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EFFECT OF ORGANO- BASED FOLIAR FERTILIZER ON CHLOROPHYLL AND NUTRITIONAL QUALITY OF OKRA VARIETIES IN DERIVED SAVANAH OF NIGERIA

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ABSTRACT

Cultivation of okra (*Abelmoschus esculentus* L.) which is a commonly grown vegetable crop in the tropics is constrained by depleting soil fertility. Use of foliar fertilizer as a supplement has been successfully reported in the temperate region hence there is need to determine the effect of foliar liquid fertilizer on okra growth and nutritional quality. Field experiments were conducted at the Abeokuta (Federal University of Agriculture [FUNAAB]) and Ibadan (National Horticulture Research Institute [NIHORT]), between May and August 2015 to evaluate the response of two okra varieties to types and rates of organic-based foliar fertilizer application. Experiment was a 2 × 2 × 5 factorial combinations laid out in Randomized Complete Block Design with three replicates at both locations. Factors were okra variety (LD88 and NHae47-4), the fertilizer types (D.I. Grow Green ® and D.I.Grow Red®) and four rate of foliar applications (0 [control], 300, 600 and 900 ml/ha) while NPK 15:15:15 served as check. The results showed that the D.I.Grow Red® at 300ml/ha produced the higher Ash (8.23%), fat (2.54%,), moisture (14.65%), and carbohydrate (47.31%) at Abeokuta 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 Ibadan. 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 Abeokuta and 600 ml/ha at Ibadan enhance fruit nutritional quality of okra. Therefore, 300 and 600 ml/ha is recommended to farmers in Abeokuta and Ibadan, respectively.

Keywords: Chlorophyll, Ash content (%), fat content (%), Crude fibre content (%), Crude protein content (%), Moisture content (%), and carbohydrate content (%).

INRODUCTION

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 plant height, maturity date, fruit size and color (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 which had grate implication for human health (Ngbede et al.,2014). It was also reported by Eke *et al*., (2008) that fresh fruit is a good source of minerals vitamins, and proteins thus plays a vital role in human diet hence can be consumed boiled and 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, subtropical 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).

Fertilizer irrespective of type is vital to crop production and attainment of sufficient food production globally (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 the short coming that emerge from direct application of fertilizer to the soil due to leaching and transfer nutrients beyond the reach of the feeder root s of the crop. Foliar feeding could be 8 to 10 times more effective than soil feeding 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 opined Reuveni and Reuveni (1995). The torrential rainfall that characterize the tropical environment which create nutrient deficiency call for alternative way of making the nutrient available to the crop for growth and development. Some foliar fertilizers the contained N.P.K and micronutrients are recommended as the efficient method of ameliorating nutrient deficiencies in vegetables and also increasing yield and quality of crop products (Kannan, 2010; Naz *et al*., 2012).

The D.I GROW ® is a natural foliar organic fertilizer that is rich in macro and micro nutrients, trace elements and humic acid, improve the growth of various vegetables, fruits and flowers as well as improve the quality of soil (Dynapharm, 2003). The exploration of folia fertilizer in production of okra and their nutritional quality therefore worth investigating. Hence the objective was to determine the effect of foliar fertilizer type and rates application on Chlorophyll and nutritional quality of okra varieties.

MATERIALS AND METHODS

Experimental location

The experiments were conducted at two different locations in 2015 growing season. The locations were the Directorate of University Teaching and Research Farms (DUFARMS) of the Federal University of Agriculture, Abeokuta a Derived savannah – transition agro ecological zone (7°15' N, 3°25' E) and at the

National Horticulture Research (NIHORT) Ibadan (7°22.5 ' N, 3°56.5 ' E) forest – transitory agro ecological zone respectively.

Source of experimental plant materials

The Seeds of okra varieties: (LD88 and NHae47-4) used for this study were sourced from the National Horticultural Research Institute (NIHORT), Ibadan. They were improved, short duration, erect growing and high yielding cultivars. while D.I.grow organic plus® liquid fertilizers were sourced from Nigerian Institute for Oil Palm Research (NIFOR), Benin City.

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 ionic elements, macro (N, P, K, Ca, Mg, S) and micro (Fe, Ze, Cu, Mo, Mn, B, Cl) iones (Table 1).

Table 1: Composition of the liquid fertilizer from the manual

ELEMENTS	D.I grow GREEN®	D.I grow RED®
	A	C
N (**%**)	2.35	1.85
P (**%**)	4.44	1.85
K (**%**)	1.75	3.31
Mg (**%**)	0.36	0.49
Fe (ppm)	867	742
Mn (ppm)	223	587
Cu (ppm)	144	105
Zn (ppm)	153	383
Bo (**%**)	0.011	0.043
Mo (**%**)	0.002	0.0076
Humic Acid (**%**)	0.68	0.68

Source A and C: Organic Plus Fertilizer2003

Pre – planting soil analysis

Composite soil samples collected from each location were analysed at the soil laboratory of institute of Agricultural Research and Training (IA&RT) to determine the soil physical and chemical properties using the Tropical Soil Biology and Fertility (TSBF) methods of soil and plant analysis (Okalebo *et al.,* 1993).

Experimental design and treatments

The experiment was a 2 × 2 × 5 factorial in a split-split-plot arrangement, with three replicates at both locations. The factors were okra varieties (LD88 and NHae47-4), the fertilizer types (D.I. Grow green ®and D.I.Grow Red®) and four rates of foliar applications (control (0) , 300, 600 and 900 ml/ha) while NPK 15:15:15 at 200kg NPK ha^{-1} (Iyagba *et al*., 2013) served as check. The main plot consisted of the two okra varieties (LD88 and NHae47-4), sub plot treatments were the two liquid fertilizers D.I. GRO W GREEN ® and D.I. GROW RED ® while the sub – sub – plot treatments were rates (0, 300, 600, 900 ml/ha and given 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 $720.5m^2$

Land preparation, soil sampling, treatment application and cultural practices.

The land was ploughed twice and harrowed once after ploughing. There was 1 m between replicates, and 0.5 m between each plots. The plots were treated with liquid fertilizers D.I. grow green ® and D.I. grow red® after two weeks and four weeks, and these were measured with the aid of 0.2mls discharged of syringe of liquid fertilizer at the rates of 0,300,600 and 900 ml/ha to knapsack sprayer which was calibrated to discharge 200 l/ha of water at constant rates. The soil fertilizer (N.P.K. 15:15:15) was applied at 200kg $NPKha^{-1}$ as a check. Three seeds each of the two (NHae47-4 and LD88) okra varieties were sown per hole and thinned to one plant per stand at two weeks after sowing (WAS). Seeds were sown at the spacing of 60 cm x 40 cm giving a total number of 1,666 plants/ha. Weeding was done manually when necessary.

Data collection

The following data were collected on the okra plants. The okra fruits were ready for first harvest at 7 weeks after sowing. Okra fruits were h arvested at interval of five days.

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 NHae47-4 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^o 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 2012 and means were separated using least significant difference LSD at 5% probability level.

RESULTS

Weather data in Abeokuta and Ibadan

In Table 2, total amount of rainfall at Ibadan and Abeokuta experimental field between May and August 2015 were 852.9 mm and 320 mm respectively. At Abeokuta and Ibadan, the highest rainfall observed was in June

and May, (165 mm, 321.9 mm) respectively, and the lowest rainfall was in July (157.9 mm) and August (29 mm) respectively. Mean Maximum Temperature at Abeokuta (May to August, 2015) ranged from 29.5^{o}C to 32.8^{o}C while minimum temperature ranged from 22.8^{o}C to 23.8^{o}C. Highest temperature was 32.8 ^{o}C for May, while the lowest temperature was 29.5^{o}C for August. In Ibadan from Mean Maximum Temperature from May to August, 2015 ranged from 28^{o}C to 33^{o}C while minimum temperature ranged from 22^{o}C to 24^{o}C. The highest temperature was in June (33^{o}C), while August had the lowest temperature of 22^{o}C (Table 2). At Abeokuta from (May to August 2015), relative humidity ranged from 61.9% to 73% (Table 2). Highest relative humidity was in June 70.8% while the lowest was 61.9% in May at Ibadan from (May to August 2015). Relative humidity ranged from 82% to 92%. Highest relative humidity was 92% August while the lowest value (82%) was in July.

Physico-Chemical properties of the soil.

The soil in the experimental sites in Ibadan and Abeokuta were sand with high proportion of sand (927.0 and 879.0 g/kg) with 37.6 and 74.9 g/kg silt, 35.4 and 46.1 g/kg clay respectively (Table 3). The pH of the soil in both locations in 2015 was 6.53 and 6.45 respectively. The soil at Abeokuta experimental site had higher nitrogen (0.8 g/kg) than that of Ibadan (0.7 g/kg) though it was below the sufficient rating level for the test crop, the same trend was also observed in both P and K in the two location hence the soil was deficient in the nutrients.

Effect of variety, types and rates of organic fertilizers on chlorophyll content of okra at Abeokuta and Ibadan during 2015 planting season

The organic foliar fertilizer rate had significant ($p \leq 0.05$) effect on the chlorophyll content of the Okra while fertilizer type, variety and their interactions was not significant on the chlorophyll content of the okra varieties (Table 4). However, variety LD88 had higher chlorophyll content in Abeokuta (46.84) than variety NHae47-4 in the two locations. The foliar organic fertilizer D.I green irrespective of time and location had higher chlorophyll content on the okra at 4WAS (39.42), 6WAS (46.57) and 8WAS (43.04) hence performed better in Ibadan. Conversely, in Abeokuta it was D.I grow red that had 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 had higher yield of chlorophyll content in Abeokuta at 4WAS (43.08),6WAS (47.47) and 8WAS (42.49). In Ibadan, it was foliar organic fertilizer rate 900 ml/ha that had 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 had higher yield of chlorophyll content (44.39) as shown in Table 4.

Table 2: Weather data of the field experimental period (May to August 2015)

Month	IBADAN					ABEOKUTA				
	Total Rainfall (mm)	Relative Humidity (%)	Temperature ^{o}C Max.	Min.	Mean	Total Rainfall (mm)	Relative Humidity (%)	Temperature ^{o}C Max.	Min.	Mean
May	321.9	89	32	24	28	60	61.9	32.8	23.8	27.8
June	233.7	90	33	24	28.5	165	70.8	30.8	22.8	27.4
July	157.9	82	29	23	26	66	73	31.5	22.8	26.6
August	139.4	92	28	22	25	29	70.3	29.5	22.8	25.6
Total	852.9	353	122	93	107.5	320	276	124.6	92.2	107.4

Source1: National Horticulture Research Institutions (NIHORT), Ibadan
Source 2: Federal University of Agriculture, Abeokuta (FUNAAB), Abeokuta

Table 3: Pre-plant soil physio- chemical properties of experimental sites during 2015 planting season

Soil Properties	IBADAN	ABEOKUTA
Soil $_{p}$H	6.5	6.5
Ca (cmol/kg)	2.6	2.5
Mg (cmol/kg)	0.6	0.7
Na (cmol/kg)	0.3	0.3
K (cmol/kg)	0.4	0.4
Exch acidity(cmol/kg)	0.7	0.1
ECEC (cmol/kg)	4.0	3.9
Total N (g/kg)	0.7	0.8
Organic C (g/kg)	5.8	6.5
Av.P (mg/kg)	4.9	5.2
Mn (mg/kg)	7.5	8.1
Cu (mg/kg)	0.4	0.3
Zn (mg/kg)	1.5	1.6
Pb (mg/kg)	0.3	0.3
Cd (mg/kg)	0.004	0.006
Sand (g/kg)	927.0	879.0
Silt (g/kg)	37.6	74.9
Clay (g/kg)	35.4	46.1
Soil texture	Sand	Sand

Table 4: Effect of variety, types and rates of organic fertilizers on chlorophyll content and harvest index of okra at Abeokuta and Ibadan during 2015 planting season

	CHLOROPHYLL CONTENT					
	4WAS		6WAS		8WAS	
	Abeokuta	Ibadan	Abeokuta	Ibadan	Abeokuta	Ibadan
Variety						
LD88	40.89	39.25	46.84	45.61	41.97	42.68
NHae47-4	39.08	39.3	44.71	45.07	40.29	42.88
L.S.D ,(5%)	Ns	Ns	Ns	Ns	Ns	Ns
Fertilizer liquid (F)						
Di grow green	40.51	39.42	45.59	46.57	40.92	43.04
Di grow red	40.68	39.12	45.96	44.11	41.34	42.52
L.S.D,(5%)	Ns	Ns	Ns	2.102	Ns	Ns
Check						
NPK	40.99	37.57	46.54	44.42	40.55	44.2
Rates (R)						
0 ml/ha	37.02	36.91	41.91	42	39.22	39.5
300 ml/ha	43.08	39.88	47.47	45.88	42.49	44.39
600 ml/ha	40.82	40.86	46.58	46.66	41.59	43.73
900 ml/ha	41.53	41.15	46.37	47.75	41.8	42.08
L.S.D,(5%)	2.747	2.933	2.668	3.323	Ns	3.538
VxR	Ns	Ns	Ns	Ns	Ns	Ns
FxR	Ns	Ns	Ns	Ns	Ns	Ns
V x F	Ns	Ns	Ns	Ns	Ns	ns
V x F x R	Ns	Ns	Ns	Ns	Ns	ns

L.S.D:Significant at 0.05% . Where: ns = not significant at ≤ 0.05

Effect of variety, types and rates of organic fertilizers on % ash, %fat, %crude fiber and % crude protein, %moisture content and %carbohydrate content at Abeokuta and Ibadan during 2015 planting season.

In both locations, significant difference ($p \leq 0.05$) 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 Abeokuta. There was a significant different ($P \leq 0.05$) in the ash in both locations. In Abeokuta, rate of 300 ml/ha had ash content of 9.4 %, followed by plants fertilized with 900 ml/ha, (7.9 %) while the unfertilized plant had ash of 5.8%. In Ibadan, rate of 300 ml/ha had ash content of 8.6% while the check NPK 15:15:15 was 8.5% followed by the unfertilized plant 5.6%.

In Abeokuta Okra 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 had 1.8% fat. In Ibadan, rate of 900 ml/ha gave Fat of 2.7%, followed by 300 ml/ha, (2.6%) and rate 600ml/ha (2.5% , (2.4%) for NPK while the unfertilized plant was1.7%.

Different crude fibre were recorded at different rate of organic foliar fertilizer applied. Okra in Abeokuta, at the rate of 300 ml/ha had 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 had 13.3% and 9.0% crude fibre respectively. In Ibadan, rate of 300 ml/ha had 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 Abeokuta, at N.P.K 15:15:15 gave crude protein content of 18.3% followed by plants fertilized with 900 ml/ha (18.1%). While other rates 600 ml/ha (16.6%) and 300 ml/ha (16.1%) were recorded. In Ibadan, rate of 900 ml/ha had 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 had 11.2%. (Table 5)

Moisture content of okra in Abeokuta, at the rate of 300 ml/ha had 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 had 4.7%. In Ibadan, rate of 600 ml/ha and 900 ml/ha had 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 Abeokuta, at the rates of 300 ml/ha had (52.0%) followed by plants fertilized with 600 ml/ha (51.2%). Carbohydrate content with other rates is (49.2%) at 900ml/ha, (44.5%) with N.P.K 15:15:15 and the unfertilized plant had (26.8%). In Ibadan, rate of 600 ml/ha had (48.0%) followed by plants fertilized with 300 ml/ha (46.6%). other rates are (45.6%) with NPK 15:15:15, (45.0%) at 900

Table 5: Effect of variety, types and rates of organic fertilizers on ash% fat%, crude fibre% and crude protein % moisture content and carbohydrate content at Abeokuta and Ibadan during 2015 planting season

	Ash %		Fat%		Crude Fibre %		Crude Protein %		Moisture %		Carbohydrate %	
	ABK	IB	ABK	IB	ABK	IB	ABK	IB	ABK	IB	ABK	IB
Varieties (V)												
LD88	7.4	7.9	2.3	2.3	12.5	13.4	16.1	17.7	16.3	16.2	45.5	42.8
NHae47-4	7.8	8.0	2.4	2.4	13.7	13.8	15.8	16.9	16.2	16.3	44.0	42.3
LSD,(5%)	Ns	Ns	Ns	ns	Ns	Ns	ns	ns	ns	Ns	ns	ns
Fertilizer liquid (F)												
D.igrow green ®	7.0	8.0	2.1	2.4	11.5	13.4	16.1	18.2	16.3	16.3	42.2	41.7
D.I grow Red ®	8.3	8.0	2.5	2.4	14.7	13.8	15.9	16.3	16.2	16.2	47.3	43.4
L.S.D,(5%)	0.6	Ns	0.2	ns	1.3	Ns	ns	ns	ns	Ns	1.7	ns
Check												
NPK	7.3	8.5	2.2	2.4	13.3	15.1	18.3	19.5	8.9	8.8	44.5	45.6
Rates (R)												
0 ml/ha	5.8	5.6	1.8	1.7	9.0	8.2	10.9	11.2	4.7	4.7	26.8	27.6
300 ml/ha	9.4	8.6	2.1	2.6	15.9	15.2	16.1	18.3	9.1	8.8	52.0	46.6
600 ml/ha	7.6	8.6	3.0	2.5	13.6	15.0	16.6	17.1	8.8	8.9	51.2	48.0
900 ml/ha	7.9	8.6	2.5	2.7	13.6	14.6	18.1	20.2	8.7	8.9	49.2	45.0
LS.D,(5%)	0.9	0.3	0.3	0.1	2.1	0.9	1.2	3.0	0.2	0.3	2.7	3.0
VxR	1.2	0.4	0.5	ns	2.9	Ns	Ns	ns	ns	Ns	3.8	ns
FxR	1.2	Ns	0.5	ns	Ns	Ns	Ns	ns	ns	Ns	3.8	ns
V x F	0.8	0.3	0.3	0.2	Ns	0.8	1.1	ns	0.2	0.3	2.4	2.7
V x F x R	1.8	0.6	0.6	0.5	4.2	1.9	2.4	6.0	0.5	0.6	5.4	6.1

LSD, (5%) = least significant difference at 5% probability level ns= non significant at ($p \leq 0.05$) , ABK =Abeokuta, IB = Ibadan

Effect of Interaction between varieties and rates on proximate analysis of % ash, fat, crude fiber and carbohydrate content in Abeokuta and Ibadan

The interaction effect ($p \leq 0.05$) between varieties and rates (Table 6) on ash content at the rate of 600 ml/ha had variety NHae47-4 ash content (9.42%), followed by 900 ml/ha, (9.13%), the other rate are 6.23% at 300 ml/ha, 6.18% at N.P.K; and the unfertilized had 6.04% .Variety LD88, at rate of 300 ml/ha had (9.32%), followed by 600 ml/ha, (9.06%) while N.P.K 15:15:15 with a value of (8.4%) and the unfertilized plant (5.59%) recorded the least values of % ash.

In Ibadan, variety NHae47-4 gave ash content at the rates of 300 ml/ha (9.07%), followed by 900 ml/ha (8.67%), the other rate N.P.K 15:15:15 (8.50%) and 600 ml/ha (8.37%), while the unfertilized had 5.62 %. The other variety, LD 88, at rate 300 ml/ha had ash content of (8.73%), followed by plant fertilized with 600ml/ha of (8.66%). The other rate at 900 ml/ha had (8.55%), and N.P.K 15:15:15 (8.21%) while the unfertilized plant had 5.49% (Table 6).

In Abeokuta, 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 were (2.63%) while the unfertilized was (1.62%). In NHae47-4, N.P.K 15:15:15 produced (3.03%) followed by (2.85%) at 900 ml/ha and unfertilized had (1.74 %). On percentage Crude fiber(cf) content in Abeokuta, variety NHae47-4 at rate of 600 ml/ha foliar organic fertilizer produced crude fibre (16.30%), followed by 300 ml/ha of 15.91%, other rate N.P.K 15:15:15 was 15.72%.The unfertilized plant had 8.87% crude fibre. The variety LD88, at rate of 900 ml/ha gave (16.20% cf), followed by N.P.K 15:15:15 of (16.16% cf). The other rate 600 ml/ha gave (10.82 cf) and 300 ml/ha gave (10.69% cf) while the unfertilized was 9.15% cf. On carbohydrate content, rate of 300 ml/ha on variety LD88 gave (56.16%), followed by 600 ml/ha, which had (55.73%) while the unfertilized had 25.79%. Variety NHae47-4 when treated with 900 ml/ha produced (53.29%), followed by 300 ml/ha, (47.87%).Other rate 600 ml/ha had 46.75% , N.P.K 15:15:15 (44.32%) and the unfertilized had 27.78% as seen in Table 6.

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

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

The interaction effect ($p \leq 0.05$) of fertilizer type and rates on crude ash content are shown on Table 7. D.I grow green fertilizer at rate of 300ml/ha had highest value of percentage ash content (9.37%). This was followed by 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, D.I grow green at rate of 900ml/ha had the highest percentage value of crude fat 2.85% and was closely followed with 2.65% crude fat from rate of 600ml/ha. The percentage carbohydrate showed that D.I grow Red at rate of 300ml/ha and 600ml/ha had value of 56.02% and 56.31% respectively.

Table 6: Effect of interaction between varieties and rates on proximate analysis of % ash, fat, crude fibre and carbohydrate content in Abeokuta and Ibadan 2015

Varieties	Rates ml/ha	Ash % Ibadan	Abeokuta	Fat % Abeokuta	Crude fibre % Abeokuta	Carbohydrate % Abeokuta
LD88	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
NHae47-4	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
LSD,(5%)		0.43	1.25	0.46	2.94	3.85

LSD, Least significant difference at 5% probability level.

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

		ABEOKUTA		
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

Effect of interaction between varieties and fertilizer on proximate analysis of % ash, fat moisture, carbohydrate, crude protein and fibre contents in Abeokuta and Ibadan.

In Abeokuta, the interaction effects of varieties and fertilizer on the nutritive content of okra showed that application of D.I grow Green on both varieties (LD88 and NHae47-4) had the highest percentage Ash content of 8.96% and 7.5 % respectively. However, in Ibadan it was D.I grow Red that had highest percentage ash content of 8.68% and 8.58% on the two varieties of NHae47-4 and LD88 respectively. The percentage content of fat does not follow this trend. In Abeokuta, D.I grow RED had higher % fat (2.83%) on LD88 while on the other variety NHae47-4, D.I grow RED had higher % fat (2.30%) content. Similar trend as above was observed in Ibadan in both varieties.

The percentage moisture content irrespective of location and varieties the trend above was observed. In variety LD88, D.I grow RED had higher moisture content 23.53% and 23.75% in both location Abeokuta and Ibadan respectively. Also D.I grow Red had higher moisture content 9.01% and 8.92% in the variety (NHae47-4) in Abeokuta and Ibadan respectively. In both Abeokuta and Ibadan, D.I grow Red had higher percentage carbohydrate 53.75% and 46.89% with LD88, while with NHae47-4, in Abeokuta D.I grow Green was best with a value of 45.71% and in Ibadan D.I grow Red was the best with percentage carbohydrate of 39.99%.

In percentage protein and fibre content, D.I grow green had higher protein and fibre value content of 14.71 % and 14 96% respectively in variety NHae47-4 both in Abeokuta and Ibadan. In variety LD88, D.I grow Green had higher percentage of protein (17.88%) content while higher percentage fibre content 14.78% was recorded with D.I grow Red. (Table 8)

Table 8: Effect of interaction between varieties and fertilizer on % ash, fat moisture, carbohydrate, crude protein and fibre contents in Abeokuta and Ibadan

		ABK	IB	ABK	IB	ABK	IB	ABK	IB	ABK	IB
Varieties	Fertilizer	Ash %		Fat %		Moisture %		Carbohydrate %		Protein %	Fibre %
LD88	D.I grow Green	8.96	7.27	1.89	2.60	23.49	23.59	38.70	45.64	17.88	11.92
NHAe -47	D.I grow Red	6.66	8.58	2.83	2.08	23.53	23.75	52.32	46.89	17.57	14.78
	D.I grow Green	7.53	7.41	2.26	2.15	8.95	8.72	45.71	37.77	14.71	14.96
	D.I grow Red	7.27	8.68	2.30	2.65	9.01	8.92	42.29	39.90	14.20	12.72
LSD 5%		0.79	0.26	0.29	0.23	0.27	0.20	2.43	2.72	1.06	0.85

LSD, (5%) = Least significant difference at 5% probability level; ABK = Abeokuta; IB =Ibadan

DISCUSSION

The soil texture of the experimental site by United State Development Association soil classification 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.

Weather condition affected the two varieties, the chlorophyll and their nutritional content especially in Ibadan. This is due to higher rainfall and relative humidity with lower temperature in Ibadan compared to Abeokuta. This might have significantly affected the effectiveness of the D.I Grow plus organic fertilizer. Though, the observed quantum of rainfall during the experimental period was below the crop rainfall requirement in Abeokuta and above in Ibadan as reported by Dada *and* 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). 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 and bad weather condition that characterize generally the tropical soils (Prochnow, 2008).

The liquid fertilizer, rich in both macro and micro nutrients 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, low soil nutrients bioavailability, hard top soil, and decreased root activity during the vegetative and reproductive growth stage of plants (Naruka *et al*., 2000; Alkaff and Hassan, 2003). It is opined that it helped timely translocation of deficient nutrients to plant system through leaf tissue (Chattopadhyay *et al.*, 2003; Fageria *et al.,* 2009).

The observed chlorophyll content in the plant and nutritional quality of the two varieties despite the unfavorable weather condition in both location of the field may be due to the role of macro and micro nutrients in 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 when plant are under some adverse weather conditions physiological process of the plant are slow down that gears towards growth and development. Hence, D.I grow plus liquid fertilizer maybe good fertilizer to make up for bad weather condition for survival of crop especially when water and minerals were not readily available to the growing crop (Kadum,2011; Sharma and Kumawat, (2011).

The similar trend values obtained in the proximate parameters content may also be attributed to the organo-based foliar fertilizer applied.

The parameters that were measured in Abeokuta under the application rate of 300 ml/ha performed better than the other application rate. While at Ibadan, higher rate 600ml/ha and 900ml/ha had better application performance, though the rate 600ml/ha maybe

economical. This may connected to the interaction between genetic makeup of the crop, climatic factor and environmental factor which is line with Adejonwo *et al*. (1989); Burnside (1993); Dikwahal *et al*. (2006) Adeyemi *et al* (2008), and Iyagba *et al* (2013) who reported that the limiting factors to okra production and other vegetables are many; such as soil type in the different location, genetic makeup of the crop, ability to use different nutrient minerals at different rate of concentration and also be able to partition the nutrients from the sources to sink (pods). Thus at different concentration in same place, different physiological manifestation by plant may be visible.

CONCLUSION AND RECOMMENDATION

The liquid fertilizer was rich in both micro and macro nutrients. It was able to supply sufficient nutrients to enhance chlorophyll and proximate content at different rate and at different location. It was also observed that D.I grow Green and Red had a similar effect on the parameters of okra at different location. However, D.I grow GREEN fertilizer at the rate of 300 ml/ha had higher performance on all the parameters in Abeokuta while in Ibadan the rate of 600 ml/ha had higher performance on the parameters. It is therefore recommended that application of 300 ml/ha and 600 mls/ha D.I grow fertilizer could be employed by farmers in Abeokuta and Ibadan respectively.

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