Effect of different levels of phosphorus and potassium on summer groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Application of 50 and 75 kg P_2O_5 ha^{-1} to groundnut were at par with each other but significantly increased plant height, spread, number and weight of matured pods plant^{-1}, 100 kernal weight, dry pod and haulm yields, protein and oil content and their yields as compared to application of 75 kg P_2O_5 ha^{-1}. The dry matter production plant^{-1} and uptake of NPK significantly increased with each additional level of phosphorus fertilization. The application of 30 and 45 kg K_2O ha^{-1} were found to be at par with each other but significantly increased number of branches plant^{-1}, dry matter production plant^{-1}, root nodules and their weight plant^{-1} at flowering and pod development stages, protein and oil content in kernal and their yields as compared to application of 15 kg P_2O_5 ha^{-1}. However, application of potassium did not influence yield attributes, dry pod and haulm yields and protein and oil yields. Uptake of N, P and K significantly increased with the increased levels of potassium fertilization.

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Key words : Summer groundnut, Growth, Nodulation, Yield, Quality, Nutrient uptake

INTRODUCTION

Fertilization played a vital role in increasing the productivity of crop even after green revolution. Though India occupies unique position in the area and production of oilseeds, judicious fertilizer management plays a pivotal role in influencing the crop yield significantly.

Phosphorus stimulates root formulation, growth and increases nitrogen fixation (More *et al.* 2002), mainly it aids in nodule formation and increases the protein and mineral content in groundnut kernel. Potassium is known for its ability to increase yield and improve quality. It is also essential for photosynthesis and pod development in groundnut (Burkhart and Collins, 1941). Thus, there is ample scope for increasing production through use of these nutrient elements. Keeping this in view, an investigation was carried out with an objective to know the effect of phosphorus and potassium on plant growth, yields attributes and yield in groundnut.

MATERIALS AND METHODS

A field experiment was conducted during summer season of 2007 at the Post Graduate Institute Research Farm, MPKV, Rahuri. The soil of the experimental field was clayey in texture. The chemical composition refected that the soil was slightly alkaline in reaction (pH 8.1) with low in available nitrogen (183.76 kg ha^{-1}), medium in available phosphorus (19.92 kg P_2O_5 ha^{-1}) and high in available potassium (398.60 kg K_2O ha^{-1}). The experiment was laid out in a factorial randomized block design with nine treatment combinations along with one control and replicated three times. The gross and net plot sizes were 6.00 m x 4.80 m and 5.60 m x 4.20 m, respectively. Single super phosphate and muriate of potash were the sources of phosphorus and potash, respectively. Full amount of P and K according to treatments was applied at the time of sowing. The uniform application of nitrogen @ 25 kg ha^{-1} as basal dose through urea + 10 t FYM ha^{-1} was applied to groundnut cv. TAG-24. The crop was dibbled on 26th February, 2007 at 30 x 10 cm spacing. Groundnut kernels were treated with PSB and *Rhizobium* culture. The observations on growth parameters and root nodules were recorded periodically and yield contributing characters and yield at harvest.

The nitrogen content in kernel and haulm was estimated by Microkjeldhal method (A.O.A.C., 2002), phosphorus content by calorimetric method (Jackson, 1973) and potassium content by flame photometer method (Hanway and Heidal, 1967). Protein content was estimated by multiplying nitrogen content by 5.46. The oil content was estimated by Soxhlet Ether Extract method (A.O.A.C., 2002). The uptake of N,P and K was calculated by multiplying yield of kernel and haulm with their respective N, P and K per cent.

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RESULTS AND DISCUSSION

The sumarrized data of as influenced by different treatments presented under the following sub heads:

Effects of phosphorus:

Application of phosphorus at higher levels *viz*., 50 and 75kg P_2O_5 ha^{-1} were found to be at par with each other (Table 1) but significantly increased plant height and spread as compared to application of phosphorus at 25 kg P_2O_5 ha^{-1} . Further, it was noticed that the number of branches and total dry matter $plant^{-1}$ were significantly increased with the increased levels of phosphorus application up to 75kg P_2O_5 ha^{-1} showing graded response to the phosphorus fertilization. Phosphorus plays important role in growth, development and photosynthesis which might have reflected in higher values for plant height, spread, more number of branches and higher total dry matter production with phosphate fertilization. These results coroborate the findings of More *et al.* (2002).

The mean number of days required for 50 per cent flowering was significantly less under application of 25 kg P_2O_5 ha^{-1} than its higher levels of 50 and 75 kg P_2O_5 ha^{-1}. Phosphate fertilization with 75 kg P_2O_5 ha^{-1} produced more number of root nodules and their weight per plant than 25 and 50 kg P_2O_5 ha^{-1} both at flowering and pod development stages except that it was at par with 50 kg P_2O_5 ha^{-1} for number of nodules per plant at flowering stage.

The increased root growth due to phosphate fertilization and symbiotic nitrogen fixation might have improved root nodulation. Kausale *et al.* (2007) reported similar results. The application of 50 and 75 kg P_2O_5 ha^{-1} was at par with each other and significantly increased number of matured pods and their weight $plant^{-1}$, 100 kernel weight and dry pod and haulm yields as compared to 25 kg P_2O_5 ha^{-1} owing to improvement in growth and yield attributes (Table 2). Similar, results were reported by Bharambe *et al*. (2004). The application of 50 and 75 kg P_2O_5 ha^{-1} were at par with each other and significantly increased oil content and oil and protein yields as compared to 25 kg P_2O_5 ha^{-1} application owing to increase in kernel yield. The protein content of the kernel and NPK uptake, were significantly increased with the increased levels of phosphate fertilization owing to increase in pod and haulm yields and N, P and K content in kernel and haulm. Similar,

Table 1 : Growth attributes and root nodulation as influenced by different phosphorus and potassium levels

Treatments	Growth attributes					Root nodulation			
	Plant height (cm)	Plant spread (cm)	Branches $plant^{-1}$	Total dry matter $plant^{-1}$ (g)	Days to 50% flowering	At flowering (42 DAS)		At pod development (70 DAS)	
						Nodules $plant^{-1}$	Wt. of nodules $plant^{-1}$ (mg)	Nodules $plant^{-1}$	Wt. of nodules $plant^{-1}$ (mg)
Phosphorus levels (kg ha^{-1}) :									
25	30.60	34.63	8.24	44.36	33.44	39.66	68.07	27.68	38.60
50	33.49	37.47	9.78	47.07	36.11	45.99	76.12	32.04	45.69
75	34.34	38.51	10.40	48.45	37.22	48.11	78.65	34.44	47.80
S.E. ±	0.41	0.48	0.15	0.43	0.43	0.86	0.71	0.60	0.49
C.D. (P=0.05)	1.22	1.43	0.46	1.26	1.29	2.55	2.11	1.78	1.46
Potassium levels (kg ha^{-1}) :									
15	32.39	36.08	8.76	45.26	35.11	42.18	72.45	29.61	40.99
30	33.92	37.12	9.62	47.10	35.67	45.06	74.73	32.00	44.77
45	33.11	37.41	10.04	47.52	36.00	46.53	75.66	32.88	46.33
S.E. ±	0.41	0.48	0.15	0.43	0.43	0.86	0.71	0.60	0.49
C.D. (P=0.05)	NS	NS	0.46	1.26	NS	2.55	2.11	1.78	1.46
Control vs. other mean :									
Control	23.30	27.60	7.00	36.53	32.33	34.66	61.88	24.33	30.56
Other mean*	32.81	36.87	9.47	46.63	35.59	44.59	74.28	31.50	44.03
S.E. ±	0.76	0.87	0.29	0.78	0.79	1.58	1.30	1.09	0.90
C.D. (P=0.05)	1.59	1.84	0.60	1.63	1.66	3.32	2.73	2.29	1.89
Interaction (P x K) :									
S.E. ±	0.72	0.83	0.27	0.74	0.75	1.49	1.23	1.04	0.85
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	31.86	35.94	9.23	45.62	35.23	43.60	73.04	30.78	42.68

* Other mean – cumulative mean of P and K levels NS=Non-signature

Table: 2 Yield attributes, yield, quality and nutrient uptake as influenced by different levels of phosphorus and potassium

Treatments	Yield attributes			Yield (q ha^{1})		Quality				Nutrient uptake (kg ha^{-1})		
						Oil		Protein		N	P	K
	Mature pods $plant^{-1}$	Wt. of mature pods $plant^{-1}$ (g)	100 kernel wt. (g)	Dry pod yield	Haulm yield	% in kernel	Yield (q ha^{-1})	% in kernel	Yield (q ha^{-1})			
Phosphorus levels (kg ha^{-1}) :												
25	14.21	12.25	36.92	25.00	34.55	48.64	8.07	24.20	4.01	129.51	13.65	60.09
50	17.19	14.60	39.90	33.26	41.75	50.42	11.99	25.74	6.12	186.58	24.37	84.65
75	18.34	15.71	40.17	34.73	43.75	51.50	13.18	26.03	6.65	202.21	28.53	92.51
S.E. ±	0.41	0.42	0.78	1.40	1.55	0.46	0.47	0.05	0.23	0.75	0.29	0.51
C.D. (P=0.05)	1.23	1.23	2.33	4.16	4.60	1.37	1.40	0.13	0.68	2.23	0.87	1.51
Potassium levels (kg ha^{-1}) :												
15	16.07	13.66	37.59	29.78	38.84	49.06	10.16	25.13	5.22	162.70	19.82	74.22
30	16.78	14.30	40.00	31.18	40.20	50.31	11.27	25.35	5.68	174.84	22.53	79.87
45	16.89	14.59	39.40	32.02	41.00	51.18	11.81	25.48	5.88	180.76	24.20	83.16
S.E. ±	0.41	0.42	0.78	1.40	1.55	0.46	0.47	0.05	0.23	0.75	0.29	0.51
C.D. (P=0.05)	NS	NS	NS	NS	NS	1.37	NS	0.13	NS	2.23	0.87	1.51
Control vs. other mean :												
Control	10.20	8.20	33.15	17.81	28.71	47.64	5.29	21.68	2.40	83.11	6.72	40.061
Other mean*	16.58	14.18	39.00	30.99	40.02	50.18	11.08	25.32	5.59	172.77	22.18	79.09
S.E. ±	0.75	0.76	1.43	2.56	2.82	0.85	0.86	0.08	0.42	1.37	0.53	0.93
C.D. (P=0.05)	1.59	1.59	3.00	5.38	5.94	1.79	1.81	0.17	0.88	2.89	1.12	1.96
Interaction (P x K) :												
S.E. ±	0.62	0.73	1.36	2.43	2.68	0.80	0.81	0.07	0.39	1.30	0.51	0.88
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	3.87	1.51	2.63
General means	15.94	13.59	38.41	29.68	38.89	49.93	10.50	24.96	5.28	163.80	20.64	75.18

* Other mean – cumulative mean of P and K levels NS=Non-significant

Table 3 : N, P and K uptake as influenced by interaction between phosphorus and potassium levels

Treatments	Nutrient uptake (kg ha^{-1})								
Phosphorus levels (kg ha^{-1})	N			P			K		
	Potassium levels (kg ha^{-1})								
	15	30	45	15	30	45	15	30	45
25	118.32	129.21	141.00	11.70	13.77	15.46	54.31	59.84	66.12
50	171.24	192.36	196.14	20.38	25.24	27.49	77.71	87.04	89.21
75	198.54	202.97	205.14	27.59	28.59	29.64	90.64	90.64	94.15
S.E. ±		1.30			0.51			0.88	
C.D. (P=0.05)		3.87			1.51			2.63	

results were reported by Dutta *et al.* (2004).

Effect of potassium:

The plant height and spread were not significantly influenced due to application of different levels of potassium. However, number of branches and total dry matters per plant were significantly increased with increased levels of potassium. Application of 45 kg P_2O_5 ha^{-1} was at par with 30 kg P_2O_5 ha^{-1} and recorded significantly higher values for number of branches and total dry matter $plant^{-1}$ at harvest compared to its lower levels. Potassium is involved in physiological and biochemical functions of plant growth *i.e.* enzyme activation, water balance, protein synthesis, starch synthesis etc. Its application in legumes improves nitrogen fixation capacity of plant. These favorable effects might have resulted in increased dry matter production $plant^{-1}$ at higher potassium levels. The increased values for number of branches and total dry matter production with higher K levels were also reported by Singh (2007).

The potassium applied @ 30 and 45 kg K_2O ha^{-1} were found to be at par with each other and produced more number of root nodules and their weight plant^{-1} than 15 kg K_2O ha^{-1} both at flowering and pod development stages except that weight of root nodules at pod development stage was significantly higher with the application of 45 kg K_2O ha^{-1}. These results are in conformity with the findings reported by Patra *et al.* (1999). The days to 50 per cent flowering, yield contributing characters *viz.*, number of matured pods and their weight plant^{-1}, 100 kernal weight, dry pod and haulm yields and protein and oil yields were not influenced significantly due to potassium fertilization (Table 2). The application of 30 and 45 kg K_2O ha^{-1} were found to be at par with each other but significantly increased protein and oil content of kernels as compared to application of 15 kg K_2O ha^{-1} which might be due to significant role of potassium in pod development. The uptake of NPK was significantly increased with the increased levels of potassium fertilization owing to increased N, P and K content in kernel and haulm. Hadwani and Gundalia (2005) also reported the similar findings.

The mean values for growth and yield attributes, number and weight of root nodules, pod and haulm yields, protein and oil content and N, P, K uptake were significantly less under control than other treatment means, which might be due to no supply of P_2O_5 and K_2O through fertilizers and native supply of these nutrients might be inadequate under control.

Effect of interaction:

The interaction effects between phosphorus and potassium levels in respect of growth attributes, nodulation, yield attributes, yield and quality parameters were found to be non-significant however, interaction effect between phosphorus and potassium significantly influenced the nutrient uptake pattern in summer groundnut.

The uptake of NPK was significantly increased with the increased levels of phosphate fertilization at all the levels of potassium (Table 3). Further, it was observed that nitrogen uptake showed graded response to increased levels of potassium at all the levels of phosphorus. Phosphorus and potassium showed graded response with increased levels of potassium at lower level of 25 kg P_2O_5 application and increased with increased levels of potassium application up to 30 kg K_2O ha^{-1} at higher level of phophorus up to 50 kg P_2O_5 ha^{-1} .

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