Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(1): 424-429
Received: 19-11-2017
Accepted: 21-12-2017

Alok Patel
Department of Soil Science and Agricultural Chemistry, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Surendra Singh
Department of Soil Science and Agricultural Chemistry, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Ajay Babu
Department of Soil Science and Agricultural Chemistry, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Sudhanshu Verma
Department of Agronomy, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Shani Kumar Singh
Department of Extension Education,Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Correspondence
Alok Patel
Department of Soil Science and Agricultural Chemistry, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Effect of monthly rainfall distribution on physico-chemical properties and availability of nutrients in upland red soil of Mirzapur

Alok Patel, Surendra Singh, Ajay Babu, Sudhanshu Verma and Shani Kumar Singh

Abstract
Investigations were carried out on the Effect of monthly rainfall distribution on physico-chemical properties and availability of nutrients in upland red soil of Mirzapur during 2016. The study was carried out in Rajiv Gandhi South campus Barkachha Mirzapur. Vindhyan hills of Mirzapur district have great diversity in parent-material, topographic situation, natural vegetation, drainage condition etc. The soils of Vindhyan region are residual in natural and formed on different kinds of parent materials under variable topographic and drainage condition. Hence, a comparative study of soil micro-morphological characters, pedological features, micro- macro fauna activities in relation to soil formation of these soil, is of great scientific value as well essential for appraising the fertility status of these soil. The climate of Vindhyan region is predominantly dry (subtropical to dry), winter season is short (December to February) but summer is long (March to October). Five plots were randomly selected for soil sampling at for different month namely: June, July (beginning of rains), August (peak of rains) September and October (end of rains). Soil depths were sampled: 0 to 15 cm at five randomly selected locations. The chemical properties that were mostly influenced by rainfall pattern are soil organic matter, total nitrogen, soil pH, available phosphorus, exchangeable cations (Ca, Mg and K), and cations exchange capacity (CEC). Study further revealed an increase of soil available nitrogen and potassium content in soils and decrease of soil available phosphors and sulphur at all the locations due to rainfall over their corresponding in red soil test values. Rainfall plays a major role in deterioration of soil fertility. The pH and organic Corban have greater influence in availability of nutrients present in soils. Available phosphorus and available sulphur are closely associated with organic matter of soils.

Keywords: Physico-chemical properties, CEC, Soil depths, Soil pH

Introduction
Red and lateritic soils of the country occurring particularly in the states of Andhra Pradesh, Tamil Nadu, Karnataka, Orissa West Bengal, Assam, Meghalaya, Manipur, Maharashtra, Kerala, Madhya Pradesh, Goa, Pondicherry Vindhyann region of eastern Uttar Pradesh. They are in general low in soil health and productivity. There soils are attributed to a number of factors in which nutritional disorders are most important. They are not only suffer from the deficiency of primary nutrient elements but also secondary nutrients. These soils occupy about an area of 70m ha covering around 28% of the total geographical area in India. They are formed mostly on granites, granitic-gneisses, schists, colluvial material, and occasionally occur on shales. Such soil receives annual rain fall ranging from 500- 4000 mm and annual potential evapotranspiration (900-1800mm) exceeds rain fall for most of the year, except during Jun to December. In India, these soil occurs in Northeastern Hill ranges, Eastern Himalayas, Central Highland, Eastern and Western Ghats, Deccan Plateau and Konkan Coastal lands. Because of the high base saturation, favorable textures and location in semi-arid (moist) to humid regions.

The Vindhyan soils of district Mirzapur in eastern U.P. India exhibit catenary`s relationship with increasing drainage intensity down or reddish brown to reddish grey and texture form loam to clay loam, clay are silt clay are observed (Akbari *et al.*, 2003) [1]. The C/N ratio of the soils in the low-lying areas was higher than that of upland and terrace soils and sand stone and lime stone-shale topo sequences (Yadav *et al*., 1997) [12]. As one of the oldest geological formation of the country, Vindhyann system covers about 80-90% portion of the Mirzapur district of U.P. The district occupies approximately an area of 144 km from north to south. On the basis of geological formation of Vindhyan system, Mirzapur district has been divided into 2 groups. (1) Upper Vindhyan system in North and in the Central part and (2) Lower Vindhyan system in southern part.

Vindhyan hills of Mirzapur district have great diversity in parent-material, topographic situation, natural vegetation, drainage condition etc. The soils of Vindhyan region are residual in natural and formed on different kinds of parent materials under variable topographic and drainage condition. Hence, a comparative study of soil micro-morphological characters, pedological features, micro- macro fauna activities in relation to soil formation of these soil, is of great scientific value as well essential for appraising the fertility status of these soil (Dhyani *et al.,* 2013) [4].

The climate of Vindhyann region is predominantly dry (subtropical to dry), winter season is short (December to February) but summer is long (March to November). The temperature rises up to 40^0C or more during summer and drops to 4^0C during December to January. The average annual rainfall of Mirzapur is 1059 mm of which 90% is received by south west monsoon. The normal period of onset of monsoon in this region is third to fourth week of June, which lasts up to end of September.

Materials and Methods

Description of Site

Mirzapur lies between 25.1337^0N North latitude and 82.5642^0 East longitude. The Rajeev Gandhi South Campus, Barkachha farm is situated at an altitude of 146 m above mean sea level. The topography of the agricultural farm is undulating and surface is rough. The upland soils are red in colure agricultural research farm has an area of 2663 acre and is situated from 8 km South-West of Mirzapur – Robertsganj highway. Mirzapur falls in a belt of semi-arid to sub-humid climate. The normal period for the onset of monsoon in this region is the third week of June and it lasts up to end of September or sometimes extends to the first week of October. Winter season are often experienced in between the month of December to mid of February. However, March to May is generally dry. On an average, out of the total annual rainfall major fraction (75 per cent) is received from June to September. The annual rainfall is about 1073 mm and out of which about 90 per cent is received by south-west monsoon while annual potential evapo-transpiration is about 1667 mm. The rainfall during the experimental period was recorded from the meteorological observatory of the Agricultural Farm of Rajiv Gandhi South Campus (BHU), Barkachha, Mirzapur, The total rainfall during the year of 2015-16 was 736.7 mm, maximum and minimum temperature are fluctuated between 35.5ºC and 16.0ºC and relative humidity between 94.0 and 33.0 per cent.

Collection of soil sample

The entire upland red soilsfalling in Rajiv Gandhi South Campus Barakachha, Mirzapur was divided into 10 location Surface soil samples from each of the identified location were collected to a depth of 0-15cm in V shape with the help of khurpi. The Soil samples were collected at each of the identified location month wise at an interval of 30 days, starting from 15, June to 15, October, 2016, surface soil symbolized as S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, and S_{10}. During entire reread of investigation, altogether 50 surface soil sampling ware collected from five time of sampling.

Collected surface soil samples were brought in to laboratory and dried in a shade at room temperature. Air dried soil samples were crushed with the help of wooden roller and sieved through 2.0 mm sieve. Finally dried soil samples were kept in a polythene bag for further Physico - chemical and available analysis.

Soil analysis

The processed soil samples were analyzed for physico-chemical properties is such as soil pH, electrical conductivity and organic carbon these sample was also available nutrients (N,P,K and S). A soil water suspension was prepared in the ratio of 1:2.5 and pH was measured with the help of pH meter (Jackson, 1973) [6]. Electrical conductivity was measured with the help of EC meter and expressed as dSm^{-1} (Sparks, 1996).Organic carbon was determined as the method out line, by Walklay and Black (1934) [10]. Available Nitrogen was determined by alkaline Potassium permanganate method as proposed by Subbiah and Asija (1956) [9]. Available phosphorus content of soil was determined by Olsen's method (Watanable and Olsen, 1965) [7]. Available potassium content of soil was determined by Flame Photometer (1 *N* ammonium acetate extract) method (Jackson, 1973) [6]. The available S was extracted by 0.15 % $cacl_2$ solution (Williams and steinborgs 1959).

Result and Discussion

Initial physico-chemical Properties of upland red soils

The physico-chemical properties of the initial surface soils of upland of ten different locations before start the rainfall are present in table1. The pH ranged between5.6-6.2 and the electrical conductivity ranged between 0.057-0.068 dSm^{-1}.The Organic carbon ranged between 0.5-0.63. This indicates that soil samples of the study area were slightly acidic in reaction with medium content of organic carbon.

Table 1: Initial physico-chemical Properties of upland red soils during the month of June, 2016

Samples No.	Soil pH	Electrical conductivity (dSm^{-1})	Soil Organic Carbon (%)
S_1	5.9	0.058	0.58
S_2	5.6	0.067	0.54
S_3	5.9	0.057	0.61
S_4	5.7	0.064	0.50
S_5	5.8	0.059	0.59
S_6	6.1	0.068	0.57
S_7	5.7	0.063	0.60
S_8	6.2	0.059	0.54
S_9	5.8	0.064	0.50
S_{10}	5.6	0.062	0.60
Range	5.6-6.2	0.057-0.068	0.49-0.61
Mean	5.83	0.062	0.551
SD	0.200	0.0037	0.0447

Available nutrients of soils: June, 2016

The available N, P, K and S content of the initial surface soil samples or the ten deferent location are presented in table 2.Theavailable nitrogen content of the initial soil ranged in

between 138.61-176.87 kg ha^{-1} with the mean value of 158.71kg ha^{-1},The available Phosphorus varied in between 14.82-16.18kg ha^{-1} with the mean value of 15.71kg ha^{-1}, The available potassium ranged in between 145.6-168kg ha^{-1} with the mean value of 157.92kg ha^{-1}, The Sulphur ranged in between 8.82-10.21kg ha^{-1} with the mean value of 9.70kg ha^{-1}.alto. Results reveals that soil available N, P, K, and S were in low status.

Table 2: Initial Available on N, P, K, and S content of upland red soil during the month of June, 2016.

Samples No.	Available N (kg ha^{-1})	Available P (Kg ha^{-1})	Available K (Kg ha^{-1})	Available S (Kg ha^{-1})
S_1	138.61	15.16	156.8	9.72
S_2	161.19	15.50	156.8	9.65
S_3	153.98	16.18	145.6	9.58
S_4	166.21	15.73	168	8.82
S_5	147.39	15.95	156.8	9.94
S_6	172.48	16.06	156.8	10.12
S_7	169.34	14.82	168	10.21
S_8	153.66	15.95	168	10.05
S_9	147.39	15.73	156.8	9.94
S_{10}	176.87	16.06	145.6	8.98
Range	138.61-176.87	14.82-16.18	145.6-168	8.82-10.21
Mean	158.71	15.71	157.92	9.70
SD	12.48	0.44	8.26	0.50

Physico-chemical properties of soil during rainy season

Physico-chemical properties of soil: July, 2016

The pH decreased slightly in comparison to the initial surface soils at all the locations. It ranged between 5.3-6.1 with the mean value 5.67. The Electrical conductivity ranged between 0.055-0.065 dSm^{-1} with the mean value of 0.059 dSm^{-1}. There was obtained slightly lower content of organic carbon in few locations as compared to the content of initial soils. It ranged between 0.49-0.61 percent with the mean value 0.55 percent. (Table 3). Decrease of pH may probably be due to loss of bases from the surface soil to lower depth during rainfall. Low content of organic carbon from the initial value might be due to leaching along with water during rainfall (Bationo *et al*., 2001) [2]. The decreasing electrical conductivity in July month might be due to leaching of soluble salts along with rain water.

Table 3: Effect of rainfall on Physico- chemical Properties of upland red soils during the month of July, 2016.

Samples No.	Soil pH	Electrical conductivity (dSm^{-1})	Soil Organic Carbon (%)
S_1	5.7	0.056	0.58
S_2	5.5	0.065	0.53
S_3	5.6	0.055	0.61
S_4	5.6	0.062	0.49
S_5	5.7	0.057	0.50
S_6	6.1	0.065	0.54
S_7	5.6	0.059	0.58
S_8	6.1	0.058	0.57
S_9	5.5	0.061	0.50
S_{10}	5.3	0.059	0.61
Range	5.3-6.1	0.055-0.065	0.49-0.61
Mean	5.6	0.059	0.55
SD	0.25	0.004	0.045

Available nutrients of soils: July, 2016

The available nitrogen content in surface soil of upland ranged in between 170.91-178.87 kg ha^{-1} with the mean value of 175.11kg ha^{-1}, during month of July. The available Phosphorus ranged in between 13.46-15.05kg ha^{-1} with an average value of 14.14 kg ha^{-1}.Theavailable potassium ranged in between 145.6-179.2kg ha^{-1} with mean value of 163.52kg ha^{-1}. The sulphur ranged in between 8.54-9.21kg ha^{-1} with mean value of 8.89kg ha^{-1} (Table 4). The content of available phosphors and sulphur were found to be lower as compared to the initial content in the soil samples. However, there was increased in the content of the available nitrogen in the month of July. This may probably be due to mineralization of high temperature during the month. The result is supported by the finding of Xiao-gang *et al.* (2007) [11]. It is also inferred that the observed result is in line with results obtained by McGvath *et al*., 2000 reported that change in soil chemical properties are strongly influenced by seasonal variations in temperature, moisture, plant growth and root activity, and by organic matter accumulation from litter fall. Yong *et al.* (2006) [13] and Ge *et al.* (2007) [5] observed that distribution of water together with soil and nutrients reduced the SOM and nutrients at up slope region.

Table 4: Effect of rainfall on the available content of N, P, K, and S during the month of July, 2016.

Samples No.	Available N (kg ha^{-1})	Available P (Kg ha^{-1})	Available K (Kg ha^{-1})	Available S (Kg ha^{-1})
S_1	171.23	14.82	168.0	8.49
S_2	170.91	14.59	168.0	8.45
S3	172.48	13.80	168.0	8.79
S_4	173.42	15.05	156.8.0	8.94
S_5	174.99	13.80	168.00	9.01
S_6	175.62	14.59	179.20	8.94
S_7	177.18	13.69	156.80	8.98
S_8	178.12	14.03	145.60	9.14
S_9	178.44	13.46	168.00	9.21
S_{10}	178.75	13.58	156.80	9.01
Range	170.91-178.75	13.46-15.05	145.6-179.2	8.45-9.21
Mean	175.11	14.14	163.52	8.89
SD	2.99	0.60	9.44	0.25

Physico-chemical properties of soils: August, 2016

The pH decreased at all the locations, over month of July ranging from 4.9-5.9 with the mean value 5.44,The Electrical conductivity ranged between 0.029-0.053 dSm^{-1} with mean value of 0.062 dSm^{-1} The Organic carbon decreased as compared to soil content in July month it ranged between 0.52-0.62 per cent with the mean value 0.58per cent (Tabl.5). The decrease in pH May probably due to heavy rainfall in this month as a result, the losse of bases from the surface soil to lower soil depth. Similarly, the low content of organic carbon at all the locations may probably be due to leaching and accumulation in lower depths.

Table 5: Effect of rainfall on the Physico- chemical Properties of upland red soils of during the month of August, 2016.

Samples No.	Soil pH	Electrical conductivity (dSm^{-1})	Soil Organic Carbon (%)
S_1	5.6	0.054	0.58
S_2	5.3	0.063	0.52
S_3	5.6	0.053	0.60
S_4	5.6	0.060	0.51
S_5	5.4	0.054	0.49
S_6	5.7	0.061	0.51
S_7	5.3	0.062	0.50
S_8	5.9	0.072	0.59
S_9	4.9	0.082	0.50
S_{10}	5.1	0.068	0.61
Range	4.9-5.9	0.029-0.053	0.49-0.61
Mean	5.44	0.062	0.54
SD	0.298	0.0090	0.047

Available nutrients of soils: August, 2016

The available nitrogen content in surface soil during the month ranged from 118.01-186.59 kg ha^{-1} with an average value of 183.17kg ha^{-1}. The available Phosphorus ranged from 11.43-13.92kg ha^{-1} with the mean value of 12.59kg ha^{-1}. The available potassium ranged between 145.6-179.2kg ha^{-1} with the mean value of 163.52kg ha^{-1}. The Sulphur ranged between 7.69-8.94kg ha^{-1} with the mean value of 8.43kg ha-1 (Table 6). The content of available phosphorus and sulphur were found lower as compared to the content in the month of July, however higher content of available nitrogen was obtained at all the locations. This may probably be due to mineralization from organic nitrogen to inorganic nitrogen (Bhuyan, *et al*. 2013) [3].

Table 6: Effect of rainfall on the available content of N, P, K, and S during the month of August, 2016

Samples No.	Available N (kg ha^{-1})	Available P (Kg ha^{-1})	Available K (Kg ha^{-1})	Available S (Kg ha^{-1})
S_1	181.89	13.69	156.80	8.25
S_2	180.01	12.33	168.00	7.95
S_3	185.02	13.01	168.00	8.39
S_4	180.95	12.22	156.80	7.94
S_5	182.52	12.90	168.00	8.76
S_6	183.14	13.92	179.20	8.84
S_7	181.57	11.88	179.20	7.68
S_8	185.02	11.77	156.80	8.79
S_9	186.59	12.78	145.60	8.94
S_{10}	185.02	11.43	156.8	8.76
Range	180.01-186.59	11.43-13.92	145.60-179.20	7.69-8.94
Mean	183.17	12.59	163.52	8.43
SD	2.150	0.817	10.83	0.45

Physico-chemical properties of soils: September, 2016

The pH of the soil decreased slightly over the content of surface soils at all the locations obtained in the month of august. It ranged between 4.9-5.9 with the mean value 5.16. The Electrical conductivity ranged between 0.058-0.066dSm^{-1} with the mean value of 0.063dSm^{-1}. The Organic carbon also

decreased as compared to the content obtained in August month. It ranged between 0.50-0.61 per cent with the mean value 0.52 per cent. (Table 7). Continuous rainfall during earlier months in July and August may probably be the main cause for decrease in the value of pH and organic content in the month of September. This was mainly associated with leaching due to rainfall.

Table 7: Effect of rainfall on the Physico- chemical Properties of upland red soils of during the month of September, 2016.

Samples No.	Soil pH	Electrical conductivity (dSm^{-1})	Soil Organic Carbon (%)
S_1	5.3	0.062	0.50
S_2	4.9	0.064	0.51
S_3	5.1	0.058	0.50
S_4	5.4	0.061	0.52
S_5	4.9	0.065	0.51
S_6	5.6	0.066	0.52
S_7	4.9	0.063	0.52
S_8	5.5	0.065	0.50
S_9	4.9	0.064	0.51
S_{10}	5.1	0.065	0.61
Range	4.9-5.9	0.058-0.066	0.50-0.61
Mean	5.16	0.063	0.52
SD	0.271	0.0024	0.032

Available nutrients of soils: September, 2016

The available nitrogen content in surface soil in the September ranged from 187.71-191.3 kg ha^{-1} with an average value of 187.87kg ha^{-1}. The available Phosphorus ranged from 9.16-12.67kg ha^{-1} with the mean value of 10.48 kg ha^{-1}. The available potassium ranged between 112-168kg ha^{-1} with the mean value of 141.12kg ha^{-1}. The Sulphur range between 7.78-8.51kg ha^{-1} with the mean value of 8.11kg ha^{-1} (Table.8). In this month also, the content of available phosphorus and sulphur were found to be lower as compared in soils of the previous However, there was slight change in the available content of nitrogen and potassium in soils. The continuous decrease in the available phosphorus might be attributed to increase in biomass in soil during rainy season (Styles and Coxon, 2007) [8].

Table 8: Effect of rainfall on the available content of N, P, K, and S during the month of September, 2016.

Samples No.	Available N (kg ha^{-1})	Available P (Kg ha^{-1})	Available K(Kg ha^{-1})	Available S(Kg ha^{-1})
S_1	187.53	11.20	168.00	7.95
S_3	191.30	10.07	112.00	8.38
S_4	187.85	9.16	156.80	8.47
S_5	191.30	12.67	134.40	7.78
S_6	184.71	9.50	156.80	8.51
S_7	185.02	10.75	112.00	8.09
S_8	186.91	9.39	145.60	7.82
S_9	187.85	11.65	156.80	8.07
S_{10}	188.16	10.07	123.20	7.87
Range	187.71-191.30	9.16-12.67	112.00-168.00	7.78-8.51
Mean	187.87	10.48	141.12	8.11
SD	2.18	1.11	19.89	0.27

Physico-chemical properties of soils: October, 2016

The pH increased slightly of the surface soil in October at all the location over September month. It ranged between5.4-6.1 with the mean value 5.7.The Electrical conductivity ranged between 0.061-0.067dSm^{-1} with the mean value of 0.064 dSm^{-1}. The Organic carbon also decreases considerably as compared with the contents in soils of September. It ranged between 0.41-0.50 per cent with the mean value 0.45per cent. (Table 9). Increase of pH may probably be due to no loss of bases from the surface due to negligible amount of rainfall in the month. Decreases of organic carbon from its values obtained in September might be due to leaching along with water.

Table 9: Effect of rainfall on the Physico- chemical Properties of upland red soils of during the month of October, 2016.

Samples No.	pH	Electrical conductivity (dSm^{-1})	Soil Organic Carbon (%)
S_1	5.8	0.064	0.50
S_2	5.5	0.067	0.46
S_3	5.7	0.062	0.50
S_4	5.6	0.061	0.48
S_5	5.7	0.065	0.45
S_6	5.8	0.063	0.45
S_7	5.9	0.064	0.41
S_8	6.1	0.067	0.42
S_9	5.4	0.064	0.45
S_{10}	5.6	0.064	0.47
Range	5.4-6.1	0.061-0.067	0.41-0.50
Mean	5.7	0.064	0.45
SD	0.20	0.0019	0.057

Available nutrients of soils: October, 2016

The available nitrogen content in surface soil in the month of October ranged from 187.53-197.57 kg ha^{-1} with an average value of 192.7kg ha^{-1}. The available Phosphorus ranged from 8.48-11.43kg ha^{-1} with the mean value of 9.92kg ha^{-1}. The available potassium ranged between 89.6-145.6kg $ha^{-1}$with the mean value of 115.36kg ha^{-1}. The Sulphur range between 6.88-8.06kg ha^{-1} with the mean value of 7.55kg ha^{-1} (Tble.10). The content of available phosphorus and sulphur were found lower as compared to the values obtained in soil sample of September, However there was slight change in the content of soil available nitrogen and potassium in this month.

Table 10: Effect of rainfall on the available content of N, P, K, and S during the month of October, 2016.

Samples No.	Available N (kg ha^{-1})	Available P (Kg ha^{-1})	Available K (Kg ha^{-1})	Available S (Kg ha^{-1})
S_1	188.16	11.43	100.80	6.96
S_2	191.30	9.62	123.20	6.88
S_3	187.53	10.97	145.60	7.12
S_4	194.12	9.84	100.80	7.58
S_5	196.94	11.09	123.20	7.57
S_6	197.57	9.28	89.60	7.72
S_7	188.16	9.39	134.40	7.95
S_8	191.30	8.48	112.00	7.65
S_9	194.43	10.63	89.60	8.03
S_{10}	197.57	8.48	134.40	8.06
Range	187.53-197.57	8.48-11.43	89.60-145.60	6.88-8.06
Mean	192.7	9.92	115.36	7.55
SD	3.97	1.062	19.79	0.43

Conclusion

The results suggest that upland red soils are acidic in nature which further decreased continuously due to rainfall because of the loss of bases from surface to lower depths. Content of organic carbon was also decreased due to rainfall in month or October from its initial values of June in soils of Rajeev Gandhi South Campus, Barkachha Mirzapur. Result further revealed an increase of soil available nitrogen and potassium content in soils and decrease of soil available phosphors and sulphur at all the locations due to rainfall over their corresponding in red soil test values.

Rainfall plays a major role in deterioration of soil fertility. The pH and organic Corban have greater influence in availability of nutrients present in soils. Available phosphorus and available Sulphur are closely associated with organic matter of soils. Hence, there is need to restore soil fertility of Rajeev Gandhi South Campus, upland red soil by addition of organic and inorganic sources of patent nutrients is sustain soil health and crop productivity in years is come.

Acknowledgement

We thankfully acknowledge the help rendered by head of department of soil science and agricultural chemistry Institute of Agricultural Sciences Banaras Hindu University for providing necessary facilities for soil samples analysis in research laboratory.

References

1. Akbari KN, Karan F, Qureshi FM, Patel VN. Fertility status of red loam soils of Mewar region of Rajasthan in relation to basic soil properties. Advances in Plant Sciences, 2003; 16(1):199-203.
2. Bationo A, Buerkert A. Soil organic carbon management for sustainable land use in Sudano – Sahelian West African. Nutrient cycling in Agro ecosystems. 2001; 6(1):131-142.
3. Bhuyan SI *et al*. Soil nutrients status in prominent agro-ecosystems of East Siang district, Arunachal Pradesh. International Journal of Environmental Sciences. 2013; 3(6).
4. Dhyani PK, Kumar P, Shahi UP, Singh SP. Soil fertility status in some soils of Muzaffarnagar District of Utter Pradesh, India, along with Ganga canal command area. African Journal of Agricultural Research. 2013; 8(14):1209-1217.
5. Ge F, Jianhui Z, Su Z, Nie X. Response of changes in soil nutrients to soil erosion on a, 2007.
6. Jackson MN. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, Purple soil of cultivated sloping land. *Acta Ecologia Sinica*, 1973; 27:459-463.
7. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium by carbonate. Circular U.S. department of Agriculture: 1400 Independence Ave. S.W. Washington DC. 1965, 939.
8. Styles D, Coxon C. Meteorological and management influences on seasonal variations in phosphorous fractions extracted from soils in western Ireland, Geoderma 2007; 142:52-164.
9. Subbiah BV, Asija LL. A rapid procedure for estimation of available nitrogen in Soil Currant Science. 1956; 25:259-260.
10. Walkey AJ, Black CA. an examination of the Degtijaraffs method of determining soil organic matter and a proposed for modification of the Chromic and titration method soil science, 1934; 37:29-38.
11. Xiao-gang L, Zed R, Emmanuel M, Singh B. Increase in pH stimulates mineralization of `native' organic carbon and nitrogen innaturally salt-affected sandy soils. Plant Soil. 2007; 290:269-282.
12. Yadav SS, Prasad J, Gaikwad ST. Occarance of relatively shallow Vertisol in Central India. Journal of the Indian Society of Soil Science. 1997; 45(4):844-845.
13. Yong L, Wang CW, Hongliang T. Research advances in nutrient runoff on sloping land in watersheds. *Aquat. Ecosyst. Health Manag*. 2006; 9:27-32.