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A Study on the Soils of Bikaner District (Rajasthan) with Reference to Soil Characteristics and Nutrient Status

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Abstract

Soil is loose and unconsolidated material that lying on top of bed rock which supports the plant growth. Soil provides basic nutrients to the plants. The sustainable yield of a soil largely depends upon its ability to supply vital nutrients for the plant growth. Nutrient contents in soil and their availability to plant are assessed by the mineral presence and weathering processes by which soil was formed. In the present investigation two different study sites have been selected at Bikaner district i.e. Sagar and Gajner. Soil samples were analyzed in laboratory which shown that soil texture is loamy Sand type having 80 – 95 % sand, 2 –10 % silt and 1–5 % clay. Plants grown in this type of soil will require more frequent irrigation and fertilizer than soils with a higher concentration of clay and sediment. Sandy loam soils are often deficient in specific micronutrients and may require additional nutrients to support healthy plant growth.

Keywords: Nutrients, Plant Growth, Sediments, Soil, Weathering.

Introduction

The portion of regolith which supports the plant growth is called as soil. Soil is loose and unconsolidated material that lying on top of bed rock. It includes alluvium, Kankar, Calcrete, weathered rock fragments of bedrock etc. It is the mixture of mineral, organic matter, water and air. Soil is important for life on earth because soil holds water and nutrients, it is an ideal place for plants to grow (Brady and Weil, 2008).The sustainable yield of a soil largely depends upon its ability to supply vital nutrients for the plant growth. Nutrient contents in soil and their availability to plant are assessed by the mineral presence and weathering processes by which soil was formed. The ideal plant growth and crop yield mainly depends on the total amount of nutrients present in the soil at a particular time and their availability which in turn is controlled by physico-chemical properties like: organic carbon, soil texture, calcium carbonate, cation exchange capacity, pH and electrical conductivity of soil (Bell and Dell, 2008). The plant growth is influenced by the type of soil and soils are influenced by the type of plant species. The physical and chemical properties of the soil are generally evaluated for their production capacity i.e., their ability to supply plant growth requirements in terms of water and nutrient media. The capacity to retain these substances depends upon its texture, porosity and structure soil – water plant relationship is therefore, of great importance (Singh and Tomar, 1982). The desert soils of Rajasthan are characterized by light texture, low organic carbon content, high pH, low CEC and salinity/ alkalinity problems (Shyampura *et al.,* 2002). Sandy soils are unfavorable for tolerable availability of micronutrients (Yadav and Meena, 2009).

Review of Literature

Review of literature gives information about soil texture and soil properties which helps us to understand the different types of soils. Irigoin *et al.,* 2016 said that soils can be paired off with reference to their topographic location and less related to the taxonomic classification. Variables like sand content, calcium, pH and sodium have a great impact on the physical and chemical behavior of soils. Soil bulk density showed negative relationships with soil properties viz. Si, C, CaCO3, OMC, total macro and total micro nutrient content (Chaudhari *et al.,* 2013). Erdal Sakin (2012) found the relationships between organic carbon, organic matter and bulk density in arid-semi arid soils in Southeast Anatolia region.

Aim of the Study

The present investigation was undertaken to assess the status of available nutrient (P, K, Fe, Cu, Mn, and Zn), along with soil properties of Bikaner district, north-western Rajasthan.

Study Area

The district of Bikaner is situated in the North-Western part of Rajasthan which is central part of Great Indian Thar Desert. It is bounded by 27°11ˈ to 29°3ˈ North latitudes and 71°54ˈ to 74°12ˈ East longitudes and it is confined on the north by Ganganagar District, on the east by Hanumangarh and Churu Districts, on south by Nagaur and Jodhpur Districts and on the west by Jaisalmer District and International border with Pakistan. The district has 30247 Sq.km. geographical area which is about 8.8 % of the total area of the state and stands at second place area wise in the state after the Jaisalmer.

Two different study sites have been selected for the study at Bikaner district. The site I Sagar which is situated about 8 km north-east of Bikaner at 28°00'50" N latitude, and 73°24'31" E longitudes which acquires about 7 sq. km. area. Study site II Gajner is situated about 30 km south-west of Bikaner at 27°56'20" N latitude, and 73°02'54" E longitudes which acquires about 64 sq. km. area. The study areas are dominated by sandy tracts which are further followed by tertiary sediment of Bikaner-Nagaur basin. The study sites have undulating topography with pediments. Weather threats are irregular in this region; like storms during summer, fog during winter, nights are frosty which provide a great variation in temperature (Ghosh, 1991 and Shyampura *et al.*, 2002).

Soil Sampling and Analysis

Method of soil sampling is perhaps the most vital step for analysis, as; a very small fraction of the huge soil mass is used for analysis. It becomes extremely important to get a truly representative soil sample from the field. At least five composite soil samples were collected up to the desired depth (Top soil, 0.30m and 0.60m depth for both the study sites during winter, summer and rainy season) by means of suitable tools.The soil samples collected and mixed thoroughly and used for analysis. Soil samples were air dried and sieved through 2 mm sieve. Each parameter was analyzed in duplicate from each of the sample and confirmed twice.

Mechanical Analysis

Soil texture was determined by 'Sieve Method'. 100 gm of soil sample was passed through a set of standard sieves and each fraction thus obtained was assigned to different textural group on the basis of practical size. Each fraction was weighted and express in percentage to determine the type of soil depending upon the percentage amount of particles of each textural group in the sample (Formed by the International society of soil science in 1927) as follows:

Soil Moisture

Soil moisture percentage was estimated by gravimetric method as given by Black, 1965. The soil moisture content may be expressed by weight as the ratio of the mass of water present to the dry to the dry weight of the soil sample, or by volume as ratio of volume of water to the total volume of the soil sample.

Physical Analysis

Maximum water holding capacity or saturation percentage was determined by preparing saturation paste of soil as suggested by Richards (1954). The water holding capacity of soil depends upon its physical and chemical nature.

Chemical analysis

Soil pH was determined by preparing 1:2 soil water suspensions and followed Jackson (1973) method. Electrical conductivity of 1:2 soil water ratio was measured by digital conductivity bridge and result were reported in ds/m at 25°C (Jackson 1973). Organic carbon was estimated by using standard potassium dichromate ($K_2Cr_2O_7$) solution in the presence of Conc. H_2SO_4 as the method given by Walkely and Black (1934). Available phosphorus content was determined by Olsen's *et al*. (1954) method using 0.5 molar sodium bicarbonate solution of pH 8.5 as extractant. Available Potassium was determined by using normal neutral ammonium acetate as an extractant with the help of flame photometer (Jackson, 1973). Available zinc, copper, manganese and iron were determined by the method of Lindsay and Norwell (1978) using AAS (Atomic Absorption Spectrophotometer Model No. 1428, Electronic Corporation of India, Hyderabad).

Results and Discussion

The study areas (Site-1Sagar and Site-2 Gajner) part of Bikaner district lies in North Western Rajasthan of great Indian Thar desert which is well known for its sandy tract. Two favorable sites were selected for soil sampling and then analyses of samples were performed. The results are shown in table 1-4

Soil texture at the top surface and at 0.30m depth was encountered sandy loam for both the sites. Further at the depth of 0.60m the soil was encountered sandy for both the sites. The soil moisture percentage was very low at the top surface and increases with the depth. The soil moisture percentage is quite high at 0.60m depth at both the sites. Moisture percentage vary from 0.5 -3.89 %. Highest level of soil moisture percentage is obtained from 0.60m depth at site -2 Gajner Village and minimum soil moisture percentage is obtained from top soil at site -1 Sagar Village.

Water holding capacity of the soil denotes the amount of water (%) retained by the unit weight of the dry soil. This is the extent to which a soil can hold capillary water against gravity. The water holding capacity of soil ranges from 1.30–3.04. Water holding capacity of soil was highest at the top surface of the site 2 Gajner village and minimum at 60 cm of site - 1 Sagar village.

pH of soil indicates the reaction of the soil weather it is acidic, normal or alkaline. Soil having pH value between 7– 8.5, is to be considered normal and those with higher than 8.5, is regarded as alkaline. pH of soil collected during different seasons at the different depths (i.e., top, 0.30m and 0.60m) ranges from 7.11 – 8.75, which shows normal status of the soil.

Electrical conductivity of the soil indicates the concentration of soluble salts. If the EC of the soil – water suspension is less than 1.5 ds/m, the soil is known as non – saline (normal). In the present study, EC of the soil sample collected during different seasons and from different depths i.e., top, 0.30m and 0.60m were ranged from 0.17 ds/m to 0.77 ds/m with lowest from 60 cm depth of site–1 Sagar village during rainy season and highest from 0.30m depth of site – 2 Gajner village during winter season.

Organic carbon is an essential constituent of the soil. If the value of organic carbon is less than 0.5%, the soils are said to be deficient in organic matter. In the present study, the organic matter of the soil collected during different season and different depths i.e., top, 0.30m and 0.60m were ranged from 0.05% - 0.27%. This shows that soil was poor in organic matter. The highest organic carbon was observed from top soil of site-1 Sagar village during winter season while lowest level of organic carbon was reported from 0.60m depth of site 1 Sagar village for the summer season.

Besides many other factors soil phosphorus is mainly responsible for the development of root and seed of the plants. Available phosphorus status of the soil collected from different depths i.e., top, 0.30m and 0.60m of both the sites during different seasons ranged from 15 kg/hac – 34 kg/hac, in which lowest obtained from 0.60m depth of site -1 Sagar village during summer season and highest level was reported from top surface of the site 1 Sagar village during winter season.

As per the soil fertility rating chart, soil with available potash below 144 kg/hac fall under low category, 144 – 366 kg/hac under medium and when it is greater than 366 kg/hac it is fall under high status with the few exception of few localities, soil of the arid zone of Rajasthan, are generally well supplied with potassium (Dhir and Kolarkar, 1974). In the present study, the soil samples collected from top surface, 0.30m and 0.60m depths for the two sites i.e. Sagar and Gajner during different season, showed a very high amount of potash during summer (244 – 505 kg/hac) and during winter season (240 – 499 kg/hac), while during rainy season, the medium range of potash (155 – 232 kg/hac) was reported from the soil.

Zinc, Iron, Copper and Manganese are essential inorganic nutrient and play a vital role in growth, development, metabolism and act as catalysts in various biochemical reactions. The critical limits for Zinc, Iron, Copper and Manganese are 0.6 ppm, 4.5 ppm, 2.0 ppm and 2.0 ppm respectively. The amount of Zinc varied from 0.52 ppm – 2.01 ppm. The highest amount of Zinc was obtained from the top surface of the site 1 Sagar village during winter season while lowest amount was reported from 0.60m depth of site 2 Gajner village during rainy season.

Good amount of Iron was observed during all the three season. Its value ranged between 6.01 ppm to 10.01 ppm. Relatively high amount of Iron was reported at the depth of 0.60m at both the sites during all the three seasons. The amount of Cu ranged between 0.07 ppm – 0.39 ppm in which highest amount was obtained from the top surface of the both the sites during all the three season while the lowest level of the Copper was obtained from 0.60m depth of site 2 Gajner village during rainy season.

Manganese ranged between 0.83 ppm to 1.16ppm. Very low amount of Mn was present at the top surface of the both sites during different season. But relatively high amount of Mn was present at the 0.60m depth of the site 2 Gajner village during winter season. Seth *et al*., (1971) reported available Mn, Cu, Zn and Fe, 6 ppm, 0.21 – 4.28 ppm, 2.07 ppm, 3 – 5.6 ppm in soil of Rajasthan respectively and stated that these amounts are adequate for plant nutrition. Mondal (1965) also reported that available forms of Mn were lower than those the soil outside the arid zone though adequate for plant growth.

Soil factor and vegetation shows dependence on each other. Vegetation shows a strong effect on the vertical dimension of the soil profile in the deserts (Schlesinger and Pilmanis 1998). Hence three different depth of soil i.e. top soil, 0.30m and 0.60m were taken into account for analysis. Result of analysis shows pH decreases with depth while EC increases with depth. K and P vary at different depths. In present study during physical analysis K, P, Zn, Fe, Cu and Mn are higher at top soil in study area. In chemical analysis EC and pH are inversely proportional to each other. When EC increase, pH deceases. Concentration of nutrients is greater at top soil and shrinks with depth (Nishita and Haug 1973; Charley and West 1975; Rostango *et al*. 1991; Schlesinger and Pilmanis 1998).

Phosphorus is essential element for plant growth and decline of this nutrient with desertification can cause poor growth of plants. The concentration of salts of K, Mn increases in soil with desertification. Reduction of organic carbon with the deterioration of ecosystem reinforces the disorganization of soil structure. The decline of water holding capacity of soil resulted from depletion of clay particles and disorganization of soil with the deterioration of ecosystem causes progressive drier condition of soil.

According to Greenland and Haves (1981) the texture and structure of soil determine the distribution of pores, which retain water. The drier state of soil accompanied with low rainfall in the great Indian Thar desert region can cause insufficient leaching of alkali and alkaline metals and due to back capillary action the concentration of K, Mn, Cu and Zn in top soil increases. Soil texture is loamy Sand type having 80 – 95 % sand, 2 – 10 % silt and 1 – 5 % clay. Plants grown in this type of soil will require more frequent irrigation and fertilizer than soils with a higher concentration of clay and sediment. Sandy loam soils are often deficient in specific micronutrients and may require additional nutrients to support healthy plant growth.

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Table 1 Soil texture, Moisture Percentage and Water holding capacity (WHC) in Soil Collected from Sagar Village and Gajner Village of Bikaner District

	Sand	**Silt**	**Clay**	**Soil texture**	**Moisture Percentage**	**WHC(%)**
Site-1 Sagar						
Top Soil	76%	19%	5.00%	Loamy Sand	0.5± 0.01	2.30± 0.01
0.30m	80%	15.00%	5.00%	Loamy Sand	1.67± 0.01	2.10± 0.01
0.60m	93.40%	5.90%	0.70%	Sandy	2.50± 0.01	1.30± 0.01
Site-2 Gajner						
Top Soil	77.00%	17.20%	5.80%	Loamy Sand	1.80± 0.01	3.04± 0.01
0.30m	82.00%	14.00%	4.00%	Loamy Sand	2.80± 0.01	2.63± 0.01
0.60m	97.40%	2.00%	0.60%	Sandy	3.89± 0.01	2.04± 0.01

Table 2 Chemical Properties of the Soil at Different Depth of Two Sites during Winter Season

Depth	pH	E.C.(Dc/m)	Org C(%)	Available Phosphorus (Kg/hac)	Available K(Kg/hac)	Zinc(ppn)	Fe(ppm)	Cu(ppm)	Mn(ppm)
Site-1 Sagar									
Top Soil	8.32±0.01	0.46±0.01	0.27±0.01	34.00±1.52	240.00±1.52	2.01±0.01	6.11±0.01	0.37±0.01	0.95±0.01
0.30m	8.01±0.01	0.64±0.01	0.15±0.01	30.00±1.52	374.00±1.52	0.51±0.01	8.16±0.01	0.08±0.01	0.97±0.01
0.60m	8.11±0.01	0.65±0.01	0.17±0.01	27.00±1.52	451.00±1.52	0.93±0.01	9.18±0.01	0.11±0.01	0.89±0.01
Site-2 Gajner									
Top Soil	8.17±0.01	0.39±0.01	0.19±0.01	28.00±1.52	479.00±1.52	0.57±0.01	7.68±0.01	0.19±0.01	1.09±0.01
0.30m	8.08±0.01	0.77±0.01	0.12±0.01	22.00±1.52	488.00±1.52	0.89±0.01	9.27±0.01	0.11±0.01	0.93±0.01
0.60m	8.05±0.01	0.64±0.01	0.13±0.01	17.00±1.52	499.00±1.52	0.65±0.01	9.99±0.01	0.13±0.01	1.16±0.01

Table 3 Chemical Properties of the Soil at Different Depth of Two Sites during Summer Season

Depth	pH	E.C.(Dc/m)	Org C(%)	Avialable Phosphorus (Kg/hac)	Available K(Kg/hac)	Zinc(ppn)	Fe(ppm)	Cu(ppm)	Mn(ppm)
Site-1 Sagar									
Top Soil	8.75±0.01	0.19±0.01	0.08±0.01	18.00±1.52	505.00±1.52	1.99±0.01	6.09±0.01	0.36±0.01	0.93±0.01
0.30m	8.45±0.01	0.21±0.01	0.09±0.01	17.00±1.52	374.00±1.52	0.54±0.01	8.11±0.01	0.13±0.01	0.98±0.01
0.60m	8.52±0.01	0.27±0.01	0.05±0.01	15.00±1.52	352.00±1.52	0.89±0.01	9.07±0.01	0.09±0.01	0.90±0.01
Site-2 Gajner									
Top Soil	8.55±0.01	0.18±0.01	0.09±0.01	21.00±1.52	423.00±1.52	0.53±0.01	7.61±0.01	0.12±0.01	1.05±0.01
0.30m	8.44±0.01	0.23±0.01	0.21±0.01	32.00±1.52	307.00±1.52	0.91±0.01	9.06±0.01	0.07±0.01	0.83±0.01
0.60m	8.53±0.01	0.24±0.01	0.16±0.01	25.00±1.52	244.00±1.52	0.64±0.01	9.99±0.01	0.11±0.01	1.16±0.01

Table 4 Chemical Properties of the Soil at Different Depth of Two Sites during Rainy Season

Depth	pH	E.C. (Dc/m)	Org. Carbon (%)	Avialable Phosphorus (Kg/hac)	Available K(Kg/hac)	Zinc(ppn)	Fe(ppm)	Cu(ppm)	Mn(ppm)
Site-1 Sagar									
Top Soil	7.96±0.01	0.18±0.01	0.12±0.01	25.00±1.52	232.00±1.52	2.00±0.01	6.09±0.01	0.39±0.01	0.86±0.01
0.30m	8.02±0.01	0.19±0.01	0.13±0.01	26.00±1.52	231.00±1.52	0.55±0.01	8.09±0.01	0.15±0.01	0.97±0.01
0.60m	8.16±0.01	0.17±0.01	0.11±0.01	19.00±1.52	203.00±1.52	0.89±0.01	9.04±0.01	0.08±0.01	0.86±0.01
Site-2 Gajner									
Top Soil	8.07±0.01	0.21±0.01	0.07±0.01	19.00±1.52	184.00±1.52	0.54±0.01	7.62±0.01	0.11±0.01	1.07±0.01
0.30m	8.16±0.01	0.23±0.01	0.09±0.01	18.00±1.52	155.00±1.52	0.92±0.01	9.05±0.01	0.08±0.01	0.85±0.01
0.60m	8.17±0.01	0.21±0.01	0.12±0.01	16.00±1.52	211.00±1.52	0.52±0.01	10.01±0.01	0.07±0.01	1.15±0.01