GROWTH AND YIELD OF OKRA UNDER GA_3 (GIBBERELLIC ACID) FOLIAR APPLICATION AND MULTINUTRIENT NPK FERTILIZER

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ABSTRACT

A field survey was conducted during the rainy season in June to September, 2023 in the research garden of Biological Science Department of Al-Qalam University, Katsina, Nigeria. Five levels of GA_3, namely; 0, 10, 15, 20 and 25 ppm were sprayed at 2 weeks after sowing. A randomized block design was used to lay out the treatments (RBD). GA_3 treatments significantly increase the plant height than control plants. GA_3 with 20 and 25 ppm significantly increase in terms of number of leaves. Okra treated with 15ppm showed highest weight of (94.58g) with 8 total numbers and lowest (38.5g) in 10ppm. Whereas, in Clemson spineless, the highest plant height (17.5cm) was recorded in 20ppm and the lowest height was (5.2cm) of the control in NPK. While in GA3 20ppm recorded (28.9cm) and the lowest 10cm. Okra treated with 10ppm showed the highest weight of (47.09g) with 5 total number and the lowest is 0 at 20ppm. The significant means were calculated using Analysis of Variance (ANOVA) where the calculated P-value of local variety (0.003975) and (0.009687) for Clemson Spineless are lower than (0.05). This implies that, there is a significant difference in the means of all the tested parameters. Therefore, the research recommends the use of local seeds during plant and growing Okra plant.

Keywords: NPK (Nitrogen, Phosphorus, Potassium), Gibberellic acid (GA3), Okra, Fertilizers

INTRODUCTION

Okra (*Abelmoschus* L.) is a popular vegetable in tropical and sub-tropical countries around the world. It is available all year round and is also planted for its pods (Abdulrahman et al., 2019; Behbahai et al., 2020). It is a member of Malvaceae hibiscus family and shares the tropical flora traits of that family native to Africa. In many parts of the world, especially in developing countries, it is used as a vegetable (Abdulrahman et al., 2022; Ali et al. 2018). It grows best in warm weather (around 26^0C). The main Okra growing countries are India, Nigeria, Pakistan, Ghana and Egypt. Due to its storage sensitivity, Okra is used fresh, cooked, or as a chemical additive in soups, salads, and stews. Fresh Okra is mostly preserved by freezing, and in some countries the fruit is dried for later use. Okra has high economic value, good nutritional and functional properties, and can improve food safety (Agatonovic et al., 2020). Okra can be grown in large plots, but fertile, well-drained soil with sufficient organic matter ensures high yield (Abdulrahman et al., 2023). To develop edible young fruit, Okra needs a moderate, well-distributed rainfall of 80 to 100cm. An average temperature between 20^oC is considered optimal for growth, flowering

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and fruiting (Da Silva et al., 2021; Abdulrahman, 2018). Okra plants responded with significant increase with increase in NPK application, this could be because most vegetable crops require NPK fertilizer of about 40-60 N, 20- 40 P and 20-40 K (kg ha-1) for optimum growth and yield development, however, where these nutrients are insufficient or inadequate, application of the deficient elements through fertilization are well encouraged and recommended under different agromatic conditions which can be manipulated to maximized production from a unit land area. Therefore, the increase in growth with increase in NPK fertilizer. Babatola and Olaniyi (1999) f Musa et al. (2017) and Smith et al. (2001) who reported that the use of NPK under good environmental conditions significantly influenced the growth of okra and cowpea. The crop requires adequate supply of nutrients particularly nitrogen, phosphorus and potassium for optimum growth and yield. Another study had shown that the application of N and or NPK led to significant increase in the growth of okra (Katung et al.1996). Growth characters such as plant height, shoot fresh weight, number of leaves per plant, number of primary branches per plants are maximized either at 60 or 90 kg N ha-1 at early stage of growth.

All plants naturally produce hormones that regulate metabolism, growth and development (the shape, size, and function of plants) in response to their environment. Hormones (or chemical messengers) are produced in different places (shoots, leaves and roots) and travel through the plant system until they bind to receptors and trigger reactions in the target cells (Ginovyan, 2019; AL-Taey & Saadoon, 2021). Hormones affect cell division, cell expansion, cell structure and function, and have the ability to control the plants' response to environmental stress (Ferguson & Grafton-Cardwell, 2014; AL-Taey, 2018). The environmental protection agency (EPA) defines plant growth regulator as any substance or mixture of substances designed by physiological action to accelerate or slow the rate of growth or maturation, or otherwise alter the behavior of plants. Furthermore, plant growth regulators are characterized by low application rates, while high doses of the same compounds are often considered herbicides. Plant hormones are naturally produced by plants and are essential in regulating their own growth. They act by controlling or altering plant growth processes such as leaf, flower formation, stem elongation, fruit development and ripening (Davies, 2010; AL-Taey, 2017). Plant growth hormone levels have been measured to positively improve plant germination, growth and development by altering plant hormonal activity (Oladunmoye et al., 2018). Plant growth hormones are widely used in agriculture, viticulture and horticulture, for example, to promote growth under non-ideal or stressful conditions; low soil fertility, disease short growing season (Abdulrahman, 2019), and to increase yields and facilitate harvesting of plants, for example, by preventing fruit drop before harvest and accelerating ripening (Da Silva 2021; AL-Taey, 2020). The application of fertilizer is necessary for enhancing the soil nutrient status and increasing crop yield. Okra requires nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sodium (Na) and Sulphur (S) for fertility maintenance and crop production. These nutrients are specific in function and must be supplied to plants at the right time and at the right quantity. Lack of sufficient amounts of these nutrients result in poor performance of the crop with growth been affected resulting to low yield (Shukla and Naik, 1993). The present research was designed to find out the influence of Gibberellic Acid (GA3) on growth and yield parameters of Okra. (*Abelmoschus esculentus)* through the following objectives

I. To determine the difference in physiological parameters of Okra in NPK

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II. To access the performance of two Okra varieties under different treatment of Gibberellic Acid.

MATERIALS AND METHODS

Study Area

The research was conducted in the Biological garden and Biological laboratory of Al-Qalam University, Katsina, north-western of Nigeria in the period, between the months of June to September, 2023.

Site Clearing

The site that was used as nursery was properly cleared, all stumps were removed. The grasses and other weeds were cleared and packed away. The site was properly leveled. The nursery appeared as a plane surface. Adequate artificial drainage was facilitated, so that the nursery was not water logged during the work (Erhonoyta et al., 2020). Sand used for the nursery operation was river sand preferably sandy loam to facilitate aeration and proper root development within the pitting mixture. Clay soil was has not been used, this is because of its poor aeration and root development (Jaberian, 2013).

Sample Collection

The Okra seeds samples were collected from seed vendors in Katsina Central Market. The samples were transported to Biological Science Laboratory of Al-Qalam University, Katsina, Nigeria. After which, they were stored in the oven for later use.

Planting

Before planting of the seeds, they were soaked overnight for 18hrs in warm water. This is to break the seed dormancy and speed up seed germination. Two seeds samples were sown per hole at a depth of about 2cm.

Experimental Design

Randomized block design (RBD) was employed as an experimental design during the research. The treatment were: (A) Okra with GA3 at 10ppm, (B) Okra with GA3 at 15ppm, (C) Okra with GA3 at 20ppm, (D) Okra with GA3 at 25ppm, and (E) Okra at 0% without any treatment, which was the control of the experiment. The experiment (treatment) was conducted in triplicate. 26 polythene bags were used during the trials.

Preparation of Gibberellic acid (GA3)

1mg of GA3 with 100ml of distilled water —>10ppm
1mg of GA3 with 95ml of distilled water—>15ppm
1mg of GA3 with 90ml of distilled water—>20ppm
1mg of GA3 with 85ml of distilled water —>25ppm
Control

Fertilizer Application

The fertilizer applied was NPK20:10:10, it was applied for 14days after planting (DAP). Whereas, the Gibberellic Acid (GA3) was at 48 DAP. This coincided with the time of floral bud initiation.

Data Collection

Growth parameters such as plant height, number of leaves, number of pods, and weight of pods have been recorded. Number of leaves and plant height were noted for up to 3 weeks. That was; 3^{rd}, 4^{th}, 5^{th} week after planting the seedlings in the garden.

Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA), to find out the significant means at P value ±0.05.

RESULTS AND DISCUSSION

In our research, the height of Okra plant treated with NPK was significantly increased throughout the treatment. The magnitude of increase of plant height was found to be more pronounced in treatment with 25 ppm NPK. This is followed by 20 to 10 ppm,

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respectively, at the same concentration (Table 1). In the 3rd, the highest plant height, (914.7 cm) was recorded for 25 ppm NPK, whereas the lowest plant height (95.5cm) was recorded in the control sample.

Table 1: Effect of NPK Fertilizer (20: 10: 10) on growth parameters of local variety at the same concentration

Treatment	week1		week2		week3	
	N.L	P.H	N.L	P.H	N.L	P.H
10ppm	7.3	7.4	4.3	9.7	3.7	10.8
15ppm	6.7	7.8	10	9.4	10	14.3
20ppm	7	6.4	5.3	9.1	8.7	11
25ppm	3	8.1	7.7	12.2	6.3	14.7
Control	3	4.5	3	5	4	5.5
Mean	5.4	6.84	6.06	9.08	6.54	11.26
STD	2.20	1.45	2.79	2.59	2.79	3.69
Variance	3.87	1.69	6.25	5.37	6.24	10.90

P-value = 0.0003

Key=N.L (number of leaves) P.H (plant height)

From Table 2, the growth gradually increased from 1st week to week 2ndweek for all the treatments. In the 2nd week, the highest plant height (28.3cm) was recorded for 20 ppm whereas the lowest plant height (10cm) in the control.

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Table 2: Effect of Gibberellic Acid on different growth parameters of local variety at different concentration

Treatment	week1		week2		week1	week2
	N.L	P.H	N.L	P.H	N.P	N.P
10ppm	10.3	18.8	10.7	20.7	2.7	3.7
15ppm	9.7	24.1	13	25	3.7	3.3
20ppm	13.3	24.7	16	28.3	2	3.7
25ppm	12.7	24	10.3	25.3	2	4.3
Control	6	10	5	10	1	1
Mean	10.4	20.32	11	21.86	2.28	3.2
STD	2.89	6.24	4.04	7.16	0.99	1.28
Variance	6.71	31.16	13.11	41.03	0.79	1.31

P-value=0.003975

KEY: N.L= Number of Leaves, P.H= Plant Height, N.P= Number of Pods

Yield Parameters of Local Variety

Okra Treated with 15ppm showed significantly highest weight of (94.58g) with 8 Total number of okra, followed by treatment 20ppm with (87.47g) and 25ppm with (65.47g) and the lowest weight recorded (38.5g) is by treatment with 10ppm.

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Table 3: Yield Parameters of Local Variety

Treatment	Number of okra	Weight(grams)
10ppm	3	38.5
15ppm	8	94.58
20ppm	7	87.47
25ppm	5	65.47

It was noted that, the height of Okra plant treated with NPK significantly increased. The magnitude of increase of plant height was found to be more pronounced in treatment with 20 ppm NPK, followed by 25ppm, 15ppm and 10 ppm respectively, at the same concentration (Table 4). In the 3rd, the highest plant height, (17.5 cm) was recorded for 20 ppm NPK, whereas the lowest plant height (5.2cm) was found in the control.

Table 4: Effect of NPK Fertilizer (20: 10: 10) on growth parameters of Clemson spineless at the same concentration

Treatments	week1		week2		week3	
	N.L	P.H	N.L	P.H	N.L	P.H
10ppm	3	4	2	5.7	5	6.7
15ppm	4.7	8.5	5.3	10.4	8.7	12
20ppm	5.3	10.7	8.3	14.8	15.7	17.5
25ppm	3	8.1	7.7	12.2	6.3	14.7
Control	3	4	2	5	3	5.2
Mean	3.8	7.06	5.06	9.62	7.74	11.22
STD	1.11	2.96	3.01	4.20	4.90	5.21
Variance	0.99	7.02	7.25	14.16	19.26	21.76

P-value=1.74E-05

KEY: N.L= Number of Leaves, P.H= Plant Height

From Table 5, the growth of Okra was gradually increased from 1st to 2ndweek for all the treatments. In the 2nd week, the highest plant height (28.9cm) was recorded in 20ppm whereas the lowest plant height (10cm) for the control.

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Table 5: Effect of Gibberellic Acid on different growth parameters of Clemson spineless at different concentration

Treatment	week1		week2		week1	week2
	N.L	P.H	N.L	P.H	N.P	N.P
10ppm	7.7	13	6.3	14.3	1	1.6
15ppm	9	18.7	8	25.3	2.7	3.3
20ppm	8.7	29	9.3	28.9	1.3	2.3
25ppm	12.7	24	12.3	25.3	5	27.3
Control	5	9	4	10	1	1
Mean	8.62	18.74	7.98	20.76	2.2	3.1
STD	2.77	8.07	3.12	8.13	1.71	2.49
Variance	6.14	52.15	7.81	52.99	2.35	4.99

P- Value = 0.009687

KEY: N.L= Number of Leaves, P.H= Plant Height N.P= Number of Pods


Plate 1: Number of Okra on 15ppm Plate 2: Number of Okra on 20ppm

Okra Treated with 10ppm showed significant weight of (47.09g) with 5 Total number of okra, followed by treatment with 15ppm with (23.4g) and 25ppm with (11.13g) and the lowest weight recorded is 0 by treatment with 20ppm

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Table 6: Yield Parameters of Clemson Spineless

Treatment	Number of okra	Weight(grams)
10ppm	5	47.09
15ppm	1	23.4
20ppm	0	0
25ppm	4	11.13

Based on the findings from this research, the height of Okra plant treated with GA3 was significantly increased. The magnitude of increase of plant height was found to be more significant in treatment with 25 ppm GA3, followed by 20 to 10 ppm of the same (Table 1). At Week 3, the highest plant height, (14.7 cm) was recorded for 25 ppm NPK, whereas the lowest plant height (5.5cm) was found in the control.GA3 enhances growth activities of plant, stimulates the rate of cell division, cell elongation, and thus, also contributes to internodes and stem elongation (Azwanida 2014; Sasidhraran et al., 2011). The results of the research are in agreement with that of mustard plant reported by Davies, (2010). They recorded the highest plant height (95.77 cm) with the application of 50 ppm GA3, which was statistically similar to 75 ppm GA3 treatment and, the lowest (77.63 cm) was found in the control. Table 2 revealed that, the growth gradually increased from week 1st to 2nd weeks for all the treatments, there is also significant increase in the control following all the GA3 treatments at different growth stages. 20 ppm has highest plant height (28.3cm) and lowest 10cm in the control. Okra Treated with 15ppm showed significant highest weight of (94.58g) with 8 Total number of Okra, followed by treatment with 20ppm with (87.47g) and 25ppm with (65.47g) and the lowest weight recorded was on treatment with 10ppm. The finding is in agreement with Emongor, (2007) for *Hibiscus sabdariffa* L. where application of GA3 increased the shoot and the root dry weight compared to other treatments. Significant increase of fruit yield in many crops due to the application of different concentrations of GA3 was reported by many investigators like; Peervan et al. (2020); Ferreira et al. (2022). The height of Clemson Spineless of Okra plant treated with NPK was significantly increased. The magnitude of increase of plant height was found to be more pronounced in treatment with 20 ppm NPK, followed by 25ppm, 15ppm and 10 ppm respectively, at the same concentration (Table 4). In the 3rd week, the highest plant height, (17.5 cm) was recorded for 20 ppm NPK, whereas the lowest plant height (5.2cm) was found in the control. Positive influences of GA3 on HI were reported by Emongor, (2007) for Cowpea. As presented in Table 5, the growth gradually increased from Week 1st to 2nd week for all the treatments. There is significant increase on the control following all the GA3 treatments at different growth stages. In the 2nd week, the highest plant height (28.9cm) was recorded in 20ppm, whereas the lowest plant height 10cm was found in control. GA3 may induce the development of xylem and phloem and in turn,

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increase the flow and deposition of assimilation products in seeds (Abdulrahman, 2022). Table 6 results revealed that, Okra treated with 10ppm showed significant highest weight of (47.09g), with 5 total number of Okra, followed by treatment with 15ppm with (23.4g), and 25ppm with (11.13g) and the lowest weight recorded was 0 by treatment with 20ppm. The findings of the research are in line with that of mustard plant reported by Davies, (2010).

CONCLUSION

Based on the findings from the present research, it is apparent that GA3 had significant effects on all the growth and yield parameters of Okra, both local variety and Clemson Spineless. GA3 at 20 ppm was found to be the optimum concentration for the highest growth and yields of Okra. On the other hand, the research recommends that Gibberellins acid (GA3) should be used under strict control. A periodic monitoring of GA3 concentration in the soil and on the plant need to strictly put in place. Further research is necessary to explore other hazardous effects of GA3 on body system and organs of animals. In addition, more studies with prolonged periods of administration of GA3 are recommended to have more knowledge on the toxic effects of GA3.

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