Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6789

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (5):** 542-548 (2018)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Soil Fertility Evaluation for Macronutrients Using Parkers Nutrient Index Approach in Some Soils of Varanasi District of Eastern Utter Pradesh, India

Shishu Pal Singh[1*], Shivraj Singh[2], Ashok Kumar[3] and Rajesh Kumar[4]

[1]Department of Agriculture Krishi Bhavan, Collectory Farm, Varanasi, U.P.

[2]Department of Environment Science, Gazipur Postgraduate College, Gazipur, U.P., India

[3]Department of Soil Science and Agricultural Chemistry, IARI, New Delhi

[4]Sri Babu Singh Daddu Ji Krashi Mahavidyalaya, Farrukhabd, UP., India

*Corresponding Author E-mail: shishupal_bhu@yahoo.co.in

Received: 12.08.2018 | Revised: 23.09.2018 | Accepted: 30.09.2018

ABSTRACT

The experiment was conducted to investigate the soil fertility status of the Varanasi district. The study consisted of field survey for collection of soil samples and their analysis for chemical and physical properties at department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Soil fertility evaluation of an area is an important aspect in context of sustainable agriculture production. The macro nutrients govern the fertility of soils and control the growth and yields of crops. In the present investigation four blocks was selected in the district Varanasi of Uttar Pradesh and studied the available macronutrient status in the soils using Parkers Nutrient Index approach made with the study of 30 sub-surface soil samples collected from farmers filed from different villages of Harhua, Baragaon, Pindra, Araziline block with the help of khurpi in zigzag motion. Collected soil samples were analyzed for pH, Electrical Conductivity,(EC) Organic Carbon (OC), Nitrogen (N), Phosphorus (P), Potassium (K) The Results reveals that the pH ranged from 6.6-8.7 with mean of 8.0 slightly acidic in nature, E.C. (dS m^{-1}) ranged from 0.144-0.320 with mean of 0.22, Organic carbon ranged from 2.78-15.39 with mean value of 7.82 gkg^{-1} and available nitrogen, phosphorus, and Potassium were ranged from 158.4-455.5, 17.10-133.4 and 122.40-157.42 kg ha^{-1}, respectively.

Key words: *Soil fertility, Organic matter, Macronutrients, Nutrients index*

INTRODUCTION

Soil fertility is a dynamic natural property and it can change under the influence of natural and human induced factors. As human population continue to increase, human disturbance on the earth's ecosystem to produce food and fiber will place greater demand on soils to supply essential nutrients. Continuous cropping for enhanced yield removes substantial amounts of nutrients from soil.

Cite this article: Singh, S.P., Singh, S., Kumar, A. and Kumar, R., Soil Fertility Evaluation for Macronutrients Using Parkers Nutrient Index Approach in Some Soils of Varanasi District of Eastern Utter Pradesh, India., *Int. J. Pure App. Biosci.* **6(5):** 542-548 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6789

Imbalanced and inadequate use of chemical fertilizers, improper irrigation and various cultural practices also deplete the soil quality rapidly[4]. Soil fertility is an important factor, which determines the growth of plant. Soil fertility is determined by the presence or absence of nutrients i.e. macro and micronutrients. Out of 17 essential plant nutrients N, P, K, Ca, Mg, and S are macronutrients. The sustainable productivity of a soil mainly depends upon its ability to supply essential nutrients to the growing plants. Soil fertility fluctuates throughout the growing season each year due to alteration in the quantity and availability of mineral nutrients by the addition of fertilizers, manure, compost, mulch, and lime in addition to leaching. Hence, evaluation of fertility status of the soils of an area or a region is an important aspect in the context of sustainable agriculture. Soil testing assess the current fertility status and provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields and to maintain the optimum fertility in soil year after year. The site specific nutrient management practices reduce the cost of cultivation and environmental pollution due to the imbalanced application of chemical fertilizers. For proper soil management, the farmer should know what amendments are necessary to optimize the productivity of soil for specific crops.The degradation of soil has started occurring both due to natural and human induced factors which in turn affecting the productivity. As human population continue to increase, human disturbance of the earth's ecosystem to produce food and fiber will place greater demand on soil to supply essential nutrients [5] .The present study was undertaken to know the macro nutrient status with electrochemical properties of soils of different villages of the four blocks of Varanasi. Present investigation was useful in judging the deficiency of macronutrient element and thereby use of fertilizers depending on their status.

The soils have ability to supply sufficient plant nutrients has decreased with higher plant productivity level associated with increased human demand for food. Therefore one of the greatest challenges today is to develop and implement soil, crop and nutrients management technologies that enhance the plant productivity and quality of soil, water and air. The evaluation of soil fertility includes the measurement of available plant nutrients and estimation of capacity of soil to maintain a continuous supply of plant nutrients for a crop. The availability of nutrients depends on various factors such as type of soil, nature of irrigation facilities, pH and organic matter content. According to [15]. Soil quality degradation process with reference to productivity or fertility encompasses physical chemical and biological degradation process.

MATERIAL AND METHODS

Description of the Study Area

Geographically the district Varanasi is situated at $25^0$18' of Northern latitude, 83^0 03' of Eastern longitude and at an altitude of 128.83 m above the mean sea level in the Indo-Gangatic plain of eastern Uttar Pradesh. The district Varanasi having alluvial soil lies in semi-arid region to sub humid belt of Northern India. It is often subjected to extreme of weather condition. The mean annual precipitation is 1100 mm. The area occasionally experiences winter cyclonic rain during December to February .In term of percentage of total rainfall, about 84% is received from June to September, 0.7% October to December, 6% from January to February and 9.3 % from March to May as premonsoonic rain .The mean relative humidity of this area is about 68% with maximum 82% and minimum 30% during July to September and April to early June, respectively. The minimum and maximum average temperature of the area range from 4.4^0 to 28.2^0C, respectively. The temperature begins to rise from February onward until the summer often exceeding 45^0C in the month of May and June. During these extremely hot months desiccating winds blow from west to

east and dust storm frequently occurs. The Location and Global Position and locations map of study area has been given in table1 and fig. 1.

Soil Sampling and Analysis

Agriculture is an important livelihood activity among the people of Varanasi district. Major Agro ecosystems in Varanasi district are paddy, wheat and vegetables etc. four block of Varanasi were selected from different agro ecological zones. 35 Surface soil samples (0-15 cm) were collected in in butter paper bag as per the standard procedure. Quartering technique was used for preparation of soil sample. The samples were dried in air and passed through 2 mm sieve and stored in cloth bag. The processed soil samples were analyzed for pH (2:5 soil water suspension), electrical conductivity (conductivity meter), organic carbon[5], Available N was determined by alkaline KMnO method [8], available phosphorous by spectrophotometer[6], available potassium using flame photometer, S by CaCl extraction 2 method as out lined by Tabatabai[9].

RESULTS AND DISCUSSION

Electrochemical Properties of soil

Soil pH

Data presented in table 2 shows that the pH value ranges from 6.6-8.7 with mean value of 8.08. The acidity, neutrality or alkalinity of a soil is measured in terms of hydrogen ion activity (active concentration) of the soil water system. The pH of the study area of the cultivated lands of Varanasi district are mostly (66%) strongly alkaline (pH 8.1-9.0) in reaction and 28% are mildly alkaline (pH 7.4-8.0); rest only 6% soils are neutral (pH 6.6-7.3) in reaction due to different physiography of the locations. Formation of carbonates of sodium and alkalization in soil take place as a result of carbonation of alumino-silicate minerals in presence of water (through rainfall).

$NaAlSi_3O_8 + H_2O + CO_2 = HAlSi_3O_8 + NaHCO_3$

$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

$Na_2CO_3 + 2\ H_2O \rightarrow 2Na^+ + 2OH^- + H_2CO_3$

Electrical Conductivity (E.C.)

Conductivity, as the measure of current carrying capacity, gives a clear idea of the soluble salts present in the soil. It plays a major role in the salinity of soils. Lesser the EC value, low will be the salinity value of soil and vice versa. Even though, soil conductivity is influenced by many factors, high conductivities are usually associated with clay-rich soil and low conductivities are associated with sandy and gravelly soils. This is a result of the shape and physical properties of the particles which make up the soil Data presented in table 2 shows that the Electrical conductivity of some cultivated soils in Varanasi district varied from 0.144 to 0.320 with mean value of 0.220 dSm^{-1}. The category of the soils with respect to conductivity (total soluble salts) in normal, as the EC of soils are below 1.0 d Sm^{-1}

Soil Organic Matter (SOM)

The term 'Soil organic matter' embraces the whole non-mineral fraction of soil, and consists essentially of a series of products, which range from decayed plant and animal tissues of fairly amorphous brown to black mineral, bearing no trace of the anatomical structure of the material, that is normally defined as the 'soil humus'. Because of the complex nature of soil humus which contains a wide variety of organic molecules, difficulties are encountered in the identification of such molecules. Attempts have, however, been made from earlier times to quantify soil organic matter simply by determining the organic carbon content of soil. Data presented in table 2 shows that the mean of SOM in the study area of was 7.81 g kg^{-1}.73% of the cultivated lands was found in medium range of organic matter. Most of the lands of Varanasi district about ¼ lands were noticed low organic matter content.

Nutrient Status in Soil

In plant nutrition, available nutrient is that portion of the nutrient in soil that can be easily absorbed and assimilated by the plants. Available nutrient constitutes only a small portion of the total nutrient present in soil. Macronutrients or major nutrients so called

because these are required in large quantities, more than that of iron. Among the macronutrients, N, P and K are termed as primary nutrients because of their large requirements by the plants, where Ca, Mg and S are termed as secondary nutrients because of their moderate requirements by plants. The data on plant available nitrogen, phosphorus, potassium in Varanasi district have been presented in Table 2.

Plant Available Nitrogen

Plant available **nitrogen** content in the study area of Varanasi district varied from 158.4-455.5 kg ha^{-1} with an average of 310.85 kg ha^{-1}. The available nitrogen content in cultivated soils of Varanasi district was low to medium range, 40% soil samples in were found in low content of available nitrogen. As the organic matter content in the study area was found low to medium range, the plant available nitrogen content in soils was observed consequently low to medium.

Plant Available Phosphorus

Phosphorus exists in soils in both inorganic and organic forms. A small portion of the total P is present in plant available form. Plant available phosphorus contents in cultivated soils of Varanasi districts varied from 17.1 to 133.4 kg ha^{-1} According to soil fertility index, more than 90% analyzed soil samples in Varanasi district are medium to high grade phosphorus; while 10% are in low category (< 22.5 kg ha^{-1}). The type of phosphorus ions present in soil solution depends on soil pH. In soils having neutral to slightly alkaline pH, the HPO_4^- ion is the most common form. Thus, in the cultivated areas of Varanasi, the plant available phosphorus is in the form of HPO_4^-. The original natural source of phosphorus is the mineral apatite and P released from organic matter. The simpler compounds of calcium such as mono and dicalcium phosphates are readily available for plant growth.

Plant Available Potassium

Potassium is one of the three major plant nutrient elements. The level of ammonium acetate extractable potassium in India has been found[10] to be low in 20%, medium in 42% and high in 38% districts. Fine textured soils.Fine textured soils generally possess larger amounts of both the forms (exchangeable and non-exchangeable) of K compared to coarse textured soils.More than 63% soils among the analyzed soil samples in Varanasi district were in the medium range and 37% soils were in low category of potassium. The average plant available soil potassium content in cultivated soils in these regions was medium range. Thus, available potassium in soil is not a serious problem in these regions for crop cultivation.

Parker's Nutrient Index:

In order to compare the levels of soil fertility of one area with those of another it is necessary to obtain a single value for each nutrient. Here the nutrient index introduced by Parker *et. al.* [7] is useful. The percentage of samples in each of the three classes, low, medium and high is multiplied by 1,2 and 3 respectively. The sum of the figures thus obtained is divided by Total Number of Samples using following equation

$$\textbf{Nutrient Index} = \frac{\text{No .of Samples (Low) X 1 + No of Samples (Medium) X 2 + No. of Samples (High) X 3}}{\text{Total Number of Samples}}$$

Rammoorthy and Bajaj[11] modified the index classification as low 1.67, medium 1.67 -2.33 and high above 2.33 to avoid under weight age to the medium categories

Table 1: Location and Global Position of Soil Samples

S. No	Sampling Location	Global Position	S. No	Sampling Location	Global Position
1	Pura Raghunathpur	N 24^0 15.039'E $83^0$54.081'	16	Dharmalpur	N 24^0 24.282' E $83^0$52.129'
2	Pura Raghunathpur	N 24^0 15.039' E $83^0$54.081'	17	Dharmalpur	N 24^0 24.220' E $83^0$52.089'
3	Pura Raghunathpur	N 24^0 14.926' E $83^0$53.282'	18	Dharmalpur	N 24^0 24.179 'E $83^0$52.147'
4	Raghunathpur	N 24^0 14.994' E $83^0$53.315'	19	Sahapur	N 24^0 25.734 ' $83^0$250719'
5	Raghunathpur	N 24^0 14.879 E $83^0$53.321	20	Sahapur	N 24^0 25.994 'E $83^0$50.362'
6	Raghunathpur	N 24^0 14.932' E $83^0$42.901'	21	Sahapur	N 24^0 25.694 'E $83^0$50.462'
7	Sagunaha	N 24^0 14.816' E $83^0$52.419'	22	Deura	N 24^0 24.538 'E $83^0$53.112'
8	Sehmalpur	N 24^0 27.636' E $83^0$50.727'	23	Deura	N 24^0 24.433 'E $83^0$52.936'
9	Sehmalpur	N 24^0 27.737' E $83^0$50.302'	24	Kashipur	N 24^0 24.590 'E $83^0$52.988'
10	Sehmalpur	N 24^0 27.76'7 E $83^0$50.411'	25	Kashipur	N 24^0 24.259' E $83^0$52.676'
11	Sehmalpur	N 24^0 27.678' E $83^0$51.179'	26	Kashipur	N 24^0 24.590 'E $83^0$52.988'
12	Bhatauli	N 24^0 27.67' E $83^0$51.312'	27	Gaura	N 24^0 25.278' E $83^0$51.678'
13	Awashanpur	N $24^0$24.187 'E $83^0$52.643'	28	Gaura	N 24^0 25.647 'E $83^0$51.223'
14	Awashanpur	N 24^0 24.189' E $83^0$52.197'	29	Gaura	N 24^0 14.221 'E $83^0$52.110'
15	Ghamahapur	N 24^0 27.636' E $83^0$50.327'	30	Gaura	N 24^0 14.918 'E $83^0$52.313'

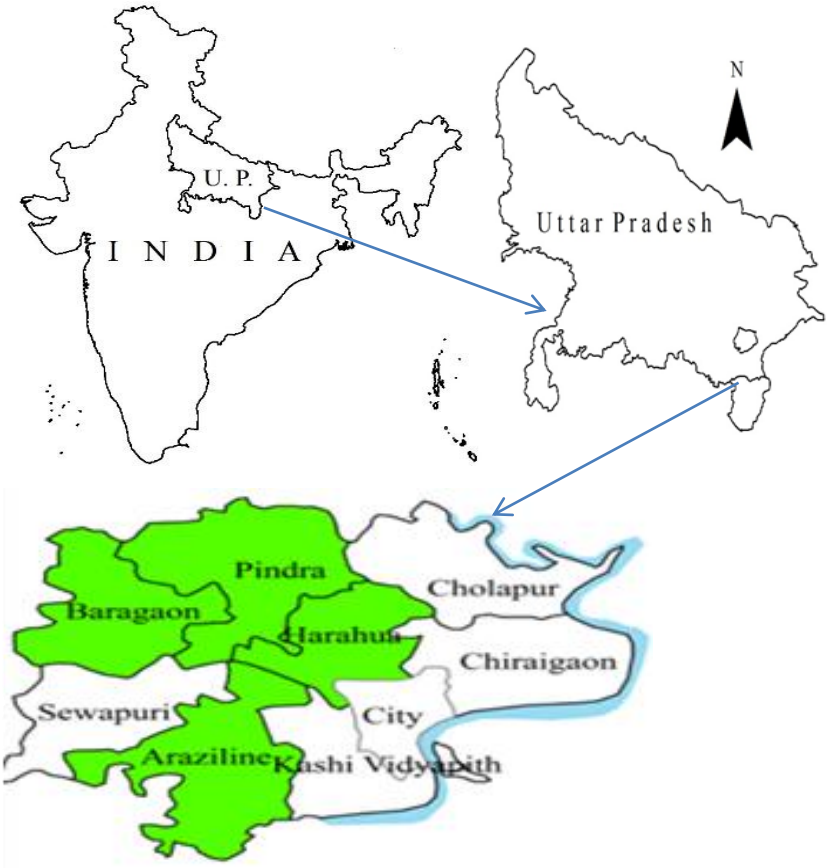

Fig. 1: Location Map of Study Area

Table 2: Electrochemical Properties and Macronutrients Status in Soils

S.No.	pH	EC	OC Kg $^{-1}$	Available N (kgha^{-1})	Available P(P_2O_5) (kgha^{-1})	Available K (K) (kgha^{-1})
1	8.5	0.275	3.39	338.8	29.00	156.42
2	8.0	0.361	12.69	348.3	99.00	142.21
3	8.2	0.161	6.45	421.6	79.30	144.27
4	8.2	0.163	12.69	348.3	84.30	134.50
5	7.7	0.138	4.42	311.6	132.1	142.53
6	8.1	0.182	4.69	411.8	125.9	127.25
7	8.1	0.871	10.77	383.5	33.70	140.45
8	8.5	0.185	2.78	374.7	85.20	122.40
9	8.0	0.132	4.70	245.8	54.70	137.48
10	8.2	0.148	6.72	206.1	28.60	153.24
11	8.6	0.158	8.40	228.9	26.80	133.75
12	8.1	0.182	5.66	158.4	29.40	146.78
13	8.6	0.165	8.40	245.0	20.50	157.42
14	8.0	0.188	9.41	256.6	26.30	134.87
15	8.1	0.195	11.08	208.9	129.8	143.59
16	8.7	0.262	9.08	321.5	128.0	137.20
17	8.1	0.171	6.43	390.3	64.50	130.48
18	8.3	0.199	15.39	412.6	133.4	152.47
19	8.7	0.301	12.76	362.1	44.20	152.34
20	8.7	0.167	7.50	204.5	51.40	132.24
21	8.9	0.236	8.74	238.3	48.30	128.75
22	6.6	0.198	9.70	252.5	54.70	143.58
23	6.0	0.172	9.07	207.0	70.10	132.80
24	8.2	0.171	8.07	234.0	18.20	150.72
25	7.5	0.157	4.00	408.1	21.90	127.36
26	7.5	0.144	7.75	320.8	22.70	137.84
27	7.6	0.224	8.49	455.4	96.40	126.64
28	8.4	0.214	3.43	390.3	31.60	144.50
29	7.3	0.159	4.04	284.1	17.10	153.42
30	7.7	0.320	5.00	355.8	33.30	132.85
Range	**6.6-8.7**	**0.144-0.320**	**2.78-15.39**	**158.4-455.5**	**17.10-133.4**	**122.40-157.42**
Mean	**8.08**	**0.22**	**7.81**	**310.85**	**60.68**	**261.1**
CV.	**0.56**	**0.14**	**3.81**	**81.75**	**39.31**	**84.49**
SD	**6.90**	**63.64**	**5.50**	**26.29**	**64.78**	**32.35**

Table 3: Rating Chart of Electrochemical Properties and Macronutrient in Soil for Plant Growth

Classification for pH values						
Strongly acid	**Moderately acid**	**Slightly acid**	**Neutral**	**Moderately alkali**	**Strongly alkali**	**Reference**
< 5.5	5.5-6.0	6.0-6.5	6.5-7.5	7.5-8.5	> 8	Muhr et al 1965
Classification for total soluble salts (EC as dS m-1)						
No deleterious effect on crop	Critical for germination		Critical for salt sensitive crop		Injurious to most crops	**Reference**
< 1.0	1.0-2.0		2.0-3.0		>3.0	Muhr et al.1965
Paramertes	**Low**		**Medium**		**High**	**Reference**
Organic Carbon (%)	< 0.50		0.50-1.0 >		>1.0	Muhret al.1965
Available N	< 280		280-560		> 560	Arora 2002
Available P	< 10		10-25		> 25	Arora 2002
Available K	< 118		118-280		>280	Arora 2002

Table 4: Nutrient Index Values for the Soil Samples of Study Area

Characteristics	Nutrient Index	Values Remarks	Nutrient Index Rating
Organic Carbon (OC)	2.3	Medium	<1.67 Low 1.67-2.33 Medium >2.33 High
Available Nitrogen (N)	1.6	Low	
Available phosphorus (P)	2.2	Medium	
Available potash (K)	3.0	High	

CONCLUSION

Based on the above study it is concluded that soil fertility status of Varanasi District Considering the concept of nutrient index value of the soil of investigated area were found in 'medium fertility status' for Organic Carbon, Avalable Phosphorus, High for Potassium and low with respect of Avalable nitrogène. The nutrient index value for Organic Carbon (OC), Nitrogène (N), Phosphorus (P), and Potassium (K), were 2.3, 1.6, 2.2; and 3.0 respectively. Against the nutrient index values < 1.6 for low, 1.67-2.33 for medium and >2.33 for high fertility status[1].and Rammoorthy and Bajaj[11].

REFERENCES

1. Meena, H.B., Sharma, P.R. and Rawat, U.S., Status of macronutrients in some soils of Tonk district of Rajasthan. Journal of Indian society of soil science. **54:** 508-512 (2006).
2. Verma, V.K., Patel, L.B., Toor, G.S. and Sharma, P.K., Spatial Distribution of macronutrients in soil of arid tract of Punjab, *Indian journal of Agriculture and Biology*. **7(2):** 370 372 (2005).
3. Soil degradationon crop productivity in east Africa, *Journal of Sustainable Agriculture*. **13(1):** 15-41.
4. Medhe SR, Tankankhar VG, Salve AN., Correlation of chemical properties, secondary nutrients and micronutrient anions from the soils of Chakur Tahsil of Latur district , Maharashrta. *Journal of Trends in life sciences*. Vol. 1. No. 2 (2012).
5. Walkley, A. and Black, T.A., An examination of the Degt. Jarett method for determination of soil organic matter and a proposed modification of cromic acid titration. *Soil Sciences*.**37:** 29-38 (1934).
6. Bray RH, Kurtz LT., Determination of total organic carbon and available forms of phosphorous in soils. *Soil Science*. **59:** 39-45 (1945).
7. Parker FW, Nelson WL, Winters E and Miles JE, The broad interpretation and application of soil test summaries. *Agronomy Journal* **43(3):** 103–112 (1951).
8. Subbiah BV and Asija GL, A rapid procedure for the determination of available nitrogen in soil. *Current Science* **25:** 259-260 (1956).
9. Tabatabai MA., Methods of soil analysis, Part 3: (Soil Science Society of America Book series No.5). *Madison*, Wisconsin, USA. pp 921-960 (1996).
10. Ghosh, A.B. and R. Hasan., Soil Fertility Map of India, Indian Agricultural Research Institute, New Delhi (1980).
11. Ramamurthy, B. and J.C. Bajaj. Soil Fertility Map of India, Indian Agricultural Research Institute, New Delhi (1969).
12. Muhr GR, Datta NP, Sankara, Subramoney H, Liley VK and Donahue RR, Soil testing in India. *US Agency for International Development*, New Delhi. pp 120 (1965).
13. Arora CL, Analysis of soil, plant and fertilizers. In fundamental of soil science (GS Sekhon, Chhonkar PK, Das DK, Goswami NN, Narayanasamy G, Poonia SR, Rattan R K and Sehgal J, Eds), *Indian Society of Soil Science*, New Delhi (2002).
14. Meena H.B., Sharma R.P. and Rawat U.S., Status of macro and micro nutrients in some soils of Tonk district of Rajasthan. *J. Indian Soc. Soil Sci.*, **54**: 508-512 (2006).
15. Lal, R. and Singh, B.R., Effect of soil degradationon crop productivity in east Africa, *Journal of Sustainable Agriculture.* **13(1):** 15-41 (1998).