



Research Article

PHYSICO-CHEMICAL PROPERTIES AND DIFFERENT POTASSIUM FRACTION FROM SOIL OF NORTH GUJARAT REGION

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Received: July 21, 2023; Revised: August 26, 2023; Accepted: August 28, 2023; Published: August 30, 2023

Abstract: A soil survey of north Gujarat region was undertaken to know the status of available nutrients, chemical properties and fractionation of potassium in soils of seven district of North Gujarat. Total 305 representative surface soil samples were collected from farmer's fields during April-2016 using multistage stratified random sampling. The soil samples were analyzed for available physico-chemical properties and fractions of potassium adopting standard analytical procedures. Soils of North Gujarat region are slightly acidic to basic in reaction with pH varied from 6.3 to 9.15 with mean value 7.86. EC range from 0.6 to 1.67 dS m⁻¹ with mean value 0.49. The organic carbon content was 0.25 to 8.90 g kg⁻¹ with mean 3.81 g kg⁻¹, the calcium carbonate content was 2.5 to 182.5 g kg⁻¹ with mean 25.93 g kg⁻¹. As regards available nutrients viz; available N (27.93 to 209.44 mg kg⁻¹) with mean 95.32 mg kg⁻¹, available P (6.61 to 52.93 mg kg⁻¹) with mean 21.71 mg kg⁻¹, available K (47.86 to 430.85 mg kg⁻¹) with mean 158.89 mg kg⁻¹, available S (5.35 to 73.15 mg kg⁻¹) with mean 22.44 mg kg⁻¹. The sand, silt and clay content in the soil varied from (50 to 95 %) with mean 86.27 %, (2.50 to 37.50 %) with mean 6.67 % and (2.50 to 30 %) with mean 7.14 % respectively. The soils were having high sand content indicating that the soils were loamy sand in texture. The water soluble K content in the soil samples varied from 1.50 to 24.33 mg kg⁻¹ with a mean value of 5.38 mg kg⁻¹, nitric acid soluble K range from 114 to 888 mg kg⁻¹ with a mean 408.53 mg kg⁻¹, exchangeable K range from 33.80 to 422.17 mg kg⁻¹ with mean 153.21 mg kg⁻¹, reserve K range from 2.40 to 776.27 mg kg⁻¹ with a mean 249.94 mg kg⁻¹ and total k range from 1004 to 5061 mg kg⁻¹ with a mean of 1945.74 mg kg⁻¹. The total k content in soils vary from 1753.73 mg kg⁻¹ (Aravali) to 2468.69 mg kg⁻¹ (Patan). The water-soluble K content in soils range from 3.01 mg kg⁻¹ (Sabarkantha) to 8.84 mg kg⁻¹ (Mehsana) and contribute 0.28 per cent towards the total k content of soils of North Gujarat region. Nitric acid soluble k content in soils range from 357.71 mg kg⁻¹ (Banaskantha) to 446.89 mg kg⁻¹ (Patan) and contributed 21.17 per cent towards the total k. Exchangeable K content in soils range from 130.83 mg kg⁻¹ (Banaskantha) to 179.55 mg kg⁻¹ (Sabarkantha) and contributed 7.92 per cent of total K. Reserve K content range from 220.11 mg kg⁻¹ (Banaskantha) to 273.01 mg kg⁻¹ (Aravali) and contributed 12.96 per cent towards total K.

Keywords: Potassium fractions, Physico-chemical properties, North Gujarat soil

Citation: Nimbalkar R.U., et al., (2023) Physico-Chemical Properties and Different Potassium Fraction from Soil of North Gujarat Region. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 15, Issue 8, pp.- 12610-12612.

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Academic Editor / Reviewer: Dr Kamal Kant

Introduction

Soil is a finite resource in term of area and its capacity to produce the biomass i.e., productivity. Soil productivity is declining with advent of modern agro-technologies. This is because of declining or disturbed soil fertility under anthropogenic activities. We are continuously mining soil nutrients since decades and centuries while farming the soil. The potassium is major nutrient for plant growth and it is mobile, unlike other major elements. After introduction of high yielding varieties, intensive and multiple cropping system along with use of high analysis nitrogenous and phosphatic fertilizers on long run resulting now the soils are started depleting in potassium from high to medium and up to low levels as evidenced by soil testing and crop response.

The amount of K present in soil solution depends on dynamic equilibrium between various forms of K and perhaps more on the rate of release from reserve phase. Thus, present soil survey was conducted to delineate potassium fractionation status in soils of north Gujarat with object to assessment of potassium fractions in the soils of North Gujarat. Potassium (K) is absorbed by plants in larger amounts than any other nutrient except N. Total soil K content ranges between 0.5 to 2.5 % and it is lower in coarse-textured soils formed from sandstone or quartzite and higher in fine textured soils formed from rocks high in K-bearing minerals [1,2]. The concentration of soil solution K is not sufficient to meet the demand of plant at any time, thus the replenishment of the solution from other phases of K is of great importance in determination the K fertility status of the soil. The amount of K present in soil solution depends on dynamic equilibrium between various forms of

K and perhaps more on the rate of release from reserve phase [3,4].

Materials and Methods

The present investigation conducting soil survey at seven district vize, Banaskantha, Mehsana, Aravalli, Sabarkantha, Kachchh, Gandhinagar and Patan from north Gujarat region, at the Sardarkrushinagar Dantiwada Agricultural University. Surface soil samples were collected from the farmers' fields during summer. Air dried soil samples were grind and pass through 2.0 mm sieve. The soil samples were analyzed for Physico-chemical parameters and four different potassium fractions as per standard procedure. The soil texture was analyzed by international pipette method [5], soil pH by potentiometry method [6], soil EC by Conductometry method [6], Organic carbon by Wet oxidation method [7], CaCO₃ by Rapid titration method [5], Available N by Alkaline permanganate method [8], Available P₂O₅ by Colorimetry method [9], Available K₂O by neutral normal ammonium acetate method [6] and Available Sulphur (ppm) by CaCl₂ extractable turbidimetry method [10]. The water soluble potassium was extracted from 1:2 soil : water ratio, after shaking in a mechanical shaker for two hours and then allowing it to stand for a period of sixteen hours as per the procedure described by Mc Lean (1960) [11], Water soluble potassium was extracted from 1:2 soil : water ratio, after shaking in a mechanical shaker for two hours and then allowing it to stand for a period of sixteen hours as per the procedure described by Mc Lean (1960) [11], available potassium was estimated as a five gram soil sample was shaken with neutral normal ammonium acetate (25 ml) and

Table-1 Physico-chemical properties in soils of North Gujarat region

District	pH	E.C. (dS m ⁻¹)	O.C. (g kg ⁻¹)	CaCO ₃ (g kg ⁻¹)	Aval. N (mg kg ⁻¹)	Aval. P ₂ O ₅ (mg kg ⁻¹)	Aval. K ₂ O (mg kg ⁻¹)	Aval. S (mg kg ⁻¹)	Sand (%)	Silt (%)	Clay (%)
Banaskantha	7.07-8.5 (7.87){0.30}	0.06-1.11 (0.31){0.21}	0.25-13.36 (3.09){2.33}	2.5-32.5 (12.39){6.20}	34.91-167.54 (96.74){31.20}	9.08-45.99 (22.31){8.28}	47.86-335.08 (137.61){55.84}	6.48-66.89 (14.81){8.63}	77.5-95 (87.68){4.11}	2.5-15 (5.21){2.81}	2.5-15 (7.26){3.26}
Mehsana	6.89-8.49 (7.73){0.35}	0.09-1.67 (0.41){0.41}	2.4-6.9 (4.39){1.08}	2.5-32.5 (12.35){5.77}	55.85-132.64 (97.04){17.40}	6.61-44.45 (21.08){9.00}	90.04-430.85 (183.88){80.60}	6.44-35.97 (15.29){6.65}	67.5-95 (86.68){4.62}	2.5-15 (6.06){3.35}	2.5-12.5 (7.16){3.50}
Aravalli	6.92-8.16 (7.67){0.29}	0.15-1.56 (0.55){0.30}	2.1-6.5 (4.43){1.91}	7.5-37.5 (21.25){9.30}	62.83-146.61 (104.49){19.53}	9.15-43.87 (23.76){9.92}	59.84-269.28 (146.46){60.07}	5.35-21.31 (14.80){4.72}	72.5-90 (85.47){4.83}	2.5-17.5 (7.11){3.98}	2.5-15 (7.42){3.00}
Sabarkantha	6.3-8.9 (7.48){0.66}	0.08-1.29 (0.42){0.28}	0.6-8.7 (3.96){1.65}	7.5-35 (17.75){8.19}	27.93-209.44 (95.12){36.99}	8.99-52.93 (22.29){9.42}	71.81-406.91 (182.56){82.75}	8.92-23.73 (15.55){4.04}	70-95 (86.79){4.36}	2.5-17.5 (6.49){3.35}	2.5-12.5 (6.73){2.43}
Kachchh	7.2-9.1 (8.09){0.45}	0.07-1.58 (0.53){0.33}	1.3-8.9 (3.58){1.70}	17.5-182.5 (66.65){35.73}	34.91-174.53 (88.68){28.86}	9.33-42.22 (18.00){7.40}	53.86-287.23 (134.81){48.12}	7.77-69.31 (36.70){18.31}	80-95 (87.31){2.89}	2.5-15 (5.91){2.50}	2.5-12.5 (6.92){2.23}
Gandhinagar	6.82-8.74 (7.92){0.48}	0.28-1.10 (0.71){0.24}	1.3-7.7 (4.23){1.69}	7.5-32.5 (13.25){6.02}	48.87-118.70 (85.18){19.82}	6.75-40.03 (20.04){8.26}	65.82-242.95 (143.88){41.97}	7.58-66.89 (25.98){17.28}	80-92.5 (86.82){3.52}	2.5-12.5 (6.93){2.67}	2.5-10 (6.25){2.5}
Patan	7.2-9.15 (8.23){0.46}	0.05-2.5 (0.53){0.46}	0.8-13.8 (3.38){2.23}	12.5-145 (37.89){24.37}	41.89-174.53 (97.89){25.93}	6.75-43.15 (24.49){11.61}	62.83-397.93 (180.96){90.37}	5.91-73.15 (31.75){21.57}	75-95 (85.48){4.25}	2.5-15 (7.71){4.00}	2.5-12.5 (6.86){2.35}
Overall	6.3-9.15 (7.86)	0.05-2.5 (0.49)	0.25-13.8 (3.87)	2.5-182.5 (25.93)	27.93-209.44 (95.32)	6.61-52.93 (21.71)	47.86-430.85 (158.89)	5.35-73.15 (22.44)	50-95 (86.25)	2.50-17.50 (6.62)	2.50-15 (7.14)

Table-2 Different forms of potassium (mg kg⁻¹) in soils of North Gujarat region

District	WS K	HNO ₃ K	Total K	Exch. K	Reserve K	Available K ₂ O
Banaskantha	1.82-16.31 (6.78){2.79}	143-831 (357.71){178.01}	1009-4251 (1902.96){641.93}	33.80-326.28 (130.83){55.81}	10.61-687.37 (220.11){179.01}	47.86-335.08 (137.61){55.84}
Mehsana	3.76-19.47 (8.84){3.40}	114-878 (410.40){218.93}	1004-3354 (1839.74){583.64}	77.85-422.17 (175.04){79.52}	2.40-776.27 (226.52){197.11}	90.04-430.85 (183.88){80.60}
Aravalli	2.08-13.11 (5.89){2.66}	139-877 (419.47){197.12}	1026-3787 (1753.73){718.48}	48.51-260.96 (140.56){59.70}	22.02-770.12 (273.01){193.68}	59.84-269.28 (146.46){60.07}
Sabarkantha	1.50-7.69 (3.01){1.35}	173-830 (428.05){186.77}	1064-3697 (1848.38){591.19}	70.31-404.82 (179.55){83.04}	5.31-725.22 (245.49){213.99}	71.81-406.91 (182.56){82.75}
Kachchh	1.54-10.06 (3.62){1.62}	134-848 (389.38){140.28}	1073-3797 (1926.66){562.76}	49.83-284.50 (131.19){48.37}	12.28-706.32 (254.57){145.22}	53.86-287.23 (134.81){48.12}
Gandhinagar	1.79-12.72 (5.02){2.72}	176-874 (407.8){170.02}	1091-2944 (1880.05){459.94}	59.39-237.81 (138.87){41.80}	46.54-718.42 (263.92){174.48}	65.82-242.95 (143.88){41.97}
Patan	1.61-24.33 (4.53){3.71}	135-888 (446.89){175.42}	1106-5061 (2468.69){1086.75}	61.15-385.37 (176.42){88.90}	5.56-618.32 (265.93){154.81}	62.83-397.93 (180.96){90.37}
Overall	1.50-24.33 (5.38)	114-888 (408.53)	1004-5061 (1945.74)	33.80-422.17 (153.21)	2.40-776.27 (249.94)	47.86-430.85 (158.59)

extracted as per the method suggested by Hanway and Heidel (1952) [12] and potassium will be determined from the extract by a flame photometer [6], nitric acid soluble potassium was extracted from soil with 1 N HNO₃ in the ratio 1:10 (Soil:HNO₃) and boiled for 10 minutes as per the procedure described by Wood and De Turk (1941) [13], exchangeable potassium was calculated by deducting the values of water-soluble potassium from those of available potassium, reverse potassium was calculated by deducting available potassium from the nitric acid soluble potassium and total potassium was estimated as per the method by Pratt (1951) [14] 0.1 gm soil was digested in 5 ml hydrofluoric acid and 0.5 ml perchloric acid in a platinum crucible. After cooling, 5 ml of (6 N) HCl and 5 ml of water were added and then boiled gently. When residue had completely dissolved in hydrochloric acid, it was transferred into 100 ml volumetric flask and volume will made at the mark and stoppered and shaken by up and down.

Results and Discussion

Soil physico-chemical properties

The data on soil physical and chemical properties are presented in [Table-1] and revealed that the soils under studies were slightly acidic to basic in reaction with pH varied from 6.30 to 9.15 with mean value 7.86. EC ranged from 0.05 to 2.50 dS m⁻¹ with mean value 0.49 dS m⁻¹. The organic carbon content ranged from 0.25 to 13.89 g kg⁻¹ with mean 3.81 g kg⁻¹, the calcium carbonate content was 2.5 to 182.5 g kg⁻¹ with mean 25.93 g kg⁻¹. As regards available nutrients viz; available N (27.93 to 209.44 mg kg⁻¹) with mean 95.32 mg kg⁻¹, available P (6.61 to 52.93 mg kg⁻¹) with mean 21.71 mg kg⁻¹, available K (47.86 to 430.85 mg kg⁻¹) with mean 158.89 mg kg⁻¹, available S (5.35 to 73.15 mg kg⁻¹) with mean 22.44 mg kg⁻¹. The sand, silt and clay content in the soil varied from (50 to 95 %) with mean 86.27 %, (2.50 to 17.50 %) with mean 6.67 % and (2.50 to 15 %) with mean 7.14 % respectively. The soils were loamy sand in texture. The soil had pH slightly neutral to alkaline in nature (1:2.5 weight/volume) with normal EC value. The soils were low in nitrogen and sulphur, medium in phosphorus and available potassium was high.

Different potassium fractions

The data on different forms of potassium are presented in [Table-2 and 3]. It is observed that the different forms of potassium from soil were extracted using

different extractants. The amount of K extracted for different forms varied widely in the seven districts viz; Banaskantha, Mehsana, Aravalli, Sabarkantha, Kachchh, Gandhinagar and Patan of North Gujarat region. The water soluble K content in the soil samples varied from 1.50 to 24.33 mg kg⁻¹ with a mean value of 5.38 mg kg⁻¹, nitric acid soluble K range from 114 to 888 mg kg⁻¹ with a mean 408.53 mg kg⁻¹, exchangeable K range from 33.80 to 422.17 mg kg⁻¹ with mean 153.21 mg kg⁻¹, reserve K range from 2.40 to 776.27 mg kg⁻¹ with a mean 249.94 mg kg⁻¹ and total k range from 1004 to 5061 mg kg⁻¹ with a mean of 1945.74 mg kg⁻¹. The results reveal that the K fractions content in the decreasing order HNO₃ K>Reserve K>Exchangeable K>Water soluble K. It was indicated that the HNO₃ K followed by reserve K fractions were more dominant in different districts of North Gujarat whereas water soluble K was lowest in all districts of North Gujarat region.

Table-3 Potassium fractions and total K content in soils of North Gujarat region

Sr.No.	WS K	HNO ₃ K	Exch. K	Reserve K	Total K
Banaskantha					
1	6.78	357.71	130.83	220.11	1902.96
2	(0.36)	(18.80)	(6.88)	(11.57)	
Mehsana					
3	8.84	410.4	175.04	226.52	1839.74
4	(0.48)	(22.31)	(9.51)	(12.31)	
Aravalli					
5	5.89	419.47	140.56	273.01	1753.73
6	(0.34)	(23.92)	(8.01)	(15.57)	
Sabarkantha					
7	3.01	428.05	179.55	245.49	1848.38
8	(0.16)	(23.16)	(9.71)	(13.28)	
Kachchh					
9	3.62	389.38	131.19	254.57	1926.66
10	(0.19)	(20.21)	(6.81)	(13.21)	
Gandhinagar					
11	5.02	407.8	138.87	263.92	1880.05
12	(0.27)	(21.69)	(7.39)	(14.04)	
Patan					
13	4.53	446.89	176.42	265.93	2468.69
14	(0.18)	(18.10)	(7.15)	(10.77)	
% Mean	(0.28)	(21.17)	(7.92)	(12.96)	

Mean value of potassium fractions

The data on mean value of potassium are presented in [Table-3] and it was observed that the total k content in soils vary from 1753.73 mg kg⁻¹ (Aravalli) to 2468.69 mg kg⁻¹ (Patan).

The water-soluble K content in soils range from 3.01 mg kg⁻¹ (Sabarkantha) to 8.84 mg kg⁻¹ (Mehsana) and contribute 0.28 per cent towards the total k content of soils of North Gujarat region. Nitric acid soluble k content in soils range from 357.71 mg kg⁻¹ (Banaskantha) to 446.89 mg kg⁻¹ (Patan) and contributed 21.17 per cent towards the total k. Exchangeable K content in soils range from 130.83 mg kg⁻¹ (Banaskantha) to 179.55 mg kg⁻¹ (Sabarkantha) and contributed 7.92 per cent of total K. Reserve K content range from 220.11 mg kg⁻¹ (Banaskantha) to 273.01 mg kg⁻¹ (Aravalli) and contributed 12.96 per cent towards total K. Results reveal that nitric acid soluble k fraction were more contributed towards the total k. Similar findings were recorded by Babar, *et al.*, (2007)[15] and Chakravarti, *et al.*, (1987)[16].

Conclusion

The soils were slightly acidic to basic in reaction with low soluble salts content. The organic carbon was ranged from low to medium while CaCO₃ ranged from medium to high category. The soils were low in available N and available S, available P was medium and available K was high. The soils of North Gujarat belongs to sandy loam, loamy sand, sandy texture, whereas loamy sand was textural class in most of soils of North Gujarat region. The soils of all districts of North Gujarat region were high in nitric acid soluble K followed by reserve K and exchangeable K which were more contributed to total K. The soils of all seven districts of North Gujarat region were lowest in water soluble K which was less contributed towards total K.

Application of research:

1. The recommendation of fertilizer application will be given to farmers as per nutrient status of soil
2. To minimize the fertilizer import and saving of Indian currency

Research Category: Soil Science and Agricultural Chemistry

Abbreviations: O.C.-Organic Carbon, EC-Electrical Conductivity

Acknowledgement / Funding: Authors are thankful to Central Sugarcane Research Station, Padegaon, 415521, Phaltan, Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, M.S., India and Department of Soil Science and Agricultural Chemistry, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, 385506, Gujarat, India

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Research project name or number: PhD Thesis

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Banaskantha, Mehsana, Aravalli, Sabarkantha, Kachchh, Gandhinagar and Patan district of North Gujarat region

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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