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# RF BASED SOIL UREA ANALYSIS USING MULTIVARIATE SYSTEM

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**Abstract**: The paper describes a novel approach for estimation of soil urea content using Radio Frequency signals. The frequency response of urea is obtained by using Radio Frequency signals. The experimental setup consists of a shielded cell, designed to obtain the frequency response of urea solution. The RF responses of urea with different concentrations in the range of 10MHz – 4.4GHz are obtained using a signal generator and a spectrum analyzer. The experimental results show that at certain frequencies, the response of urea to RF changes in accordance with the changes in the concentration of urea and at other frequencies, it has a flat response. Since the response of urea to RF changes in accordance to the concentration of urea, these results can be used for the prediction of unknown concentration of urea based on a multivariate system. The calibration set for the PLSR model is generated by taking different concentrations of urea. To predict the unknown urea concentration, PLSR model uses the calibration set for regression.

**Keywords**: RF, urea, multivariate analysis.

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## INTRODUCTION

Technological advances in the field of sensing and signal processing has opened new areas for the development of on-the-go soil sensors. Traditional methods of soil analysis are very time consuming and costly. Moreover, the spatial and temporal variability of a field are not taken into consideration for the soil analysis. This leads to improper use of fertilizers which causes problems such as surface and groundwater contamination. Precision farming technique, which is also called as Site Specific Crop Management (SSCM) is based on the application of just the right amount of nutrients at the right location based on the crop requirements. This technique aims to improve the profitability and it can also help in protecting soil and water resources. Kitchen et al have shown how precision farming techniques can increase profitability [1].

Soil nutrient testing is one method that can be used to determine the soil nutrient contents and make efficient use of fertilizers so as to enhance the agricultural production without having adverse effect on the resources. Hergert et al have shown how the economic environment of crop production has changed substantially since the introduction of soil fertilizer recommendations [2].

At National University of Miryang, Korea, H.Kim et al have done extensive studies on soil sensor development and an excellent comprehensive study has been published elsewhere[3]. For e.g. accurate monitoring of soil nitrate has been limited by the relatively long turn-around time of laboratory analysis because soil nitrate can be easily lost by leaching and denitrification between the time of testing and plant uptake. To reduce this turnaround time Ehsani et al have suggested PLS and PCR technique for signal processing [4]. Mi Yeon Cho have used poly (ethylene oxide)-urea complex film to understand the electrical characteristics as a function of urea concentration [5].

In this manuscript, under the soil nutrient sensing approaches section describes the various methods of estimating soil parameters. The experimental setup section explains the construction of the cell and the technique used for measurement of RF absorption. The results and discussions section gives the responses of urea with different concentrations at various frequency ranges. The concluding section gives the present and the future scope of the research work.

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## NUTRIENT SENSING APPROACHES

Various sensing techniques are available for the measurement of soil macronutrients (N, P, and K). Depending on the measurement methods used, these techniques are classified into two types:

- Optical sensing that uses reflectance spectroscopy to detect the level of energy absorbed/reflected by soil particles or nutrient ions
- Electrochemical sensing that uses ion-selective electrodes which generate a voltage or current output in response to the activity of selected ions [3].
- This paper presents a novel method for the estimation of urea content in soil that uses RF signals and is based on multivariate system.

## EXPERIMENTAL SETUP

The block diagram of the experimental setup is as shown in fig.1.

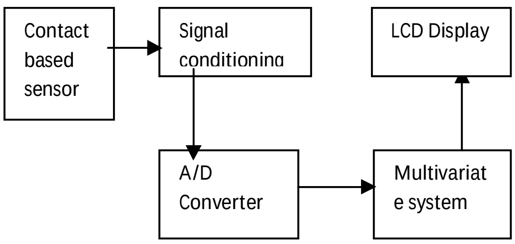


**Figure 1: Block diagram**

To measure the RF responses of soil a component, a cell is designed which is based on the contact type method of measurement. The cell is a cylindrical tube made up of plastic and has a cable running through it from one end to the other. The RF signals are injected through this cable into the solution inside the cell, whose response is to be measured. One end of the cable is connected to a tracking generator through which signals are injected into the solution and the other end is connected to a spectrum analyzer for obtaining the RF response of the solution. The cell is covered with a copper foil and this full setup is then enclosed in a copper tube. This assembly is then enclosed inside iron plates. This is done so as to shield the setup from external EMI interferences. A Signal Hound tracking generator USB-TG44A and a Signal Hound spectrum analyzer USB-SA124B were used for obtaining the response. The cell was tested for noise free measurement using standard RG cable of similar attenuation as that of the cell. The response of the cable was found to be similar to the attenuation levels as per the specifications provided by the manufacturer.

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The response of urea solution was obtained for frequencies ranging from 10MHz to 4GHz. The experimental setup is as shown in Figure1.

**Figure 2: Experimental setup**

As per the literature, the urea content in normal Goan soil is found to be of the order of 43.43kg/ha. Based on this, urea samples were prepared. Different concentrations of urea mixed with distilled water were taken and placed in the cell. Signal is injected into the cell from one end of the cable and the output signal is taken from the other end of the cable.

**RESULTS AND DISCUSSIONS**

The results obtained are described in the form of graphs as shown in fig.3 to fig.7 . The graphs show the responses of water and urea solutions of different concentrations at various frequency ranges. The concentrations of urea are denoted as 0.5Urea which corresponds to 150mg of urea in 20ml of distilled water, 1Urea corresponds to 300mg of urea in 20ml of distilled water, 2Urea corresponds to 600mg of urea in 20 ml of distilled water and 3Urea corresponds to 900mg of Urea in 20ml of distilled water. It may be noted that figures are shown only in the range where there is observable response. Figures with flat response are not shown.

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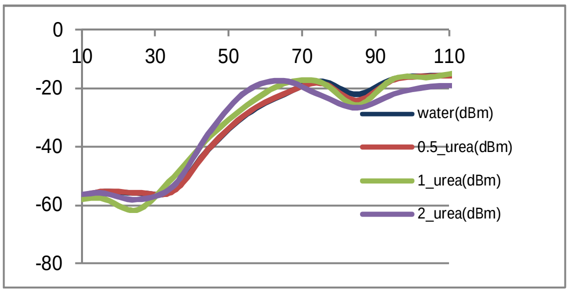


**Figure 3: Frequency response of urea in 10MHz-110MHz range**

Figure 3 shows the frequency response of different urea concentrations in the range of 10MHz-110MHz. It is observed that at 85MHz, there is a trough and the attenuation level is increasing with the increase in the concentration of urea.

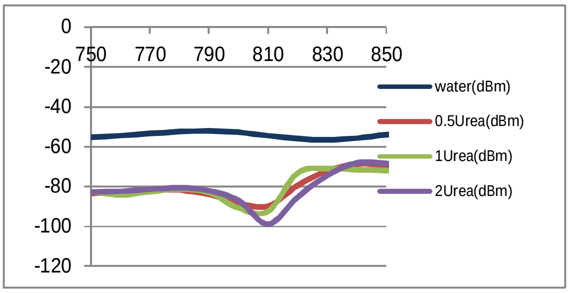


**Figure 4: Frequency response of urea in 750MHz-850MHz range**

In figure 4 it is observed that there is a trough at 810MHz, the attenuation level of which is found to increase as we increase the concentration of urea.

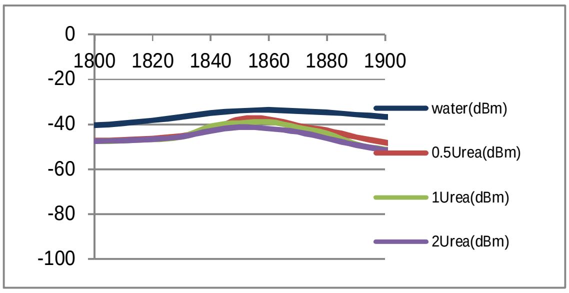


**Figure 5: Frequency response of urea in 1800MHz-1900MHz range**

From figure 5 we can see that the peak at 1850MHz is decreasing as we increase the concentration of urea.

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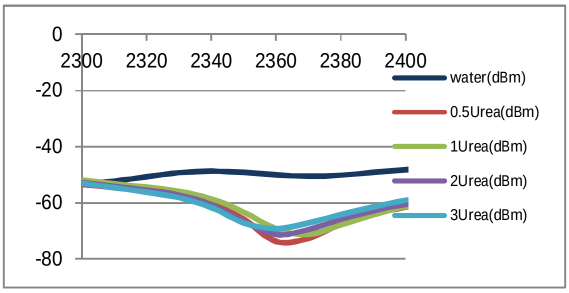


**Figure 6: Frequency response of urea in 750MHz-850MHz range**

In figure 6, we observe that there is a trough present at 2360MHz and the attenuation level is found to be increasing as we increase the concentration of urea.

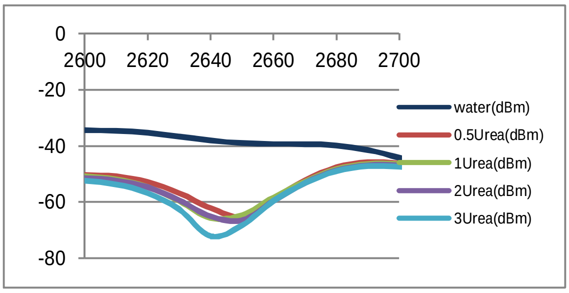


**Figure 7: Frequency response of urea in 750MHz-850MHz range**

From figure 7, we observe that the trough at 2650MHz is increasing with the increase in the concentration of urea.

Variations at certain frequencies are observed due to molecular absorption of urea however, molecular study of urea is not important here as we use analytical tools to estimate the quantities. It is observed that at some frequencies, attenuation increases with increase in the concentration of urea and at certain other frequencies the attenuation is found to be decreasing with increase in the concentration of urea.

The frequency response of urea is changing in accordance to the variations in the concentration of urea. These frequency points at which the variations are observed can be fed as input points to a multivariate system to predict the concentration of an unknown sample of urea.

## CONCLUSION

Preliminary studies are limited only to urea concentration and the same technique can be extended for finding the frequency responses of other soil components. These responses can

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be combined together and can be used for predicting unknown soil components based on multivariate analysis. To find the correlation between the various soil components, Partial Least Square Regression is to be used. Partial least square (PLS) is a method for constructing predictive models when the factors are many and highly collinear. The emphasis is on predicting the responses and not necessarily on trying to understand the underlying relationship between the variables. The rate of error generated is quite low in PLSR as it has the capability of noise reduction.

This method can be of great significance in the field of agriculture, for predicting soil content in real time, thus aiding in SSCM. The new micro electronics techniques such as FPGA, can be used to incorporate multivariate block for signal processing and a user friendly device can be made available to farmers for soil analysis.

**REFERENCES:**

1. N. R. Kitchen, K. A. Sudduth, D. B. Myers, R. E. Massey, E. J. Sadler, R. N. Lerch, J. W. Hummel and H. L. Palm, (2005), "Development of a conservation-oriented precision agriculture system: Crop production assessment and plan implementation", Journal of Soil Water Conservation, Vol. 60 No. 6, pp 421-430

2. Hergert, G.W., W.L. Pan, D.R. Huggins, J.H. Grove and T.R. Peck,(1997) " Adequacy of current fertilizer recommendations for site specific management" , F.J. Pierce and E.J. Sadler (ed.) The State of Site-Specific Management for Agriculture. ASA, Madison, WI, pp 283-300.

3. H. Kim, K. A. Sudduth and J. W. Hummel,(2009) " Soil macronutrient sensing for precision agriculture", Journal of Environment Monitoring, Vol. 11, pp 1810-1824.

4. M. R. Ehsani, S. K. Upadhyaya, D. Slaughter, S. Shafii and M. Pelletier,(1999) " A NIR technique for rapid dtermination of soil mineral nitrogen", Precision Agriculture, Vol. 1, pp 217-234.

5. Mi Yeon Cho, Kyoungah Cho, and Sangsig Kim,(2012) " Electrical Characteristics of poly (ethylene oxide)- urea complex film" Transactions on electrical and electronic materials, Vol. 13, No.3, pp 136-138.