Correlations of Environmental Soil and Dielectric Constant with Microwave Remote Sensing

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Abstract

In this research paper an attempt has been made by author to describe soil and dielectric constant. Environment plays pivotal role on soil. Environment is obviously related with soil and soil is also related with environment i.e. vice versa. It has been seen that dielectric constant increases where electrical conductivity increases. Further it has been observed that electrical conductivity increases when percentage of silt and clay although electrical conductivity decreases percentage of sand increases and also bulk density. Again it has been seen that electrical conductivity increases, when porosity, increases.

KEYWORDS: Environment, soil, porosity, electrical conductivity, bulk density.

INTRODUCTION :-

Soils are complex mixture of minerals , water, air, organic matter, and countless organisms that are the decaying remains of once-living things. The properties of soil such as physical properties, chemical properties, geographic properties are really important in production of agriculture. To perform dielectric constant microwave test bench generally used. The parameter of soil affects the production of grains. There are a lot of parameters but moisture content is the very important. In the laboratory the properties of soil are utilized for study which is very useful in agriculture. Now a day a lot of concerned researchers have found out update technology, model and techniques between soil moisture and dielectric properties. Climate also affects the agriculture. There are different methods of measurement of dielectric constant of soil at microwave frequencies. It forms at the source of land – it is the skin of the earth. Soil is capable of supporting plant life and is vital to life on earth. Soil performs many critical functions in almost any ecosystem i.e. farm, forest, grassland, marsh, or suburban water shed. Climate change can have a very big impact on soils and the functions that soil performs. In agriculture, climate changes will affect crop production as changes in soil, air temperature and rainfall affect the ability of crops to reach maturity and their potential harvest. Soil is an important part of the water cyle (or hydrological cycle)- the balances of this will also be affected by climate change. Soil property helps the supply of water and air, which is important to sustain the plat life[1]. Correlations of electrical conductivity and dielectric constant with physic-chemical properties of block soils D.V. Ahire et al.[2] have studied significant positive correlation of electrical conductivity and dielectric constant Martin C. et al. [3] have shown that the electrical conductivity of soil water is a good indicator for absorbing the amount of nutrient available for crops. Soil and dielectric constant in very important in microwave remote sensing . Many researchers have performed as well as showed the importance of dielectric constant, pH, bulk density, electrical

conductivity, sand-silt. clay, porosity, etc. Study of dielectric constant of soil as a function of moisture content at different frequency level were carried out in previous by many researchers. Majority of researchers have showed that the dielectric constant of soils is strongly affected on moisture content. Again Shrivastava S.K. and Mishra G.P[4] analysed the characteiristics of soils of Chhattisgarh at X-band frequency and shown the dependence of dielectric constant of soil on its soil texture of soils. The soil of Chhattisgarh and the soil of north Maharashtra in mostly identical. By knowledge and observation of physical properties, chemical properties, dielectric properties of soil is useful in agriculture to predict quality and fertility of soil[5]. Soil study helps a lot. Wet soil is a mixture of soil particulars , air voids and liquid water[6]. Soil behaviour of a region is an important part in relation to sustainable agricultural production. The macronutrients and micronutrients are important soil element that control its fertility[7]. It has been seen that the dielectric constant of soils depend an the moisture constant in the soils and frequency of measurement . Dielectric constant of soils increases slowly with increase in the moisture content in the soil up to transition moisture[8].

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(2016). Indian agriculture occupies an eminent position in global cultivation of rice, wheat, sugarcane, pulses, and vegetables. There are a lot of parameter to affect agriculture product but physical properties, chemical properties, and electrical properties plays pivotal role. Generally **physical properties** are consist of following points viz :

Sand : %
Silt : %
Clay : %
Bulk density : mgm^{-3}
Particle density : mgm^{-3}
Maximum water holding capacity : %
Porosity : %
Wilting point : W_p
Field capacity
Transition moisture.: W_t

Chemical properties:

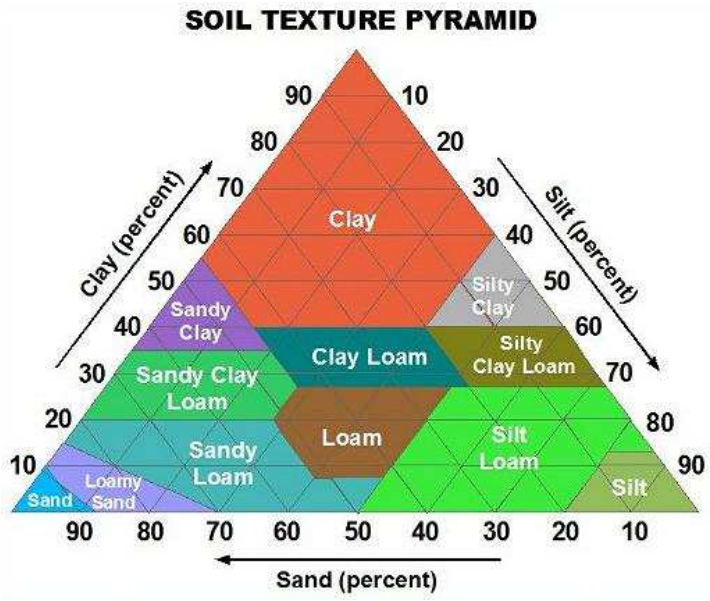
pH
E.C. :(dSm^{-1})
Organic carbon : %
Calcium carbonate :%
Available nitrogen : Kg/ha
Available phosphorus : Kg/ha
Available potassium : Kg/ha
Available iron : ppm
Available manganese : ppm
Available zinc : ppm
Available copper : ppm

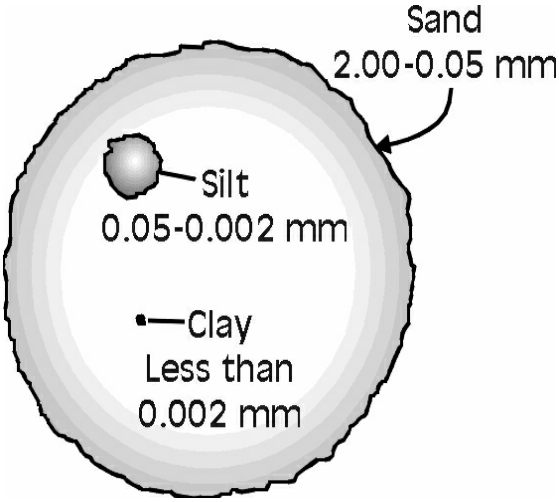
Electrical Properties :

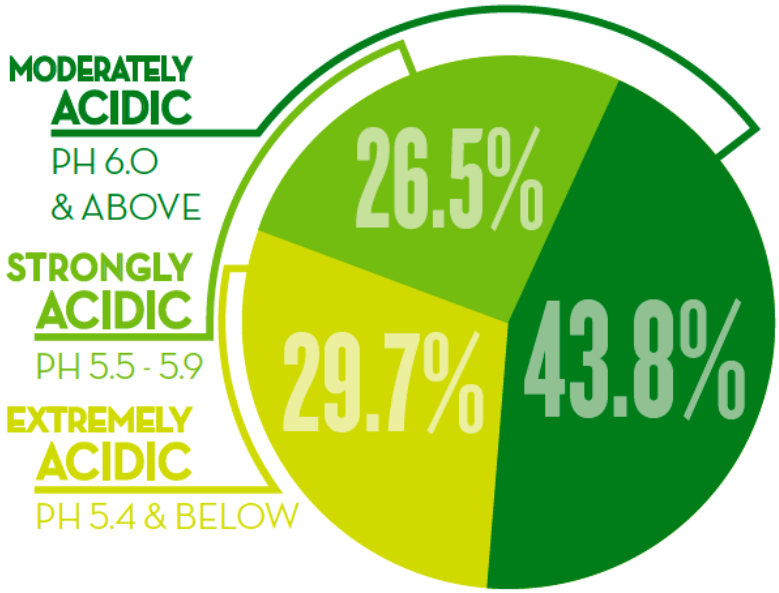
Dielectric constant :
Dielectric loss :
Tangent loss :
Relaxation time :
Emissivity :
Microwave conductivity :

1. THEORETICAL COMSIDERATION:

The dielectric properties of soil are function of its naturally available chemical constituents such as carbon, sodium, potassium, iron and physical properties such as sand, silt, clay. In a non-homogenous medium such as soil, the dielectric constant is combination of individual dielectric constant of its physical properties ,naturally available macronutrients, micronutrients, minerals , organic and inorganic matter content many researchers working on this aspect , studied dielectric parameter of different materials with various methods.


SOIL TEXTURE PYRAMID
Clay
Silty Clay
Sandy Clay
Clay Loam
Silty Clay Loam
Sandy Clay Loam
Loam
Silt Loam
Sandy Loam
Loamy Sand
Sand
Silt
Clay (percent)
Silt (percent)
Sand (percent)
90
80
70
60
50
40
30
20
10


Sand
2.00-0.05 mm
Silt
0.05-0.002 mm
Clay
Less than
0.002 mm


MODERATELY
ACIDIC
PH 6.0
& ABOVE
26.5%
STRONGLY
ACIDIC
PH 5.5 - 5.9
29.7%
43.8%
EXTREMELY
ACIDIC
PH 5.4 & BELOW

An important property, which can be used to characterize the structural state of soil is bulk density as,

$$\rho_b = \frac{mass\ of\ dry\ soil}{Volume\ of\ bulk\ soil} = \rho_b = \frac{CA}{DA} = \frac{C}{D}$$

Where,

$\rho_b = Soil\ bulk\ densit$

$\rho_b = Soil\ particle\ density$

A= area

c= equivalent depth filled with solid

D= total equivalent of soil.

Bulk density is a weight measurement by which the entire soil volume is taken into consideration soil that are loose and porous will have low weights per unit volume i.e. bulk densities , and those are more compact will have correspondingly higher values. The voids or openings between the particles are collectively known as the pore space. Dry soils have most of their pore spaces filled with air, while for very wet soils it is the opposite. Soil temperature is the most important growth factor of plants. Water movement and availability and the rate of most chemical reactions that release nutrients are also dependent upon soil temperature. Temperature of the soil is a function of a number of parameters .

The dielectric constant ε' of the soils is determined by the relation [2]

$$\varepsilon' = \frac{g_{e+\left(\frac{\lambda gs}{2a}\right)^2}}{1+\left(\frac{\lambda gs}{2a}\right)^2}$$

where , a = inner width of rectangular waveguide

$\lambda_{gs} = wavelength\ in\ the\ air\ filled\ guide$

ge= real part of the admittance

2. RESULT AND DISCUSSION :

It has been seen that dielectric constant increases where electrical conductivity increases. Further it has been observed that electrical conductivity increases when percentage of silt and clay although electrical conductivity decreases percentage of sand increases and also bulk density. Again it has been seen that electrical conductivity increases, when porosity, increases. The dielectric constant of the soil is influenced by the magnitude of backscattering wet soil gives higher return compared with dry soil. Soil moisture is the major component of the soil in relation to plant growth. Soil moisture is response of the land surface to atmosphere forcing and controls the partitioning of rainfall into runoff and infiltration climate change affects the soil moisture.

3. CONCLUSSONS:

Environment, climate is directly related with soil. The physical properties, chemical properties, geographical properties affect the dielectric properties of soil.

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