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Potassium fixation capacity of soil in surface and sub-surface alkaline soils of Ballia district

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Abstract

Potassium fixation capacity of soil with their physico-chemical, physical and chemical nature of surface and sub-surface soils of Ballia district was analysed from different village's soil samples. Potassium fixation capacity of surface soil was ranges from 40.4 – 136.3 % and sub-surface soil ranged from 56.2 – 116.2 % of targated distinguished village soils with their nature as soil pH of surface soil ranged from 7.55 – 8.03 and sub-surface soil 7.21 – 8.35 and where EC was in considerable range in both depth, Organic carbon content varied from 0.37 – 1.20 % in surface soil and 0.18 – 0.60 % in sub-surface soil, Available N, P and K content in surface soil from 221.2 – 347.6 kg ha^{-1}, 9.74 – 14.85 kg ha^{-1}, 201.6 – 436.8 kg ha^{-1} and sub- surface soil ranged from 158.0 – 293.8 kg ha^{-1}, 8.74 -12.81kg ha^{-1}, 246.4 – 414.4 kg ha^{-1}, the textural class of those soils varied from loamy sand to clay loam respectively.

Keywords - Potassium fixation, soil organic carbon, NPK content and soil texture

Introduction

Potassium (K) is known as quality elements and uptake by plants for healthy growth, but Indian agriculture has traditionally relied on the native soil resources of potassium. It's constitutes an average of 1.9% of the earth crust (Tisdale *et al.* 1995). It is an essential macro nutrient element required for growth and development of plants, animals and human beings also. Soil K is known to exist in different forms *viz*. water soluble, exchangeable, non-exchangeable forms of potassium are prime important as for their availability is concern to plants. There is dynamic equilibrium among different forms of soil potassium and any depletion in a given forms would shift the equilibrium in the direction to replenish it (Sardi and Csitari, 1998). However, under certain circumstances the rate of replenishment may not be rapid enough to meet the crop need. Comparison of results presents in different revise dealing with status of potassium in India soils (Srinvasa Rao *et al*., 2002), indicated that during the last two decades low available K category soils has virtually remained the same while most of area has decreased. Growing of continuous crops without adequate use of K may leads to depletion of all form K and subsequent degradation of clay and silt minerals. Historically low application rates of k in crop have led to over- dependence on the native soil reserve K (Sarkar *et al*., 2014). Among the different forms of potassium, water soluble and exchangeable or fixed K is slowly available and the minerals or structural K is considered to be the most difficulty available from of potassium. The first two are considered to be the labile pool of K in supplying when the easily available K is depleted by crop removal or leaching the liable pool (Subehia *et al.*, 2003). The fixation of applied potassium in soil mainly depends on the amount and nature of clay minerals, degree of weathering and chemical and mechanical composition of soils. Potassium availability to plants are depending upon the amount and type of clay minerals up to 57% of applied K can be absorbed by the soil colloids (Pal and Singh, 1993). The study relating to K fixation thus provides the genuine information on the reaction rates of added K between different phases of soil K and the fate of applied fertilizer K. This process assumes great importance, because it not only controls the dynamics of different forms of k in soil but also indicates the soil potentiality to long term K supply to plants. The soils which have high initial K states, the fixation appears to be low and becomes double due to exhaustive cropping (Srinivasa Rao *et al*., 2002). Keeping all this in view, an attempt has been made to study the properties of soil with potassium fixation capacity of soil of different sites of Ballia district.

Materials and methods

Ballia district, the eastern part of the state of Uttar Pradesh is situated in central portion of the Ganges basin. The geographical extent of the district lies between latitude from 25°23" to 26°11" north and at longitudes from 83°38" to 84°39" east with elevation of about 57 to 66 meters of mean sea level. The mean annual rainfall ranges from 950 to 1150 mm. The district has an area of 1,981 sq. km. For the investigation, soil samples were collected form different villages, air dried in shade and powdered gently with a wooden mallet and passed through 2 mm sieve. Soil pH was determined in 1:2.5 soil water suspension using glass electrode. Electrical conductivity (EC) was determined in 1:2.5 soil-water suspetion using Conductivity meter and expressed as dSm^{-1} (Jackson, 1973). Organic carbon (O.C.) was determined by rapid titration method (Walkley and

Black, 1934). Available nitrogen (N) was determined by alkaline potassium per manganete extractable nitrogen method (Subbiah and Asija, 1956), available phosphorus (P) by Olsen's *et al*. (1954) and available potassium (K) by N neutral ammonium acetate extractable method described by Muhr *et al*. (1965). Soil texture (sand, silt and clay %) determined by Intenational Pipette method (Jackson, 1973). Potassium fixation capacity was determined by aletnate wetting and dying methods (Jackson, 1973) also.

Results and discussions

Soil pH

Soil pH (table-1) of from 5 sample sites of Ballia district soil of surface samples (0-15 cm) and sub-surface (15-30cm) were found in the range of 7.55-8.03 and sub-surface soil were found in 6.57-8.35 in different village soil except Raini and Malap. The increasing range of pH towards alkaline for surface soil and subsurface were found in all sample site showed 7.55 pH at 8.35. The pH value was greater in subsurface than surface soils which is attributed to the dominance of neutral soluble salts (Abrol *et al.*, 1988).

Electrical conductivity of soil (EC)

Soils under study ranged from 1.012 dSm-1 to 1.013 (table-1) indicated no marks variation among all sites sample. A relative lower EC 1.012 dSm^{-1} value in surface layer as compared to sub-surface soils 1.011 dSm-1 was observed with no marked difference at two sites of Suraha Tal site-2.

Organic carbon (%)

The content was decreased with increased soil depth of all sites. The sapmling sites were appeared maximum organic carbon content 1.20 % at 0-15 cm to 0.79 % at subsurface soil. Although, the lowest organic carbon content was fairly high in surface soil due to greater organic materials accumulation was observed on the gradual decreased with depth and elevation of site of Tal land soil (Sahu and Bala, 1995).

Available Nitrogen (kg/ha)

Available nitrogen content (table 1) in soil of two depth sites, surface and subsurface were showed decreasing range from 201.6 to 436.8 kg ha^{-1} thoughout the depth of all targated village. However, content was maximum (436.8kg/ha) in surface soil horizons in suraha Tal site-2 and decreased with soil depth at sample site possible due to the accumulation of natural vegetation residues and organic materials, it might be there where more microbial transformation due to water-logged body (Prasuna Rani *et al.* 1992) as compared to sub surface soil have appeard Daulatpur village soil.

Available phosphorus (kg/ha)

The greater amount of available phosphorus (table.1) was observed in surface soils sample then the subsurface soil. So, that in surface soil have appeared low amount of phosphorus might be due to phosphorus fixation capacity of soil under mixed alluviate soil, current fallow land use system (Das *et al*., 1997) with respect to phosphorus fixation capacity of soil. Available phosphorus content in all site samples were high value than sub surface it might be due to supplementation of the depleted phosphorus through external source *i.e.* fertilizeres (Thangaswamy *et al.,* 2005). So that the greater of amount of available P (14.85kg/ha) was observed in Suraha tal site-2 as compared to other villages.

Potassium (kg/ ha)

Greater value of available K in surface soil (436.8 kg/ha) in Daulatpur (table 1) and the lower value of sub-surface soils (224.0 kg/ha) of Shivparva village. Soil of Shivpura site have might be due to potassic minerals. The greater amount (398.4 kg/ha) was found in Malap village in sub surface soil than surface (291.2 kg/ha) soil. So that, some village soil has appeared greater values in surface soil than sub surface and some village soil showed higher value than surface soil, such type of irregular patter of available K dynamic might be due to K dominating clay minerals.

Potassium fixation capacity (%)

K fixation capacity of the soil (table 2) was varied to a great extent and it was ranged from 40.4 – 98.3 %. It was observed that, surface soil showed 40.4 – 98.3 % and sub-surface soil 56.2 – 92.9 % due to potassium fixation has plays a significant role in soil-plant system influencing the effective role of fertilization (Singh *et al.* 2020). At higher K fertilizer rates, exchangeable K was higher, and as a consequence lower wet K fixation capacity were obtained on the band application with higher values in dry condition fixation K. A good correlation was obtained between dry K fixation capacity of the soils and ammonium acetate exchangeable K in wet condition soils having high value of clay.

Sand, silt and clay (%)

Value of per cent sand, silt and clay measured at surface and sub-surface soils (table-2) of different sites samples by decreased with increase in soil depth at all sites samples. The percentage of sand, silt and clay in different soil varied from surface soil *viz.* sand, silt, clay, 27, 45, 28 % and 17, 44, 36 % respectively, according to the textural class of these soils varied from loamy sand to clay loam (Pandey and Girish, 2007). Irrespective of the land use system soil texture was finer in sub-surface horizons than in the surface sample sites might be due to the sample sites viz., clay illuviations and flooding also.

Conclusion

pH of surface and sub-surface soil has increased with depth of sampling under the considerable alkaline range and observed with little variation of all sites, EC of surface and sub-surface soil have no marked difference. The surface samples have greater available N indicated high organic matter accumulation during sample sites than the subsurface. Similarly, surface samples appeared optimum medium range of available P and higher range of available K content of Suraha Tal land soils than subsurface samples. The highest range of potassium fixation capacity of sub-surface soil sample of all sites was observed then surface soil showed increasing. The greater amount of organic contect was observed in Suraha Tal land surface soil among the all sites. Therefore, potassium fixation is plays considerable significant role in the soil-plant system to mitigate the effectiveness of chemical fertilizers behaviour.

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Table-1 pH, EC (dSm^{-1}) and available N, P, K (Kg/ha) of surface and sub-surface soil of different village of Ballia

Sample Sites	Surface Soil (0-15 cm)					Sub-Surface soil (15-30 cm)				
	pH	EC	N	P	K	pH	EC	N	P	K
Daulatpur	7.55	1.012	316.0	10.72	436.8	8.25	1.009	252.0	9.04	336.0
Bedua	7.26	1.011	284.4	9.74	392.0	8.35	1.009	158.0	8.74	246.4
Malap	7.21	1.014	347.6	9.75	291.2	7.38	1.006	158.0	8.71	398.4
Milki	7.74	1.014	221.2	10.71	268.8	7.21	1.005	158.0	9.71	414.4
Surahatal site – 1	8.03	1.015	316.0	12.71	369.6	8.03	1.009	221.2	11.70	302.4
Surahatal site – 2	8.02	1.012	352.8	14.85	358.4	8.02	1.006	252.8	12.81	324.8
Narhi	7.35	1.013	347.6	10.72	425.4	8.03	1.011	284.4	9.01	398.4
Parikhara	7.25	1.013	347.6	10.40	358.4	8.40	1.010	293.8	9.45	280.0
Raini	7.11	1.011	227.5	11.80	201.6	7.11	1.010	189.6	10.45	369.6
Shivpura	7.52	1.014	316.0	12.81	224.0	8.02	1.009	252.8	10.85	414.4

Table-2 Organic carbon, Potassium fixation capacity (PFC %) and sand, silt and clay content (%) in surface soils and sub-surface soils of different villages of Ballia district

Sample Sites	Surface Soil (0-15 cm)					Sub-Surface soil (15-30 cm)				
	O.C. (%)	PFC (%)	Sand	Silt	Clay	O.C. (%)	PFC (%)	Sand	Silt	Clay
Daulatpur	0.67	94.2	19	44	37	0.60	56.2	18	47	35
Bedua	0.75	64.0	21	45	34	0.6	68.6	21	50	29
Malap	0.90	92.3	27	45	28	0.45	92.9	23	45	32
Milki	0.60	94.4	20	45	35	0.30	92.2	22	44	34
Surahatal site – 1	1.20	88.8	18	47	35	0.30	68.6	17	46	35
Surahatal site – 2	1.12	80.3	17	47	36	0.25	88.5	17	47	36
Narhi	0.70	40.4	18	45	37	0.40	68.3	16	45	39
Parikhara	0.79	98.3	21	45	34	0.50	60.3	22	46	32
Raini	0.82	92.2	20	45	35	0.40	88.2	21	44	35
Shivpura	0.37	92.3	22	46	32	0.18	68.4	21	44	35

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