Agropedology 2023, 33 (01), 77-84
doi.org/10.47114/j.agroped.2023.jun 8

Soil Fertility Evaluation and Mapping of Burugamaradoddi Microwatershed of Ramanagara Taluk, Ramanagara District, Karnataka

B. G. Vasanthi[2], B. K. Chaitra[1*], B. Mamatha[1], A. Sathish[1]

[1]*Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bengaluru-560065*
[2]*AICRP on Dryland Agriculture, UAS, GKVK, Bengaluru-560065*

Abstract: The present investigation was conducted to know the soil fertility status of Burugamaradoddi microwatershed of Ramanagara district. The soil samples were collected from 0-15 cm soil depth from 70 locations. Soil fertility maps were prepared for pH, electrical conductivity, organic carbon, available nitrogen, available phosphorous, available potassium and available sulphur, exchangeable calcium and magnesium, available boron and available micronutrients *viz.,* iron, manganese, zinc, copper and zinc. Results revealed that the soils were slightly acidic (pH: 5.35-8.32) to moderately alkaline and electrical conductivity of soil were non- saline to slightly saline. The organic carbon status ranged from low to high (0.15-0.90%), and available nitrogen was mostly low. The soil available phosphorus was low to medium; available potassium was in low to medium range and exchangeable calcium and magnesium were found in sufficient range, available sulphur was in low to high range. Regarding available micronutrients, boron and zinc were in low category and level of copper, iron and manganese were in sufficient range. The assessment of soil fertility in Burugamaradoddi micro-watershed revealed that, watershed had better soil fertility status in soil.

Key words: *Soil fertility status, soil nutrients mapping, watershed.*

Introduction

Soil is a sole of infinite living organisms, the sustainable management of these soil resources is essential for maintenance of environmental balance but today the indiscriminate use of soil resources coupled with lack of management has, led to degradation of soil resources. The natural resources are the national treasures the proper planning of these are prerequisite for the best possible utilization. Recently the concept of watershed based holistic development has emerged as one of the potential approaches in rain fed areas, which can lead to higher productivity and sustainability in agricultural production. The sustainable development of a region need not only require protection and reclamation of natural resources particularly soil and land, but also need a scientific basis for the management in harmony with environment. For the sustainable use of the natural resources, a detailed study of land resources giving its potential and constraints to use becomes a pre-requisite for planning. Land use according to its capability is essential for conserving natural resources for sustainable agriculture (Kiran *et al*. 2019).

Knowledge of soil and land resources with respect to their spatial distribution, characteristics, potentials, limitations and their suitability for alternate

*Corresponding author: (Email: chaitra1492@gmail.com)

land uses helps in formulating strategies to obtain higher productivity on sustained basis in order to meet the food requirement of growing population. Soil resource inventory through characterization of resources provides an insight into the potentials and limitations of soil productivity and a framework for the management of soil resources which is needed to realize the concept of watershed development approach successfully. Land use and management practices have considerable influence on available status of nutrients.

The systematic inventory of natural resources like soil, water, land use, forest*, etc.* at a faster rate through scientific methods by using modern tools like remote sensing (RS) geographic information system (GIS) and global position system (GPS) it helps in providing adequate information in terms of land form slope land use and soil characteristics *viz.,* texture, depth, structure, stoniness, drainage, acidity, salinity *etc*. Thus the advent of these has revolutionized in mapping of spatial and non-spatial natural resource information which helps in evolving a variable decision support for achieving sustainable development of agriculture with an objective to characterize soil in respect to physical and chemical properties and soil classification, the suitability of various crops were computed with GIS to determine the effect of soil properties on various crops. Considering the above points the present investigation detailed soil survey was under taken to "Soil Fertility Evaluation and mapping of Burugamaradoddi micro-watershed of Ramanagara Taluk, Ramanagara District" was undertaken using RS and GPS.

Materials and Methods

Description of the study area

The study area is Burugamaradoddi micro-watershed (Kempegaudanadoddi sub-watershed, Ramanagara taluk, Ramanagara district) covering an area of 726 ha and it is located between north latitude 12° 45' 48.56" to 12° 47' 54.096" N and east longitude 77° 18' 8.218" to 77° 20' 2.228" E. The micro-watershed is located in central Karnataka plateau, hot, moist, semi-arid eco-sub region, southern plateau and hill Region. The climate of the watershed is semi-arid monsoon with distinct summer, winter and rainy seasons. The average annual rainfall ranges from 679.1 to 888.9 mm of which more than 50 per cent is received during the *kharif* season. The elevation is 800 to 900 m.

The major soils are red loamy and remaining areas are lateritic. The main crops grown are Ragi (*Eleusine coracana)*, Paddy (*Oryza sativa*), Maize (*Zea mays*), Redgram (*Cajanaus cajan*) and Groundnut (*Arachis hypogea*). The Closepet granites are the major geological feature of the district. The Closepet granite contains enclaves of migmatite, gneisses, quartzite and amphibolites. Most soils of the micro-watershed area are deep with non-gravelly in nature. Entire micro-watershed area is having slight erosion (644 ha).

Soil sampling, soil analysis and statistical analysis

The survey of India toposheet (57 A/6) was used to prepare base maps covering village of Burugamaradoddi, this micro watershed. The cadastral map having parcel boundaries and survey numbers are produced from KSRSAC Bangalore. The boundary of the micro watershed was obtained from the watershed Atlas prepared by KSRSAC. Detailed soil survey was taken up using standard proforma as per the guidelines given in USDA Soil Survey Manual (Anonymous 2014). Surface soil samples collected from 0 to 15 cm in the year 2022 from farmer's fields at 320 m grid interval.

The surface texture was analysed by feel method at field level. The pH (1:2.5) and electrical conductivity (EC) (1:2.5) of soils were measured using standard procedures as described by (Jackson 1973). Organic carbon was determined using the Walkley-Black method (Piper 2002). Available nitrogen was estimated by alkaline permanganate method (Subbiah and Asija 1956). Available phosphorus (Olsen P) and (Brays P) were measured using sodium bicarbonate ($NaHCO_3$) as an extractant (Olsen and Sommers 1982) and Ammonium fluoride & and hydrogen chloric acid as an extractant (Bray and Kurtz 1945) respectively. Available potassium was determined using the ammonium acetate method Exchangeable calcium and magnesium were determined by using EDTA Complexometry titration

method (Ammonium acetate) as an extractant (Black 1965). Available sulphur was measured using 0.15 percent calcium chloride ($CaCl_2.2H_2O$) as an extractant (Williams and Steinbergs 1959). Micronutrients (iron, manganese, copper and zinc) were extracted by DTPA using the procedure outlined by (Lindsay and Norvell 1978). Analytical data was interpreted and statistical parameters like range, mean and standard deviation values were calculated.

Soil Fertility Mapping

Using topographic (1:50000) map or Base map (Figure 2) and Google Earth or satellite image as a reference, location map of the study area was developed using Arc GIS 10 (Figure 1). By recording boundary coordinate points using GPS, delineation of sub-watershed was carried out. After that, the respective coordinate points marked using GPS were fed into the GIS environment; then, polygons for the watershed and for each land use were created by digitizing the recorded boundary points. Soil fertility data generated has been assessed and individual maps for soil reaction, electrical conductivity, organic carbon, available nitrogen, available phosphorous, available potassium, available sulphur, exchangeable calcium and exchangeable magnesium and available micronutrients (iron, manganese, copper and zinc) and available Boron of the micro-watershed have been generated by using the Kriging method under Geographical Information System.

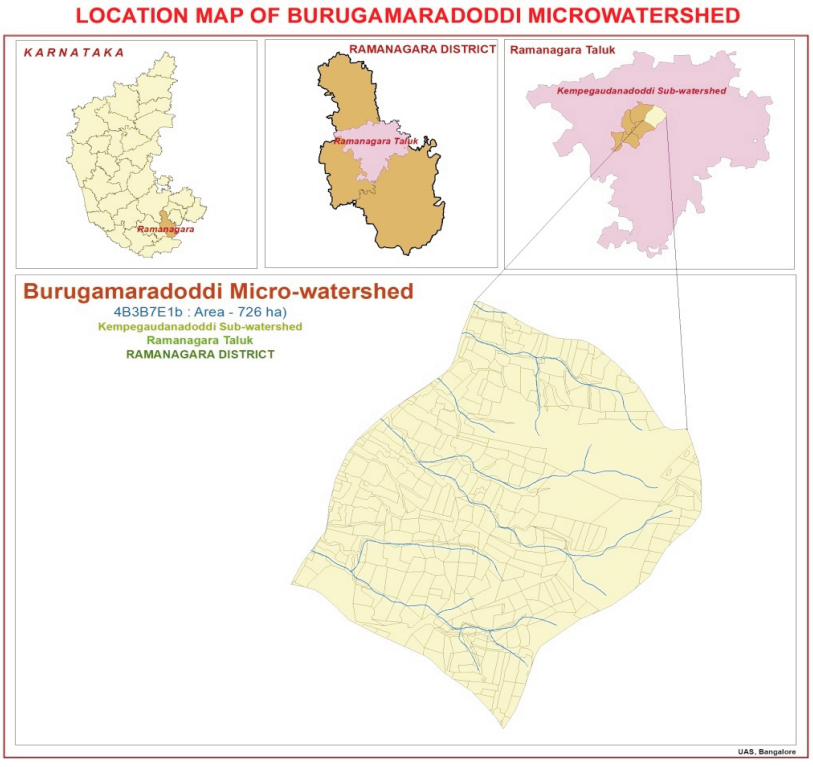

Fig.1. Location map of Burugamaradoddi microwatershed.

Results and Discussion

Physico-chemical properties of Burugamaradoddi Micro watershed

The soil pH of the micro watershed were ranged from slightly acidic to moderately alkaline (Table 1) may be due to variation in soil pH was related to the parent material, and topography. The relatively low pH in red soils was mainly due to iron hydroxide species which contributed for higher for higher H^+ concentration (Dasog and Patil 2011). On area basis, 220.6 ha (30.4 %) was slightly acid, moderately alkaline, 216.1 ha (29.8 %)

neutral and 119.7 ha (16.4 %) slightly alkaline nature in this micro watershed area (Figure 2).

The electrical conductivity was found very low (0.02-0.89 dS m^{-1}) indicating that the soils of selected micro watershed were non saline in nature (Table 1). The normal EC may be ascribed to leaching of salts to lower horizons. (Sharma *et al.* 2008).

Table 1. Physico-chemical properties of Burugamaradoddi microwatershed of Ramanagara Taluk, Ramanagara district

Parameters	Range	Mean	SD
Soil Reaction (pH)	5.35 - 8.32	6.71	0.72
Electrical Conductivity (dSm^{-1})	0.02 - 0.89	0.17	0.11
Organic Carbon (%)	0.15 - 0.9	0.46	0.17
Available Nitrogen (kg ha^{-1})	106.6 - 285	172.7	40.78
Available Phosphorus (kg ha^{-1})	10.26 - 55.43	30.15	12.66
Available Potassium (kg ha^{-1})	24.48 - 314.28	91.58	54.52
Exchangeable Calcium (C mol p^{+} kg^{-1})	1.5 - 10.5	14.55	2.16
Exchangeable Magnesium(C mol p^{+} kg^{-1})	1.0 - 6.5	4.52	1.36
Available Sulphur (ppm)	10.35 - 21.99	14.55	3.09
Available Iron (ppm)	1.9 - 7.19	4.11	1.19
Available Manganese (ppm)	2.45 - 8.11	3.63	1.03
Available Copper (ppm)	0.48 - 1.77	0.82	0.2
Available Zinc (ppm)	0.13 - 1.13	0.56	0.27
Available Boron (ppm)	0.21 - 1.05	0.69	0.17

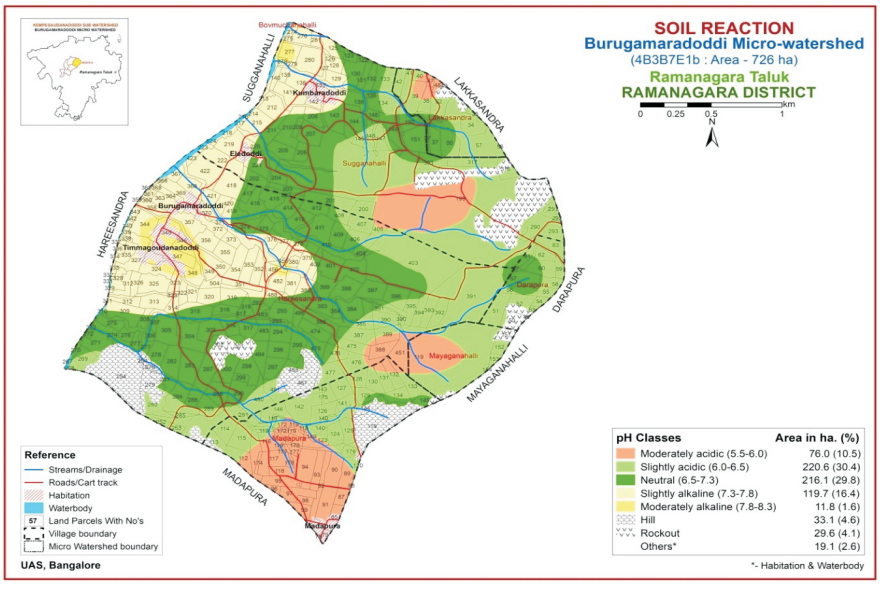

Fig. 2. Soil reaction Map of Burugamaradoddi micro-watershed.

The soil organic carbon content (SOC) was low in majority of soil samples and it ranged from (0.15-0.90 % Table 1) accounting 644.2 ha (88.7 %) of micro-watershed area was low. The low organic matter content in the soils was attributed to the prevalence of tropical condition, where the degradation of organic matter occurs at a faster rate coupled with low vegetation cover, thereby leaving less organic carbon in the soils (Sireesha and Naidu 2013).

Available major nutrients

The study revealed that, total area of watershed was low in the available N (106.60 - 285.00 kg ha^{-1} Table 1). It is quite obvious that the efficiency of applied nitrogen is very low due to the fact that N is lost through various mechanisms like microbial fixation, leaching loss and run off. And also may be ascribed due to nutrient removal or may be due to nutrient uptake by the crops (Somasundaram *et al*. 2012).

The available phosphorus values of watershed were found low to medium status in soils (10.26 - 55.43 kg ha^{-1} Table.1). The Low P_2O_5 availability in these soils is related to their high pH, calcareousness and low organic matter content. (Patil *et al.* 2011) reported for soils of Karnataka that available P_2O_5 status in the soils was low due to high calcium carbonate content. GIS Mapping of available phosphorus content in the micro watershed revealed that, 87.6 per cent of the area (636.5 ha) was in medium range.

The available K_2O content in the micro watershed was ranged from 24.48-314.28 kg ha^{-1} with mean value of 91.58 74 kg ha^{-1}(Table 1). It has been brought out more clearly in maps as 87.1 per cent area of micro watershed was low (Figure 3). Low available K_2O in soils signifies higher leaching regime as evidenced by low base saturation in these soils (Patil and Dasog 1999).

The exchangeable calcium and magnesium values were found in sufficient range [1.5 to 10.5 and 1.00 to 6.5 C mol (p^+) kg^{-1} respectively Table.1] accounting 100 per cent of the area was sufficient category. This was due to Ca^{2+} shows the strongest relationship with clay compares to $Mg2^+$ and K^+. Magnesium was present in lower amount than Ca^{2+} because of its mobility. The dominance of Ca and Mg in the soil was due to soils derived from the basic cation rich minerals (Kiran *et al.* 2019).

The available S content of soils of the micro watershed varied from 10.35-21.99 ppm soil with mean value of 14.55 ppm Table 1). GIS mapping of available S revealed that, the entire area under study was medium in available sulphur status. Low and medium level variation of available sulphur was due to lack of sulphur addition and continuous removal of S by crops (Shankaraiah *et al.* 2006).

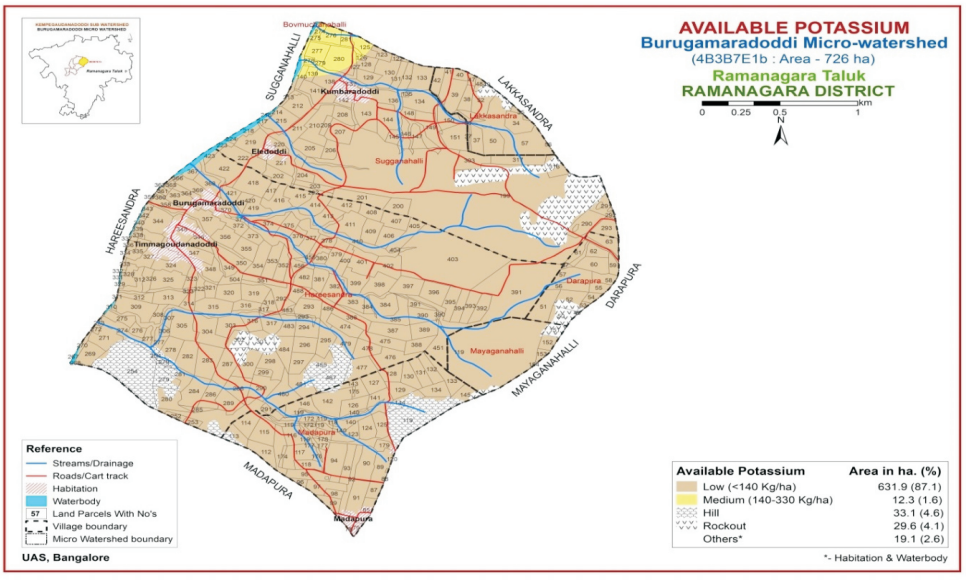

Fig. 3. Available Potassium Map of Burugamaradoddi micro-watershed

Available micro nutrients

The results revealed that, available boron and zinc were in low category (0.2 - 1.05 and 0.13 - 1.13 ppm respectively) and the level of copper, iron and manganese were in sufficient range (0.48 - 1.77, 1.9 - 7.19, and 2.45 - 8.11 ppm respectively Table 1). The trend in availability of micro-nutrients in irrigated area was similar to rain - fed areas in the watershed with Zn availability being low to medium whereas, Cu and Fe availability range from high to very high (Balasubramaniam *et al.* 2005). It has been brought out more clearly in maps of available Mn and Cu, 87.1 per cent area of micro watershed was in sufficient category. The GIS Mapping of available Fe and Zn content in the micro watershed (Figure 4 and Figure 5) revealed that, 69 per cent of the area (500.9 ha) and 73.2 per cent (531.80 ha) were in deficient category.

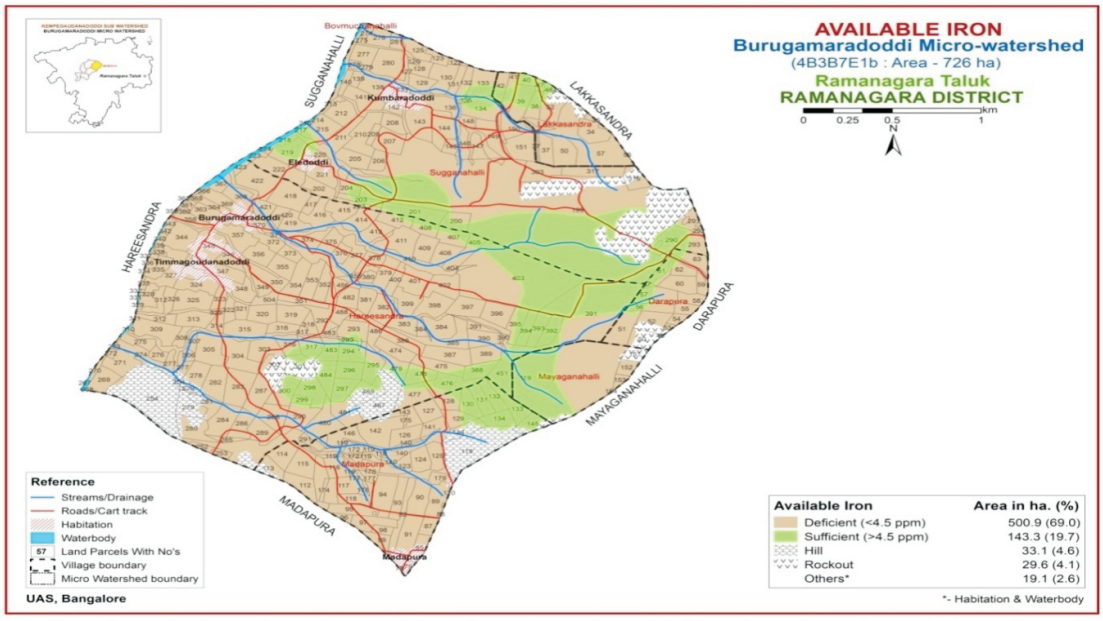

Fig. 4. Available Iron of Burugamaradoddi micro-watershed.

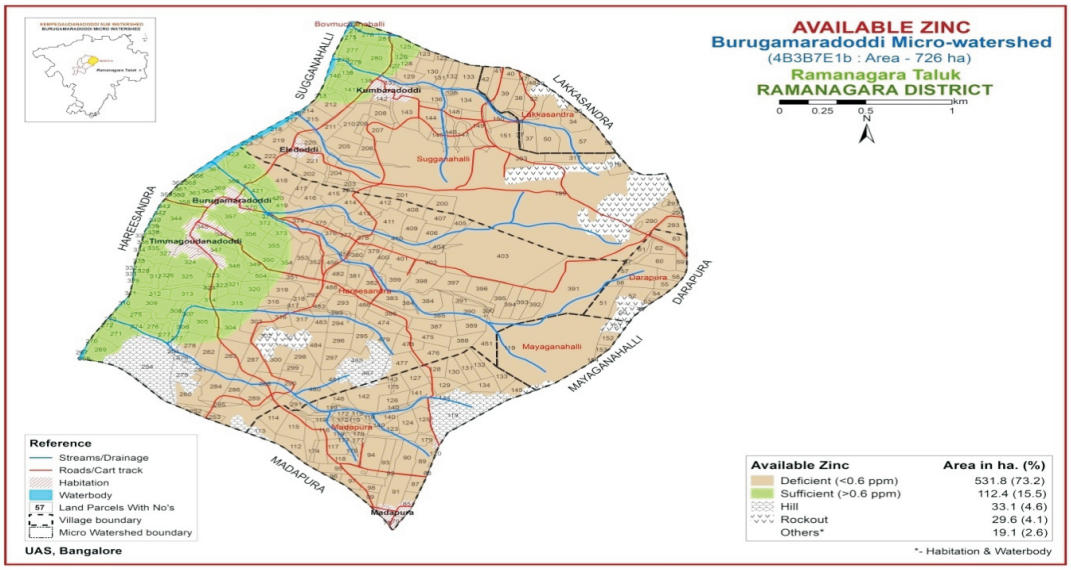

Fig. 5. Available Zinc in Burugamaradoddi micro-watershed.

Conclusions:

From the study, it can be concluded that the soils of Burugamaradoddi microwatershed are neutral to strongly alkaline with non-saline to slight salinity. Alkaline soils in the study area need immediate attention for their management to arrest further degradation. Soil organic carbon content was low to medium. Available nitrogen was low to medium, available phosphorous and potassium was low to high, and available sulphur was sufficient. Regarding available micronutrients, zinc and boron were deficient in about 3/4th of the micro-watershed area whereas iron, manganese and copper were sufficient in the soils. The fertility status of nutrients in Burugamaradoddi micro-watershed revealed that the available nitrogen, available sulphur, available iron and zinc are important soil fertility constraints indicating their immediate attention for sustained crop production. The deficient micronutrients need to be replenished to avoid the crops suffering from their deficiency and for optimum utilization of other nutrients. Application of FYM, vermi-compost and zinc as zinc sulphate along with application of recommended nutrients are urgently required to improve soil fertility and crop productivity on sustainable basis.

Acknowledgement

Authors are thankful to state government finding this project under KWDP-III, Watershed Development to Prevent Drought WDD; Government of Karnataka, Bengaluru. The authors sincerely acknowledge nodal officer Dr. Sathish. A. of WDPD Project, GoK, UAS Bangalore for extending the facilities carry out the research and Dr. B. G. Vasanthi, Senior Scientist, AICRP, Dry land Agriculture, University of Agricultural Sciences, Bangalore for their help and scientific insight during the study.

References

Anonymous (2014). Keys to Soil Taxonomy, United States Department of Agriculture, Washington. D. C, USA.

Balasubramaniam, P., Mani, A.K. and Duraisami, V. P. (2005). Micronutrient status of rainfed red soils (Entisols and Alfisols) of Dharmapuri district, Tamil Nadu.9 **(4-6)**:248-251

Black, C. A. (1965). Methods of Soil Analysis Part- II. Chemical and mineralogical properties. Agronomy Monograph No. 9, Am. Soc. Agron., Inc. Madison, Wisconsin, USA, 18-25.

Bray, R. H. and Kurtz, L.T. (1945). Determination of total, organic, and available forms of phosphorus in soil. *Soil Science* **59**, 39-45.

Dasog, G.S., and Patil, P. L. (2011). Genesis and classification of black, red and lateritic soils of Karnataka. In: Soil Science Research in North Karnataka, Dharwad chapter of ISSS (Ed.), 76th annual convention of ISSS, p. 1- 10.

Jackson, M. L. (1973). Soil Chemical Analysis, Prentice All India Private Limited, New Delhi, 38-82.

Kiran Kumara, H. A., Hundekar, S. T., Patil, P. L., Bidari, B. I. and Tolanur, S. I. (2019). Land resources inventory of Hittnalli micro-watershed of Vijayapura district of Karnataka, *Journal of Pharmacognosy and Phytochemistry* **8 (4)**: 2539-2545.

Lindsay, W. L. and Norvell, W. A. (1978). Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Science Society of American Journal* **43**:421-428.

Nelson, D. W. and Sommers, L. E. (1996). Total carbon, organic carbon, and organic matter. In Methods of Soil Analysis, Part 3. Chemical Methods (D.L. Sparks, Ed.), Madison, Wisconsin, 961-1010.

Olsen, S. R. and Sommers, L. E. (1982). Phosphorus. In Methods of Soil Analysis Part 2, 2nd edition, Madison, Wisconsin, 403-430.

Patil, P.L. and Dasog, G.S. (1999). Genesis and classification of ferruginous soils in western ghat and coastal region of north Karnataka. *Agropedology* **9**, 1-15.

Patil, P. L., Radder, B. M. and Aladakatti, Y. R. (2011).Effect of Moisture Regimes, Zinc and Iron Levels on Yield, WUE and Nutrients Uptake in Chilli + Cotton Cropping System .*Journal of Indian Society Soil Science* **59**:401-406

Piper C. S. (2002). Soil and Plant Analysis. Hans publishers, Bombay, India, 368.

Sireesha, P.V.G., and Naidu, M.V.S., (2013). Studies on genesis, characterization and classification of soils in semi-arid agro- ecological region: A case study in Banaganapallemandal of Kurnool district in Andhra Pradesh. *Journal of Indian Society Soil science* **61(3)**: 161-178.

Sharma, P. K, Anil Sood, R. K., Setia, N. S., Tur Deepak and Harpinder Singh (2008). Mapping of micronutrients in soils of Amritsar district, Punjab-A GIS Approach. *Journal of the Indian Society of Soil Science* **56**:34-41.

Somasundaram, J., Singh, R. K., Ali, S., Sethy, B. K., Singh, D., Lakaria, B. L., Chaudhary, R. S., Singh, R. K. and Sinha, N. K. (2012). Soil aggregated and other properties as influenced by different long term land uses under table land scape topography of Chambal region, Rajasthan, India, **10(3)**: 212-217.

Shankaraiah, M., Sreemannarayana, B. and Srinivasaraju, A., (2006).Studies on the status and distribution of sulphur in black soils (Vertisols) of Karimnagar district, Andhra Pradesh. *Indian Journal of Dryland Agricultural Research Development* **21**:74- 79.

Subbaiah, B. V. and Asija, C. L. (1956).A rapid procedure for the estimation of available nitrogen in soils. *Current Science* **25**:32.

Williams, C. H. and Steinbergs, A., (1959). Methods and Analysis of Soils, Plants, Water and Fertilizers FDCO, New Delhi. India, **58**:133.

Received: July, 2023 *Accepted: November, 2023*