Estimation of Dielectric Constant of Herbal Based Soil In Relation to Microwave Remote Sensing

Meenakshi Chandra[1], A. K. Shrivastava[2*], Prachi Tiwari[3]

[1,3] Research Scholar, Dr. C V Raman University Kota, Bilaspur Chhattisgarh India
[2]Dean, Faculty of Science , Dr. C V Raman University Kota , Bilaspur Chhattisgarh India
Email: meenakshichandra2011@gmail.com[1], drakshrivastava01@gmail.com[2]
*Corresponding Author

Received: 10.07.2024 Revised: 12.08.2024 Accepted: 22.09.2024

ABSTRACT
In this paper an attempt has been made by authors to estimate dielectric constant of herbal based soil of Chhattisgarh state. Soil Physics is a new research area in present scenario. Microwave remote sensing dielectric behaviour of soil helps in agricultural production in the form of cultivation. Soil is very important for human being. From the very childhood I was extremely impressed with civilization, culture, agriculture, farming, day to day life, and challenges of Achanakmar Tiger Reserve. The doctor, so called Baiga, Baba, Hakim used to forest plant for treatment. There are a lot of plant which are beneficial in diseases. In my point of view there are some specific properties in soil also. Now it has been correlated with Soil Physics, herbal based soil and Ethnobotany. Herbal based plants are the panacea for rural people as well as tribal area. The tribal people depend on forests for their livelihood and most of the rural people still depend on traditional medicine as a primary healthcare source. India is rich in medicinal plant diversity which is distributed in different geographical, environmental conditions and associated tribal and folk knowledge systems. This research is interdisciplinary and covers ethnobotany. Ethnobotany is the organized study of the relationship between plants and human. Plants are related with soil and soil is related with Soil Physics. Remote sensing is the backbone of the space programme. Remote sensing plays a prominent role in many domains related to the observation of the earth such as agriculture monitoring, military battles, and cover, oceanography, etc. the art of measuring an object or entity without touching it. "The science and art of obtaining information about an object, area or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation". Again it has been stated that dielectric constant of herbal based soil plays pivotal role in production of grains. Further it has been observed that the dielectric constant of dry soil varies in between 3.01 to 3.13

Keywords: Microwave, dielectric constant, agriculture, herbal, ethnobotany, soil.

INTRODUCTION

It is well known that from one giga hertz to three hundred giga hertz is known as microwave. The frequency ranges play pivotal role in research to achieve desired result. There are so many frequency bands such as S, L, C, K, Ku, and X, etc. All bands are important and has own importance. Textural analysis refers to relative proportion of several size groups of individual soil grains in a mass of soil. Physical properties play an important role in microwave dielectric characterization of soil. Solid phase of the mineral soil mainly consists of discrete mineral particles as the amount of amorphous material including organic matter is usually small. Mineral particles are not exactly spherical but vary widely in their shape; therefore, these particles are usually classified into three conveniently separable groups according to certain size range based on their equivalent diameter. The groups of different size range of mineral particles are known as soil separates, primary particles or textural fractions, namely: sand, silt and clay. Soil texture refers to the prominent size range of mineral particles, and is defined both qualitatively and quantitively. Qualitatively, it refers to the feel of soil whether coarse and gritty or fine and smooth when rubbed between thumb and forefinger. Quantitatively, soil texture is the relative proportion of sand, silt and clay content on weight basis. The term soil texture is often used interchangeably with mechanical composition of soil. It is more or less a static property affecting almost all other soil properties. Land use capability and soil management practices largely depend on the texture. Soil particles of size less than 2 mm in diameter are included in the classification and are considered as soil material normally used in soil analysis. Some soils contain large sized particles which may create problem in tillage operations but do

not contribute substantially to important soil properties. The particles greater than 2 mm are known as gravels (2-4 mm), pebbles (4-76 mm), cobbles (76-250), stones (250-600 mm), and still larger (>600 mm) as boulders. Systems of classification of soil particles according to their size are given by table as,

Table 1: Systems of Classification of Soil Particles According to Their Size

International Society of Soil Science (ISSS)		United States Department of Agriculture (USDA)	
Particle	Diameter (mm)	Particle	Diameter (mm)
Coarse Sand	2.0-0.2	Very Coarse Sand	2.0-1.0
Fine Sand	0.2-0.02	Coarse Sand	1.0-0.5
Silt	0.02-0.002	Medium Sand	0.5-0.25
Clay	<0.002	Fine Sand	0.25-0.10
		Very fine Sand	0.10-0.05
		Silt	0.05-0.002
		Clay	<0.002

Sand, silt and clay have different properties. The properties of texture is given in table as,

Table 2: Properties of Sand, Silt and Clay

Particle	Properties
Sand	Visible to naked eye, generally spherical or cubical in shape, feel gritty, low water and nutrients holding capacity, loose when dry, very low plasticity and stickiness when wet.
Silt	Not visible to naked eye, seen through an ordinary microscope, generally spherical or cubical in shape, low to medium in capacity to hold water and nutrients, feel smooth, some plasticity and stickiness when wet.
Clay	Visible only through an electron microscope, platy in shape, high water and nutrients holding capacity, hard when dry, high degree of plasticity and stickiness when wet, exhibit swelling and shrinkage behaviour.

The overall textural designation of a soil as determined from the relative proportion of its sand, silt and clay contents is called the textural class. Textural class not only conveys the textural composition of soils but also indicates their physical properties. Soils based on their relative proportions of sand, silt, and clay contents, are classified into twelve textural classes as shown in textural triangle.

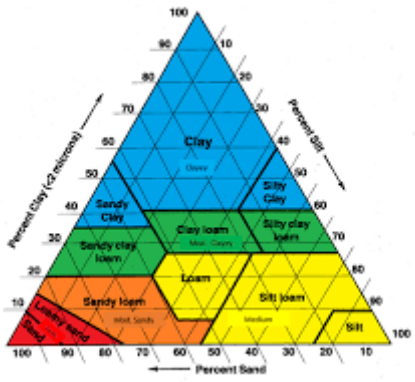

Fig 1: Soil Triangle

Microwave remote sensing plays important role in agriculture as well as agricultural upgradation. Research is very important for researcher's successive development. Nowadays agriculture sector plays an important role in Indian economy. It has been observed that during PANDEMIC period agriculture sector has not affected completely. Soil plays as nucleus in the field of production of grains. Soil is the mixture of rock debris and organic materials which develop on the earth's surface. The Major factors affecting the formation of soil are relief, parent material, climate, vegetation and other life forms and time. Whenever dig a pit on land it has been seen about soil. It has been found that it consists of three layers which are called horizons. 'Horizon A' is the topmost zone, where organic materials have got incorporated with the mineral matter, nutrients and water, which are necessary for the growth of agriculture. 'Horizon

B' is a transition zone between the 'horizon A' and 'horizon C' and contains matter derived from below as well as from above. It has same organic matter in it, although the mineral matter is noticeably weathered. 'Horizon C' is composed of the loose parent material. This layer is the first stage in the soil formation process and eventually forms the above two layers. This arrangement of layers is known as the soil profile. India has varied relief features, land forms, climatic realms and vegetation types. These have contributed in the development of various types of soils in India. In ancient times, soils used to be classified into two main groups – Urvara and Usara, which were fertile and sterile, respectively. In the 16th century A.D., soils were classified on the basis of their inherent characteristics and external features such as texture, colour, slop of land and mixture content in the soil. Based on texture, main soil types are sand, silt and clay. On the basis of colour soil are red, yellow and black etc. After independence soil survey of India (SSI), established in 1956, made comprehensive studies of soils in selected area like in Damodar valley. ICAR has classified the soils of India into the order as per the united State Department of Agriculture (USDA) soil taxonomy.On the basis of genesis colour composition and location, the soils of India have been classified into seven types:

MATERIALS AND METHODS

Soil is the unconsolidated or loose covering of fine rock particles that covers the surface of the earth. The soil water content is most important physical properties of soil. Soil plays pivotal role in agriculture. As a primary motivation to pursue research on the correlation between dielectric properties, physical, chemical properties; it is essential to determine the quality of agricultural products and food materials so as to meet the consumers' expectations that are growing quickly. The dielectric characterization applications in agriculture have been collected along with their techniques and measurements. Indian agriculture occupies an eminent position in global cultivation of rice, wheat, sugarcane, pulses, and vegetables. There is a lot of parameters to affect agriculture product but physical properties, chemical properties, and electrical properties plays pivotal role. Generally the properties are consist of following points viz mass volume relationship of soil constituents, dry bulk density, total weight bulk density, dry specific volume, porosity, void ratio, soil wetness, mass wetness, volume wetness, water volume ratio, degree of saturation, air filled porosity, total porosity, particle size distribution, Stoke's law, soil structure and aggregation, soil structure management, soil color, soil consistency, soil plasticity, plasticity indices, soil compaction, soil crusting, hydration, swelling, specific surface, soil tilth and tillage, soil conditioners, soil water, total soil water potential, gravitational potential, pressure potential, matric potential, pneumatic potential, osmotic potential, soil moisture, water capacity, hysteresis, Darcy's law, hydraulic conductivity, hydraulic fluidity, Reynold number, soil water diffusivity, infiltration, redistribution of soil moisture, soil water balance, evaporation, groundwater drainage, solute transport, diffusion, hydrodynamic dispersion, soil air, soil aeration, thermal properties of soil, soil temperature, soil rheology. Eighteen essential elements are present in the soil. i.e. Molybdenum (MoO_4^{2-}) and Nickel Zinc (Zn^{2+}), Copper (Cu^{2+}), Chlorine (Cl^-), Cobalt (Co^{2+}), Hydrogen (H_2O), Oxygen (O_2, H_2O), (Ni^{2+}), Nitrogen (NO_3^+, NH_4^+), Phosphorus ($H_2PO_4^-, HPO_4^{2-}$), Potassium (K^+), Calcium (Ca_2^+), Magnesium (Mg_2^+), Sulfur (SO_4^{2-}), Iron (Fe^{2+}), Manganise (Mn^{2+}), Boron (HBO_3), Carbon (CO_2). So it will be studied microwave dielectric characterization of soil texture.In this research paper, it has been focused on wave guide cell method. The microwave test benchhasbeen used to determine dielectric properties (dielectric constant and dielectric loss). Therearealot ofbands as L-band, S-band, C-band, X-band, Ku -band.

Sample collection

After getting the research topic, it has been planned as well as designed the process of research work. The targeted research area is surveyed and visited for sampling. The research locations were different places (from beginning to meeting point) of herbal based. Thereare five places from where samples were collected as Auri Gabhra, Raipur; Govt. Agriculture College Bilaspur, Khamanali Nursury Jashpur Nagar, Keshkal Baster and Sirrird Machandra Durg.

Preparation of sample

After collecting the sample the soil is dried and crushed. Nowsieving process is followed to gain fine powder form of soil sample and remove the coarserparticles from the soil. The sieved out particles are then dried in hot air oven to a temperaturearound 110°C for 24 hours in order to remove any trace of moisture. The sample now called MUT(Material Under Testing).The chemical properties of soil are also measured and the samples were analyses for soil pH, Electrical Conductivity, Organic Carbon, Nitrogen, Phosphorous, Potassium, Iron, Manganese, Zinc, Copper, Boron, and Sulfur. The electrical properties (dielectric constant and dielectric loss) at different moisture content are measured from the lab of U. V. S. Mahavidyalaya Latori, Surajpur(C.G.).

Dielectric constant of soil

The table represent the real and imaginary part of dielectric constant at different moisture level (0%, 10%, 20%, 30%, 40%). Moisture content of soil is an important parameter that influences theproperties ofsoil.

Table 3: Dielectric constant and dielectric loss at moisture content (0%,10%,20%,30%,40%)

S.No.	Sample	Realpartofdielectricconstant					Imaginarypartofdielectricconstant				
		Drysoil(0%)	10%	20%	30%	40%	Drysoil(0%)	10%	20%	30%	40%
01	**S_1/ Auri Gabhra, Raipur**	3.01	6.31	11.11	16.56	26.00	0.10	0.19	0.27	1.0	1.23
02	**S_2/ Govt. Agriculture Bilaspur**	3.07	6.47	11.13	16.63	26.17	0.12	0.19	0.33	1.1	1.26
03	**S_3/ Khamananli Nursery**	3.10	6.63	11.18	16.84	26.29	0.14	0.19	0.38	1.5	1.29
04	**S_4/ Keshkal, Baster**	3.13	6.78	11.23	16.93	26.37	0.16	0.21	0.41	1.7	1.33
05	**S_5 /SirrirdMachandraurg**	3.13	6.87	11.27	16.97	26.41	0.19	0.23	0.44	1.8	1.41

RESULT & DISCUSSION

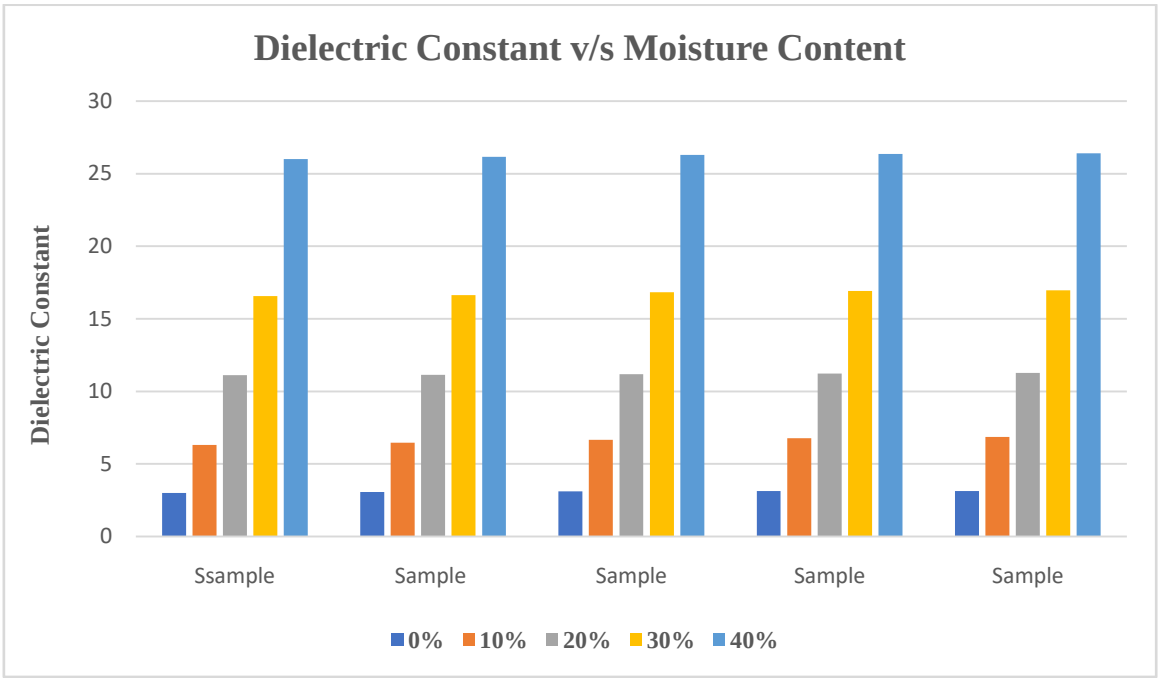

Fig 2 : Dielectric Constant v/s Moisture Content

It has been seen that the value of dielectric constant of dry soil has been found in between 3.01 to 3.13. It has been seen that the value of dielectric constant at 10% moisture has been estimated in between 6.31 to 6.87. It has been seen that the value of dielectric constant at 20% moisture has been estimated in between 11.11 to 11.27. It has been seen that the value of dielectric constant at 30% moisture has been calculated in between 16.56 to 16.97. It has been seen that the value of dielectric constant at 40% moisture has been estimated in between 26.00 to 26.41. Further it has been concluded that dielectric constant is very important and significant role in production as well as agriculture for progressive farmers.

REFERENCES

[1] Afsana Chandani and Biswas Deepa (2020) Study of Some Ethno-Medicinal Wild Edible Plants Used For Several Strong Diseases In District Jashpur, Chhattisgarh, International Research Journal of Multidisciplinary Scope, 1 (4) : 52-60

[2] CallaO.P.N.,(2004), Vivek Ranjan, and Gangadhar L. Naik Estimation of Dielectric Constant of Soil from the Given Texture at Microwave Frequency" Indian Journal of Radio & Space Physics, Vol 33, pp 196-200.

[3] https://www.google.com/search?sca_esv=b4d3f7bebdf6aa5f&rlz=1C1VDKB_enIN1125IN1125&sxsrf=ADLYWIIJHvBvRrwblX4pph9kZJv6Xr6GyA:1729738290316&q=soil+triangle&udm=2&fbs=AEQNm0CvspUPonaF8UH5s_LBD3JPX4RSeMPt9v8oIaeGMh2T2D1DyqhnuPxLgMgOaYPYX7OtOF4SxbM4YPsyWUMdeXRPZhCDnq-5Z-yoSNSuzzuqe-AJEcgubqbZZMyt_grANnsjG430usNqxcfNkddhKrAc7ZdUqqRTe-LY6ueoAHENlT69FE4GZz5taUYsEQezNmmRFXnASP-Ran4mbpidC5JNYU_oow&sa=X&ved=2ahUKEwix0uSigaaJAxWtcGwGHYTjFlIQtKgLegQIDhAB&biw=1536&bih=730&dpr=1.25#imgrc=GrE6h7akJjqxqM&imgdii=cKMzwn_wknCv4M

[4] Mohan Rajesh, (2015), Measurement of Soil Moisture Content At Microwave Frequencies, Science Direct, Procedia Computer Science 46 PP 1238-1245..

[5] Mohan Rajesh, (2015), Study And Analysis of Dielectric Behaviour of Fertilised Soil At Microwave Frequency , EJAET, 2(2): Pp. 73-79.

[6] Narayan Rajeshri (2011), Remote Sensing Characteristics Of Soil At X-Band Microwave Frequency Range (10.45 Ghz), Dissertation, DR.C.V.Raman University, Kota, Bilaspur, Chhattisgarh, India.

[7] Patel Lakhapati (2021). Microwave Remote Sensing Dielectric Behaviour of Soil And Utilization In Agriculture, Scripown Publication, ISBN: 978-93-90833-85-6.

[8] PithoriSuryaraj (2018). Remote Sensing Techniques In Agriculture, Pacific Books International, ISBN: 978-93-86655-84-4.

[9] Shrivastava A.K.(2021). Microwave Dielectric Parameter of Soil Texture, Scripown Publication, ISBN: 978-93-90833-31-3.

[10] Suraj R. H., Jadeyegowda M., Kushalappa C.G., Maheshwarappa V., Chandrashekhar S.Y., (2020), An Ethnobotanical Study Of Medicinal Pteridophytes In Kodagu Region Of Western Ghats India, International Journal of Current Microbiology And Applied Sciences, Vol. 9, No. 10.

[11] Uzun Seyran Palabas and Koca Cennet (2020), Ethnobotanical Survey Of Medicinal Plants Traded In Herbal Markets Of Kahramanmaras, Plant Diversity, https://doi.org./10.1016/j.pld.2020.12.003

[12] Vanderbroek Ina, Pieroni Andrea, Steppp John, (2020), Reshaping The Future Of Ethnobiology Research After The COVID-19 Pandemic, Nature Plants, Vol. 6, 723-730.