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Effect of potassium and sulphur on growth, yield and economics of summer groundnut (*Arachis hypogaea* L.)

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Abstract
Effect of potassium and sulphur on growth, yield and quality of summer groundnut (*Arachis hypogaea* L.) was studied at the PG Research Farm, Agronomy Section, RCSM College of Agriculture, Kolhapur (MS) during summer, 2018. The growth characters, yield attributes and yield of groundnut were influenced significantly due to application of different potassium and sulphur levels. The growth attributes *viz*., plant height, number of branches plant^{-1}, plant spread plant^{-1}, dry matter plant^{-1} were recorded highest with application of 45 kg K_2O ha^{-1} which was at par with 30 kg K_2O ha^{-1}, but significantly superior over rest of treatments. The yield attributes *viz.*, number of pods plant^{-1}, weight of pods plant^{-1}, weight of 100 kernels, shelling %, SMK % as well as dry pod yield (32.49 q ha^{-1}), dry haulm yield (44.86 q ha^{-1}) and harvest index (42.15%) were recorded maximum with application of 45 kg K_2O ha^{-1} which was at statistically par with application of 30 kg K_2O ha^{-1}, but significantly superior over rest of treatments. As regards to the application of sulphure, the growth attributes *viz*., plant height, number of branches plant^{-1}, plant spread plant^{-1}, dry matter plant^{-1} were recorded highest with application of 40 kg S ha^{-1} which was at par with application of 20 kg S ha^{-1}, but significantly superior over 10 kg S ha^{-1}. The yield attributes *viz.*, number of pods plant^{-1}, weight of pods plant^{-1}, weight of 100 kernels, shelling %, SMK %, dry pod yield (32.92 q ha^{-1}), dry haulm yield (45.27 q ha^{-1}) and harvest index (41.10%) were recorded maximum with application of 40 kg S ha^{-1} which was at par with 20 kg S ha^{-1}, but significantly superior over 10 kg S ha^{-1}. Application of 45 kg K_2O ha^{-1} and 40 kg S ha^{-1} secured the maximum net monetary returns 81809 Rs ha^{-1} and 77803 Rs ha^{-1} with BCR of 2.33 and 2.27, respectively, followed by application of 30 kg K_2O ha^{-1} and 20 kg S ha^{-1}.

Keywords: Groundnut, potassium, sulphur, growth attributes, yield attributes

Introduction
Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crop in India. It belongs to family Leguminoseae. Groundnut appeared to have originated in South America i.e., North-West of Brazil and the secondary centre of its cultivation is in Africa and then spread to other parts of the world. The crop has its own importance due to high edible oil and nutritional value of kernel as human food and haulm as rich fodder for cattle. It is a valuable cash crop planted by millions of small farmers because of its economic and nutritional value. Its kernels are rich source of edible oil (48-52%) and protein (25-28%). The groundnut kernel contains about 50 per cent edible oil. The remaining 50 per cent of the seed has higher quality protein (21.4-26.45%), carbohydrates (6- 24.9%) and minerals and vitamins (Das, 1997). The groundnut oil is generally used in the preparation of vanspati tup, soap, cosmetics and cold creams besides as cooking medium. This contains 20 per cent saturated and 80 per cent unsaturated fatty acid. Poly saturated fatty acid has two types i.e. oleic (40-50%) and linoleic (24-35%) [Mathur and Khan, 1997] [7].

The potassium is also one of the major plant nutrient, which is important for growth and development of plants. Potassium application is not regularly practiced, it plays equally important role as nitrogen and phosphorus in plants metabolic activities. It helps the plants in using the water economically.

Sulphur is a now recognized, as the fourth major plant nutrient, along with Nitrogen, Phosphorous and Potassium, therefore sulphur is now very much a part of balanced fertilization and nutrition for oilseed crops in general and for groundnut crop in particular. It is one of the important pre-requisites for enhance productivity and quality of groundnut. Sulphur as plant nutrients is becoming increasingly important in dry land agriculture as it is master

nutrient of all oilseed crops. Among the field crops, oilseeds and pulses are more responsive to sulphur.

Soil analysis of Indian soils has indicated that the soils are medium to low in the potassium and deficient in sulphur. Potassium and sulphur plays a vital role in plant nutrition. Individual and combined effect of these nutrients on yield and yield attributes is not well documented, though these factors play an important role in groundnut production. Keeping these considerations in view an experiment was planned entitled "Effect of Potassium and Sulphur on Growth, Yield and Quality of summer Groundnut (*Arachis hypogaea* L.),

Materials and methods

The field experiment was conducted at Post Graduate Research Farm, R.C.S.M. College of Agriculture, Kolhapur during summer, 2018. The topography of experimental field was fairly uniform and leveled. The soil was vertisol (medium black) in nature and about one meter deep with good drainage. The soil of experimental field has pH 7.7, EC 0.31 d Sm^{-1}, organic carbon 0.18%, available N, P_2O_5, K_2O 238.84, 23.65 and 249.10 kg ha^{-1}, respectively. The treatments comprising of twelve treatment combinations of three potassium levels (K_0- 00 kg K_2O ha^{-1}, K_1- 15 kg K_2O ha^{-1}, K_2- 30 kg K_2O ha^{-1}, K_3- 45 kg K_2O ha^{-1}) and three sulphur levels (S_1- 10 kg S ha^{-1}, S_2- 20 kg S ha^{-1}, S_3- 40 kg S ha^{-1}) and these treatments were replicated three times in factorial randomized block design (FRBD). Application of organic manure through farmyard manure was done well before 15 days of dibbling. The groundnut crop was fertilized with 25 kg N and 50 kg P_2O_5 ha^{-1}. The application of N through urea, P_2O_5 through Diammonium phosphate, K_2O through Muriate of Potash and S through Gypsum was done as per the treatments. The quantity of Sulphur and Potassium were applied as per treatment to each plot at the time of sowing. Five plants were randomly selected from each net plot each treatment replication wise and labelled by fixing bamboo pegs. These plants were further used for recording biometric observations and yield contributing characters. The final yield was recorded from net plot area of each treatment and converted in hectare basis. The data obtained from various characters under study were analysed by the method of analysis of varience as described by Gomez and Gomez, 1984.

Groundnut variety 'Phule Chaitanya (KDG-160)' was grown in the experimental field with recommended package of practices. Fertilizers were applied uniformly at the rate of 25 kg N and 50 kg P_2O_5 ha^{-1} and K_2O-as per treatments.

Result and discussion

Effect on growth characters of groundnut

Effect of Potassium Levels

The different growth attributing characters as influenced by different treatment were presented in Table 1. The highest values of all growth characters *viz.* plant height, number of branches $plant^{-1}$, plant spread $plant^{-1}$, dry matter $plant^{-1}$ at harvest were recorded with application of 45 kg K_2O ha^{-1} which was statistically at par with application of 30 kg K_2O ha^{-1} but significantly superior over rest of the treatments. This may be due to its profound influence stress resistance and the vegetative crop growth resulting in higher growth attributing characters. Similar results were also reported by Ponnuswami *et al.*, (1993) [9] at Tamil Nadu (India), Patra *et al.*, (1995) [8] at Research farm, IGKV, Raipur (C.G.) and Shahid *et al*., (1999) at VNMKV, Parbhani.

Effect of Sulphur Levels

The maximum values of all growth characters *viz* plant height, number of branches $plant^{-1}$, plant spread $plant^{-1}$, dry matter $plant^{-1}$, at harvest were recorded with application of 40 kg S ha^{-1} which was statistically equal important with application of 20 kg S ha^{-1} but significantly superior over rest of the treatments. The results were conformity with Reddy *et al.*, (1992) [11] at PDKV, Akola and Shahid *et al*., (1999) at VNMKV, Parbhani.

Effect on yield attributing characters of groundnut

Effect of Potassium Levels

The different yield attributing characters as influenced by different treatment were presented in Table 2. The all yield attributes viz. number of pods $plant^{-1}$, weight of pods $plant^{-1}$, weight of 100 kernels, SMK (%) and shelling per cent at harvest were recorded highest with application of 45 kg K_2O ha^{-1} and found statistically at par with application of 30 kg K_2O ha^{-1} but significantly superior over rest of the treatments. This was might be due to positive impact on growth attributes results in to the better values of yield attributes. Similar results were also reported by Singh (2007) [13] at Zonal Agricultural Research Station, Mainpuri, Umar *et al.*, (1999), Devarajan and Kothanandaraman (1981) and Badiger *et al.*, (1988).

Effect of Sulphur Levels

The highest values of all growth characters viz. plant number of pods $plant^{-1}$, weight of pods $plant^{-1}$, weight of 100 kernels, SMK and shelling per cent at harvest were recorded with application of 40 kg S ha^{-1} which was significantly at par with application of 20 kg S ha^{-1} but significantly superior over rest of the treatments. Similar results were also reported by Rao *et al.*, (2013) at Tirupati.

Effect on yield of groundnut

Effect of Potassium Levels

The dry pod, dry haulm yields and harvest index as influenced by different treatment were presented in Table 3. The significantly highest values of dry pod, dry haulm yields and harvest index at harvest were recorded with application of 45 kg K_2O ha^{-1} and statistically comparable with 30 kg K_2O ha^{-1}. but significantly superior over rest of the treatments, Higher pod and haulm yield could be attributed to favourable changes in physical and chemical characteristics of the soil which might have enabled better pod formation. Moreover, the positive influence of these treatments through immediate supply of potassium at the early stage of the crop, which might have improved adequate biomass production and improvement in yield parameters resulting in higher pod yield. Similar results were reported by Gashti *et al.*, (2012) [15], Veeramani and Subrahmaniyan (2015) [15], Singh (2007) [13] at Zonal Agricultural Research Station, Mainpuri.

Effect of Sulphur Levels

The significantly highest values of dry pod, dry haulm yields and harvest index at harvest were recorded highest with application of 40 kg S ha^{-1} over rest of treatment except application of 20 kg S ha^{-1}. Similar result were also reported by Banu *et al.*, (2017) [2] at Anand Agricultural University, Anand,

Effect on economics of groundnut

Effect of Potassium Levels

The cost of cultivation, gross monetary, net monetary returns and B:C ratio influenced by different treatment were presented in Table 4. The higher values of net monetary return and B: C ratio of groundnut were recorded with application of 45 kg K_2O ha^{-1}, followed by application of 30 kg K_2O ha^{-1} over rest of treatments.

Effect of Sulphur Levels

The maximum values of net monetary return and B: C ratio of groundnut were recorded with application of 40 kg S ha^{-1} followed by application of 20 kg S ha^{-1}.

Conclusions

Based on the present investigation of one year data the following concluded that application of 30 kg K_2O ha^{-1} and application of 20 kg S ha^{-1} found beneficial in increasing growth, yield attributes and yield of summer groundnut. These treatments also increases gross and net monetary returns as well as benefit cost ratio for summer production of groundnut

By and large, recommended that an application of 30 kg K_2O ha^{-1}, 20 kg S ha^{-1} resulted in higher yields and return of groundnut.

Table 1: effect of potassium and sulphur levels on growth attributes of summer groundnut at harvest

Treatments	Plant height (cm)	Plant spread (cm)	Number of branches plant^{-1}	Dry matter plant^{-1} (g)
Potassium levels				
K_0- 00 (kg K_2O ha^{-1})	29.47	22.12	11.57	30.94
K_1- 15 (kg K_2O ha^{-1})	30.51	23.28	12.51	32.47
K_2- 30 (kg K_2O ha^{-1})	31.97	24.31	13.74	35.16
K_3- 45 (kg K_2O ha^{-1})	33.16	25.46	14.11	37.30
S. Em±	0.86	0.64	0.27	0.81
C. D. at 5%	2.54	1.89	0.81	2.40
Sulphur levels				
S_1 - 10 (kg S ha^{-1})	29.07	22.88	12.32	32.19
S_2 - 20 (kg S ha^{-1})	31.48	23.48	13.13	34.04
S_3 - 40 (kg S ha^{-1})	33.34	25.02	13.51	35.68
S. Em±	0.75	0.55	0.24	0.70
C. D. at 5%	2.20	1.63	0.70	2.08
Interactions (K × S)				
S. E m±	1.50	1.11	0.47	1.41
C. D. at 5%	NS	NS	NS	NS
General mean	31.28	23.79	12.98	33.97

Table 2: Effect of potassium and sulphur levels on yield parameters of summer groundnut at harvest

Treatments	Number of pods plant^{-1}	Weight of pods plant^{-1} (g)	Weight of 100 kernels (g)	SMK (%)	Shelling (%)
Potassium levels					
K_0- 00 (kg K_2O ha^{-1})	42.22	39.69	43.52	75.20	66.22
K_1- 15 (kg K_2O ha^{-1})	44.00	41.26	44.47	76.51	67.61
K_2- 30 (kg K_2O ha^{-1})	47.97	45.09	48.41	79.87	68.52
K_3- 45 (kg K_2O ha^{-1})	49.24	46.71	50.24	81.52	69.67
S. Em±	1.16	1.08	1.06	0.90	0.42
C. D. at 5%	3.40	3.18	3.12	2.64	1.25
Sulphur levels					
S_1 - 10 (kg S ha^{-1})	43.98	41.32	44.14	76.72	67.20
S_2 - 20 (kg S ha^{-1})	45.56	42.82	46.61	78.39	68.36
S_3 - 40 (kg S ha^{-1})	48.04	45.42	49.22	79.69	68.44
S. Em±	1.00	0.94	0.92	0.78	0.37
C. D. at 5%	2.95	2.76	2.70	2.28	1.08
Interactions (K × S)					
S. E m±	2.01	1.88	1.84	1.56	0.74
C. D. at 5%	NS	NS	NS	NS	NS
General mean	45.86	43.19	46.66	78.28	68

Table 3: Effect of potassium and sulphur levels on dry pod, dry haulm yields and harvest index of summer groundnut

Treatments	Dry pod yield (q ha^{-1})	Dry haulm yield (q ha^{-1})	Harvest index (%)
Potassium levels			
K_0- 00 (kg K_2O ha^{-1})	26.82	40.23	40.15
K_1- 15 (kg K_2O ha^{-1})	29.11	42.62	40.58
K_2- 30 (kg K_2O ha^{-1})	30.67	43.93	41.70
K_3- 45 (kg K_2O ha^{-1})	32.49	44.86	42.15
S. Em±	1.09	0.74	0.15
C. D. at 5%	3.01	2.20	0.46
Sulphur levels			
S_1 - 10 (kg S ha^{-1})	26.04	38.65	40.25
S_2 - 20 (kg S ha^{-1})	30.36	42.63	41.65
S_3 - 40 (kg S ha^{-1})	32.92	45.27	42.10

S. Em±	0.89	0.96	0.17
C. D. at 5%	2.61	2.87	0.49
Interactions (K × S)			
S. E m±	1.78	1.92	0.34
C. D. at 5%	NS	NS	NS
General mean	29.77	42.59	41.22

Table 4: Effect of potassium and sulphur levels on cost of cultivation, gross monetary, net monetary returns and B:C ratio of summer groundnut

Treatments	Cost of Cultivation (Rs ha^{-1})	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C ratio
Potassium levels				
K_0- 00 (kg K_2O ha^{-1})	58365	116100	57735	1.98
K_1- 15 (kg K_2O ha^{-1})	59140	130052	70912	2.19
K_2- 30 (kg K_2O ha^{-1})	60760	139743	78983	2.29
K_3- 45 (kg K_2O ha^{-1})	61450	143259	81809	2.33
S. Em±	-	1204	1204	-
C. D. at 5%	-	3532	3532	-
Sulphur levels				
S_1 - 10 (kg S ha^{-1})	59345	127783	68438	2.15
S_2 - 20 (kg S ha^{-1})	60130	134919	74789	2.24
S_3 - 40 (kg S ha^{-1})	61050	138853	77803	2.27
S. Em±	-	1315	1315	-
C. D. at 5%	-	3944	3944	-
Interactions (K × S)				
S. E m±	-	2086	2086	-
C. D. at 5%	-	NS	NS	-
General mean	60034.29	133887	73852.71	2.23

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