Comparative Evaluation Of Effects Of Leaf Extracts Of Selected Fallow Species And N.P.K (15:15:15) Fertilizer On The Performance Of Okra, *Ebelmuscus Esculentus* In Abuja, Nigeria.

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Abstract: The study, designed to determine whether the leaf extracts of the selected fallow species in comparison with N.P.K. fertilizer (15:15:15) would improve soil fertility, reduce over dependence of farmers on in organic fertilizer for soil fertility maintenance and to assess their effects on the growth performance of *Ebelmuscus esculentus* (0kra), was conducted at the Teaching and Research Farm of the Faculty of Agriculture, University Abuja, Nigeria. Randomized Complete Block Design with three replications was used. Growth and yield parameters determined were plant height, leaf area, number of leaves/plant, number of branches/plant and fresh fruit yields. Post harvest soil analysis showed that the fertility status of the soil in plots sprayed with leaf extracts of *Moringa oleifera, Leucaena leucocephala* and *Gliricidia septum* was moderately improved compared to those treated with N.P.K fertilizer. The yield of *Abelmuscus esculentus* treated with *Moringa* extracts were significantly ($p>0.05$) high (10.2 tha^{-1} in 2013 and 7.9 t ha $^{-1}$ in 2014) compared to those given *Leucaena,* (6.2 t ha $^{-1}$ in 2013 and5.1 t ha^{-1} in2014) *Gliricidia* (3.1t ha^{-1} in 2013 and 2.8 t ha^{-1} in 2014)*, Parkia* (3.8 t ha^{-1} in 2013 and 2.5 t ha^{-1} in 2014) and those in the control plots (1.98 t ha^{-1} in 2013 and 1.6 t ha $^{-1}$ in 2014). Comparatively, application of N.P.K. fertilizer increased the fruit yield of Okra, (11.0 t ha^{-1} in 2013 and 8 t ha^{-1} in 2014). The insect Podagrica that feeds heavily on okra leaves was seen in control plots and in the areas given N.P.K. fertilizers. The leaves of okra stands in such areas were significantly perforated while in areas sprayed with leaf extracts especially that of *Moringa oleifera* and *Leucaena leucocephala,* the insects were not seen and the leaves of the okra stands were not seriously attacked.

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Introduction

Consumer society, in order to meet the growing need for food, agricultural land per unit area is required to achieve maximum efficiency and highest quality product. It is known that the nutrition of the plant is the one of the most important factors controlling agricultural productivity and quality. Fertilization increases efficiency and obtains better quality of product recovery in agricultural activities. Non-organic fertilizers mainly contain phosphate, nitrate, ammonium and potassium salts. Fertilizer industry is considered to be source of heavy metals like Aluminum, Lead, Cupper, and natural radionuclide like 238U, 232Th, and 210Po (FAO, 2009). Evidently, in recent years, fertilizer consumption increased exponentially throughout the world, causing serious environmental problems. Fertilization may lead to accumulation of heavy metals in soil and plant system, some of which can enter the food chain through plant absorption (Sönmez, et al, 2007).

The dependency on the use of inorganic fertilizers as a source of plant nutrients by farmers and their high cost is further associated with land and soil degradation and environmental pollution (Phiri, 2010).

The amount of nitrate may increase in drinking water and rivers as a result of high levels of nitrogen fertilizer use and that of phosphate as a result of the transport of phosphorous fertilizer. High level of Nitrogen fertilizer are known to consists of carcinogenic substances such as nitrosamines (Sonmez et al 2007). Harmful accumulation of nitrates and nitrites had been observed in lettuce and spinach leaves fertilized with high level of nitrogen fertilizers. The above attendant problems associated with the use of inorganic fertilizers had driven research into alternative sources of plant nutrition in the field of Agriculture. Organic fertilizers are being formulated to gradually substitute the inorganic fertilizers but quantity in supply at a given time is not enough for the teaming population of farmers in Nigeria. In Abuja, effort is being made by the Federal Ministry of Agriculture and other relevant agencies to provide alternative safe natural plant nutrients,(Anyaegbu and Iwuanyanwu, 2014). While Anyaegbu and Iwuanyanwu, (2014) had reported significant yield of *Solanium melongena* as influenced by *Moringa oleifera* Extracts, Anyaegbu et al, (2013) reported improved growth performance of *Telfaria occidentalis* when treated with *Moringa* extracts. Currently the degree of human pressure on *Moringa oleifera* because of its multi-purpose values is strong enough to drive it into extension. Apart from being eaten as sweet vegetable, extracts from other parts of the plant are known to possess diverse medicinal and biological activity on human and animals which gave it the name, “Miracle Plant” (Yang et al 2006). Thus, to concentrate on the use of *Moringa* as a bio- organic fertilizer would add more pressure on the plants. Hence extracts from other fallow species are being tried as possible alternatives to *Moringa* in soil fertility maintenance.

Therefore, this study is designed to determine whether the leaf extracts of the selected fallow species in comparison with N.P.K. fertilizer (15:15:15) would improve soil fertility, whether their application would help to reduce over dependence of farmers on in organic fertilizer for soil fertility maintenance and to assess their effects on the growth performance of *Ebelmuscus esculentus* (0kra).

Materials And Methods

The trial was conducted at the Teaching and Research Farm of the Faculty of Agriculture, University Abuja, Nigeria, in 2013 and 2014 cropping seasons respectively. The Federal Capital Territory (FCT) is located between latitude $8^0$25’ and $9^0$54’ North of the equator and Longitude 6^0 45^1 and 7^0 45’ East of Greenwich Meridian. The Territory covers an area of 8,000 square kilometers and occupies about 0.87% of Nigeria. It is bordered by four states namely Niger to the West, and North West, Nassarawa to the East, Kogi to the South and Kaduna to the North of the territory. The climate of Federal Capital Territory (FCT) is the hot, humid Tropical type.

The FCT records its highest temperatures and greatest diurnal ranges during the dry season months, when the maximum temperature ranges between 30.41^{0}C and 35.1^{0}C. During the rainy season on the other hand, the maximum temperature ranges between 25.8^{0}C and 30.2^{0}C.

The vegetation in the study area is dominated by herbaceous plants interspersed with shrubs and Trees.

In the first year, the experimental site was cleared, ploughed and the experimental layout of Randomized Complete Block Design was established covering an area of 20.5m x 11m. Three replications were used in the trial and each replicate contained 6 plots, giving a total of 18 plots in the experiment. Each plot, containing 49 stands of Okra, measured 3m x 3m and separated from each other within the replicate by a 50cm pathway and between replicates by one meter alley.

Prior to planting, a composite soil sample in the experimental site was collected to determine the initial nutrient status of the soil. Soil samples collected were oven dried, ground and sieved through 2mm sieve and the sand, silt and clay contents were determined by the Bouyoucos (1951). The soil pH was determined using the Iyagba et al.(2012) pH-metre in a 1:2.5 soil/water ratio, Total Nitrogen content by micro-kjedahl method (Jackson, 1962) Available phosphorus by Bray 1 method (Bray and Kurtz,1945). Calcium (Ca) and Magnesium (Mg) were determined by the Atomic Absorption Spectrophotometer (AAS) and Potassium (K) and Sodium (Na) by flame emission photometry. The organic carbon was according to Walkey and Black (1934) and the present organic matter was estimated by multiplying the percent organic carbon with a factor of 1.724. Planting was done at the end of March. Seeds of okra (*Abelmoschus esculentus* (L.) Moench) var. Clemson Spineless’ were collected from local market in Gwagwalada. Planting spacing was 50cm x 50cm giving a plant population of 40, 000 stand per hectare. After germination, one uniform seedling was kept in each hole and the rests were thinned out. Total number of seedlings per plot was 49.

The experimental treatments of which effects were evaluated include, N.P.K (20:10:10) 200 kg ha^{-1}, Leaf extracts of *Moringa oleifera, Gliricidia septum, Leucaena leucocephala, Parkia biglobosa* and the Control.

In the preparation, new shoots of the selected fallow species were harvested and their leaves were pounded in a mortar, one species after the other. For each amount of 100g of the leaves pounded, 8 litres of water was poured into it, stirred properly for about 25 minutes to help maximize the amount of extracts and the solution was filtered by placing it in a cloth and wringing out the liquid. The extracts were used within five hours from cutting and extracting as recommended by Culver et al (2012). For plots that were given 200kg ha^{-1}N.P.K fertilizer, application was done 14 days after planting.

In Foliar application, the liquid extract was sprayed directly on the entire plant, from the tip to the basal region. 25ml of the solution was sprayed per plant every two weeks. Basal application of fertilizer (50 kg ha^{-1}N.P.K fertilizer) as recommended by *Palada (1996*) was given to the stands for foliar application.

Growth and yield parameters determined were plant height, leaf area, number of leaves/plant, number of branches/plant and fresh fruit yields. Weeding, mulching and other cultural practices were done as and when required. Number of leaves and number of branches were recorded at the opening of first flower and continued at 15 days interval till final harvest. The final data (addition of all counts) were used in the tables. The fruits of okra of all the treatments were harvested at marketable stage. Before harvesting the number of flowers produced and aborted, and number of fruits per plant were recorded. Length, circumference of fruits of each treatment were recorded just immediately after harvest.

Data were assessed by Analysis of Variance (ANOVA) for a Randomized Complete Block Design (RCBD; $X_{ij} = \mu + T_i + \beta_j + €_{ij}$, where Xij = Trial SS, μ = Population mean =0, Ti = Experimental treatment effect, βj = Block effect and €ij = error term). Treatment Means were compared by the use of Least Significant Difference (LSD), at a probability of 5% according to Anyaegbu (1995).

Results of some parameters were presented in form of tables while others were put in form of Bar charts.

Results And Discussion

In Nigeria, the limiting factors in Okra production and other vegetables among others include weed management, fertile soils, tillage practices, low yielding varieties and sub-optimal planting density (Adejonwo *et al.,* 1989; Burnside, 1993; Dikwahal *et al.* 2006; Adeyemi *et al*., 2008; Iyagba *et al*., 2012). In this study, pre – planting soil analysis (Table 1), has shown that the fertility status of the soil of the experimental area was relatively poor. A soil pH of 5.8 is strongly acidic. Hence all the cat ions or basic elements assessed through chemical analysis were relatively low in concentration, (Table 1). Thus, their low concentrations in addition to low percentage of clay soil gave rise to a low Cation Exchange Capacity, (4.323%). The clay type identified, was the Low Activity Clay. The Cropping history of the area showed that the place has been under continuous cropping with only 6 months fallow period. Unplanned continuous cropping has a great consequence on the fertility status of the soil. It will be recalled that *Flinn and Lageman (1980),* observed that increasing intensity of cultivation and shorter fallows on the ultisols of three farm villages in Imo State of Nigeria caused a decline in the soil pH 4.85, 5.14 and 5.18 respectively.

The post harvest soil analysis showed that the fertility status of the soil in plots sprayed with leaf extracts of *Moringa oleifera, Leucaena leucocephala* and *Gliricidia septum* was moderately improved compared to those treated with N.P.K fertilizer, (Tables 2 and 3). Anyaegbu et al, (2013) reported a remarkable improvement in the fertility status of the soil as influenced by the application of *Moringa oleifera* plant extracts, especially the solid leaf extracts and the bark decoction.

In both 2013 and 2014, soil pH was improved from 5.8 to 6.5 in the plots treated with *Moringa, Leucaena, and Gliriidia* leaf extracts. The soil chemical properties in the control plots were drastically reduced in both 2013 and 2014 respectively. The pH of the soil in the N.P.K. fertilizer treated plots decreased significantly especially in 2014 (Table 3). Cropping history also showed that the farmers, in their continuous cropping system had been applying fertilizer regularly. Reduced soil pH therefore was an after math of the bad farming practice.

Growth parameters of Okra as influenced by leaf extracts of selected fallow species and N.P.K fertilizer is shown in Tables (4 and 5). In both years, differences occurred in the growth parameters of the crop with the application of the leaf extracts and N.P.K fertilizer. Highest plant height was recorded in plots that were treated with N.P.K. fertilizer though not significantly different from those that were applied with *Moringa* leaf extract. This was followed by the stands sprayed with the extracts of *Leucaena leucocephalla*. The trend of the result was the same in all the growth parameters being assessed in the trial. Anyaegbu et al (2013) reported that application of the various forms of *Moringa* extracts significantly affected the growth development of *Telfaria occidentalis*. The poorest result on growth development of Okra in this study was recorded from control plots in both 2013 and 2014.

The results of the vegetative parameters of *Abelmuscus esculentus* as influenced by selected fallow species and N.P.K(15:15:15) fertilizer were almost the same with those of the yield and yield components. The yield and yield components of *Abelmuscus esculentus* treated with *Moringa* extracts were significantly ($p>0.05$) high compared to those given *Leucaena, Gliricidia, Parkia* and those in the control plots, (Fig. 1 and 2). This confirms the assertions that *Moringa oleifera* is a fertility plant. The plant has been reported by some Authors, (*Caceres, 1991, Zarkales et al 1995, Palada 1995* etc.) as a plant growth enhancer. According to *Palada, (1996)*, one of the active substances, Zeatin, extracted from the plant is a plant hormone from the Cytokinins group. *Edward, (2007)* reported that Radish and Bean yields treated with *Moringa* leaf extracts increased by 94% and 64% respectively over those grown in the Control plots. Significant yield increases had also been reported in pea nut, Soy beans, Sorghum, and Tomato with foliar application of *Moringa* leaf extracts, *(Palada 1996*). *Palada* (1996) added that the *Moringa* extract produced an overall increase in yield of between 20 – 35% based on data such as the stem diameter, number of nodules, number of axels, number of flowers buds and number of fruits per flower bud. The yield and yield components of the stand sprayed with leaf extracts of *Leucaena leucocephalla* were better ($p>0.05$) than those sprayed with *Gliricidia* and *Parkia* leaf extracts respectively. During the 1970s and 1980s *Leucaena* was promoted as a "miracle tree" due to its multiple uses. *Leucocephala* is a legume and in the symbiosis with *Rhizobia* bacteria, it is able to fix about 500 kg nitrogen per ha annually. The nitrogen fixing nodules are found on the small lateral roots near the soil surface. Its leaves make for excellent green manure.

Fresh fruit yield and its components were lowest without the application of NPK fertilizer (control plots) in both 2013 and 2014. Comparatively, application of N.P.K. fertilizer increased the fruit yield of Okra, (Fig 1 and 2). The result was in consonance with the findings of Babatola *et al* (2010), Omotosho and Shittu (2007) and Kolawole *et al*. (2008) that increasing the rate of NPK fertilizer would cause an

Increase in the performance of okra. According to Dademal *et al*. (2004) higher NPK fertilizer dose will cause an increase in the uptake of N, P and K nutrients. Nitrogen has been known to enhance leaf production while phosphorus enhances flowering, fruiting and seed formation.

Recommended rates of NPK fertilization for okra vary greatly depending on the variety and environment. While Windham (1966) recommended between 27 and 54 kg ha-^{1} of N for 'Clemson Spineless 'okra variety depending on the soil type, Majanbu *et al*. (1985) recommended either 35 or 70 kg ha-^{1} of N depending on the variety. According to Kolawole *et al* (2008), application of 30 + 15 + 15 kg ha^{-1} to Clemson Spineless influenced the highest fruit yield, Jokoso 60 + 30 + 30 kg NPK ha-1 and Sologo 60 + 30 + 90kg NPK ha^{-1} will be adequate. Several authors have also reported differential responses to fertilizer application for various okra varieties (Blennerhassett and El-Zaftawi, 1986; Rani *et al*, 1989; Khan *et al*., 2002). Omotoso and Shittu (2007) reported that NPK fertilizer application significantly increased growth parameters (plant height, leaf area, root length, number of leaves), yield and yield components with optimum yield of okra at 150 NPK kgha^{-1} in South Western Nigeria.

However it was observed in this study that while the soil properties was moderately improved with pH of 6.4 in areas that were sprayed with leaf extracts after harvest, it was relatively poor with soil pH of 5.2 in 2013 and 4.5 in 2014 in the areas given N.P.K. fertilizer. Thus, the continuous use of fertilizer without any amelioration will completely render the soil infertile.

During the trial, the insect, Podagrica that feeds heavily on okra leaves was seen in control plots and in the areas given N.P.K. fertilizers. The leaves of Okra stands in such areas were significantly perforated, an indication that the pest fed heavily on them, thus reducing the photosynthetic ability of the stands. Conversely in areas treated sprayed with leaf extracts especially that of *Moringa oleifera* and *Leucaena leucocephala,* the insects were not seen and the leaves of the okra stands in those areas were not seriously attacked. The situation may have accounted for the improved fruit yield of stands sprayed with Moringa leaf extracts. Hence the extracts may have insecticidal properties. **Marcus et al (2009) reported that leaf extracts of *L. leucocephala, A. polyneuron* caused 69.24%, mortality termites.**

Table 1. Pre – planting Soil physic – chemical properties of the experimental site in 2012 and 2013 beside Biaji river in Kubwa, Abuja.

Parameters Planting	before
pH in water (1:2.5)	5.8
% organic matter	0.82
Total Nitrogen	0.175
P (ppm)	10.3
K (Cmol kg^{-1})	0.23
Mg (Cmol kg^{-1})	0.64
Na (Cmol kg^{-1})	0.073
Ca (Cmolkg^{-1})	3.20
Clay (%)	10.6
Silt (%)	78
Sand (%)	78
ECEC (%)	4.343

Table 2 Soil physic – chemical properties of the experimental site as Influenced by *Moringa* extracts and different fertilizers in FCT, in 2013.

Parameters											
Treatments	%	ppm	← Cmol kg^{-1}		→	←	%	→	pH	N	P
K	Ca	Mg	Na	OM	Clay Silt	Sand					
Moringa	6.4	0.23	10.6	0.21	3.54	1.12	0.01	0.75	10.2	78	78
Gliricidia	6.2	0.15	9.3	0.18	2.45	0.64	1.05	0.58	10.2	78	78
Leucaena	6.4	0.19	7.5	0.15	2.58	1.08	0.02	0.77	10.2	78	78
Parkia.	5.1	0.16	12.1	0.21	2.55	0.65	0.05	0.43	10.3	78	78
N.P.K	5.2	0.17	11.6	0.33	1.82	0.43	0.07	0.48	10.7	78	78
Control	4.8	0.06	8.7	0.04	0.78	0.98	0.08	0.35	10.6	78	78

Table 3 Soil physic – chemical properties of the experimental site as Influenced by *Moringa* extracts and different fertilizers in FCT, in 2014.

Parameters											
Treatments	%	ppm	← Cmol kg^{-1}		→		←		% →	pH	N
P	K	Ca	Mg	Na	OM	Clay Silt	Sand				
Moringa	6.4	0.61	6.4	0.41	0.58	1.23	0.71	0.58	11.4	76.7	77
Gliricidia	6.5	0.63	7.1	0.49	0.67	1.33	0.10	0.68	16.3	76.4	77
Leucaena	6.5	0.64	6.8	0.60	0.62	1.22	0.36	0.59	16.6	76.3	77
Parkia.	5.8	0.34	10.3	0.41	0.58	1.16	2.04	0.40	15.6	76.1	78
N.P.K.	4.5	0.23	7.6	0.64	0.64	1.23	0.63	0.65	16.4	76.9	73
Control	4.0	0.05	3.3	0.13	0.15	0.38	2.84	0.15	15.3	76.2	75

Table 4 Growth Parameters of Okra as influenced by the Leave Extracts of Selected Fallow Species and N.P.K fertilizer, in 2013.

Leave Extracts		Parameters		
	Height/ Plant(cm)	leaf Area/ plant(cm^2)	No. of leaves/ plant	No,of branches/ plant
Moringa oleifera	64.8a	37.6a	28.7a	3.4a
Gliricidia septum	23.4c	18.1c	17.3c	1b
Leucaena leucocephala	45.7b	25.5b	21.5b	1.3b
Parkia biblosa	24.6c	19.3c	17.5c	1b
N.P.K (15:15:15)	67.3a	38.8a	31.1a	3.6a
Control	15.4d	12.3d	10.1d	0c
LSD (α 0.05)	**10.2**	**6.23**	**5.87**	**0.20**

Table 5 Growth Parameters of Okra as influenced by the Leave Extracts of Selected Fallow Species and N.P.K fertilizer, in 2014.

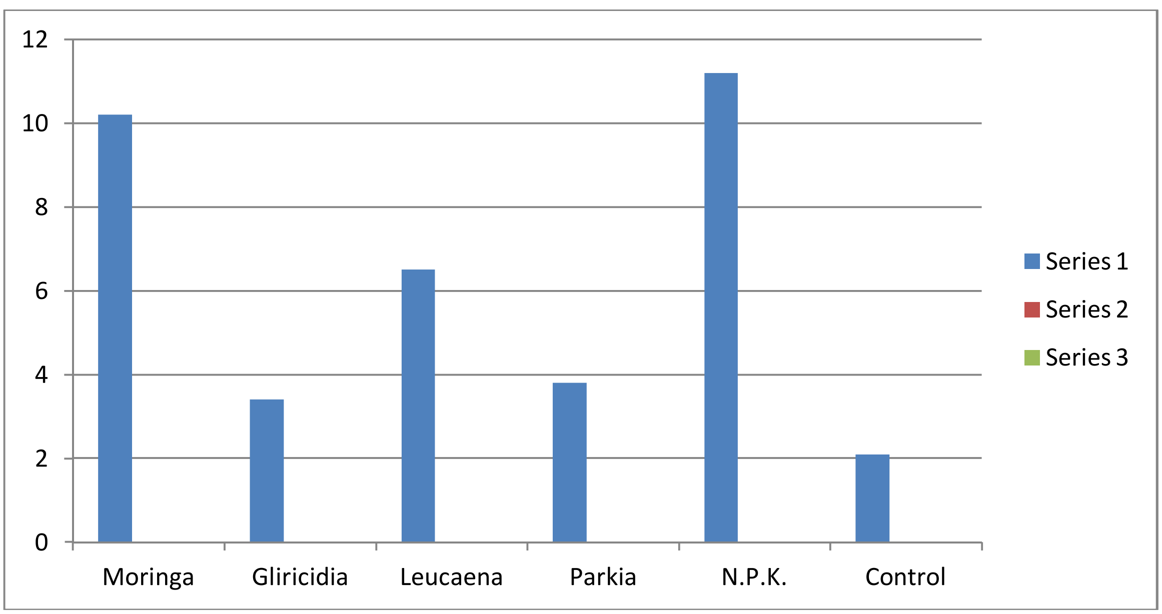
Leave Extracts		Parameters		
	Height/ Plant(cm)	leaf Area/ plant(cm^2)	No. of leaves/ plant	No. of branches/ plant
Moringa oleifera	63.6a	44.8a	22.0a	3.1b
Gliricidia septum	20.2d	20.3b	14.3b	1b
Leucaena leucocephala	53.7b	23.1b	18.5b	1.3b
Parkia biblosa	20.4d	15.7b	14.5b	1b
N.P.K (15:15:15)	69.3a	47.2a	28.1a	3.8a
Control	14.1e	10.1c	8.1d	0c
LSD (α 0.05)	**5.51**	**9.16**	**8.62**	**0.41**

Table 6 Yield Components of Okra as influenced by the Leave Extracts of Selected Fallow Species and N.P.K fertilizer, in 2013.

Leave Extracts	Parameters				
	No. of flowers/ Plant	No. of flowers aborted/ fruits/ plant(cm^2)	No of fruit plant	length (cm)/	circumference (cm)/ fruit
Moringa oleifera	20.6a	2.7c	17.9a	12.3b	4.1a
Gliricidia septum	12.8c	3.5b	7.2d	6.2c	2.1d
Leucaena leucocephala	13.3c	3.3c	10.1c	10.7b	2.8c
Parkia biblosa	11.6d	3.6c	6.3d	5.6c	2.0d
N.P.K (15:15:15)	18.4b	4.8b	14.1b	14.5a	3.5b
Control	10.7d	5.3a	4.1e	6.6d	1.8e
LSD (α 0.05)	2.05	**1.86**	**3.1**	**2.12**	**0.55**

Table 7 Yield Components of Okra as influenced by the Leave Extracts of Selected Fallow Species and N.P.K fertilizer, in 2014.

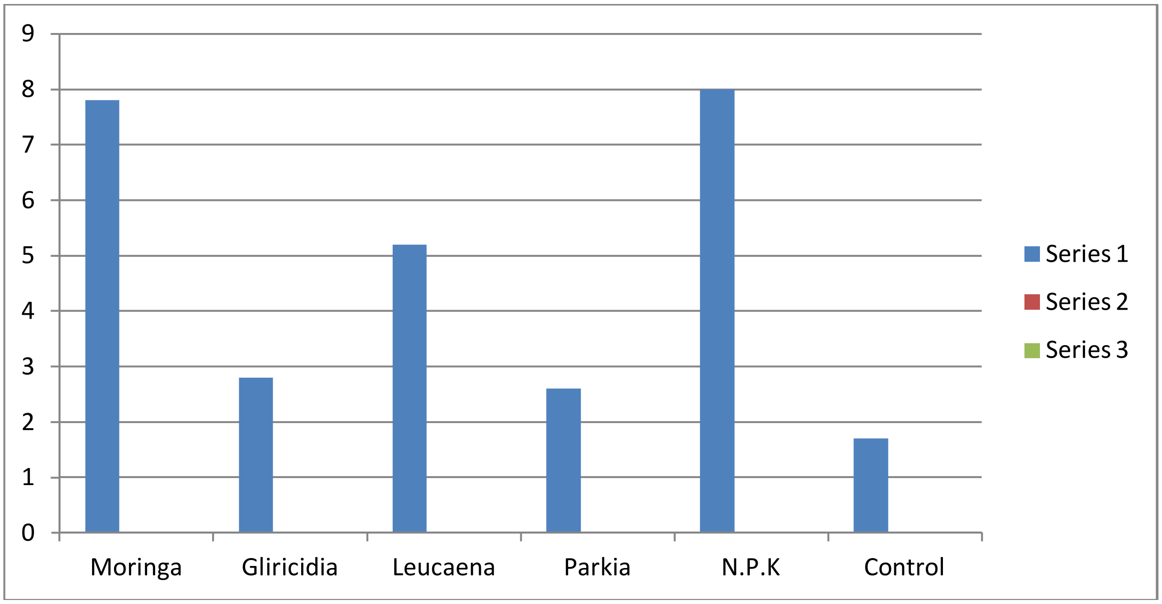
Leave Extracts	Parameters				
	No. of flowers/ Plant	No. of flowers aborted/ fruits/ plant(cm^2)	No of fruit plant	length (cm)/	circumference (cm)/ fruit
Moringa oleifera	14.6a	1.3d	11.9a	10.3b	4.9a
Gliricidia septum	10.8d	2.8c	7.2c	6.0d	2.8d
Leucaena leucocephala	12.2c	2.4c	8.1c	8.7c	3.1c
Parkia biblosa	8.5e	2.6b	6.3c	6.8d	2.0d
N.P.K (15:15:15)	17.3a	2.7b	13.6a	12.5a	4.3b
Control	6.7f	3.3a	4.1d	6.5d	1.2e
LSD (α 0.05)	**1.12**	**0.16**	**2.86**	**1.42**	**0.12**



(a) (d) (c) (d) (a) (e)

Fig.1 Fruit yield of Okra (t ha $^{-1}$) as influenced by Leave Extracts of Fallow species and N.P.K.(15:15:15) fertilizer in 2013.

Bars carrying different letters (a – e) as shown below the fallow species differed Significantly, (LSD= 1.86)



(a) (b) (c) (a) (d) (e)

Fig 2 Fruit yield of Okra (t ha $^{-1}$) as influenced by Leave Extracts of Fallow species and N.P.K.(15:15:15) fertilizer in 2014.
Bars carrying different letters (a – d) as shown below the fallow species differed Significantly, (LSD= 1.32)

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