The Pharma Innovation Journal 2022; 11(12): 1987-1990

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 1987-1990
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www.thepharmajournal.com
Received: 13-10-2022
Accepted: 15-11-2022

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Soil fertility evaluation for macronutrients using Parkers nutrient index approach in some soils of Sindhudurg District of Maharashtra

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Abstract
The experiment was conducted to investigate the soil fertility status of the Sindhudurg 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, Regional Fruit Research Station Vengurle, 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 Sindhudurg of Maharashtra and studied the available macronutrient status in the soils using Parkers Nutrient Index approach made with the study of 29 sub-surface soil samples collected from farmers field from different villages of Kudal, Kankwali and Vaibhavwadi 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 4.5-6.4 with mean of 5.8 moderately acidic in nature, E.C. (dSm^{-1}) ranged from 0.031-0.172 with mean of 0.066, Organic carbon ranged from 1.11-6.74 with mean value of 2.47 gkg-1 and available nitrogen, phosphorus, and Potassium were ranged from 147.3-445.3, 4.7-16.4 and 81.3-720.86 kg ha^{-1}, respectively.

Keywords: 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. Imbalanced and inadequate use of chemical fertilizers, improper irrigation and various cultural practices also deplete the soil quality rapidly. 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 .The present studies was undertaken to know the macro nutrient status with electrochemical properties of soils of different villages of the three blocks of Sindhudurg.

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 Soil quality degradation process with reference to productivity or fertility encompasses physical chemical and biological degradation process.

Material and Methods

The study area consisting Kudal, Kankwali and Vaibhavwadi of Sindhudurg district are located between 15.86 latitude and 73.64 longitudes in Konkan region of Maharashtra. The geology of the area is the Deccan trap i.e. a volcanic formation of basalt. The typical topography associated with high rainfall and other climatic conditions has given rise to laterite and lateritic soils which cover an area of about10.73 lakh hectares in Southern Raigad and whole of Ratnagiri and Sindhudurg districts (Kadrekar *et al*., 1981) This area is characterized by hilly terrain which receives on an average 2500 to 3000 mm rainfall during the period from June to middle of October.

The representative soil samples were collected from all cashew gardens before onset of monsoon i.e. in the month of May, 2016. The soil samples were air dried and sieved through 2.0 mm sieve for different parameters and 0.5 mm sieve for organic carbon determination. The soil samples were analyzed for important physico-chemical properties following the standard laboratory procedure. The pH and electrical conductivity of the soils were estimated using soil: water suspension 1:2.5 (Jackson, 1973), organic carbon content by wet oxidation method (Black, 1965), the available nitrogen was estimated by alkaline KMnO4 method Subbiah and Asija (1956) [8], available phosphorus was extracted by NH4F-HCl method (Bray and Kurtz, 1945) [6], the available potassium was extracted by shaking with neutral normal ammonium acetate by flame photometer method (Tondon, 1993). The soil fertility rating was described by Muhr *et al*. (1968). However the nutrient index concept was described by Parker *et al*. (1951) [7],

Results and Discussion

Electrochemical Properties of soil

Soil pH: Data presented in table 1 show that the pH value ranges from 4.5-6.4 with mean value of 5.80. 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 Sindhudurg district is mostly moderately acidic in reaction due to different physiographic of the locations.

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 1 shows that the Electrical conductivity of some cultivated soils in Sindhudurg district varied from 0.031 to 0.172 with mean value of 0.066 dSm-1. The category of the soils with respect to conductivity (total soluble salts) in normal, as the EC of soils is below 1.0 dSm^{-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 1 shows that the mean of SOM in the study area of was 2.47% of the cultivated lands was found in high range of organic matter. Most of the lands of Sindhudurg 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 Sindhudurg district have been presented in Table 1.

Plant Available Nitrogen

Plant available nitrogen content in the study area of Sindhudurg district varied from 147.3-445.3 kg ha^{-1} with an average of 298.01 kg ha^{-1}.The available nitrogen content in cultivated soils of Sindhudurg district was low to medium range, 60% 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 Sindhudurg districts varied from 4.7 to 16.4 kg ha^{-1} According to soil fertility index, more than 90% analyzed soil samples in Sindhudurg district are low grade phosphorus; while 10% are in medium category. The type of phosphorus ions present in soil solution depends on soil P^H. In soils having moderately acidic P^H, the $HPO4^-$ ion is the most common form. Thus, in the cultivated areas of Sindhudurg, the plant available phosphorus is in the form of $HPO4^-$. 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 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 79% soils among the analyzed soil samples in Sindhudurg district were in the high range and 21% 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.* 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

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

Rammoorthy and Bajaj modified the index classification as low 1.67, medium 1.67 -2.33 and high above 2.33 to avoid underweight age to the medium categories.

Table 1: Nutritional Survey of soil samples in Sindhudurg District during 2016

Sr. No.	pH (1:2.5)	EC (dSm^{-1})	Organic Carbon (%)	Availble Nitrogen Kg ha^{-1}	Availble Phosphorus Kg ha^{-1}	Availble Potassium Kg ha^{-1}
1	5.99	0.062	1.93	147.39	13.7	85.09
2	5.03	0.043	1.13	153.64	10.6	121.95
3	5.23	0.031	2.61	279.10	17.4	106.36
4	5.30	0.041	2.22	338.68	11.8	225.06
5	6.42	0.050	2.45	426.49	7.1	262.73
6	5.99	0.060	4.05	254.01	8.6	362.86
7	5.69	0.035	1.31	379.45	10.6	179.40
8	5.66	0.042	2.02	301.05	12.9	249.86
9	5.59	0.039	1.11	329.28	6.7	362.46
10	5.29	0.047	4.13	247.74	11.8	200.54
11	5.70	0.040	1.24	254.01	9.8	203.11
12	5.26	0.104	4.09	244.60	12.7	81.3
13	5.80	0.097	3.12	379.45	8.8	153.38
14	5.79	0.040	3.70	316.73	5.7	101.01
15	5.10	0.063	1.13	445.31	5.9	130.48
16	5.10	0.065	2.53	404.54	7.5	509.61
17	5.38	0.043	1.17	357.50	4.7	184.82
18	5.39	0.062	5.57	420.22	11.8	321.27
19	5.64	0.116	6.74	297.92	9.2	168.83
20	5.49	0.078	1.48	413.95	8.4	409.21
21	5.35	0.057	1.91	370.04	16.4	347.28
22	5.66	0.081	1.87	247.74	11.8	365.85
23	5.40	0.070	1.05	203.84	10.0	433.32
24	5.29	0.073	2.21	219.52	16.2	500.94
25	5.53	0.078	1.78	247.74	12.2	264.01
26	5.40	0.088	1.63	272.83	6.1	526.55
27	5.16	0.081	1.79	203.84	14.7	720.86
28	4.50	0.172	1.28	260.28	8.2	388.07
29	5.32	0.075	4.55	222.65	7.2	320.32

Table 2: 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 [12]
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 [12]
Parameters			Low	Medium	High	Reference
Organic Carbon (%)			< 0.50	0.50-1.0 >	>1.0	Muhr et al.1965 [12]
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 3: Nutrient Index Values for the Soil Samples of Study Area

Characteristics	Nutrient Index	Values Remarks	Nutrient Index Rating
Organic Carbon (OC)	2.3	High	<1.67 Low 1.67-2.33 Medium >2.33 High
Available Nitrogen (N)	1.4	Low	
Available phosphorus (P)	1.1	Low	
Available potash (K)	1.7	Medium	

Conclusion

Based on the above study it is concluded that soil fertility status of Sindhudurg District Considering the concept of nutrient index value of the soil of investigated area were found in 'high fertility status' for Organic Carbon, Available Phosphorus, High for Potassium and low with respect of Available nitrogen. The nutrient index value for Organic Carbon (OC), Nitrogen (N), Phosphorus (P), and Potassium (K), were 2.3, 1.4, 1.3; and 1.7 respectively. Against the nutrient index values < 1.6 for low, 1.67-2.33 for medium and >2.33 for high fertility status. Rammoorthy and Bajaj (1956) [11].

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