Study of physical and chemical properties of surface soils of Navanagar block of Ballia district, U.P.

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Abstract

Surface (0-15 cm) soil samples were collected from thirty village of Nagra block for to study the status of soil properties for crop suitability. Soil samples were found in category of low status of available phosphorus, medium status of available nitrogen and potassium. Physical, physico-chemical and chemical parameters were found in greater variation among the village. The organic carbon status was found in the category of medium, available sulphur content in different village soils have showed in low to medium range and free $CaCO_3$ was also in considerable range. Similarly, the physic-chemical parameters such as pH and E.C. were in not unsuitable range and their value ranged for crop cultivation. Bulk density, water holding capacity were found in suitable range but need to maintain at that level.

Keywords- Available nutrients, soil physical properties and phyico-chemical properties

Introduction

In order to improve the soil productivity in proper understanding of the soil is absolutely necessary knowing status of available plants nutrients in the soil, helps in deciding the amount and kind of fertilizer and manures to be used for the particular crop. It helps in avoiding the economic loss in fertilizer use (Pratap, 2017). Soil fertility refers to the inherent capacity of a soil to supply essential nutrients to plant in adequate and right proportion for optimum growth, is one of the key components to determine productivity management. Indian soils demands it's build up and sustain at a high level to produce adequate food to feed its burgeoning population. Proper management of soil fertility demands careful fertilization of constraints of current nutrient deficiency and monitoring changes of soil fertility to predict areas to developing deficiencies, these deficiencies need to be alleviated through sound and proven practices of nutrient, water, crop, energy and soil management. (Ranjan, 2015). The macronutrients N, P, K are important soil elements that control the soil fertility. Nitrogen is available in inorganic form to the plants. It is essential constituent of chlorophyll, protoplasm protein, and nucleic acid and imparts dark green colour required for photosynthesis. Phosphorus is the structural component (Ravindra, 2007) of the plant cell. Therefore, the present study was undertaken to investigate the soil properties of Navanagar block of different crops growing areas for nutrient supply system.

Materials and methods

Ballia city lies between the parallels of 25°33' and 26°11' N latitude and 83°39' and 84°39' E longitude and 59 m above the sea level and almost in Indogangetic soil belt in the semi-arid zone as per U.S.A. classification. The mean annual rainfall ranges from 950-1150 mm and normally confined during May-July. Normally the maximum temperature ranges from 30.2°C to 45.3°C there is a gradual increase in temperature up to May and decrease from June to January. The 30 composite surface soil samples (0-15cm) were collected from ten sampling points in each village and 30 villages were chosen in Navanagar Block Ballia district. The samples were placed in numbered calico bags, labelled carefully considering the location and depth of soil. The samples were transported to laboratory for analysis. Soil sampling was done from each village of which come under block Navanagar villages. Soil samples were processed, air dried, powdered and sieved through 2 mm brass sieve and stored separately in polythene bag for physical and chemical analysis. Soil pH was determined by glass electrode pH meter in 1:2.5 soil water suspension (Chopra and Kanwar,1999), Calcium carbonate was determined by rapid titration method (Puri,1930) by taking 10 g of air-dry soil sample in a 250 ml conical flask. Bulk density was obtained by dividing the weight of soil by volume of soil and expressed as described in method by Kanwar and Chopra (1998), organic carbon was determined by Walkley's and Black's method as described by (Walkley's and Black's, 1934) rapid titration method as described by Kanwar and Chopra (1998). Available nitrogen determined by alkaline potassium permanganate method (Subbiah and Asija, 1956). Available phosphorus estimated by using Olsen's *et al.* (1954) method and coloure was developed by ascorbic acid. Available potassium was analysed by Ammonium acetate extraction method described by Muhr *et al.*, (1965). Available Sulphur was determined by Williams and Steinberg (1959), rapid extraction method. The statistical methods were adopted for variation of data by Chandel (2004).

Results and discussion

pH and E.C.

Soil pH and EC of Navanagar block (table 1) showed that soil pH varied from 6.5 to 8.1 with mean value of 6.5 and standard deviation =0.65 as per classification of soil reaction suggested by Brady (1985). Out of 30 samples, 3 samples were moderately acidic, (pH 6.4 to 6.5) and 6 samples were slightly acidic, and 16 samples were (pH 6.6-7.3), and 8 samples were slightly alkaline (pH 7.5 to 8), 1 sample was medium alkaline (pH 8.0 to 8.5). The maximum soil pH 8.1 was found in sample 29 and minimum 6.5 pH were observed in Sample 9. The electrical conductivity of soils ranged from 0.99 to1.00 dSm^{-1} with mean values of 1.06 dSm^{-1}. The maximum values of electrical conductivity (1.40 dSm^{-1}) were obtained in sample 19 and minimum value of electrical conductivity (0.99 dSm-^{1}) in 3 of sample (1st 29), (2nd 11), (3rd 1 samples). Which might be ascribed to the lateral movement of water from the construction of earthen bund on ground (Singh *et. al.* 2005). Electrical conductivity varied between 0.990 and 1.009 dSm^{-1} characteristic of the normal black alleviate soil. But it has not much more variation among the villages of Navanagar block. The variation in pH value of different village has attributed to the dominance of location to season crop raising and farmers using imbalance chemical fertilizers and cultural practices (Singh *et al.* 2016 and Singh *et al.* 2023).

Bulk density (Mg m^{-3})

The bulk density of soils (table-1) ranged from 1.33 to 1.35 Mg m^{-3} with mean value of 1.38, s.d=0.36.The highest value of bulk density(1.55 Mg m^{-3})was observed in sample number 26 while minimum bulk density value (1.26 Mg m-3)was found in sample number 7 with 43.43 C.V. The greater bulk density values have indicator of increased mineral content in soil (Singh, *et al.* 2019).

Organic Carbon (%)

Percent organic carbon status (table-2) ranged from 0.63-0.26% with average value of 0.40 % and CV 35.75, the maximum organic carbon content (0.63%) was found in sample number 25 and minimum (0.11%) in the sample number of 12 and 17. Differences in organic carbon content of the soil and high rate of possible CO_2 evolution leads to low organic carbon similar findings were given Sarkar *et al.* (1998) and Singh *et al.,* 2023). Organic carbon content was indicated the huge variation in soils of village due to might be different land use system no application of organic manure and pedogenic process which leads to oxidation of organic matter in CO_2. The difference in organic carbon content of the soil and high rate of possible CO_2 evolution leads to low organic carbon (Dutta *et al.* 2017).

Available nitrogen (kg/ha)

Available nitrogen content (table-2) varied from 137.00 to 286 kg/ha with the mean value of 209.17 kg ha^{-1} and s.d.43.43. The maximum amount (286.00 kg ha^{-1}) of available nitrogen was found in the sample number 19. While, minimum (137.0 kg ha^{-1}) was observed in sample number10. On the basis of the ratings suggested by Subbiah and Asijia (1956), almost all the soil samples were found medium to lower range. It has quite obvious that efficiency of applied N is medium due to the fact that N is lost through various mechanisms like NH_3 volatilization nitrification, succeeding dentrification, chemical and microbial fixation, leaching and runoff (Dhanve *et al.,* 2018)).

Available phosphorus (kg/ha)

The available phosphorus status (Table-2) ranged from 6.0 to 19.25 kg ha^{-1} with mean value of 12.44 kg ha^{-1} and s.d.3.68. The maximum amount of available phosphorus (19.25 kg ha^{-1}) was found in sample number 23 and the minimum (6.00 kg ha^{-1}) was observed in sample 3. On the basis of limits, all the soil sample were found to be low to medium range of all villages of Navanagar block. The broad variation of available phosphorus in among the village of their surface soil might be due to pedogenic process as well application pattern of organic and inorganic fertilizer which leads to fixation capacity.

Available Potassium

That available potassium status (table-2) in the soils ranged from 210-425 kg/ha with mean value of 300 kg/ha and s.d. 52.75. The maximum status of available potassium (425 kgha^{-1}) was found in sample number 17 and the minimum (210 kg ha^{-1}) in sample number 30. As per Muhr *et al.* (1963*)* recommendation most of them samples are in medium to higher range. The greater amount of available K in maximum village of Navanagar block might be due to dominating clay minerals which have source of k solubilisation.

Available Sulphur (mg/kg)

The data presented in table 2 on available sulphur in the soils of Navanagar block were ranged from 5.0 to 17.75 mg/kg respectively. The available sulphur varied with average content 8.52 mg/kg with s.d. 2.98.The maximum value was observed from (17.75 mg/kg) in samples number 11while minimum value was recorded (5.00 mg/kg) in 18 number sample. The available sulphur in the soils of navanagar block was ranged between low to medium might be due to low organic carbon content and sulphur inducing sources which are eliminate the sulphur enrichment in cropping system.

Water Holding Capacity

The Water Holding Capacity tables 1 of cultivated soils of Navanagar block were comparatively higher with the mean value of 40.57% with standard deviation 4.55 then the recently developed cultivated soils of navanagar block varied ranged (55.09-37.35%). The highest water holding capacity was 55.09% and the lowest water holding capacity was (34.54%). Thus, the major soil physical constraints might be Bharthaw soil *i.e.* low water retentions and high permeability, slow permeability, surface and subsurface mechanical impedance and shallow depth of the soils which either restrict crop growth or reduce efficiency of basic inputs. Such as water movement, aeration and fertilizer etc.

Free Calcium carbonate (CaCO₃)

In the Navanagar block of the Ballia district, the free $CaCO_3$ varies from 2.3-4.0% mean value 3.82% standard deviation 0.49. Maximum values were obtained from villages 4.60 Rudrwar and lowest in the 2.30 villages of Navanagar. The soils of navanagar blocks have higher $CaCO_3$ than soils of Navanagar is due to climatic condition and deposition of calcite .in arid and semi arid regions rain water will sink into the Ground very quickly. Later, as the surface dries out the water below the surface soil will rise, carrying dissolved minerals from lower layer upward with it.

Table-1 Soil physical and physico-chemical status of soils of Navanagar block

S. No.	Name of Village		B.D. (Mgm⁻³)	W.H.C. (%)	pH	E.C. (dSm⁻¹)	CaCO₃ (%)
1.	Navanagar		1.33	55.091	7.6	0.99	2.3
2.	Chandi		1.35	44.219	7.4	1.00	2.8
3.	Majhwaliya		1.37	40.875	7.6	1.00	4.0
4.	Harsar		1.31	36.211	7.7	1.01	4.1
5.	Bhati		1.37	34.541	6.6	1.03	3.9
6.	Gajipakar		1.32	34.921	6.4	1.00	3.9
7.	Rampur Katrai		1.26	35.211	6.5	1.02	4.1
8.	Chak prem		1.31	40.531	6.5	1.09	3.9
9.	Sisotar		1.39	42.891	6.4	1.23	4.2
10.	Siwankala		1.27	4o.219	7.5	1.30	3.8
11.	Chetan kishor		1.43	43.579	7.6	0.99	3.7
12.	Sisotar-2		1.44	38.938	7.1	1.00	4.0
13.	Lilkar		1.35	37.637	7.2	1.04	3.9
14.	Chakjahi urf		1.46	45.093	6.4	1.06	3.6
15.	Chakprushotam		1.31	46.724	6.8	1.11	4.0
16.	Kathaura		1.43	40.566	6.6	1.08	3.8
17.	Rudrawar		1.46	40.891	6.7	1.06	4.3
18.	Jamui		1.31	34.961	6.8	0.99	4.6
19.	Narhni Tur		1.30	35.211	7.6	1.40	4.2
20.	Kodai		1.32	43.341	6.5	1.20	4.3
21.	Mahro		1.32	44.351	6.5	1.00	3.6
22.	Sikiya		1.34	39.615	6.7	1.21	4.2
23.	Basti Bujurg		1.43	45.173	6.6	1.00	3.7
24.	Koth		1.47	42.128	6.5	1.30	3.4
25.	Deokali		1.50	38.085	7.9	1.00	3.7
26.	Belsari		1.55	36.082	7.4	1.01	4.3
27.	Duha Bihra		1.38	37.085	6.9	1.1	4.0
28	Thoridih		1.42	40.417	7.2	1.00	2.8
29.	Jajauli		1.45	45.184	8.1	0.99	3.4
30.	Bharthaw		1.35	37.351	7.8	1.00	4.0
	Maximum		1.55	55.09	8.1	1.23	4.6
	Minimum		1.26	34.54	6.4	0.99	2.3
	Mean		1.38	40.57	6.37	1.06	3.82
	S.D.		0.36	4.55		0.54	0.49
	C.V		25.84	11.22		50.99	12.84

Table 2 Chemical properties of surface soil different village of Navanagar block

S.No.	Village	Organic Carbon (%)	Available Nitrogen (N) Kgha^{-1}	Available Phosphorus (P) Kgha^{-1}	Available Potassium (K) Kgha^{-1}	Available Sulphur (S) mgkg^{-1}
1.	Navanagar	0.56	170	10.39	291	8.25
2.	Chandi	0.38	210	8.06	268	11.01
3.	Majhwaliya	0.23	192	6.0	313	13.0
4.	Harsar	0.26	225	11.11	268	11.37
5.	Bhati	0.35	153	9.04	291	7.5
6.	Gajipakar	0.49	166	12.54	280	7.25
7.	Rampur Katrai	0.46	200	9.67	257	7.0
8.	Chakprem	0.26	178	9.4	280	13.12
9.	Sisotar	0.53	241	6.72	358	8.37
10.	Siwankala	0.43	137	12.72	246	7.87
11.	Chetan Kishor	0.22	147	10.75	268	17.75
12.	Sisotar2	0.11	194	14.21	257	8.56
13.	Lilkar	0.44	185	11.44	302	11.87
14.	Chakjahi urf	0.56	210	8.0	324	12.5
15.	Chakprushotam	0.31	267	8.9	414	11.0
16.	Kathaura	0.43	285	13.85	380	8.53
17.	Rudrawar	0.63	240	15.25	425	6.25
18.	Jamui	0.56	250	18.91	324	5.0
19.	Narhni Turk	0.51	286	10.45	291	9.5
20.	Kodai	0.57	244	12.42	280	6.25
21.	Mahro	0.25	225	14.32	392	6.9
22.	Sikiya	0.11	285	16.45	235	5.4
23.	Basti Bujurg	0.49	284	19.25	268	5.68
24.	Koth	0.58	185	13.85	313	6.33
25.	Deokali	0.61	172	19.1	280	7.0
26.	Belsari	0.44	185	15.35	358	6.9
27.	Duha Bihra	0.33	166	15.28	313	5.68
28.	Thoridih	0.45	191	18.09	246	8.53
29.	Jajauli	0.43	188	12.09	268	5.58
30.	Bharthaw	0.26	214	9.5	210	5.68
	Maximum	1.00	286	19.25	425	17.75
	Minimum	0.11	137	6.0	210	5.0
	Mean	0.40	209	12.44	300	8.52
	S.D.	0.20	43.43	3.68	52.75	2.98
	C.V.	35.75	20.76	29.58	17.58	35.01

Conclusion

Soil available nutrients status of different village of Navanagar block were found in category of low status of available phosphorus, medium status of available nitrogen and potassium. Physical, physico-chemical and chemical parameters were found in greater variation among the village. The Organic carbon status was found in the category of medium, available sulphur content in different village soils have showed in low to medium range and free $CaCO_3$ was also in considerable range. Similarly, the physic-chemical parameters such as pH and E.C are in not unsuitable range and their value ranged for crop cultivation. Bulk density, water holding capacity were found in suitable range but need to maintain at that level.

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