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Effects of N, P and K Fertilizers on Yield, Content and Uptake of N, P and K by Sesame (*Sesamum indicum*)

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ABSTRACT

A pot experiment was conducted to study the effects of N, P and K fertilization on yield, N, P and K content and uptake by sesame. The experiment comprised 4 nitrogen rates (0, 37.5, 75, 112.5 kg N ha^{-1}), 3 phosphorus rates (0, 22.5 & 45 kg P_2O_5 ha^{-1}) and 3 rates of potassium (0, 22.5 & 45 kg K_2O ha^{-1}). Optimum number of capsule and seed yield was obtained at 75 kg N ha^{-1} while dry matter yield was highest at 112.5 kg N ha^{-1}. Application of P at 45 kg P_2O_5 ha^{-1} significantly increased number of capsules, seed and dry matter yields $plant^{-1}$. N fertilization at 75 kg N ha^{-1} increased shoot N and K content by 155 and 8%, respectively. Shoot P content increased by 3.14 folds at 37.5 kg N ha^{-1}. P and K showed no significant influence on N and P shoot content. N fertilization enhanced N, P and K shoot uptake by 260, 43 and 46%, respectively. There was no significant increase in N and K shoot uptake during P fertilization, while P uptake was increased by 72%. K did not significantly increase N and P shoot uptake but K shoot uptake was increased by 18%. The strength of relationship between seed yield and N, P and K uptake was very strong. © 2010 Friends Science Publishers

Key Words: Nitrogen; Phosphorus; Potassium; Shoot content; Nutrient uptake; Sesame

INTRODUCTION

Sesame or benniseed (*Sesamum indicum* L.) is cultivated in almost all tropical and subtropical Asian and African countries for its highly nutritious and edible seeds (Iwo *et al.*, 2002). The seeds serve as ingredients in soup and a source of oil (43%) (Biswas *et al.*, 2001) and the cake after oil extraction is used as cattle feeds. It is also used in local preparation of weaning food (Lalude & Fashakin, 2006).

Sesame nutrition remained very controversial for long time (Okpara *et al.*, 2007). While most researchers were of the opinion that sesame does not require any fertilization, some believed that the crop needed to be fertilized. Fertilizer is an important option that should be adopted in order to improve crop yields in most soils of the northeastern part of Nigeria and most parts of Africa because N, P and K are among the limiting nutrients of the savanna soils. Adequate supply of nitrogen is beneficial for carbohydrates and protein metabolism, promoting cell division and cell enlargement. Similarly, good supply of P is usually associated with increased root density and proliferation, which aid in extensive exploration and supply of nutrients and water to the growing plant parts, resulting in increased growth and yield traits, thereby ensuring more seed and dry matter yield (Maiti & Jana, 1985). Understanding the dynamics of these nutrients in terms of their uptake, translocation and distribution in sesame plant is an important aspect of its nutrition that will help in taking decisions that will improve its production and management. It will also help in adaptation of proper package and practice for sesame crop and reduce the cost of fertilization.

Reports of nutrition studies carried out in the tropics have shown significant yield increases due to fertilizer application. Rao *et al.* (1994) reported increases in sesame yields from the application of nitrogen and Schilling and Cattan (1991) reported similar increases in sesame yields from the application of nitrogen, phosphorus and sulfur in Burkina Faso. Similar responses were reported by Subramanian *et al.* (1979), where high yields were obtained from the application of nitrogen and potassium in India. However, in other investigations, Olowe and Busari (2002) and Muhamman *et al.* (2009) reported non-significant responses to P fertilization, while Voh (1998) observed that of K fertilization.

Many studies have been conducted to elucidate the factors controlling N, P and K uptake efficiencies and nutrient content in plants; extent of root-soil association, amount of N, P and K supply, uptake efficiency of the root system and soil moisture supply (Cox *et al.*, 1985; Tillman *et al.*, 1991). In plant nutrition studies, Mengel *et al.* (1983) observed that nutrient uptake rates are determined mainly by the physiological need of the plant. However, there is scarce information on nutrition of sesame involving its shoot

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nutrient concentration and uptake efficiencies. Similarly, a study of nutrient uptake, translocation and distribution of N, P and K will help in understanding the utilization efficiencies of these nutrients to optimize their fertilization benefits.

Therefore, based on the poor nitrogen and phosphorus levels of the soils of northern guinea savanna zone of Nigeria, high cost of fertilizers and the nutritional value of sesame to both humans and animals, this study was planned to evaluate the effects of different rates of N, P and K on yields of sesame, shoot nutrient content and uptake and to determine appropriate fertilizer recommendation for sesame production.

MATERIALS AND METHODS

A 4 x 3 x 3 factorial experiment was conducted in the screen house of the FAO/TCP farm of the Adamawa State University, Mubi, Nigeria (10^o 15' N, 13^o 16' E & 696 m above sea level) to study the effect of nitrogen, phosphorus and potassium on the nutrition of sesame (*Sesamum indicum* L.). The experiment consists of 4 nitrogen rates (0, 18.75, 37.5, 56.25 mg N kg^{-1} soil or 0, 37.5, 75 & 112.5 kg ha^{-1}), 3 phosphorus rates (0, 11.25 & 22.5 mg P_2O_5 kg^{-1} soil or 0, 22.5 & 45 kg ha^{-1}) and 3 rates of potassium (0, 11.25 & 22.5 mg K_2O kg^{-1} soil or 0, 22.5 & 45 kg ha^{-1}). There were 36 treatment combinations replicated 3 times, giving a total of 108 pots and arranged in completely randomized design (CRD). N, P and K sources were from ammonium nitrate, calcium dihydrogen phosphate and potassium chloride salts, respectively.

Top soil (0-15 cm) was collected from the experimental site, air dried and sieved through a 2 mm screen. Five kg of the soil was placed in plastic pots and five seeds per pot were sown evenly. The plants were irrigated to 75% equivalent to 790 cm^3 of water. The shoot was cut and oven dried at 65^oC for N, P and K determination. Growth and yield characters were determined. Total N was determined by the modified Kjeldhal method (Bremner, 1982). Available P by Bray P1 method (Bray & Kurtz, 1945) and determined by spectrometry, while K was extracted in 1 M NH_4OAc buffered at pH 7 (Page *et al.*, 1982) and determined by flame photometer.

Data collected was subjected to analysis of variance (ANOVA). Duncan's Multiple Range Test (DMRT) was used for mean separation, where differences were significant, at 5% level of probability.

RESULTS

The N fertilization influenced all the yield parameters except number of seeds per pod (Table I). Number of pods per plant was significantly increased by N fertilization. Application of N fertilizer at 75 kg produced the optimum number of pods. Seed yields were higher by 18.1% at 37.5 kg, 24.6% at 75 kg and 25.2% at 112.5 kg N ha^{-1} over 0 kg N ha^{-1}. Dry matter yield differed significantly from each other at all N rates and linear increase was recorded with increased N rates. Dry matter yields were higher by 13.44% at 37.5 kg, 37.18% at 75 kg and 45.04% at 112.5 kg N ha^{-1} over 0 kg N ha^{-1}.

Phosphorus fertilizer application significantly increased the parameters of sesame except for number of seeds per pod. Number of pods, seed yield and dry matter yields were significantly higher at 45 kg P_2O_5 ha^{-1} than at 22.5 kg P_2O_5 ha^{-1}.

K fertilizer application had significant influence on number of pods per plant. Number of seed per pod, seed yield and dry matter yield were not significantly influenced by K fertilizer application. The interaction between N and K fertilizers was only significant ($P<0.05$) for seed and dry matter yields (Table II). The interaction between N and K for seed yield was highest when N was applied at 75 kg N ha^{-1} and K at 22.5 kg K_2O ha^{-1}. For dry matter yield, the highest value (12.20 g pot^{-1}) was recorded between the interaction of N at 112.5 kg N ha^{-1} and K at 0 kg K_2O ha^{-1}. The interaction effect of P and K on yield components of sesame was not significant. The interaction of N, P and K fertilizers was significant for seed and dry matter yields (Table III). Highest seed yield was obtained at 75 kg N, 45 kg P_2O_5 and 22.5 kg K_2O ha^{-1} fertilization with corresponding seed yield of 4.10 g $plant^{-1}$. Highest dry matter yield (13.14 g $plant^{-1}$) was obtained at 112.5 kg N, 45 kg P_2O_5 and 45 kg K_2O ha^{-1}.

Shoot N content: The shoot content and uptake of N, P and K are presented in Table IV. Shoot N content was significantly influenced by N fertilizer application. Shoot N content was highest (2.63%) at N application of 112.5 kg ha^{-1}. This is at par with shoot N content (2.53%) recorded at N application of 75 kg ha^{-1}. The application of P and K fertilizer had no significant effect on shoot N content. All interactions effect were not significant ($P=0.05$).

Shoot P content: N, P and K fertilizer application did not show any significant effect on shoot P content. All interaction effects were also not significant.

Shoot K content: Application of N at 75 kg N ha^{-1} had the optimum shoot K content. Also P and K fertilizer application did not have any significant effect on shoot K content neither do the interactions.

N uptake: Shoot N uptake was highest (33.98 mg N $plant^{-1}$) at N application of 112.5 kg N ha^{-1}. However, shoot N uptake at 75 and 112.5 kg ha^{-1} did not differ significantly from each other. The trend in N uptake in response to P fertilizer was similar but higher levels of K did not correspondingly increase N uptake. Despite the significant response in the shoot uptake of N and P to the application of P fertilizers, no significant differences were recorded in all interactions. N and K, N and P and N, P and K fertilizer interactions did not significantly influence N uptake.

P uptake: Shoot P uptake was significantly influenced by N fertilizer application. Highest P uptake was recorded at 75 kg N ha^{-1}. These two rates were not significantly different

Table I: Effects of N, P and K fertilizers on yield and yield components of sesame grown in pots

Fertilizer	Number of pods plant^{-1}	Number of seed pod^{-1}	Seed yield (g plant^{-1})	Dry matter (g plant^{-1})
N (kg ha^{-1})	Mean SD	Mean SD	Mean SD	Mean SD
0	19.78^{c}±4.24	46.04^{a}±4.07	2.58^{c}±0.47	8.26^{d}±1.78
37.5	24.63^{b}±3.94	47.04^{a}±4.92	$3..15^{b}$±0.76	9.39^{c}±1.77
75	29.37^{a}±3.73	47.30^{a}±4.86	3.42^{a}±0.45	11.33^{b}±1.43
112.5	28.48^{a}±4.84	47.48^{a}±2.83	3.45^{a}±0.35	11.98^{a}±1.22
SE±	0.73	1.11	0.08	0.22
P (Kg ha^{-1})				
0	23.58^{b}±5.58	46.56^{a}±4.22	3.13^{b}±0.71	9.58^{b}±2.11
22.5	25.03^{b}±4.94	46.14^{a}±4.13	2.96^{b}±0.53	10.13^{b}±2.16
45	28.08^{a}±5.53	48.19^{a}±3.02	3.34^{a}±0.60	11.00^{a}±1.99
SE±	0.63	0.96	0.07	0.19
K (Kg ha^{-1})				
0	24.36^{b}±6.32	46.17^{a}±3.44	3.07^{a}±0.61	10.10^{a}±2.40
22.5	25.92^{b}±4.89	47.58^{a}±3.60	3.20^{a}±0.75	10.27^{a}±2.29
45	26.42^{a}±5.54	47.14^{a}±3.35	3.18^{a}±0.51	10.34^{a}±1.76
SE±	0.63	0.96	0.07	0.19
Interaction				
N x K	ns	ns	*	**
P x K	ns	ns	ns	ns
N x P	ns	ns	ns	ns
N x P x K	ns	ns	**	***
SE±	2.20	3.34	0.25	0.68

* = Significant difference at 5% level of probability
** = Significant difference at 1% level of probability
***= Significant difference at 0.1% level of probability
ns = Not significant at 5% level of probability

Table II: Interaction effect of N and K fertilizer on (a) seed and (b) dry matter yields of sesame (g plant^{-1})

N (kg ha^{-1})	(a)			(b)		
	K (kg ha^{-1})					
	0	22.5	45	0	22.5	45
	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
0	2.51^{e} ±0.66	2.51^{e} ±0.44	2.72^{d} ±0.23	7.57^{c} ±2.41	8.56^{c} ±1.72	8.66^{bc} ±0.85
37.5	2.89^{b-d} ±0.58	3.10^{a-d} ±0.97	3.44^{a-d} ±0.67	9.23^{bc} ±1.51	8.41^{c} ±0.98	10.52^{ab} ±2.10
75	3.34^{a-d} ±0.25	3.79^{a} ±0.47	3.12^{a-d} ±0.34	11.42^{a} ±0.64	12.06^{a} ±1.86	10.50^{ab} ±1.18
112.5	3.52^{ab} ±0.32	3.38^{a-d} ±0.38	3.45^{a-c} ±0.38	12.20^{a} ±1.31	12.05^{a} ±1.09	11.69^{a} ±1.32
SE±	0.25			0.68		

Table III: Interaction effect of N, P, and K fertilizer on (a) seed and (b) dry matter yield of sesame (g plant^{-1})

N (kg ha^{-1})	K (kg ha^{-1})						
		(a)			(b)		
	P	0	22.5	45	0	22.5	45
	(kg ha^{-1})	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
0	0	1.84^{k} ±0.22	2.77^{e-j} ±0.33	2.71^{e-j} ±0.28	4.76^{l} ±0.09	8.65^{g-k} ±1.43	8.53^{h-k} ±0.24
	22.5	2.41^{i-k} ±0.28	2.16^{jk} ±0.04	2.57^{g-k} ±0.09	8.02^{k} ±1.60	7.66^{k} ±2.73	8.37^{i-k} ±1.22
	45	3.28^{a-i} ±0.15	2.59^{g-k} ±0.61	2.88^{d-i} ±0.18	9.93^{d-k} ±0.36	9.37^{d-k} ±0.43	9.07^{e-k} ±0.97
37.5	0	3.08^{b-i} ±0.22	3.77^{a-c} ±1.33	2.78^{e-i} ±0.36	10.39^{c-i} ±0.84	8.31^{i-k} ±0.57	8.52^{h-k} ±1.05
	22.5	2.55^{h-k} ±0.17	2.89^{c-i} ±0.90	3.48^{b-f} ±0.55	8.10^{jk} ±0.85	8.81^{f-i} ±1.72	10.35^{c-j} ±0.38
	45	3.06^{b-i} ±0.99	2.66^{e-i} ±0.42	3.91^{ab} ±0.22	9.20^{d-k} ±1.93	8.11^{jk} ±0.42	12.71^{ab} ±1.78
75	0	3.50^{a-e} ±0.17	3.90^{ab} ±0.44	2.95^{c-i} ±0.28	11.46^{a-d} ±0.63	12.70^{ab} ±1.50	9.42^{d-k} ±0.87
	22.5	3.15^{b-i} ±0.13	3.37^{a-h} ±0.39	3.19^{b-i} ±0.37	11.48^{a-c} ±0.83	10.87^{a-g} ±2.55	11.03^{a-f} ±1.48
	45	3.36^{a-h} ±0.34	4.10^{a} ±0.35	3.24^{a-h} ±0.43	11.32^{a-e} ±0.71	12.59^{a-c} ±1.37	11.06^{a-f} ±0.09
112.5	0	3.86^{ab} ±0.09	3.08^{b-i} ±0.54	3.36^{a-h} ±0.52	11.02^{a-f} ±0.81	10.70^{b-h} ±0.34	10.60^{b-i} ±0.05
	22.5	3.27^{a-i} ±0.25	3.39^{a-h} ±0.04	3.28^{a-i} ±0.31	12.73^{ab} ±0.32	12.74^{ab} ±0.20	11.33^{a-e} ±0.20
	45	3.44^{a-g} ±0.27	3.68^{a-d} ±0.12	3.70^{a-d} ±0.25	12.84^{ab} ±1.73	12.72^{ab} ±0.65	13.14^{a} ±1.35
	SE±	0.25			0.68		

Means followed by the same letter(s) are not significantly different at 5% level of probability using Duncan Multiple Range Test

from each other but were higher and differ significantly from P uptake at 0 and 37.5 kg N ha^{-1} with corresponding values of 2.47 and 2.61 mg plant^{-1}, respectively. P fertilizer application had a significant influence on the uptake of P. Highest P uptake (3.89 mg plant^{-1}) was recorded at 45 kg P_2O_5 ha^{-1} rate and differed significantly from the other P rates. Application of K fertilizer at 22.5 kg K_2O ha^{-1} produced the highest P uptake among the K fertilizer rates

Table IV: Interaction effect of N, P, and K fertilizers on percent plant content, uptake and soil status of N, P and K

N (kg ha^{-1})	% N	% P	% K	N uptake	P uptake	K uptake
				←	mg plant^{-1}	→
	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD	Mean SD
0	0.99^{c} ±0.52	0.27±0.15	1.33^{ab} ±0.35	9.14^{c} ±5.41	2.61^{b} ±1.59	12.34^{b} ±4.57
37.5	1.77^{b} ±0.95	1.12±0.57	1.21^{b} ±0.29	18.88^{b} ±11.46	2.47^{b} ±1.28	12.67^{b} ±4.25
75	2.53^{a} ±0.86	0.29±0.14	1.44^{a} ±0.56	32.99^{a} ±11.19	3.73^{a} ±1.88	18.06^{a} ±7.52
112.5	2.63^{a} ±1.05	0.22±0.11	1.27^{ab} ±0.33	33.98^{a} ±14,25	2.98^{ab} ±1.50	16.83^{a} ±4.43
SE±	0.18	0.44	0.07	2.16	0.28	0.92
		ns				
P (kg ha^{-1})						
0	2.13±1.24	0.21±0.13	1.42±0.45	24.21±15.78	2.26^{b} ±1.61	15.83±6.36
22.5	1.77±0.80	0.24±0.11	1.24±0.34	20.97±12.04	2.69^{b} ±1.31	14.01±5.23
45	2.05±1.17	0.98±0.15	1.27±0.39	26.06±16.70	3.89^{a} ±1.54	15.69±5.96
SE±	0.16	0.38	0.06	1.88	0.24	0.80
	ns	ns	ns	ns		ns
K (kg ha^{-1})						
0	2.09±1.10	0.26±0.12	1.21±0.39	25.07±15.48	3.02±1.58	13.65^{b} ±5.58
22.5	1.98±1.15	0.27±0.14	1.33±0.42	22.98±14.86	3.15±1.84	15.22^{ab} ±6.59
45	1.87±1.02	0.89±0.16	1.39±0.38	23.18±15.19	2.68±1.47	16.05^{a}±5.23
SE±	0.16	0.38	0.06	1.88	0.24	0.80
	ns	ns	ns	ns	ns	
Interaction						
N x K	ns	ns	ns	ns	ns	ns
P x K	ns	ns	ns	ns	ns	ns
N x P	ns	ns	ns	ns	ns	ns
N x P x K	ns	ns	ns	ns	ns	*
SE±	0.54	1.32	0.22	6.51	0.83	2.76

* = Significant difference at 5% level of probability

ns = Not significant at 5% level of probability

Table V: Interaction effect of N, P and K fertilizer on the uptake of K by sesame (mg plant^{-1})

N (kg ha^{-1})		K (kg ha^{-1})		
		0	22.5	45
	P (kg ha^{-1})	Mean SD	Mean SD	Mean SD
0	0	6.27^{h} ±3.63	16.57^{b-g} ±6.88	13.46^{b-h} ±3.30
	22.5	11.50^{c-h} ±3.28	10.86^{d-h} ±3.76	9.22^{f-h} ±1.49
	45	17.38^{a-g} ±2.71	12.64^{b-h} ±4.03	13.17^{b-h} ±2.64
37.5	0	16.73^{a-g} ±2.51	12.16^{b-h} ±2.42	12.55^{b-h} ±1.41
	22.5	8.24^{a-g} ±2.94	11.51^{d-h} ±1.23	14.22^{b-h} ±2.79
	45	9.61^{f-h} ±2.99	9.02^{f-h} ±2.45	20.03^{a-d} ±3.66
75	0	13.81^{b-h} ±2.34	14.99^{b-h} ±4.01	19.99^{a-d} ±3.38
	22.5	9.93^{f-h} ±3.53	26.07^{a} ±5.09	19.50^{a-d} ±4.75
	45	19.60^{a-d} ±5.80	21.65^{ab} ±11.62	16.96^{a-g} ±7.83
112.5	0	14.00^{g-h} ±2.73	13.29^{b-g} ±1.60	17.88^{a-g} ±7.13
	22.5	20.87^{a-g} ±6.03	19.71^{a-d} ±0.58	17.53^{a-g} ±3.15
	45	15.88^{b-g} ±6.70	14.21^{b-h} ±3.63	18.09^{a-g} ±2.49
SE±		2.76		

Means followed by the same letter(s) are not significantly different at 5% level of probability using Duncan Multiple Range Test

followed by 45 kg K_2O ha^{-1} fertilizer application. However, P uptakes at all K fertilizer rates were statistically not different.

K uptake: Shoot K uptake was highest (26.07 mg plant^{-1}) at 75, 0 and 22.5 kg N, P and K interactions. The lowest being 6.27 mg K obtained from soils, where none of the fertilizers were applied. For K uptake, only N, P and K interactions showed significant response and highest uptake of 26.07 mg K plant^{-1} was attained at 75 kg N, 22.5 kg P_2O_5 and 22.5 kg K ha^{-1} (Table V).

DISCUSSION

Nitrogen fertilization increased number of pods and dry matter yields up to 75 and 112.5 kg N ha^{-1} respectively, while sesame seed yield benefited from applied N only up to 75 kg N ha^{-1}. Increase in number of pods and dry matter yield could be as a result of nitrogen being involved in carbohydrate and protein metabolism that promotes cell division and enlargement resulting in more productive pods and dry matter yields. The results are in line with Malik *et al.* (2003) who reported increase in number of pods plant^{-1} with increasing N rate. Increasing the N level from 75 to 112.5 kg N ha^{-1} reduced the rate of increase in seed yield and the difference became non-significant. This led to excessive vegetative growth at the expense of seed production. Thus, 75 kg N ha^{-1} is sufficient enough to increase seed yield and that it gave a better partitioning of biomass as higher doses of nitrogen promote only investment of biomass in vegetative organs (Relm & Espig, 1991). The higher seed yields obtained with moderate application of N were associated with number of pods $plant^{-1}$ (r = 0.583***).

Phosphorus gave a significantly greater number of pods, seed and dry matter yields at 45 kg P_2O_5 ha^{-1} fertilization probably, because good supply of phosphorus is usually associated with increased root density and proliferation, which aid in extensive exploration and supply of nutrients and water to the growing plant parts. The significant yield increase observed at increased P rates was consistent with Rao *et al.* (1994) and at variance with Muhamman *et al.* (2009), who reported non-significant increase at 45 kg P_2O_5 ha^{-1}. The significant increase at 45 kg P_2O_5 ha^{-1} is an indication of low availability of P in the soil.

K fertilization gave substantial increase in number of capsules $plant^{-1}$, while seed and dry matter yields did not respond significantly. In concurrence, Weis (1983) reported that K is seldom applied to sesame but where applied, it is done as a compound mixture and can be necessary to maintain nutritional balance where substantial amounts of N and P are applied. Interaction between N and K was significant for seed and dry matter yields, while P and K interactions on yield components were not significant. There were significant and positive correlation between seed yield and number of capsules $plant^{-1}$ and dry matter yields (r = 0.583*** & 0.574***, respectively).

Shoot N content of sesame increased significantly with N fertilization at 37.5 kg N ha^{-1} over control. Havlin *et al.* (2006) observed that when a nutrient is deficient, increasing nutrient availability will increase plant nutrient content and crop yield until critical nutrient range is exceeded. There was significant increase in N content of sesame shoots at 45 kg P_2O_5 ha^{-1} fertilization. In a similar finding, Mugwira *et al.* (1997) reported that P increased shoot N content of plants. Increase in shoot N content from increasing P rate shows that P plays a role in uptake and utilization of N by developing extensive roots through, which nitrogen can be absorbed and distributed to other parts of the plant. Increasing K rate depressed Shoot N concentration, while responses were not significant in all interactions of N, P and K.

The N uptake (33.98 mg N $plant^{-1}$) was highest at 112.5 kg ha^{-1} fertilization. Sieling *et al*. (2006) observed that N uptake increased with N rate up to 240 kg N ha^{-1}. P fertilization did not influence N uptake. This could be due to the low level of P fertilization since responses at P higher than 45 kg P_2O_5 ha^{-1} has been observed. N gave a substantial increase in P uptake at 75 kg N ha^{-1} by 44% and increased N rate to 112.5 kg N ha^{-1} depressed P uptake by 25%. P uptake increased from increase in N rate. Havlin *et al.* (2006) also reported that N promotes P uptake by increasing tap root growth, plant metabolism, P solubility and availability of P by decreasing the soil pH through NH_4^+ absorption. P uptake increased with P fertilization up to 45 kg P_2O_5 ha^{-1} by 72% over control. Higher uptake of P at 45 kg P_2O_5 ha^{-1} is an indication of the low availability of P in soil and the demand of the plant (Marschner *et al.,* 1997). Influence of K on P uptake was not significant. The significant increase in K uptake at 75 kg N ha^{-1} by 46% over control is consistent with the reports of Kemp *et al.* (1983). Increased K uptake by 18% over control at 45 kg K_2O ha^{-1} agrees with the findings of Fageria (2001).

In conclusion, 75 kg N and 45 kg P_2O_5 ha^{-1} is best for sesame. N and P enhanced the uptake of each other. Sesame responses to K fertilization were poor, therefore rates lower than 22.5 kg ha^{-1} should be studied for the purpose of nutritional balance. This work will help in adaptation of proper package and practice for sesame crop and that higher doses should be avoided to reduce the cost of fertilization.

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