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Study of Presence of Available Potassium and Fertility Index of Farmland Soil of Danta Taluka Territory District: Banaskantha (Gujarat)

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Abstract: ***Quality of farmland soil is based on analytical results of various parameters like pH, electrical conductivity (EC), total organic carbon, available nitrogen (N), available phosphorus (P2O5) and available potassium (K2O). This study was carried out during year 2014-15 under soil health card project of Gujarat government. This study leads us to the conclusion of the nutrient's quantity of soil of Danta Taluka, District- Banaskantha, Gujarat (India). Almost medium and high potassium content found for all the 34 villages of Danta taluka covered under the study. The average fertility index for available potassium for this taluka is 2.14. This information will help farmers to decide the problems related to soil nutrients, thereby quality as well as quantity of fertilizers would be added to soil in order to achieve high agriculture yield with minimal use of fertilizers.***

Keywords: Quality of soil, Fertility index, Available Potassium

1. Introduction

Soils represent dynamic ecosystems, making it appropriate to think about them in terms such as health, vitality and bioproductivity. Soils are the resources that provide humans with more than 90% of all the food we eat. Our challenge is to manage soils in a sustainable fashion so that they will provide for human needs in the future. However, the measurement of soil processes and of the soil properties linked to these also depend on the use and location of the soil. When evaluating soil health, it is therefore common to explore a range of soil physical, chemical, and biological properties (Brevik E. C.)[1]. Soil mainly consists of 50% pore space (air and water) and 50% solid phase. The solid phase is broadly composed of 45% mineral matter and 5% organic constituents (Gupta P. K., 2000; Kaur H., 2013)[2], [3].

Farmers in Asia, for centuries, have practiced ancient cultural system that ensured modest but stable yields, yet maintained a desired level of fertility in soil. This equilibrium is disturbed by the need to increase production through introduction of high yielding varieties, intensive use of chemical fertilizers and pesticides and extensive tillage. There are now concerns whether the dramatic increase in production, which followed the Green Revolution, is sustainable.

Soil analysis report based nutrient management has emerged as a key issue in efforts to increase agricultural productivity since optimal use of fertilizers. Hence, based on the soil analysis report one can improve crop productivity and minimize wastage of these nutrients, thus minimizing impact on environment leading to bias through optimal production. Deficiencies of primary, secondary and micronutrients have been observed in intensive cultivated areas. Several States including Andhra Pradesh, Gujarat, Haryana, Karnataka and Uttar Pradesh have made commendable progress in soil testing programme in various ways such as expansion of soil testing facilities, popularization of the programme in campaign mode, development of soil fertility maps and use of information technology in delivering soil nutrient status and appropriate recommendation to farmers. This compendium is an effort to put together existing status of soil testing facilities state wise and highlight main issues in soil testing programme Compendium on soil health (Rawls R., 1997) [4]. Soil is important to everyone either directly or indirectly. It is the natural bodies on which agricultural products grow and it has fragile ecosystem (Sinha A. K. and Shrivastava, 2000; Kaur H., 2002)[5], [6].

One of the communication deals with quality of soil of Shehra Taluka Dist: Panchmahals, Gujarat, India. Soil samples were collected from 4 different villages of Shehra Taluka. Quality characteristics of soil such as pH, Electrical Conductivity (EC), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Total organic Carbon, Available Nitrogen (N), Available Phosphorus (P_2O_5) and Available Potassium (K_2O) were determined as per standard methods. They found the values of earlier listed parameter in the moderate range (Patel K.P., 2015) [7].

Another group studied soil samples of 10 different villages of tribal area surrounding Dahod. The physicochemical properties such as moisture content, specific gravity, pH measurement and estimations of Mg^{2+}, Na^{+}, K^{+} and Cl^{-}, HCO_3^{-}, PO_4^{3-}, NO_3^{-} % of soil were well studied. The fertility of the soil depends on the concentration of N, P, K organic and inorganic materials and water. Nitrogen is required for growth of plant and is a constituent of chlorophyll, plant protein and nucleic acid. Phosphorous is most often limiting nutrients remains present in plant nucleic acid act as energy storage. It helps in transfer of energy. Potassium is found in its mineral form and affect plants all division, carbohydrate formation, translocation of sugar, various enzyme action and resistance to certain plant disease, over 60 enzymes are known to require potassium for activation. Amount of nutrients to be added to soil for crop production depend on

their present amount in that soil. Fertilizer addition is recommended, now a day an STR (Soil Test Recommendation) basis, in which contents of major nutrients (N, P, K) are determined following standard methods before sowing. Their values suggest quality of soil in terms of its nutrients contents i.e. high, medium, or low nutrients. These nutrients contents are than deduced from required amount of nutrients for following crop and this much amount of nutrients is now recommended for addition to soil(Miller R. W. and Donahue R. L., 1995; Patel B. S. and Dabhi H. R., 2009) [8] ,[9].

One of the communication deals with quality of soil of Kalol and Godhra Taluka soil samples were collected from nineteen different villages of Kalol, Godhra taluka. Physicochemical study of soil is based on various parameter like pH, conductivity, total organic carbon available nitrogen (N), available phosphorus (P_2O_5) and potassium (K_2O) were determined as per standard methods. Results show that for available phosphorus of soil of the Kalol and Godhra Taluka with their fertility index (Patel D. H. and Lakdawala M. M., 2013) [10].

Fertilizer addition is recommended, now a day on STR (Soil Test Recommendation) basis in which contents of major nutrients (N, P, K) are determined following standard methods before sowing. Their values suggest quality of soil in terms of its nutrients contents i.e. high, medium or low nutrients. These nutrients content are than deduced from required amount of nutrients for following crop and this much amount of nutrients is now recommended for addition to soil(Miller R. W. and Donahue R. L., 1995) [8]. One of The communication deals with quality of soil of Dahegam Taluka, Gujarat, India. Soil samples were collected from forty different villages of Dahegam Taluka. Quality characteristics of soil such as pH, Electrical Conductivity (EC), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Bicarbonate (HCO_3^-), Chloride(Cl^-), Total Organic Carbon, Available Nitrogen (N), Available Phosphorus (P_2O_5) and Available Potassium (K_2O) were determined as per standard methods. Results show that 20% soils are deficient in organic carbon whereas 95% soils are deficient in available potassium (Shah M. et al. 2011) [11].

Soil fertility testing is really the combination of three discrete but interrelated processes: analysis, interpretation, and recommendation (Eckert D. J., 1987) [12]. Stefanic's definition (1994) [13] explains the most of the fundamental biological feature of the soil fertility: "Fertility is the fundamental feature of the soil, that results from the vital activity of micro-population, of plant roots, of accumulated enzymes and chemical processes, generators of biomass, humus, mineral salts and active biologic substances". The fertility level is related with the potential level of bioaccumulation and mineralization processes, these depending on the programme and conditions of the ecological subsystem evolution and on anthropic influences". This definition has the quality to be analytical. Understanding the definition in detail, the analyses of soil samples can be used for quantifying the level of soil fertility.

Use of fertilizer to raise the soil test level above this critical value will not produce an economic return on the cost of that addition. Once the critical soil test level for a nutrient is reached, crop yield will be limited by some other factor such as soil moisture, length of growing season, weed pressure, an insect or disease problem, or another nutrient level. Potassium is an essential nutrient for agricultural crops because it plays an important role in several physiological processes in plant. There are about 50 enzymes, responsible for energy transfer and formation of sugars, starch and protein that are affected by potassium presence in plant (Krauss A., 1997; Darst B. C., 1992) [14], [15]. Potassium content in soils depends on the type of parent material and degree of soil and mineral weathering. Potassium in Soil exists in four forms that are in equilibrium, each differing in its availability to crops. These forms, in increasing order are: mineral, non-exchangeable (fixed or difficultly available), exchangeable, and solution (Havlin J. L. et al. 2004) [16]. D. H. Patel and M. M. Lakdawala have reported the study of available potash in soil of Panchamahal district (Patel D. H. and Lakdawala M. M., 2016) [17].

Present study is an attempt to find out the nutrient's quantity in soil of Danta Taluka, District- Banaskantha Gujarat. This information will help farmers to decide the amount of fertilizer to be feed in soil to make the production economic. The objective of this paper was to evaluate the status of potassium in selected soil samples using the traditional Flame photometric method for the determination of potassium (NH_4OAc, K). Thereby it is elaborated the trend in fertility status of soils of Danta Taluka, District- Banaskantha, Gujarat State.

2. Experimental

2.1 Materials and Methods

The soil analysis data are the best source available to assess soil fertility status. All 34 villages from Danta Taluka covering North, South, East and West, were selected for this study. A representative soil samples was collected from each village which represent soils of 4 to 10 farm's depending upon area of village. Representative soil samples were collected following standard quadric procedure and taken in polythene bags. In laboratory these samples were analyzed for different chemical parameters following standard methods (Jackson M. L., 1967) [18]. AR grade reagents and double distilled water were used for soil analysis. Results were compared with standard values (Patel D. H. and Lakdawala M. M., 2016) [17] to find out low, medium or high nutrient's content essential for STR. Soil sample is shaken with neutral normal ammonium acetate. During the extraction process, ammonium ions replace potassium ions absorbed on the soil colloids.

$$\text{Colloid } K^+ + CH_3COONH_4 \longrightarrow \text{Colloid } NH_4^+ + CH_3COOK$$

Being the almost similar ionic radii, K^+ is more effectively replaced by NH_4^+. The extract is then filtered and potassium is determined with flame photometer.

2.2 Experimental setup

Take 5 gm soil was added with 50 ml of 1 N neutral ammonium acetate solution and shake for 30 minutes on a horizontal shaker. Filter the content through a 11 µm pore sized filter paper. Filtrate was then aspired to the flame photometer and reading was noted. Blank reading was also taken. The available K_2O value can be calculated from this photometric reading by multiplying a standard factor. Based on the soil analysis result data for available Potassium, soil samples are generally categorized into three categories i.e. low, medium and high and is depicted in Table 1. Using these fertility classes nutrient index was calculated (Patel D. H. and Lakdawala M. M., 2016) [17].

3. Results and Discussion

Table 1 represent the range of low, medium and high potassium content as per standard of soil analysis, it is the permissible standard according to Anand Agriculture University. These values are used to determine the category of soil whether the soil sample have low, medium or high content of potassium.

Experimental values of available potassium of soil of the Danta Taluka with their fertility index are depicted in the Table 2. This table describes the number of samples lies in Low, Medium and High potassium content. The same table represents the calculated values of fertility index for available K_2O of the soil for all the villages covered in the study.

Data presented in Table 2 shows that soils of most of the village covered in the present study contain lower potassium and some of the villages have high range of potassium that might be due to the excessive use of fertilizers. Rest of the samples lies in medium range indicates good quality of soil suggest sufficient amount of presence of available potassium and hence there is not any need to feed the soil with nutrient supplements. Results are in tune with farming practices followed by farmers of this region. Most of the farmer's are using chemical fertilizers like potash since last 25 to 30 years which contains concentrated amount of potassium and nitrogen, organic carbon and phosphorus. Due to higher cost and rare availability of phosphatic fertilizers they are less preferred. On the basis of these results farmers are advised to use integrated nutrient management practice to maintain optimum concentration of all the essential nutrients for plants. Farmers are also advised to add biofertilizers containing organic carbon and nitrogen solubilising bacteria. The graphical representation clearly confirms the recent status of all 34 villages for the presence of potassium in their soil.

Figure 1 stands for the village wise category for number of sample lies in low, medium and high content available potassium. This clears that how many samples were collected from the village and what is the status of available potassium level in that sample whether it has low, medium or high nitrogen content. Using these fertility classes nutrient/fertility index was calculated as per the following equation.

$$Fertility\ Index = \frac{(NL \times 1 + NM \times 2 + NH \times 3)}{100}$$

Where, NL, NM and NH are number of samples falling in low, medium and high classes of potassium status of samples analyzed for a given area. Figure 2 shows the fertility index for available potassium is finally used for recommendation of fertilizers and crop selection.

Table 1: Range of Low, Medium and High category of Available Potassium in the form of K_2O

Category	*Total Available potassium*
Low	<140 kg K_2O/ Ha
Medium	140-280 kg K_2O/ Ha
High	>280 kg K_2O/ Ha

Table 2: Study of Presence of Potassium Content in the soil of Danta Taluka territory of Banaskantha District

Sr. No.	Village	No of sample	No of samples in LMH Potassium content			Fertility Index
			Low	Medium	High	
1	Balavantpura	72	9	51	12	1.47
2	Begadiyavas	40	0	20	20	1.00
3	Bhanpur	86	1	26	59	2.30
4	Chhota pipodara	49	1	14	34	1.31
5	Chorasan	79	8	61	10	1.60
6	Dhagadiya	67	1	33	33	1.66
7	Ganchhera	90	0	75	15	1.95
8	Ghantodi	84	18	53	13	1.63
9	Hathi pagala	60	6	29	25	1.39
10	Hedo	69	0	33	36	1.74
11	Jasavantpura	45	3	6	36	1.23
12	Jhamaru	118	1	9	108	3.43
13	Jitpur	207	32	168	7	3.89
14	Kansa	81	1	55	25	1.86
15	Kesharpura	93	0	10	83	2.69
16	Kundel	184	35	138	11	3.44
17	Madhusudanpura	46	4	24	18	1.06
18	Mahobatgadh	82	0	16	66	2.30
19	Mahudi	55	1	50	4	1.13
20	Mandali	111	6	24	81	2.97
21	Mankanchampa	91	28	45	18	1.72
22	Motabamodara	44	0	2	42	1.30
23	Motipura	40	10	28	2	0.72
24	Navaniya	45	1	30	14	1.03
25	Pethapur	190	10	168	12	3.82
26	Pith(Navanagar)	40	14	21	5	0.71
27	Pruthvirajgadh	38	11	25	2	0.67
28	Punjpur	324	2	162	160	8.06
29	Ratanpur	228	0	96	132	5.88
30	Udavas	12	2	7	3	0.25
31	Vadusan	63	11	39	13	1.28
32	Vaghadacha	59	6	44	9	1.21
33	Velavada	133	1	65	67	3.32
34	Vijalasan	155	45	95	15	2.80

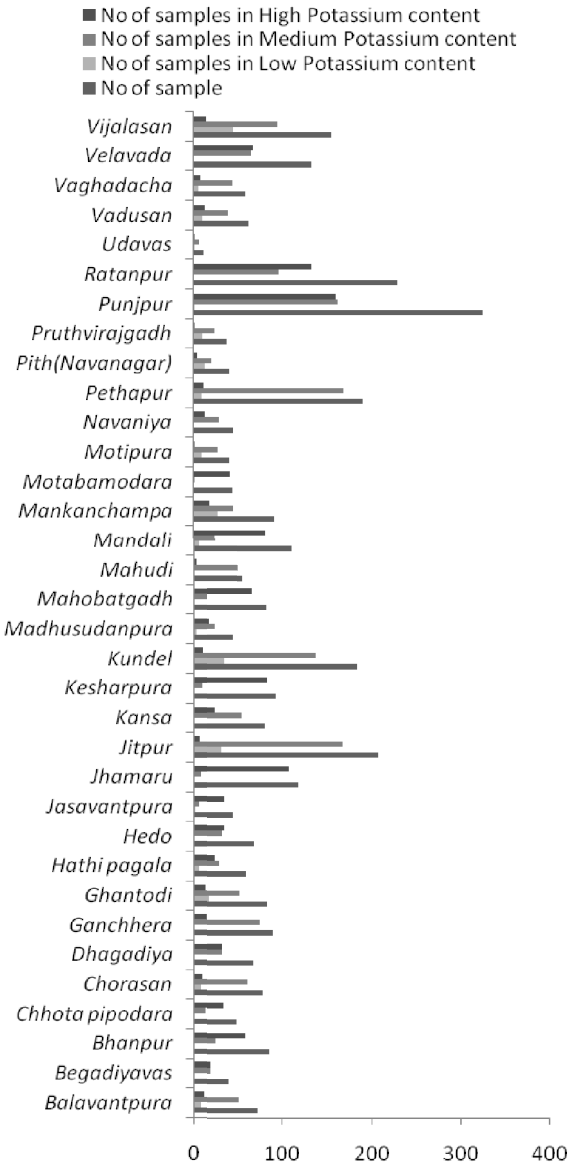

Figure 1: Numbers of samples of Danta Taluka lies in Low, Medium and High available potassium content range

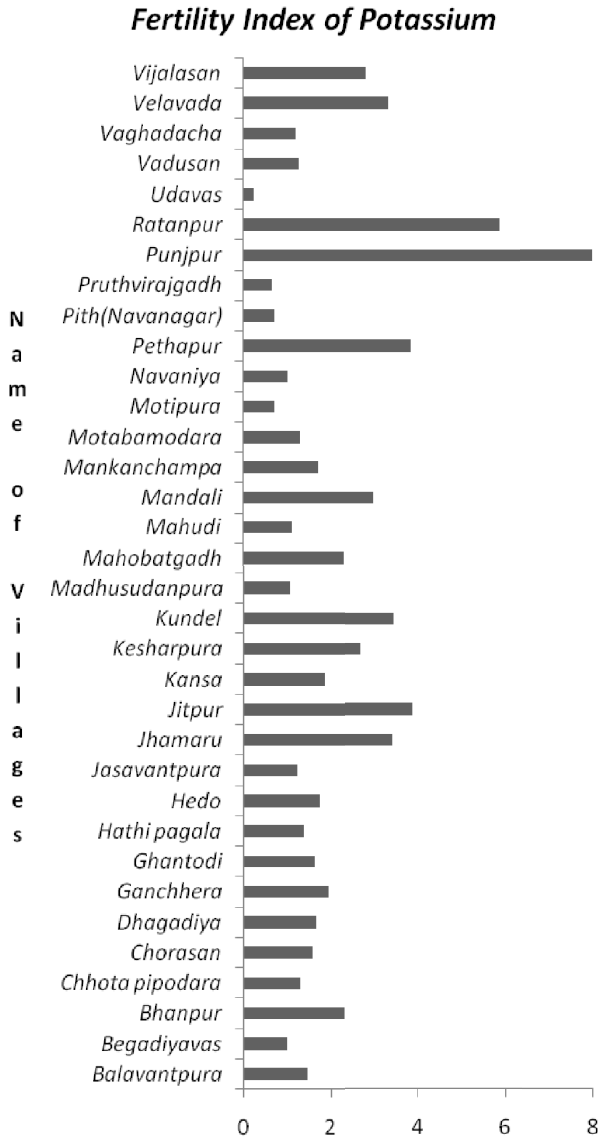

Figure 2: Fertility index for Potassium content of Danta Taluka territory of Banaskantha District

4. Conclusion

It can be concluded from this study that the potassium deficient farmland soil is recommended for potash rich fertilizer. Thus fertility status of soil is evaluated from this study for making fertilizer recommendations. One can classify soil into different types of soil groups, fertility groups for preparing soil maps and soil fertility maps which are presented in form of graphics. Prediction of the probable crop response to applied nutrients is possible. By identification of the type and degree of soil related problems like salinity, alkalinity and acidity etc. it is possible to suggest appropriate reclamation/ amelioration measures. It is also concluded how to find out suitability for growing crops and orchard. Study the soil genesis and suitability for irrigation could be easier with this conclusion.

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