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Nutrient Analysis of Agriculture and Forest Soil in High Altitude of Kodaikanal

S. Himalini and M. Razia†
Department of Biotechnology, Mother Teresa Women's University, Kodaikanal, 624 101, India
†Corresponding author: M. Razia

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ABSTRACT

Soil is a principal source of nutrients essential for plant growth. The purpose of this study is to estimate pH, texture, electrical conductivity, soil organic carbon, and macro and micronutrients in agriculture and forest soils of Kodaikanal. Nutrient rank in agriculture soil is higher when compared to the forest soil. In agriculture lands, soil quality is based on the parent material, and here the usage of fertilizers and manures in the soil are reflected in the nutrient availability. Forest soil had an adequate amount of nutrients; nitrogen, phosphorus and potassium as 94mg/kg, 24 mg/kg and 123 mg/kg, respectively, due to the presence of microorganisms, recycling and metabolism of wastes, whereas agriculture soil had 492mg/kg, 115mg/kg and 593mg/kg of NPK. It was shown that there was an abnormal increase in the amount of nutrients in agriculture soil due to the extensive usage of fertilizers, which on the other hand leads to the decrease in soil fertility.

INTRODUCTION

Soil is the cradle for most of the crucial nutrients required for crops. It is a media for plant growth; recycles nutrients and organic matter and stores carbon. Soil nutrients are closely related to agricultural land and their associated management practices (Duiker & Beegle 2005). Some agriculture lands have soil aggregation, which is formed by various processes like physical, chemical and biological forces which are mainly responsible for their stabilization (Kong et al. 2006). Microorganisms play a major role in the enrichment of the soil fertility (Kawaguchi & Yoda 1986). Soil nutrient analysis provides the information to farmers with an estimate of the amount of fertilizers to be supplemented into the field (Ponette 2001). Nutrient analysis determines the amount and strength of adsorption of nutrients by soil surfaces and also plays a vital role in the solubility of nutrients in soil (Agbede 2010) because high yields of good quality crops require an abundant supply of essential nutrient elements (Bonfante & Bouma 2015). Soil productivity is an important factor which is defined as the capacity of soil, in its normal environment to support plant growth. Maintaining the productivity of soil in a particular condition favours regeneration, survival and long-term growth of desired forest vegetation (Askari et al. 2014). The pH is a measure of the soil acidity and alkalinity that gives an indication for the activity of hydrogen ion (H^+) and hydroxyl ion (OH^-) in a water solution (Reijneveld et al. 2009). Soil texture and soil moisture is also an important factor for determining the crop productivity. Soil texture governs most of the properties of the soil, which include its permeability, capacity to retain water, degree of aeration, ability to make the nutrients stored in the clay-humus complex available to plants, ability to withstand mechanical working of the topsoil, and finally, its ability to support a permanent plant cover (Wang et al. 2010). It will influence the physical and chemical properties of the soil. Water supplement is firstly dependent on the rainfall in that particular area, then by the volume (depth) of the soil and its texture, which determines how much water, can be stored (Ross et al. 2012). The amount of soil moisture is normal in both the lands, which are an important consideration when making cropping and fertility decisions (Andre et al. 2010).

Soil is the fundamental resource of the forest. In the forest soil, nutrients, particularly Ca, were estimated from stem, wood and bark (Andre & Ponette 2003). The soils are formed from dead biomass (leaves, branches and stems) and are an important pool of carbon and nutrients. In the forest, all biomass (branches, foliage and tops) contains a large amount of nutrients (Yanai 1991). For soil nutrient analysis, soil carbon (C) and nitrogen (N) are the master variables to determine the soil fertility (Pritchett & Fisher 1987). For each tree harvest and treatment in forest, N, P, K, Ca and Mg outputs were compared with the nutrient stocks in soils (stocks of total N and P, available P and exchangeable K, Ca and Mg) to assess the potential impacts on soil fertility (Tamminen et al. 2012). Physical and chemical characteristics of soil can be influenced by forest management (Yowhan 1992). The plant takes up all positive and negatively charged ions from the soil (Smethurst 1990). Phosphorus is unique among elements in being a sensitive and a persistent indicator of human settlement activity (Holliday & Gartner 2007). Accumulation of phosphorus in different forms and also due to its highly restricted leaching in comparison to many other elements (Wells et al. 2000). Since the circulation of nutrients within a forest ecosystem is often greater than inputs received from outside the system (Schlesinger & Bernhardt 1991), such management will need to minimize impacts from stem removal and the redistribution of nutrient capital in harvested areas. The present study deals with the analysis of 17 soil samples of two different ecological regions (agriculture and forest) of Kodaikanal, Tamil Nadu of South India.

MATERIALS AND METHODS

Sampling sites: Soil samples were collected from 17 different sites at the depth of 0-15 cm in agriculture lands and forest areas located at Kodaikanal during southwest monsoon (September 2018). Kodaikanal is located in Dindigul district of Tamil Nadu with an area of 1039.46 km2 which is geographically located between 77°14'26" and 77°45'28"E longitudes and 10°6'25" and 10°26'54"N latitudes. The average rainfall is 1437mm. The soil samples were classified according to Chinese Soil Taxonomy (Gong et al. 2003) and USA soil taxonomy.

Collection of soil samples: Soil samples were collected randomly in the study area from nine regions of agriculture lands at Paerungadu, Kombai, Pallangi, Vallakatuoodai, Villpatty, Kovilpatty, Attuvampatty, Naidupuram and Maatupatty (Table 1). The major crops cultivated in these areas are carrot, beans, garlic, potato, avocado and plums. Soil samples were also collected from eight undisturbed forest regions, from Mannavanur, Pine forest, Tiger forest, Addukam forest, BL Shed, Bombay Shola, Bear Shola and Guna cave (Table 3). The major trees available in these forests are pine, teak and eucalyptus. The debris and stones were removed from the collected soil samples and then sieved. The sieved samples each (500g) were sent for nutrient analysis.

RESULTS AND DISCUSSION

The pH ranged from 4.15-6.4 in agriculture soil, and 3.86-5.64 in forest soil. Agriculture soil was slightly acidic when compared to the forest soils, which shows the optimal nutrients to the soil (Kimmins 1997). Temperature of the agriculture lands, while collected, was ranged from 19°C to 25°C and forest soil from 18°C to 20°C respectively. Both, in agriculture and forest, the maximum EC was 0.34dSm^{-1} and 0.92dSm^{-1}; whereas forest soil indicated the presence of high organic matter and high quantities of elements. This illustrated that the clay soil generally has greater EC (Brady & Weil 2007) and accumulation of low soil organic materials

Table 1: Physical properties of agriculture land of Kodaikanal.

S.No	Place	Latitudes & Longitudes	Temperature, °C	pH	EC, dS m^{-1}	Organic carbon, %
1	Paerungadu	10°17'29"N, 77°27'23"E	25	5.41	0.12	0.99
2	Kombai	10°17'30"N, 77°26'22"E	22	6.07	0.16	0.58
3	Pallangi	10°16'10"N, 77°29'4"E	19	4.30	0.18	0.52
4	Vallakatuodai	10°16'6"N, 77°29'10"E	20	7.77	0.13	0.38
5	Villpatty	10°16'6"N, 77°29'10"E	19	5.71	0.22	0.41
6	Kovilpatty	10°16'23"N, 77°30'24"E	19	5.03	0.06	0.88
7	Attuvampatty	10°15'58"N, 77°29'10"E	20	5.40	0.22	0.44
8	Naidupuram	10°15'39"N, 77°29'60"E	22	5.27	0.18	0.92
9	Mattupatty	10°16'88"N, 77°29'10"E	20	4.15	0.34	0.62

Table 2: Macro and micronutrients of agriculture land of Kodaikanal.

S.No	Place	Macro nutrients, mg/kg			Micro nutrients, ppm			
		N	P	K	Zn	Cu	Fe	Mn
1	Paerungadu	492	70	201	5.97	2.85	18.01	4.95
2	Kombai	319	30	340	1.87	1.20	29.36	7.42
3	Pallangi	319	75	293	4.07	2.92	20.32	8.60
4	Vallakatuodai	182	22	114	1.27	1.26	20.54	4.82
5	Villpatty	344	60	302	6.15	2.70	32.14	9
6	Kovilpatty	402	90	210	1.63	1.55	18.12	4.95
7	Attuvampatty	350	80	300	6.71	1.80	18.12	18.41
8	Naidupuram	420	115	413	2.27	1.02	21.76	5.58
9	Mattupatty	423	95	593	3.22	1.55	20.64	6.91

Table 3: Physical properties of forest soils of Kodaikanal.

S.No	Place	Temperature, °C	pH	Latitudes & Longitudes	EC, dS m^{-1}	Organic carbon, %
1	Mannavanur	18	5.64	10°17'8"N, 77°27'2"E	0.18	0.52
2	Pine forest	20	4.45	10°13'8"N, 77°28'2"E	0.20	0.41
3	Tiger Shola	19	4.08	10°12'8"N, 77°28'2"E	0.22	0.13
4	Addukam	18	4.32	10°11'8"N, 77°27'2"E	0.18	0.15
5	BL Shed	18	3.86	10°18'11"N, 77°23'11"E	0.16	0.25
6	Bombay shola	18	4.46	10°13'43"N, 77°29'1"E	0.18	0.18
7	Bear shoal	18	5.01	10°13'56"N, 77°27'53"E	0.20	0.32
8	Guna cave	18	4.07	10°210'7"N, 77°46'20"E	0.08	0.48

Table 4: Macro and micronutrients of forest soils of Kodaikanal.

S.No	Place	Macro nutrients, mg/kg			Micro nutrients, ppm			
		N	P	K	Zn	Cu	Fe	Mn
1	Mannavanur	90	4	61	0.68	0.98	5.3	3.1
2	Pine forest	85	11	65	0.54	0.92	5.6	3.6
3	Tiger Shola	92	24	61	0.61	0.86	4.8	3.8
4	Addukam	84	18	92	0.78	0.94	4.3	4.1
5	BL Shed	91	37	69	0.69	0.72	3.9	3
6	Bombay shola	87	13	100	5.1	3.6	0.41	0.81
7	Bear shoal	94	14	123	0.71	0.93	5.4	3.8
8	Guna cave	88	11	65	0.69	0.95	4.5	2.9

(Richard & Vepraskas 2001).

The organic carbon of both agriculture and forest soils was <1%, which shows low accumulation of organic carbon. Nitrogen was adequate in both the soils, the presence of nitrogen in different chemical forms of elements in the soil is important, if N uptake is high it leads to lower applications (Cerny 2012). Potassium in agriculture forest soil was adequate. The normal level in the soil helps in uptake of nutrients for the plants. Potassium is needed in smaller proportion to the plant growth, only 1-4% of total P becomes plant available during their growing season. Phosphorus level in both the soils is adequate, if there is high phosphorus movement from soil to surface water, it will lead to damages in vegetation and aqua systems (Fahey 1991). The availability of high micronutrients will decrease the pH. Micronutrients such as Zn, Cu, Fe, Mg are sufficient in all agriculture soils and adequate in undisturbed soils as mentioned in the Tables 2 and 4.

CONCLUSION

In the present investigation, soil samples were collected from the both, agriculture and forest areas. The texture of the soils was sandy clay loam and the colour of the soils was reddish brown. The macro and micronutrients were found to be higher in agriculture soil than forest soil samples which concluded that Kodaikanal soil is rich in nutrients. The usage of fertilizers by the farmers without prior knowledge of soil fertility may result in an adverse effect on soil and crops due to over usage of fertilizers. The usage of organic manure will increase soil nutrients and crop production. This should come into practice. Finally, the inputs of synthetic fertilizers supplied in farming systems for maintaining and raising crop and forage productivity should be avoided. Large quantity of manure is produced by livestock; such manure has value in maintaining and improving soil nutrients should be practiced. The abundance or lack of nutrients can significantly affect the microbial population and diversity as well as plant growth development.

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