Effect of type and rates of Organo-based foliar fertilizer on chlorophyll and nutritional quality of Okra varieties in rainforest and rainforest/savanna transition agro-ecology of Nigeria

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ABSTRACT

Okra (*Abelmoschus esculentus* L.) is a commonly grown vegetable crop in the tropics, is constrained by depleting soil fertility as a result of heavy torrential rainfall. The Use of foliar fertilizer as a supplement has been successfully reported in the temperate region. Tropics most of the time experience heavy down pour of rainfall and wash off plant nutrient, hence, the need to ameliorate the nutrient is inevitable through the use of foliar liquid fertilizer. Field experiments were conducted at two different agro ecological zones: the Directorate of University Farms, Federal University of Agriculture, Abeokuta (FUNAAB) and National Horticulture Research Institute (NIHORT), Ibadan to evaluate the response of two okra varieties to types and rates of organic-based foliar fertilizer application. 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 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 8 weeks after sowing (WAS) fruit samples from both locations were analyzed for proximate and chlorophyll contents. Data were subjected to analysis of variance and means were separated using LSD at 5% probability level. The D.I.Grow Red® at 300ml/ha gave the higher Ash (8.23%), fat (2.54%,), moisture (14.65%), and carbohydrate (47.31%) at FUNAAB while 600 ml/ha produced significantly the higher ash, crude fibre, moisture and carbohydrate (9.37%, 15.94%, 9.13%, and 52.02%), respectively in NIHORT. The study concluded that okra variety LD88 had superior growth performance. Application of D.I.Grow Red® at the rate of 300 ml/ha at FUNAAB and 600 ml/ha at NIHORT enhance the fruit nutritional quality of okra.

Keywords: Chlorophyll; Ash; fat; Crude fibre; Crude protein; Moisture; Carbohydrate

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INRODUCTION

Vegetable is an important protective food for the maintenance of health and prevention of disease and contains valuable food ingredients. The health implication of vegetable cannot be compromised in growth and body metabolism (Edet and Etim, 2007) while they also play major role in maintaining alkaline reservation of the human system (Ngbede *et al.* 2014). Vegetable production has been recognized as the most accessible and affordable sources of micronutrient, high vitamin and mineral content (Bakhru, 2003). Okra is a vegetable crop that belongs to the genus *Abelmoschus* family *Malvaceae* and has two main species: *caillei* and *esculentus* (L.) (Siemonsma 1982).

Varieties vary with size of fruit, plant height, color, maturity date (Udoh *et al.,* 2005). Okra contains protein carbohydrate, and vitamin C in large quantity (Adeboye and Oputa, 1996). The essential and non-essential amino acids that okra contains are comparable to Soybean. It was also reported by Eke *et al*., (2008) that fresh okra fruit is a good source of minerals vitamins, and proteins. As a result, it plays a vital role in human diet and it can be consumed boiled or fried cooked the young immature fruits. In Nigeria, okra is usually boiled in water resulting in slimy soups and sauces, which are relished. The fruits serve as soup thickeners (Schippers, 2000). The flowers, leaves and buds are also edible. Okra seeds could be dried and the seed is a nutritious condiment that can be used to prepare vegetable curds, or ground and roasted to be used as coffee additive or substitute (Farinde *et al.*, 2001). Okra leaves are considered good cattle feed, but this is seldom compatible with the primary use of the plant.

Okra production worldwide is estimated at six million tonnes per year. In West Africa, it is estimated at 500,000 to 600,000 tonnes per year (Burkil, 1997). The total area under cultivation has increased over the years; India is the world largest producer followed by Nigeria and Sudan (Varmudy, 2011). They are cultivated in warm temperate, sub- tropical and tropical regions over the world (NRC, 2006). Okra is the most important fruit vegetable crop and a source of calories of about (4550Kcal/kg) (Babatunde *et al.,* 2007). There are two distinct seasons for okra production in Nigeria, the wet and the dry seasons. During the dry season, okra fruits are produced in low quantities (Bamire and Oke, 2003). Okra can be grown on a wide range of soil types; fruit yield and the greenish color acceptability is known to be mostly limited by soil fertility and cultural management.

Fertilizer is a very essential input in crop production with nutrients such as Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), and Sodium (Na) for fertility maintenance and crop production. These nutrients are specific in function and must be supplied to plants at the right time and quantity. Lack of optimum amount of these nutrients may result to poor performance of the crop, resulting to low yield (Shukla and Naik, 1993). Palm *et al*; (1993) described organic and inorganic fertilizer as essential tools in okra production. Omotosho and Shittu (2007), reported that fertilizer application rate of 150 kg NPK ha^{-1} for ring method of fertilizer application are effective for the growth and yield of okra while Iyagba (2013) reported that fertilizer application rates of 200kg NPK ha^{-1} and ring method of fertilizer application are effective for the growth and yield of okra. Reuveni and Reuveni (1995) reported that foliar feeding is an effective method for correcting soil deficiencies and overcoming other nutrients limitation in the soil. Reuveni and Reuveni (1995) opined that foliar feeding could be 8 to 10 times more effective than the direct soil feeding of plant and up to 90 percent of a foliar fed nutrient solution could be found in the smallest root of a plant within 60 minutes of application. Hence, the exploration of organic foliar fertilizer in production of okra and the effect in the okra nutritional quality is eminent.

Foliar fertilizers that contain the primary plant nutrient; N.P.K and other micronutrients are commonly recommended as the most efficient method of ameliorating nutrient deficiencies in vegetables and also to increase the yield and quality of crop products (Kannan, 2010; Naz *et al*., 2012). The D.I GROW ® a natural foliar organic fertilizers purported to be rich in macro and micro nutrients, trace elements and humic acid, with the ability to improve the growth of various vegetables, fruits and flowers as well as improve the quality of soil (Dynapharm ,2003). Hence the objective is to determine the effect of type and foliar fertilizer rates application on Chlorophyll and nutritional quality of okra varieties

MATERIALS AND METHODS

Experimental location and Source of experimental plant materials

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 known as Rainforest/Savanna transition zone ($7^0$15' N, $3^0$25' E). Average rainfall and mean temperature was 1238 mm and 27.1°C respectively. The National Horticulture Research Institute (NIHORT), Ibadan, Oyo State, is a Rainforest agro-ecology on the longitude $(7{\cdot}22)^0$N, and latitude $(3{\cdot}56)^0$E with average rainfall and temperature 1311mm and 26.5°C. The okra varieties (LD88 and NHAE-47) were sourced from the National Horticulture Research Institute (NIHORT), Ibadan while D.I grows organic plus® liquid fertilizers were sources from Nigerian Institute for Oil Palm Research (NIFOR), Benin, Edo State.

Nutrient composition of the liquid fertilizer

The Liquid organic fertilizers are made up of two types, D. I. Grow green ® and D.I Grow red ®. The two types of liquid were formulated from Acadian seaweed *(Ascophyllum nodosum)*, with complete elements of macro (N, P, K, Ca, Mg, S) and micro (Fe, Ze, Cu, Mo, Mn, B, Cl) iones (Table 1).

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

ELEMENTS	D.I grow GREEN® (S.I Unit)		D.I grow RED® Content	
	S.I Unit		S.I Unit	
	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%

S.I : International System of Units
Source A and C: Dynapharm International manual.2003 In: Organic Plus Fertilizer 2016. Source B and D: Unit modified from ppm to % (2016)

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).

Experimental design and treatments

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. The factors were okra varieties (LD88 and NHAE–47), the fertilizer types (D.I. Grow green ®and D.I.Grow Red®) and four rates of foliar applications (0, 300, 600 and 900 ml/ha) while NPK 15:15:15 of soil incorporation served as check at the recommended rates of 200kg NPK ha^{-1}(Iyagba *et al*., 2013) . The main plot treatments consisted of the two okra varieties (LD88 and NHAE- 47), sub plot treatments were the two liquid fertilizers D.I. GROW GREEN ® and D.I. GROW RED ®while the sub – sub – plot treatments were rates (0, 300, 600, 900 ml/ha and 200kg NPK ha^{-1}N.P.K

15:15:15 of which gave 20 treatments combination. Total number of plot was 60 plots while the main plot size was $8.4m^2$. The total area plot size was $720.5m^2$

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.

Data collection

***Chlorophyll content*:** This was determined using SPAD 500 chlorophyll meter on the tagged plants at 2, 4, 6 and 8WAS.

***Proximate analysis*:** The moisture, ash and crude fibre contents of samples of NHAE-47 and LD88 were determined using Standard Chemical Methods described by Association of Official Analytical Chemistry (AOAC,1990). Soxhlet extraction technique using petroleum ether (40-50° C) was used to evaluate the fat contents of the samples (Pearson *et al.,* 1981). Kjedahl method was used to determine the crude protein contents of the samples as described by (AOAC, 1990). The contents of carbohydrate of the samples were estimated by difference % carbohydrate = 100% - sum of percentage of moisture, ash, fat, crude fibre and crude protein contents as described by (Akpambang *et al.,* 2008).

Statistical analysis

Data collected were analyses using ANOVA (Analysis of Variance) of Genstat Discovery Statistical Package and means were separated using least significant difference LSD at 5% probability level.

RESULTS

Physico-Chemical properties of the soil

The soil in the experimental sites in FUNAAB and NIHORT were sand with high proportion of sand (927.0 and 879.0 g/kg) with 37.6 and 74.9g/kg silt, 35.4 and 46.1g/kg clay respectively (Table 2). The pH of the soil in both locations in 2015 was 6.53 and 6.45 respectively. The soil at FUNAAB experimental site had higher nitrogen (0.8 g/kg) than that of NIHORT (0.7 g/kg).

Weather Data in FUNAAB and NIHORT

In Table3, total amount of rainfall at FUNAAB and NIHORT experimental field between May and August 2015 were 852.9mm and 320mm respectively. At FUNAAB and NIHORT, the highest rainfall was observed in June and May respectively, (165mm, 321.9mm) and the lowest rainfall was in July (157.9 mm) and August (29mm) respectively. Mean Maximum Temperature at FUNAAB (May to August, 2015) ranged from 29.5^{0}C to 32.8^{o}C while minimum temperature ranged from 22.8^{0}C to 23.8^{0}C. Highest temperature was 32.8 ^{0}C for May, while the lowest temperature was 29.5^{0}C for August. In NIHORT from (May to August 2015) Mean Maximum Temperature at NIHORT (May to August, 2015) ranged from 28^{0}C to 33^{o}C while minimum temperature ranged from 22^{0}C to 24^{0}C. The highest temperature was in June 33 ^{0}C, while August had the lowest temperature of 22^{0}C (Table 3) at FUNAAB from (May to August 2015), relative humidity ranged from 61.9% to 73% (Table 3). Highest relative humidity was in June 70.8% while the lowest was 61.9% in May in NIHORT from (May to August 2015). Relative humidity ranged from 82% to 92%. Highest relative humidity was 92% August while the lowest value was in July (82%).

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

Soil Properties	NIHORT	FUNAAB
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 of the experimental period FUNAAB and NIHORT

Total Rainfall (mm)		Relative Humidity (%)		Temperature ^0C					
				Maximum		Minimum		Mean	
NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNA
246.3	69	89	62.8	33	33.8	24	24.1	28.5	28.
321.9	60	89	61.9	32	32.8	24	23.8	28	27.
233.7	165	90	70.8	33	30.8	24	22.8	28.5	27.
157.9	66	82	73	29	31.5	23	22.8	26	26.
139.4	29	92	70.3	28	29.5	22	22.8	25	25.
1099.2	389	442	338.8	155	158.4	177	116.3	136	135.

ational Horticulture Research Institutions (NIHORT)
irectorate of University Teaching and Research Farms (DUFARMS) of the Federal University of Agriculture, Abeokuta

Chlorophyll content of okra* as influenced by interaction of varieties, fertilizer type and rates of *organic fertilizers at FUNNAB and NIHORT during 2015 planting season

The organic foliar fertilizer rate had significant ($p \leq 0.05$) effect on the chlorophyll content of the Okra varieties while fertilizer type, varieties and their interactions was not significant on the chlorophyll content of the okra varieties (Table 4). However, variety LD88 had higher chlorophyll content in FUNAAB (46.84) than variety NHAE-47 in the two locations. The foliar organic fertilizer D.I green irrespective of time and location gave higher chlorophyll content on the okra at 4WAS (39.42), 6WAS (46.57) and 8WAS (43.04) hence performed better in NIHORT. Conversely, in FUNAAB it was D.I grow red that gave higher chlorophyll content on the okra irrespective of time and location at 4WAS (40.68), 6WAS (45.96) and 8WAS (41.34).

Foliar organic fertilizer rate 300ml/ha gave higher yield of chlorophyll content in FUNAAB at 4WAS (43.08), 6WAS (47.47) and 8WAS (42.49). In NIHORT, it was foliar organic fertilizer rate 900ml/ha that gave higher chlorophyll content on the okra at 4WAS (41.15),6WAS (47.75) and while at 8WAS it was foliar organic fertilizer rate 300ml/ha gave higher yield of chlorophyll content (44.39) as shown in Table 4.

Effect of variety, types and rates of organic fertilizers on chlorophyll content and harvest index of okra at FUNN NIHORT during 2015 planting season

	Chlorophyll content 4WAS		Chlorophyll content 6WAS		Chlorophyll content 8WAS	
	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT
es						
3	40.89	39.25	46.84	45.61	41.97	42.68
47	39.08	39.3	44.71	45.07	40.29	42.88
).5%	Ns	Ns	Ns	Ns	Ns	Ns
tilizer liquid (F)						
green	40.51	39.42	45.59	46.57	40.92	43.04
red	40.68	39.12	45.96	44.11	41.34	42.52
	40.99	37.57	46.54	44.42	40.55	44.2
05%	Ns	Ns	Ns	2.102*	Ns	Ns
R)						
ia	37.02	36.91	41.91	42	39.22	39.5
/ha	43.08	39.88	47.47	45.88	42.49	44.39
/ha	40.82	40.86	46.58	46.66	41.59	43.73
/ha	41.53	41.15	46.37	47.75	41.8	42.08
05%	2.747	2.933	2.668	3.323	Ns	3.538
	Ns	Ns	Ns	Ns	Ns	Ns
	Ns	Ns	Ns	Ns	Ns	Ns
F	Ns	Ns	Ns	Ns	Ns	Ns
× R	Ns	Ns	Ns	Ns	Ns	Ns

cant at ≤

Effect of variety, types and rates of organic fertilizers on % ash, %fat, %crude fiber and % crude protein, %moisture content and %carbohydrate content at FUNNAB and NIHORT during planting season

In both locations, significant different ($p \leq 0.05$) on the proximate analysis were recorded. The organic fertilizer D.I Grow red performed better while D.I grow Green had the least performance in FUNAAB. There was a significant different ($P \leq 0.05$) in the crude ash in both locations. In FUNAAB, rate of 300 ml/ha gave crude ash content of 9.4 %, followed by plants fertilized with 900 ml/ha, (7.9 %) while the unfertilized plant had crude ash of 5.8%. In NIHORT, at rate of 300 ml/ha, crude Ash content was 8.6% while the check NPK 15:15:15 was 8.5% followed by the unfertilized plant 5.6%.

In FUNAAB Okra crude fat at the rate of 600 ml/ha was 3.0% followed by plants fertilized with 900 ml/ha (2.5%) and the check N.P.K was 2.2% while the unfertilized plant was 1.8% crude fat. In NIHORT, rate of 900 ml/ha was Crude Fat (2.7%), followed by 300 ml/ha, (2.6%) and rate 600ml/ha (2.5%, 2.4%) for NPK while the unfertilized plant was 1.7%.

Different crude fibre were recorded at different rate of organic foliar fertilizer applied. Okra in FUNAAB, at the rate of 300 ml/ha was 15.9% crude fibre, followed by with plants that received organic foliar fertilizer of 600 ml/ha (13.6%) and 900 ml/ha (13.6%) while N.P.K and the unfertilized plant was 13.3% and 9.0% crude fibre respectively. In NIHORT, rate of 300 ml/ha was crude fibre of 15.2% followed by plants fertilized with organic foliar fertilizer of 600 ml/ha and N.P.K 15:15:15 which were 15.1% respectively (Table 5).

Okra in FUNAAB, at rate of 200 kg NPK ha^{-1} (N. P. K 15:15:15) had crude protein content of 18.3% followed by plants fertilized with 900 ml/ha (18.1%), while others were at rates 600 ml/ha (16.6%) and 300 ml/ha (16.1%) respectively. In NIHORT, rate of 900 ml/ha had Pod Crude Protein of (20.2%) followed by plants fertilized with N.P.K 15:15:15 (19.5%) Crude Protein. Other rates 300 ml/ha (18.3%) and 600 ml/ha (17.12%) were recorded while the unfertilized plant was 11.2% (Table 5)

Moisture content of okra in FUNAAB, at the rate of 300 ml/ha gave 9.1% followed by plants fertilized with N.P.K 15:15:15 (8.9%), Other moisture content with other rates are 8.8% at 600 ml/ha, 8.7% at 900 ml/ha, while the unfertilized plant was 4.7%. In NIHORT, rate of 600 ml/ha and 900 ml/ha gave moisture content of 8.9% followed by plants fertilized with 300 ml/ha and N.P.K 15:15:15 (8.8%). Moisture content with the unfertilized plant was (4.7%). (Table 5)

Carbohydrate content of okra from FUNAAB, at the rates of 300 ml/ha was (52.0%) followed by plants fertilized with 600 ml/ha (51.2%). Carbohydrate content with other rates at 900ml/ha (49.2%), N.P.K 15:15:15 (44.5%) and the unfertilized plant had (26.8%). In NIHORT, at rate of 600 ml/ha was (48.0%) followed by plants fertilized with 300 ml/ha (46.6%). other rates were with NPK 15:15:15 (45.6%), at 900 ml/ha (45.0%) while the unfertilized plant had (27.60%). (Table 5)

ariety, types and rates of organic fertilizers on Ash%, Fat%, Crude fibre% and Crude protein, Moisture content % and Carboh FUNNAB and NIHORT during planting season

	Ash %		Fat%		CrudeFibre %		Crude Protein %		Moisture %		
	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT	F
)											
	7.4	7.9	2.3	2.3	12.5	13.4	16.1	17.7	16.3	16.2	
	7.8	8.0	2.4	2.4	13.7	13.8	15.8	16.9	16.2	16.3	
.	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	
	7.0	8.0	2.1	2.4	11.5	13.4	16.1	18.2	16.3	16.3	
	8.3	8.0	2.5	2.4	14.7	13.8	15.9	16.3	16.2	16.2	
	7.3	8.5	2.2	2.4	13.3	15.1	18.3	19.5	8.9	8.8	
%	0.6	Ns	0.2	Ns	1.3	Ns	Ns	Ns	Ns	Ns	
	5.8	5.6	1.8	1.7	9.0	8.2	10.9	11.2	4.7	4.7	
	9.4	8.6	2.1	2.6	15.9	15.2	16.1	18.3	9.1	8.8	
	7.6	8.6	3.0	2.5	13.6	15.0	16.6	17.1	8.8	8.9	
	7.9	8.6	2.5	2.7	13.6	14.6	18.1	20.2	8.7	8.9	
	0.9	0.3	0.3	0.1	2.1	0.9	1.2	3.0	0.2	0.3	
	1.2	0.4	0.5	Ns	2.9	Ns	Ns	Ns	Ns	Ns	
	1.2	Ns	0.5	Ns	Ns	Ns	Ns	Ns	Ns	Ns	
	0.8	0.3	0.3	0.2	Ns	0.8	1.1	ns	0.2	0.3	
	1.8	0.6	0.6	0.5	4.2	1.9	2.4	6.0	0.5	0.6	

LSD 5% - least significant difference at 5% probability level. Ns- not significant at ($p \leq 0.05$)

Proximate analysis of % ash, fat, crude fiber and carbohydrate content as influenced by Interaction between varieties and organic fertilizer rates in FUNAAB and NIHORT

In Table 6, variety NHAe–47 ash content at the rate of 600 ml/ha was 9.42%, followed by 900 ml/ha, (9.13%), while on the other rates was observed 6.23% at 300 ml/ha, 6.18% at N.P.K; and the unfertilized had 6.04%. On variety LD88, at rate of 300 ml/ha was observed (9.32%), followed by 600 ml/ha, (9.06%), N.P.K 15:15:15 (8.4%) while the unfertilized plant (5.59%) recorded the least values of % ash.

In NIHORT, on variety NHAe – 47 was observed ash content 9.07% at the rates of 300 ml/ha, followed by 900 ml/ha (8.67%), and others were N.P.K 15:15:15 (8.50%) and 600 ml/ha (8.37%), while the unfertilized was 5.62% ash content. The other variety, LD88 at rate 300 ml/ha was; ash content of (8.73%), followed by plant fertilized with 600ml/ha (8.66%). On the other rate was observed at 900 ml/ha (8.55%), and N.P.K 15:15:15 (8.21%) while the unfertilized plant was 5.49% (Table 6).

In FUNAAB, percentage fat content from variety LD88 when treated with N.P.K 15:15:15 was (2.95%) followed by 600 ml/ha, (2.63%). Other rates 900 ml/ha was (2.63%) while the unfertilized was (1.62%). In NHAe -47, N.P.K 15:15:15 was (3.03%) followed by (2.85%) at 900 ml/ha and unfertilized had (1.74 %). On percentage Crude fiber (cf) content in FUNAAB, variety NHAe – 47 at rate of 600 ml/ha foliar organic fertilizer was crude fibre (cf) (16.30%), followed by 300 ml/ha of 15.91%, other rate N.P.K 15:15:15 was 15.72%. On unfertilized plant was observed 8.87% crude fibre.

The variety LD88, at rate of 900 ml/ha was (16.20%), followed by N.P.K 15:15:15 of (16.16%). Also on other rate 600 ml/ha was observed (10.82% cf) and 300 ml/ha (10.69%) while the unfertilized was 9.15% cf. The carbohydrate content at rate of 300 ml/ha on variety LD88 was (56.16%), followed by 600 ml/ha (55.73%) while the unfertilized was 25.79%. Variety NHAe-47 when treated with 900 ml/ha was (53.29%), followed by 300 ml/ha, (47. 87%).Other rate was 600 ml/ha (46.75%) , N.P.K 15:15:15 (44.32%) and the unfertilized 27.78% (Table 6).

Effect of interaction between varieties and rates on proximate analysis of % ash, fat, crude fibre and carbohydra in FUNAAB and NIHORT 2015

		Ash %		Fat %	Crude fibre %	Carbohydr
es	Rates ml/ha	NIHORT	FUNAAB	FUNAAB	FUNAAB	FUNAA
	NPK	8.21	8.40	2.95	16.16	44.74
	0	5.49	5.59	1.62	9.15	25.79
	300	8.73	9.32	2.51	10.69	56.16
	600	8.66	9.06	2.63	10.82	55.73
	900	8.55	6.70	2.10	16.20	45.10
47	NPK	8.50	6.18	3.03	15.72	44.32
	0	5.62	6.04	1.74	8.87	27.78
	300	9.07	6.23	2.04	15.91	47.87
	600	8.37	9.42	1.75	16.30	46.75
	900	8.67	9.13	2.85	11.00	53.29
%		0.43	1.25	0.46	2.94	3.85

t significant difference at 5% probability level.

Interaction effect of fertilizer type and rates on percentage (%) ash content

Table 7 shows the Interaction effect of fertilizer type and rates on percentage ash content in FUNAAB. Application of D. I. Grow green fertilizer at rate of 300ml/ha gave highest value of percentage ash content (9.37%). This was followed with the rate of 300ml/ha (9.36%) from D.I grow Red while the least percentage ash content was recorded in the control plant. In the fat content, it was observed that D.I grow green at rate of 900ml/ha gave the highest percentage value of crude fat (2.85%) and was closely followed with fertilizer rate of 600ml/ha (2.65%). The percentage carbohydrate showed that D.I grow Red at rate of 300ml/ha and 600ml/ha yielded value of 56.02% and 56.31% respectively.

Table 7: Effect of interaction between fertilizer and rates on % ash, fat and carbohydrate content in FUNAAB 2015

		FUNAAB		
Fertilizer	Rates ml/ha	Ash %	Fat%	Carbohydrate %
D.I grow Green	NPK	8.43	2.99	44.53
	0	5.58	1.74	27.56
	300	9.37	2.49	47.72
	600	8.68	2.67	46.47
	900	9.18	2.85	44.75
D.I grow Red	NPK	6.20	2.99	44.53
	0	6.05	1.71	26.02
	300	9.36	1.76	56.31
	600	6.56	1.92	56.02
	900	6.65	2.10	53.65
LSD 5%		1.25	0.46	3.85

LSD: Least significant difference at 5% probability level.

Interaction effect of varieties and fertilizer on proximate analysis of % ash, fat moisture, carbohydrate, crude protein and fibre contents in FUNAAB and NIHORT.

In FUNAAB, the interaction effects of varieties and fertilizer on the nutritive content of okra was observed that application of D.I grow Green on both varieties (LD88 and NHAE-47) had the highest percentage Ash content of 8.96% and 7.5 % respectively. However, in NIHORT it was D.I grow Red that had highest percentage ash content of 8.68% and 8.58% on the two varieties NHAE-47 and LD88 respectively. The percentage content of fat does not follow this trend. In FUNAAB, D.I grow RED had higher % fat (2.83%) on LD88 while on the other variety NHAE-47, D.I grow RED was observed higher % fat content (2.30%). Similar trend as above was observed in NIHORT on both varieties.

In the percentage moisture content irrespective of location and varieties the above trend was observed. In variety LD88, D.I grow RED had higher moisture content 23.53% and 23.75% in both location FUNAAB and NIHORT respectively. Also D.I grow Red had higher moisture content 9.01% and 8.92% in the variety (NHAE-47) in FUNAAB and NIHORT respectively. In both FUNAAB and NIHORT, D.I grow Red was observed to had higher percentage carbohydrate 53.75% and 46.89% with LD88, while with NHAE-47, in FUNAAB D.I grow Green was best with a value of 45.71% and in NIHORT D.I grow Red was the best with percentage carbohydrate of 39.99%.

The percentage protein and fibre content, shows that D.I grow green gave higher protein and fibre value content of 14.71 % and 14 96% respectively in variety NHAE-47 both in FUNAAB and NIHORT. While in variety LD88, D.I grow Green gave higher percentage of protein (17.88%) content and higher percentage fibre content 14.78% was recorded with D.I grow Red (Table 8).

Effect of interaction between varieties and fertilizer on % ash, fat moisture, carbohydrate, crude protein and fibr contents in FUNAAB and NIHORT

	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB	NIHORT	FUNAAB
Fertilizer	Ash %		Fat %		Moisture %		Carbohydrate %		Protein %
D.I grow Green	8.96	7.27	1.89	2.60	23.49	23.59	38.70	45.64	17.88
D.I grow Red	6.66	8.58	2.83	2.08	23.53	23.75	52.32	46.89	17.57
D.I grow Green	7.53	7.41	2.26	2.15	8.95	8.72	45.71	37.77	14.71
D.I grow Red	7.27	8.68	2.30	2.65	9.01	8.92	42.29	39.90	14.20
	0.79	0.26	0.29	0.23	0.27	0.20	2.43	2.72	1.06

st significant difference at 5% probability level

DISCUSSION

The soil texture of the experimental site by United State Development Association soil classification was sandy texture, this texture may be attributed to parent material (PM) from which the soil was formed and the climate of the area. The soil texture might be formed from sandstone and quartz parent material in this environment thus sandy texture of the soil. This is in line with the findings of Brady and Weils (1999) that the high sand content of soil could be attributed to high content of quartz and sandstone in the parent material.

The Weather condition affected the two varieties, the chlorophyll and their nutritional content especially in NIHORT. This is due to higher rainfall and relative humidity with lower temperature in NIHORT compared to FUNAAB which might have significantly affected the effectiveness of the D.I Grow plus organic fertilizer. The observed quantum of rainfall during the experimental period was below the crop rainfall requirement in FUNAAB and above in NIHORT as reported by Dada *an*d Fayinminnu (2010) for okra cultivation. The observed temperatures during the period of the experiment were within the range of temperature requirement for the optimum performance of the crop as reported by Tindall (1983) and Nonnecke (1989). The soil pH though almost neutral and was within the favorable range for crop cultivation, but its fertility status was poor as a result of torrential rainfall that characterize generally the tropical soils (Prochnow, 2008) which also might have affected the performance of the foliar fertilizer.

The liquid fertilizers are reported to be rich in both macro and micro nutrients and were applied to enhance both chlorophyll and the nutritional quality of the okra. Foliar organic fertilizer is considered as a supplement to the application of nutrients under adverse soil and environmental situations, especially soil low in nutrients or not-available and decreased root activity during the vegetative and reproductive growth stage of plants (Naruka *et al*., 2000; Alkaff and Hassan, 2003). Chattopadhyay *et al*., 2003; Fageria *et al.,* 2009 opined that it helped timely translocation of deficient nutrients to plant system through leaf tissue.

The observed chlorophyll content in the plant and nutritional quality of the two varieties despite the unfavorable weather condition in both locations were subdue by the formation and role of macro and micro nutrients in the liquid fertilizer thus affecting the physiological process, cell division and elongation which indirectly affected the tissue formation and consequently vegetative growth and the reproductive stage of the crop. These results corroborate the work of Abdul Rasool *et al.,* 2010 and Kadum,2011 that when plant are under some adverse weather conditions, foliar liquid fertilizer application has the capacity to cushion the effect because of the immediate assumption through the leaf tissues. Kadum,2011; Sharma and Kumawat*,* (2011) also submitted that D.I grow plus liquid fertilizer have potentials to make up for nutrient deficiency and bad weather condition for survival of crop especially when water and minerals are not readily available to the growing crop.

In some parameters it was observed that the application rate of 300 ml/ha performed better than the other application rate however in NIHORT though 900 ml/ha gave higher value, in some instances 600 ml/ha produced better yield parameters .This variance in quantity of nutrients needed for survival might be due to climatic factor and the initial soil nutrient and environmental factor around the crop which is line to Dikwahal *et al*. (2006), Adeyemi *et al*

(2008), Shehata *et al*. (2011) and Iyagba *et al* (2013) who reported that the limiting factors to crop production and other vegetables are many which may be attributed to the soil types in the different locations, genetic makeup of the crop, ability to use different nutrient minerals at different rate of concentration and also ability to partitioning the nutrients from the sources to sink.

The Proximate content analysis of fruits were affected differently by rates and types of liquid fertilizer applied on varieties at the interaction level. Statistically, there was different effect on the responses of liquid fertilizer types with different concentration rates with higher performance on LD88 varieties. On ash, fat, crude fibre, moisture, and the carbohydrate content, it was evident that the proximate parameters among the different fertilizer were different from those with NPK and control (Akanbi *et al*., 2007). Crude protein was highest in soil incorporated NPK, followed by D.I grow red followed by D.I grow green and the least was from the unfertilized plant. Fashina *et al*. (2002) reported that varying concentration and mode of application of fertilizer nutrient source significantly changed the crop tissue and the nutritional values. The fact that crude protein is highest in soil incorporated NPK is an indication that the ease with which crop absorb and use nutrients for growth and development has implication on the nutrient availability, absorption, assimilation and metabolism ability of the crop.

CONCLUSION

This study examined the type and application rate of two newly introduced organo based foliar fertilizers on chlorophyll and proximate content of okra. The liquid fertilizer was able to supply sufficient nutrients to enhance chlorophyll and proximate content at different rate and at different location. It was observed that D. I grow Green and D. I grow Red had different effect on the parameters at different location. On the okra varieties, D.I. grow GREEN fertilizer at the rate of 300 ml/ha performed better in FUNAAB while in NIHORT the rate of 600 ml/ha was the best in this different agro ecological zone.

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