INFLUENCE OF PHYSICO-CHEMICAL PROPERTIES OF RED AND BLACK SOILS OF WARDHA REGION ON GROWTH OF PLANTS

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ABSTRACT

Study was conducted to evaluate the status of physico-chemical properties of red and black soils from selected sites of Wardha region and its effect on growth of plants. The results obtained from this study were showed that the texture of red soil is sandy clay loam, loam, sandy loam and loam sand whereas texture of black soil is silty-clay and clay. Bulk density and water holding capacity of red soil is less than black soil .The pH of red soils were acidic to slightly alkaline in reaction, low in electrical conductivity and low in organic matter than black soil . Black soil is high in nutrients than red soil. Red soil is less fertile than black soil after analysis of fertility status.

Keywords: *Physicochemical properties, bulk density, electrical conductivity, fertility status.*

Introduction:

The search for agro-socioeconomic sustainability and new production System paradigms are greatest challenges of modern agriculture which involves among other technological practice an adequate soil management. For appropriate management of soils it is essential to understand physical and chemical properties of soils. Soil is a dynamic natural body developed as a result of pedogenic processes through weathering of rocks consisting of mineral and organic constituents, possessing definite chemical, physical, mineralogical and biological properties, having a variable depth over the surface of the earth, and providing a medium for plant growth [1]. The physico-chemical properties of soils play an important role in determining the retention and availability of nutrients in the soils. The nutrient supply in soils is depends on the level of organic matter, degree of microbial activity, change in pH, types and amount of clay and status of soil moisture [2].

The per Capita cultivable land has been declined from 0.32 ha in 1950's through 0.14 by the turn of the century to less than 0.1 ha by 2020. The challenge is thus being faced not only of increasing productivity on sustainable basis, but also of the preserving and maintaining of soil resource bases for the posterity. The ability of the land to produce is limited and the limits to produce are set by soil, climate and landform conditions. However, the capacity of a soil to produce is limited and the limits to production are set by intrinsic characteristics, agro-ecological settings, use and management [3].

Man is dependent on soil because he obtains all the basic necessities of life like food, fiber, shelter from it, but good soils are also dependent on human civilization. Due to the intimate relationship of man's prosperity with soil, it is very essential that unwise exploitation and misuse of soils be avoided. The knowledge of the soils in respect of its origin and formation, nature and properties and distribution becomes imperative in this connection. Such

information's are not only useful in agriculture but are equally important for foresters, geologists and engineers for land use planning and soil management [4].

The most important and basic natural resource is soil. It is evident that the production of food, fodder, fuel and feed to meet the requirement of human beings and animals is primarily dependent upon agriculture and allied areas which are dependent on soil resources. Soil resources of the world are finite, easily degraded by misuse and mismanagement, nonrenewable over the human time frame, and shrinking because of degradation and conversion to nonagricultural uses [5]. Soil sustainability and productivity depends on an adequate equilibrium among the soil properties [6]. Soil is a complex system where in chemical, physical and biochemical factors are held in dynamic equilibrium [7]. Chemical and biological properties of soils as these properties interact in a complex way to give a soil its quality or capacity to function [8]. The importance of soil fertility and plant nutrition to the health and survival of all life cannot be overstated. Understanding of the diversity distribution, characteristics and process of soil is important for agriculture development and productivity of agricultural system [9].

The status of soil fertility determines the level of crop productivity. In the present study an effort is made to determine physicochemical properties of soil. For the sustainable development of a region, the resources particularly soil and land needs not only protection and reclamation but also a scientific basis for the management in harmony with environment. These resources should be managed on a sustainable manner so that the changes proposed to meet the needs of development are brought out without diminishing the potential for their future use [10].

Various types of soils are found in the Wardha region. These are black soils, red or lateritic soils, mixed red and black soils, coastal alluvial soils and red and yellow soils. Black soil is quite fertile and capable of producing very good cotton and jowar crops. Mixed red and black soils, red loam and red and yellow soils are less fertile compared to black soils.

MATERIALS AND METHODS:

Soil samples were collected from the surface 10 – 30 cm soil depths from various sites of Wardha region. The soil samples collected from each site were air dried and passed through 2-mm sieve for the determination of most of the soil quality indicators; however, the soil samples for organic carbon, total N, and total P analyses were ground to pass 0.5-mm size sieve. The soil samples of Wardha region are analyzed as per the analysis techniques suggested by various researchers. The physical characteristics of soil are texture was determined by the Bouyoucous hydrometer method [11], bulk density was determined by clod method described by Black (1965)[12] and maximum water holding capacity is measured as suggested by Piper (1965)[13].Chemical properties of soil are the soil pH was determined in1:2.5 soil-water suspension by potentiometery as proposed by Jackson (1973)[14],$CaCO_3$ is determined by rapid titration method Piper C.S., (1966), Electrical conductivity was determined by conductivity meter in the soil water suspension of 1:2.5 Richard, (1954)[15], Organic carbon was determined by Wet Oxidation method (Walkley and black Rapid titration method.[16],Cation exchange capacity of the soil was determined by equilibrating the soil with neutral normal sodium acetate solution and the excess salts were removed by 95 % isopropyl alcohol Anon[17]. Available nitrogen from soil is determined by alkaline permanganate method (Subbiah and Asija)[18].Available phosphorus was determined by Olsen method ($NaHCO_3$)[19]. Available potassium was determined by neutral ammonium acetate method [20,21]. Micronutrients Fe, Mn, Zn and Cu are determined by using DTPA extraction and by atomic absorption spectrophotometer (AAS) [22].

RESULT AND DISCUSSION:

The characteristics and properties obtained after soil analysis are tabulated in following table-

Table 1.Physical properties of red soil of Wardha Region

Sample No.	Depth (cm)	Particle size distribution			Textural class	Bulk density Mg m^{-3}	Water holding capacity (%)
		Sand (%)	Silt (%)	Clay (%)			
1	10-30	72.5	5.0	22.5	Sandy clay loam	1.44	29.17
2	10-30	50.0	30.0	20.0	loam	1.48	14.83
3	10-30	62.5	25.0	12.5	Sandy loam	1.37	18.11
4	10-30	50.0	30.0	20.0	loam	1.56	18.18
5	10-30	62.5	12.5	25.0	Sandy clay loam	1.49	19.73
6	10-30	72.5	15.0	12.5	Loamy sand	1.26	14.2
7	10-30	74.5	10.5	15.0	Sandy loam	1.42	17.2
8	10-30	75.0	10.0	15.0	Sandy loam	1.22	18.62
9	10-30	72.5	15.0	12.5	Loamy sand	1.40	19.7
10	10-30	70.0	17.5	12.5	Sandy loam	1.49	19.73
11	10-30	72.5	15.0	12.5	Sandy loam	1.43	17.84
12	10-30	70.5	8.0	21.5	Sandy clay loam	1.57	16.4
13	10-30	51.0	30.0	19.0	loam	1.57	16.1
14	10-30	61.7	24.0	12.0	Sandy loam	1.53	18.13
15	10-30	52.0	30.0	18.0	loam	1.56	18.0
16	10-30	70.5	7.0	22.5	Sandy clay loam	1.52	18.3
17	10-30	71.2	15.1	13.7	Loamy sand	1.50	14.0
18	10-30	73.1	16.5	10.4	Sandy loam	1.56	16.4
19	10-30	73.1	10.1	16.8	Sandy loam	1.43	15.9
20	10-30	71.0	16.5	12.5	Loamy sand	1.39	17.2

Table 2. Physical properties of Black soil of Wardha Region

Sample No.	Depth (cm.)	Particle size distribution			Textural class	Bulk Density Mg m^{-3}	Water holding Capacity(%)
		Sand (%)	Silt (%)	Clay (%)			
1	10-30	0.8	35.1	64.1	Clay	1.69	45.6
2	10-30	0.5	33.5	66.0	Clay	1.70	46.2
3	10-30	0.5	33.5	66.0	Clay	1.68	45.0
4	10-30	0.3	29.5	70.2	Clay	1.72	40.0
5	10-30	0.9	33.4	65.7	Clay	1.70	39.5
6	10-30	0.5	30.5	69.0	Clay	1.71	43.5
7	10-30	0.3	29.0	70.7	Clay	1.69	44.9
8	10-30	0.2	28.7	71.1	Clay	1.72	52.4
9	10-30	0.3	27.0	72.1	Clay	1.74	50.8
10	10-30	0.2	28.8	71.0	Clay	1.76	51.6
11	10-30	3.2	46.4	50.4	silty-clay	1.74	52.6
12	10-30	1.7	49.2	49.1	Silty-clay	1.73	52.8
13	10-30	1.7	59.6	38.7	Silty-clay	1.76	55.3
14	10-30	1.2	33.3	65.7	Clay	1.75	54.6
15	10-30	2.1	35.8	62.1	Clay	1.69	49.8
16	10-30	2.6	36.1	61.3	Clay	1.70	50.6
17	10-30	2.7	34.8	62.5	Clay	1.76	59.8
18	10-30	2.7	34.6	62.7	Clay	1.72	58.7
19	10-30	1.6	59.7	38.7	silty-clay	1.74	60.0
20	10-30	0.8	51.3	47.9	silty-clay	1.73	57.5

Table 5. Chemical properties of black soil l of Wardha Region

Sample No.	pH	EC (dS m-1)	OC (%)	CaCO3 (%)	CEC Cmol(p+)Kg-1
1	7.5	0.33	0.60	3.10	37.5
2	7.2	0.41	0.59	3.9	36.9
3	7.3	0.32	0.62	5.8	38.0
4	7.1	0.31	0.70	4.2	38.2
5	7.4	0.53	0.74	7.5	39.5
6	7.3	0.62	0.72	6.2	39.0
7	6.8	0.91	0.69	9.7	38.7
8	6.6	0.79	0.71	10.4	39.5
9	6.5	1.02	0.77	11.1	39.4
10	6.5	1.03	0.78	8.9	37.7
11	6.9	1.01	0.81	9.1	38.0
12	6.8	0.68	0.82	8.6	40.0
13	6.8	0.78	0.84	9.6	41.5
14	6.7	0.56	0.85	10.2	42.6
15	7.1	0.53	0.86	11.3	40.9
16	7.5	0.74	0.79	12.1	42.3
17	6.9	0.76	0.85	12.3	43.5
18	6.8	0.83	0.88	11.8	39.9
19	6.7	0.95	0.86	9.6	45.1
20	7.5	0.54	0.87	8.3	44.0

Table6. Chemical properties of red soil l of Wardha Region

Sample No.	pH	EC (dS m-1)	OC (%)	CaCO3 (%)	CEC Cmol (p+) Kg-1
1	6.4	0.18	0.30	0.4	11.1
2	6.3	0.22	0.38	0.1	14.5
3	5.1	0.19	0.24	0.5	7.3
4	5.9	0.17	0.24	0.2	16.2
5	6.2	0.23	0.27	0.3	17.7
6	6.2	0.22	0.34	0.6	7.8
7	6.3	0.22	0.21	0.3	8.4
8	5.2	0.16	0.22	0.4	10.3
9	6.6	0.21	0.19	0.5	15.3
10	6.0	0.31	0.33	0.1	16.8
11	6.2	0.22	0.30	0.2	17.9
12	5.6	0.14	0.18	0.3	11.1
13	6.2	0.19	0.30	0.5	13.6
14	5.9	0.14	0.36	0.6	7.3
15	6.2	0.14	0.34	0.5	15.2
16	5.6	0.19	0.15	0.3	16.3
17	6.2	0.16	0.31	0.1	9.2
18	6.0	0.21	0.32	0.2	9.5
19	6.7	0.17	0.38	0.4	9.6
20	6.4	0.15	0.23	0.3	13.20

Table 5. Major available macro-nutrients in red soil Of Wardha region

Sample No	Available N(Kg/ha)	Available P (Kg/ha)	Available K(Kg/ha)
1	140	18.90	275
2	217	18.80	367
3	161	13.40	289
4	163	14.20	293
5	171	14.60	301
6	157	12.10	287
7	159	13.20	290
8	150	11.18	280
9	169	12.30	356
10	219	20.30	263
11	148	12.30	283
12	145	15.65	260
13	212	17.50	365
14	162	14.20	287
15	160	15.30	205
16	170	13.50	308
17	159	13.15	278
18	160	14.15	285
19	145	12.70	285
20	165	13.20	356

Table 6. Major available macro-nutrients in black soil of Wardha regon

Sample No	Available N(Kg/ha)	Available P (Kg/ha)	Available K(Kg/ha)
1	179.0	31.2	384.5
2	203.0	30.9	390.0
3	210.6	31.5	400.0
4	216.8	32.5	399.1
5	217.6	31.5	402.3
6	218.9	29.9	400.6
7	191.6	31.0	406.5
8	198.0	28.6	410.9
9	210.0	32.4	400.9
10	218.9	31.3	409.8
11	219.9	30.3	398.1
12	220.0	33.2	387.5
13	226.5	32.5	408.6
14	222.8	34.0	366.5
15	219.0	32.6	403.0
16	224.8	30.0	411.6
17	219.8	29.7	398.5
18	198.9	31.4	400.2
19	222.9	30.7	400.5
20	218.8	29.5	389.7

Table 7. Major available micro-nutrients in red soil of Wardha region

Sample No	Zn (ppm)	Cu (ppm)	Fe ((ppm)	Mn (ppm)
1	0.50	2.77	7.59	8.70
2	0.61	5.02	13.39	14.17
3	0.51	5.98	18.90	18.01
4	0.42	6.15	18.58	12.46
5	0.52	6.17	18.76	10.24
6	0.61	5.56	20.20	9.98
7	0.41	6.18	22.52	8.82
8	0.53	4.41	7.12	16.38
9	0.44	3.82	11.88	10.78
10	0.61	4.98	17.06	16.42
11	0.54	4.99	21.03	17.49
12	0.53	3.65	12.42	15.19
13	0.61	6.03	13.81	26.97
14	0.53	6.95	15.01	22.63
15	0.44	7.10	10.64	23.51
16	0.52	5.98	12.12	24.64
17	0.54	6.50	10.54	21.73
18	0.56	7.10	12.30	19.19
19	0.65	2.77	10.34	17.86
20	0.65	4.78	8.94	14.79

Table 8 Major available micro-nutrients in black soil of Wardha region.

Sample No.	Zn (ppm)	Cu (ppm)	Fe ((ppm)	Mn (ppm)
1	0.6	2.7	3.5	18.0
2	0.5	5.9	3.4	19.5
3	0.6	7.8	3.1	18.6
4	0.7	7.5	2.9	20.5
5	0.5	6.5	2.6	22.0
6	0.8	6.8	2.9	23.5
7	0.6	6.9	3.0	25.4
8	0.4	7.0	2.1	29.0
9	0.5	6.4	1.9	28.9
10	0.6	7.1	1.8	28.3
11	0.6	6.8	1.7	26.7
12	0.3	7.2	2.2	30.9
13	0.6	6.7	3.3	31.8
14	0.5	6.5	2.2	30.6
15	0.6	6.9	2.7	29.8
16	0.7	5.9	2.5	30.8
17	0.6	4.9	1.6	31.5
18	0.4	6.0	2.6	29.8
19	0.2	6.5	2.9	30.6
20	0.4	6.4	3.0	28.9

Table 9 Growth measurement of Spinach plants

Sample No.	Plant height(cm)			No. of leaves			Fresh weight(g)			Dry weight(g)			Leaf area(cm^2)		
	B	R	R+ N	B	R	R+ N	B	R	R+ N	B	R	R+ N	B	R	R+ N
1	6.2	5.0	5.8	9	6	8	10.0	7.3	9.8	2.0	0.9	1.9	60.0	40.0	58.0
2	6.0	4.9	5.3	8	6	7	12.0	9.5	10.7	1.3	0.7	1.2	55.0	32.0	52.0
2	6.0	5.0	5.5	8	6	7	10.5	7.0	10.4	1.6	0.8	1.4	59.0	35.0	54.0
4	6.1	5.0	5.5	7	5	7	12.3	8.0	11.6	1.4	0.8	1.2	61.0	44.0	58.0
5	6.0	4.8	5.4	9	6	7	12.5	9.2	12.0	1.5	0.5	1.3	62.0	39.0	59.0
6	6.2	5.1	5.8	9	6	7	11.0	6.8	10.6	1.6	0.7	1.4	50.0	33.0	48.0
7	6.4	5.2	5.9	8	5	7	13.0	9.0	12.7	1.8	0.9	1.5	49.0	41.0	45.0
8	6.3	5.2	6.0	8	6	7	10.7	7.6	10.5	1.7	0.4	1.5	56.0	33.0	53.0
9	6.2	5.1	5.9	8	6	7	12.1	6.9	11.9	1.7	0.5	1.6	65.0	31.0	61.0
10	6.2	5.2	5.8	9	7	8	11.5	7.5	11.2	1.2	0.9	1.1	63.0	30.0	60.0
11	6.8	5.2	6.5	9	7	8	10.7	7.8	10.5	1.9	0.5	1.8	70.0	42.0	67.0
12	6.6	5.3	6.2	8	6	7	10.9	9.1	10.6	1.4	0.4	1.2	69.0	45.0	65.0
13	7.0	5.2	6.8	7	5	7	11.6	9.2	11.5	1.9	1.1	1.5	68.0	44.0	63.0
14	7.1	5.4	6.9	9	6	7	10.1	9.0	10.0	2.0	1.3	1.8	52.0	32.0	50.0
15	6.7	5.5	6.3	8	5	8	13.3	7.2	12.9	1.6	1.2	1.2	64.0	47.0	62.0
16	6.8	5.4	6.1	9	5	8	12.6	7.1	12.3	1.5	0.6	1.3	53.0	38.0	50.0
17	7.3	5.2	6.9	9	6	8	12.2	7.0	12.0	2.1	1.2	1.9	57.0	32.0	54.0
18	8.0	6.0	7.2	8	6	7	11.8	8.2	11.4	2.5	0.6	2.1	70.0	45.0	67.0
19	6.9	6.0	6.3	9	6	8	11.3	8.3	11.0	2.3	0.4	2.0	62.0	43.0	60.0
20	7.0	6.0	6.7	8	6	7	12.1	8.7	11.9	2.6	0.3	2.3	52.0	42.0	50.0

** B- Black soil ,R-Red soil, R+N –Red soil with nutrients

The sand content of red soil ranged from 50 - 75 %.The silt content ranged from 5 - 30 % and clay content ranged from 10.4 - 22.5 % in red soil of Wardha region. It indicates that the texture of red soils of Wardha region was found to vary from sandy clay loam, sandy loam, loam and loamy sand. The sand content of black soil ranged from 0.2 - 3.2%. The silt content ranged from 27.0 - 59.7%. and clay content ranged from 38.7 - 72.1%. The bulk densities of red soil of Wardha region varied between 1.22 - 1.57 Mgm^{-3} whereas the bulk densities of black soil of Wardha region varied between 1.68 - 1.76 Mgm^{-3}. The available maximum water holding capacity of red soil of Wardha region obtained in between 14.0 - 29.17% where as the available water holding capacity of black soil obtained in between 39.5 - 60%. pH of red soil of Wardha region ranged from 5.1 - 6.7 and pH of black soil ranged from 6.5 - 7.5. The electrical conductivity values of red soil of Wardha region ranged from 0.14 - 0.23 dSm^{-1} whereas the electrical conductivity values of black soil of Wardha region ranged from 0.31 – 1.03 dSm^{-1}. Free calcium carbonate ($CaCO_3$) in red soils of Wardha region ranged from 0.1- 0.6% whereas in black soil, $CaCO_3$ ranged from 3.9 – 11.8%. The organic carbon content of red soil varied from 0.15 - 0.38 % whereas black soil varied from 0.59 - 0.88%. CEC of red soil of Wardha region ranged from 7.2 - 17.9 cmol (p+) Kg^{-1}, whereas CEC of black soil ranged from 36.9 - 45.1cmol (p+) Kg^{-1}. The available nitrogen content in all red soil of Wardha region, ranged from 140 - 219 Kg/ha whereas the available nitrogen content in all black soil of Wardha region ranging between 179 - 226.5 Kg/ha. The available phosphorus content in red soil is ranges between 11.8 - 20.30 Kg/ha whereas the available phosphorus content in black soil is ranges from 28.6 - 34.00 Kg/ha. In red soil of Wardha region available potassium ranging between 205 - 367 Kg/ha and the available potassium content in black soil is ranges from 366.5 - 411.6 Kg/ha. Available Cu in all red soil in Wardha region is ranged between 2.77 - 7.10 ppm whereas available Cu in all black soil, of Wardha region is ranged in between 2.7 - 7.8 ppm. Available iron in red soil of Wardha region ranged between 7.12 - 22.52 ppm whereas the available iron in black soil of Wardha region is ranged from 1.6 - 3.5 ppm. The available manganese in red soil of Wardha region is ranged from 8.70 - 26.97 ppm whereas the available manganese in black soil of Wardha region is ranged from 18.6 - 31.5 ppm.

The characteristics and properties obtained after soil analysis plays a very important role on the growth and productivity of the plant. Measurement of plant growth in red soil, red soil with nutrients and black soil is carried out by using various growth parameters.

CONCLUSION-

From the above result it is concluded that the sand content of the red soils is higher whereas the black soil contain higher percentage of clay. Bulk density of red soil is lower due to low clay content. The maximum water holding capacity of red soil of Wardha region was relatively low compared to black soil which is due to amount of clay content and organic matter. pH of red soil was neutral to slightly acidic in nature whereas the black soil was moderately to strongly alkaline. The percentage of calcium carbonate is more in black soil as compared to red soil. The soil organic carbon data shows that red soil is very low in organic carbon content. The cation exchange capacity of red soil of Wardha region was found to be low as compared to black soil of Wardha region. The available nitrogen, phosphorus and potassium content of red soil are low. Fe content is higher in red soil than Cu and Mn where as Red soil is low in Zn. Productivity is associated with nutrient status, physical condition and chemical condition of the soil. Results indicates that, Plant height, number of leaves, fresh weight, dry weight and leaf area of all plants under experimentation in black soil is high compared to red soil and red soil with nutrients. These growth parameters show significant change after application of nutrients in red soil. Variation in growth parameters in these soils is due to difference in values of physicochemical properties and nutrient status.

It is observed that growth of plants under experimentation in red soil showed poor growth compared to black soil due to sandy texture, less water holding capacity, low pH and CEC, low amount of organic matter and nutrient deficiency. Red soil with nutrients showed better growth as compared to red soil and is in close proximity to black soil. From this it is concluded that red soil of Wardha region is less fertile and hence it needs to enhance by integrated nutrient management.

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REFERENCES

[1] . Zende, G. K. 1988. Fertility management for higher sugar production. Maharashtra sugar 9(4): 9- 25.

[2].Velayutham, M and Bhattacharyya, T. Soil resource management. Proceedings of, *International Conference on Managing Natural Resources for Sustainable Agricultural Production,* in the 21st Century, New Delhi (2000).

[3].Lal, R. and B.R. Singh. Effect of soil degradation on crop productivity in East Africa. *Journal of Sustainable Agriculture*,13 (1): (1998), Pp. 15-41.

[4].Moraes, M.H., Perez Gomar, E., Benez, S.H., and Barilli, *J. Effects of Long-Term Management Systems on Soil Quality*, (12th ISCO Conference Beijing) 2002, Pp.1-6.

[5].Shukla A.K., Tiwari B. K,, R.R. Mishra, , *Journal of Rev. Eco. Biol. sol*, 26(3) (1989) Pp.249-265.

[6].Achalu Chimdi, Heluf Gebrekidan, Kibebew Kibret, Abi Tadesse, *Journal of Biodiversity and Environmental Sciences (JBES)*, Vol. 2, No. 3, (2012) Pp. 57-71.

[7].Sharma K.L. Principal Scientist and National Fellow (ICAR) Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad, Soil quality improvement and assessment in relation to conservation agricultural pp.1-10.

[8].Curl E.H.and Truelove. B., "The Rhizoshere".springer verlag.New York.(1986) pp.228.

[9]. R.I. and Parr J.F., *American Journal of Alternative Agriculture*, 7 (12) (1992) Pp.2-3.

[10]. Kanwar, J. S., Characterization and classification of Chandapuri watershed in Rajasthan. Journal of the Indian Society of Soil Science, (1994) pp.42: 245-255.

[11].G.T. Bouyoucous. *Agronomic journal*, 54, (1962), Pp. 464-465.

[12].Black. C.A. *Methods of soil analysis part I and II* (American society of Agronomic pub.no.9, Inc. Madison. Wisconsin. USA.), 1965, Pp.18-25.

[13]. C.S., *Soil and plant Analysis,* (Inter science publishers, Inc. New York), 1966.

[14].Jackson M. l. *Soil Chemical Analysis*, (Prentice Hall of India private limited, New Delhi), 1973.

[15]Richard, L.A, *Diagnosis and Improvement of saline and Alkali soils*, (Agril. Handbook Co, USDA, Washington, D.C), 60, 1954.

[16] . A and Black, I.A, *journal of soil science,* (1934), Pp.29-38

[17]Anonymous., *Soil Resource Mapping of Different State in India (Laboratory methods)* (NBSS and LUP publication. Nagpur, India), 1987.

[18]Subbiah V.V. and G.K. Asiaja, journal *of Cure .Sci*.26 ;(1956), Pp.258-260

[19] Olsen S.R. Cole, C.V. Watanable F.S. and Dean, L.A., *U.S. Dept. of Agriculture Circular* 939,(1954), pp.19-23.

[20] Page A.L, Miller R.H. and Keeney D.R. *Methods of soil analysis, Part II, Soil science society of America*, (Inc. publishers, Madison,Wiscosin. USA.), 1989, Pp. 21-22.

[21] Hanway, J.J and H. Hiedal, *Agric. Bull*. 57, (1954)1-13.

[22] Lindsay W. L. and Norvell, *soil science society American journal*. 42, (1978), Pp.421-428.