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Effect of FYM and potassium on yield and nutrient uptake by *kharif* groundnut grown in loamy sand

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Abstract
A field experiment was conducted at Castor Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the *kharif*, 2019 to investigate the effect of FYM and potassium on growth, yield attributes and yield, nutrient uptake by *kharif* groundnut in loamy sand. The soil of the experimental area was loamy sand in texture having pH value 7.2, with low organic carbon and nitrogen content while medium in available phosphorus and potassium. The treatment comprised of two levels of FYM (0 and 5 t ha^{-1}), three levels of potassium (20, 40 and 60 kg ha^{-1}) and two levels of KMB (with and without) was laid out in randomized block design with factorial concept with three replication using variety 'TG 37 A' as a test crop. Application of FYM @ 5 t ha^{-1} recorded significantly higher number of root nodules $plant^{-1}$, number pods $plant^{-1}$, pod weight $plant^{-1}$, pod and haulm yields, seed index, harvest index as well as shelling percentage, higher uptake of nitrogen, phosphorus and potassium by kernel and haulm, maximum gross and net realizations.
As potassium application increase, there was progressive and significant increase in number of nodules $plant^{-1}$, number of pods $plant^{-1}$, pod weight $plant^{-1}$, pod and haulm yields and seed index, uptake of nitrogen, phosphorus and potassium by kernel and haulm, highest gross and net realizations as well as benefit: cost ratio (BCR) with 60 kg K_2O ha^{-1}.
Application of KMB showed marked increase with KMB turned out superior with respect to number of root nodules $plant^{-1}$, pod and haulm yields, seed index as well as uptake of nitrogen and potassium by kernel and by haulm. Maximum gross and net realizations as well as benefit: cost ratio with KMB.

Keywords: Groundnut, growth, yield, uptake, FYM, potassium, KMB

Introduction
Oilseed crops have a specific position in Indian agriculture because edible oil is next to food grain in the Indian diet. The major edible oilseeds produced in different parts of India are groundnut, rapeseed, mustard, soybean, sunflower, safflower, sesame and niger. Out of these crops groundnut is good source of oil and protein, thus groundnut is considered as "king of oilseed crop" (Sathya Priya *et al.,* 2013) [8]. Groundnut (*Arachis hypogea* L.) is the premier oilseed crop of India and originated from Latin America and was introduced into West Africa by Portuguese in the 16th Century (Taru *et al.,* 2008) [9]. The crop has its own importance due to high edible oil and nutritional value of kernel as human food and haulm as rich feed for animals. Thus, it is an important food, fodder and cash crop for the farmers of India. Gujarat is the largest producing state accounting for 40 per cent of total groundnut produced in the country. Groundnut production and productivity of Gujarat were 4.50 MT and 2764.19 kg ha^{-1} respectively, during the *kharif*, 2019-20 (DOA, Gujarat). Groundnut being a legume improves residual fertility which in turn helps succeeding crop. Hence, incorporation of organic manures such as FYM in this experiment as it considered a good source of nutrients and low C: N ratio for quick decomposition. The application of FYM increase the growth, yield and quality as well as additional return and net benefit (Hargilas, 2018) [4]. Potassium is considered one of the primary nutrients responsible for quality of crop and ionic balance. It is considered a key element which can directly improve the income of farmers just by improving the quality of produce. Besides the quality of produce, potassium also imparts pest and disease resistance in the field crops (Hallock and Garren, 1968) [3]. Commercial use of Potassium Mobilizing Bacteria (KMB) is new in to agriculture. Farmers of North Gujarat use KMB in high K requiring crop like potato, which is responsive to KMB application.

Material and Methods
The field experiment was conducted during *kharif*, 2019 at Castor Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District Banaskantha (Gujarat).

The treatments comprised of two levels of FYM (F_1: 0 t ha^{-1} and F_2: 5 t ha^{-1}), three levels of potassium (K_1: 20 kg K_2O ha^{-1}, K_2: 40 kg K_2O ha^{-1} and K_3: 60 kg K_2O ha^{-1}) and two levels of KMB (B_1: With and B_2: Without) was laid out in randomized block design with factorial concept with three replication. Groundnut variety TG 37 A was used as a test crop. The soil of the experimental area was loamy sand in texture having pH value 7.2, which was low organic carbon (0.15 %) and nitrogen (140 kg ha^{-1}), while it was medium in available phosphorus (43.5 kg ha^{-1}) and potassium (172 kg ha^{-1}). As per treatment FYM and potassium were applied along with seed treatment of KMB. Urea and DAP was applied as a basal doses, inoculation of seeds with PSB and *Rhizobium.* In data observations growth, yield attributes and yield, soil properties as well as nutrient uptake was recorded at harvest, number of nodules recorded at 45 DAS. The obtained data were statistically analyzed using standard procedure suggested by Panse and Sukhtame (1967) [6] for the design of experiment.

Results and Discussion

Effect of FYM

Results indicated that growth parameters *viz.*, plant population and plant height at harvest was not affected by FYM application but number of nodules $plant^{-1}$(70.5) was significantly positive influenced by FYM application with 5 t ha^{-1}compared to 0 t ha^{-1}. All the yield attributes and yield *viz.*, number of pods $plant^{-1}$(26.58), pod weight $plant^{-1}$ (18.40 g), pod (2877 kg ha^{-1}) and haulm yields (4576 kg ha^{-1}), seed index (41.67 g), harvest index (38.57 %) and shelling percentage (73.35 %) were recorded significantly @ 5 t FYM ha^{-1} (F_2) over no application of FYM (F_1). However, number of unfilled pods $plant^{-1}$(2.69) significantly higher with treatment F_1 (0 t FYM ha^{-1}). Uptake N (71.57 kg ha^{-1}), P (9.64 kg ha^{-1}), K (12.99 kg ha^{-1}) by kernels and N (68.40 kg ha^{-1}), P (9.17 kg ha^{-1}), K (30.28 kg ha^{-1}) by haulm of *kharif* groundnut crop was significantly affected on application of FYM @ 5 t ha^{-1}(F_2) than 0 t ha^{-1}(F_1). There was marginal increase in gross and net realizations with the application of 5 t FYM ha^{-1} over 0 t FYM ha^{-1}. Maximum gross realizations of 1,55,946 Rs ha^{-1}, net realizations of 1,03,803 Rs ha^{-1} was obtained by application of 5 t FYM ha^{-1} (F_2). It was closely followed by 0 t FYM ha^{-1} with gross realization 1,31,811Rs ha^{-1}, net realizations of 89,667 Rs ha^{-1}. While, maximum benefit: cost ratio (BCR) 3.13 recorded with 0 t FYM ha^{-1} (F_1). The organic acids produced from decomposition of organic matter might be responsible for quick release of nutrients from native pool, result in greater availability on nutrients to growing plants and increase nutrient uptake by crop. The results are in line with those reported by Jat and Ahalawat (2010) [5] and Vishwakarma *et al*. (2012) [10].

Effect of potassium

As potassium application increase there was progressive and significant increase in most of growth and yield attributes and yield, and uptake by crop. Plant height and plant population were non significantly affected. Whereas, number of nodules $plant^{-1}$ (69.52), number of pods $plant^{-1}$ (26.17), pod weight $plant^{-1}$ (18.20g), pod (2737 kg ha^{-1}) and haulm yields (4529 kg ha^{-1}) and seed index (41.63 g) significantly increased with higher level of potassium application. While, 40 and 60 kg k_2O ha^{-1} being on par. Moreover, number of unfilled pods $plant^{-1}$ (2.67) significantly higher with treatment K_1 (20 K_2O ha^{-1}). However, harvest index and shelling percent remained unaffected with potassium application. Among three levels, K_3 level (60 kg K_2O ha^{-1}) recorded significantly higher uptake of N(66.30 kg ha^{-1}), P (9.03 kg ha^{-1}), K (11.99 kg ha^{-1}) by kernel and N (67.59 kg ha^{-1}), P (8.62 kg ha^{-1}), K (29.80 kg ha^{-1}) by haulm than lower levels of potassium and it was significantly at par with 40 kg K_2O ha^{-1} (K_2). With application of 60 kg K_2O ha^{-1} highest gross (1, 49, 226 ` $ha^{-1}$) and net realizations (1, 05, 883 ` ha^{-1}) as well as benefit: cost ratio (BCR) (3.44). The improvement in the yield attributing characters and yield might be due to the fact that potassium acts as catalytic agent in activating a number of enzymes and synthesis to peptide bonds. Potassium plays a crucial role in meristematic growth through its effect on the synthesis of phyto hormones. The results similarly with those of Chandra *et al.* (2006) [2] and Reddy *et al.* (2011) [7].

Effect of KMB

Growth parameters *i.e.*, plant population, plant height, plant population, plant height, no. of pods $plant^{-1}$, pod weight $plant^{-1}$, no. of unfilled pods $plant^{-1}$ observed non significant. However, number of nodules $plant^{-1}$ (68.23) recorded significant with inoculation of KMB. Seed treatment of KMB influenced significantly on pod (2729 kg ha^{-1}) and haulm (4473 kg ha^{-1}) yields attributing characters along with seed index (41.65 g). While yield of groundnut positively affected with KMB as seed inoculation. Uptake of N (64.64 kg ha^{-1}) and K (11.28 kg ha^{-1}) in kernel and uptake of N (65.55 kg ha^{-1}) and K (28.75 kg ha^{-1}) by haulm increased significantly with KMB inoculation of seeds. However, phosphorus uptake by crop non significantly affected. As compared to B_2 (without KMB) maximum gross (1, 48, 576 ` $ha^{-1}$) and net realizations (1, 06, 360 ` ha^{-1}) as well as benefit: cost ratio (BCR) (3.52) with inoculation of KMB (B_1). Cumulative effect of improvement in yield attributing characters under KMB treated plot might have contributed for the increase in the total yield of crop. This results in conformity with those reported by Badoni *et al*. (2017) [1].

Table 1: Effect of levels of FYM, potassium and KMB on plant population at harvest, plant height (cm) of harvest, number of nodules plant^{-1} at 45DAS, number of pods plant^{-1}, Pod weight plant^{-1} (g), Number of unfilled pods plant^{-1} by *kharif* groundnut.

Treatments	Plant population at harvest	Plant height (cm) at harvest	Number of nodules plant^{-1} at 45 DAS	Number of pods plant^{-1}	Pod weight plant^{-1} (g)	Number of unfilled pods plant^{-1}
Level of FYM						
F_1 (0 t ha^{-1})	247	47.8	62.1	23.47	16.00	2.69
F_2 (5 t ha^{-1})	251	49.9	70.5	26.58	18.40	2.10
S.Em. ±	2.86	0.91	1.3	0.42	0.32	0.06
CD at 5%	NS	NS	3.8	1.23	0.92	0.18
Level of potassium						
K_1 (20 kg ha^{-1})	247	48.1	62.5	23.75	15.94	2.67
K_2 (40 kg ha^{-1})	249	48.9	67.0	25.16	17.46	2.34
K_3 (60 kg ha^{-1})	250	49.5	69.5	26.17	18.20	2.19
S.Em. ±	3.50	1.12	1.6	0.52	0.39	0.07
CD at 5%	NS	NS	4.6	1.51	1.13	0.22
Level of KMB						
B_1 (With)	249	49.1	68.2	25.52	17.53	2.49
B_2 (Without)	248	48.5	64.4	24.54	16.87	2.31
S.Em. ±	2.86	0.91	1.3	0.42	0.32	0.06
CD at 5%	NS	NS	3.8	NS	NS	NS

Table 2: Effect of levels of FYM, potassium and KMB on Pod yield (kg ha^{-1}), Haulm yield (kg ha^{-1}), Seed index (g), Harvest Index (%) and Shelling (%) of *kharif* groundnut.

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Seed index (g)	Harvest Index (%)	Shelling (%)
Level of FYM					
F_1 (0 t ha^{-1})	2401	4156	40.39	36.57	67.94
F_2 (5 t ha^{-1})	2877	4576	41.67	38.57	73.35
S.Em. ±	53.92	60.47	0.32	0.53	0.83
CD at 5%	158	177	0.93	1.56	2.44
Level of potassium					
K_1 (20 kg ha^{-1})	2501	4211	40.05	37.19	69.04
K_2 (40 kg ha^{-1})	2678	4360	41.40	37.98	70.77
K_3 (60 kg ha^{-1})	2737	4529	41.63	37.54	72.14
S.Em. ±	66.04	74.06	0.39	0.65	1.02
CD at 5%	194	217	1.13	NS	NS
Level of KMB					
B_1 (With)	2729	4473	41.65	37.80	70.96
B_2 (Without)	2549	4260	40.40	37.33	70.33
S.Em. ±	53.92	60.47	0.32	0.53	0.83
CD at 5%	158	177	0.93	NS	NS

Table 3: Effect of levels of FYM, potassium and KMB on nitrogen, phosphorus and potassium uptake (kg ha^{-1}) by kernel and haulm of *kharif* groundnut

Treatments	Nutrient uptake by kernel (kg ha^{-1})			Nutrient uptake by haulm (kg ha^{-1})		
	N	P	K	N	P	K
Levels of FYM						
F_1 (0 t ha^{-1})	51.91	6.95	8.46	58.46	7.25	25.08
F_2 (5 t ha^{-1})	71.57	9.64	12.99	68.40	9.17	30.28
S.Em. ±	1.51	0.24	0.32	0.93	0.14	0.49
CD at 5%	4.42	0.70	0.93	2.72	0.42	1.44
Level of potassium						
K_1 (20 kg ha^{-1})	56.08	7.35	9.28	59.26	7.84	25.36
K_2 (40 kg ha^{-1})	62.84	8.50	10.89	63.44	8.17	27.87
K_3 (60 kg ha^{-1})	66.30	9.03	11.99	67.59	8.62	29.80
S.Em. ±	1.85	0.29	0.39	1.14	0.18	0.60
CD at 5%	5.42	0.86	1.14	3.34	0.52	1.77
Levels of KMB						
B_1 (With)	64.64	8.56	11.28	65.55	8.38	28.75
B_2 (Without)	58.83	8.03	10.16	61.31	8.04	26.61
S.Em. ±	1.51	0.24	0.32	0.93	0.14	0.49
CD at 5%	4.42	NS	0.93	2.72	NS	1.44

Table 4: Economics of different treatments

Treatment	Yield (kg/ha)		Gross realization (₹/ha)	Fixed cost (₹/ha)	Variable Cost (₹/ha)	Total cost (₹/ha)	Net realization (₹/ha)	BCR
	Pod	Haulm						
Level of FYM								
F_1 (0 t ha^{-1})	2401	4156	131811	42143	0	42143	89667	3.13
F_2 (5 t ha^{-1})	2877	4576	155946	42143	10000	52143	103803	2.99
Level of potassium								
K_1 (20 kg ha^{-1})	2501	4211	136734	42143	400	42543	94191	3.21
K_2 (40 kg ha^{-1})	2678	4360	145675	42143	800	42943	102732	3.39
K_3 (60 kg ha^{-1})	2737	4529	149226	42143	1200	43343	105883	3.44
Level of KMB								
B_1 (With)	2729	4473	148576	42143	72	42215	106360	3.52
B_2 (Without)	2549	4260	139181	42143	0	42143	97038	3.30

Conclusions

On the basis of the result obtained from the present investigation, it is concluded that, to achieve profitable yield and quality produce from *kharif*, groundnut (TG 37 A) grown under loamy sand which manure @ 5 t FYM ha^{-1} and 40 kg K_2O ha^{-1} along with seed inoculation with KMB and recommended dose of nitrogen and phosphorus.

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