Original Research Article

Prospects of integrated application of Moringa (*Moringa Oleifera*) Leaf extract, NPK fertilizer and poultry manure on Okra (*Abelmoschus esculentus*) Production

ABSTRACT

A field trial was conducted to investigate the effects of integrated application of morionga leaf extract (*moringa oleifera)*, poultry manure, and NPK 15-15-15 fertilizer on the growth and yield attributes of okra(*Abelmoschus esculentus*) at the Teaching and Research Farm of Ekiti State University, Ado-Ekiti, Nigeria during 2018 cropping season. The experimental design was a randomized complete block with three replicates. The treatments included; poultry manure (PM), moringa leaf (ML), NPK fertilizer (NPKF), NPK fertilizer + moringa leaf (ML+ NPKF), poultry manure and moringa leaf (ML+PM), and control (C). At 2 weeks after planting (WAP), PM, NPKF, and ML+PM gave okra plant height of 3.74 cm, 3.98 cm and 3.82 cm respectively which were significantly higher than 2.7 cm for C, while ML gave the highest plant height of 4.05 cm which was significantly higher than other treatments. Of all the treatments, ML+PM gave the highest fruit weight of 1.343 t/ha and differed significantly ($P < 0.05$) from the rest of other treatments, while C had the least fruit weight of 0.199 t/ha. ML+PM, NPKF, and ML+ NPKF gave total fruit number per plant of 47, 44 and 36 respectively, which differed significantly ($P < 0.05$) significantly to other treatment and the C gave the least fruit number of 15.67 per plant. The results showed that the application of PM+ML significantly improved the growth and yield of okra, hence poultry manure and moringa leaf should be used instead of NPK fertilizer, which can also lower the cost of production.

1. INTRODUCTION

Okra (Abelmoschus esculentus L. Moench) is one of the most widely cultivated and utilized species of the family Malvaceae (Naveed *et al.,* 2009). It is an essential vegetable especially in India, West Africa, Brazil and the United States (Kemble et al., 1995; ECHO; 2003, Alimi, 2004). It is grown throughout the warm temperate and tropical regions of the world for its fibrous fruits or pods. It is found in almost every market in Africa and Nigeria (Schipper, 2000). In the recent years, increasing attention has been paid to the roles of okra diet in human health (Ohr, 2004) as it is recommended to people suffering from renal colic, leucorrhoea and general weakness (Rai and Yadav, 2005). The major antioxidants of okra are vitamins C and E carotenoid which contribute to the first defense line against oxidative stress (Krinsky, 2001). The seeds can be used as a source of edible oil as well as in the soap industry (Oyolu, 1983). Okra seed is rich in protein and unsaturated fatty acids such as linoleic acids (Oyelade et al., 2003). Okra is a popular healthy food due to its high fibre, vitamin C and folate content. It is a good ingredient of soup and stew (Osekita, 2000) and can also be eaten raw, cooked or in processed forms.

Moringa (*Moringa oleifera*) belongs to the plant family Moringaceae (Mark, 2010). Moringa can be used for food, medicine and other beneficiary uses (Farooq et al., 2007). The most incredible thing about moringa is the amount of nutritional value and medicinal uses based on the chemical compound found in this plant. Moringa contains over 40 anti-oxidants (Farey, 2005). Moringa leaf extract is a natural plant growth enhancer (Andras, 2005). The leaves of moringa are rich in zeatin (zeatin is one of the most powerful cytokinnins). Zeatin does not only promote the growth of a plant but also have an anti-aging potential and protective effect in plant (Andra, 2005).

The fertility of the soil can be maintained and nutrient status boosted through the use of fertilizers. However, application of inorganic fertilizer has its own demerits which include; soil

acidification, environmental pollution, nutrient imbalance and trace element deficiency, also inorganic fertilizer is no longer within the reach of poor and local farmers due to its high cost (Rahman, 2004).Continuous use of inorganic fertilizers often results in a number of problems, such as leaching, surface and ground water contamination, soil acidification, reduction in useful microbial communities and increased sensitivity to harmful insects (Chen, 2006).Thus, there is the need for alternative organic sources of Nitrogen to maintain the soil fertility.

Poultry manure is an organic fertilizer essential for the maintenance of soil physical and chemical conditions for good plant growth. It is cheap, readily available and effective as a good source of nitrogen (N) for sustainable crop production.

To this end, this study is aimed at investigating the effects of M*oringa oleifera* as an organic fertilizer in combination with other nutrient sources

2. MATERIALS AND METHODS

2.1 Site Description

The study was conducted at Ekiti State University, Ado-Ekiti, Teaching and Research farm, between June and September, 2017. The area experiences a tropical climate with distinct wet and dry season. The rainy season spans from late March or early April to late October with a break in August. The dry season starts from November to early March. The mean annual total rainfall is about 1,367mm while the average number of rainy days is about 112 days per annum. Temperature is almost uniform throughout the year with very little deviation from the mean annual temperature of 27^0C.

2.2 Experimental Design and Treatments

Six treatments were arranged in a randomized complete block design with a sub-plot dimension of 2.4m x 1.5m and replicated three times. The treatments included; a control (C), poultry manure (PM), air dried moringa leaf (ML), NPK 15-15-15(NPK), moringa leaf + poultry manure (ML+PM), and moringa leaf + NPK 15-15-15 (ML+NPK) to give 18 experimental units. The milled

moringa leaves and the poultry manure already cured were added to the soil at the rate of 10 t/ha, two weeks before planting (WBP) to allow for proper decomposition and mineralization, while the NPK fertilizer was applied two weeks after planting (WAP) at the rate of 250 Kg/ha. Three okra seeds were sown per hole at 30 cm x 60 cm spacing and later thinned down to two seedlings per stand at 2WAP. Weeding was done manually on a regular basis.

2.3Collection and Analysis of Soil, Moringa leaf and Poultry Manure Samples

Top soil (0-15 cm) samples were randomly collected from cultivated farm, bulked to form a composite sample, which was air dried and sieved using a 2mm mesh size. The routine analyses as described by Udo *et al.*; (2009) for physical and chemical properties were carried out on the composite sample. Fresh moringa leaves collected from the research site, were oven dried at 65^{o}Cto a constant weight and ground to pass through a 0.5mm and analyzed for N, P, K, Ca, Mg, and organic C. Poultry manure was obtained from the dump site of the Faculty Poultry House, processed and analysed.

2.4 Collection and Analysis of data

Data were collected on stem girth, plant height, leaf area, and fruit and yield attributes of okra. Fruit yield was determined at each harvest using weighting balance. Plant height and stem girth were measured with a measuring tape and vernier caliper, respectively. Data collected were subjected to analysis of variance and treatment means separated using Duncan's Multiple Range Test at 0.05 level of probability.

3. RESULTS

3.1 Pre-cropping physical and chemical properties of soil in the study site and Soil Samples

Tables 1show the pre-cropping physical and chemical properties of soil used for the experiment. The soil was slightly acidic (pH=6.59) and sandy loam. The soil had 1.45%N, 2.50%organic matter and 24.20mg/g available P, while exchangeable K, Ca, and Mg were 34.5 $mglkg^{-1}$, 50.5 $mglkg^{-1}$, and 39.2 $mglkg^{-1}$, respectively.

Table 1: Pre-cropping physical and chemical analyses of experimental soil

Physical Parameters	**Value (%)**
Sand	74.32
Silt	8.08
Clay	17.60
Textural class	Sandy loam
Chemical properties	**Value (%)**
pH	6.59
Organic carbon	1.55
Organic matter	2.50
Total Nitrogen	1.45
Available P (mg/100g)	24.20
Exchangeable bases	**(mg/100g)**
K	345.39
Ca	505.0
Mg	392.0
Zn	199.45

3.2 Chemical analyses of Moringa leaf and Poultry manure used in the experiment

The ML was slightly acidic (pH=6.39), while PM was slightly alkaline (pH=8.16). The ML exchangeable K, total N and available P, were 104.0mg/Kg, 4.70% and 0.72m/kg respectively while PM had 0.9cmg/kg exchangeable K, 3.49% total N and 4.1mg/kg available P.

Table 2: Chemical Analyses of Poultry Manure and Moringa Leaf

Element	PM	ML
N%	3.49	4.70
P(mg/100g)	41.00	7.19
K(mg/100g)	9.00	1040.00
pH	8.16	6.39
Organic carbon (%)	21.25	50.77
Organic matter (%)	35.29	88.10
Mg(mg/100g)	159.00	22.00
Ca (mg/100g)	13.00	212.45
Zn (mg/100g)	31.90	37.95
Fe	905.00	205.00
Mn	6.60	2.09
C:N	5.49	10.95

PM = Poultry Manure; ML = Moringa Leaf

3.3. Effects of poultry manure, NPK fertilizer, Moringa Leaf extract and their combination on the growth parameters of Okra

Effects of integrated application of Poultry Manure, NPK fertilizer, and Moringa Leaf extract on Okra plant height are presented in Table 3 showed that at 4 WAP, ML + PM gave the highest plant height of 9.90 cm, followed by NPKF (9.48 cm), with no significant difference but differed significantly to ML (8.22 cm), ML + NPKF (7.70cm), and the least value was giving by C, while at 8 WAP, PM+ML gave the highest value of 60.49 cm and was significantly difference from NPKF (44.91 cm), PM (42.72 cm), ML + NPKF (39.98 cm), ML (36.80 cm) and the least plant height of 25.64 cm was obtained at C. The effects of integrated application of moringa leaf extract, poultry manure and NPK fertilizer on okra number of leaves as presented in Table 3 showed that ML + PM (4.98) gave the highest number of leaves for okra at 4 WAP which was significantly higher in than other treatments, while ML+PM gave the highest number of leaves of 4.98 at 8 WAP which also differed significantly to other treatments and C gave the least value of 5.61 at 8 WAP. The effects of integrated application of moringa leaf, NPK fertilizer and poultry manure on the leaf area of okra as presented in Table 3, could be seen that ML + PM gave the highest leaf area of 32.70 cm^2 and 138.45cm^2 at 4 and 8 WAP respectively, which differed significantly from other treatments in all the weeks of samplings except at 4 WAP where ML + PM (32.7 cm^2) showed not significant different to ML (32.09 cm^2). The effects of integrated application of moringa leaf, NPK fertilizer and poultry manure on the stem girth of okra also presented in Table 3, showed that ML gave significantly highest values of stem girth of 1.12 cm at 4 WAP among the treatments except for ML+ PM (1.01 cm^2), while NPKF gave the highest values of 1.70 cm at 8 WAP with no significant difference to ML+PM (1.69 cm) and ML (1.67 cm) but differed significantly to ML + NPKF (1.5 cm), PM (1.37 cm) and C (1.40 cm).

Table 3: Effects of poultry manure, NPK fertilizer, Moringa Leaf extract and their combination on the growth parameters of Okra

Treatment	Number of leaves		Leaf area (cm^2)		Plant height (cm)		Stem girth (cm)	
	4WAP	8WAP	4WAP	8WAP	4WAP	8WAP	4WAP	8WAP
C	4.10ab	5.61b	23.44b	103.52c	7.04b	25.64c	0.92ab	1.40b
PM	3.27ab	6.71b	28.32ab	110.53b	7.08b	42.72ab	0.90ab	1.37b
NPKF	4.74a	6.77ab	29.16ab	116.64ab	9.48a	44.91ab	0.91ab	1.70a
ML	3.73b	6.54ab	32.09a	119.59ab	8.22ab	36.80b	1.12a	1.67a
ML+NPKF	4.14ab	6.27ab	29.26ab	123.60ab	7.70ab	39.98ab	0.93ab	1.50ab
ML+PM	4.98a	7.13a	32.70a	138.45a	9.90a	60.49a	1.01a	1.69a

PM= Poultry manure; NPKF=NPK fertilizer; ML= Moringa leaf; ML+NPKF=Moringa leaf + NPK fertilizer; ML+PM= Moringa leaf + Poultry manure; C=Control. Mean values with different letter (s) in the same column are significantly different at 0.05 (DMRT).

3.4 Okra fruit yield and yield components

The effects of integrated application of moringa leaf, NPK fertilizer and poultry manure on the okra fruit yield and yield components as presented in Table 4 shows that, ML+PM gave the highest total fruit weight of 1.343 t/ha which was significantly higher than 0.684 t/ha for NPKF, 0.549 t/ha for ML+NPKF, and 0.226t/ha for ML and C gave the least value of 0.174 t/ha. Also ML + PM gave highest fruit number of 47 per plot and differed significantly to ML (21) but not from NPKF (44) and ML+ NPKF (36) and C gave the least value of 15.67.

Table 4: Effects of poultry manure, NPK fertilizer, Moringa Leaf extract and their combination on the Yield of Okra

Treatment	FN (per plot)	F/P	AFL	AFD	TFW (t/ha)
C	15.67b	3.00	5.87ab	2.17ab	0.199bc
NPKF	44.00a	5.03	6.22a	2.12ab	0.684ab
ML	21.00ab	9.47	5.42ab	2.09b	0.226b
ML+NPKF	36.00a	6.27	5.48ab	2.17ab	0.549ab
ML+ PM	47.00a	9.50	5.68ab	2.20a	1.343a

FY=Fruit Number, F/P=Fruit/Plant, TFW=Total fruit Weight, AFL=Average Fruit Length, AFD=Average Fruit Diameter. Mean values with different letter (s) in the same column are significantly different at 0.05 (DMRT). PM= Poultry manure; NPKF=NPK fertilizer; ML= Moringa leaf; ML+NPKF=Moringa leaf + NPK fertilizer; ML+PM= Moringa leaf + Poultry manure; C=Control

4. DISCUSSION

The pH value of the soil was within the range of 6-7 which is adequate for optimum performance of vegetables (Purselglove, 1991). This revealed that there is need for soil amendment to improve the growth and yield of okra. Previous studies had shown that milled moringa leaf and poultry manure are rich in nutrient (Farey, 2005; Mark, 2010; Annette, 2012) and thereby can be used as soil amendments. Milled moringa leaf has been used as growth enhancer and as a soil amendment through foliar spray (Farey, 2005). The application of these treatments had positive and significant effects on the growth and yield of okra.

Application of moringa leaf with poultry manure consistently and significantly increased the plant height compared to other treatments except NPKF at 4WAP. This might be due to the enhanced mobilization of metabolites/inorganic solutes such as zeatin, ascorbic acid, Ca and K present in moringa leaf leading to the growth of plumule and the increase in the amylase activity and reducing sugars, contributing to early vigour and increase plant growth (Foidi, 2012).The number of leaves of okra was significantly higher in NPKF (4.98) and ML + PM (4.98) compare to other treatment at 4 WAP, while ML+PM gave the highest number of leaf of 7.13 at 8WAP. The increase in number of leaves of okra overtime might have resulted from consistent and adequate supply of nutrient to the soil by poultry manure and moringa leaf which in turn must have enhanced rapid vegetative growth of the okra plant. The higher value of 138.45cm^2 recorded by treatment ML+PM in the leaf area of okra at 8WAP could be attributed to the fact that the nutrient status of the plot treated with moringa leaf and poultry manure significantly increased the availability of micro and macro nutrient in the soil for plant uptake, also increased the microbial activity in the soil. Treatment ML and NPKF had the highest value for stem girth of okra of 1.12 cm and 1.70 cm at 4 and 8 WAP respectively. The increased in stem girth of okra at 8 WAP by NPKF could be as a result of abundant supply of nitrogen by the NPK fertilizer (Akanbi *et al*., 2010).

ML+PM gave significantly increased fruit number of 47.0 compared to other treatments except ML+NPKF and NPKF, while the control had the lowest value (14.67). PM+ML gave the highest

total fruit weight (1.343 t/ha) of okra in the experiment and differed significantly from other treatments and C gave the least value of 0.199 t/ha.

From the findings in this study, combination of poultry manure and moringa leaf consistently gave the highest values of growth and yield parameters of okra, compared to sole NPK fertilizer.

There is an increase in the mineral content of the soil as a result of the application of the moringa extracts which in turn improved the growth performance of the crops. Hussein (1996) had earlier reported that application of poultry manure increased soil pH, organic matter and available phosphorous, microbial activity in the nutrient metabolism. Rao *et al* (1983) reported that juice extracted from the leaves of *Moringa oleifera* can be used to make foliar nutrient capable of increasing crop yield by 38%. Anyaegbu,(2013) reported enhanced growth performance of *Telfaria occidentalis* with the application of moringa extracts. Jason (2013) noted in his write- up that moringa leaf extract contains a plant growth hormone called zeatin which has been reported to increase yields by 25 – 30% for nearly any crop, Jason added that the compound leaves and stems of moringa make excellent fertilizer.

5. SUMMARY AND CONCLUSIONS

The results of this study showed that solely application of moringa leaf extract, as a growth enhancer or biostimulant increased the growth and yield of okra. It also indicated that the complimentary application of moringa leaf especially with poultry manure increased the growth and yield of okra significantly, thus application of moringa leaf either sole or with poultry manure significant increase the yield and reduce the production cost with marginal profit.

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