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Comparative effects of Varying Rates of Moringa Leaf, Poultry Manure and NPK Fertilizer on the Growth, Yield and Quality of Okra (*Abelmoschusesculentus* L. Moench)

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Abstract— *The fertilizer management practices have not ensure the desired improvement in yield for okra (Abelmoschusesculentus L. Moench) due to differences in fertilizer types. The search continues for nutrient sources that would provide adequate nutrition for the crop on the season. A pot experiment was carried out at the Teaching and Research Farm, Ekiti State University, Ado Ekiti, Nigeria to evaluate the growth and fruit yield responses of okra (Abelmoschusesculentus L. Moench) to the application of air-dried milled moringa leaf (MML), poultry manure (PM) and NPK fertilizer. The MML was applied at 400, 800, and 1200 kg/ha; NPK 15-15-15 at 250 kg/ha and PM at 10 t/ha separately and in all possible combinations in completely randomized design in three replicates. The parameters measured were plant height, stem girth, number of leaves, leaf area, number of fruits and fruit weight. The single treatments differed significantly (P = 0.05) with the combinations of the treatments giving better performance. The 800 kg/ha MML + PM treatment gave the tallest plants (103.33 cm) and followed by single application of PM (102.33 cm). The application of 400 kg/ha MML + PM + NPK produced the highest number of fruits but 800 kg/ha MML + PM + NPK gave the highest fresh fruit (42.70 g) and dry fruit (20.50 g) weight. 800 kg/ha gave best growth performance among MML but 1200 kg/ha gave best yield. This suggests that MML can be used as source of nutrients to grow okra.*

Keywords— npk, milled moringa leaf, okra (Abelmoschusesculentus), poultry manure.

I. INTRODUCTION

Okra (*Abelmoschusesculentus*L., Moench) is grown for fresh fruits in the tropical and subtropical regions and ranks first in terms of calorie for human consumption (Babatunde, 2007). The output of okra constituted about 4.6 percent of the total staple food production in Nigeria between 1970 and 2003 (CBN, 2004). Inadequate weed management, infertile soils, cultivation of low-yielding varieties and sub-optimal planting densities are some of the major constraints to high okra yield and production in Nigeria (Iyagba, *et al*., 2013) which necessitated the development of various agronomic practices the farmers can adopt to improveokra growth and fresh pod yield.

The soil in Nigeria are inherently poor in fertility on account of low available nutrients and organic matter contents such that the application of organic and inorganic fertilizers would be the rule for high crop production. Inorganic fertilizers have been promoted as the panacea tothis low fertility and nutrient losses, more so as the added fertilizer nutrients become immediately availablein the soils for uptake by crops. The fresh fruit yields of okra increased with NPK fertilizer application and the recommended optimum rates had differed among the varieties (Babatola, 2006).However, the long term dependence on high rates of inorganic fertilizer has demerits: soil acidification, nutrient imbalance and trace element deficiencies especially of manganese (Mn) and zinc (Zn) (Asadu*et al*., 2004). These have catalyzed the identification and use of organic materials as alternative nutrient sources. Besides, the scarcity of fertilizers and resultant high prices which are beyond the reach of resource-poor farmers mean that the recommended fertilizer rates are hardly met if any at all (Rahman,

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2004). Organic manures are relatively resistant to microbial degradation but are essential for enhancing soil nutrient availability and maintaining optimum soil physical conditions.

Poultry manure have been reported to influence positively the growth and fruit yield of okra (Ashraf *et* al., 2016; Ali*et al*., 2013; Tiamiyu*et al*., 2012) which had led to the increase in the its use as nutrients sources by farmers. Poultry manure is a very cheap and effective source of nutrients, especially nitrogen (N) but ready availability remains an important issue since large amounts must be applied to give optimum yield. Also, plant residues: banana peels (Jonathan *et al*., 2012), *Senna siamea*, *Leucaenaleucocephala*and*Gliricidiasepium* (Akande*et al* 2010; Olujobi and Ayodele, 2013), sea weeds (Khan *et al*., 2009), *Moringaoleifera* (Fahey, 2005) are sources of nutrients needed to improve crop production. *Moringaoleifera* is a good sources of green manure as it compared very well with other green manure crops such as lablab beans (Fuglie, 2008). Fuglie (2008) reported the use of moringa seedlings as green manure for crop production. *Moringaoleifera* was one of the green manure used by Makinde*et al*. (2016) in the production of fluted pumpkin who concluded that plant materias can be used as an alternative to synthetic fertilizers. Moringa leaves are rich in zeatin, a naturally-occurring cytokinin and other compounds such as ascorbates, vitamin E, and phenolics which confer on the leaf extract the status of a natural plant growth enhancer (Nagar *et al*., 2006).

Harlin*et al.* (2004) advocated for the integrated use of organic manure and inorganic fertilizers to supply the nutrients required to sustain maximum crop productivity and profitability while minimizing the negative environmental impacts from nutrient use. Therefore, this study was carried out to evaluate the comparative effects of moringa leaf, poultry manure and NPK fertilizer singly and in combination on the growth and yield of okra (*Abelmoschusesculentus)* in Ado – Ekiti. Southwestern Nigeria.

II. MATERIALS AND METHOD

Experimental Site

The experiment was conducted at the Teaching and Research Farm,Ekiti State University, Ado-Ekiti, during the 2015 cropping season. The study site lies on latitude 5˚45′ N and longitude 8˚15′ E and experiences tropical climate characterized by a wet and dry seasons. The long wet season is from late March to November and divided into early and late seasons by little dry season in July to August.

Collection and analysis of soil, moringa and poultry manure samples

Top soil (0-15 cm) samples were randomly collected from cultivated farm, bulked to form a composite sample, air-dried and sieved using a 2mm mesh size. The routine analyses as described in Udo *et* a*l*. (2009) for physical and chemical properties were carried out on the soil sample. 10 kg of the soil sample were measured into 10l plastic containers that were perforated at the base. Fresh *Moringaoleifera* leaves were air-dried and milled. Poultry manure was also obtained from the dump site of the Poultry House on the Farm, air-dried and finely crushed.

Experimental design

The treatments consisted of milled moringa leaf (MML) at 400, 800 and 1200 kg/ha, 10 t/ha poultry manure (PM) and 250 kg/ha NPK 15-15-15 fertilizer singly and in all possible combinations and control. The MML and PM were applied 2 weeks before planting while the NPK fertilizer was applied 2 weeks after planting (WAP). Two seeds of okra (NHAe 47-4 variety) were sowed to each pot and thinned to one seedling after emergence at 2 WAP. The experiment was laid out in a Completely Randomized Design (CRD) with three replicates. Adequate watering, weeding and pest control were carried out as required.

Data collection and statistical analysis

Data were collected on plant height, number of leaves and leaf area at intervals of two (2) weeks from 2 WAP. The leaf area was calculated as the product of leaf length and leaf breath and coefficient factor obtained with the graphical method (Pandey and Singh, 2011). Harvesting of fresh fruits begins at 9 WAP which was done in 4 days interval. The number of fruits per plant was counted while the fruit weight per plant (fresh and dry) were recorded.All data collected were subjected to analysis of variance (ANOVA) and the treatment means were separated by Fisher's Least Significant Difference (LSD) at 5% probability.

III. RESULTS

Moringa, poultry manure and soil samples

Table 1 shows the pre-cropping soil properties and some chemical properties of the PM and MML. The soil was a slightly acidic (pH=6.24) loamy sand, containing 0.09%N, 1.48% organic matter and16.59 $mgkg^{-1}$ available P while exchangeable K, Na, Ca, and Mg were 0.25, 0.03,2.38,1.12 $cmolkg^{-1}$ respectively. The MML was slightly acidic (pH=6.37) while PM was slightly alkaline (pH=8.25). MML was higher in exchangeable K (10.40 $cmolkg^{-1}$), total N (4.51%) and available P (7.16 mkg^{-1}) than PM with 0.09 $cmolkg^{-1}$ exchangeable K, 3.76% total N and 3.00 $mgkg^{-1}$ available P.

Plant height

Table 2 shows that okra plant height increased with theMML levels and the application of NPK 15-15-15 and

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PM. Among the single application treatments, M_2 and M_3 gave the highest values which did not different significantly at 2 WAP. NPK gave the highest value at 4 WAP
which did not differ from M_2 and M_3 at 4 WAP. M_2 gave the highest value at 6 WAP while
PM gave the highest followed by M_2 which was similar to NPK fertilizer application at 8 WAP. Okra treated with M_2 gave the tallest plant (71.33 cm) among the MML rates which was significantly different from M_1 and M_3. M_3 + NPK produced the tallest plants at 2, 4 and 6
WAP and did not differ from M_2 + PM at 2 and 4 WAP which gave the best value at 8 WAP. M_2 + PM + NPK produced the tallest plants throughout the sampling period.

Table.1: Chemical and physical properties of soil, poultry manure and dried milled moringa leafsamples

Parameter	**Soil**	**Poultry manure**	**Dried milled moringa leaf**
pH	6.24	8.25	6.37
Organic C (%)	0.86	21.35	51.87
Organic matter (%)	1.48	36.80	89.40
N(%)	0.09	3.76	4.51
C:N ratio	9.56	5.68	11.5
Available. P ($mgkg^{-1}$)	16.59	3.00	7.16
Exchangeable K ($cmolkg^{-1}$)	0.25	0.09	10.40
Exchangeable Na ($cmolkg^{-1}$)	0.03	-	-
Exchangeable Ca ($cmolkg^{-1}$)	2.38	0.13	2.11
Exchangeable Mg ($cmolkg^{-1}$)	1.12	1.57	2.20
ECEC ($cmolkg^{-1}$)	4.19	-	-
Physical Characteristics		-	-
Sand (gkg^{-1})	840	-	-
Silt (gkg^{-1})	98	-	-
Clay (gkg^{-1})	62	-	-
Textural Class	Loamy Sand		

Table.2: The Comparative effects of Moringa Leaf, Poultry manure and NPK Fertilizer on the Plant Height (cm) of Okra (Abelmoschusesculentus)

Treatments	**Week after planting**			
	2	**4**	**6**	**8**
Control	8.50c	21.33f	38.17f	54.57e
M_1	9.23c	22.50f	38.67f	59.70e
M_2	21.50ab	36.00d	55.67d	71.33cd
M_3	20.13b	34.33de	47.00e	66.00de
NPK	15.13bc	38.00cd	51.67de	70.40d
PM	13.67c	28.33e	50.00de	76.67cd
M_1+NPK	21.50ab	36.50d	57.00d	78.60c
M_2+NPK	18.00bc	31.25e	50.00de	70.50d
M_3+NPK	25.83a	60.17a	85.67a	102.33a
M_1+PM	13.33c	41.83c	65.00c	83.00c
M_2+PM	19.27b	52.17b	81.67ab	103.33a
M_3+PM	16.10bc	47.67b	73.00b	94.33b
M_1+PM+NPK	17.00bc	42.33c	70.33bc	94.67b
M_2+PM+NPK	25.83a	60.33a	80.00ab	98.33a
M_3+PM+NPK	17.50bc	48.67b	75.07b	94.00b
LSD (5%)	5.26	4.62	7.91	7.69

M: Moringa, (M_1=400kg/ha, M_2=800kg/ha, M_3=1200kg/ha); NPK 15:15:15 Fertilizer, PM: Poultry manure. Mean with different letter in the same column are significantly different at 5% probability.

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Number of leaves

Single and combined application of MML, PM and NPK 15-15-15 did not significantly affect the number of leaves in okra (Table 3). At 2 WAP, the single application of NPK and M_2 gave the highest number of leaves while PM produced most leaves at 4-8 WAP followed by M_1, M_2 and NPK at 4 and 6 WAP and M_3 at 8 WAP. M_2 + PM gave the highest number of leaves over the 2-8 WAP while M_2 + PM + NPK and M_1 + PM + NPK produced the highest number of leaves at 2-4 and 6-8 WAP respectively.

Leaf area

Sole application of M_2 gave the largest leaf area 2-4 WAP while the largest area was with PM at 6-8 WAP. M_3 + NPK gave largest leaf area at 2 WAP, M_2 + PM produced largest leaf area at 4 WAP while M_3 + NPK, M_1 + PM, M_2 + PM and M_3 + PM gave highest values which were not significantly different at 6 WAP. M_2 + PM + NPK gave the highest value at 2-8 WAP.

Fruit yield

Table 5 shows that PM and NPK produced the same average number of fruit per plant (4) followed by M_3 (3). NPK has the highest average fresh and dry fruit weights of 37 and 17.10 g respectively which were different significantly from PM with 22.80 and 10.20 g. M_3 gave the best performance in okra yield compared to M_1 and M_2. M_3 + NPK and M_2 + PM did not differ in their average number of fruit per plant but M_3 + NPK gave higher values of average fresh fruit weight that is significantly different to M_2 + PM. The treatment combination M_1+PM+NPKproduced the highest average number of fruits per plant (5)while M_3+PM+NPK had the highest average fresh fruit weight (42.72g) and dry fruit weight (20.50 g). The fresh and dry fruit weight yields recorded from the combination of MML, PM and NPK were significantly higher than other combinations.

Table.3: The comparative effects of milled moringaleaf, poultry manure and NPK fertilizer on the number of leaves of okra

Treatments*	Week after planting			
	2	4	6	8
Control	3.33	4.67	5.00	5.00
M_1	3.00	5.00	5.00	6.00
M_2	5.00	5.00	5.00	6.00
M_3	3.00	4.33	5.00	6.33
NPK	5.00	5.00	5.00	6.00
PM	4.67	5.67	6.00	6.67
M_1+NPK	3.67	4.33	5.00	5.67
M_2+NPK	4.00	4.50	5.50	6.00
M_3+NPK	3.50	4.50	5.00	6.00
M_1+PM	3.33	5.00	5.67	6.00
M_2+PM	5.00	5.33	6.00	6.33
M_3+PM	3.67	5.33	5.67	6.33
M_1+PM+NPK	3.33	5.00	6.00	6.67
M_2+PM+NPK	5.33	6.33	5.67	6.33
M_3+PM+NPK	4.00	5.00	5.67	6.67
LSD (5%)	1.64	1.60	1.00	1.00

M: Moringa, (M_1=400kg/ha, M_2=800kg/ha, M_3=1200kg/ha); NPK 15:15:15 Fertilizer, PM: Poultry manure, NS: Not significant.

Table.4: The Comparative effects of Moringa Leaf, Poultry manure and NPK Fertilizer on the Leaf Area (cm^2) of Okra (Abelmoschusesculentus)

Treatments	Week after planting			
	2	4	6	8
Control	11.43g	32.89i	63.83g	95.67i
M_1	11.85g	35.86h	83.57f	127.11h
M_2	51.87c	84.13e	131.74de	167.32g
M_3	29.18e	64.49f	94.56f	156.09g
NPK	27.87e	62.66fg	103.37e	190.07f

PM	19.72f	47.87g	164.43cd	285.92e
M_1+NPK	33.95d	72.17f	180.54c	274.15e
M_2+NPK	21.21f	53.24h	61.04	136.17
M_3+NPK	83.42a	177.96c	227.93b	341.43bc
M_1+PM	28.33e	156.33d	224.98b	338.22c
M_2+PM	35.46d	202.49b	217.35b	333.67cd
M_3+PM	33.50d	185.73c	232.21b	334.75c
M_1+PM+NPK	33.53d	92.00f	210.00b	322.19d
M_2+PM+NPK	64.95b	292.89a	328.68a	418.59a
M_3+PM+NPK	33.11d	152.19e	236.53b	350.55b
LSD (5%)	3.79	10.29	36.48	12.10

M: Moringa, (M_1=400kg/ha, M_2=800kg/ha, M_3=1200kg/ha); NPK 15:15:15 Fertilizer, PM: Poultry manure. Mean with different letter in the same column are significantly different at 5% probability.

Table.5: The comparative effects of milled moringa leaf, poultry manure and NPK fertilizer on the number of fruit, fresh and dry fruit weight of okra.

Treatments	**Number of Fruit**	**Weight of Fruit (g)**	
		Fresh	**Dry**
Control	1.10e	2.10i	1.30i
M_1	2.20d	5.50h	3.40h
M_2	2.67c	10.50g	5.10g
M_3	3.00c	16.70f	6.80f
NPK	4.00b	37.80b	17.10b
PM	4.00b	22.80de	10.20e
M_1+NPK	3.00c	19.40e	7.50f
M_2+NPK	3.00c	7.90gh	3.00h
M_3+NPK	4.00b	38.90b	16.30bc
M_1+PM	3.00c	20.60e	9.60d
M_2+PM	4.00b	34.50c	17.30b
M_3+PM	3.00c	23.70d	15.30c
M_1+PM+NPK	5.00a	23.40d	12.00d
M_2+PM+NPK	3.00b	42.70a	20.50a
M_3+PM+NPK	4.00b	38.50b	19.60a
LSD (5%)	0.47	2.27	1.08

M: Moringa, (M_1=400kg/ha, M_2=800kg/ha, M_3=1200kg/ha); NPK 15:15:15 Fertilizer, PM: Poultry manure. Mean with different letter in the same column are significantly different at 5% probability.

IV. DISCUSSION

The pH value of the soil (pH=6.24) was within the pH range of 6 – 7 considered as suitable for optimum performance of vegetables (Purselglove 1992). The total N was very low compared to the critical level of 0.1% for N in the soils of Nigeria (FMANR, 1990) suggesting the need for its increased supply in the soil to improve the growth and yield of okra.This expectation was met with the application of NPK, PM and MML singly and in all combinations which increased the selected growth parameters at all sampling occasions.

Studies have shown that MML and PM are rich in nutrients (Patterson *et. al., 1998;* Fahey, 2005; Mark, 2010; Annette, 2012) and can thereby be used as soil amendments. Treatments with PM significantly influenced the height of okra plants. Moringa has been used as a growth enhancer (Fahey, 2005, Aluko, 2016) through foliar spray of the leaf extract but not as soil amendment. The response of okra to soil-applied MML was reflected in the growth parameters and fruit yield. Fuglie (2008) andMvumi*et al*. (2012 and 2013) had reported increased in the yields of crops with the application of moringa leaf extract. The increase in MML rates resulted in higher fruit yield which is similar to the observation of Aluko (2016) that the increase in concentration of moringa leaf extract as foliar spray improved pepper fruit yield. The significant increase in the growth parameters confirms the ability of plant residues to compete favorably with the inorganic fertilizers as sources of nutrients (Olujobi and Ayodele,

2013).MML and PM increased okra growth in the same magnitude as NPK 15-15-15 fertilizer and confirms that organic materials improved crop production by gradual release of nutrients (Akande*et al*.,2010). The use of organic and inorganic fertilizer mixture to improve okra crop production observed by Akande*et al (*2010) and Olujobi and Ayodele (2013) is similar to the response of MML + PM + NPK which would ensure steady release of nutrients, especially N that exerts the greater control on growth and yield potentialities of the soil in south western Nigeria (Olaniyi, 2006).

The integrated application of NPK 15-15-15, PM and MML gave higher yield compared to the sole application of these sources. Havlin*et al* (2004) had advocated the integrated approach to nutrient management in crop production for better performance. Akande*et al* (2010) noted that the combination of organic and inorganic fertilizer produced better yields of okra. The sole application of NPK 15-15-15 gave a better performance in terms of number of fruits and fresh fruit and dry fruit weights compared to the sole application of MML and PM. This is associated with ready availability of nutrients from NPK 15-15-15 produced in water-soluble form whereas PM would undergo microbial decomposition and mineralization through which nutrients are slowly released over a long period.

V. CONCLUSION

The results showed that the application of NPK 15-15-15, poultry manure and milled moringa leaf had significant effect on the performance of okra. The combination of NPK 15-15-15, poultry manure and milled moringa leaf gave better performance. Application of MML at different rates gave significant effect in growth characters except in number of leaves. Thus, milled moringa leaf can serve as source of nutrients for the production of okra.

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