J. Soils and Crops 33 (2) 363-368, December 2024

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

COMPARATIVE STUDY OF PHYSICO-CHEMICAL PROPERTIES OF SOIL

D. V. K. Narasingham[1], A. K. Shrivastava[2] and Ashutosh Pandey[3]

ABSTRACT

The comparative study was undertaken to assess the available physico-chemical status of the different places i.e. Bilaspur (Kargi Road Kota) sample (S_1), Gourlla-Pendra-Marwahi (Shivni) sample (S_2), Mungeli, (Baghamuda) sample (S_3), Raigarh (Kharsia) sample (S_4), Bilaigarh-Sarangarh (Baramkela) sample (S_5), Korba (Pali) sample (S_6) and Janjgir-Champa (Akaltara) sample (S_7). The study was focused on the integrated use of macronutrients and micronutrients. The experiment was carried out at Soil Testing Centre, Government of Chhattisgarh during premonsoon i.e. *rabi* season in 2022. The samples were collected from seven places which were Bilaspur (Kargi Road Kota), Gourlla-Pendra-Marwahi (Shivni), Mungeli, (Baghamuda) Raigarh (Kharsia), Bilaigarh-Sarangarh (Baramkela), Korba (Pali) and Janjgir-Champa (Akaltara). Before dielectric characterization a several properties was studied as well as analyzed. It was found that twelve elements *viz*., pH, EC, OC, N, P, K, S, Zn, B, Cu, Mn, Fe, were responsible for physico-chemical properties. Also electrolytic process was very important. Further the value of EC was obtained sufficient in soil samples of Kargi Road Kota S_1, Shivni S_2, Baghamuda S_3, Kharsia S_4,Baramkela S_5, and Akaltara S_7 and was obtained deficient in soil sample of Pali S_6. The value of pH was recorded sufficient in soil samples of Baramkela S_3 and Akaltara S_7 and was obtained deficient in soil samples of Shivni S_2 and Pali S_5 and was obtained maximum in soil sample of Pali S_6. The value of nitrogen was recorded sufficient in soil samples of Kargi Road Kota S_1 and Akaltara S_7 and was recorded deficient in soil samples of Shivni S_2, Baghamuda S_3, Kharsia S_4, Baramkela S_5 and Pali S_6. The phosphorus content was recorded sufficient in soil samples of Kargi Road Kota S_1, Baghamuda S_3, and Pali S_6 but was recorded deficient in soil samples of Shivni S_2, Kharsia S_4, and Baramkela S_5 . Potassium content was recorded sufficient in soil samples of Kargi Road Kota S_1, Shivni S_2 and Akaltara S_7 but was recorded maximum in soil samples of Baghamuda S_3, Kharsia S_4, Baramkela S_5, and Akaltara S_7. Sulfur content was recorded sufficient in soil samples of Karagi Road Kota S_1, Shivni S_2, Baghamuda S_3, Kharsia S_4, Baramkela S_5 and Pali S_6 and recorded deficient in soil sample of Akaltara S_7. The value of iron was recorded sufficient in all samples. The value of zinc was recorded sufficient in soil sample of Baramkela S_5 and maximum in rest of the soil samples. The value of manganese was found maximum in all soil samples. Copper content was recorded sufficient in sample of Baramkela S_3 and recorded maximum in soil samples of Kargi Road Kota S_1, Shivni S_2, Kharsia S_4, Baramkela S_5, Pali S_6 and Akatara S_7. Boron content was found maximum in all samples. This study is useful for agricultural scientists and progressive farmers for improving soil conditions and crop production.

(Key words: Remote sensing, dielectric characterization, chemical properties, elements, soil)

INTRODUCTION

Soil is consisting of soil particles, liquid, and gas and ranges from very soft, organic deposits through less compressible clays and sands to soft rock. A soil may contain virtually any element contained in Earth's crust (Calla *et al.*, 2004). However, by far the most abundant are oxygen, silicon, hydrogen, and aluminum, magnesium, and carbon, comprise over 99 per cent of the soil mass of soil worldwide. Chemical properties are very important (Nishant *et al.*, 2018). Macro and micro elements are also very important. pH is also important. The role of integrated use of organic and inorganic sources on physico-chemical properties is very important (Kaur *et al.*, 2023). There is a vital role of cation exchange under a given set of environmental conditions i.e. temperature, pressure, pH, chemical, and biological, composition of the water, clay absorbs cations of specific types and amount. Organic and chemical fertilizers are yield component for production of soybean (Fayera and Alemayehu, 2021). The most common adsorbed cation in residual and nonmarine sedimentary soils are calcium, magnesium, sodium, and potassium. Diffusion process is also very important. Chemical transport through sands is dominated by advection where in dissolved and suspended species are carried with flowing water (Navarkhale, 2016). However, in fine- grained soils, where in the hydraulic flow rates are

1. Res. Scholar, Dr. C. V. Raman University Kota, Bilaspur, Chhattisgarh, INDIA
2. Dean, Faculty of Science, Dr. C. V. Raman University Kota, Bilaspur, Chhattisgarh, INDIA
3. Astt. Professor, Dr. C. V. Raman University Kota, Bilaspur, Chhattisgarh, INDIA

very small. Considering the importance of physico-chemical properties it was studied comprehensively.

Soil testing is analyzing the soil for its fertility evaluation. The data are useful for recommending the type and amount of fertilizer and other amendments for increase and profitable crop production (Sahu and Shrivastava, 2023). The objectives of soil testing's are to assess the nutrient status or fertility status of a soil, to predict the amount of fertilizer needed to supplement the nutrient supply in soil, to evaluate the nutrient status of soils of an area with the object of having an estimate of fertilizer requirement of the area, and to compare fertility levels of two or more areas (Shrivastava and Pandey, 2021). Soil testing is analyzing the soil for its fertility evaluation. The data are useful for recommending the type and amount of fertilizer and other amendments for increase and profitable crop production.

Table 1. Limiting free solution diffusion coefficients for some simple electrolytes

Electrolyte	$D_0 10^{10} (m^2/s)$
Hcl	33.36
HBr	34.00
LiCl	13.6
LiBr	13.77
NaCl	16.10
NaBr	16.25
NaI	16.14
KCl	19.93
KBr	20.16
KI	19.99
CsCl	20.44
$CaCl_2$	13.35
$BaCl_2$	13.85

MATERIALS AND METHODS

Sample collection

After selecting the topic, it was planned as well as designed the process of research work. The targeted research area was surveyed and visited for sampling. The research locations were different places. There were seven places from where samples were collected as Bilaspur, Gourlla – Pendra- Marwahi (GPM), Mungeli, Raigarh, Bilaigarh – Sarangarh, Korba, Janjgir – Champa. Samples were collected in the month of June 2022. The sample one was collected from Bilaspur (Kargi Road Kota), two collected from Gourlla-Pendra-Marwahi (Shivni), the three collected from Mungeli, (Baghamuda), the four collected from Raigarh (Kharsia), the five collected from Bilaigarh-Sarangarh (Baramkela), the six collected from Korba (Pali) and the seven collected from Janjgir-Champa (Akaltara). The standard value of pH, EC, OC, N, P, K, S, Zn, B, Cu, Mn and Fe are 7, 02 dSm^{-1}, 0.51-0.75, 280-560 kg ha^{-1}, 10-25 kg ha^{-1},145-337 kg ha^{-1} ,>0.6 ppm, >0.5ppm, >0.2ppm, >2.0 ppm, >10 ppm ,4.5 ppm, respectively. These all elements were tested in Govt. Soil Testing Centre, Bilaspur (Anonymous, 2022).

Preparation of sample

After collecting the sample the soil were dried and crushed. Now sieving process was followed to gain fine powder form of soil sample and removed the coarser particles from the soil. The sieved out particles were then dried in hot air oven to a temperature around 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 were measured from Soil Testing Centre, Nehru Chowk, Govt. Of Chhattisgarh, Bilaspur (C.G.).

RESULTS AND DISCUSSION

Physico-chemical properties of soil

Soil samples of Kargi Road Kota (S_1), Shivni (S_2), Baghamuda (S_3), Kharsia (S_4), Baramkela (S_5), Pali (S_6), and Akaltara (S_7) were collected and prepared for testing. The pH of the soil samples was found in the range of 5.4 to 7.8, indicating slightly acidic to slightly alkaline reaction. The lowest pH (5.4) was observed in the village Shivni ($S_{2)}$ whereas, the highest pH (7.8) was found in village Pali (S_6). The electrical conductivity was observed in the range of 0.1 to 0.5 dSm^{-1}, which was within the acceptable limit.

Organic Carbon

The standard value of organic carbon is 0.51-0.75%. The organic carbon content was reported sufficient (0.75) from village Baramkela (S_5) whereas noted deficient in soil samples of Kargi Road Kota (S_1), Shivni (S_2), Baghamuda (S_3), Baramkela (S_4), Pali (S_6), and Akaltara (S_7). The very low to medium content of organic carbon might be due to different management practices and manuring.

Available macronutrient status in the soils of different places

The nitrogen (N) was found most sufficient in village Kargi Road Kota (S_1) and Akaltara (S_7) and recorded deficient in soil samples of Shivni (S_2), Baghamuda (S_3), Kharsia (S_4), Baramkela (S_5) and Pali (S_6) whereas the standard value is in between 280-560 kg ha^{-1}. This shows that some of the samples analyzed were to be low to moderately low in available nitrogen. As the organic content in soils was too low to moderate and therefore nitrogen availability was also low. The low nitrogen content in soils mainly due to its low addition, higher mobility, and losses through ammonia volatization, leaching, run-off, denitrification, a microbial and chemical fixation. Swati *et al.* (2020) reported low nitrogen content in the major portion of Nagpur district (107.8 to 347.6 kg ha^{-1}).

It was observed that the phosphorus was deficient in soil sample of Baramkela (S_5) whereas phosphorus was sufficient in soil samples of Kargi Road Kota (S_1), Baghamuda (S_3) and Pali (S_6). The standard value of phosphorus is in between 10-25 kg ha^{-1}. By considering the mean value of the soil sample the lowest phosphorus was found in the soils of Baramkela (S_5) while the highest phosphorus content in soils was found in sample of Baghamuda (S_3). This reveals that the soils were low to

Table 2. Physico-chemical properties of soils of different places

Sl. No.	Elements/ Standard Values	Bilaspur (Kargi Rd Kota) (S_1)	Gourella-Pendra-–Marwahi (Shivni) (S_2)	Mungeli (Bagha-muda) (S_3)	Raigarh (Kharsia) (S_4)	Bilaigarh – Sarangarh (Baramkela) (S_5)	Korba (Pali) (S_6)	Janjgir – Champa (Akaltara) (S_7)
1	pH(7)	7.40	5.40	7.30	7.60	6.10	7.80	7.10
2	Electrical Conductivity (EC)0-2 (dsm^{-1})	0.50	0.40	0.40	0.30	0.40	0.10	0.40
3	Organic Carbon (OC) 0.51-0.75%	0.45	0.30	0.45	0.30	0.75	0.30	0.30
4	Nitrogen (N)280-560 ($kg\ ha^{-1}$)	363	100	125	162	125	125	375
5	Phosphorus (P)10-25 ($kg\ ha^{-1}$)	16.12	8.96	10.75	6.27	3.58	13.44	8.96
6	Potassium (K)145-337($kg\ ha^{-1}$)	235	275	435	706	390	368	225
7	Sulfur (S)(>10 ppm)	21.25	12.50	17.50	18.75	13.75	17.50	10.00
8	Zinc (Zn)(>0.6ppm)	2.175	2.145	1.434	2.149	1.143	2.043	1.245
9	Boron (B)(>0.5ppm)	4	3	6	4	4	3	4
10	Copper (Cu)(>0.2ppm)	3.175	2.154	0.845	3.148	7.149	1.455	2.340
11	Manganese (Mn)(>2.0 ppm)	47.79	31.49	45.46	31.29	31.43	28.14	38.49
12	Iron (Fe)(>4.5 ppm)	31.29	17.85	17.73	15.79	18.89	21.55	27.48

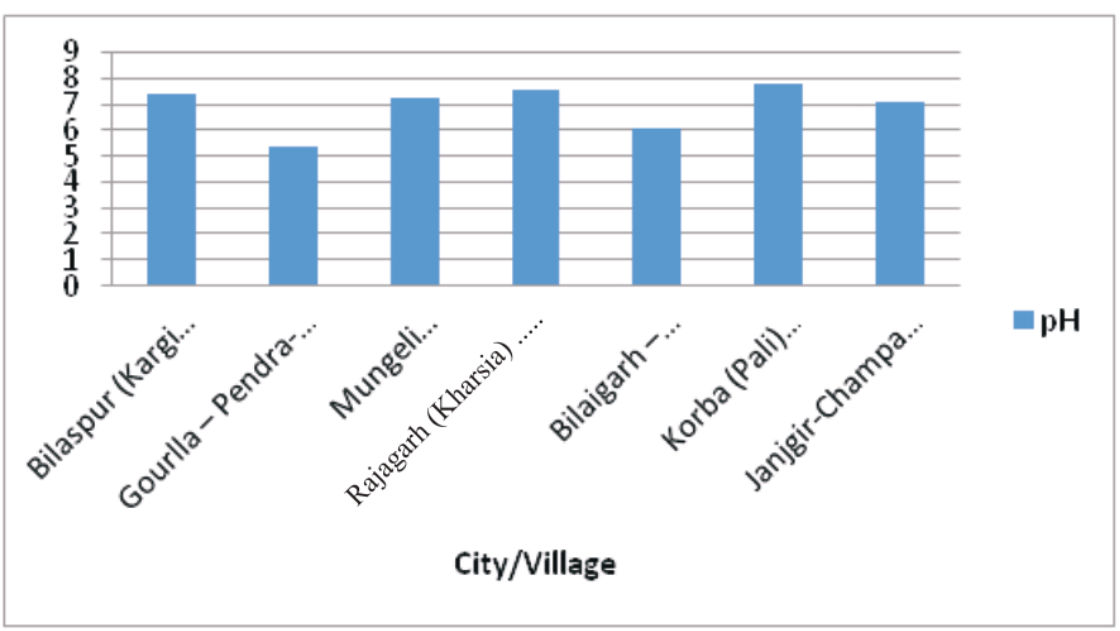

Figure 1.pH content

Figure 2. Electrical Conductivity

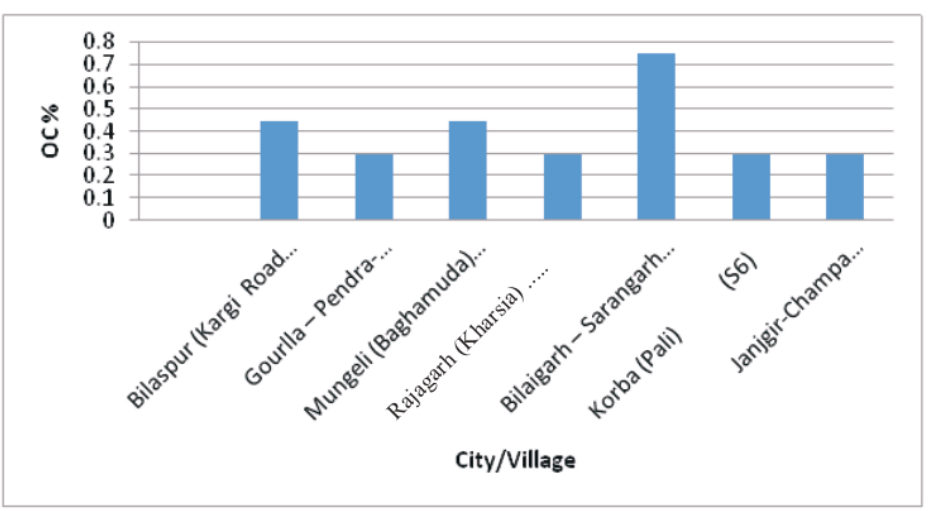

Figure 3. Organic Carbon content

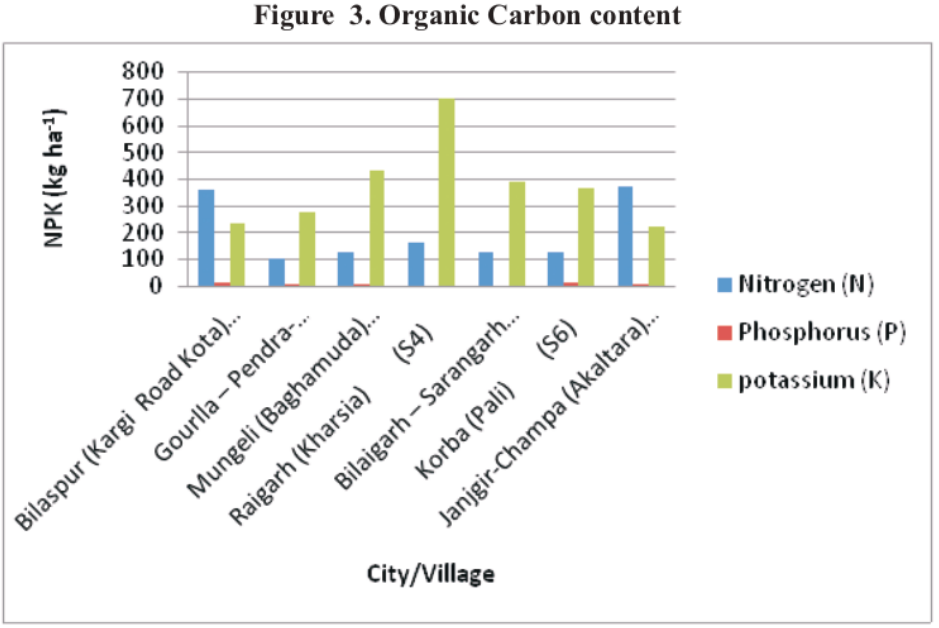

Figure 4. N P K content

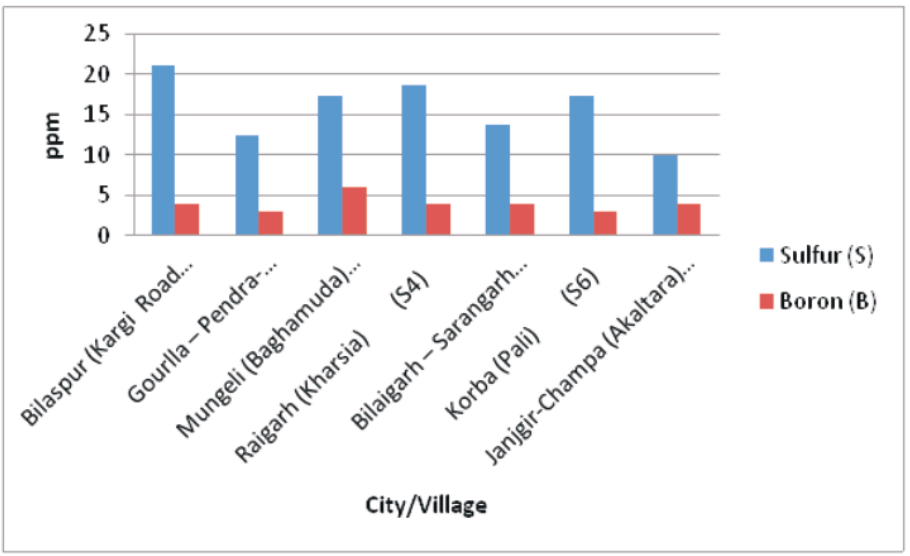

Figure 5. S and B content

Figure 6. Zn and Cu content

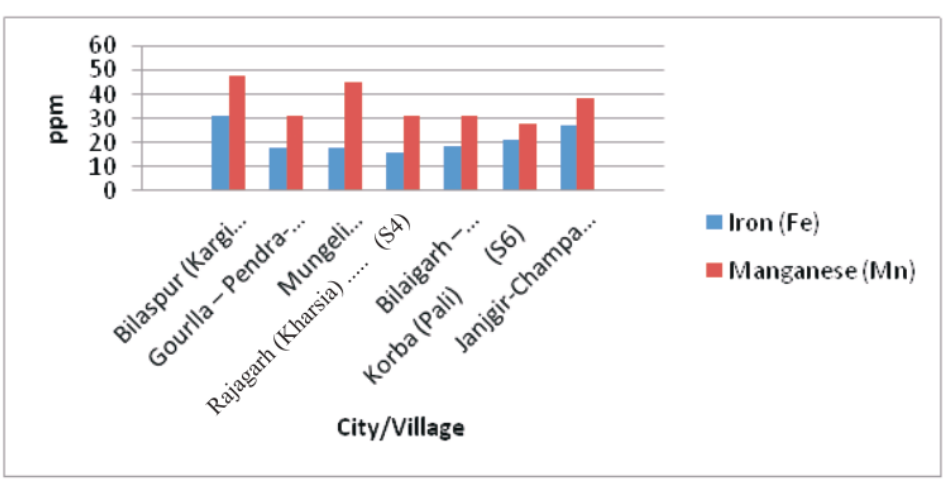

Figure 7. Fe and Mn content

moderately high in available phosphorus. The low amount of phosphorus in some soils might be due to the fixation of phosphorus with the time elapsed between fertilizer application and crop uptake.

The standard value of potassium is in the range of 145 to 337 kg ha^{-1}. The available potassium content of soils of the different places ranged from 235 to 435 kg ha^{-1}. The lowest potassium content was found in the soil sample of village Akaltara (S_7) whereas, the highest was recorded in the soil sample of village Kharsia (S_4) . This reveals that the soils were high in potassium content. Kore *et al.* (2017) reported that the soils were medium to very high in available potassium in the Amgaon tehsil of Gondia district, Maharashtra. This high level of available potassium might be due to the presence of potassium-rich parent material. Potassium is an essential nutrient for plants, animals, and humans, and it plays a crucial role in various biological processes. Potassium is highly reactive, especially with water and oxygen. It reacts vigorously with water, producing hydrogen gas and forming potassium hydroxide (KOH). It also reacts with oxygen in the air, forming a layer of potassium oxide (K_2O) on its surface. Potassium is a crucial nutrient for plant growth and is an essential component of fertilizers. Potassium fertilizers, such as potassium chloride (potash), potassium sulfate, and potassium nitrate, are used to supply potassium to crops and to improve soil fertility.

The standard value of sulfur is greater than 10 ppm. The sulfur content of soil samples Shivani (S_2) and Baramkela (S_5) were most sufficient whereas soil sample of Akaltara (S_7) was deficient and found very high in soil samples of Kargi Road Kota (S_1), Kharsia (S_4) and Pali (S_6). Management of S in the soil can be done by applying S to seedbed, incorporating straw instead of completely removing or burning it. We can replace some urea with ammonium sulphate or S-containing fertilizers like single superphosphate, gypsum and potassium sulphate. Manure (livestock and poultry manure) is an excellent source of sulfur.

Available micronutrient status in the soils of different places

Zinc is very important element for soil which plays an important part in crop growth activities such as photosynthetic processes, respiration, and nitrogen metabolism-protein synthesis. It is involved in the production of IAA, the regulation of auxin concentration in plant, and other biochemical and physiological process such as the initiation of development for reproductive organs. The standard value is greater than 0.6 ppm. In soil samples of Baghamuda (S_3), Baramkela (S_5) and Akaltara (S_7) the observed values were sufficient and the values were very high in soil samples of Kargi Road Kota (S_1), Shivni (S_2), Kharsia (S_4) and Pali (S_6).

The standard value of iron is greater than 4.5 ppm. The reported values were higher in soil samples of Kargi Road Kota S_1, Shivni S_2, Baghamuda S_3, Kharsia S_4, Baramkela S_5, Pali S_6, and Akaltara S_7.

Also the values of manganese were very high in soil samples of Kargi Road Kota S_1, Shivni S_2, Baghamuda S_3,Kharsia S_4, Baramkela S_5, Pali S_6, and Akaltara S_7. The copper was recorded very sufficient in soil sample of Baghamuda (S_3), high in soil samples of Kargi Road Kota S_1, Shivni S_2, Baghamuda S_3, Kharsia S_4, Baramkela S_5, Pali S_6, and Akaltara S_7. The standard value of copper is greater than 0.2 ppm. The standard value of boron is greater than 0.5. The values were recorded very high in all soil samples. Micronutrient boron promotes higher mobilization of food and minerals from source to developing fruit which is extremely active sink.

This study is useful for agricultural scientists and progressive farmers for improving soil condition and crop production.

REFERENCES

Anonymous, 2022.Soil Testing Centre Nehru Chowk, Govt. of Chhattisgarh, Bilaspur, Chhattisgarh.

Calla, O.P.N., B. Baruah, K.P.MishraM.Kalita., and S.S. Haquqe, 2004. Variability of Dielectric Constant of Dry Soil with its Physical Constituents at Microwave Frequencies and Validation of the CVCG Model", JRSP.**33**: 125.

Fayera, A. and W. Alemayehu, 2021. Effect of organic and chemical fertilizers on growth, yield and yield components of soybean. J. Soils and Crops. **31** (1):16.

Kaur, Navjot., M. Singh, A. Kaur, and B.Kaur, 2023.Integrated use of Organic and Inorganic Sources on Physico-Chemical Properties of Lettuce Grown Soil: J. Soils and Crops, **33**(2):293-296.

Kore, M. A., O.D. Kuchanwar, S.B. Punekar and S.Goud, 2017.Characteristics of rice growing soils in Amgon tehsil of Gondia district. J. Soils and Crops. **27**(1):187-193

Navarkhale,V.V. 2016.Study of Two Indian Soils, JOCPR"**8**(i): 153:160.

Nishat, S.R., R. Gulam, A. R. Khan, and Y. H. Shaikh, 2018. Review on Dielectric Properties of Soil at Various Band of Microwave Frequency, IJRAR**. 5**(4): 699-701.

Sahu, J. P. and A. K. Shrivastava, 2023 Soil Texture: Panacea For Agriculture. Eur. Chem. Bull.**12**(1):956-976.

Shrivastava, A.K. and Ashutosh Pandey, 2021. Microwave. Dielectric Parameter of Soil Texture, Scrip own Publication, ISBN: 978-93-90833-31-3.

Swati, T.V.,W.P. Badole , S.Kawade and R.M. Ghodpage, 2020. Assessment of soil Fertility status in Selected villages under Jalyuki Shivar in Nagpur District. J. Soils and Crops.**30**(1):132-138.

Rec. on 02.04.2024 & Acc. on 15.05.2024