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Assessment Of Potassium Supplying Capacity of Soils of Nalgonda District of Telangana State through Neubauer Seedling Technique

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ABSTRACT

Twenty soil samples with the background of different management practices, soil type and depth were collected representing different villages in Nalgonda district of Telangana state, India, in the year 2016. The purpose was to assess the potassium supplying capacity of these variable soils through Neubauer technique with maize as test crop. Standard methods were adopted to assess different potassium forms in the samples. In this study the Neubauer value of 297 mg 100g^{-1} soil, was recorded in the soil of Kondamadugu (Bibinagar mandal) indicating the highest amount of potassium uptake while, the lowest uptake of 59 mg 100g^{-1} soil was recorded in the soils belonging to Kacharam village. Neubauer values showed positive correlation with all the fractions of potassium. However, maximum positive correlation is shown with available and exchangeable K (r = 0.21), indicating that the available and exchangeable potassium had pronounced effect on the uptake of potassium by the crop plants over other fractions.

Key words: *K supplying capacity, Neubauer technique, K fractions, Correlation*

INTRODUCTION

Neubauer seedling technique is based on the principle of rapid and intensive uptake of nutrient elements by a large number of seedlings grown in a small quantity of soil. Because of the large number of seedlings, there is a rapid formation of an extensive network of roots that exhaust the available nutrient elements within a short period. The Neubauer seedling technique is used to assess the nutrient element (s) removed from soil by the plant roots[5]. The Neubauer number of a soil for a particular nutrient element is a measure of the amount of root-soluble nutrient element (s) present in a given mass of dry soil. The Neubauer numbers can be thought as critical levels. They represent the soil test value (s) below which an increase in crop yield can be obtained with the addition of the nutrient element in question[5].The Neubauer technique has been used extensively to determine the availability of K[1,7] to plants.

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With this method potassium supplying capacity of a soil can be determined by growing large number of seedlings exhaustively for test soil. Because of its rapidity, it is considered that the Neubauer method could be useful in laboratories where recommendations regarding potential nutrient element uptake and crop response to applied nutrient elements are required urgently. Soil potassium exists in dynamic equilibrium in four forms *viz.*, water soluble, exchangeable, non-exchangeable and total K, of which the first two are important for the growth of higher plants and microbes. Potassium, an important element of several minerals, is released to water soluble and exchangeable forms by weathering of the minerals at widely differing rates. Maize is an exhaustive crop, which absorbs maximum amount nutrient from the soil. The crop is also used as an indicator plant for potassium and it shows symptoms for potassium deficiency with slight deficiency of nutrient. Therefore, this crop was selected for this study.

MATERIALS AND METHOD

Initial survey was conducted to collect soil samples from 20 villages from Nalgonda District of Telangana State. These twenty villages were selected based on the certain variables *viz*., soil type, soil depth, management practices and cropping sequence. The initial soil properties for all the 20 soil samples such as texture, bulk density, field capacity, pH, EC, OC, CEC, available N, P and K were analyzed by following standard procedures (Table 1). For rapid assessement of K supplying capacity of different soils, Neubauer technique was adopted. For which, 25 maize seeds were grown in 100g soil sample mixed with 50g sand along with control (seeds grown on only sand) for 17 days. After 17 days, the plant dry weight was noted, potassium content in plants was determined and potassium uptake was calculated for 100 maize seedlings and expressed as potassium uptake (in mg) from 100 gram soil.

Different potassium fractions were estimated by resorting standard proctocols, and potassium content in the respective extracts was measured using the flame photometer (ELICO CL 361) and different fractions were expressed as mg K kg^{-1}soil as briefly described below:

i) *Water soluble potassium*: Water soluble potassium was determined in 1:5 soil : water extract by shaking soil-water suspension for 5 minutes[4].

ii) *Available potassium:* The available potassium was determined using neutral normal ammonium acetate with 1:5 soil : N*N* NH_4OAC, after shaking for 5 minutes as described by Hanway and Heidal[3].

iii) *Exchangeable potassium:* The exchangeable potassium was obtained as a difference of the available and water soluble potassium[4].

iv) *Non-exchangeable potassium / fixed potassium*: The non-exchangeable potassium was obtained by deducting the available potassium from 1 *N* HNO_3 extractable potassium[12].

v) *Total potassium:* 0.1 g of soil (passed through 0.16 mm sieve) was taken in to a platinum crucible and 5 ml of 48% hydrofluoric acid was added. The crucible was placed on a sand bath (maintained at 200 to 225 ^{0}C) till it gets evaporated to dryness. The crucible was cooled and 5 mL of 6 *N* HCl was added. Filtered the solution in to a 100 mL volumetric flask and made up the volume with water. The K concentration in this was measured using flame photometer.

RESULTS AND DISCUSSIONS

In the soils of Nalgonda district, the fractions (water soluble, exchangeable, non-exchangeable/ fixed potassium and total potassium) were analysed and expressed in mg kg^{-1} of soil. The data pertaining to different fractions of potassium is presented in the Table.2

The water soluble potassium in the soils ranged from 12.0 to 67.5 mg kg^{-1} with a mean value of 23.0 mg kg^{-1} of soil. The highest water soluble potassium content was recorded in the soils of Anantharam and lowest was recorded in Veeravally.

The 1 *N* NH_4OAc extractable potassium content ranged from 38 mg kg^{-1} of soil in Veeravally to 294 mg kg^{-1} in Ammanbole with an average value of 130.9 mg kg^{-1} of soil. Lowest exchangeable potassium content of 26 mg kg^{-1} of soil was recorded in the soil of Veeravally and the highest value of 239 mg kg^{-1} of soil was recorded in soil of Ammanbole with an average of 108 mg kg^{-1} of soil. Non – exchangeable/fixed potassium ranged between 140mg kg^{-1}soil (Gudur) to 262 mg kg^{-1} soil (Ammanbole) with an average value of 194 mg kg^{-1} of soil while, total potassium content in soils representing Nalgonda district ranged between 11,500 to 18,000 mg kg^{-1} of soil with an average value of 14,960 mg kg^{-1} of soil. Highest total potassium content was recorded in soils of Malkapur and lowest was in the soils of Anantaram and Kolanupaka (Table 2).

It has been observed, the water soluble, exchangeable and non exchangeable/fixed potassium constituted 0.15, 0.72 and 1.30 percent, respectively of total potassium values. This indicates that about 0.15 and 0.72 percent of total potassium is available to plants as water soluble and exchangeable fractions. The fixed potassium constituted only 1.30% of the total K. It indicates that these soils contain relatively less portion of total K in the form of fixed K which would supply K to the growing crops over a long period of time.

Low contribution of water soluble K to the total K in soil was also reported by Sharma *et al.*[10] and Gurumurthy and Prakasha[2]. Appreciably low levels of water soluble, exchangeable and non exchangeable K in the soils might be due to continuous cropping without additions of K through fertilizers[9]. Similar results were obtained by Laxminarayana *et al*.[6] in Meghalaya.

The water soluble, exchangeable and non exchangeable potassium constituted only 2.17 per cent of the total K, indicating that the per cent contribution of mineral K (not analysed in this study) to total K in these soils was > 90 per cent. It can be inferred that dominance of this form of K over the other forms. Similar observation were made by Sharma *et al*[10].

The study indicated the highest amount of potassium uptake (Neubauer value), 297 mg $100g^{-1}$ soil and also dry matter yield, 6.95 g was recorded in the soil of Kondamadugu (Bibinagar mandal) and the lowest uptake of 59 mg $100g^{-1}$ soil and also dry matter yield of was recorded in the soil of Kacharam (Yadagirigutta mandal) (Table 3). There was a wide variation in dry matter yields in different soils due to the variation in potassium supplying power of soils. The highest dry matter yield, 6.95 g was recorded in the soil of Kondamadugu (Bibinagar mandal) and lowest dry matter yield, 1.88 g was recorded in Jameelapet (Bibinagar mandal) and Veeravally (Bhuvanagiri mandal). This means that the highest K supplying capacity was seen in the soil of Kondamadugu which was medium in available potassium content and lowest K supplying capacity was seen in soils of Jameelapet and Veeravally. Nath and Dey[8] also observed variation in dry matter yields in the alluvial soils of Assam and in Aridisols of Rajasthan[11]. This can be ascribed to the variation in K supplying power of soils.

Neubauer values has shown positive correlation with all the fractions of potassium. Maximum positive correlation is shown with available and exchangeable K (r = 0.21), elucidating that the available and exchangeable potassium effected more on the uptake of potassium by the crop plants when compared with other fractions. Neubauer values has shown negative correlation with total K which indicating that total K is not available to plants unless it becomes available in water soluble and exchangeable form. (Table4).

Table 1: Assesment of initial soil properties of selected soil samples representing Nalgonda district of Telangana state

S.No.	Mandal	Village	Soil texture	BD (Mgm^{-3})	MWHC (%)	pH (1:2.5)	EC(1:2.5) (dS m^{-1})	CEC [c mol (p^+ kg^{-1}soil]	OC (%)	SAK (kg ha^{-1})	FC (%)
1	Bhuvanagiri	Veervally	Clay loam	1.46	46.8	7.9	1.10	14.50	0.64	102	37.44
2	Choutuppal	Khairthpur	Clay loam	1.71	34.02	8.5	0.25	10.38	0.63	140	27.21
3	Gundala	Anantaram	Clay loam	1.73	38.05	8.1	0.75	15.70	0.56	150	30.44
4	Tungathurthy	Reddygudem	Clay	1.52	45.54	8.0	0.42	13.64	0.62	163	36.43
5	Yadgirigutta	Kacharam	Clay loam	1.71	40.55	8.3	0.27	14.08	0.22	175	32.44
6	Alair	Kolanupaka	Clay	1.75	44.34	7.9	0.31	13.71	0.52	177	35.23
7	Bibinagar	Kondamadugu	Clay	1.82	29.31	6.4	0.23	13.20	0.62	195	23.44
8	Bibinagar	Jameelapet	Sandy clay loam	1.60	42.75	7.9	0.55	11.02	0.61	197	34.20
9	Yadgirigutta	Saidapur	Clay loam	1.63	37.00	8.1	0.08	8.80	0.44	297	29.60
10	Alair	Sharmapuram	Clay loam	1.64	38.66	7.7	0.25	8.60	0.62	317	31.33
11	Chilkur	Kondapuram	Clay	1.63	43.80	7.1	0.22	10.63	0.52	327	35.04
12	B. Pochampalle	Juloor	Sandy clay loam	1.56	41.00	8.2	0.43	12.71	0.60	356	32.84
13	Chilkur	Chilkur	Clay loam	1.73	43.59	8.2	0.27	13.43	0.61	413	34.87
14	Valigonda	Arrur	Clay loam	1.53	43.98	7.6	0.52	13.54	0.64	462	35.18
15	B.Pochampalle	Deshmukhi	Sandy clay loam	1.64	38.90	7.8	0.22	11.10	0.51	480	31.12
16	Choutuppal	Malkapur	Sandy clay loam	1.53	47.99	8.6	0.31	14.10	0.63	492	38.39
17	B.Pochampalle	Danthur	Sandy clay loam	1.68	42.90	7.8	0.26	11.55	0.45	542	34.32
18	Bibinagar	Gudur	Sandy clay loam	1.49	43.50	7.7	0.34	11.09	0.65	591	34.80
19	Bhuvanagiri	Anantharam	Sandy clay loam	1.70	33.87	6.9	0.33	6.95	0.48	671	26.61
20	Alair	Ammanbole	Clay loam	1.58	45.81	6.4	0.29	13.43	0.58	790	36.64

Note
BD= Bulk density; MWHC= Maximum water holding capacity; EC= electrical conductivity; CEC= Cation exchange capacity; OC= Organic carbon; AN= Available nitrogen; AP= Available phosphorus; AK= Available potassium; FC= Field capacity

Table 2: Fractions of potassium in the soils of Nalgonda district (mg K kg^{-1})

S.no.	Village	Water soluble K	N*N*NH_4OAc extractable K	Exchangeable K	1*N* HNO_3 extractable K	Non exchangeable/ fixed K	Total K	Total K (%)
1	Veeravally	12.0	38.0	26.0	252	214.0	14,800	1.48
2	Khairthpur	14.0	52.0	38.0	244	192.0	13,600	1.36
3	Anantaram	14.0	56.0	42.0	260	204.0	11,500	1.15
4	Reddygudem	13.0	60.5	47.5	320	259.5	15,300	1.53
5	Kacharam	15.0	65.0	50.0	288	223.0	14,900	1.49
6	Kolanupaka	10.5	66.0	55.5	272	206.0	11,500	1.15
7	Kondamadugu	13.5	72.5	59.0	280	207.5	15,100	1.51
8	Jameelapet	14.5	73.5	59.0	284	210.5	13,800	1.38
9	Saidapur	16.0	110.5	94.5	332	221.5	15,500	1.55
10	Sharmapuram	15.0	118.0	103.0	296	178.0	18,800	1.88
11	Kondapuram	17.0	121.5	104.5	376	254.5	16,800	1.68
12	Juloor	20.0	132.5	112.5	356	223.5	13,400	1.34
13	Chilkur	17.0	154.0	137.0	412	258.0	15,900	1.59
14	Arrur	25.5	172.0	146.5	380	208.0	12,000	1.20
15	Deshmukhi	31.0	178.5	147.5	320	141.5	17,100	1.71
16	Malkapur	23.5	183.0	159.5	332	149.0	18,200	1.82
17	Danthur	32.5	201.5	169.0	388	186.5	18,300	1.83
18	Gudur	34.0	220.0	186.0	360	140.0	12,400	1.24
19	Anantharam	67.5	249.5	182.0	400	150.5	14,200	1.42
20	Ammanbole	55.0	294.0	239.0	556	262.0	16,000	1.60

Table 3: Neubauer values (mg K_2O 100 g^{-1} soil) in soils of Nalgonda

S.No.	Village	Dry weight (g)	Neubauer values
1	Veeravally	1.88	130
2	Khairthpur	3.58	185
3	Anantaram	4.24	216
4	Reddygudem	5.10	183
5	Kacharam	2.42	54
6	Kolanupaka	3.52	96
7	Kondamadugu	6.95	297
8	Jameelapet	1.88	210
9	Saidapur	2.82	136
10	Sharmapuram	4.56	151
11	Kondapuram	3.80	157
12	Juloor	6.20	313
13	Chilkur	6.75	221
14	Arrur	2.20	216
15	Deshmukhi	3.98	170
16	Malkapur	3.16	181
17	Danthur	4.15	89
18	Gudur	3.36	221
19	Anantharam	3.42	197
20	Ammanbole	4.80	238

Table 4: Correlation among different fractions of potassium and Neubauer values

	Water soluble K	Exchangeable K	Non-Exchangeable K	Total K	Available K	Neubauer values
Water soluble K	-	0.82*	-0.11	0.18	0.88*	0.17
Exchangeable K	-	-	0.005	0.38	0.99*	0.21
Non Exchangeable K	-	-	-	0.02	-0.02	0.07
Total K	-	-	-	-	0.34	-0.09
Available K	-	-	-	-	-	0.21

*Significant at 5% level of significance

CONCLUSIONS

Wide variations was observed in dry matter content in different soils which shows the variation in potassium supplying capacity in these soils. Neubauer values have shown highest correlation with available potassium and exchangeable potassium when compared with other potassium fractions.

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