International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Preprocessing and Statistical Analysis of Soil Parameters using Conventional Laboratory Techniques and Non-Imaging Spectral Techniques for Vaijapur Taluka.

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Abstract: ***Agriculture is very important factor for all population in India. Indian economy and most of the peoples in India is totally depends upon agriculture and agriculture is depends upon soil quality. Soil provides various ecosystem services and also support to human health. To manage and preserve soil for future generations it is important to know more about soil. Soil quality is composed of its properties such as physical, chemical and biological and also categorized its nutrients in two sections like micronutrients and macronutrients. In soil quality soil macronutrients plays very crucial role for improvement of agriculture. To know about status of soil macronutrients various methods are needed. The main objective of this study is compare soil laboratory analysis methods and soil spectral analysis methods for quantitative estimation of soil macronutrients. With the help of these two methods we accurately predicted the soil macronutrients which helps in estimation of macronutrients and identifying the soil quality. In this study descriptive statistics is used for final estimation of soil macronutrients.We got better results using spectral analysis techniques compare to soil laboratory analysis techniques and this results gives contribution in agriculture sector and also helpful to farmers for taking decision related to crop.***

Keywords: VNIR-SWIR, Preprocessing, Spectroscopy.

I. INTRODUCTION

Soil, water, and air these are the natural resources present on or surrounding of the earth. We depend on natural vegetation and natural resources such as Land, Soil as well as Wildlife Resources for our survival. All these form the basic components of our ecosystem [3]. So that the soil is one of the most important and vital natural resource of earth's critical zone. It is a complex mixture of minerals, water, air and organic matter and also it's called as "skin of the earth.

" The soil is defined by many ways one of them is Soil Science Society of America Glossary of Soil Science Terms define the soil is the unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants[4]. The soil body contained elements such as climate, time, organisms, topography and parent material. The highest vulnerability in soils is the result of the communication of these factors and their impact on the development of various soil profiles [5]. It is capable of supporting plant life and it is very crucial to life on earth also. Soil supplies ecosystem services, filters water, provide nutrients to the
Vegetation's (crops, plants) which supplies us food, energy and fiber to maintain the human health and habitation. The world is highly dependent on the food production and the food production mostly depends on the soil quality. So, knowledge about soil quality along with its components should be known [6].There are extraordinary pressures on soil due to urbanization, industrialization or from degradation. Soils are reducing their quality which are unbalancing the agricultural practices and food production. Consequently, soil quality and its management with planning are essential to preserve the soil with its quality for future generations [7]. The quality and health of soil is important for both agricultural sustainability and environmental quality which connected to the plant, animal and human health. In the last few decades, it has been a challenge to find the ultimate convenient technique for studying soil characteristics effectually and at thesame time, decreasing the time and effort involved in field sampling and laboratory investigation [8],[9]. This has been major concern not only for soil scientist but also for environmental specialist. Traditional laboratory methods are very expensive, time consuming and needed expert operator to obtain chemical analysis .Inversely hyperspectral non-imaging data is a speedy, appropriate, less expensive, nondestructive diagnostic technique that can be provide a robust and reliable approach to evaluate contradictory soil properties without the need of chemicals [10].The objective of present study is to compare laboratory results with spectral results for draught area selected for this study.

Revised Manuscript Received on 30 July 2019.
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II. STUDY AREA

Vaijapur taluka is a drought-prone interior of Maharashtra State, India. It is suffering from the problem of agricultural productivity. And situated at the latitude of 19°40' to 20°15' north and longitude of 74°35' to 75°00' east covering an area of approximately 1510.5 sq. km and fall in Survey of India Toposheet No. 46 L/16 Vaijapur is located 514m (1,666 ft) above sea level on the western margin of the Deccan plateau[11].

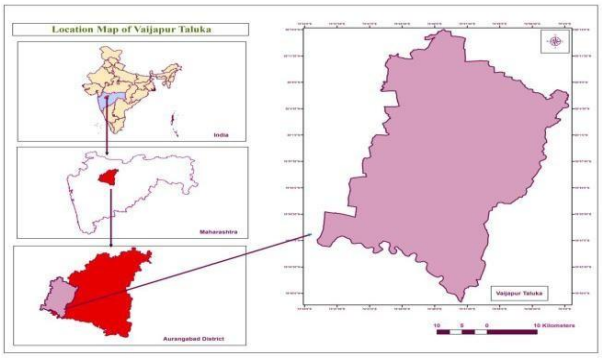

Figure 01: Graphical Location of Study Area

A. Creation of Database

In month June, July, September and October 2017, 35 soil samples were collected from Gramin1, Gramin 2, Khandala, Shivrai , Nandgaon, Bhaggaon and Ghaigaon in Vaijapur taluka. In each site 5 samples were taken of 1-2 km distance , approximately 1 kg of surface soils was obtained from (0-20 cm land surface) and it stored in air tight plastic ziplock bags. Little bits of stones and plant parts in the soil samples were evacuated by hand picking before analysis. And taken for estimations to the laboratory. We also used Global Position System to record the corresponding Geographical Coordinates. These soil samples divided into two portions one for spectral measurement & other for laboratory analysis.

III. ACQUISITION OF SPECTRAL REFLECTANCE OF SOIL BY USING VNIR-SWIR

The soil samples were taken for spectral measurement in dark room using Analytical spectral Devices (ASD) Field Spec4 Spectroradiometer for collecting the reflectance spectra of soil. The ASD Spectroradiometer provides the reflectance spectra at VNIR–SWIR region having wavelength range from 350-2500nm, providing the total of 2151 reflectance variables for each spectrum. The instrument has a high spectral resolution with 3 nm for 350-1000 nm and 10 nm for 1000>2500 nm onward with sampling interval 1.4 nm and 2 nm for each range. This instrument uses a 75 W tungsten quartz halogen filament lamp as an illumination source for illuminating the soil sample [12],[13],[14],[15]. The lamp was set as 60º of Zenith angle at distance of 45 cm above the soil sample. The reflected light was collected in 1 nm bandwidths between 350-2500nm with an 8º Field of View (FOV) fiber optic cable of Spectroradiometer that was kept off-nadir at a distance of 15 cm above the soil sample. The instrument was optimized and calibrated using white spectralon for every sample to obtain absolute reflectance for controlled laboratory readings before sample were recorded. The total of 10 spectra of each sample was recorded to minimize the noise produced by the instrument for obtaining the final spectra. We got 350 soil spectra's for 30 samples for creation of database. The RS3 spectral acquisition software was used to collect soil spectral measurements. We also used Global Position System to record the corresponding Geographical coordinates.

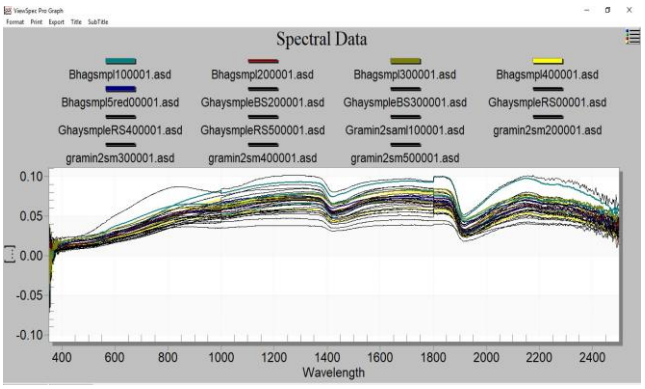

Figure 02: Raw spectral signature collected by VNIR-SWIR

A. Pre-processing of spectral data

FieldSpec4 Spectroradiometer is a Non-Imaging point spectroscopy, in this we record spectra one point at a time. we apply some preprocessing techniques including 1st and 2nd Derivatives with derivative gap 5 is taken on raw spectra to solve break points and decrease the baseline effects to improve spectral features. In Fig 3 (a) and (b) shows preprocessing of spectral data. After preprocessing each spectral signature export into text/data format for further analysis purpose.

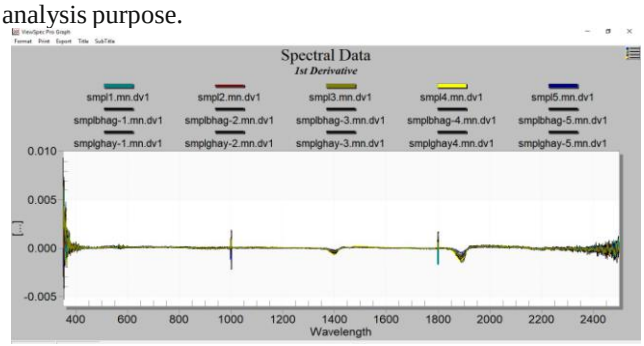

Figure 3(a): 1st Derivative of the all soil samples

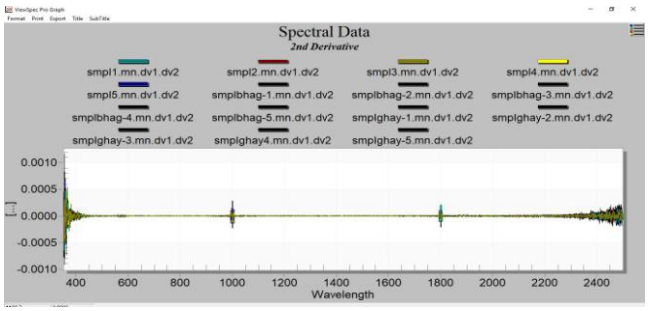

Figure 3(b): IInd Derivative of the all soil samples

IV. ANALYSIS OF SOIL PARAMETERS BY LABORATORY METHOS

The descriptive statistics of soil physicochemical parameters of the processed soil samples were studied under laboratory conditions are given in Table 1.

Table 1. Descriptive statistics of the Soil Physicochemical parameters analyzed using conventional laboratory method

Soil Parameters	Mean	Min	Max	Median	Std.Dev	Range	Variance
pH	8.304	7.736	8.699	8.347	0.219	0.963	0.047
Sand %	32.143	21.46	39.82	31.88	4.112	18.36	16.911
Silt %	29.884	20.77	37.04	30.99	4.757	16.27	22.626
Clay %	38.006	27.19	45.34	39.26	4.779	18.15	22.841
Soil Moisture	20.601	7.338	47.666	20.547	6.914	40.328	47.803
Potassium(K)%	0.018	0.004	0.048	0.017	0.01	0.045	0.0001
Phosphorus(P)%	0.002	0.0001	0.009	0.002	0.002	0.009	0
Calcium(Ca)%	0.261	0.18	0.313	0.261	0.028	0.132	0.001
Magnesium(Mg)%	0.037	0.002	0.069	0.037	0.016	0.066	0.0001
Nitrogen(N)%	0.009	0.006	0.011	0.008	0.001	0.006	0

The Table 1 shows that ,the soil pH value ranged from 7.73 to 8.69.According to normal soil pH range is 8.01 to 8.70.Most of the soil samples are having pH range below 8.30.According to results it is observed that the soil reaction of the studied areas is alkaline in nature. Soil texture .The texture classes of soils were calculated in the terms as sand, silt, clay with average values 32.143%, 29.884%and 38.006% respectively. The percentage of clay concentrations were highest values than sand and silt textures. The textural class clay was varied from 27.190 % and 45.340%, sand was varied between 21.460 % and 39.820 % along with silt was varied between 20.770 % and 37.040%.It means that the study area is comes under in clay loam texture class. Whereas Soil moisture percentage was 20.601 varied with 7.338 and 47.666. Average values of Potassium (K), Phosphorus (P) were 0.018% and 0.002% . We also calculate Calcium(Ca) and Magnesium (Mg) with average 0.261% and 0.037% .The total average of Nitrogen(N) was 0.009%.The overall analysis of soil parameters by laboratory measurement shown in below fig 4.

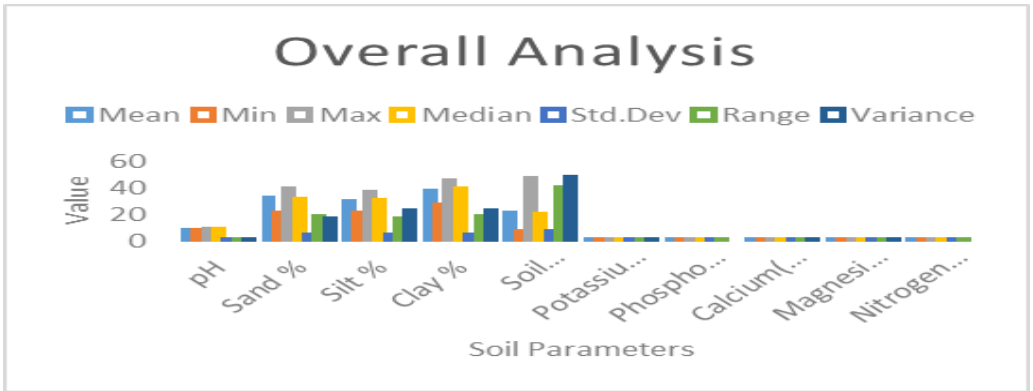

Figure 4.Overall analysis of soil parameters by laboratory measurement

IV. ANALYSIS OF SOIL PARAMETERS BY SPECTRAL MEASUREMENT

The Descriptive statistics of soil parameters of the processed soil samples were studied by spectral measurement are given in Table 2.

Table 2. Descriptive statistics of soil parameters

	pH	SOM	Sand	Silt	Clay	Soil Moisture	Carbon	Nitrogen	Potassium	Phosphorus	Calcium	Magnesium
Mean	0.061	0.054	0.04	0.047	0.065	0.055	0.064	0.064	0.062	0.056	0.07	0.059
Max	0.178	0.167	0.122	0.146	0.196	0.164	0.184	0.192	0.189	0.171	0.206	0.186
Min	0.033	0.033	0.021	0.024	0.034	0.029	0.033	0.033	0.034	0.03	0.035	0.033
Range	0.146	0.135	0.101	0.122	0.162	0.135	0.151	0.159	0.155	0.141	0.171	0.153
Std.Dev	0.023	0.021	0.016	0.02	0.025	0.021	0.024	0.025	0.024	0.022	0.033	0.024
Variance	0.001	0	0	0	0.001	0	0.001	0.001	0.001	0.001	0.001	0.001

The Table 2 shows Descriptive statistics of soil parameters with respective to all samples.In table 2 shows the overall average percentage of all soil parameters of Vaijapur taluka.The average percenatge of pH value in study area is 0.061,whereas the soil organic matter present in study area with 0.033 to 0.167. The texture classes of soils have also calculated in the terms as sand, silt, clay with average values 0.040, 0.047 and 0.065. The percentage of clay concentrations have highest values than sand and silt textures. The textural class clay have varied from 0.034 to 0.196.Sand was varied between 0.021 to 0.122 along with silt was varied between 0.024 to 0.146 .The highest value of calcium is vary from 0.035 to0.206 whereas the soil moisture varied between 0.029 to0.164 with average 0.055.Average percentage of carbon and nitrogen have same 0.064 whereas for potassium, phosphorus average percentage is 0.062 and 0.056 respectively. Average percentage of calcium is 0.079 varied with 0.035 to 0.206 and for magnesium average is 0.059 and it is varied from 0.033 to 0.186.The overall analysis of soil parameters by spectral measurement shown in fig 5.

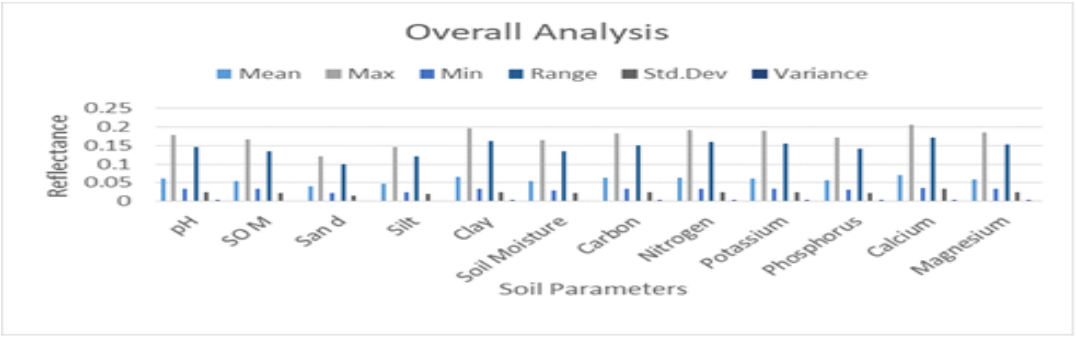

Figure 5.Overall analysis of soil parameters by spectral measurement

VI. CONCLUSION

The traditional soil testing methods, namely laboratory analysis methods are tedious, costly and require experienced operator in chemical analysis. Concurrently these techniques won't be helpful in on-line observing processes. Thus, there is a persistent requirement for evaluating a predictable and cost effective technique for rapid analysis. To overcoming these difficulties VNIR-SWIR Spectroscopy has presented auspicious results for estimation of soil contents because spectroscopy is a non-destructive analysis method and also it is not harmful to environment. Furthermore, the descriptive statistical techniques which is used in this study have shown better spectral analysis techniques results compare to soil laboratory techniques and to be a powerful tool in spectroscopic analysis and helpful to farmers for making decision.

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ACKNOWLEDGMENT

The authors would like to acknowledge to UGC for providing RGNFellowship and also extend gratitude to DIST-FIST program to Department of Computer Science & I.T, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, and M.S.India for providing lab facilities.

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