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PERFORMANCE OF SESAME UNDER NPK FERTILIZATION IN THE SOUTHERN GUINEA SAVANNA AGRO-ECOLOGICAL ZONE OF NIGERIA.

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ABSTRACT

The role of primary macronutrients in the nutrition of Sesame plant (*Sesame indicum.* L) cannot be over emphasize. These three primary nutrient elements, nitrogen, (N) phosphorus (P) and potassium (K) play vital role in several physiological and biochemical processes in crop plants. A field trial was conducted to evaluate the role and effects of these nutrients in sesame plant at National Cereals Research Institute (NCRI) Badeggi, southern guinea savanna agro-ecological zone of Nigeria. The objectives of the study were to evaluate; the effects of NPK fertilization on the performance and growth parameters of sesame. The treatments were 0N, 0P, 0K, 60N, 30P, 30K kg ha^{-1} (recommended rate), 60N, 0P, 0K kg ha, $^{-1}$ 60N ,30P ,0K kg ha^{-1} 60N, 0P, 30K kg ha^{-1} 0N, 30P, 0K kg ha^{-1} 0N,30P,30k kg ha^{-1} 0N,0P,30k kg ha^{-1}. The experimental layout was Randomized Complete Block Design (RCBD) with three replications. The application of the primary nutrients enhances the growth and yields of the plant, but reduces the maturity period. The highest grain yield of 3,893 kgha^{-1} was obtained from the treatment with 60N,0P,30K kgha^{-1} which was significantly different from that of the other treatments. The lowest grain yield of 1,546 kgha^{-1} which was significantly lower than that of the other treatments was recorded for the control.

KEYWORDS: NPK fertilization, Sesame, Southern Guinea Savanna, Agro-ecological Zone.

INTRODUCTION

Sesame plant is an erect annual herb growing up to 2 m tall with a strongly tapering taproot up to 90 cm long that bears many lateral roots. Many cultivars of sesame crop with varying characteristics exist. These can be distinguished by their branching habit, leaf morphology, fruit dehiscence and seed colour. Sesame is a broadleaf plant that grows to a height up to 1.5 to 2 meters, depending on the variety and growing conditions (Geremew *et al*., 2012). Sesame is the second most important edible oil crop in Nigeria after groundnut, since its introduction into Nigeria after the Second World War.

It has been recognized as a crop with a high economic potential in Nigeria, both as a source of raw materials for industries and a reliable foreign exchange earner (Alegbejo, 2019; NCRI, 2021). The primary macro-nutrients are nitrogen, phosphorus and potassium. They are the most frequently required nutrients in crop fertilization program. They boost the plant enzyme function, improves biochemical processes and help in plant cell division. Lack of primary nutrients can affect plant health, growth and consequently affect the crop production output. Nitrogen is the most used and most essential of the three primary nutrients. It is the major source of protein content of crop plants.

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Nitrogen does not only enhance yield but also improves food quality (Leghari *et al.,*2019). Nitrogen also improves quality of leaves, biomass production and the protein content of sesame seeds. The addition of N generally has the greatest effect on plant growth and a considerable influence on plant product quality, especially through increases in protein concentration and oil quality of sesame (Rajasekar *et al*., 2017). Phosphorus is an essential macronutrient involved in most growth processes. It is an essential component of most organic compounds in the plant, including nucleic acids, proteins, phospholipids, sugar phosphates, enzymes, and energy-rich phosphate compounds. Potassium is another essential primary nutrient that plays a major role in the metabolic process and stress management of plants. Moreover, it is important for better drought tolerance and protein synthesis in sesame (Ahmad *et al*.,2018).

Statement of Research Problem

Studies conducted revealed that farmers in Southern Guinea Savanna areas of Nigeria do not really follow definite fertilizer recommendations for sesame either as a sole crop or when grown in mixture with other crops, which are mostly cereals (Olowe, 2017). Survey reports by various researchers in Nigeria have shown that fertilizers are not applied to sesame even in major sesame growing areas. (Idowu, *et al.,* 2016; Ugbani, *et al.,* 2018; Babaji *et al.,* 2019; Hamman, 2021). The low fertility status of the moist savannah soils and low level of right agronomic management practices, are responsible for low yield of sesame in Nigeria. Sesame nutrition has remained very controversial for long time, while some researchers are of the opinion that sesame does not require fertilization while others believe that the crop needs to be fertilized (Okpara *et al.,* 2016). The productivity of the crop in Nigeria is very low, about 250 to 450 kg ha^{-1} compared to the global yield level of 1.5 to 2 t ha^{-1}, because traditional sesame grower in Nigeria rarely applies the primary macronutrients (NPK) to the soil as they believe the crop perform well even without fertilization and on poor soils (Haruna and Usman, 2019). One of the limitations in sesame production is the lack of information about nutrient requirements and deficiencies. Therefore, the objective of the study is to evaluate; The effects of NPK fertilization on the performance, growth and yield of sesame.

MATERIAL S AND METHODS

Description of the Study Area

The field trial was conducted during 2023 rainy season at National Cereals Research Institute (NCRI) Teaching and Research Farm Badeggi (Latitude 9^0 04' 03.290"N, Longitude 6^0 05' 33. 708"E and at Altitude 100 m above sea level). The climate of badeggi in Niger state is sub-humid and the rainfall pattern is monomodal, with rainy season starting from April to October with an average rainfall monthly ranging from 80 mm to 200 mm and annual rainfall of 800 mm to 1200 mm. Its geological landscape is developed on a sedimentary basin formed by Nupe sand stones and younger sediments deposited by rivers and weathering (NCRI, 2021).

Experimental Design and Treatments

The experimental design was Randomized Complete Block (RCBD) with three replicates to give a total of 24 plots. The gross plot size of the experimental plots was 3 m x 3 m ($9m^2$) with 1 m alley way between the plots, while the net plot size was 1.5 m x 1.5 m (6.25 m^2). The treatments consist of the primary macronutrients N, P, K with eight levels, 0 N + 0 P + 0 K (absolute control), 60 N + 30 P + 30 K kg ha^{-1}(recommended rate), 60 N+ 0 P+0 K kg ha^{-1}, 60N+ 30 P+ 0 K kg ha^{-1}, 60 N + 0P+ 30 K kg ha^{-1}, 0 N+ 30 P+0 K kg ha^{-1}, 0 N +30 P+30 K, kg ha^{-1}, 0 N+ 0 P +30 K kg ha^{-1}.

Table.1: Treatments and their designations.

S/N	Treatments	Designations
1	0N + 0P + 0K (absolute control)	A
2	60N + 30P + 30K kg ha^{-1} At recommended rate of (N, P, K)	B
3	60N+ 0P + 0K kg ha^{-1} At recommended rate of (N)	C
4	60N + 30P + 0K kg ha^{-1} At recommended rate of (N and P)	D
5	60N + 0P + 30K kg ha^{-1} At recommended rate of (N and k)	E
6	0N + 30P + 0K kg ha^{-1} At recommended rate of (P)	F
7	0N + 30P + 30K, kg ha^{-1} At recommended rate of (P and K)	G
8	0N + 0P + 30K kg ha^{-1} At recommended rate of (K)	H

The experimental field was ploughed and ridged manually at 50 cm apart. The prepared land was then marked out and sub-divided into required plots and replications in accordance with the marked layout design of the experiment. The sesame variety, NCRIBEN04E was used for the trial. The sesame seeds were weighed on an electronic kitchen scale 10g each plot and planted manually at a shallow depth of 1cm by drilling on the ridges at inter-row spacing of 50 cm.

For plots requiring P and K fertilization, P and K were applied using single superphosphate and muriate of potash respectively by basal application at planting time. For plots requiring N application, N was supplied by urea fertilizer and 1/3 was applied 2weeks after sowing (2WAS) and the remaining 2/3 applied at 6 weeks after sowing (6WAS). All the fertilizers were applied by band placement method at 5 cm away from plant stand and 5cm deep.

Hoe weeding was done at 3WAS and 6WAS.

Data Collection

Data were collected from 5 randomly tagged plants on plant height, days to 50% flowering, number of branches, number of capsules per plant and grain yield, within each experimental plot during the plant growth at 6, 8, 10 and 12 weeks after sowing (WAS).

Plant height

Plant height of five (5) tagged plants in each plot was measured from the base of the plant to its apex using meter rule and the mean calculated and recorded.

Days to 50% flowering

The number of days to 50% flowering, i.e. days to half of the experimental plot; flowering in each plot was observed and recorded.

Number of branches per plant

The number of branches on each of the five (5) tagged plants in each of the experimental plots was counted at 6,8,10 and 12 WAS, and the mean was calculated and recorded.

Numbers of capsules yield per plant

This was determined by carefully counting the number of capsules on each of the five (5) tagged plants from each of the experimental plots and the mean was calculated and recorded.

Harvesting

The fully matured plants from each of the five (5) tagged plants in each of the 24 experimental plots were harvested manually by carefully cutting the stem at the base using sharp sickle. The harvested plants were then placed in a sack and allow to fully dry before threshing.

Grain yield

The clean grain from net plot of each of the experimental plots; was weighed to determine the grain yield and converted to per hectare.

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) and where significant, means were compared using Duncan Multiple Range Test (DMRT). Pearson correlation analysis was used to determine the relationship between the soil and agronomic parameters. All computations were done using Statistical Tools for Agricultural Research (STAR, 2020). Means were compared at 5% level of probability unless otherwise stated.

RESULTS AND DISCUSSIONS

Effects of NPK fertilization on Growth and Yield Components of sesame

The effects of primary nutrients NPK fertilization on plant height at different growth stages are shown in Table.3. The primary nutrients had significant effect on plant height at all the growth stages. The results showed that the effects were more pronounced at the early growth stages, where application of the nutrient produced significantly taller plants than the control irrespective of the rate or nutrients applied. The results showed that the growth rate at the early stage of the crop was significantly influenced by these nutrients compared to the later growth stages of the crop. This result also shows that sesame growth rate within the first six (6) weeks of planting was significantly influenced by these three essential primary plants nutrients, NPK, but at later stages of life, N and K fertilizers seems to play a more significant role than the P Fertilizer. The result of this study is consistent with the results as observed by NCRI; (2021), who observed that fertilization with NPK significantly influenced the growth of sesame plant within the first eight (8) weeks of planting. It has been observed by Roy *et al.;* (2008) that plant height, number of leaves and number of branches were increased with increased in nitrogen levels up to 90 kg ha^{-1}, but the number of capsules per plant and while 1000 seeds weight did not respond to nitrogen application.

Table 2: Effects of NPK fertilization on plant height at different growth stages.

Treatments	Plant Height (cm)			
	6 WAS	8 WAS	10 WAS	12 WAS
0N+0P+0K	18.00b	40.33d	90.07d	98.90de
60N+30P+30	31.87a	58.13bc	97.47c	103.70cd
60N+0P+0K	27.67a	64.67abc	104.90b	113.13ab
60N+30P+0k	29.80a	66.13ab	92.47cd	102.53cd
60N+0P+30K	29.80a	62.33abc	112.37a	119.13a
0N+30P+0K	29.20a	57.67bc	83.33e	93.30e
0N+30P+30K	27.33a	69.07a	79.33e	84.00f
0N+0P+30k	28.87a	56.00c	95.87cd	109.17bc
SE ±	3.34	3.76	2.61	3.56

Means in the same column followed with the same letter (s) are not significantly different at 5 % level of probability.

Effect of NPK fertilization on number of Branches of sesame.

The effects of primary nutrients (NPK) on number of branches are shown in Table.3. The number of branches produced at all growth stages of the plant was significantly affected by fertilization with the nutrients. The application of the recommended rate of the primary nutrients produced more branches than the other treatments at the early growth stage of the crop. Similarly, Srivastava *et al*., (2016). also reported that the primary nutrients play significant roles in the number of branches produced by sesame plant as their application is one of the major farming operations needed to correct their deficiencies in the soil in order to ensure good growth of crops. Shehu *et al.,* (2010) working in Nigeria reported an increase in the number of branches, number of leaves, total dry matter and seed yield with increased N up to 122.5 kg ha^{-1}, but plant height and number of seed per capsules were not affected by N level above 37.5kg ha^{-1}, while the number of capsules increases with increase in N up to 75 kg ha^{-1}.

Table.3. Effects of NPK fertilization on number of Branches of sesame.

Treatment	Number of branches			
	6 WAS	8 WAS	10 WAS	12 WAS
0N + 0P+ 0K	1b	1c	4bc	4bc
60N +30P+ 30K	2a	3a	4bc	5ab
60N+ 0P+ 0K	2a	2b	6a	6 ab
60N + 30P+ 0k	1b	2b	4bc	3c
60N + 0P + 30K	1b	1c	5a	6a
0N + 30P +0K	1b	1c	4bc	5ab
0N+ 30P+30K	1b	1c	3c	4bc
0N+0P+30k	1b	1c	3c	4bc
SE±	0.40	0.25	0.5	0.47

Means in the same column followed with the same letter (s) are not significantly different at 5 % level of probability.

Effects of NPK fertilization on Days to 50% flowering, number of capsules yield and grain yield per hectare

Generally, the application of the nutrients reduced significantly the number of days to flowering compared to the control except treatment with K only which had similar number of days to flowering as the control (Table4). The results of the days to 50 % flowering suggest that the application of the nutrients have positive influence on the plant metabolic process and early maturity. This result is in close conformity with Ahmad *et al.;* (2018) that reported that the application of NPK fertilization at the rate of 60N:30P:30K kg ha^{-1} gives the best result for soil health, growth and yield parameter of sesame in Southern Guinean Savannah of Nigeria. However, it has been reported by Mankar and Santao (1995) Owuna (2006) that, days to 50 % flowering, weight of capsule per plant, seed weight per capsule, 1000 seed weight were not significant with increased N level up to 60 kg N ha^{-1}. It has also been reported by Muhammad *et al.,* (2009) that days to 50 % flowering and days to maturity were not significantly affected by increased N level up to 90 kg N ha^{-1}, but weight of biomass at harvest, dry weight of leaves and number of capsules per plant were increased with increased nitrogen up to 90 kg ha^{-1}.

Number of Capsules

The number of capsules produced by each plant was significantly affected by the application of the nutrients (Table 4). All the fertilized treatments produced significantly higher number of capsules compared to the control, except the treatments without N, and the one without N and P which had statistically similar number of capsules by each plant. The application of N and K without P produced the highest number of capsules; (74) while the lowest number (24) was produced by the control and application of only K. The treatments with N produced more capsules than those without N with only P or K or both. The application of inorganic fertilizer has been reported to increase yield compared to control plot without fertilizer application by researchers Haruna, 2010; Umar *et al.,* 2012). Nitrogen and K nutrients play major role in several physiological process and K performs functions including enzyme activation, therefore their availability influences the growth and yield of crops (Kale *et al.,* 2019).

Grain Yield

The grain yield is significantly higher than the average yield of 450 kg ha^{-1} quoted for Nigeria, 825 kg ha-1 in Ethiopia, 609 kg ha^{-1} in Uganda and 1323 kg ha^{-1} in Egypt and the projected potential yield of 1.2 t ha^{-1} for Nigeria (FAO,2009). As would be expected, the results of the grain yield were similar to that of the capsules produced by each plant (Table 4). There was significant effect of nutrient fertilization on the grain yield. The control had the lowest yield of 1547 kg ha^{-1} which was significantly different from that of the fertilized treatments except the treatment with P and K without N (1840 kg ha^{-1}). Similar to capsule production, the treatment with N and K without P produced the highest yield of 3893 kg ha^{-1} which was significantly different from that of the other treatments. These results suggest that N and K are more important than P in the growth and development of sesame plant. The low average yield in Nigeria may be ascribe to the traditional sesame growers not applying fertilizers that supply the primary nutrients due to their belief that the crop can perform well without fertilization and on poor soils. This is in addition to lack of improved seeds, improper agronomic practices such as under or over planting densities and lack of pest and diseases control (Haruna and Usman, 2019).

Table; Effects of primary nutrients on Days to 50% flowering, numbers of capsules yield per plant and Grain yield per hectare of sesame Plant

Treatments	Days To 50 % Flowering	Number of Capsules Plant $^{-1}$	Grain Yield (kgha^{-1})
0N + 0P + 0K	55a	24c	1547e
60N +30P +30K	39d	49b	3067b
60N + 0P + 0K	44c	50b	3333b
60N + 30P +0k	43c	50b	2453cb
60N + 0P +30K	45bc	74a	3893a
0N + 30P + 0K	48b	40b	2640c
0N + 30P + 30K	48b	24c	1840e
0N + 0P + 30k	53a	29c	2267d
SE±	1.66	4.61	159.28

Means in the same column followed with the same letters are not significantly different at 5% level of probability

CONCLUSION

The study had evaluated the effects of the primary nutrients, N, P, K fertilization in sesame plant production in Badeggi, southern Guinea savanna of Nigeria. Fertilization of Sesame crop with primary nutrients reduced the maturity period of the plant. Nitrogen and K were the most critical in the performance of the plant. The combined application of N and K without P gave the highest yields.

RECOMMENDATIONS

Based on the findings of this study, the following are recommended;

i. The soil organic matter should be increased by incorporating crop residues to improve the physical, chemical, and biological properties of the soil.
ii. Adequate fertilization with primary nutrients.
iii. More studies to be carried out to validate the results of this study.
iv. Studies to be carried out on the appropriate rate of the secondary and micronutrients.

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f 60N: 30P: 30K (kg ha^{-1}) recorded the highest value of 2.80, followed by the application of 60N and 30P (kg ha^{-1}) which recorded a mean value of 2.00. The rest were not significantly different. At 10 WAS, the application of 60N (kg ha^{-1}) only recorded the highest mean value of 6.07, followed by the application of 60N and 30k (kg ha^{-1}) that recorded 5.40 mean value. The rest were not significantly different. At 12WAS, the application of 60N:30k (kg ha^{-1}) recorded a mean value of 6.40 follow by the application of 60N only with the mean value of 5.40. The rest of the treatment's combinations were not significantly different. This result implies that these three primary plant nutrients play significant roles in the numbers of branches of the sesame plant and this result is in conformity with (Srivastava et al., 2016). That reported that fertilizer application is one major farming operation needed to correct deficiencies in the soil in order to ensure proper growth and functioning of crops with the aim of increasing yield.