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Effect of Organic Matter on the Electrical Parameters of Soil Samples from Western Ghat Zone of Maharashtra

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***Abstract*—The soil sample from various localities of Western Ghat of Maharashtra,(Igatpuri) was undertaken. The experiment was conducted on silt clay loam soil in Igatpuri (Nashik district, Maharashtra, India) to determine the effect of organic matter of soil on its electrical parameters. The soil characterization was carried out with respect to particle size, bulk density, water holding capacity, hydraulic conductivity, soil pH N,P,K, Iron, Manganese , Zinc, Copper, Electrical conductivity, free calcium carbonate and organic carbon.An automated X-bandmicrowave set-up in the TE_{10} mode with Reflex Klystron source operating at frequency 9 GHz is used for measuring dielectric constants. These properties are important in better understanding of soil physics, agricultural application and analyzing the satellite data in remotesensing. A study of soil profile supplemented by physical and chemical properties of the soil will give full picture of soil fertility and productivity. Every soil has its natural fertility, which differs from soil-to-soil. In the world, cropping pattern is not same; it changes from one place to another place with response to types of their soil and its characteristics. It is observed that continuous rice-based cropping systems are implicated for increased bulk density of soil, irrespective of soil types.**

***Keywords*—Dielectric constant, tangent loss, microwave conductivity, relaxation time, moisture content**

I. Introduction

Land is the basic resource of human society. Its utilization shows a reciprocal relationship between ecological conditions of a region and man. Proper nutrition is essential for satisfactory crop growth and production. The use of soil tests can help to determine the status of plant available nutrients to develop fertilizer recommendations to achieve optimum crop production. The profit potential for farmers depends on producing enough crop per acre to keep production costs below the selling price. Efficient application of the correct types and amounts of fertilizers for the supply of the nutrients is an important part of achieving profitable yields.

There are at least 16 elements known to be essential for plant growth. Carbon (C), hydrogen (H), and oxygen (O) are derived from carbon dioxide (CO_2) and water (H_2O). Nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), magnesium (Mg), boron (B), chlorine(Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn) are normally derived from the soil in the form of inorganic salts. Ninety-four to 99.5 per cent of fresh plant material is made up of carbon, hydrogen and oxygen. The other nutrients make up the remaining 0.5 to 6.0 percent.

The ecosystem characteristics of soil microorganism and the nutrient uptake of irrigated rice were investigated in a split-block experiment with different fertilization treatments, including control (no fertilizer application), PK, NK, NP, NPK fertilization, in the main block, and conventional rice and hybrid rice comparison, in the sub block (1). Soil is an intimate mixture of organic and inorganic materials, water and air. The relative amount of air and water present depends on way the soil particles are packed together. Soil texture is characterized by percentage of sand, silt and clay in it.

Soil is major natural resource, having large diversity of ecosystem services and goods, which provide many tangible and intangible benefits to human being (Daily et al. 1997) During some last few decades researches on soil quality and education program have been increased all over the world (Karlen et al., 2003). Soil quality can be defined as "the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation" (Karlen et al., 1997)

II. LITERATURE REVIEW

Due to dependence of dielectric constant on the physical constituents and chemical composition of the soil, the study of its variability with physical constituents and chemical composition is required. The dielectric constant of Indian soils is dependent on the texture of soil i.e. the percent content of sand, slit and clay. Significant positive correlation of dielectric constant with sand content of soil and negative correlation with clay and silt content of soil was observed.(2) . The dielectric constant varies with the status of nutrients available in soil. (3) The measurement of dielectric constant of soil as a function of moisture content has been carried out over wide frequency range in the past several years using soils of widely different texture structures by Wang and Schmugge (4). Soil texture can be expressed significantly by its electrical conductivity and dielectric constant. Clay textured soil is highly conductive while sandy soils are poor conductors; reported by Marx et al (5). The dielectric constant of soil is a measure of the response of a soil to electromagnetic waves. This response is composed of two parts, real & imaginary, which determine wave velocity and energy losses respectively (6). It has been observed that the dielectric constant of soils depend on the moisture content in the soils and frequency of measurement. Dielectric constant of soils increases slowly with increase in the moisture content in the soil up to the transition moisture, after which it increases rapidlywithmoisturecontent.(7)

The present work provides the information about dielectric constant of soils of western ghat of Maharashtra at X - band microwave frequency 9 GHz and its relationship with the physical parameters of ten soil samples collected from different locations of Igatpuri.

III. MATERIALS AND METHODS

Soil samples were collected from ten different agricultural land of Igatpuri Tahsil, Nasik, Maharashtra. Igatpuri is a town and a Hill Station Igatpuri is surrounded by the highest peaks in Sahyaadri i.e. Western Ghats council in Nashik District in the Indian state of Maharashtra. Soil samples were collected in the depth of 0-20cm from desired location.
The details of the land are given below.

Table No.1: Details of the land

Sample No.	Name of the farmer	Survey No.	Area	Latitude	Longitude	Previous crop	New crop
1	Kondaji Khandu Tokade	35	Deole	19°72"39'	73°65"11'	Masur, Harbhara	Rice
2	Dinanath Pandurang Bhagat	53	Take (Ghoti)	19°70"42'	73°61"09'	Tomato, Chilly	Rice
3	Gopal Dharma Jagtap	7477	Talegaon	19°68"73'	73°55"92'	Rice	Rice
4	Arun Haribhau Jadhav	350/3	Alwand	19°71"59'	73°60"86'	Groundnut, Bajra, Udad	Rice
5	Nivrutti Namdeo Chaudhari	572	Khambale	19°74"06'	73°63"78'	Brijal	Rice
6	Shravan Savliram Potkule	118	Senvad	19°77"82'	73°67"31'	Rice	Rice
7	Dashrath Muralidhar Malunjkar	54	Wadiwarhe	19°86"13'	73°67"87'	Groundnut, Soyabean	Grapes, Soyabean
8	Kailas Thakaji Mate	375	Morambi	19°85"10'	73°65"52'	Rice	Rice, Tomato
9	Santu Rama Sarai	316/B	Kushegaon	19°86"42'	73°57"87'	Wheat, Brinjal, Cucumber	Rice
10	Trimbak Kishan Mahale	29	Wanjole	19°83"60'	73°56"66'	Onion	Rice

Soil samples were completely air dried and passed through 2mm sieve and stored in properly labelled cloth bags as per the standard procedures. Quartering technique was used for the preparation of soil samples. The sieved out particles are then oven dried to a temperature around 110^0 C for several hours in order to completely remove any trace of moisture. Such dry sample is then called as oven dry or dry base sample when compared with wet samples. The choices of measurement technique, equipment, and sample holder design depend upon the dielectric materials to be measured, and the frequency or frequency range of interest (8).

Table No.2: Physical characteristics

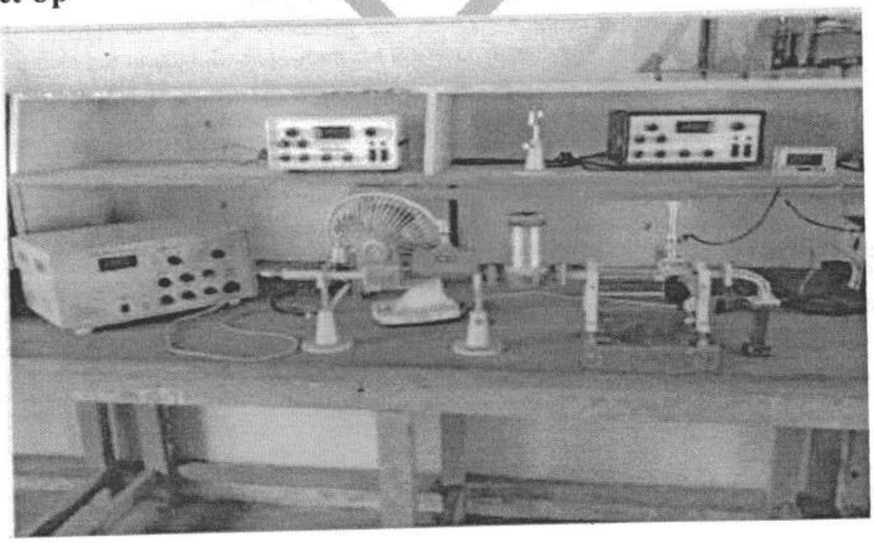
Sample No.	Bulk Density(gmcm-1)	Particle Density (gmcm-1)	Water holding capacity(%)	Hydraulic conductivity (cm/hr)	Sand (%)	Silt (%)	Clay (%)	Textural Class
1	1.22	2.63	48	3.95Moderate	47.22	37.45	15.33	Loam
2	1.29	2.47	39	4.52Moderate	52.5	31.75	15.75	Sandy Loam
3	1.42	2.42	46	4.23Moderate	57.75	26	16.25	Sandy Loam
4	1.21	2.46	44	3.95Moderate	47.82	45.1	7.08	Loam
5	1.2	2.22	48	3.95Moderate	48.25	38.75	13	Loam
6	1.21	2.3	41	3.53Moderate	73.82	22.58	3.6	Loamy Sand
7	1.17	2.16	47	3.1Moderate	42.25	40.25	17.5	Loam
8	1.21	2.17	45	3.1Moderate	41	34.25	24.75	Loam
9	1.2	2.16	48	4.94Moderate	67.77	13	19.23	Sandy Loam
10	1.29	2.04	42	4.23Moderate	64.05	21.93	14.02	Sandy Loam

Table No.3: Chemical characteristics

Sample No.	Ph (1:2.5)	Electric cond (dSm-1)	Organic Carbon (%)	Calcium Carbonate (%)	Avai. Nitrogen (kgha-1)	Avai. Phosphorus (kgha-1)	Avai. Potassium (kgha-1)	Iron (ppm)	Manganese(ppm)	Zinc (ppm)	Copper (ppm)
1	7.26 Neutral	0.21 Normal	0.39 Low	3 Moderately Calcareous	90 Very Low	8.04 Low	150 Low	9.01 High	11.04 High	0.85 High	5.76 High
2	7.01 Neutral	0.32 Normal	0.11 Very Low	2.5 Moderately Calcareous	90 Very Low	24.12 Moderately High	192 Medium	8.52 High	11.44 High	1.17 High	4.1 High
3	7.11 Neutral	0.21 Normal	0.66 Moderately High	1 Barely Calcareous	135 Very Low	17.74 Medium	222 Moderately High	10.00 High	11.77 High	5.4 High	4.78 High
4	7.19 Neutral	0.2 Normal	0.29 Low	0.5 Barely Calcareous	147 Low	20.51 Medium	249 Moderately High	12.34 High	10.97 High	2.23 High	5.95 High
5	7.32 Neutral	0.15 Normal	0.23 Low	2.5 Moderately Calcareous	147 Low	9.98	269 High	9.49 High	11.17 High	0.95 High	3.8 High
6	7.37 Neutral	0.13 Normal	0.64 Moderately High	2.5 Moderately Calcareous	135 Very Low	2.22 Very Low	297 High	9.03 High	10.69 High	0 Low	4.3 High
7	7.28 Neutral	0.29 Normal	1 High	1.25 Slightly Calcareous	158 Low	118.64 Very High	339 Very High	6.5 High	11.44 High	8.22 High	7.84 High
8	7.65 Mildly Alkaline	0.13 Normal	0.55 Medium	0.75 Barely Calcareous	124 Very Low	7.48 Low	357 Very High	4.81 High	10.73 High	4.11 High	2.96 High
9	7.57 Mildly Alkaline	0.14 Normal	0.93 High	0.75 Barely Calcareous	147 Low	69.03 Very High	237 Very High	7.16 High	11.77 High	0.04 Low	4.84 High
10	7.28 Neutral	0.35 Normal	0.81 High	0.25 Non Calcareous	147 Low	64.87 Very High	407 Very High	8.85 High	11.44 High	0 Low	2.69 High

In the present paper, Two Point Method has been used to measure the dielectric constant of the soil. The waveguide cell method is used to determine dielectric constant of the soil samples. The X band microwave bench is set up in TE10 mode with Gunn Source operating at X band frequencies at room temperature. The dielectric cell shorted with matched load is connected at load end. The reflected wave combined with incidental wave to give standing wave pattern. These standing wave patterns are used to determine the values of shift in minima resulted due to before and after inserting the sample. In this measurement the technique used is the infinite sample method (9). An X band microwave bench operating at 9 GHz in the TE10 mode with slotted section and crystal detector are used for measurement of VSWR and the shift of minima is needed in this technique.

IV. Experimental Set Up



Micronutrient-use efficiency (grain yield per unit nutrient applied) was in the order of Cu > Zn > Mn > Fe > Mo > B.(10) .Although soil has a profound effect on agriculture it is a derived factor of rocks, climate, vegetation and time together. Soil is the fundamental medium for crops. It acts as a bond or link between biotic and a biotic components. Soil has certain physical chemical and biological elements in it, which determine the thickness, structure and fertility of the soil. Jainedra Kumar (1985) has rightly pointed out the need for careful study of soil in order to make efficient land use as soil provides basic nutrients to plants for longer than chemical fertilizers. Soil texture has remarkable effect on the dielectric properties. The dielectric constant of soil is a measure of the response of a soil to electromagnetic waves. This response is composed of two parts, real & imaginary, which determine wave velocity and energy losses respectively. These soil samples are sieved by sieve shaker to remove the coarse particles. This fine particles are then oven dried for several hours to remove moisture. Soil samples of various moisture are prepared by adding an exact amount of distilled water to dry soil. The gravimetric soil moisture content in percentage Wc [%]. is calculated using wet [W_1]. and dry [W_2]. soil masses using the following relation

$$W_p = 0.06774 - 0.00064 \times sand + 0.00478 \times clay \quad \text{..........(2)}$$

$$W_t = 0.49 \times W_p + 0.165 \quad \text{..........(3)}$$

Rice can be cultivated under a variety of climatic and soil conditions. Rice comes up well in different soil types. For normal growth, a pH range of 5.0-8.0 is suitable.Different Climatic Factors Affecting Rice Cultivation There are many varieties of rice which are cultivated with differential response to climatic factors, such as :

V. RAINFALL

Rainfall is the most important weather element for successful cultivation of rice. The distribution of rainfall in different regions is greatly influenced by the physical features of the terrain, the situation of the mountains and plateau.

VI. TEMPERATURE

Temperature is another climatic factor which has a favorable and in some cases unfavorable influence on the development, growth and yield of rice. Rice being a tropical and sub-tropical plant, requires a fairly high temperature, ranging from 20° to 40°C. The optimum temperature of 30°C during day time and 20°C during night time seems to be more favorable for the development and growth of rice crop. . Rice cultivation is conditioned by temperature parameters at the different phases of growth. The critical mean temperature for flowering and fertilization ranges from 16 to 20^0C, whereas, during ripening, the range is from 18 to 32^0C. Temperature beyond 35^0C affects grain filling. Three Seasons for Rice Cultivation There are three seasons for growing rice. These three seasons are named according to the season of harvest of the crop.

- Autumn Rice/Pre-Kharif Rice
- Summer Rice/Rabi Rice
- Winter Rice/Kharif Rice

Sunlight is very essential for the development and growth of the plants. In fact, sunlight is the source of energy for plant life. The yield of rice is influenced by the solar radiation particularly during the last 35 to 45 days of its ripening period. The effect of solar radiation is more profound where water, temperature and nitrogenous nutrients are not limiting factors. Bright sunshine with low temperature during ripening period of the crop helps in the development of carbohydrates in the grains.

Therefore, the rice growing seasons vary in different parts, depending upon temperature, rainfall, soil types, water availability and other climatic conditions. If the mean temperature is found favorable for rice cultivation throughout the year then, two or three crops of rice are grown in a year. Where rainfall is high and winter temperature is fairly low, only one crop of rice is grown. Rice cultivation has been carried into all regions having the necessary warmth and abundant moisture favorable to its growth, mainly subtropical rather than hot or cold. Experts point out that, rice is grown in such varied soil conditions that it is difficult to point out the soil on which it cannot be grown. However, soils having

- Good water retention capacity.
- Good amount of clay and organic matter are considered ideal for rice cultivation.

It grows well in soils having a pH range between 5.5 and 6.5. The classification of soils has been done depending upon the soil texture, colour of the soil etc. At microwave frequencies (generally about 1 GHz and higher), transmission line waveguide, coaxial line, resonant cavity, and free space techniques are commonly used. Transmission line techniques are not cumbersome because they do not require special sample preparation. The dielectric properties can be measured easily by this technique with the use of slotted line and standing wave indicator.(11) The mineral fraction of soil contains particles of widely varying sizes, shapes and chemical compositions. The properties of soil are mainly classified into three groups i) Physical ii) Chemical & iii) Electrical. The electrical properties of material are mainly the permittivity and permeability.

Table No.4 Electrical Properties of Igatpuri

Sample no.	Mean		tanδ=ε''/ε'	σ=ωε0ε''	Γ=ε''ωε'	emissivity
	ε'	ε''				
1	0.43935	0.027480	0.0625469	0.013592823	674803007	0.95888624
2	0.43815	0.026405	0.0602647	0.013061080	646634152	0.95861996
3	0.48170	0.035335	0.0733548	0.017478253	951330438	0.96738169
4	0.48225	0.039815	0.0825609	0.019694259	1073170205	0.96748130
5	0.43825	0.026465	0.0603879	0.013090759	648251415	0.95864221
6	0.42825	0.025910	0.0605020	0.012816231	620175257	0.95636432
7	0.43925	0.027360	0.0622880	0.013533465	671703349	0.95886411
8	0.43690	0.026410	0.0604486	0.013063553	644911463	0.95834097
9	0.48010	0.034760	0.0724016	0.017193832	932741122	0.96709044
10	0.48250	0.039615	0.0821036	0.019595330	1068332962	0.96752650

The electrical characteristic of every material is dependent on its dielectric properties. Laboratory studies of dielectric properties of soils with varied moisture, texture, temperature density, as well as other chemical and physical properties of soils are very important in correlating remotely sensed data with actual field conditions and in distinguishing targets having identical dielectric properties.(12) Electric conductivity of soil has significant correlation with the texture of soil.(13)

VII. RESULT AND DISCUSSION

Rice is a crop of tropical climate. However, it is also grown successfully in humid to sub-humid regions under subtropical and temperate climate. Rice is cultivated in almost all types of soils with varying productivity. Under high temperature, high humidity with sufficient rainfall and irrigation facilities, rice can be grown in any type of soil. The major soil groups where rice is grown are riverine alluvium, red-yellow, red loamy, hill and sub-montane, Terai, laterite, costal alluvium, red sandy, mixed red and black and medium and shallow black soils. Depending upon the climate and water availability rice is grown in all the three seasons, i.e. Kharif, Rabi and summer. Depending upon the variety crop duration vary from 100 to 150 days. In northern and western India (J and K, Himachal Pradesh, Punjab, Haryana, Uttaranchal, Uttar Pradesh Gujrat, Rajasthan, Maharashtra) rice is grown mainly in Kharif, while in southern and eastern India it is grown round the year in three seasons with varying sowing time and periods. Rice is the main staple food in Asia, where about 90% of the world's rice is produced and consumed. China is the world's biggest producer, growing one-third of Asia's total on 29 million ha. India produces nearly a quarter on 43 million ha. Farmers in Asia achieve, on average, about 60% only of the yield potentially achievable with existing varieties and climatic conditions. About 75% of the global rice production comes from irrigated rice systems, because most rice varieties express their full yield potential when water supply is adequate. Modern high-yielding rice varieties absorb potassium in greater quantities than any other essential nutrient.Proper phosphorus (P) nutrition is critical for producing maximum rice grain yields. Phosphorus is very important in the early vegetative growth stages. Phosphorus promotes strong early plant growth and development of a strong root system. (14) Nitrogen increases plant height, panicle number, leaf size, spikelet number, and number of filled spikelets, which largely determine the yield capacity of a rice plant. Proper phosphorus (P) nutrition is critical for producing maximum rice grain yields. Phosphorus is very important in the early vegetative growth stages. Phosphorus promotes strong early plant growth and development of a strong root system. It is important to rice plants because it promotes tillering, root development, early flowering, and ripening.Often P deficiency in rice is referred to as a "hidden hunger" because the symptoms are not apparent unless P-deficient plants are directly compared with plants that have sufficient P. When compared with healthy rice of the same age, P-deficient rice is characterized by an abnormal bluish green color of the foliage with poor tillering and plants that are slow to canopy and slow to mature. When plant comparisons are not available, plant tissue testing is the best tool for diagnosis of P deficiency.Rice plants that are deficient in P are stunted and dirty-dark green, and they have erect leaves, relatively few tillers, and decreased root mass.

From observation table, it is observed that in soil of western ghat avaibility of phosphorus and potassium is sufficient. The available iron zinc copper and manganese are in proper extent.ie, suitable for the rice crop.

VIII. CONCLUSION

Rice can be cultivated under a variety of climatic and soil conditions. Rice comes up well in different soil types. For normal growth, a pH range of 5.0-8.0 is suitable. It is observed that soil pH in the range of 7.01-7.57.Also soils in the Western Ghat of Maharashtra ie, Igatpuri are high in available phosphorus and potassium and moderate in organic matter and nitrogen.So rice is successfully grown in Western Ghat of Maharashtra ie, Igatpuri.The results have importance not only for better understanding of soil physics but also microwave remote sensing application.

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