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Influence of Nitrogen and Phosphorus Fertilizer on Growth and Yield of Vegetable Sesame (*Sesamum radiatum* Schum.) in the Nigerian Savanna

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ABSTRACT

A field experiment was conducted to evaluate the response of vegetable sesame to nitrogen and phosphorus fertilization. The treatments consisted of a factorial combination of three rates each of N 0, 50 and 100 kg N ha^{-1} and P 0, 11, and 22 kg P ha^{-1}). Arranged in a Randomized Complete Block Design with three replicates. The crop established a positive response to N application, with higher values for growth, vegetative and yield optimized at the highest rate of 100 kg N ha^{-1}. The application of 22 kg P ha^{-1} resulted in taller plants, with a greater number of leaves and branches and heavier dry leaf weight. Combined application of 100 kg N + 22 kg P had the highest values of growth and yield parameters, while those that received none of the two fertilizers recorded the lowest values for both growth and yield components. Therefore, application of 100 kg N ha^{-1} resulted in rapid vegetative growth and higher vegetative yield, while the application of 22 kg P ha^{-1} led to rapid crop growth of vegetative sesame during the early stages.

Key words: Vegetable sesame, Nitrogen, Phosphorus, Fertilization.

INTRODUCTION

Vegetable Sesame (*Sesamum radiatum* Schum) is a member of the family Pedaliaceae that occurs throughout tropical Africa mainly as a weed (Hutchinson and Dalziel, 1983). It is gathered as a wild plant and used as a pot herb and also used solely as an ingredient for vegetable soup. The crop is rich in protein, vitamins, and minerals. (Tindall, 1986). Two types are common: the grain and vegetable types (Malhai et al., 1978). The grain type belongs to the following species: *Sesamum orientale* Linne, *Sesamum indicum* Linne while the vegetable type belongs to *Sesamum radiatum* Schum. Sesame species have great variability in leaf size, leaf shape, growth and regrowth ability, number of economic branches and color (Edema, 1978). The crop is an annual, short-lived growing leafy vegetable with an erect stem of about 1.0-1.5 m high depending on the variety and environmental conditions. The leaves are the most important and economic part of the crop and are of various shapes and colour ranging from light green to dark green. Vegetable sesame is a hardy plant that exhibits a low water requirement, vigorous growth, high genetic diversity and productivity (Anonymous, 1985). It requires medium clay loams that are fertile. High. High fertility is desirable for profitable vegetable sesame (Schmidt, 1971; Babaji *et. al.,* 2006; Mukhtar *et. al.,* 2006; Auwalu, 2006). An experiment conducted in Bauchi during the rainy seasons of 1996 and 1997 found a significant increase in plant height, number of leaves, and leaf fresh weight with the application of 30 to 60 kg N and 15 to 30 kg P ha^{-1}. Therefore, it is important to reconfirm the crop's response to N and P fertilizers under the local conditions of Samaru, Zaria, where the crop plays a vital role in the means of many families. A preliminary study was therefore conducted during the 2008 rainy season to determine the effect of nitrogen and phosphorus fertilizer on the growth and vegetable yield of vegetable sesame.

MATERIALS AND METHOD

A field experiment was conducted at the research farm of the Institute for Agricultural Research, Ahmadu Bello University, Samaru, Zaria (Latitude 11^0 11 N and Altitude 686m above sea level) in the Northern Guinea Savanna ecological zone of Nigeria. The treatment consisted of a factorial

combination of three levels of nitrogen (0, 50, 100 kg N/ha) and phosphorus (0, 11, 22 KgP/ha). The treatments were later factorially combined and laid out in a Randomized Complete Block Design (RBCD) with three replications. Urea (46%) was used as a source of nitrogen. The N was applied in 2 equal split doses at 1 and 4 WAS. Single superphosphate (SSP, 18%$P2O_2$) was applied as a source of P in one dose at planting. Both fertilizers were applied by band placement. Between two stands, a distance of 10 cm was maintained from each stand.

The experimental field was first ploughed and harrowed before making ridges, and the ridges were flattened to form a bed of 1.5 m x 1 m ($1.5m^2$) size. The bed was raised above ground for better drainage. The seedlings were gap-filled at 3 weeks after sowing (WAS) with inter- and intra-row spacing of 20 x 20 cm to each other. Vegetable sesame seeds were sown directly onto the already prepared seed bed. Small pitches of the seeds were sown at 1- 2 cm depth and heavily covered with soil. The crop was thinned to three seedlings per stand at a spacing of 20 x 20 cm. Weeds were controlled manually by hoeing at 3, 6 and 9 WAS as well as by hand picking. The plant was harvested manually at maturity by hand-pulling of two inner rows.

The harvested plants were immediately weighed, and the fresh vegetable yield was determined. Likewise, at full maturity, another two rows of the crop were harvested, put in a jute bag and thoroughly beaten. The seeds collected were put in a tagged envelope and later weighed. The data collected were subjected to analysis of variance (ANOVA) using the F test as described by Snedecor and Cochran (1967) to check for significant differences among the means. The differences between the means were compared using the Duncan Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS

The effect of rates of nitrogen and phosphorus fertilizer on the height of vegetable sesame at 5, 7, 9 and 11 (WAS) is shown in Table 1. Application of nitrogen significantly influenced the height of vegetable sesame. Each increase in nitrogen rate from 0 to 50 and further to 100 Kg/ha had led to a corresponding increase in the height of vegetable sesame at all the sampling periods. Application of phosphorus fertilizer also significantly influenced the height of vegetable sesame at 5, 7, 9 and 11 WAS. Tallest plants were obtained at the highest rate of 22 Kg/ha. This, in turn, was on par with those at 11 kg/ha at 7 and 9 WAS only.

Table 1: Effect of Nitrogen and Phosphorus levels on Plant height (cm) of Vegetable sesame at Samaru during the 2018 rainy season

Treatment	Week after sowing (WAS)			
	5	7	9	11
Nitrogen (KgN/ha)				
0	4.43c	6.11c	35.70c	37.15c
50	5.78b	7.44b	48.42b	51.01b
100	7.12a	8.54a	56.74a	61.60a
SE+	0.13	0.16	2.09	2.14
Phosphorus (KgP/ha)				
0	5.52b	7.09b	42.42b	39.40c
11	5.67b	7.28ab	48.93a	50.02b
22	6.14a	7.73a	49.42a	63.32a
SE	0.13	0.16	2.09	2.14
Interaction				
N x P	**	NS	NS	NS

Means in column of any set of treatment followed by unlike letter(s) are significantly different at 5% level of significance using DMRT.
NS = Not Significant.

The interaction of nitrogen and phosphorus on the height of vegetable sesame was significant at 5 WAS (Table 2). At fixed P levels of 0, 11 and 22 kg/ha, increasing the N rate from 0 further significantly increased the plant height of vegetable sesame. But when the effect of increasing P level at fixed N

rates of 50 and 100 kg/ha was studied, it was observed that 0 and 22 kg\p/ha had statistically similar plant height that was taller than for 11 KgP/ha. However, at a fixed N rate of 50 kg/ha, varying the P rates did not significantly affect height when N was not applied; 22 kg/ha had taller plants than the P treatment.

Table 2: Interaction of Nitrogen and Phosphorus on the Plant height of Vegetable sesame at 5 WAS at Samaru during the 2008 rainy season

Treatment	Phosphorus (KgP/ha)		
	0	11	22
Nitrogen (KgN/ha)			
0	3.93e	4.57de	4.80d
50	5.63c	5.67c	6.03c
100	7.00ab	6.77b	7.60a
SE±	0.22		

Interaction means followed by unlike letter(s) are significantly different at 5% level of significance using DMRT.

Table 3 shows the effect of nitrogen and phosphorus fertilizer on plant dry weight of vegetable sesame at 9 and 13 (WAS). Application of nitrogen significantly influenced plant dry weight of vegetable sesame at 9 and 13 weeks after sowing (WAS). Each increase in nitrogen rate from 0 to 50 KgN/ha and further to 100 KgN/ha had led to a corresponding increase in plant dry weight of vegetable sesame. Phosphorus fertilizer did not significantly affect plant dry weight of vegetable sesame. Increase in P rate from 0-11 and further to 22 KgN/ha had led to significant improvement in plant dry weight. The interaction of nitrogen and phosphorus fertilizer on plant dry weight was not significant at 9 and 13 (WAS).

Table 3: Effect of Nitrogen and Phosphorus levels on plant dry weight (g) of Vegetable sesame at Samaru during the 2018 rainy season

Treatment	Week after sowing (WAS)	
	9	13
Nitrogen (KgN/ha)		
0	5.91c	10.22c
50	10.77b	18.01b
100	13.44a	28.30a
SE±	0.32	0.54
Phosphorus (KgP/ha)		
0	9.58	13.13c
11	10.05	17.99b
22	10.45	20.41a
SE±	0.32	0.54
Interaction		
N x P	**NS**	**NS**

Means in column of any set of treatment followed by unlike letter(s) are significantly different at 5% level of significance using DMRT.
NS = Not Significant.

Response of stem dry weight to application of N and P at 9 and 13 weeks after sowing (WAS) is presented in Table 4. Application of nitrogen significantly influenced stem dry weight of vegetable sesame at 9 and 13 (WAS). Each increasing N rate from 0 to 50 KgN/ha and further to 100 KgN/ha significantly increased stem dry weight of vegetable sesame. Application of phosphorus fertilizer also significantly influenced stem dry weight of vegetable sesame at 9 and 13 WAS; stem dry weight of vegetable sesame that received 22 KgP/ha was heavier than for the control. The interaction of nitrogen and phosphorus on stem dry weight was not significant.

The influence of N and P fertilizer on fresh vegetable yield of vegetable sesame is shown in Table 5. Increasing N from 0 to 50 KgN/ha and further to 100 KgN/ha significantly increased the fresh vegetable yield. Fresh vegetable yield did not respond significantly to the application of phosphorus fertilizer. The interaction of nitrogen and phosphorus fertilizer on fresh vegetable yield of vegetable sesame was not significant.

Table 4: Effect of Nitrogen and Phosphorus levels on stem dry weight (g) of Vegetable sesame at Samaru during the 2018 rainy season

Treatment	Week after sowing (WAS)	
	9	13
Nitrogen (KgN/ha)		
0	2.94c	4.09c
50	4.74b	7.44b
100	6.20a	9.04a
SE±	0.16	0.26
Phosphorus (KgP/ha)		
0	4.43b	6.76c
11	4.52ab	8.30b
22	4.94a	9.04a
SE±	0.16	0.26
Interaction		
N x P	**NS**	**NS**

Means in column of any set of treatment followed by unlike letter(s) are significantly different at 5% level of significance using DMRT.
NS = Not Significant.

Table 5: Effect of nitrogen and phosphorus fertilizer levels on Fresh vegetable yield of sesame at Samaru during the 2008 rainy season

Treatment	Fresh Vegetable Yield (t/ha)
Nitrogen (KgN/ha)	
0	12.99c
50	23.81b
100	30.26a
SE±	1.15
Phosphorus (KgP/ha)	
0	20.47
11	23.26
22	23.29
SE±	1.15
Interaction	**NS**

Means in column of any set of treatment followed by unlike letter(s) are significantly different at 5% level of significance using DMRT.
NS = Not Significant.

DISCUSSION AND CONCLUSION

Vegetable sesame showed either similarities or differences in growth and development. The variation in growth and development could be attributed to the adequate and well-distributed rainfall experienced in 2008, which was adequate for both vegetative and reproductive phases of the crop. The significant response of growth and yield parameters of vegetable sesame to nitrogen fertilizer recorded in this experiment was expected. This is due to the fact that nitrogen is one of the limiting nutrients in savannah soil and plays an important role in rapid vegetative growth. Nitrogen is also important in photosynthesis due to its role in the formation of chlorophyll, nucleic acids, and amino acids. The similarity in percent dry matter allocated to stem between the N fertilizer and unfertilized plots at 13 WAS could mean that allocation of dry matter to the plant part could either be genetically controlled or the N requirement was satisfied at an earlier stage. However, other crop parameters responded significantly to N application, with an optimum value attained at 100 KgN/ha indicating that

the crop need is yet to be met. The significant response of plant height, plant dry weight, stem dry weight and fresh vegetable yield to N shows that production of taller plants with more leaves could mean increased interception of light and photosynthesis. This, in turn, means more assimilate production that makes up the plant parts. Hence, the reason for attaining the highest vegetable and grain yields at similar N rates. This agrees with what was reported by Osman (1993). Phosphorus is important in root development, which in turn is responsible for moisture uptake and nutrients, as well as providing anchorage.

Phosphorus is one of the most essential elements needed by plants due to the fact that it is a constituent of the cell nucleus. The status of P in most savanna soils, especially those with a history of intensive cultivation, is generally low. Hence, the reason for the significant response of some parameters of vegetable sesame to P application. The response of plant height at11 (WAS) was significant up to the highest P rates of 22 KgP/ha significant. But for the plant dry weight and stem dry weight, the response was up to 11 KgP/ha only at 5 and 9 WAS, indicating that the crop need was met at this rate. Vegetable sesame generally responded to phosphorus application in this trial. This could probably have been as a result of low phosphorus status of the experimental soil. This is in conformity with the findings of Alabi (2006) that reported a positive response of vegetable sesame growth parameters to applied phosphorus in P-deficient soil. Application of phosphorus fertilizer had resulted in the production of taller pepper with large plant dry weight and enhanced growth rate. This, in turn, means greater light interception, thereby leading to greater assimilate production that led to higher stem and total vegetable sesame plant dry weights.

The significant interaction of N x P on plant height and number of leaves could be due to the importance of N and P as nutrients in the growth and development of the plant. The low N and P in savannah soil might have contributed immensely to the positive response of these parameters. The results show that the highest N rate of 100 KgN/ha had the highest value for plant height, plant dry weight, stem dry weight and fresh vegetable yield of vegetable sesame. significantly influenced by phosphorus application, with taller plants recorded at the highest P rate of 22 KgP/ha. Likewise, optimum leaf and plant dry weight at 13 WAS, stem dry weight, and leaf dry weight were highest at a P rate of 22 KgP/ha. The combination of N x P at the rates of 100 KgN/ha and 22 KgP/ha had the taller plants with the highest number of leaves. In conclusion, application of 100 kgN/ha and 22 KgP/ha resulted in the highest vegetable sesame yield.

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