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Research Article

SALIENT SOIL CHARACTERISTICS AND POTASSIUM FIXATION IN VEGETABLE GROWING SOILS OF RANGA REDDY AND MAHABOOBNAGAR DISTRICTS OF TELANGANA

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Abstract- In the present investigation salient soil characteristics and potassium fixing capacities of vegetable growing soils of Rangareddy and Mahaboobnagar districts were studied during the year 2013-14. Rangareddy and Mahaboobnagar soils were slightly acidic to moderately alkaline in reaction, non saline in nature, organic carbon was low to high, low CEC. The texture of the soils of Ranga Reddy were loamy sand, loam and sandy loam and Mahaboobnagar were sandy loam, loam, loamy sand and sandy clay loam. The data revealed that the soils of Ranga Reddy and Mahaboobnagar districts were light textured with sand as dominant fraction. The potassium fixing capacity of soils of Ranga Reddy district varied from 11.2 to 44.8 kg ha^{-1} with a mean value of 20.3 kg ha^{-1}. The K fixing capacity of soils of Mahaboobnagar district found to be in the range of 11.2 to 67.2 kg ha^{-1} with a mean of 23.8 kg ha^{-1} Potassium fixation capacity was low. Potassium fixation capacity of soil showed positive correlation with all soil characteristics except sand, which was significantly and negatively correlated (r = -0.647**). Presently the study indicated that soil properties have profound influence on potassium fixation capacity of soils.

Keywords- Potassium fixation capacity, vegetable growing soils.

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Introduction

Generally the crop response to K application is expected, where the soils are low in available potassium. But, there are reports, where crop response to K fertilization is positive even in soils high in K status. This suggests that factors other than the level of available K in surface soil can influence the growth and K availability to plants. These factors fall into several distinct categories such as type of soil clay minerals, concentration of K, soil pH, fixation and release of K, K supplying capacity of soil, interaction with other elements, moisture content, mobility and accessibility, method and time of application, sources of K supply, plant factors etc. [1].

Potassium fixation in soils i.e. transformation of available K forms into unavailable form, has a direct effect on K availability and on the degree of fertilizer K uptake by plants. For more effective evaluation of crop needs for potassium a better understanding of the soil behavior towards K fixation is essential. Hence it is imperative to know the fixation characteristics of soils to make rational recommendations about K-fertilizers. Among the various factors affecting K fixation, soil clay (quantity and type) content plays an important role. Potassium fixing capacity of soils is also regulated by soil characteristics, plant type and intensive cultivation, nutrients application. Soils differ in tendencies to fix applied K in forms unavailable to plants and each soil has its fixing capacity for K which must be satisfied before a change in soil solution occurs. This parameter helps in understanding the behaviour of soil and helps in predicting the response of crops to applied nutrients and to make judicious fertilizer recommendation.

Vegetables are grown intensively with unbalanced fertilization in villages of Ranga Reddy and Mahaboobnagar districts which are around hyderabad city because of market facility. In intensive cultivation alternate wetting and drying type of irrigation was followed, due to this potassium was fixed in the interlayer spaces of clay and silt particles. A vegetable crop responds to K fertilization and plays an important role at fruit development and maturity. Hence it is imperative to know the fixation characteristics of soils with a view to making rational recommendations about K fertilizers.

Material and Methods

Vegetable growing soils, thirty two surface soils (0-15cm) of Ranga Reddy and forty surface soils (0-15cm) of Mahaboobnagar districts of Telangana were collected and analysed for physical properties by using standard methods [2] and physicochemical, chemical properties by using standard methods [3].

Thirty two selected vegetable growing soils each sixteen surface soils (0-15cm) of Ranga Reddy and Mahaboobnagar districts of Telangana were analysed for potassium fixing capacity of soils. Potassium fixing capacity was determined by following the wet fixation method [4]. Well processed soil (5g) was taken in each of the nine conical flasks and potassium through KCl solution was added to give the concentrations of 0, 25, 50, 100, 150, 200, 250, 300 and 500 µg/5g soil in such a manner that the final soil : solution ratio was adjusted to 1: 2. The contents in the flasks were incubated for 72 hours at room temperature taking all necessary precautions to prevent evaporation. After incubation, 25ml of N N NH_4OAC solution was added to all the conical flasks. The contents were shaken for 5 minutes and K in the filtrate was estimated using flame photometer. Potassium fixing capacity was computed from the amounts of K added and extracted at different levels.

Results and Discussion

Salient characteristics of vegetable growing soils

The physical, physico-chemical and chemical properties of the vegetable growing soils of Ranga Reddy (18 mandals) and Mahaboobnagar (22 mandals) districts covering 32 and 40 villages, respectively, were analyzed and the data are presented in [Tables-1 and 2], respectively.

Table-1 *Salient characteristics of the vegetable growing soils of Ranga Reddy district*

S. No	Mandal	Village Name	pH	EC (dS m^{-1})	CEC cmol (p^+) kg^{-1}	OC (g kg^{-1})	Available N (kg ha^{-1})	Available P (kg P_2O_5 ha^{-1})	Available K (kg K_2O ha^{-1})	sand (%)	silt (%)	clay (%)	Textural class
1	Moinabad	Kothireddypalli	7.1	0.118	4.6	9	138.0	10.8	322.6	92	4	4	Sand
2	Chevella	Chenvelli	8.2	0.170	27.7	13	200.7	24.4	505.3	63	24	13	Sandy loam
3	Chevella	Lakshmiguda	8.0	0.253	21.3	10	188.2	26.4	732.5	74	16	10	Sandy loam
4	Pudur	Pothireddyguda	8.4	0.237	32.6	9	175.6	11.5	1116.9	74	20	6	Sandy loam
5	Pudur	Changomul	8.0	0.150	18.0	9	200.7	12.8	829.2	65	24	11	Sandy loam
6	Parigi	Narayanpur	7.6	0.135	31.0	6	163.1	11.0	428.7	68	16	16	Sandy loam
7	Parigi	Ragapur	7.9	0.174	21.8	13	200.7	37.2	1092.7	62	24	14	Sandy loam
8	Doma	Wootpally	6.3	0.086	4.2	7	175.6	10.3	224.4	86	4	10	Loamy sand
9	Doma	Sivareddypalli	7.6	0.156	17.9	13	200.7	29.0	1618.2	62	22	16	Sandy loam
10	Shankarpally	Parveda	7.9	0.220	34.8	13	188.2	17.2	1182.7	64	20	16	Sandy loam
11	Shankarpally	Mahalingapuram	8.0	0.205	29.0	7	175.6	22.3	599.4	63	20	17	Sandy loam
12	Nawabpet	Nawabpet	7.6	0.172	24.7	8	175.6	33.6	289.0	76	16	8	Sandy loam
13	Nawabpet	Chittigadda	8.0	0.163	22.1	7	175.6	12.3	725.8	74	14	12	Sandy loam
14	Vikarabad	Kathagadi	7.7	0.104	29.6	10	175.6	10.0	419.3	82	12	6	Loamy sand
15	Vikarabad	Girgidpalli	6.9	0.397	18.0	10	250.9	43.1	295.7	72	20	8	Sandy loam
16	Shabad	Antharam	7.5	0.202	15.8	11	213.2	54.9	595.4	69	18	13	Sandy loam
17	Shabad	Kakkuluru	7.6	0.173	15.2	11	213.2	64.1	408.6	82	12	6	Loamy Sand
18	Medchal	Railapur	7.8	0.184	14.3	12	200.7	50.3	1856.1	76	14	10	Sandy loam
19	Medchal	Masireddypalli	6.1	0.054	8.9	13	163.1	10.0	182.8	86	4	10	Loamy sand
20	Shameerpet	Adraspally	7.4	0.157	12.5	12	200.7	64.9	979.8	69	16	15	Sandy loam
21	Basheerabad	Muduchinthalapalli	6.4	0.143	14.6	9	213.2	50.5	1198.8	81	6	13	Sandy loam
22	Keesara	Keesara	7.9	0.141	8.5	8	175.6	10.5	672.0	76	12	12	Sandy loam
23	Keesara	Bogaram	6.9	0.108	7.1	5	150.5	11.0	338.7	86	6	8	Loamy sand
24	Manchal	Arutla	7.6	0.222	16.8	12	250.9	64.1	1729.7	69	18	13	Sandy loam
25	Manchal	Manchal	7.6	0.137	13.9	10	200.7	48.0	337.3	84	10	6	Loamy sand
26	Ibrahimpatnam	Kappapahad	7.8	0.233	16.5	12	213.2	61.6	930.0	82	12	6	Loamy sand
27	Ibrahimpatnam	Kongarakonal	7.8	0.132	11.9	8	188.2	11.8	606.1	84	8	8	Loamy sand
28	Maheshwaram	Ravirala	7.4	0.219	14.8	13	188.2	60.3	1120.9	84	6	10	Loamy sand
29	Shamshabad	Kocharam	6.2	0.353	16.0	13	213.2	58.5	438.1	82	6	12	Sandy loam
30	Shamshabad	Malkaram	7.4	0.225	14.1	10	200.7	40.0	934.1	82	10	8	Loamy sand
31	Moinabad	Venkatapur	7.4	0.108	19.3	4	175.6	15.6	426.0	83	14	3	Loamy sand
32	Rajendranagar	College farm	7.9	0.286	15.9	8	175.6	20.5	419.3	78	10	12	Sandy loam
Mean			7.5	0.18	17.92	10	191.0	31.5	736.1	76	14	10	
Range			6.1-8.4	0.054-0.397	4.2- 34.8	4-13	138 -250.9	10-64.9	182.8-1856.1	62-92	4- 24	3-17	

Particle size distribution

The relative proportion of sand, silt and clay fractions of soils of Ranga Reddy district ranged from 62 to 92 per cent (with a mean of 76 per cent), 4 to 24 per cent (with a mean of 14 per cent) and 3 to 17 (with a mean 10 per cent), respectively. The sand, silt and clay fractions of the soils of Mahaboobnagar district ranged from 61 to 93 per cent (with a mean of 76 percent), 2 to 28 per cent (with a mean of 12 per cent) and 3 to 22 (with a mean 12 per cent), respectively. According to the USDA textural classification the soils of Ranga Reddy were varied from sandy loam (63 per cent), loamy sand (34 per cent) and sand (3 per cent). The texture of soils of Mahaboobnagar varied from sandy loam (65 per cent), loamy sand (20 per cent), sand (10 per cent) and sandy clay loam (5 per cent). The data revealed that the vegetable growing soils of Ranga Reddy and Mahaboobnagar districts were light textured with sand as dominant fraction.

Soil reaction (pH)

The pH of soils of Ranga Reddy district varied from 6.1 to 8.4 (mean value of 7.5), while that of the soils of Mahaboobnagar ranged from 5.3 to 8.6 (mean value of 7.7) indicating that the soils under investigation were moderately acidic to alkaline.

Electrical Conductivity (EC)

The electrical conductivity of soils of Ranga Reddy district varied from 0.054 to 0.397 dSm^{-1}, with the mean value of 0.18 dSm^{-1}, while that of the soils of Mahaboobnagar ranged from 0.02 to 0.316 dS m^{-1}, with the mean value of 0.133 dSm^{-1} indicating that the soils under investigation were non saline in nature.

Organic Carbon

The organic carbon content of the soils of Ranga Reddy district varied from 4 to 13 g kg^{-1}, with a mean value of 10 g kg^{-1}. About 81 per cent of the soils are high in organic carbon, while 13 and 6 per cent were medium and low, respectively. In soils of Mahaboobnagar district, the values ranged from 3 to 13 g kg^{-1}, with a mean of 9 g kg^{-1}. In these soils, 68 per cent of the soils had high organic carbon, while 15 and 17 per cent of soils found to have medium and low organic carbon contents, respectively.

Available nitrogen

The available nitrogen content of the soils of Ranga Reddy district varied from 138.0 to 250.9 kg ha^{-1} (mean of 190.0 kg ha^{-1}), indicating that the soils were low in available nitrogen. The available nitrogen content of the soils of Mahaboobnagar district showed a range from 75.3 to 313.6 kg ha^{-1} (mean of 202 kg ha^{-1}). Among the soils analyzed from Mahaboobnagar district, 12.5 per cent of the soils were medium in available nitrogen and the rest of the soils were low in available nitrogen.

Available phosphorus

The available phosphorus content (P_2O_5)of soils of Ranga Reddy district was in the range of 10 to 64.9 kg ha^{-1}, with a mean of 31.5 kg ha^{-1}, indicating that 49 per cent of the soils were low in available phosphorus while, 33 and 18 per cent of the soils found to have medium and high available phosphorus contents, respectively. The available phosphorus status in soils of Mahaboobnagar district were in the range of 10 to 65.1 kg ha^{-1}, among which 70 per cent of the soils were low in available phosphorus while 25 and 5 per cent of the soils had medium and high available phosphorus.

Table-2 *Salient characteristics of the vegetable growing soils of Mahaboobnagar district*

S. No	Mandal	Village Name	pH	EC (dS m^{-1})	CEC cmol (p+) kg^{-1}	OC (g kg^{-1})	Available N (kg ha^{-1})	Available P (kg P_2O_5 ha^{-1})	Available K (kg K_2O ha^{-1})	sand %	silt %	clay %	Textural Class
1	Kothur	Penjerla	7.7	0.087	11.8	6	138.0	46.7	532.2	83	8	9	Loamy sand
2	Kothur	Kodicherla	7.7	0.102	10.5	4	188.2	52.1	172.0	86	4	10	Loamy sand
3	Keshampet	PapireddyGudem	6.1	0.042	15.8	6	250.9	65.2	268.8	68	10	22	Sandy clay loam
4	Keshampet	Pomalapally	7.8	0.094	12.9	7	188.2	17.2	598.1	83	6	11	Loamy sand
5	Farookhnagar	Farookhnagar	8.1	0.091	19.9	7	313.6	12.1	224.4	71	12	17	Sandy loam
6	Farookhnagar	Mogiligidda	7.6	0.129	14.7	7	200.7	24.9	272.8	77	14	9	Sandy loam
7	Balanagar	Ammapally	6.1	0.123	14.7	11	288.5	59.0	794.3	73	10	17	Sandy loam
8	Balanagar	ChinnaRevalli	7.7	0.059	10.3	4	250.9	15.1	71.2	85	4	11	Loamy sand
9	Jedcharla	Gangapuram	7.7	0.105	12.9	10	301.1	20.5	349.4	69	16	15	Sandy loam
10	Midjil	Midjil	8.0	0.056	4.3	3	125.4	17.2	96.8	90	4	6	Sand
11	Midjil	Vurukonda	5.7	0.023	10.5	3	276.0	11.0	139.8	83	4	13	Sandy loam
12	Kalwakurthy	Kalwakurthy	5.3	0.02	3.9	3	100.4	10.0	90.0	87	6	7	Loamy sand
13	Veldanda	Kotra	7.1	0.037	7.1	3	200.7	11.5	104.8	90	2	8	Sand
14	Amangal	Kadthal	8.1	0.091	13.8	8	188.2	32.8	266.1	78	6	16	Sandy loam
15	Kodangal	Kodangal	8.2	0.106	22.4	8	200.7	13.6	306.4	70	20	10	Sandy loam
16	Tadoor	Indrakal	8.0	0.097	13.1	11	163.1	23.6	358.8	79	8	13	Sandy loam
17	Tadoor	Yatamatapur	8.4	0.171	28.7	9	200.7	11.0	448.9	68	16	16	Sandy loam
18	Nagurkurnool	Nagarkurnool	8.3	0.126	15.8	9	313.6	32.1	370.9	67	18	15	Sandy loam
19	Nagurkurnool	Uyalawada	7.6	0.180	18.0	12	175.6	22.3	532.2	77	12	11	Sandy loam
20	Bijinapalle	Bijinapalle	8.5	0.117	16.2	12	276.0	10.3	380.4	73	14	13	Sandy loam
21	Bijinapalle	Mahadevnipet	7.0	0.073	11.3	11	200.7	55.7	184.1	77	6	17	Sandy loam
22	Waddepalli	Waddepalli	8.1	0.215	24.6	13	225.8	15.4	916.6	67	22	11	Sandy loam
23	Waddepalli	Jilledidinne	8.1	0.236	27.5	11	213.3	23.1	1022.8	64	22	14	Sandy loam
24	Alampur	Koneru	8.3	0.250	21.2	12	200.7	14.6	1002.6	72	16	12	Sandy loam
25	Alampur	Utkur	8.1	0.258	28.7	13	175.6	11.8	971.7	64	22	14	Sandy loam
26	Manopadu	Kalukuntla	8.1	0.252	29.8	7	138.0	13.6	1016.1	62	28	10	Sandy loam
27	Manopadu	A.Budidapadu	8.1	0.243	19.4	12	200.7	10.8	731.1	61	24	15	Sandy loam
28	Itikyal	Duvasipalli	8.2	0.260	19.1	10	200.7	10.5	1022.8	64	22	14	Sandy loam
29	Itikyal	Jinkalapalli	8.1	0.249	19.0	10	188.2	11.0	903.2	67	24	9	Sandy loam
30	Balmoor	Kandanagula	8.1	0.094	7.3	10	138.0	10.0	176.1	84	4	12	Loamy sand
31	Balmoor	Ghattuthumen	8.2	0.108	11.8	10	150.5	13.3	375.0	85	4	11	Loamy sand
32	Achampet	Nadimpally	7.9	0.146	14.5	12	200.7	42.3	224.4	76	12	12	Sandy loam
33	Achampet	Pulijala	8.2	0.065	10.9	5	188.2	12.6	246.0	76	10	14	Sandy loam
34	Uppunutala	Uppunutala	8.3	0.128	13.6	11	200.7	43.1	655.9	68	10	22	Sandy clayloam
35	Uppunutala	Molgara	8.6	0.067	8.7	10	163.1	21.0	279.6	84	4	12	Loamy sand
36	Kodangal	Udimeshwaram	7.1	0.030	8.0	9	75.3	10.3	130.4	93	4	3	Sand
37	Bomraspeta	Yenkepalli	8.4	0.168	14.9	9	213.3	10.3	255.4	89	4	7	Sand
38	Bomraspeta	Vadicherla	7.8	0.159	22.7	13	288.5	10.3	793.0	65	20	15	Sandy loam
39	Kosigi	Nacharam	6.9	0.138	15.0	12	200.7	10.0	240.6	81	8	11	Sandy loam
40	Kosigi	Kosigi	7.9	0.316	14.4	12	175.6	11.5	416.6	77	10	13	Sandy loam
Mean			7.7	0.133	15.5	9	202.0	21.7	448.6	76	12	12	
Range			5.3-8.6	0.020-0.316	3.9 -29.8	3-13	75.3-313.6	10.0- 65.1	71.2 -1022.8	61 - 93	2 - 28	3 -22	

Available potassium

The available potassium content (K_2O) of the soils of Ranga Reddy district was in the range of 182.8 to 1856.1 kg ha^{-1} with a mean value of 736.1 kg ha^{-1}. The per cent samples falling under medium and high available K status were 16 and 84, respectively. The available potassium content of the soils of Mahaboobnagar district was in the range of 71.2 to 1022.8 kg ha^{-1} with a mean value of 448.6 kg ha^{-1}. Among the soils analyzed 15, 32.5 and 52.5 per cent samples were under low, medium and high categories as per the ratings of available potassium.

Cation exchange capacity

The cation exchange capacity (CEC)of the of soils of Ranga Reddy district varied from 4.2 to 34.8 cmol (p+) kg^{-1} with the mean value of 18.0 cmol (p+) kg^{-1}. The soils of Mahaboobnagar ranged from 3.92 to 29.77 cmol (p+) kg^{-1}, with the mean value of 15.48 cmol (p+) kg^{-1}.

The soils of Ranga Reddy and Mahaboobnagar districts are light textured, moderately acidic to alkaline and non saline. Low to high in organic carbon content, low CEC and the available N, P and K status of majority of the soils of Rangareddy and Mahaboobnagar district are low, low to medium and medium to high, respectively [5].

Keeping in view the available potassium status of vegetable growing soils of Ranga Reddy and Mahaboobnagar districts, 16 soils each from both the districts were selected covering low, medium and high K soils for conducting further detailed study related to potassium fixing capacity of soils.

Potassium fixing capacity of soils

Potassium fixing capacity of soils is an important factor based on which K recommendations are given apart from available K status of soils. The K fixing capacity of soils depend on several factors like soil texture, type of clay minerals, potassium content in soils etc. the fixing capacity of vegetable growing soils of Ranga Reddy and Mahaboobnagar districts are shown in [Fig-1 to 8].

The potassium fixing capacity of soils of Ranga Reddy district varied from 11.2 to 44.8 kg ha^{-1} with a mean value of 20.3 kg ha^{-1}. The K fixing capacity of soils of Mahaboobnagar district found to be in the range of 11.2 to 67.2 kg ha^{-1} with a mean of 23.8 kg ha^{-1}. In general almost all the soils showed low potassium fixing capacity, because most of soils of Ranga Reddy and Mahaboobnagar district were loamy sand and sandy loam in texture with low clay content.

Correlations were worked out among soil properties and K-fixing capacity and the values are given in [Table-3]

Potassium fixing capacity of soil showed positive correlation with CEC (r = 0.536**), OC (r = 0.349*), clay (r = 0.422*) and silt (r = 0.555**). This indicates that the type of clay minerals present in the clay fraction and primary minerals in silt fraction are responsible for K fixation and release and also influences the changes

in available K from time to time. As the soils of these two districts are light textured with low clay content the K fixing capacity of these soils is low [6].

Table-3 *Relationships between different forms of potassium, soil characteristics and with K fixation capacity*

	pH	EC	CEC	OC	Sand	Silt	clay
K fixation capacity	0.152	0.412*	0.536**	0.349*	-0.647**	0.555**	0.422*

* Significant at 0.05 per cent level (0.3494)
**Significant at 0.01 per cent level (0.4487)

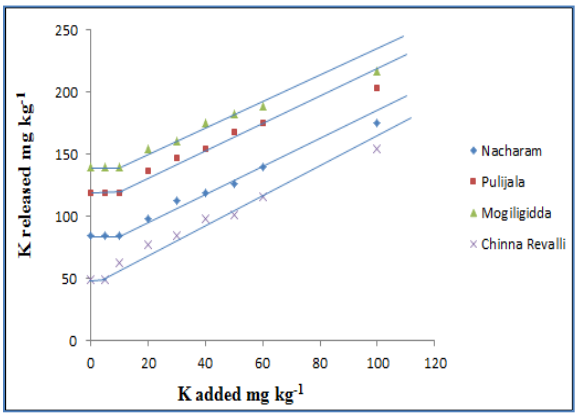

Fig-1 Potassium fixing capacity of soils of Nacharam, Pulijala, Mogiligadda and Chinna revalli villages of Mahaboobnagar district.

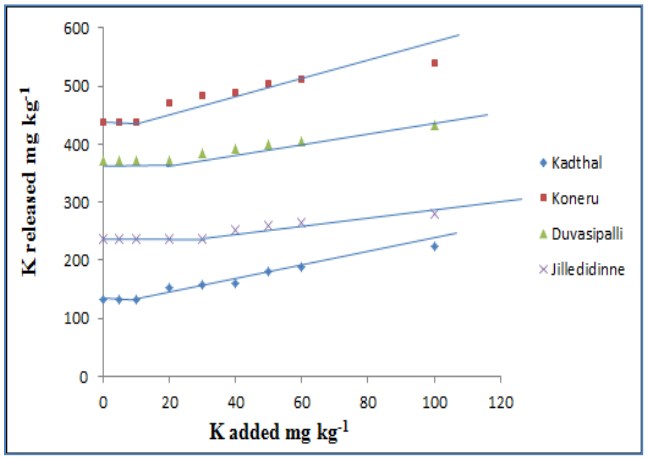

Fig-2 Potassium fixing capacity of soils of Kadthal, Koneru, Duvasipalli and Jilledidinne villages of Mahaboobnagar district.

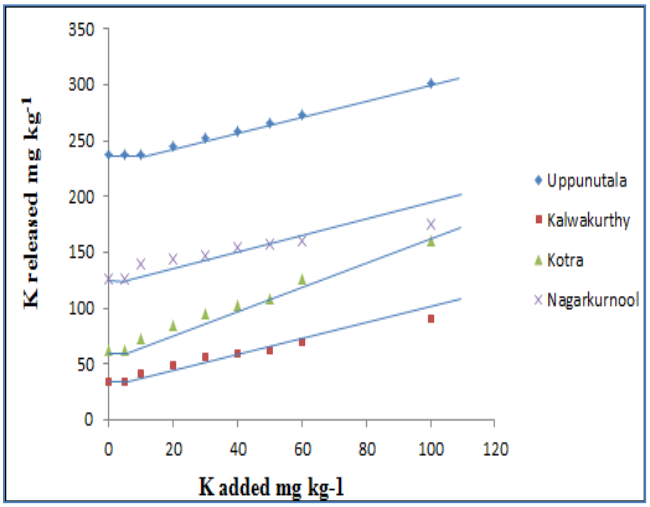

Fig-3 Potassium fixing capacity of soils of Uppununtala, Kalwakurthy, Kotra and Nagarkurnool villages of Mahaboobnagar district.

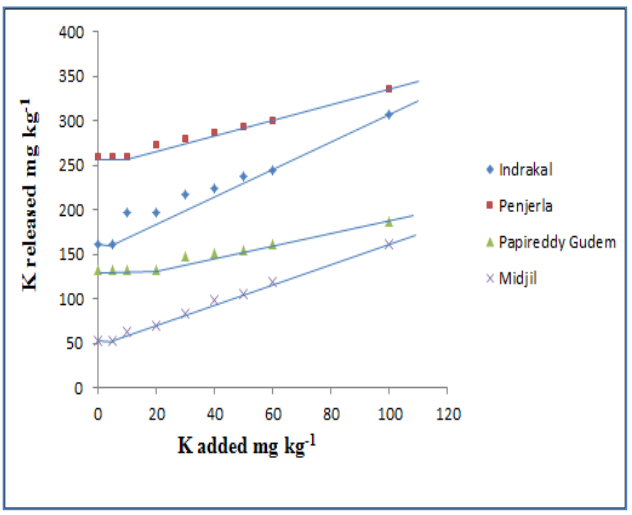

Fig-4 Potassium fixing capacity of soils of Indrakal, Penjerla, Papireddy gudem and Midjil villages of Mahaboobnagar district.

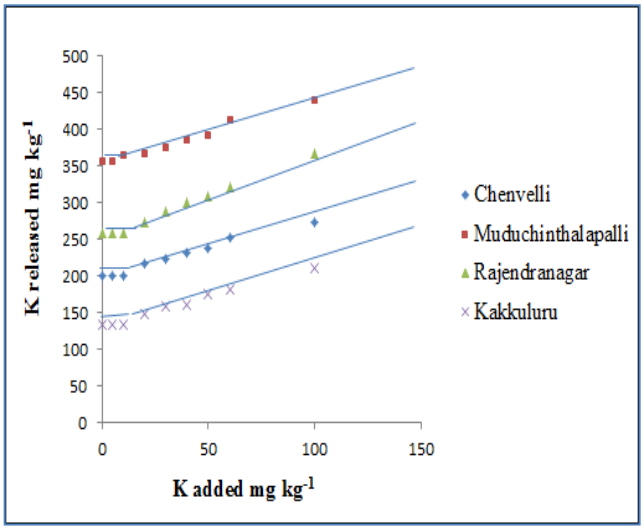

Fig-5 Potassium fixing capacity of soils of Chenvelli, Muduchinthalapalli, Rajendranagar and Kakkaluru villages of Ranga Reddy district.

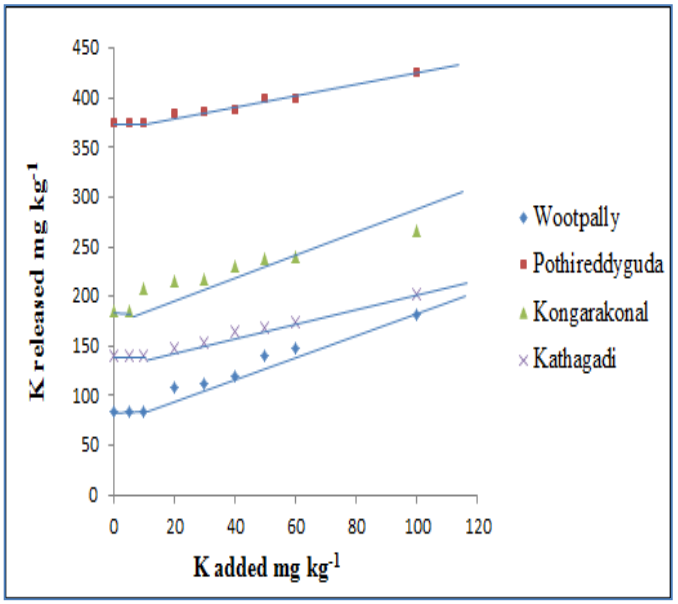

Fig-6 Potassium fixing capacity of soils of Wootpally, Pothireddyguda, Kongarakonal and Kathagadi villages of Ranga Reddy district.

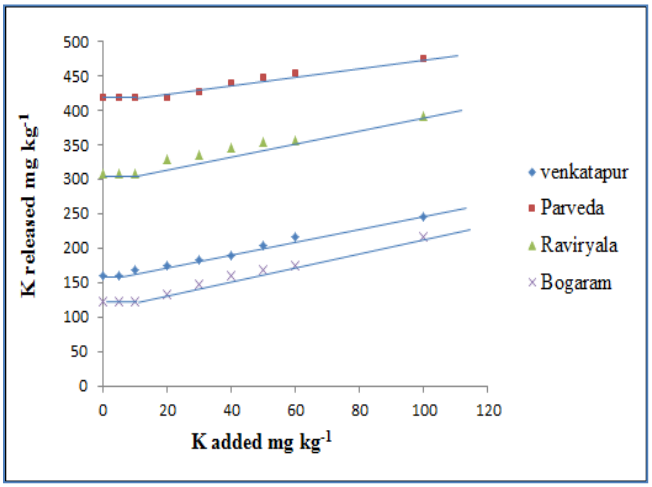

Fig-7 Potassium fixing capacity of soils of Venkatapur, Parveda, Raviryala and Bogaram villages of Ranga Reddy district.

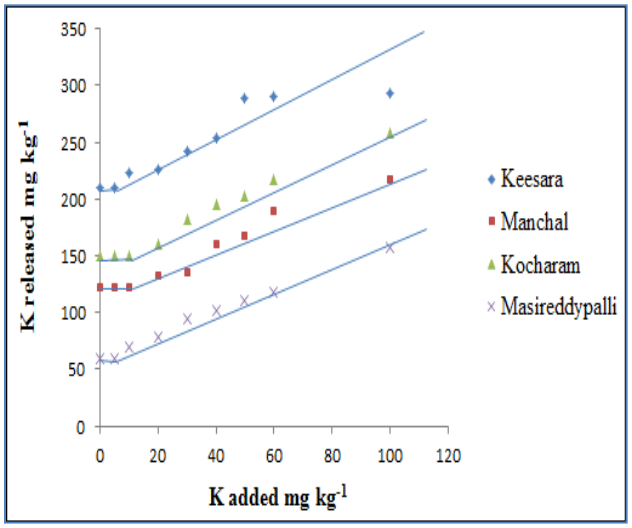

Fig-8 Potassium fixing capacity of soils of Keesara, Manchal, Kocharam and Masireddypalli villages of Ranga Reddy district.

Potassium fixing capacity showed positive and significant correlation with clay (r = 0.62**) this suggests that finer fraction of soil provides more surface area for K fixation [7].

Conclusion

Presently the study indicated that soil properties have profound influence on potassium fixation capacity of soils. Soils of Rangareddy and Mahaboobnagar districts were low in potassium fixing capacity. Low potassium fixing capacity of soils is due to low silt and clay % as the silt and clay fractions of soils are largely responsible for potassium fixation. This suggests that the finer fractions of soils provide more surface area and increase in number of potassium fixing sites in soil.

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Conflict of Interest: None declared

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