Nitrogen, Phosphorus and Potassium nutrition of Sesame (*Sesamum indicum*) in Mubi, Nigeria.

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Abstract: A pot experiment was conducted during the dry spell of 2005, in the screen house at the FAO/TCP farm of the Adamawa State University, Mubi to assess the nitrogen, phosphorus and potassium nutrition on the productivity sesame (*Sesamum indicum* L.). The treatments consisted of factorial combinations of four rates of nitrogen fertilizer (0, 37.5, 75 and 112.5 kg ha^{-1}), three rates of phosphorus (0, 22.5 and 45 kg ha^{-1}) and three rates of potassium (0, 22.5 and 45 kg ha^{-1}) that were laid out in a completely randomized block design replicated three times. Results showed that highest number of branches, leaves, seeds per pod, seed yield and dry matter was recorded from the highest N rate of 112.5 kg ha^{-1}. Optimum number of leaves and dry matter was attained at 112.5 kg N ha^{-1} while number of pods and seed yield were attained at 75 kg N ha^{-1}. Number of seeds per pod was not significantly affected by N application. Sesame height and number of branches were optimum at 22.5 kg P ha^{-1} while number of leaves, seeds per pod, seed yield and dry matter were optimum at 45 kg P ha^{-1}. K fertilizer did not significantly affect the number of branches, seeds per pod, seed yield and dry matter while number of leaves and pods were optimum at 22.5 and 45 kg K ha^{-1} respectively. In conclusion, application of 75 kg N ha^{-1}, 45 kg P ha^{-1} and 22.5 kg K ha^{-1} produced the highest seed yield. [New York Science Journal 2010;3(12):21-27]. (ISSN: 1554-0200).

Keywords: Nitrogen rates; phosphorus rates; potassium rates; sesame; yield characters

Introduction

Sesame (*Sesamum indicum* L.) is an important oil seed crop of the warm region of the tropics and sub-tropics. It is considered to be the most ancient oil seed crop as Ethiopia is considered to be the centre of cultivated crops (Weis, 1983). The importance of sesame lies in its high content of oil, protein, calcium, iron and methionine (Gupta et al, 1998). The demand for this important crop is on the increase with Chinese Agro-product companies demanding for over 15,000 metric tones valued at $12 million or N1.86 billion. Nigeria is expected to have generated about $150 million in 2004 (Anon, 2005).

Farmers in the savanna areas of Nigeria have no definite fertilizer recommendations for the production of sesame as a sole crop as most crops are grown in a mixture with sorghum or millet (Singh and Msari, 1986). Survey reports have also shown that fertilizers are not applied to sesame even in major sesame growing areas of Nigeria. This, view was upheld by many farmers especially in the savanna areas of Nigeria. This coupled with the low fertility status of the soil and low levels of management are responsible for low yield of sesame in Nigeria.

However, there are paucities of information about the production of sesame as a sole crop and there is disparity in formation about sesame response to fertilizer application. Researches on the nutrition of sesame in the tropics have shown significant yield increase due to nitrogen, Phosphorus and potassium in India (Subrammanian et el, 1979, Dauley and Singh, 1982, Kalaiseivan, 2002), Pakistan (Malik et al, 2003), nitrogen and phosphorus in Tanzania (Taylor, et al, 1986). This becomes imperative to establish a fertilizer recommendation from this part of the globe. Hence this study was initiated with the objectives of determining the effects of rates of nitrogen, phosphorus and potassium fertilizers on the performance of sesame under Mubi conditions.

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 and 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 and 112.5 kg ha^{-1}), 3 phosphorus rates (0, 11.25 and 22.5 mg P kg^{-1} soil or 0, 22.5 and 45 kg ha^{-1}) and 3 rates of potassium (0, 11.25 and 22.5 mg K kg^{-1} soil or 0, 22.5 and 45 kg ha^{-1}). There were 36 treatment combinations replicated 3 times, giving a total of 108 pots and arranged in completely randomized design. 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. Three kg of the soil was placed in plastic pots and five seeds per pot were sown evenly.

The seedlings were thinned down to one plant, two weeks after sowing. The plants were irrigated to 75% equivalent to 790 cm^3 of water. Harvesting was done after the pods were mature. Growth and yield characters were determined. 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 effects of N, P, and K fertilizers on yield and yield components of sesame are shown in Table 1. Application of N fertilizer significantly influenced all the parameters except plant height and number of seeds pod^{-1}. Application of N at 37.5 kg N ha^{-1} slightly increased plant height while 75 and 112.5 kg N ha^{-1} showed a decrease of 0.2 and 4.8% lower than the control. However, the differences were not significant ($P>0.05$). Number of branches increased linearly with increased N rates. Application of 112.5 kg N ha^{-1} gave the highest
number of branches (2.11) which significantly differed from N application at 37.5 and 0 kg N

ha^{-1} but did not differ significantly from 75 kg N ha^{-1} rate. Number of leaves had a similar trend, 37.5 and 75 kg N ha^{-1} were not significantly different from each other but were significantly higher than 0 kg N ha^{-1} and lower than 112.5 kg N ha^{-1} rate. Number of pods was significantly influenced by application of N fertilizer. Application of N fertilizer at 75 and 112.5 kg N ha^{-1} did not differ significantly from each other but differ with 37.5 and 0 kg N ha^{-1} rates with higher values. Number of pods per plant produced at 37.5 kg N ha^{-1} application was significantly higher than pods produced at 0 kg N ha^{-1}. Number of seeds per pod was similar in the pots that received N fertilizer and those that did not. 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}. Application of N fertilizer significantly influenced dry matter yield at harvest. Dry matter yield differed significantly from each other at all N rates as 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 enhanced the vegetative and yield parameters of sesame except for number of seeds in pods. Higher values than control was recorded at 22.5 and 45 kg P ha^{-1} for plant height, number of branches per plant and number of leaves. Number of pods, seed yield and dry matter yields were significantly higher at 45 kg P ha^{-1} than at 22.5 kg P ha^{-1}.

K fertilizer application had significant influence on the plant height, number of leaves and number of pods per plant. Number of branches, number of seed per pod, seed yield and dry matter yield were not significantly influenced by K fertilizer application. K application at 45 kg ha^{-1} significantly reduced plant height than control.

The interaction between N and K fertilizers was only significant ($P<0.05$) for seed yield and dry matter yield (Fig. 1a and b). 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 ha^{-1}. For dry matter yield, the highest value (12.20 g pot^{-1}) was recorded at the interaction of N at 112.5 kg N ha^{-1} and 0 kg K ha^{-1}.

The interaction effect of P and K on the growth, yield and yield components of sesame was not significant. The interaction effects between N and P fertilizers on plant height (Fig. 2a) and branches (Fig. 2b) were significant. Number of branches was highest at 112.5 kg N ha^{-1} and 45 kg P ha^{-1}. The interaction of N, P and K fertilizers was significant for seed (Table 2) and dry matter yield (Table 3). Highest seed yield was obtained when 75 kg N, 45 Kg P and 22.5 kg K ha^{-1} (4.10 g $plant^{-1)}$. Highest dry matter yield was obtained at 112.5 kg N, 45 kg P and 45 kg K ha^{-1} (13.14 g $plant^{-1)}$. The pot that did not receive either of the fertilizers recorded the lowest seed (1.84 g $plant^{-1}$) and dry matter (4.76 g $plant^{-1}$) yields.

Table 1: Effects of N, P and K fertilizers on yield and yield components of sesame grown in pots.

Fertilizer	Plant height (cm)	Number of branches	Number of leaves (plant^{-1})	Number of pods plant^{-1}	Number of seed pod^{-1}	Seed yield (g lant^{-1})	Dry matter (g plant^{-1})
N (kg ha^{-1})							
0	105.33^{a}	1.52^{c}	29.00^{c}	19.78^{c}	46.04^{a}	2.58^{c}	8.26^{d}
37.5	106.44^{a}	1.74^{bc}	36.22^{b}	24.63^{b}	47.04^{a}	3..15^{b}	9.39^{c}
75	105.11^{a}	1.93^{ab}	35.59^{b}	29.37^{a}	47.30^{a}	3.42^{a}	11.33^{b}
112.5	100.19^{a}	2.11^{a}	38.63^{a}	28.48^{a}	47.48^{a}	3.45^{a}	11.98^{a}
SE±	12.13	0.36	1.94	2.20	3.34	0.25	0.68
P (kg ha^{-1})							
0	91.17^{b}	1.56^{b}	30.64^{c}	23.58^{b}	46.56^{a}	3.13^{b}	9.58^{b}
22.5	114.44^{a}	2.03^{a}	34.31^{b}	25.03^{b}	46.14^{a}	2.96^{b}	10.13^{b}
45	107.19^{a}	1.89^{a}	39.64^{a}	28.08^{a}	48.19^{a}	3.34^{a}	11.00^{a}
SE±	12.13	0.36	1.94	2.20	3.34	0.25	0.68
K (kg ha^{-1})							
0	112.72^{a}	2.00^{a}	32.64^{b}	24.36^{b}	46.17^{a}	3.07^{a}	10.10^{a}
22.5	105.47^{a}	1.72^{a}	36.11^{a}	25.92^{b}	47.58^{a}	3.20^{a}	10.27^{a}
45	94.61^{b}	1.75^{a}	35.83^{a}	26.42^{a}	47.14^{a}	3.18^{a}	10.34^{a}
SE±	12.13	0.36	1.94	2.20	3.34	0.25	0.68
Interaction							
N x K	ns	ns	ns	ns	ns	*	**
P x K	ns	ns	ns	ns	ns	ns	ns
N x P	***	**	ns	ns	ns	ns	ns
N x P x K	ns	ns	ns	ns	ns	**	***
SE±	12.13	0.36	1.94	2.20	3.34	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.

* = 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

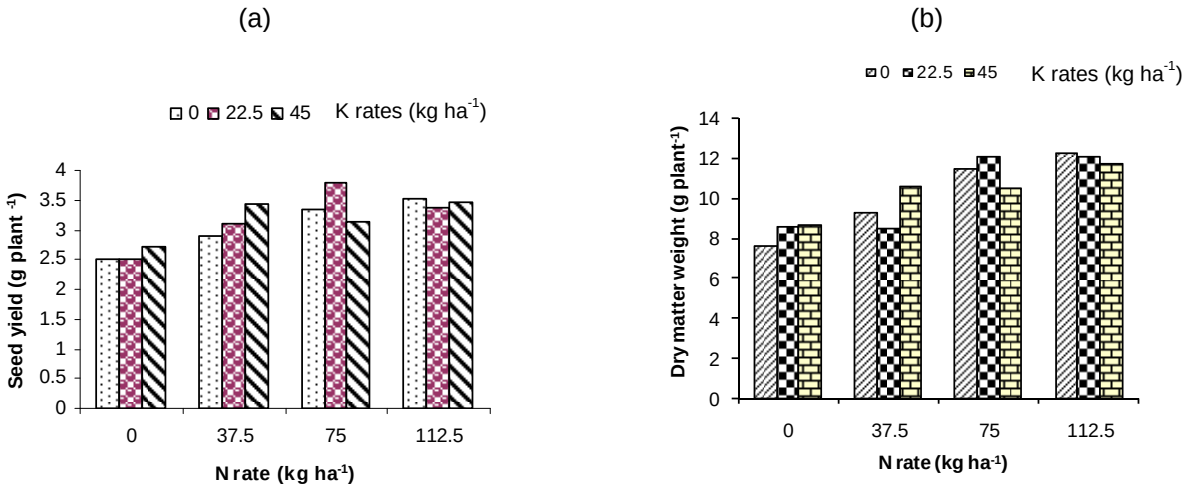

Fig. 1: Interaction effect of N and K on (a) seed yield (b) dry matter yield of sesame (g plant^{-1})

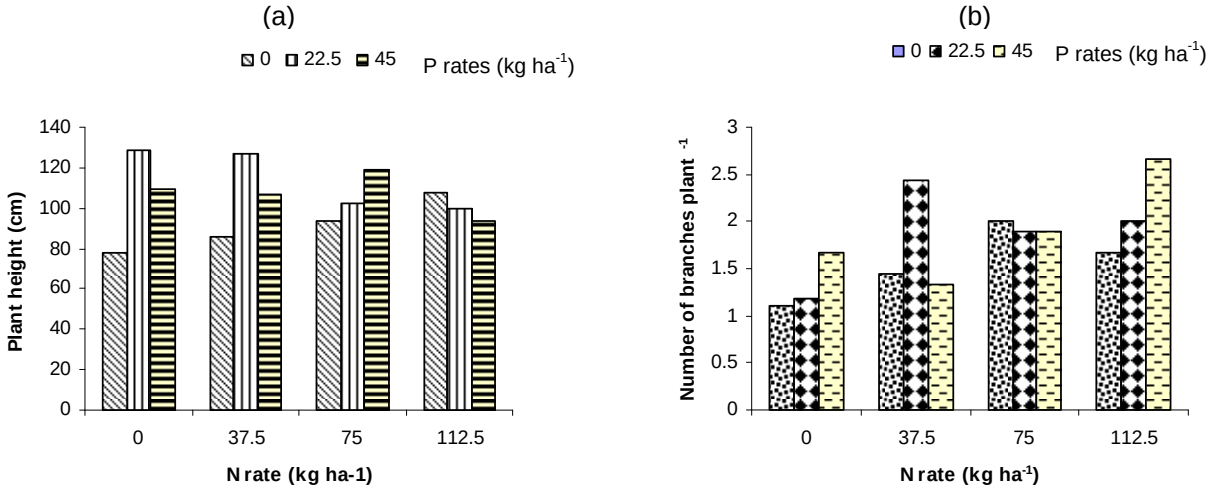

Fig. 2: Interaction effect of N and P on (a) plant height (b) number of branches of sesame plant^{-1})

Table 2: Interaction effect of N, P, and K fertilizer on seed yield of sesame (g plant^{-1}).
Means followed by the same letter(s) are not significantly different at 5% level of probability using Duncan Multiple Range Test.

N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1}) 0	22.5	45
0	0	1.84^{k}	2.77^{e-j}	2.71^{e-j}
	22.5	2.41^{i-k}	2.16^{jk}	2.57^{g-k}
	45	3.28^{a-i}	2.59^{g-k}	2.88^{d-i}
37.5	0	3.08^{b-i}	3.77^{a-c}	2.78^{e-i}
	22.5	2.55^{h-k}	2.89^{c-i}	3.48^{b-f}
	45	3.06^{b-i}	2.66^{e-i}	3.91^{ab}
75	0	3.50^{a-e}	3.90^{ab}	2.95^{c-i}
	22.5	3.15^{b-i}	3.37^{a-h}	3.19^{b-i}
	45	3.36^{a-h}	4.10^{a}	3.24^{a-h}
112.5	0	3.86^{ab}	3.08^{b-i}	3.36^{a-h}
	22.5	3.27^{a-i}	3.39^{a-h}	3.28^{a-i}
	45	3.44^{a-g}	3.68^{a-d}	3.70^{a-d}
	SE±	0.25		

Table 3: Interaction effect of N, P, and K fertilizer on dry matter yield of sesame (g plant^{-1}).

N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1}) 0	22.5	45
0	0	4.76^{l}	8.65^{g-k}	8.53^{h-k}
	22.5	8.02^{k}	7.66^{k}	8.37^{i-k}
	45	9.93^{d-k}	9.37^{d-k}	9.07^{e-k}
37.5	0	10.39^{c-i}	8.31^{i-k}	8.52^{h-k}
	22.5	8.10^{jk}	8.81^{f-i}	10.35^{c-j}
	45	9.20^{d-k}	8.11^{jk}	12.71^{ab}
75	0	11.46^{a-d}	12.70^{ab}	9.42^{d-k}
	22.5	11.48^{a-c}	10.87^{a-g}	11.03^{a-f}
	45	11.32^{a-e}	12.59^{a-c}	11.06^{a-f}
112.5	0	11.02^{a-f}	10.70^{b-h}	10.60^{b-i}
	22.5	12.73^{ab}	12.74^{ab}	11.33^{a-e}
	45	12.84^{ab}	12.72^{ab}	13.14^{a}
	SE±	0.68		

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

Discussion

The significant response of yield and yield characters to N application is an indication of the role N in plant nutrition. N is one of the limiting nutrients in the savanna soils and plays an important role in vegetative growth, Number of branches, leaves, pods, seed per pod, seed yield an dry matter were highest at 112.5 kg N ha^{-1} rate. Optimum number of pods and seed yield were obtained at 75 kg N ha^{-1} indicating that the crop needs is met at this level while number of leaves and dry matter yields were attained at 112.5 kg N ha^{-1} indicating that the crop need of this important character is yet to be met. The present findings are in conformity with the results obtained by Subrammanian et al, (1979) and Babaji et al (2006) who reported significant increase in the number of pods at 60 kg N ha^{-1}. The highest seed yield recorded at 112.5 kg N ha^{-1} is in agreement with the findings of Roy et al, (1995) who recorded highest seed yield of sesame in India at 120 kg N ha^{-1}. The optimum seed yield obtained at 75 kg N ha^{-1} is also in conformity with findings of Roy et al, (1995) who reported economically optimum yield from 66.27 – 69.13 kg N ha^{-1}.

The significant response of the number of leaves to N may have led to increase in photosynthetic activity thereby resulting in heavily branched plant. This in turn enhanced pod production and thus increased seed yield. This result agrees with the findings of Sharma and Kawal (1993), Ishwar et al (1994) and Mankar and Satao (1995).

Results obtained from this study shows significant improvement in the growth and yield characters as a result of phosphorus fertilizer application. This may not be surprising considering the role of P in root development which in turn plays a very important role in the uptake of moisture and nutrients as well as providing anchorage. Its essentiality is noted as it is a constituent of cell nucleus and functions in cell division as energy provider. The response of plant height and number of branches were significant up to 22.5 kg P ha^{-1}, while number of leaves, number of pods, seed yield and dry matter yield were significant up to 45 kg P ha^{-1} rate. The significant response of leaves, number of pods and seed yield to P application obtained in this study differ from the reports of Olowe and Busari (2000) and Muhamman et al (2009) who reported non significance at 60 and 45 kg P ha^{-1} respectively but corroborates with the reports of Deshmuch et al (1990) and Kene et al (1992). The status of P in savanna soils especially those with history of intensive cultivation are generally low, hence the significant response to such growth parameters of sesame to P fertilizer application.

Improvements were recorded in number of leaves and pods as a result of K fertilizer application. The lack of response to other growth and yield characters could be associated with its functions and thus little influence on growth and yield of sesame unlike N and P. This agrees with the findings of Weis (1983) who reported that K is often applied as a compound mixture not because it is required by sesame but can b e necessary to maintain nutritional balance where substantial amounts of N and P are applied.

The significant interaction of N x K on seed yield and dry matter could be due to the nutritional balance in the uptake of N which significantly improved number of branches, leaves and pods. The significant interaction between N and P on plant height and number of branches could be due to the importance of these nutrients in the growth and development of crops. P functions in the formation of more roots there by enhancing the uptake of more nutrients including N. This is indicated in the significant and positive correlation between P and N uptake. Similar results were reported by Ishwar et al (1994) and Mankar and Satao (1995). Significant interaction of N x P x K on seed yield and dry matter could be due to nutritional balance that favours the functioning of each nutrient in the growth and development of crops.

Conclusion

Optimum seed yield of sesame was recorded at 75 kg N and 45 kg P ha^{-1} while performance of sesame to K fertilizer application at rate lower than 22.5 kg ha^{-1} need to be studied. However, the strength of relationship between seed yield and number of branches, leaves and pods were found to be very strong.

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