Response of okra varieties to different humic acid fertilizer levels.

Abstract

Background and Objective: Poor soil fertility is a great limitation to crop production. The adverse effects of chemical fertilizer and the unavailability of organic fertilizer in large quantities are another challenge. The research was conducted at theResearch Farm of Ekiti State University, Ado-Ekiti, Nigeria to examine the effects of appropriate doses of humic acid (HA) fertilizers for maximum performance of okra. **Materials and Methods:** The experiment was laid out in Randomized Complete Block Design (RCBD) with three replicates. The two factorial experiments comprise four levels of humic acid fertilizer (0, 5.0, 10.0, and 15.0 g HA plant^{-1}) and NPK 15-15-15 (150 kg hac^{-1}), and two okra varieties. The two okra varieties were allocated to main plots while the fertilizer levels were allocated to sub-plots. The collected data on final plant height (cm), the number of leaves per plant, the number of fruits per plant, the weight of fresh fruit per plant (g), the fruit length (cm), the leaf area (cm^{3}), the fruit diameter (cm), and the stem diameter (cm) and analyzed with the IRRI STAR Software. **Results**: The result showed that the traits measured were significantly different for (HA) levels and NPK fertilizers. The varieties were significantly different for the measured traits except for leaf area, fruit diameter, and fruit length while the varieties x amendment levels were significant for plant height, leaf area, fruit diameter, and stem diameter while others are not significant. The measured traits increases as the humic acid levels increase. It was observed that the plants that received 15.0 g HA plant^{-1} performed better, followed by 10.0g HA plant-^{1} and NPK 15-15-15 respectively. However, the differences in the plants that received 5.0g HA plant^{-1} and 7.5g HA plant^{-1} were minute. **Conclusion**: It is therefore concluded that 5.0g HA plant^{-1} should be applied for optimal okra yield.

Keywords: Fertilizer level, Humic acid, Okra, Traits, Yield.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is a vegetable crop that is majorly cultivated for its tender fruits and seed oil [1]. Okra is an annual crop grown mainly within the tropical and subtropical zones across the world [2]. The immature okra pods were used for soup preparation [3] or mixed with other soup ingredients to augment viscosity [4]. The pods are rich in protein content, amino acids, vitamins, fat, mineral elements, and fibre [5]. The crop growth, development, and yield are results of its genotypic expression [6] but the genotypic expression is a factor of the environment where the crop is grown. Among the factors includes, the soil micronutrients and bio-stimulants that played a key role in the efficient use of available nutrients in the soil [7]. Micronutrients are essential for plant growth and development, and their deficiencies result in crop yield reduction. Okra is a high fresh pod-yielding crop varying from 4,480 to 5,500 kg ha^{-1} depending on the okra varieties grown, prevailing environmental factors where the crop is grown and agronomic practices adopted [8].

Poor fresh pod yield in okra production has been a limiting factor due to insufficient soil nutrients for optimum plant performance [9]. Inorganic fertilizers have been the major way of supplementing deficient soil nutrients. These inorganic fertilizers are not eco-friendly, cost-effective, and not affordable to poor resource farmers [10]. The use of organic fertilizer in place of inorganic fertilizer is a way forward. However, some organic manuals are bulky, not readily available, and not properly decomposed which harbors pests and pathogens [11]. The use of natural substances such as humic substances is an emerging technique in rescuing the farmers and the ecosystem from the detrimental effects of inorganic fertilizer [12].

Humic substances are remains of decomposed living organisms (plants and animals) through a series of geochemistry stages [13]. The humic substance is classified into humic acid and fulvic acid based on their solubility [14]. Humic acid comprises different soil nutrients with phenolic and carboxylic compounds that increase soil physical and biochemical properties that increase soil organism population [15] and enhance soil nutrient availability by chelating and co-transporting micronutrients to plants [16]. Humic acid is found to promote plant hormones such as cytokinnin and auxin [17,18]. This research was conducted to determine the effects of humic acid fertilizers and the appropriate application levels for maximum performance and to compare humic acid at different levels with NPK 15-15-15 fertilizers.

2.0 MATERIALS AND METHODS

2.1 Research location description

The study was carried out at the Teaching and Research Farm of the Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti between September to December 2022. The experimental area is situated within a tropical humid climate. The study location was left to follow for two years before the commencement of the study. The fallow vegetation was mechanically ploughed, harrowed, and ridged. A composite soil sample was taken from the experimental site randomly at a depth of 0-15cm before land preparation with the soil auger.

2.2 Experimental materials

The two okra varieties (Clemson spineless and EW-Okra denoted as V1 and V2 respectively) and NPK 15-15-15 used for the research were gotten from the Agricultural Fountain Input Supply Agency of the Ekiti State Government Ministry of Agriculture, Ado-Ekiti, Nigeria. The two varieties were products of Premier Seed Company, Zaria, and East-West Seeds Company. The humic acid fertilizer was gotten from Red Arrow Nigeria Limited., Anambra Nigeria.

2.3 Experimental design and treatment

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates. The two factorial experiment comprises four levels of humic acid (0, 5.0, 10.0, 15.0) g plant^{-1} and NPK 15-15-15, and two okra varieties. The two okra varieties were allocated to main plots while the fertilizer levels were allocated to sub-plots. Each row was 15 m long and the plant was sown at a depth of 2-3 cm in 60 x 50 cm spacing. The crops were raised by adopting good routine agronomic practices. NPK 15-15-15 fertilizer was applied at 150 kg ha^{-1} using the ring method two weeks after planting [19].

2.4 Data collection and Statistical Analysis

Five randomly selected plants per plot were tagged for data collection. Data were collected on plant height (cm), number of leaves per plant, number of fruits per plant, fresh fruit weight per plant (g), leaf area (cm^3), fruit diameter (cm), fruit length (cm), and stem diameter (cm). The plant height was measured 10 weeks after planting with the aid of the meter rule, fresh fruit weight per plant was weighed using the electronic sensitive scale at every harvest and later added together while fruit diameter (cm), fruit length (cm), and stem diameter (cm) were measured with Vernier caliper. Data were analyzed using the IRRI STAR Software version 2.0.1 (2014). Means were separated using the Dun can multiple Range Test ($P \leq 0.05$) level of significance.

3. RESULTS AND DISCUSSION

3.1 Soil Properties of the Experimental Site

The chemical and physical properties of the soil (0-15cm) in the experimentalsite were presented in Table 1. The values for the soil pH, total carbon (g kg^{-1}), organicmatter (g kg^{-1}), Total Nitrogen (g kg^{-1}), Available Phosphorus (mg kg^{-1}), Ca^{2+} (cmol kg^{-1}), Mg^{2+} (C mol kg^{-1}), K^+ (cmol kg^{-1}), Na^+ (cmol kg^{-1}) 5.88, 0.89, 9.0, 1.02, 0.61, 0.11 and 0.12 respectively. Thesoil textural class is Sandy loam. Soils in most parts of West and Central Africa are inherently low in nutrients[20]. They are mainly kaolinitic Alfisols that are generally low in organic matter and cation exchange capacity [20]. The pH value of 5.88 indicates that the soil is slightly acidic in nature. The pH of the soil is within the acceptable range [21]. At this soil pH level, the soil nutrient availability for plant root uptake is high [22]. The total nitrogen and organic matter content in the soil were low compared to the respective 1.5-2.0 g kg^{-1} and 25-30 g kg^{-1} soil nutrient critical levels. The soil available phosphorus was also below the soil nutrient critical level of 10-15 mg kg^{-1}[23]. Moreover, exchangeable potassium which is 0.11 cmol kg^{-1} was less compared to the critical range of 0.6 to 0.8 cmol kg^{-1}. Soil texture is an essential soil property that determined the soil nutrient and water-holding capacity, plant growth, and development. The textural class of the soil is sandy loam.

Table 1: The soil physiochemical properties of the soil sample.

Properties	Values
Sand (g kg^{-1})	591.74
Clay (g kg^{-1})	198.20
Silt (g kg^{-1})	210.06
Textural Class	Sandy loam
pH (H_20)	5.88
Total Carbon (g kg^{-1})	8.93
Organic Matter (g kg^{-1})	1.50
Total Nitrogen (g kg^{-1})	0.89
Available Phosphorus (mg kg^{-1})	9.0
Ca^{2+} (cmol kg^{-1})	1.02
Mg^{2+} (cmol kg^{-1})	0.61
K^+ (cmol kg^{-1})	0.11
Na^+ (cmol kg^{-1})	0.12

The analysis of variance for all the traits measured was presented in Table 2. There were significant differences in all the traits measured in the two varieties except leaf area, fruit diameter, and fruit length though at different levels. This could be a result of differences in the genetic constituent of these varieties [24]. The levels of humic acid amendment and NPK fertilizer were significant among all the measured traits ($P<0.01$) except fruit length. The variety by amendment levels interaction was significant for plant height, leaf area, and fruit diameter ($P<0.05$), and stem diameter is significant ($P<0.01$) while other measured traits were not significant. This showed that humic acid levels and fertilizer had effects traits measured.

The mean performance of the traits measured was presented in Table 3. The result revealed that the parameters measured increase as the humic acid level increase. It was observed that the plant height increases as the humic acid level increases. However, the percentage increase in plant height that received 10.0 and 15.0 g HA plant^{-1} was low compared to the plants that received 5.0 and 10.0 g HA plant^{-1}. The percentage increase from 10.0 to 15.0 g HA plant^{-1} was 1.78%. Moreover, the plants that received NPK 15-15-15 fertilizer application recorded lesser value for plant height compared to the plants that received 10.0 and 15.0g HA plant^{-1}. The result showed that humic acid at 10.0 g per plant enhances the growth of okra more than NPK 15-15-15 fertilizer. There were significant differences among all the traits studied at different amendment levels. The results showed that the plant that received 0 g HA level (control) had the least mean value for all the traits studied while 15.0 g HA level had the highest mean value for all the studied traits. The performances of the plants that received humic acid beyond that of NPK 15-15-15 could be the role of humic acid in nitrogen, sulfur and, phosphorous uptake and cell elongation properties [25].

The application of humic acid increases the uptake of calcium, which plays a major role in the mitotic cell division of apical meristems and influences plant height. Similar findings were reported by Nadeem *et al*., [26].

Canellas *et al*., [27] reported the significant roles humic acid played in plant growth and development. Humic acid increases the leaf chlorophyll content which aids photosynthetic activity and increase photosynthate formation and hence, the yield of a crop is increased. The findings from this study are in agreement with the reports of Sadeghi *et al*., [28] who found a significant increase in the yields of cucumber, pepper, and tomato respectively with the application of humic acid. The report of Sarhan[2011] on potatoes shows that humic acid is beneficial for plants.

CONCLUSION

From this research, okra performance including fruit yield increases as the humic acid level increase. Okra plants that received 0 g HA plant^{-1} had the least pod yield value while those that received 15.0 g HA plant^{-1} had the highest pod yield value The research revealed that 10.0 and 15.0g HA plant^{-1} gave higher pod yield than 150 kg NPK 15-15-15 ha^{-1}. However, the percentage yield increase from 10.0 and 15.0g HA plant^{-1}was minimal. It is therefore recommended that humic acid should be applied to the okra plant at the rate of 10.0g HA plant^{-1} for maximal and profitable pod yield.

Significance statement:

The study confirmed that humic acid which is cheaper and not toxic to the environment compared to inorganic Fertilizers can be used to boost crop productively.

Table 2: Analysis of variance for the measured agronomic traits.

SoV	DF	PH (cm)	NLP^{-1}	NFP^{-1}	FFWP-1 (g)	LA (cm)	FD (cm)	FL (cm)	SD (cm)
Rep	2	44.74	11.09	1.40	0.0065	1.51	0.02	4.21	0.03
Variety	1	2728.05**	0.85*	17.46*	0.0009**	0.10	0.0003	1.30	0.35*
Amend. Levels	4	71.85**	4.14**	12.33**	0.0094**	3.00**	0.46**	9.13	0.17**
Variety: Amend. Level	4	5.91*	1.07	0.12	0.0002	0.25*	0.09*	1.49	0.02**
Error	29								

*, ** significant at 5% and 1% levels respectively

Note: SOV: Source of variation; PH: Plant height; NLP^{-1}: Number of leaves per plant; NFP^{-1}: Number of fruits per plant; $WFFP^{-1}$: Weight of fresh fruit per plant; LA: Leaf area; FD: Fruit diameter; FL: Fruit length and SD: Stem diameter.

Table 3: The mean performance for some measured traits in Okra.

Amend. Level	PH (cm)	NLP^{-1}	NFP^{-1}	WFFP^{-1}	LA (cm^3)	FD (cm)	FL (cm)	SD (cm)
H0	76.09d	14.84c	11.88d	0.31d	12.37b	5.65c	9.06bc	2.45d
H5.0	79.89c	15.67bc	14.34c	0.36c	12.09b	5.94bc	8.45c	2.58c
H10.0	83.40a	16.64ab	15.15ab	0.40ab	12.58b	6.08abc	10.35ab	2.74b
H15.0	84.92a	16.94a	15.59a	0.41a	13.68a	6.40a	11.28a	2.97a
NPK	82.40b	16.09ab	14.40bc	0.38bc	13.51a	6.19ab	11.02a	2.94a

Means with the same letter (s) in each Column are not significantly different ($P<0.05$) according to Duncan's Multiple Range Test (DMRT).
Note: PH: Plant height; NLP^{-1}: Number of leaves per plant; NFP^{-1}: Number of fruits per plant; WFFP^{-1}: Weight of fresh fruit per plant; LA: Leaf area; FD: Fruit diameter; FL: Fruit length; SD: Stem diameter and H: Humic.

Declarations

Limitations of the study

None

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