37 [c mol kg<sup>-1</sup>] and 6.12 to 12.15 [c mol kg<sup>-1</sup>] with mean value of 24.46 and 10.53 respectively. The calcium and magnesium content in the soil may be affect by the amount of rainfall

intensity. Similar results were observed by Naga Raju Kola and Babu Rao Gudipudi (2020)<sup>[15]</sup>. The sulphur of soil in the study area varies from 4.85 to 63.80 mg Kg<sup>-1</sup>. The available sulphur was found high in the entire study area. Similar findings were reported by (Basavaraju *et al.*, 2005)<sup>[3]</sup> and (Varaprasad Rao *et al.*, 2008)<sup>[15]</sup>.

**Table 6:** Estimation of Secondary nutrients status of soil of Guntur District

Village Name	Ex. Ca [c mol kg <sup>-1</sup> ]			Ex. Mg [c mol kg <sup>-1</sup> ]			S (mg Kg <sup>-1</sup> )		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
<b>Amaravathi</b>									
S <sub>1</sub>	22.39	27.39	25.89	10.39	9.79	9.19	35.00	32.00	26.00
S <sub>2</sub>	24.55	23.35	23.95	12.15	11.55	11.05	20.00	18.00	15.00
S <sub>3</sub>	27.63	24.13	25.93	11.13	10.33	10.13	22.00	20.00	15.00
<b>Guntur</b>									
S <sub>4</sub>	34.37	32.57	33.07	9.37	8.57	8.17	20.00	19.00	17.00
S <sub>5</sub>	26.16	24.16	23.06	10.06	9.66	9.16	23.00	20.00	18.00
S <sub>6</sub>	25.65	23.85	24.35	7.05	6.65	6.95	25.00	23.00	21.00
<b>Mangalagiri</b>									
S <sub>7</sub>	24.74	23.34	23.04	7.74	7.64	7.54	27.00	25.00	22.00
S <sub>8</sub>	23.53	22.33	21.93	6.63	6.53	6.43	29.00	27.00	25.00
S <sub>9</sub>	28.72	27.22	26.62	6.32	6.12	6.22	32.00	30.00	28.00

	F- test	SEm ( $\pm$ )	CD at 5%	F- test	SEm ( $\pm$ )	CD at 5%	F- test	SEm ( $\pm$ )	CD at 5%
Due to Depth	S	0.998	2.115	S	0.203	0.430	S	0.768	1.628



**Fig 2:** Chemical properties of soil sample

## Conclusion

We conclude the soil of Guntur District have good physical condition, the amount of macro nutrient element is low to medium and the micro nutrient are high. The deficiency of nutrients can be mitigated by the use of some inorganic fertilizers or organic fertilizers. Organic farming not only improves the physical condition of the soil but also enriches the soil with essential plant nutrients at low costs of production. By studying the soil sample, productivity of potato, peas, cabbage, soybean, maize, rice are most suitable based on the soil analyse results.

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