JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

CHNS Analysis of Soil Samples from Patalganga River (Maharashtra, India)

Ninad Marathe[1] and Bhavita P. Chavan*[2]

[1]Research Scholar, The Institute of Science, 15 Madam Cama Road, Mumbai- 400 032.

[2]Professor and Head, Department of Zoology, Government of Maharashtra,

Ismail Yusuf College, Jogeshwari (East), Mumbai-400060.

Corresponding Author: prbchavan@gmail.com

ABSTRACT

Many rivers in India are threatened by water and soil pollution, particularly those that flow through industrial areas. The Patalganga river flows through Khopoli township, Khalapur area, Patalganga industrial sector and provides water to over 40 villages in Raigad district, Maharashtra. Pollutants in the water have an impact on the soil quality of the riverbed, which is principally responsible for supplying nutrients to aquatic vegetation. Carbon, hydrogen, nitrogen and sulphur are important elements which contribute to the productive capacity of soil. In the present investigation, six monthly soil samples from seven selected sites along the Patalganga river belt were collected for C, H, N, S analysis. The highest elemental (C, H, N, S) percentage was found to be carbon while hydrogen and nitrogen levels varied in the soil samples. The study showed significant relationship between the elements and pollution impacting the river ecosystem.

Key words: Patalganga, pollutants, soil, C,H,N,S, ecosystem.

Introduction

Soil is the uppermost weathered layer of the earth's crust. Weathered mineral rock particles, living, dead, and decomposing organic elements, water, and air make up the composition. Soil is a biologically active matrix where plant roots, seeds, bacteria, fungus, algae, viruses and organisms live.The movement of elements through the earth's biotic and abiotic components is known as nutrient cycle.It is the movement of elements within and between ecosystems, as well as their modification and thus connects ecosystems biotic and abiotic components. The three fundamental elements that plants use in the greatest proportions are hydrogen, carbon, and oxygen, and they serve as the building blocks for plant growth. Carbon, hydrogen, nitrogen and sulphur are important elements which contribute to the productive capacity of soil. Most living things in soils, including plants, insects, bacteria and fungi, are dependent on organic matter for nutrients and energy. (Wagh et al., 2013).

The soil quality of a river environment is critical to the survival of aquatic plants and fauna. Soil pH could be useful for soil pollution control through the distribution and removal of harmful substances from systems (Neina et al., 2019). Furthermore, nutrients in the soil bring agricultural advantages to the farmer. The plant requires 16 essential nutrients of which carbon, hydrogen and oxygen are received from the atmosphere, soil and water. Nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, zinc, manganese, copper, boron, molybdenum, and chlorine are the remaining required elements (Khairnar et al., 2019). Organic carbon (OC) enters the soil through the decomposition of plant and animal residues, root exudates, living and dead microorganisms, and soil biota. It is the main source of energy for soil microorganisms. (Khatoon et al., 2017). Soil contamination can be caused by industrial runoff, agricultural activities, waste disposal, human interference, deforestation, excessive use of fertilisers and pesticides, anthropogenic activities and natural disasters.

The majority of industries in India are located around riverbanks. In Raigad district of Maharashtra, the Patalganga river located at 18.48°N 73.4°E is a major source of water for Khopoli township, Khalapur area, and Patalganga industrial sector. The Patalganga river has often been contaminated by partially treated or untreated effluents generated by industries, as well as anthropogenic activities (Desai B, 1993). Polluted water percolates through the riverbed, harming river wildlife and causing soil pollution. Patalganga is a prominent river in terms of socioeconomics. Rivers play a major role in integrating and organizing the landscape and molding the ecological setting of a basin. They are the prime factors controlling the global water cycle and in the hydrological cycle they are the most dynamic agents of transport (Raj et al., 2009). Every year rivers carry a huge amount of top soils from its river bank area and deposit it in another part of its bank (Das et al., 2018). With a length of 65 kilometres, the Patalganga river is an important river in Maharashtra and serves as a major water source for Panvel, Alibaug, and Rasayani. The Patalganga industrial area is, located on the river's left bank which is next to Mohopada village and is one of MIDC's 13 chemical industrial zones, located in Khalapur taluka and is part of the Raigad district. The Khopoli power project's runoff, untreated or partially treated industrial effluents and domestic waste water make their way into the river which flows through an industrial belt at Rasayani, MIDC, towards villages like Vayal, Chavane, Apta, Kasar bhat and Aware till it meets the Dharamtar Creek. Hence, the present investigation was undertaken to study the levels of carbon, hydrogen, nitrogen and sulphur present in the soil from seven different selected sites along the Patalganga river belt.

Materials and Methods

In the present investigation, monthly soil samples were collected in clean and sealed plastic bags from seven selected sites namely Khopoli, Vayal, Rasayani, Chavane, Apta, Kasar bhat and Aware along the river belt from January 2019 to June 2019. Samples were collected in the morning more towards the river. Soil samples were immediately transported to the laboratory and oven dried. Soon after drying, stones and other similar objects were picked up and the soil was grounded with the help of a mortar and pestle to break up aggregates or lumps, taking care not to break actual soil particles. The soil was then passed through a 2 mm sieve to obtain thoroughly dried powder form of soil sample.

The CHNS(O) Analyzer (EUROVECTOR Elemental Analyzer Model Euro EA3100) was used to determine the percentage of Carbon (C), Hydrogen (H), Nitrogen (N) and Sulphur (S) present in the soil samples. Similar work was reported by (Jose et al., 2009) determining the carbon, hydrogen, nitrogen and sulphur contents with an elemental analyser (Leco model CHNS-932). Empty tin capsule was first placed in weighing balance and 25 mg of soil sample, was put into it which was then placed in a carazole of the auto sampler. The tin capsules containing the soil sample with the help of piston were introduced in the reactor part of the analyzer. After the oxidation reaction for 2 to 3 seconds, the combustion and reduction processes were followed. Due to presence of copper, combustion took place while tungsten helped for reduction reaction. Then the gases C, H, N, and S got separated and further moved to the GC column. Thermal conductivity detector (TCD) helped to detect the elemental percentage of the gases. The first peak seen was of N, then C, H and S respectively. After the run was completed the chromatogram showed the percentage on Y axis and retention time (RT) on X axis. For the working of CHNS(O) analyser, Helium gas was used as the carrier gas; Oxygen was used for combustion process and oil free air compressor was used for auto sampler part. The CHNS(O) software used for the experiment was Weaver.net. According to Bhattacharyya et al., 2015 the introduction of C/N analyser has an edge over classical analytical techniques; but it requires careful selection of standards and developing appropriate methods keeping in view of various agro-ecoregions of the country.

Sampling location at Vayal (Upstream) 18.8745° N, 73.2093° E

Sampling location at Apta (Downstream) 18.8516° N, 73.1305° E

Results and Discussion

In the present investigation, the levels of Carbon (C), Hydrogen (H), Nitrogen (N) and Sulphur (S) in soil samples from Patalganga river were studied and readings recorded (Fig. 1, 2 and 3). Except Khopoli and Vayal, all the other sites showed a decline in carbon content in the month of April. Lowest carbon content percentage was observed at Khopoli in the month of March; Apta, Kasar bhat and Aware in the month of April as well as at Chavane and Aware in the month of May. Highest carbon content percentage was observed at Vayal in the month of May. The overall carbon content percentage ranged between 0% to 3%. Carbon is the most abundant element in soil organic matter and it contributes to the water-retention capacity, structure, and fertility of soil. When soil is exposed to air, it oxidises, effectively burning the carbon in the soil. Topsoil ranges between 0.5% to 3% organic carbon for most soils. Soils with less than 0.5% organic carbon belong to desert areas. Soils with 12% to 18% organic carbon are called organic soils. Soil organic carbon plays an important role as a source of plant nutrients and in maintaining the soil integrity (Solanki et al., 2012). Soil respiration and its rate across ecosystem are extremely important as it plays a large role in global carbon cycling as well as other nutrient cycles. (Khatoon et al., 2017). The amount of carbon estimated in this study is found to be within the range.

Except Khopoli and Kasar bhat, all sites showed a decrease in the hydrogen content percentage in the month of February. Except Khopoli and Vayal, all sites showed an increase in the hydrogen content percentage in the month of June. With lowest hydrogen content percentage being 0 in some of the sites, the highest hydrogen content percentage was observed at Apta in the month of January. The overall hydrogen content percentage ranged between 0% to 2% and showed fluctuating levels at some sites. Hydrogen ions are essential for plant respiration as well as assisting proton gradients in driving the electron transport chain in photosynthesis. The amount of Hydrogen affects pH and the accessibility of other elements in soil and at high and low pH values nutrient deficiencies can be observed; therefore, hydrogen plays an important role in the development of plants. (Chopra et al., 2020).

All the sites except Vayal showed a decline in nitrogen content in the month of February. An elevation in nitrogen content in the month of March was observed in all sites except Khopoli and Kasar bhat. Highest nitrogen content percentage was observed at Chavane in the month of January. In the present study the overall nitrogen content percentage ranged between 0% to 2% and decreasing trend was observed from the months January to June. Deficiency of nitrogen is almost universal in Indian soils (Deshmukh, 2012). Higher amounts of Nitrogen in the month of January may be due to excess release of sewage water into the river which settles down at the riverbanks and mixes with the soil. Sewage water contains high amount of Nitrogen. (Rai et al., 2011) have showed similar findings. Nitrogen is critical for plant growth, metabolism, and chlorophyll production. (Seiyaboh et al. 2017) have reported similar findings with high nitrogen content owing to runoff which adds domestic sewage to the sediments. The fertility and biodiversity in an aquatic system is greatly influenced by nitrogen concentration of the sediment (Kumar et al., 2012). The plant cannot grow taller or generate enough food if it does not have adequate nitrogen. Small changes in nitrogen content for some crops can result in large effects on plant growth and the quality of forage abd fruit. (Shirgave et al., 2015). Nitrogen supply has large effect on leaf growth because it increases the leaf area of plants and, on that way, it influences on photosynthesis (Bojovic et al., 2009). Stunted growth in plants is due to a nitrogen deficiency in the soil. Nitrogen is essential for plant growth as it is a constituent of all proteins and nucleic acid and hence of all protoplasm (Raut et al., 2020). Nitrogen is essential to nearly every aspect of plant growth. (Jadhav, 2012).

In the present study, sulphur content percentage present showed negligible values at all sampling sites in all the months. In plants, sulphur is required for the formation of proteins, enzymes, vitamins, and chlorophyll. It is essential for legume nodule formation and nitrogen fixation efficiency. Soil sulphur deficiency has been reported to be on an rise in Western Europe and Hungary (Flaete et al., 2005). Areas of sulphur deficiency are becoming widespread throughout the world due to the use of high-analysis low sulphur fertilizers, low sulphur returns with farmyard manure, high yielding varieties and intensive agriculture, declining use of sulphur containing fungicides and reduced atmospheric input caused by stricter emission regulation. An insufficient sulphur supply can affect yield and quality of the crops, caused by the sulphur requirement for protein and enzyme synthesis as well it is a constituent of the amino acids, methionine and cysteine (Jamal et al., 2010). (Luczkowska et al., 2015) reported chlorosis in sulphur deficient plant, sulphur being essential element of growth and plant functioning its deficiency may cause serious economic problems.

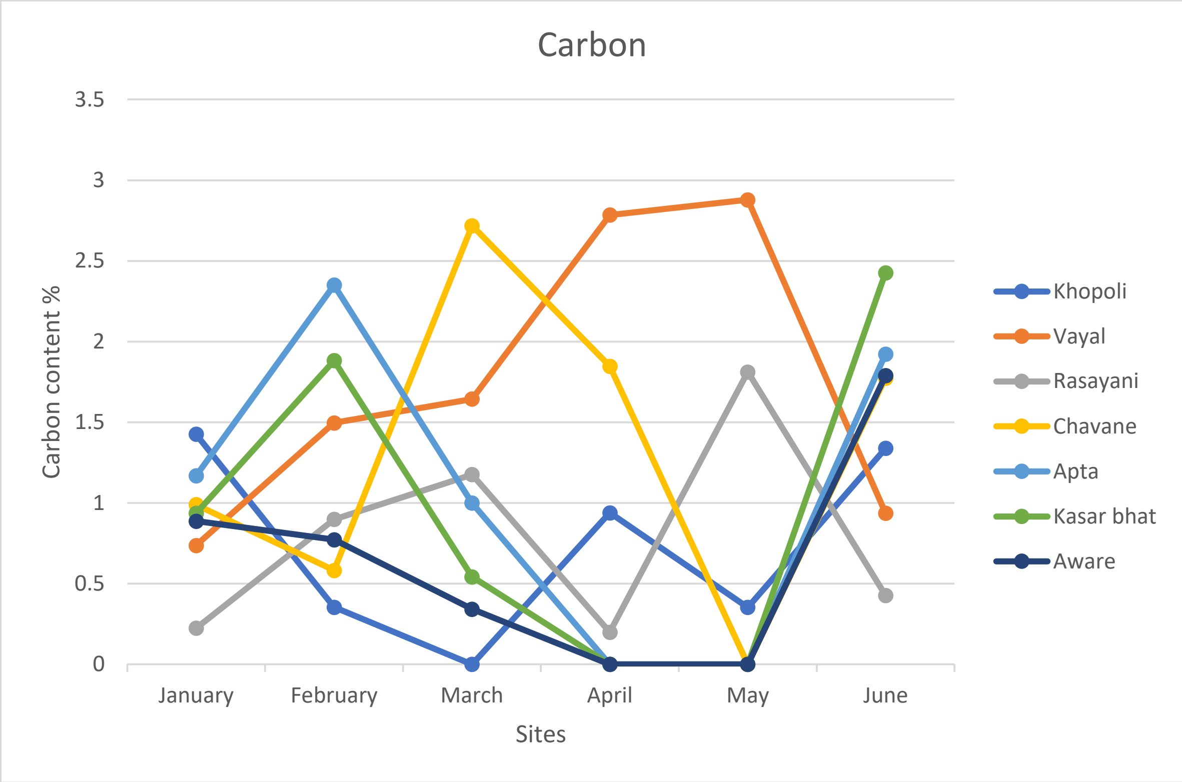

Fig. 1: Monthly variations of Carbon content in Patalganga River

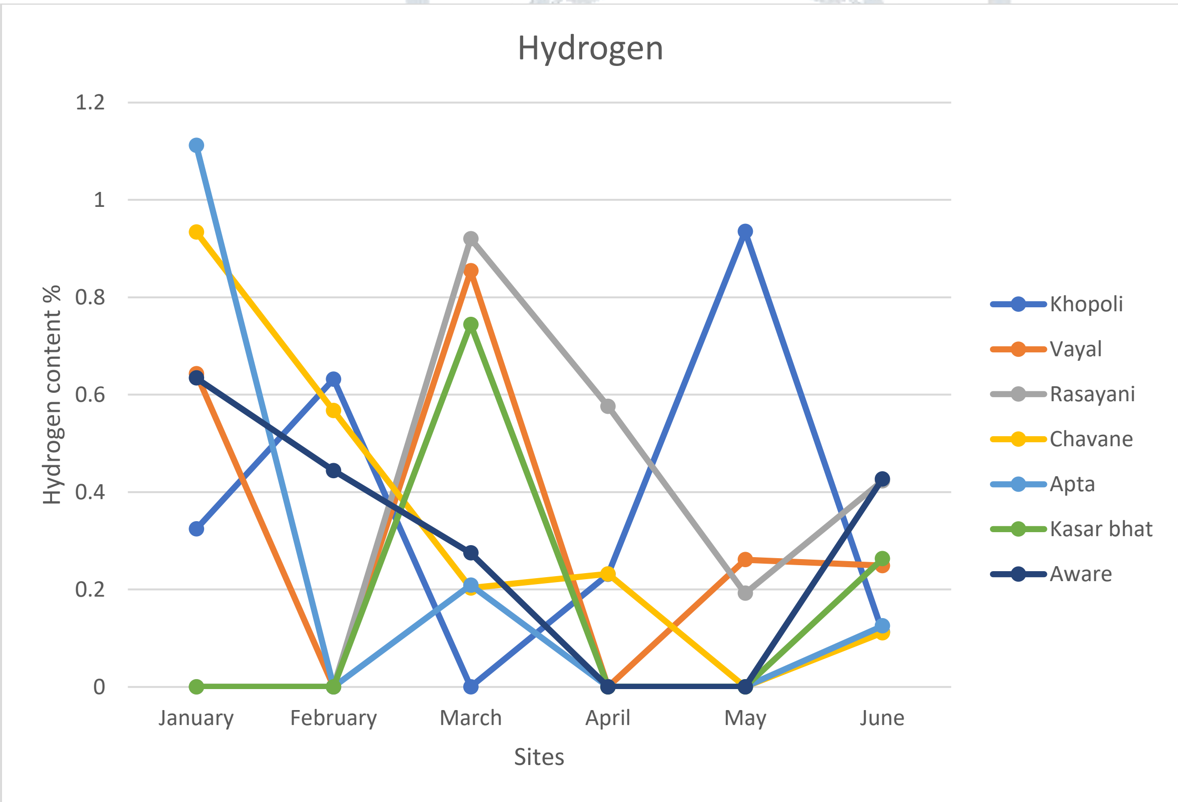

Fig. 2: Monthly variations of Hydrogen content in Patalganga River

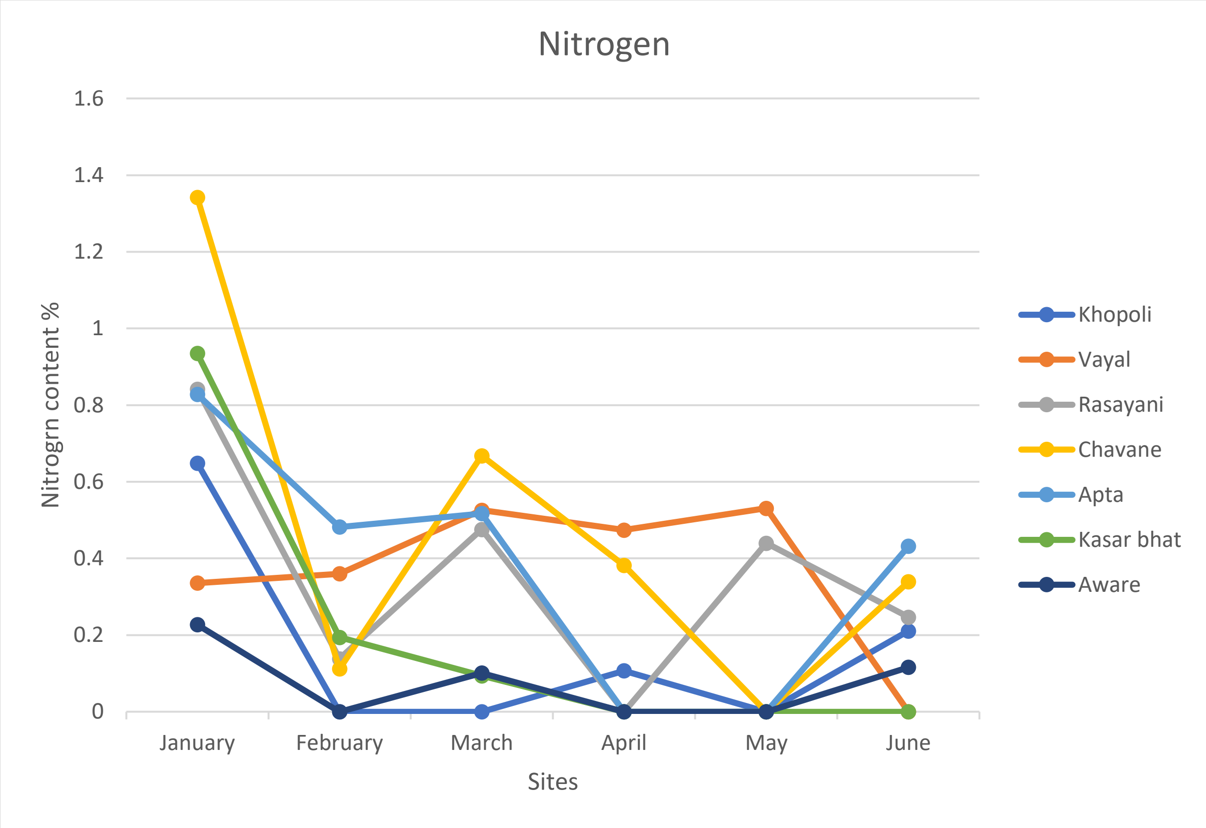

Fig. 3: Monthly variations of Nitrogen content in Patalganga River

Conclusion

Hence,in the present investigation the amount of carbon estimated in the soil samples was found to be within the range, hydrogen levels showed fluctuation, an decrease in nitrogen content and negligible sulphur element, all clearly indicates the pollution status of the soil present along the riverbelt. As the population living nearby the river banks of the Patalganga river is dependent on its soil and ecosystem for agricultural use as well as natural resources derived from trees and plants, continuous monitoring of essential elements in the soil is necessary and warrants attention to minimize pollution of the river water body and its ecosystem.

Acknowledgements

Authors are thankful to Dr. Jairam Khobragade, Director, The Institute of Science and the Head, Department of Zoology, The Institute of Science, Mumbai. Authors are also thankful to Dr. Swati Wavhal, Principal, Govt. of Maharashtra Ismail Yusuf College, Jogeshwari, Mumbai.

References

Arshad Jamal, Yong-Sun Moon and Malik Zainul Abdin, 2010. Review article Sulphur -a general overview and interaction with nitrogen. Australian Journal of Crop Science. 4(7):523-529.

Biljana Bojovic and Aca Markovic, 2009. CORRELATION BETWEEN NITROGEN AND CHLOROPHYLL CONTENT IN WHEAT (Triticum aestivum L.). Kragujevac J. Sci. 31 (2009) 69-74.

Das A, David AA, Swaroop N, Thomas T, Rao S and Hasan A, 2018. Assessment of physico-chemical properties of river bank soil of Yamuna in Allahabad city, Uttar Pradesh. International Journal of Chemical Studies 2018; 6(3): 2412-2417.

Desai, 1993.

Dora Neina, 2019. Review Article The Role of Soil pH in Plant Nutrition and Soil Remediation. Hindawi Applied and Environmental Soil Science Volume 2019, Article ID 5794869, 9 pages.

Dorota Łuczkowska, Barbara Cichy, Mariusz Nowak and Andrzej Paszek, 2015. Liquid nitrogen-sulphur fertilizers – answer on sulphur deficiency in soil. CHEMIK 2015, 69, 9, 557–563.

Enetimi Idah Seiyaboh, Sylvester Chibueze Izah and Solomon Oweibi, 2017. Physico-chemical Characteristics of Sediment from Sagbama Creek, Nigeria. Biotechnological research 2017; Vol. 3 (1): 25-28.

Flaete, NES., Hollung, K., Ruud, L., Sogn, T., Faergestad, EM., Skarpeid, HJ., Magnus, EM. and Uhlen AK., 2005. Combined nitrogen and sulphur fertilization and its effect on wheat quality and protein composition measured by SE-FPLC and proteomics. Journal of Cereal Science 41(3): 357-369.

Gordana Ludajic, Lato Pezo, Nada Filipovic and Jelena Filipovic, 2013. Toxic and Essential Elements in Agricultural Soil and Wheat Toksicni I Esencijalni Elementi U poljoprivrednom Zemljistu I Psenici. Journal on Processing and Energy in Agriculture 17 (2013) 1. 1821-4487 (2013) 17; 1; p 43-46.

H. A. Solanki and N. H. Chavda, 2012. Physico-chemical Analysis with Reference to Seasonal Changes in Soils of Victoria park Reserve Forest, Bhavnagar (Gujarat). Life sciences Leaflets 8: 62-68, 2012.

Hina Khatoon, Praveen Solanki, Maitrayie Narayan, Lakshmi Tewari and JPN Rai, 2017. Role of microbes in organic carbon decomposition and maintenance of soil ecosystem. International Journal of Chemical Studies 2017; 5(6): 1648-1656.

Jose M. Guerra-García, M. Pilar Cabezas, Elena Baeza-Rojano, Isabel Pacios-Palma and J. Carlos Garcia-Gomez, 2009. Carbon, nitrogen, hydrogen and sulphur components of intertidal caprellids (Crustacea) from southern Spain. Aquatic Biology Vol. 8: 39–43.

K. K. Deshmukh, 2012. Evaluation of Soil Fertility Status from Sangamner Area, Ahmednagar District, Maharashtra, India. Rasayan J. Chem., Vol. 5, No. 3, 398-406.

Kumar RN, Solanki R and Kumar NJI, 2012. Geochemistry of Sabarmati River and Kharicut Canal, Ahmedabad, Gujarat. International Journal Of Environmental Sciences. 2012; 2(4):1909-1919.

Mayur Dattatray Khairnar and Sagar Sreekumar Nair, 2019. Study on Eggshell and Fruit peels as a Fertilizer. Proceedings of International Conference on Sustainable Development (ICSD 2019) In Association with Novateur Publications IJIERT-ISSN No: 2394-3696.

Pandit Shirgave and Avinash Ramteke, 2015. Physicochemical Status of Fertile Soil around Arjunnagar, District Kolhapur, Maharashtra, India. International Journal of Chemical Studies 2015; 3(2): 98- 101.

Raj N and Azeez PA, 2009. Spatial and temporal variation in surface water chemistry of a tropical river, the river Bharathapuzha, India. Current Science. 2009; 96(2):245- 251.

Ranjit Raut, Prashant Harale and Anil Kurhe, 2020. Studies on Soil Quality Parameters in Relations to Cropping Patterns, Micronutrients and pH from Goagalgaon area in Ahmednagar District of Maharashtra, India. International Journal For Innovative Research in Multidisciplinary Field. ISSN: 2455-0620 Volume - 6, Issue - 9, Sept – 2020.

Shobha D. Jadhav, 2012. Investigation of some Parameters and Nutrients from Sewage Irrigated and River Water Irrigated Soil Samples from Gadhinglaj, Maharashtra. Rasayan J. Chem. Vol. 5, No. 4, 493-495.

Sumithra S, Ankalaiah C, Rao D and Yamuna RT, 2013. A case study on physico – chemical characteristics of soil around industrial and agricultural area of Yerraguntla, Kadapa district, A. P, india. Int. J. Geo. Earth and Environ. Sci. 2013,3(2), 28-34.

Swapnil Rai, A. K. Chopra, Chakresh Pathak, Dinesh Kr Sharma, Renu Sharma and P. M. Gupta, 2011. Comparative study of some physicochemical parameters of soil irrigated with sewage water and canal water of Dehradun city, India. Archives of Applied Science Research, 2011, 3 (2): 318- 325.

T. Bhattacharyya*, S. K. Ray, U. K. Mauryaa , P. Chandran, D. K. Pal, S. L. Durge, A. M. Nimkar, S. M. Sheikh, H. W. Kuchankar, B. Telpande, Vishakha Dongre and Ashwini Kolhe, 2015. Carbon and nitrogen estimation in soils : Standardizing methods and internal standards for C/N analyzer. J. Indian Chem. Soc., Vol. 92, February 2015, pp. 263-269.

Vivek Chopra and Jai Gopal Sharma, 2020. Assessment of elemental Carbon, Nitrogen, Hydrogen and Sulphur in alluvial sediments of River Yamuna in Delhi region. Eco. Env. & Cons. 26 (November Suppl. Issue) : 2020; pp. (S174-S181).

Wagh G. S., Chavhan D. M. and Sayyed M. R. G., 2013. Physicochemical Analysis of Soils from Eastern Part of Pune City. Universal Journal of Environmental Research and Technology. Volume 3, Issue 1: 93-99.