ISSN:
Print - 2277 - 0755
Online - 2315 - 7453

Journal of Agricultural Science and Environment

GROWTH AND YIELD OF OKRA VARIETIES AS AFFECTED BY RATES OF ORGANO-BASED FOLIAR FERTILIZERS IN RAINFOREST AND RAINFOREST/ SAVANNA TRANSITION AGRO-ECOLOGY OF NIGERIA

***[1]P.O. AKINTOKUN, [1]D.U. AMUOFU, [1]M.O. ATAYESE AND [2]C.O. ADEJUYIGBE**

[1]Department of Plant Physiology and Crop Production, Federal University of Agriculture, Abeokuta, Nigeria.
[2]Department of Soil Science and Land Management, Federal University of Agriculture, Abeokuta, Nigeria.
***Corresponding Author**: akinpius97@yahoo.com **Tel**: 2348037215443

ABSTRACT

A field experiments were conducted at the Directorate of University Farms, Federal University of Agriculture, Abeokuta (FUNAAB) and National Horticulture Research Institute (NIHORT), Ibadan between May and August 2015 to assess the effect of different f organo-based fertilizer (fertilizer applied on the leaves) and their rate on growth and yield of two Okra Varieties: LD88 (Late Maturity), and NHAe–47 (Early Maturity). The experiment was laid out in randomized complete block design and replicated three times. The experiment was a 2 × 2 × 5 factorial combinations laid out in a Randomized Complete Block Design in a split-split-plot arrangement, with three replicates at both locations. Factors were okra varieties (LD88 and NHAe–47), the fertilizer types (D.I grow green ® and D.I grow red®) and four rate of foliar applications (0, 300, 600 and 900 ml/ha) while NPK 15:15:15 served as check were applied at 4,6, and 8 Weeks After Sowing (WAS). Agronomic data were obtained from growth and yield variables. Results showed that varieties had significant (P≤ 0.05) effect on growth and yield variables. Variety of LD88 had higher plant height and more leaves than NHAe-47 at both locations. Foliar fertilizer had significant (P≤ 0.05) effect on growth and yield variables. The D.I Grow Green® produced significantly numbers of leaves (11, 9). Application rate of 300 ml/ha and 600 ml/ha D.I.Grow Green® gave a better performance. The LD88 variety produced significantly (P< 0.05) longer pod length (4.68 cm), fresh fruit weight (4.84 t/ha) and dry fruit weight (0.31 t/ha) than NHAe-47. Application rate of 600 mls/ha D.I.Grow Red® produced significantly fresh fruit weight (5.79 t/ha) compared to control (1.32 t/ha). In conclusion, okra variety LD88 had superior growth and yield performance. Application of D.I.Grow Red® at the rate of 300 ml/ha at Funaab and 600ml/ha at Nihort enhance fruit yield performance on okra. Therefore, 300ml/ha and 600ml/ha could be recommended to farmers in Rainforest/Savanna transition (Abeokuta) and Rainforest agro-ecology (Ibadan), respectively

Keywords: growth, fertilizer types, rates, variety, yield component

INTRODUCTION

Vegetable is an important protective food for the maintenance of health and prevention of disease and contains valuable food ingredients. It can be successfully utilized to build up and repair the dead body cells

(Bakhru, 2003; Edet and Etim, 2007; Ngbede *et al.,* 2014). Ngbede *et al.*(2014) citing Bakhru (2003) reported that vegetables are valuable in maintaining alkaline reserve in the body. They also have valued mainly for their high vitamin and mineral content (Bakhru, 2003).

Siemonsma (1982) reported that okra is a vegetable crop that belongs to the genus *Abelmoschus* Family *Malvaceae* and has two main species: *caillei* and *esculentus* (L.). These crops are cultivated in warm temperate, sub - tropical and tropical regions over the world (NRC, 2006).

Production of okra constitutes about 4.6 percent of the total staple food production in Nigeria from the year 1970 – 2003 (CBN, 2004; Ngbede *el al.,2014*). Okra is the most important fruit vegetable crop and a source of calories of about (4550Kcal/kg) (Babatunde *et al.,* 2007., Akintokun *et al.,* 2019). Gibbon and Pain (1984) reported that okra is one of the most commonly grown fruits vegetable crops in the tropics. Okra cultivation is widely embraced and practiced because of its importance economically. It is also found almost in every market in Africa. Varieties such as green velvet, white velvet, long pod, lady finger, dwarf green pods vary with size of fruit, plant height, color and maturity date (Udoh *et al.,* 2005). Okra production worldwide is estimated at six million tonnes per year. There are two distinct seasons for okra production in Nigeria, the wet and the dry seasons. During the dry season, Okra fruit are produced in low quantities and are scarce and very expensive. (Bamire and Oke, 2003). In the wet season, it is produced in large qu antities much more than what the local populace can consume. Okra requires nutrients such as Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Sodium (Na) and Sulphur (S). These nutrients are specific in function and must be supplied to plants at the right time and at the right quantity. Lack of sufficient amount of these nutrients may result to poor performance of the crop with growth being affected hence to low yield (Shukla and Naik,1993).

Fertilizer is a very essential input in crop production Akintokun and Owoeye (2011). It can be applied in different ways to the soil and crop; solid state to the soil or liquid state to the leaves.

The inadequate and inappropriate use of agriculture inputs gave the importance of organic and inorganic fertilizer as essential tools in okra production (Palm *et al*, 1993). Omotosho and Shittu 2007, **reported the use of inorganic** fertilizer application rate of 150 kg NPK ha^{-1} in south west, 200kg NPK ha^{-1} in south east and ring method of fertilizer application as effective approach for the growth and yield of okra.

Yet, the need to meet food demand of ever increasing human population, by various ways of ameliorating soil nutrients is in demand despite the exploration of inorganic and organic fertilizer (solid state) in crop production. This different way was not total full proved to solve the nutrient problem deficiency in the soil that affect the crop because of torrential rainfall that characterized the tropical environment which make soil and the nutrient vulnerable to be wash away.

Till date, many ways of amelioration this nutrients deficiency in the soil to meet food demand is still ongoing. Dhargalkar and Pereira (2005) used Seaweed extracts (Biostimulants) as folia spray to grow crops which are safe, non-toxic, and harmless to both human and animals. The application of

seaweed extract improves soil health and also enhance the yield and quality of organic vegetables production thereby increasing the domestic and international market value (Chatterjee and Thirumdasu 2014).

Reuveni and Reuveni (1995) reported that foliar application is an effective method for correcting soil deficiencies and overcoming the soils nutrient inability to be transfer to the plant. Tests have shown that foliar feeding can be 8 to 10 times more effective than soil feeding and up to 90 percent of a foliar fed nutrient solution can be found in the smallest root of a plant within 60 minutes of application. Foliar fertilizers have therefore been used on many crops for at least 40 years and these containing N,P,K and micronutrients are commonly recommended as the most efficient method of remedying nutrient deficiencies in vegetables and of increasing yield and quality of crop products due to the rapid absorption of nutrients in the plant.

D.I grow ® organic fertilizer is a new folia fertilizer with potentials and purported to be rich in macro and micro nutrients, trace nutrients and humic acid that is capable to improves the growth of various vegetables, fruits and flowers as well as improve the quality of soil. These foliar fertilizers are more economical and effective than the granulated form of fertilizer, which can be attributed to the presence of micronutrients such as manganese, zinc, iron and magnesium. (Organic Plus Fertilizer Dynapharm international manual, 2003).

The use of foliar fertilizers as supplement may have a great impact on the crop and yield of plant and also reduces or eliminates the problems cause by torrential rainfall; erosion and leaching of plant nutrients from root zone of the crop hence plant roots not able to take up the necessary nutrient requirement to support the growth. It is therefore imperative to look inward with the possibility of exploring liquid state fertilizer through folia application to check the effect of torrential rain fall wash of plant nutrient.

Cultivation of okra using foliar fertilizer spray to meet food demand of the population in face of ever decreasing soil carrying capacity due to aforementioned; soil erosion and torrential rainfall in the tropics worth investigating. Hence, the objective is to determine the effect of foliar fertilizer types and rates (D.I.Grow organic plus ®) on growth and yield of okra varieties.

MATERIALS AND METHODS

Description of the study areas

The experiments were conducted at two different locations. The locations were; Directorate of University Teaching and Research Farms (DUFARMS) of the Federal University of Agriculture, Abeokuta Ogun State. It is transition zone between forest to the south and Savannah to the North of Nigeria. It is on Latitude $(7.5)^0$E and Longitude $(4)^0$N. Average rainfall and mean temperature was 1238mm and 27.1^{o}C respectively. At the National Horticulture Research Institutions (NIHORT) Ibadan, Oyo State, it is on the longitude $(7.22)^0$N, and latitude $(3.56)^0$E with average rainfall and temperature 1311mm and 26.5^{o}C respectively. The okra varieties (LD88 and NHAE-47) was sourced from the National Horticulture Research Institutions (NIHORT) Ibadan while D.I grow organic plus® liquid fertilizers were sources from Nigerian Institute for Oil Palm Research (NIFOR) Benin, Edo State.

Organo-based Fertilizer Used

D.I. Grow Organic plus is made up of two

types of liquid D. I Grow green ® and D.I grow red ®, formulated from Acadian seaweed *(AscophyIlumnodosum)*, with complete ionic elements, macro and micro nutrients as shown in Table 1.

Table 1: Plant Nutrient Composition of Organo-Based foliar fertilizer

ELEMENTS	D.I grow GREEN® Content		D.I grow RED® Content	
	A	B	C	D
Nitrogen	2.35%	2.35%	1.85%	1.85%
Phosphorus	4.44%	4.44%	1.85%	1.85%
Potassium	1.75%	1.75%	3.31%	3.31%
Magnesium	0.36%	0.36%	0.49%	0.49%
Iron	867 ppm	0.0867%	742 ppm	0.0742%
Manganesse	223 ppm	0.0223%	587 ppm	0.0587%
Copper	144 ppm	0.0144%	105 ppm	0.0105%
Zinc	153 ppm	0.0153%	383 ppm	0.0383%
Boron	0.011%	0.011%	43 ppm	0.0043%
Molybdenum	0.002%	0.002%	76 ppm	0.0076%
Humic Acid	0.68%	0.68%	0.68%	0.68%

Source A and C(Old unit): Organic Plus Fertilizer 2003.In: Dynapharm International manual (2016)

Source B and D (S.I Unit) : modified from ppm to % (2016)

S.I: International System of Units

The Physico-chemical Analyses of Soil and Treatment

Soil samples were collected both vertically and horizontally on the field using soil auger at a depth of 0 -20cm. The composite soil sample were mixed and used for physico-chemical analyses, prior to the planting. The following analyses were carried out-pH, exchangeable bases, Na (cmol/kg), k (cmol/kg), Ca (cmol/kg), H+ (cmol/kg), CEC (cmol/kg), Available P (cmol/kg), Organic carbon (%), Organic matter (%), % N, % of silt, % of clay and % of sand using the Tropical Soil Biology and Fertility (TSBF) methods of soil and plant analysis by Okalebo *et al.,* (1993).

The treatment were two okra variety (LD88 and NHAE–47), the fertilizer types (D.I. grow green® and D.I.Grow red®) and four rate of foliar applications (0, 300, 600 and 900 ml/ha) while NPK 15:15:15 served as check at the recommended rates 200kg ha^{-1} (Iyagba *et al* 2013). The main plot treatment consisted of two varieties (LD88 and NHAe- 47), sub plot treatments were two (2) liquid fertilizers D.I. grow green® and D.I. grow red ® while the sub – sub – plot were rates (0, 300, 600, 900 ml/ha) which gives 18 treatments combination. In the two different locations, the experiment was 2 × 2 × 5 factorial combinations laid out in Randomized Complete Block Design in a split-split-plot arrangement, with three replicates at both locations.

Field work.

The field was layout with 1 m between each main plot, 0.5 m between each sub plot, 0.5 between sub – sub- plots and 1.5 m between replicates. Each of the main plots was surrounded by 0.5 m high bunds to prevent erosion and flow of liquid fertilizers treatments between plots during rainfall.

The plots were treated with liquid fertilizers D.I grow green ® and D.I grow red® fertilizer after two weeks and four weeks. The organo-based liquid fertilizer was measured with the aid of 0.2mls discharged of syringe at 0 ml/ha, 300ml/ha, 600 ml/ha and 900 ml/ha rates to knapsack sprayer calibrated to discharge 200 l/ha of water at constant rate. While to the soil was applied compound fertilizer (N.P.K. 15:15:15) as check at the recommended rates of 200kg NPK ha^{-1}(Iyagba *et al*., 2013). Three seeds of the two okra varieties were sown and thinned to one plant per stand two weeks after sowing (WAS) at 60 cm × 40 cm. Weeding was done manually from three weeks after planting. The following data were collected at two weeks' interval; plant height, number of leaves, stem girth, days to 50 % flowering: fresh fruit weight, dry fruit weight, pod length and pod diameter. Data collected were subjected to ANOVA (Analysis of Variance) using Genstat Discovery Statistical Package. and means of significant treatment were separated using Fisher's least significant test (LSD) at 5% probability level.

RESULTS

Soil physico-chemical properties at the experimental sites

The soil in the site of experiment at Abeokuta and Ibadan were both sand with high proportion of sand (927.0 and 879.0 g/kg respectively), 37.6 and 74.9 silt, 35.4 and 46.1g/kg clay in Abeokuta and Ibadan respectively (Table 2). Soil pH at the experimental site in both locations in 2015 was neutral 6.53 and 6.45 respectively. The soil in the experiment site in Abeokuta was richer in more nitrogen (0.8 g/kg) than that of Ibadan. (0.7 g/kg) Table 2.

Table 2: Physical and Chemical properties of the Soil before planting

Soil Properties	IBADAN	ABEOKUTA
Soil PH	6.5	6.4
Sand (g/kg)	927.00	879.00
Silt (g/kg)	37.60	74.90
Clay (g/kg)	35.40	46.10
Soil Texture	Sand	Sand
Organic matter	9.97	11.18
Total N(g/kg)	0.70	0.80
Av.P (mg/kg)	4.94	5.23
K (cmol/kg)	0.35	0.44
Na (cmol/kg)	0.30	0.29
Mg (cmol/kg)	0.64	0.73
Ca (cmol/kg)	2.63	2.54
Exch.acidity (mol/kg)	0.06	0.11
ECEC(cmol/kg)	3.98	3.92
Mn (mg/kg)	7.47	8.14
Cu (mg/kg)	0.37	0.29
Zn (mg/kg)	1.47	1.56
Pb (mg/kg)	0.27	0.32
Cd (mg/kg)	0.004	0.006
Soil series	Iwo	Iwo

Weather Data in Abeokuta and Ibadan

Total amount of rainfall at Abeokuta and Ibadan experiment field between April and August 2015 were 1,099.2mm and 389mm respectively. At Abeokuta and Ibadan, the highest rainfall observed was in June and May respectively, (165mm, 321.9mm) and the lowest rainfall was in August and July (29mm, 157.9 mm) respectively. Mean Temperature at Abeokuta (May to August, 2015) ranged from 25.6^{0}C to 27.8^{0}C while minimum temperature ranged from 22.8^{0}C to 23.8^{0}C. The temperatures were observed to decline gradually as the months progressed from May to August. Highest maximum temperature between this period was 32.8 ^{0}C for May, while the lowest minimum temperature was 29.5^{0}C for August. In Ibadan, between May –August 2015, Mean Temperature ranged between 25^{0}C to 28^{0}C while minimum temperature ranged from 22^{0}C to 24^{0}C. The temperature was observed to decline gradually as the months progressed inwards from May to August. The highest maximum temperature was in June with 33^{0}C, while August had the lowest minimum temperature of 28^{0}C (Table 3). In Abeokuta from (May to August 2015), relative

humidity ranged from 61.9% to 70.3% (Table 3). Highest relative humidity during this period was in July with values of 73% while the lowest was in May (61.9%). In Ibadan from May to August 2015 relative humidity ranged from 82% to 92%. Highest relative humidity during this period was in August with values of 92% while the lowest value was in July (82%).

Effect of types and rates of organic fertilizers on Plant height (cm), number of leaves, and 50% days to flowering of okra varieties at Abeokuta (FUNNAB) and Ibadan (NIHORT).

At 4, 6, 8 weeks after sowing (WAS) there was a varietal effect ($p \leq 0.05$) on plant height in both locations. The variety of LD88 was significantly taller than plant NHAE-47. At 50% flowering, there was more flowers produced from NHAE-47 variety compare to LD88 in both locations. Liquid fertilizer had significant effect ($p \leq 0.05$) on plant height at NIHORT 4WAS but not at FUNAAB but the significant effect ($p \leq 0.05$) of the Liquid fertilizer was observed on the numbers of leaves at 6WAS and 8WAS at FUNAAB but not at NIHORT. It was observed that D.I. grow green® fertilizer at NIHORT enhanced the plant height at 4WAS (Table 4). Rates of fertilizer significantly influenced the plant height and numbers of leaves ($p \leq 0.05$) in NIHORT at 4WAS and 8WAS. Rates of 300 ml/ha application produced taller plant height, and more numbers of leaves compare to other application rates (Table 4). At FUNNAB, 6WAS and 8WAS 300 ml/ha produced taller plant and more number of leaves compared to other application rates, while in NIHORT application rate 600 ml/ ha produced taller plant, number of leaves at 4WAS and 8WAS.

Plant height of okra as influenced by interaction of varieties, fertilizer and rates of application 8WAS at Ibadan (NIHORT) and Abeokuta (FUNNAB)

In Table 5, at NIHORT, the interaction had significant effect ($p \leq 0.05$) on variety. D.I grow green produced taller plant (55.33cm) at 300ml/ha application rates and was followed by application rates of 900 ml/ha from D.I grow Red (55.32cm). On variety NHAe-47 application rate 600 and 900ml/ha of D.I grow green gave taller plant (45.22 cm) and followed by application rate 300 ml/ha of D.I grow Red (42.56 cm) and closely followed by application rate of 600 and 900ml/ha of D.I grow red (42.11 cm), the control (unfertilized) plot produced the short plant height the range between 29.10 cm - 35.12 cm. In FUNNAB (Figure1), the interaction showed that there was a significant effect ($p \leq 0.05$) on plant height at 8WAS. The D.I grow green produced the taller plant height of LD88 at the rates of 900 ml/ha (83.8cm), followed by D.I grow green at 300 ml/ha (77.6cm), then followed by rate of 600 ml/ha (75.9cm), which also have a similar trend with D.I grow red (75.5cm) at the same rate then followed by NPK 15:15:15 fertilizer(63.4cm). The control (unfertilized) plot produced the least plant height 34.1cm.

Table 3: Weather data of the experimental period at ABEOKUTA and IBADAN 2015

Month	Total Rainfall (mm)		Relative Humidity (%)		Temperature °C					
					Maximum		Minimum		Mean	
	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta
January	6.6	0	90	47.7	33	35.2	24	20.3	28.5	28.9
February	28.4	51	88	61.4	35	34.3	23	24.6	29	29.3
March	189.6	67	88	60.4	32	35.3	24	25.1	28	28.8
April	246.3	69	89	62.8	33	33.8	24	24.1	28.5	28.2
May	321.9	60	89	61.9	32	32.8	24	23.8	28	27.8
June	233.7	165	90	70.8	33	30.8	24	22.8	28.5	27.4
July	157.9	66	82	73	29	31.5	23	22.8	26	26.6
August	139.4	29	92	70.3	28	29.5	22	22.8	25	25.6
Total	1321	507	708	508	255	263.2	188	286.3	221.5	223

Table 4: Effect of types and rates of organic fertilizers on Plant height (cm), number of leaves, and 50% days to flowering of okra varieties at both locations (ABEOKUTA and IBADAN)

	Plant height (cm)						Number of leaves						50% flowering	
	4WAS		6WAS		8WAS		4WAS		6WAS		8WAS			
	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan
Varieties (V)														
NHAe-47	15.6	11.0	38.4	29.6	62.2	38.4	6.0	5.5	10.5	6.3	10.5	12.5	49.0	50.0
LD88	20.2	14.2	48.5	34.7	66.2	48.5	6.2	5.7	9.7	6.3	9.7	11.3	29.0	35.0
LSD0.05%	1.6	1.1	3.1	2.5	ns	3.1	ns	ns	ns	ns	ns	ns	0.4	0.4
Fertilizers liquid (F)														
D.I grow (Green)	18.6	13.5	43.0	30.7	64.0	44.0	6.1	5.5	10.7	6.3	10.7	12.3	42.0	44.0
D.I grow (Red)	17.3	11.8	44.0	33.6	64.4	43.0	6.1	5.6	9.6	6.3	9.6	11.5	44.0	44.0
NPK 15:15:15	16.9	13.2	41.1	33.5	67.3	42.4	6.3	5.7	9.9	6.0	9.9	12.2	46.0	40.0
LSD 0.05%	ns	1.1	ns	ns	ns	ns	ns	ns	0.1	ns	0.1	0.1	ns	Ns
Rates (R)														
0 ml/ha	17.5	10.1	38.6	29.6	45.4	40.0	5.9	5.1	9.0	6.1	9.5	8.1	36.0	41.0
300 ml/ha	17.8	14.0	48.7	32.1	68.9	41.1	6.1	5.8	9.9	6.3	11.2	12.5	49.0	43.0
600 ml/ha	18.6	14.6	43.7	34.6	68.0	48.7	6.1	5.9	10	6.8	10.1	13.5	42.0	48.0
900 ml/ha	18.7	11.2	45.2	30.9	61.4	45.2	6.2	5.4	9.5	6.4	9.9	13.1	40.0	48.0
LSD 0.05	ns	1.7	4.9	ns	7.8	4.9	ns	0.1	ns	ns	ns	1.0	ns	ns
Interaction														
V×R	ns	ns	ns	ns	ns	ns	0.1	ns	0.3	ns	0.2	0.3	ns	ns
F×R	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.2	ns	ns
V ×F	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.1	ns	ns
V× F×R	ns	ns	9.7	ns	15.7	9.7	ns	ns	ns	ns	ns	0.3	ns	ns

LSD Least significant differences at 5% probability level, ns= non-significant difference

Table 5: Between Varieties, Fertilizer and Rates of Application on Plant Height at 8W Treatment Interaction AS at IBADAN

Varieties	Fertilizer types	Rates ml/ha	Plant Height IBADAN
LD88	D.I grow Green	NPK	50.51
		0	35.12
		300	55.33
		600	54.22
		900	54.22
	D.I grow Red	NPK	50.11
		0	41.99
		300	43.06
		600	49.92
		900	55.32
NHAe – 47	D.I grow Green	NPK	42.11
		0	29.1
		300	40.89
		600	45.22
		900	45.22
	D.I grow Red	NPK	42.5 6
		0	30.89
		300	42.56
		600	42.11
		900	42.11
	LSD 5%		9.7

LSD = least significant difference represents at5% probability level

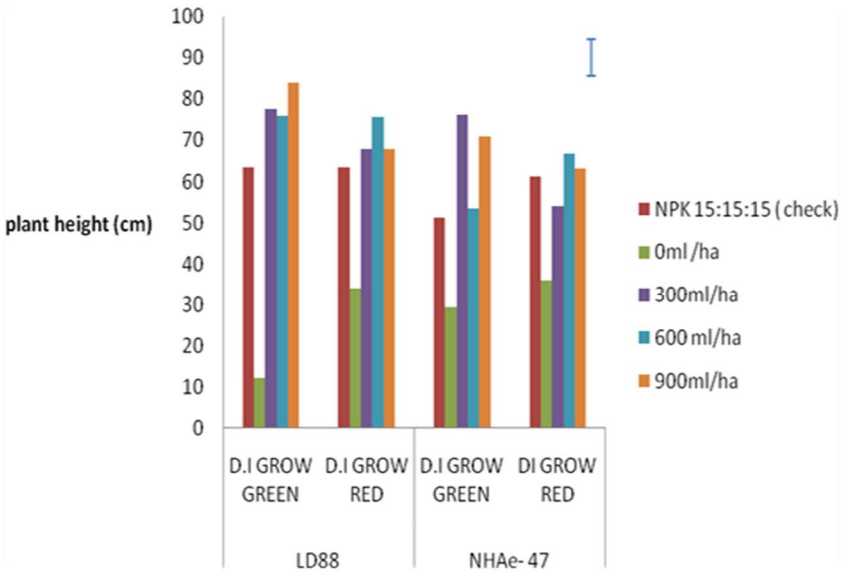

Figure 1: Effect of interaction between varieties, fertilizer and rates application on height at 8 WAS in ABEOKUTA

Effect of types of fertilizers and rates on fresh fruit, dry fruit, fruit length, and fruit girth on okra varieties at Ibadan (FUNNAB) and Ibadan (NIHORT).

Table 6, shows that in Funaab there was a significant difference ($p \leq 0.05$) on fresh fruit yield tons/ha where LD88 produce more fruit compare with NHAe-47. In Nihort, NHAe- 47 produce more fruit compared with LD88. On dry fruit weight matter in Funaab, LD88 had more weight compare with NHAe -47. The fresh fruit yield in both locations shows D.I grow Red fertilizer application gave better fruit yield compare with D.I grow green. On dry fruit weight, there was no significant difference in both locations. On pod length at Funaab, D.I grow Red fertilizer had a significant ($p \leq 0.05$) pod length. Rates of 300ml/ha fertilizer application significantly influenced the fresh fruit yield, dry fruit yield, pod length and pod girth ($p \leq 0.05$) in Funaab, while in NIHORT 600mls/ha application rates had a better fresh fruit yield compare to other application rate.

Fresh fruit yield (tons/ha) of okra varieties as influenced by interaction of varieties, fertilizer and rates of application at Ibadan (NIHORT).

At NIHORT (Figure 2), the interaction showed that there was a significant effect ($p \leq 0.05$) on fresh fruit yield(tons/ha). D.I grow Red ® at the application rates of 600 ml/ha on LD88 varieties gave higher yield 7.88 tons/ha. On NHAE-47 variety, application of D.I grow Red ® at rate of 300 ml/ha gave 6.34 tons/ha and followed by 900 ml/ha (6.12 tons /ha). D.I grow green ® at the application rates of 300 ml/ha on LD88 gave (3.51 tons /ha) followed by NPK on both varieties (3.04, 2.22 tons/ha), while the unfertilized plant (control) had the least yield for both varieties with a trend range of (0.92 t/ha, 1.16 tons/ha) respectively.

Table 6: Effect of types of fertilizers and rates on Fresh fruit, dry fruit, Dry fruit, Pod length, and Pod girth of okra varieties at the two locations (ABEOKUTA and IBADAN)

	Fresh Fruit yield tons/ha		Dry Fruit yield tons/ha		Pod length (cm)		Pod girth (mm)	
	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan
Varieties (V)								
NHAe-47	3.3	3.3	0.2	1.2	1.9	2.5	3.8	6.6
LD88	4.8	2.3	0.3	0.7	4.6	2.8	4.6	2.0
L.SD 5%	0.8	0.5	0.1	Ns	0.8	ns	ns	Ns
Fertilizer liquid								
D.I grow (Green)	3.3	2.2	0.2	1.0	2.6	3.1	3.8	3.0
D.I grow (Red)	4.9	3.4	0.2	1.0	3.9	2.2	4.6	6.6
NPK								
15:15:15	2.5	2.6	0.2	1.2	2.4	2.2	4.5	2.0
LSD 5%	0.8	0.5	ns	Ns	0.8	ns	ns	Ns
0 ml/ha	2.1	1.3	0.1	0.5	1.9	1.6	3.4	1.0
300 ml/ha	5.8	3.2	0.4	1.0	4.9	3.0	4.9	1.6
600 ml/ha	5.7	4.1	0.3	1.3	4.1	3.8	4.3	3.0
900 ml/ha	4.2	2.6	0.2	0.8	3.0	2.8	4.0	1.0
L.S.D 5%	1.2	0.8	0.1	Ns	1.3	ns	1.2	Ns
Interactions								
V×R	Ns	ns	ns	ns	ns	ns	ns	Ns
F×R	Ns	ns	ns	ns	ns	ns	ns	Ns
V×F	Ns	ns	ns	ns	ns	ns	ns	Ns
V × F × R	Ns	1.6	ns	ns	ns	ns	ns	Ns

LSD Least significant differences at 5% probability level, ns= non-significant difference

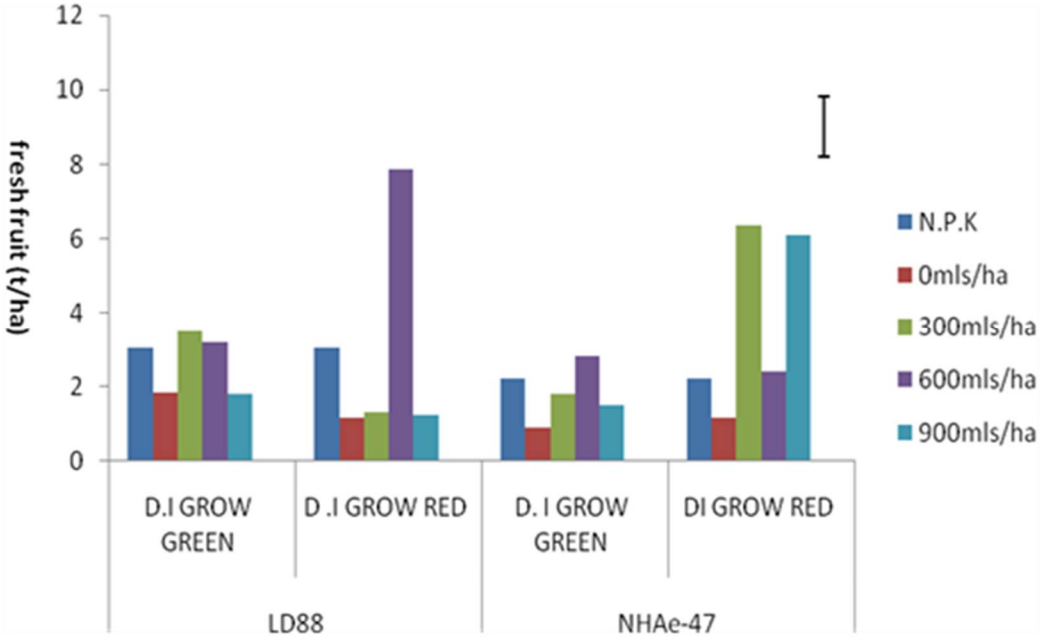

Figure 2: Effect of interaction between varieties fertilizer and rates on fresh fruit yield (tons/ha) of okra varieties in IBADAN 2015

DISCUSSION

The soil of the experimental site was sandy texture (Table 2) which may be attributed to parent material (PM) from which the soil was formed. The soil that originated from sandstone and quartz parent material, are classified as sandy texture by soil classification (USDA). This is in line with the findings of Brady and Weils (1999) who opines that there is positive relationship between high sand content of soil and high content of quartz in the parent material. The soil pH though indicated that the soil was almost neutral and was within the favorable range for crop cultivation, but its fertility status was poor as tropical soils experienced torrential rainfall impartation year in and year out. Prochnow,2008 in his work on optimizing nutrient use in low fertility soil of the tropics submitted that tropical soil is very fragile and the effect of heavy rainfall most of the time leads to washing away of the top soil that are nutrient bed for the plant growth and development.

Foliar fertilizer which is rich in both macro and micro nutrients at the application rates were able to supply sufficient nutrient to enhance growth and yield of the okra plant. The increased plant height in the two varieties (Table 4) due to application of D.I grow green may also be connected to the available water (rainfall), the role of macro and micro nutrients formulation of the liquid fertilizer and better distribution of D. I grow plus fertilizer that contains N in which enhance the physiological process, cell division and elongation which directly affect tissue formation and consequently vegetative growth. These results are in accordance with those obtained

by Khalifa *et al.,* 2003, Zelalem *et al.,* 2009, Abdul Rasool *et al.,* 2010 and Kadum, 2011in their findings corroborate this in their previous work that the plant height among other factors also was influenced by availability of Nitrogen in the soil and other macro and micro nutrients which cumulated to plant vegetative growth.

The interactive effect of varieties, fertilizer and rates in both locations at 8WAS, shows that D.I grow green perform better on plant height and number of leave at rate of 600 ml/ha, however the variety NHAE–47 at application rate 900ml/ha of D.I Grow green the plant had a better number of leaves which is due to D.I Grow green composition as reported by Dynapharm International manual (2016) that D.I grow green is used to increase growth of the plants during the vegetative phase and moreover the quantum of rainfall available also aided this observation The presence of humic acid as part of the composition of this liquid fertilizer also may be responsible for the plant growth**.** Michael,2017 in his work on Science of humus and how it benefits submitted that Humic acid is a group of molecules that bind to and help plants roots receive water and nutrients. Also serves as a medium for transport nutrient from soil to the plant thus the level of humic acid can drastically increase plant growth and yield.

The early flowering initiation at 50% flowering in both locations could be due to high N in the foliar fertilizer and also presence of humic acid in the composition of the liquid fertilizer which played important role in the balancing between vegetative and reproductive growth of okra Michael, 2017. This confirmation is line with work of Zebarth *et al* 2004 and Zelalem *et al.,* 2009) that nitrogen played major in conjuncture with other macro elements in earliness in flower initiation of potato plant and the quality of the root.

In Abeokuta, **st**atistically, the yield of okra plant performed better than Ibadan. This might be attributed to the different quantity of plant nutrient in this soil that are available to the crop and the plant nutrient uptake as influenced by the environment. Gathungu *et al*., (2000) found that early and well distribution of fertilizer that contains N led to faster early growth in plant height, number of shoots, tubers, stolons and dry matter. D.I grow Red produced better yield than D.I grow Green which is in accordance to Dynapharm International manual (2016) who submitted that of D.I grow red enhances flower and fruit formation, makes fruits bigger and also increases the yield. The formulation of D.I grow Red may be responsible because more essential nutrient; Potassium, Magnisium and Manganesse that responsible for this trait are more in the D.I grow Red composition.

The fertilizer rates of 300 t/ha had a better performance on yield parameters than the other rate which could be attributed to the effectiveness of applied rate of D.I grow plus fertilizer. Also Afe *et al.,* (2015) corroborated the influenced of this low rate in influencing yield especially in earlier setting of flower that emergence of first flower appeared in all treated plants at least 5-10days earlier than control. Dwivedi *et al*., (2014) also reported that seaweed extracts not only increase the vegetative growth of the plant but it also triggers the early flowering, fruiting in crops and ultimately increase the seed yields when applied at lower rate to the crop.

This studies therefore agreed with many other studies (Naruka *et al*.,2000; Alkaff and

Hassan, 2003; Chattopadhyay *et a*l., 2003; Abbasi *et al* 2010 and Zodape *et al*., 2011) who reported the benefits of foliar fertilization such as improve growth, yield, and product quality.

Conclusion and Recommendation

This study examined the growth, and yield of okra as affected by the application of two newly introduced foliar fertilizers as plant nutrient buffers The liquid fertilizer, rich in both micro and macro nutrients were able to supply sufficient nutrients to enhance growth and yield. D.I grow Green and Red had different impact on growth and yield of okra varieties.

Application rate of 300 ml/ha and 600 ml/ha D.I.Grow Green® gave a better performance. The LD88 variety produced significantly ($P < 0.05$) longer pod length (cm), fresh fruit weight (t/ha) and dry fruit weight (t/ha) than NHAe-47. Application rate of 600 mls/ha D.I.Grow Red® produced significantly fresh fruit weight (t/ha) compared to control (t/ha).

In conclusion, okra variety LD88 had superior growth and yield performance. Application of D.I.Grow Red® at the rate of 300 ml/ha at Abeokuta and 600ml/ha at Ibadan enhance fruit yield performance on okra. Therefore, 300ml/ha and 600ml/ha could be recommended to farmers in Rainforest/Savanna transition (Abeokuta) and Rainforest agro-ecology (Ibadan), respectively

REFERENCES

Abbasi,F.F., Baloch M.A., Zia-ul-hassan., K.H.Wagan., A.N.Shah., Raipar, I 2010. Growth and Yield of Okra Under Foliar Application of some New Multinutrients fertilizer Products. *Pak.J Agric.Engg., Vet.Sci.*,26 (26)(2):11-18

Abdul Rasool I.J; K.D. H. Al-Jebory., F.H. Al-Sahaf. 2010. Effect of Foliar Application of Unigreen and Solu Potash on Yield and Quality of Potato Tuber. *Jordan Journal of Agricultural Science.* 6(1):111 - 119.

Alkaff, H. A., Hassan, A. A. 2003. Effect of Biofertilizer, Organic Fertilizer and Foliar Application of Power 4 on the Growth and Yield of Okra Plants. *Journal of National Applied Sciences* 7 (2): 25-35.

Afe, A.I Atanda S, Aduloju M.O, Ogundare S.K., Talabi A.A 2015: Response of Maize (*Zea mays* L) to Combine Application of Organic and Inorganic (Soil and Foliar Applied) Fertilizer. *Africa Journal of Biotechnology* Volume 14(44): 3006-3010.

Akintokun P.O., Amoofu D.U., Atayese M.O., Sowemimo F.A 2019. Effect of type and rate of organo-based Foliar Fertilizer on Chlorophyll and Nutritional quality of Okra varieties in rainforest and rainforest/savanah transition agro-ecology of Nigeria. International Journal of Organic Agricultute Research and Development Volume 15:14-34

Akintokun, P.O Owoeye, O.O 2011. Effect of Land-use Pattern on Phosphorus and Potassiun Fixation and Maize Performance. *Journal of Agricultural Science and Environment* volume11(1) 40-49.

Babatunde, R.O., Omotosho, O.A., Sholatan, O.S. 2007. Socio-economic Charac-

teristics and Food Security of Farming Households in Kwara State, North-Central Nigeria. *Pakistain Journal of Nutrition* (6): 49-58.

Bakhru, H.K. 2003. *Foods that heal: The Natural way to good health.* Orient paperbacks, Delhi, pp 82 – 90.

Bamire, A.S., Oke, J.T. 2003.Profitability of Vegetable Farming under Rainy and Dry Season Production in Southwestern Nigeria. *Journal of Vegetable Crop Production* (9):11 – 18

Brady, C., Weils, R. R. 1999.Nature and Properties of Soil, Twelfth Edition, Prentice Hall, New Delhi pp 74 – 114.

Central Bank of Nigeria (CBN) 2004. Annual Report and Statistical Bulletin, Volume 6, No. 12, December 2004.

Chatterjee, R., Thirumdasu, R.K 2014. Nutrient Management in Organic Vegetable Production.*International Journal of Food, Agriculture and Veterinary Sciences* (4): 156-170.

Chattopadhyay, S. B., Mukhopadhyay, T. P., Thapa, U. 2003. Response of Foliar Feeding of Boron and Molybdenum on Growth and Yield of Okra in Terai Zone of West Bengal *Environmental Ecology* 21 (3): 702-705.

Dhargalkar, V.K and Pereira, N. 2005. Seaweed: Promising Plant of the Millennium. Science and Culture 71: 60-66

Dwivedi, S.K., Meshram, M.R., Pal, A., Pandey, N., Ghosh, A 2014. Impact of Natural Organic Fertilizer (Seaweed Sap) on Productivity and Nutrient Status of Black Gram (*Phaseolus mungo L.*). The Bioscan 9: 1535-1539.

Dynapharm Intenational Manual. 2003. Organic Plus Fertilizer Dynapharm Health Wealth Freedom Edet, G.E. and Etim, N.A. 2007. Gender Role in Fluted Pumpkin (*Telferia occidentalis*) Production in Akwa Ibom State. *Proceeding of the 41st Annual Conference of the Agricultural society of Nigeria (ASN)* pp 612 – 615.

Gathungu, G.K., Shibairo, S.I., Githiri, S.M., Mburu, M.W.K., Ojambo, P.S. Kidanemariam, H.M. 2000. The Effect of Source, Time and Methods of Nitrogen Application on Growth and Yield Component of Potato in Kenya. *Africa Crop Science* (8): 387-402

Gibbon, D., Pain, A. 1984. Crops of the Drier Regions of the Tropics. International Tropical Agriculture Science. Longman London. pp. 137.

Iyagba, A.G., Onuegbu, B.A., Ibe , A.E. 2013. Growth and Yield Response of Okra *(Abelmoschus esuculentus (L.)*Moench) to NPK Fertilizer Rates and Weed Interference in South Eastern Nigeria. *International Resources Journal of Agricultural Science and Soil Science* 3 (9): 328 – 335.

Kadum, E.A.H. 2011.Effect of Spraying Organic Fertilizer on Growth and Yield of three Potato Cultivar. M.Sc. Thesis in Agric College, Busogo Campus. Kufa University.

Khalifa, R., Kh, M., Nofal, O.A., Badran, N.M. 2003. Influence of Foliar Feeding with Micronutrients on the Yield and Nutritional Status of Winter Potato varieties. Diamond. *Annuals Agricultural Science. Ain Shams University Cairo* 48 (2): 473 – 483.

Michael Martin Melendres 2017. Humic Acid :The Science of Humus and how it bene-

fits soil. In Ecofarmingdaily. www.ecofarmingdaily.com

Naruka, I. S., Gujar, K.D., Lal, G. 2000. Effect of Foliar Application of Zinc and Molybdenum on Growth and Yield of Okra (*Abelmoschus esculentus L*. Moench) Pusasawani Haryana. *Journal of Horticultural Science*, 29 (3/4): 266-267.

National Research Council (NRC) 2006. Lost Crops of Africa: Volume 11: Vegetable, National Academic Press. Washington DC. USA ISBN: 0-309-66582- (5): 378.

Ngbede SO, Ibekwe HN, Okpara SC, Onyegbule UN and Adejumo L, 2014.An Overview of Okra Production, Processing, Marketing, Utilization and Constraints in Ayaragu in Ivo Local Government Area of Ebonyi State, Nigeria. *Greener Journal of Agricultural Sciences*. 4(4):136-143

Okalebo, J.R., Gathua, K.W., Woomer, P.L., 1993. *Laboratory Methods of Soil and Plant Analysis: A Working Manual*. Nairobi: Tropical Soil Biology and Fertility Programme.Pg45

Omotoso S.O., Shittu O.S. 2007. Effect of NPK Fertilizer Rates and Method of Application on Growth and Yield of Okra (*Abelmoschus esculentus* (L.) Moench) at Ado-Ekiti South-western, Nigeria. *International Journal of Agricultural Research (*2): 614-619.

Organic Plus Fertilizer manual 2003 in *Dynapharm intenational manual 2016 page1-10*

Palm, C.A., Myer, J.K. and Nandwa, S.M. 1993. Combined Use of Organic and Inorganic Nutrient Sources for Soil Fertility Maintenance and Replenishment. *Soil Science Society of America Special Publication* (51): 193-217

Prochnow, L.I. 2008. Optimizing Nutrient Use in Low Fertility Soils of the Tropics. *Better Crops* 92(3):19 – 21 http:// www.ipni.net/bettercrops

Reuveni, M., Reuveni, R. 1995. Efficacy of Foliar Sprays of Phosphates in Controlling Powdery Mildews in Field Grown Nectarine, Mango Trees and Grapevines. *Crop Protection.* (14): 311 -314

Shukla, V., Nailk, L.B. 1993.*Agro-Technique for Malvaceae Vegetables*, In: Ifovance in horticulture, Volume 5. Malhotra publishing house, New Delhi, India, pp 399-425.

Siemonsma, J.S. 1982. The Cultivation of Okra (*Abelmoschus* spp.), Tropical Fruit-Vegetable (with special reference to the Ivory Coast). D.H.O. Thesis, Wageningen Agricultural University Wageningen, The Netherland. pp 297.

Zebarth, B.J., Leclerc, Y., Moreau, G. and Botha, E. 2004. Rate and Timing Fertilization of Russet Burbank Potato: Yield and Processing Quality. *Canadian Journal of Plant Science*, 84: 855-863.

Zelalem, A., Tekalign, T., Nigussie, D. 2009. Response of Potato (*Solanum tuberosum*L.) to Different Rates of Nitrogen and Phosphorus Fertilization on Vertisols at DebreBerhan, in the Central Highlands of Ethiopia. *African Journal of Plant Science*, 3: 16-24.

(Manuscript received: 7th May, 2019; accepted: 2nd June, 2020).