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Concentration and Uptake of Potassium by Maize *(Zea mays* L.) in Soils of Kurnool District of A.P

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ABSTRACT

An investigation was carried out during the year 2015 -16 to study and determine the concentration and uptake of potassium by maize crop in 30 soils of different cropping systems (rice-rice, maize-maize, rice-maize/mustard, fallow-bengal gram and groundnut-groundnut) in Kurnool district of Andhra Pradesh. Dry matter, K content and K uptake were significantly increased with increase in each level of potassium from 0 to 90 kg K_2O ha^{-1}. There was abundant increase in above parameters from no K fertilizer application to 30 kg K_2O ha^{-1} and the increase was gradual with increase in each level of fertilizer from 30 to 90 kg K_2O ha^{-1}. All the above parameters showed significant difference with soil K status, K levels and their interaction. Percent increase in K content at 90 kg K_2O ha^{-1} over control in Srinagaram soils (initial soil K status 2088 kg ha^{-1}) was 21 percent where as in Balapalapalli soils (initial soil K status 217 kg ha^{-1}) was 59 percent.
Key words: *Maize, Dry matter, K content and K uptake.*

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INTRODUCTION

Potassium, one of the major nutrients required by plants in amounts similar or greater than nitrogen plays a diverse role in plant metabolism. In the past, research on potassium has lagged behind those of the other major nutrients because of the general impression that most of the Indian soils are well supplied with the element. However, after introduction of high yielding varieties and increasing use of nitrogen and phosphorus in the last two decades, crop responses to potassium have become widespread. To evaluate the intrinsic fertility status of these soils with reference to pot culture technique using maize as test crop was conducted.
Maize is the most important food grain crop next only to rice and wheat in world and India. Maize has become a crop of interest among the farmers of Kurnool and Nandyal Region of A.P., because of poor yields of conventional crops of pulses, increasing of pests and diseases, weed menace and less remunerative prices with good marketing facilities (Ranga *et al.* 2011). Keeping this in view, the present investigation was carried out to study the concentration and uptake of potassium by maize in soils of Kurnool district of A.P

MATERIAL AND METHODS

The study was undertaken in the Department of Soil Science and Agricultural chemistry, Agricultural College, Mahanandi during the period of 2015-16. Representative surface soil (0-15 cm) 60 soil samples in bulk were collected from 5 cropping systems (black and red soils viz. rice-rice, rice-maize/mustard, maize-maize, fallow-bengalgram, groundnut-groundnut). Soil samples were extracted with neutral normal ammonium acetate for K status. Based on K content selected 30 soil samples for K studies. The soil samples collected were air dried and passed through 2mm sieve. Each sample was then sub-sampled, by quartering and finally a representative soil sample was preserved in a polythene bag for laboratory analysis .The selected soils were analyzed for their initial soil properties. The particle size analysis was carried out by Bouyoucous hydrometer method (Piper, 1966). The pH and EC were determined in 1:2 soils: water suspension using pH meter and EC meter (Jackson, 1973). The free $CaCO_3$ content was determined as per procedure given by Piper (1966).The texture of the soils ranged from sandy loam to clay *i.e.* belongs to moderately coarse to fine texture. A pot culture experiment was conducted by using 5 Kg each of the 2.0 mm sieved soil of different cropping system were taken in earthen pots and P-3396 maize hybrid used as test crop. The four levels of potassium doses as 0,30,60,90 Kg ha $^{-1}$ K_2O AND 30 soils based on initial soil K status thus total 120 treatments each replicated thrice was in completely randomized design. A common recommended dose of nitrogen (250 Kg ha $^{-1}$ N) and phosphorous (60 Kg ha $^{-1}$ P_2O_5) applied to all the treatments. The maize seedlings @ three per pot sown in each pot. Two plants will be removed at 10 DAS and incorporated in same pot then only one plant maintained in each pot. The crop harvested at 60 DAS. Plant samples collected at 60 DAS were oven dried and recorded the dry matter. K content was determined by using flame photometer (Piper,1966) in the tri acid digest with the composition of HNO_3 : $HClO_4$: H_2SO_4 (9:4:1) The potassium uptake was calculated using the following formula and expressed in g pot $^{-1}$

$$\text{Nutrient uptake (g pot}^{-1}\text{)} = \frac{\text{Nutrient content (\%)} \times \text{Dry matter production (g pot}^{-1}\text{)}}{100}$$

RESULTS AND DISCUSSION:

Physico-chenrical and physical characteristics of the soils

The pH of the soils used in the study varied from 6.9 to 8.4 (Table 1). Thus, the soils under study are neutral to slightly alkaline in reaction. The EC of soils varied from 0.10 dS m-^{1} to 0.69 dS m-' with a mean value of 0.27 dS m $^{-1}$. The soils were non-calcareous and texture of the soils varied from sandy loam to clay, which are moderately coarse to fine in texture. The organic carbon of the soils varied from 0.21 percent to 0.51 per cent with a mean of 0.40 per cent (Table 1). The available nitrogen content of the soils varied from 159 kg ha^{-1} to 307 kg ha^{-1} with a mean value of 248 kg ha^{-1}. The soils are low to medium in available nitrogen. The available phosphorus content of the soils varied from 68 kg ha^{-1} to 169 kg ha^{-1} with a mean value of 121 kg ha^{-1}. The soils are high in available phosphorus. The available potassium content of the soils varied from 217 kg ha^{-1} to 2088 kg ha^{-1} with a mean value of 671 kg ha^{-1}. The soils are medium to high in available potassium.

Dry matter production (g pot^{-1}) at 60 DAS as influenced by K levels

The data presented in table 2 indicated that mean dry matter production was significantly increased with increase in each level of potassium i.e., from 26.77 g pot^{-1} at 0 kg K_2O ha^{-1} to 48.77 g pot^{-1} at 90 kg K_2O ha^{-1}.The abundant increase over control to 30 kg K_2O ha^{-1} was observed and the increase was gradual with each increasing level of K fertilizer from 30 to 90 kg K_2O ha^{-1}. The increase in dry matter content at 90 kg K_2O ha^{-1}over control was 45 percent. The mean dry matter production of different villages ranged from 24.96 g pot^{-1} in Balapalapalli village to 56.34 g pot^{-1} in Srinagaram village, which have lowest and highest native soil K fertility respectively. Interaction effect on both K levels and soil K status was also significant. The results ranged from 9.63 g pot^{-1} in Balapalapalli village with native fertility to 64.48 g pot^{-1} at 90 kg K_2O ha^{-1} in Srinagaram village. The increase in dry matter with increasing levels of K application were reported by Srinivasa Rao and Takkar (1997) in sorghum crop, Rakesh Kumar *et al.,*(2004) and Asif iqbal *et al.,* (2015) in maize crop.

K content as influenced by K levels

The data presented in the table 3 indicated that graded levels of K application increased the K concentrations from 2.30 percent in control to 3.50 percent at 90 kg K_2O ha^{-1}. The increase in K content at 90 kg K_2O ha^{-1}over control was 34 percent. The increased K content with graded levels of potassium application was also reported by Srinivasa Rao and Takkar (1997) in sorghum crop, Rakesh Kumar *et al.,* (2004) and Asif iqbal*et al.,* (2015) in maize crop.

The mean K content of different villages ranged from 2.48 percent in Balapalapalli village to 3.94 percent in Srinagaram village, which have lowest and highest native K soil fertility respectively .Interaction effect of graded levels of potassium and K status were also significant. The results ranged from 1.35 per cent in Balapalapalli village with native K fertility (control) to 4.45 per cent in Srinagaram village at 90 kg K_2O ha^{-1}.Percent increase in K content at 90 kg K_2O ha^{-1} over control in Srinagaram soils was 21 percent where as in Balapalapalli soils was 59 percent. It indicates that soils having high initial K status show less response than soils having low initial K status. These results clearly indicated that even though, soils are having high initial K status external application is needed especially in high K requirement crops. Similar reports were given by Srinivasa Rao and Takkar (1997) and Srinivasa Rao, *et al*.,2007.

K uptake by rice crop as influenced by K levels and soil K status

The data presented in the table 4 indicated that mean K uptake was significantly increased with increase in each level of potassium and the values ranged from 0.64 g pot^{-1} to 1.72 g pot^{-1} for 0 to 90 kg K_2O ha^{-1} respectively. The response observed at 90 kg K_2O ha^{-1} was 60 percent over control. Singh, *et al*.,2010. Mean K uptake of different villages ranged from 0.70 g pot^{-1} in Balapalapalli soils to 2.25 g pot^{-1} in Srinagaram village soils. Which have lowest and highest native K soil fertility respectively. The K uptake ranged from 0.13 g pot^{-1} in soils of Balapalapalli with native K soil fertility to 2.87 g pot^{-1} in Srinagaram village at 90 kg K_2O ha^{-1}.

CONCLUSIONS

Dry matter, K content and K uptake were significantly increased with increase in each level of potassium from 0 kg K_2O ha^{-1} to 90 kg K_2O ha^{-1}.There was abundant increase in plant parameters from no K fertilizer application to 30 kg K_2O ha^{-1} and the increase was gradual with increase in each level of fertilizer from 30 to 90 kg K_2O ha^{-1}. All the above parameters showed significant difference with soil K status, K levels and their interaction. Percent increase in K content at 90 kg K_2O ha^{-1} over control in Srinagaram soil was 23 percent where as in Balapalapalli soils it was 53 percent. It indicates that soils having high intial K status show less response than soils having low intial K status. These results clearely indicated that even though, soils are having high intial K status external application is needed especially for high K requirement crop.

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Table 1. physico-chemical properties of experimental soils

S. No	Village Name	Gps coordinates	pH	EC (dS m^{-1})	$CaCO_3$ (%)	O.C (%)	Texture	Available N kg ha^{-1}	Available P_2O_5	Available K_2O
1	RARS,Nandyal	N:15⁰28.500 E:078⁰30.159	8.2	0.22	0.68	0.47	Clay	259	109	603
2	Battaluru	N:15⁰14.102 E:078⁰28.127	8.1	0.46	0.49	0.43	Silty loam	284	88	509
3	Nallagatla	N:15⁰13.219 E:078⁰30.157	7.9	0.20	2.27	0.44	Silty clay loam	246	105	490
4	Kaminenipalli	N:15⁰23.479 E:078⁰33.197	7.5	0.18	0.22	0.27	Loam	162.	82	220
5	Yerragudidinna	N:15⁰11.186 E:078⁰31.912	7.4	0.21	2.72	0.36	Silty clay loam	212	90	348
6	M.C. farm	N:15⁰25.577 E:078⁰22.563	7.3	0.32	1.58	0.46	Sandy loam	224	125	748
7	Srinagaram	N:15⁰27.141 E:078⁰33.734	8.3	0.68	0.22	0.44	Sandy clay loam	272	134	2088
8	Tamadapalli	N:15⁰28.524 E:078⁰32.900	8.1	0.27	0.22	0.55	Silty clay loam	307	125	906
9	Velpanuru	N:15⁰42.042 E:078⁰31.273	8.2	0.20	1.36	0.46	Sandy clay	289	129	951
10	Mahanandi	N:15⁰26.212 E:078⁰37.344	7.9	0.20	1.59	0.45	Silty clay loam	236	105	576
11	Nallakalva	N:15⁰52.568 E:078⁰41.425	7.2	0.17	2.04	0.34	Loam	209	106	351
12	M.C.farm	N:15⁰28.416 E:078⁰23.492	7.4	0.18	1.45	0.48	Sandy loam	292	126	874
13	Kanala	N:15⁰25.814 E:078⁰27.581	8.2	0.19	0.90	0.39	Silty clay loam	283	134	659
14	Bhemunipadu	N:15⁰23..332 E:078⁰31.676	8.4	0.55	2.07	0.33	Sandy clay loam	213	139	351
15	Bollavaram	N:15⁰27.512 E:078⁰24.421	7.9	0.30	2.32	0.41	Sandy clay	253	106	957

							loam			
16	Rythunagaram	N:15^{0}28.406 E:078^{0}32.475	7.3	0.57	0.45	0.43	Loam	290	142	994
17	Ayyavarikoduru	N:15^{0}31.234 E:078^{0}31.68	7.2	0.22	1.81	0.44	Sandy clay loam	221	156	552
18	Gajulapalli	N:15^{0}24.263 E:078^{0}38.046	7.5	0.10	2.12	0.41	Sandy clay loam	246	164	817
19	RARS,Nandyal	N:15^{0}28.150 E:078^{0}30.229	8.1	0.68	2.04	0.50	Silty clay loam	297	162	699
20	Venkateswarwpuram	N:15^{0}32.340 E:078^{0}22.563	8.3	0.69	1.68	0.51	Silty clay loam	242	169	970
21	Neravada	N:15^{0}33.752 E:078^{0}24.793	8.0	0.17	1.13	0.48	Silty loam	302	136	563
22	Balapanuru	N:15^{0}29.918 E:078^{0}20.197	8.2	0.26	1.81	0.47	Silty clay loam	251	129	874
23	Kouluru	N:15^{0}33.334 E:078^{0}25.194	8.0	0.21	0.90	0.53	Silty clay loam	291	128	1273
24	Boyirevula	N:15^{0}41.097 E:078^{0}33.616	7.8	0.31	0.18	0.34	Sandy clay loam	224	95	314
25	M.C.farm	N:15^{0}53.121 E:078^{0}33.374	7.4	0.11.	0.45	0.27	Sandy loam	261	127	539
26	Shankarapalli	N:15^{0}52.672 E:077^{0}62.472	7.1	0.19	0.90	0.27	Sandy loam	201	112	544
27	Muddaram	N:15^{0}53.451 E:077^{0}66.537	7.2	0.14	0.22	0.21	Sandy loam	159	68	190
28	Balapuram	N:15^{0}54.326 E:077^{0}63.612	7.1	0.26	5.21	0.42	Loam	245	113	807
29	Balapalapalli	N:15^{0}55.251 E:077^{0}71.691	7.2	0.66	0.22	0.34	Sandy loam	188	111	154
30	Yembavi	N:15^{0}48.780 E:078^{0}21.420	6.9	0.10	2.72	0.24	Sandy loam	281	128	217
Mean				**0.31**	**2.13**	**0.40**		**248**	**121**	**671**

Table 2. Dry matter production (g pot^{-1}) as influenced by graded levels of potassium

S.NO	Village Name	K Levels (kg K_2O ha^{-1})				MEAN
		0 (T1)	30 (T2)	60 (T3)	90 (T4)	
1	RARS,Nandyal	28.91	39.86	46.60	52.48	**41.96**
2	Battaluru	27.86	38.53	45.48	50.68	**40.63**
3	Nallagatla	25.98	35.19	42.16	46.53	**37.46**
4	Kaminenipalli	11.74	23.68	33.48	40.66	**27.39**
5	Yerragudidinna	23.99	33.66	40.66	45.47	**35.94**
6	M.C. farm	32.07	39.71	47.15	51.37	**42.57**
7	Srinagaram	44.26	55.66	60.96	64.48	**56.34**
8	Tamadapalli	34.89	42.62	49.22	53.67	**45.10**
9	Velpanuru	35.98	43.56	49.47	53.57	**45.64**
10	Mahanandi	25.05	33.67	40.60	45.87	**36.29**
11	Nallakalva	21.76	33.65	40.75	45.4	**35.39**
12	M.C.farm	33.35	41.47	47.56	52.47	**43.71**
13	Kanala	26.77	36.76	43.59	49.19	**39.07**
14	Bhemunipadu	18.37	31.56	38.55	44.37	**33.21**
15	Rythunagaram	33.36	41.55	47.48	52.68	**43.76**
16	Bollavaram	36.06	42.55	48.05	52.6	**44.81**
17	Ayyavarikoduru	23.19	33.80	40.89	45.83	**35.92**
18	Gajulapalli	29.47	38.15	44.63	48.17	**40.10**
19	RARS,Nandyal	28.42	39.50	45.47	50.58	**40.99**
20	Venkateswarwpuram	32.37	41.45	47.55	52.55	**43.48**
21	Neravada	24.99	36.58	43.67	48.81	**38.51**
22	Balapanuru	31.36	40.47	46.56	51.87	**42.56**
23	Kouluru	38.16	45.87	50.93	55.20	**47.54**
24	Boyirevula	14.37	29.36	38.36	44.55	**37.42**
25	M.C.farm	22.84	36.66	43.50	48.66	**37.91**
26	Shankarapalli	24.80	35.85	42.40	47.40	**37.61**

27	Muddaram	10.52	21.54	31.65	38.06	**25.44**
28	Balapuram	28.93	40.36	46.45	52.20	**41.98**
29	Balapalapalli	9.63	21.45	31.46	37.33	**24.96**
30	Yembavi	11.17	24.76	34.80	40.45	**27.79**
	Mean	**26.77**	**36.65**	**43.67**	**48.77**	

CD at 5% level of significance

	CD	SE(d)	SE(m)
Factor (A) K levels	**0.71**	**0.35**	**0.25**
Factor (B) villages/soil K status	**2.76**	**1.38**	**0.97**
Factor (A x B)	**3.91**	**1.95**	**1.38**

Table 3 K content (g pot^{-1}) in plant as influenced by graded levels of potassium

S.No	Village Name	K Levels (kg K_2O ha^{-1})				MEAN
		0 (T1)	30 (T2)	60 (T3)	90 (T4)	
1	RARS,Nandyal	2.20	2.43	2.93	3.21	**2.69**
2	Battaluru	2.03	2.27	2.78	3.10	**2.55**
3	Nallagatla	2.08	2.31	2.83	3.08	**2.58**
4	Kaminenipalli	1.45	2.17	2.93	3.20	**2.44**
5	Yerragudidinna	1.95	2.45	2.93	3.20	**2.63**
6	M.C. farm	2.59	2.56	3.06	3.29	**2.88**
7	Srinagaram	3.50	3.75	4.07	4.45	**3.94**
8	Tamadapalli	2.70	2.71	3.21	3.40	**3.01**
9	Velpanuru	3.25	3.40	4.00	4.20	**3.71**
10	Mahanandi	2.35	2.57	3.11	3.20	**2.81**
11	Nallakalva	1.91	2.41	3.20	3.40	**2.73**
12	M.C.farm	2.70	2.61	3.47	3.65	**3.11**
13	Kanala	2.46	2.71	3.46	3.62	**3.06**
14	Bhemunipadu	1.73	2.23	3.00	3.21	**2.54**
15	Rythunagaram	3.21	3.41	3.81	4.06	**3.62**
16	Bollavaram	3.20	3.30	4.10	4.25	**3.71**
17	Ayyavarikoduru	2.03	2.25	3.03	3.26	**2.64**
18	Gajulapalli	2.33	2.61	3.00	3.48	**2.86**
19	RARS,Nandyal	2.35	2.71	3.23	3.46	**2.94**
20	Venkateswarwpuram	2.95	3.45	3.01	3.75	**3.29**
21	Neravada	2.26	2.76	3.22	3.36	**2.90**
22	Balapanuru	2.45	2.66	3.41	3.76	**3.07**
23	Kouluru	2.75	3.02	3.51	3.83	**3.28**
24	Boyirevula	1.71	2.45	3.18	3.47	**2.70**
25	M.C.farm	2.15	2.38	3.06	3.34	**2.73**
26	Shankarapalli	2.24	2.42	2.97	3.21	**2.71**
27	Muddaram	1.41	2.15	2.91	3.35	**2.46**
28	Balapuram	2.40	2.65	3.23	3.58	**2.97**
29	Balapalapalli	1.35	2.11	3.12	3.32	**2.48**
30	Yembavi	1.40	2.17	3.16	3.40	**2.53**
	Mean	**2.30**	**2.64**	**3.23**	**3.50**	

CD at 5% level of significance

	CD	SE(d)	SE(m)
Factor (A) K levels	**0.04**	**0.02**	**0.01**
Factor (B) villages/soil K status	**0.18**	**0.09**	**0.06**
Factor (A x B)	**0.26**	**0.13**	**0.09**

Table 4 K uptake (g pot^{-1}) in plant as influenced by graded levels of potassium

S.NO	Village Name	K Levels (kg K_2O ha^{-1})				MEAN
		0 (T1)	30 (T2)	60 (T3)	90 (T4)	
1	RARS,Nandyal	0.64	0.97	1.37	1.68	**1.16**
2	Battaluru	0.57	0.87	1.26	1.57	**1.07**
3	Nallagatla	0.54	0.81	1.19	1.43	**0.99**
4	Kaminenipalli	0.17	0.51	0.98	1.30	**0.74**

5	Yerragudidinna	0.47	0.82	1.19	1.46	**0.98**
6	M.C. farm ,rice	0.83	1.02	1.44	1.69	**1.25**
7	Srinagaram	1.55	2.09	2.48	2.87	**2.25**
8	Tamadapalli	0.94	1.16	1.58	1.82	**1.38**
9	Velpanuru	1.17	1.48	1.98	2.25	**1.72**
10	Mahanandi	0.59	0.87	1.26	1.47	**1.05**
11	Nallakalva	0.42	0.81	1.30	1.54	**1.02**
12	M.C.farm, maize	0.90	1.08	1.65	1.92	**1.39**
13	Kanala	0.66	1.00	1.51	1.78	**1.24**
14	Bhemunipadu	0.32	0.70	1.16	1.42	**0.90**
15	Rythunagaram	1.07	1.42	1.81	2.14	**1.61**
16	Bollavaram	1.15	1.40	1.97	2.24	**1.69**
17	Ayyavarikoduru	0.47	0.76	1.24	1.49	**0.99**
18	Gajulapalli	0.69	1.00	1.34	1.68	**1.17**
19	RARS,Nandyal	0.67	1.07	1.47	1.75	**1.24**
20	Venkateswarwpuram	0.95	1.43	1.43	1.97	**1.45**
21	Neravada	0.56	1.01	1.41	1.64	**1.16**
22	Balapanuru	0.77	1.08	1.59	1.95	**1.35**
23	Kouluru	1.05	1.39	1.79	2.11	**1.58**
24	Boyirevula	0.02	0.72	1.22	1.55	**0.88**
25	M.C.farm	0.49	0.87	1.33	1.63	**1.08**
26	Shankarapalli	0.56	0.87	1.26	1.52	**1.05**
27	Muddaram	0.15	0.46	0.92	1.28	**0.70**
28	Balapuram	0.69	1.07	1.50	1.87	**1.28**
29	Balapalapalli	0.13	0.45	0.98	1.24	**0.70**
30	Yembavi	0.16	0.54	1.10	1.38	**0.79**
Mean		**0.64**	**0.99**	**1.42**	**1.72**	

CD at 5% level of significance

	CD	SE(d)	SE(m)
Factor (A) K levels	**0.035**	**0.017**	**0.026**
Factor (B) villages/soil K status	**0.138**	**0.062**	**0.040**
Factor (A x B)	**0.196**	**0.09**	**0.06**

CITATION OF THIS ARTICLE

I.Rajeevana, P.Kavitha, M .Sreenivasa Chari and M.Sreenivasa Reddy. Concentration and Uptake of Potassium by Maize *(Zea mays* L.) in Soils of Kurnool District of A.P. Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue 2, 2017: 189-194