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Potassium fertilization to summer groundnut in medium black calcareous soil

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Abstract
A field experiment was conducted during three summer season (2011 to 2013) at Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, to study the effect of potassium fertilization on yield, quality and nutrients uptake by summer groundnut. The experiment was laid out in randomized block design with seven treatments comprising of three levels of potassium *viz*; 25, 50 and 75 kg ha^{-1} each as basal and in two split (1/2 at sowing and 1/2 at 30 days after sowing) along with control (No potassium). The average higher pod (2505 kg ha^{-1}) and haulm (4479 kg ha^{-1}) yield were recorded with application of 75 kg K_2O ha^{-1} in two split. Increase in groundnut pod yield to the tune of 23.6 percent over control. The higher shelling percentage, oil content and HPS count were recorded with potassium application of 50 kg K_2O ha^{-1} as basal. Significantly higher uptake of N and K by pod and haulm and S by haulm were recorded with application of 75 kg K_2O ha^{-1} in two split while, P uptake by pod and haulm and S uptake by haulm were recorded with application of 50 kg K_2O ha^{-1} in two split.

Keywords: Summer groundnut, Potassium levels, yields, nutrients content and uptakes

Introduction
India is the second largest producer of groundnuts after China. Groundnut ranks first in the production among major oilseeds of India accounting for 42 per cent of the oilseeds production in the country during 2014-15. Gujarat is the largest producer contributing 25 per cent of the total production of groundnut followed by Andhra Pradesh, Tamil Nadu and Karnataka (Sameer *et al*, 2014) [19]. Groundnut is growing mainly as *kharif* crop under rain fed conditions. Nowadays, area under summer groundnut cultivation is increasing due to increase in irrigation facilities and higher yield production. Gujarat stands first production in India. About 85 per cent of this contribution comes from the five districts of Saurashtra region. Therefore, the Saurashtra region is regarded as oil bowl of the State. However, the productivity of groundnut is just 1200 kg/ha in the state, the reasons are many. But the vital factor is continuous monocropping of groundnut since last 60 years. It caused multi-nutritional disorders in the soils (Golakiya and Patel, 1996) [5]. Inadequate and improper fertilizer application is one of the reasons for its low productivity. In fact, balanced fertilizer use is essential not only for increasing the production of summer groundnut but even for maintaining the present production levels. This is realized when it is evident that an average crop of groundnut removes about 112 kg N, 20 kg P_2O_5 and 84 kg K_2O from one hectare. The soil with high free lime content on exchange complex predominantly occupied with calcium may need high dose of potassium for better crop response (Golakiya, 1999) [5]. Potassium deficiency manifests stunted growth with drying up of leaf margins in the crop. Its main function is to promote the formation of oil. Potassium ion (K^+) is also crucial from physiological point of view in case of water uptake and transport. Keeping this in view, a field experiment was conducted to study the effect various levels of potassium on yield of summer groundnut under medium black calcareous soils of Saurashtra Region of Gujarat.

Materials and Methods
A field experiments were conducted in three consecutive summer seasons of 2011, 2012 and 2013 at main Oilseeds Research Station, (Latitide 21.30' N, longitude 70.26' E and altitude 61m) Junagadh Agricultural University, Junagadh, Gujarat, India. The experiment was laid out in randomized block design with four replications.

The characteristics of the experimental soils was clayey in texture had organic carbon 4.9 g kg^{-1}, available nitrogen 247 kg ha^{-1}, available phosphorus 55 kg ha^{-1}, available potassium 235 kg ha^{-1}, sulfur 19 mg kg^{-1} and $CaCO_3$ 35% with pH 7.8. and $EC_{2.5}$ 0.32 dS m^{-1}.The experiment comprising seven treatments of three levels of potassium *viz*; 25, 50 and 75 kg ha^{-1} each as basal and in two split (1/2 at sowing and 1/2 at 30 days after sowing) along with control (No potassium). Groundnut kernels (var. GG 6) at the rate of 100 kg ha^{-1} were sown in row with spacing of 45 cm x 10 cm and all the recommended package of practices were followed. All three years groundnut crop was sown on 4th week of January and harvested in last week of May. The recommended dose of fertilizer (25.0:50.0:0; N: P_2O_5: K_2O) were commonly applied in all the plots. The nitrogen and phosphorus was applied through urea and diammonium phosphate (DAP) and treatments wise potassium were applied through muriate of potash (KCl). The crop was harvested as its full maturity stage and pod and haulm samples were collected from each plot, oven dry at 60 ºC to constant weight and ground to pass through a 0.5 mm sieve for chemical analysis. The nitrogen content was determined by the micro Kjeldahls method as described by A.O.A.C (1965) [1]. The phosphorus determined by Vanadomolybdo phosphoric yellow colour method as described by Jackson (1973) [8], potassium by Flame Photometer as described by Jackson (1973) [8] and sulphur content as per the method developed by Williams and Steinbergs (1959) [25], after wet digestion of plant tissues with HNO_3:$HClO_4$ (3:1) di-acid (Jeckson, 1973) [8]. While, the soils samples were analyzed for available nitrogen by micro-Kjeldahl's methods (Subbaiah, and Asija, 1956) [24], phosphorus by Olsen method (Olsen *et al*., 1954) [12], potassium by flame photometer (Jackson, 1973) [8] and sulphur by turbidity method (Chaudhary & Cornfield, 1966) [2]. The data were subjected to statistical analysis by adopting appropriate analysis of variance as described by Panse and Sukhatme (1967) [13].

Results and Discussion

Yield and quality parameter

The data presented in Table-1 indicated that the pod and haulm yield of summer groundnut was significantly influenced by different potassium treatments in pooled results. The average higher pod (2505 kg ha^{-1}) and haulm (4479 kg ha^{-1}) yield were recorded with application of 75 kg K_2O ha^{-1} in two split, followed by treatment 50 kg K_2O ha^{-1} in two split. The application of potassium 75 kg ha^{-1} (in two split) increase the groundnut pod yield by 23.6 percent over control. The significant increase in yield could be attributed to better growth and development attained by the crop due to application of potassium, known to be potassium involved in photosynthesis, protein metabolism and energy transfer reactions. The beneficial effect of potassium on the yields might be attributed to its important role plays in many enzymatic systems, photosynthesis, and synthesis of proteins and carbohydrates (Marschner, 1995) [10]. Moreover, K enhances translocation from leaves to capsules and seeds. The response of K_2O up to 40-75 kg K_2O ha^{-1} for summer groundnut under irrigated condition has also been reported by Singh *et al*. (2004) [23]. Deshmukh *et al*. (1992) [3] reported that pod of summer groundnut were significantly increased with the split application of potassium (75 per cent of K at sowing and 25 per cent at flowering stage). Similar results were also observed by Sakarvadia and Yadav (1994) [14], Singh (2007) [22], Hadwani and Gundalia (2005) [7], Meena *et al.* (2018) [11] and Sakarvadia *et al.* (2019) [16] in groundnut. As far as quality parameters concern, the application of potassium significantly influenced the quality parameters of groundnut (Table-2).The significantly higher shelling percentage (73.92), oil content (47.49%) and HPS count (84.60) were recorded with application of 50 kg K_2O ha^{-1} as basal, follow by treatment 50 kg K_2O ha^{-1} in two split. It could be due to potassium play important role in carbohydrate metabolism, synthesis of proteins and oil. Similar results were also reported by Sanadi, *et al.* (2018) [20] and Sakarvadia *et al.* (2019) [16].

Table 1: Effect of potassium on yield of summer groundnut

Treatments	Yield (kg ha^{-1})							
	Pod				Haulm			
	2011	2012	2013	Pooled	2011	2012	2013	Pooled
T_1 - Control	1939	1872	2267	2026	3472	3472	4375	3773
T_2 - K_{25} Basal	2191	2163	2351	2235	4271	3785	4965	4340
T_3 - K_{50} Basal	2382	2222	2575	2393	4236	3889	5035	4387
T_4 - K_{75} Basal	2250	2252	2618	2373	4132	3924	5104	4387
T_5 - K_{25} (Two split)	2163	2233	2340	2245	4167	3958	5139	4421
T_6 - K_{50} (Two split)	2364	2350	2618	2444	4236	3959	5208	4468
T_7 - K_{75} (Two split)	2452	2387	2677	2505	4167	4028	5243	4479
S.Em.±	103	97	99	58	161	173	178	99
C.D.(P=0.05)	306	287	295	163	479	NS	529	280

Table 2: Effect potassium on quality parameter of summer groundnut

Treatment	Quality parameters		
	Shelling (%)	Oil (%)	HPS Count
T_1 - Control	71.80	46.60	86.50
T_2 - K_{25} Basal	72.86	47.48	83.47
T_3 - K_{50} Basal	73.92	47.79	84.60
T_4 - K_{75} Basal	73.25	47.68	83.40
T_5 - K_{25} (Two split)	73.35	47.39	82.76
T_6 - K_{50} (Two split)	73.50	47.76	84.28
T_7 - K_{75} (Two split)	72.72	47.50	82.29
S.Em.±	0.313	0.161	0.81
C.D. at 5%	0.888	0.456	2.29

Nutrients content and uptake

The data presented in Table-3&4 revealed that N, P, K and S content and uptake by pod and haulm of groundnut was significantly influenced by different potassium treatments, except N and S content in haulm. Significantly higher N, P, K and S (4.06, 0.324, 0.613 and 0.188%) content in pod and N and K (2.18 and 0.639%) content in haulm were recorded with application of 75 kg K_2O ha^{-1} as basal, respectively (Table-3). While, significantly higher uptake of N (101.8 and 97.79 kg ha^{-1}) and K (14.58 and 28.53 kg ha^{-1}) by pod and haulm, respectively and S (4.64 kg ha^{-1}) by haulm were recorded with application of 75 kg K_2O ha^{-1} in two split while, P (7.66 and 6.75 kg ha^{-1}) uptake by pod and haulm, respectively and S (9.90 kg ha^{-1}) uptake by haulm were recorded with application of 50 kg K_2O ha^{-1} in two split. This means that the potassium fertilizer may enhance plant utilization of nutrients which was reflected in a good growth and biological yield. Dutta *et al*. (2003) [4] reported that potassium content in kernel and haulm was significantly increased by increased potassium application and the highest was observed at 50 kg K_2O ha^{-1}. Uptake of N, P and K by kernel and haulm were significantly increased with the increased levels of potassium fertilization (Salve and Gunjal, 2011) [18]. These results are akin to those reported by Shahid *et al.* (2002) [21], Sakarvadia *et al.* (2010) [15], Salve *et al.* (2010) [17] and Sakarvadia *et al.* (2019) [16] in groundnut crop.

Table 3: Effect potassium on nutrients content in groundnut

Treatment	Nutrient content in groundnut (%)							
	Pod				Haulm			
	N	P	K	S	N	P	K	S
T_1 - Control	3.87	0.296	0.544	0.167	1.94	0.145	0.513	0.213
T_2 - K_{25} Basal	3.87	0.314	0.575	0.169	2.07	0.138	0.574	0.219
T_3 - K_{50} Basal	3.99	0.316	0.598	0.175	2.08	0.147	0.614	0.219
T_4 - K_{75} Basal	4.06	0.324	0.613	0.188	2.18	0.144	0.639	0.222
T_5 - K_{25} (Two split)	3.97	0.309	0.570	0.175	2.09	0.144	0.567	0.219
T_6 - K_{50} (Two split)	4.03	0.314	0.595	0.185	2.08	0.150	0.634	0.221
T_7 - K_{75} (Two split)	4.04	0.315	0.580	0.185	2.18	0.144	0.638	0.217
S.Em.±	0.04	0.005	0.011	0.003	0.03	0.004	0.008	0.004
C.D. at 5%	0.11	0.014	0.035	0.008	0.11	NS	0.023	NS

Table 4: Effect potassium on nutrients uptake by groundnut

Treatment	Nutrient uptake by groundnut (kg ha^{-1})							
	Pod				Haulm			
	N	P	K	S	N	P	K	S
T_1 - Control	78.3	6.14	11.02	3.39	73.48	5.50	19.40	8.01
T_2 - K_{25} Basal	86.6	7.25	12.86	3.78	90.01	6.03	25.11	9.56
T_3 - K_{50} Basal	95.5	7.58	14.29	4.19	91.63	6.47	27.10	9.56
T_4 - K_{75} Basal	95.6	7.44	14.57	4.47	92.93	6.35	28.00	9.72
T_5 - K_{25} (Two split)	89.2	6.94	12.83	3.95	92.82	6.37	25.11	9.73
T_6 - K_{50} (Two split)	98.6	7.66	14.54	4.54	93.11	6.75	28.42	9.90
T_7 - K_{75} (Two split)	101.8	7.43	14.58	4.64	97.79	6.45	28.53	9.77
S.Em.±	2.34	0.21	0.35	0.112	2.31	0.208	0.70	0.231
C.D. at 5%	6.65	0.61	1.00	0.317	6.56	0.591	1.99	0.656

Conclusion

Based on the three years study it may be concluded that the application of potassium 50 kg ha^{-1} either basal or in two split beneficial for enhancement of pod yield as well as quality of summer groundnut.

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