GENOTYPIC VARIATIONS OF MORINGA ACCESSIONS *(Moringa oleifera Lam) AS INFLUENCED BY* POULTRY MANURE RATES IN THE TROPICAL RAINFOREST AGROECOLOGY OF SOUTHEASTERN NIGERIA

J.C. Obiefuna[1] and A.I. Nwonuala[2]

1. Department of Crop Science and Technology, Federal University of Technology, Owerri, Nigeria
2. Department of Crop/Soil Science Rivers State University of Science and Technology, Port Harcourt, Nigeria.

ABSTRACT

The current awareness of moringa (*Moringa oleifera*) as a multipurpose healthcare crop demands a sustainable production package for the Nigerian farmers. This study evaluated the growth and yield responses of selected moringa accessions of Nigeria. The treatments were five moringa accessions (Ilorin, Lafiagi, Mokwa, Nsukka and Egbu) manured with three poultry manure rates (0.0, 5.0 and 10.0 t ha^{-1}). The 5x 3 factorial experiment was laid out in a randomized complete block design of three replicates means were separated. The moringa accessions showed significant ($P<0.05$) growth and yield responses to poultry manure application. The unmanured Mokwa accession developed shortest stands (112.0 cm) while Egbu accessions manured with 5.0 t ha^{-1} produced vigorous plants (345.0 cm). The application of 5-10 t ha^{-1} poultry manure accelerated early flowering especially in Nsukka accessions (138 days) and improved fruit yields in all accessions. Lack of manure delayed flowering and caused poor fruit yields in moringa. Although the application of 5.0-10 t ha^{-1} of poultry manure produced very high and similar fruit yields in each moringa accession. The application of 10.0 t ha^{-1} to Nsukka accession produced the highest fruit yield and so recommended as the preliminary production of moringa in the rainforest agroecology of southeastern Nigeria. Further work continues on optimum poultry manure rate for sustainable moringa production.

Keywords: *Moringa, poultry manure, agroecology, Nigeria.*

Introduction

Moringa tree *(Moringa oleifera Lam)* belonging to the Moringaceae family and a native of India is widely distributed in the tropical regions specifically the pacific (Aregheore, 2002), West Africa (Freiberger *and* Pandergrant, 2001). Central America and Carribean (Foildl and Paul 2008). As a result of wide distribution of moringa, the common name for this crop is diverse and strongly dependent on the locality. Thus, the English common names include Horseradish tree, Drumstick tree, never die tree, miracle tree, life saver tree (Keay, 1989). In Nigeria, moringa is found across the agroecological zones and ethnic groupings. The major ethnic names according to Gbile, (1984) are zogallandi (Hausa) Okwe-oyibo (Igbo) and Ewe-igbale (Yoruba). In southeastern agroecology, moringa features prominently as a semi-cultivated or volunteer live fence and yam stakes in compound and nearby farms (Akobundu *et al.*, 1992). The multipurpose crop has nutritional and medicinal uses to human, fodder for livestock and for environmental/slope stabilization (Fakey, 2005, Ofoh *et al.*, 2011).

The efficacy of moringa products to curb malnutrition and cure diseases has currently created global awareness to advocate consumption and use of moringa products as an excellent indigenous source of highly digestible protein, iron, vitamin C and carotenoids for the rural poor where meat protein intake is low and undernourishment a major concern. Among Nigerian farmers moringa is a semi-cultivated crop as live fence or volunteer live stake in home gardens. In spite of the widely acclaimed nutritional and medicinal utilization of moringa the crop is neglected in research and training by the National Agricultural Research System in Nigeria. Thus, moringa is not a mandate crop of any agricultural research institutes of Nigeria.

So far only very little research on varietal variations of moringa are available. Recently, research on moringa at Federal University of Technology, Owerri involved nursery management of five moringa ccessions in Nigeria (Ofoh *et al.*, 2011). As a continuum of the moringa nursery management, the development of genotypic field establishment and agronomic practices for sustainable production of the accessions became the logical priority. This work reported the response of five moringa seedling accessions, to poultry manure rates in the rainforest agroecology of southeastern Nigeria.

Materials and methods

The experiment was conducted at the Teaching and Research Farm, Federal University of Technology, Owerri, Imo State located at latitude $05^0\ 20^1$N of the equator and longitude $07^0\ 02^1$E of the Greenwich Meridian and at an altitude of about 80m above sea level. Owerri is in the humid tropics characterised by high temperature range of 20-35^{0}C, bimodal annual rainfall (>4000mm) with peaks in July and September with intervening low rainfall in August (August break).

The rainy season spans from March to November while the dry season spans from December to March. The ultisoil is the dominant soil group in the area, and are characteristically sandy, of low nutrient reserve, acidic and highly erodible. The acquired seeds of five moringa accessions were tagged after the location of collection as Ilorin and Lafiagi in Kwara State, Mokwa from Niger State, Nsukka (Enugu State) and Egbu (Imo State). The seeds were raised in black polythene bags arranged in open nursery and the two year fallow land used for the experiment was cleared, ploughed and harrowed. Random samples of soil in the experimental field were taken at 0-30cm depth with the soil augur, bulked and analysed. Seedlings were transplanted with ball of earth at eight (8) weeks after emergence (Ofoh *et al.* 2011).

The seedlings were each spaced 3.0 x 2.0m between and within rows respectively. The treatments consisted of five (5) moringa accessions (Ilorin, Lafiagi, Mokwa, Nsukka and Egbu) and three (3) rates (0, 10, 20t ha^{-1}) of poultry manure applied two weeks after transplanting. The 5 x 3 factorial experiment was laid in randomized complete block design with three replicates. Growth and yield data were collected and analyzed using Genstat Release Discovery 8.0. Means were separated using Fisher Least Significant Difference (FLSD) at 5% probability level (Obi, 2002).

Results and Discussion

The seed emergence of moringa accessions in the nursery was uniform, (5-6) days after planting (Table 1). However, the total seedling emergence showed significant ($P<0.05$) variations. Thus, all the seeds of Nsukka and Egbu accessions emerged (100%) while the seed emergence was comparatively lowest (92%) in Mokwa accessions.

Table 1: Seedling emergence and morphological characteristics of the moringa seedling accessions at transplanting after 8 weeks in the nursery to the field.

Accession	Days to 50% emergence	Emergence %	Height (cm)	Girth (cm)	Number of Leaves	Nodes	Internode length (cm)	Growth vigour crop/plant/days	Root length (cm)	Field establishment %
Ilorin	6.42	98.54	24.54	1.01	7.65	6.62	4.00	3.00	36.64	76.58
Lafiagi	6.04	94.06	25.50	0.90	6.54	6.40	4.02	3.00	37.05	76.60
Mokwa	6.14	92.08	28.60	0.82	6.56	6.60	4.22	3.01	38.04	77.58
Nsukka	6.04	100.00	36.62	2.55	10.65	6.68	6.02	3.72	44.54	89.04
Egbu	5.82	100.00	36.92	2.07	10.45	6.24	5.00	3.74	48.64	88.56
$LSD_{0.05}$	**NS**	**2.18**	**3.06**	**0.05**	**1.06**	**NS**	**1.14**	**0.48**	**5.26**	**2.50**

In the field, the transplanted seedlings from the different accessions established remarkable variations in aerial and underground growth characteristics. Thus, the seedlings from Nsukka and Egbu accessions were superior in aerial growth characteristics which include moringa seedling height, girth, number of nodes and leaves and extensive underground root system. The significant growth variations among the accessions in the nursery is likely ecological or genetic variations since the nursery medium, environment and care were uniform (Ofoh, *et al.* 2011).

The moringa accessions (Table 2) responded significantly ($P<0.05$) in morphological and reproductive characteristics to poultry manure application. The application of increasing levels of poultry manure further enhanced growth. Thus unmanured Ilorin and Mokwa moringa accessions were short, spindly with limited number of leaves and barely two meters tall at maturity (flowering). The application of 5 t ha^{-1} of poultry manure produced plants of moderate growth and stature. The significant variations in reproductive attributes of the moringa accessions indicated that both zero and high (10 t ha^{-1}) applications of poultry manure delayed flowering in moringa. The application of increasing poultry manure rate significantly ($P<0.05$) reduced floral abortion and enhanced fruit development. Floral abortion was highest in unmanured Ilorin accession. The unmanured Ilorin and Mokwa accessions matured late (165 in Lafiagi to 180 days in Mokwa) after transplanting. The application of 10 t ha^{-1} poultry manure slightly (150-166 days) delayed flowering which was adequately compensated for by improved yield across accessions. The application of 5 t ha^{-1} poultry manure enhanced early flowering in Nsukka accessions (138 days).

Table 2: Morphological response of moringa accessions to poultry manure at flowering

Accessions	Manure t ha^{-1}	Days for 50%		Height (cm)	Girth (cm)	Number per tree		
		Flowering	Fruit maturity			Leaves	Flowers	Branches
Ilorin	0	175.50	247.08	126.74	5.20	24.00	1.08	1.35
	5	145.65	216.54	201.65	8.54	25.02	3.09	2.13
	10	150.50	214.06	254.82	10.46	26.24	4.94	2.10
	$\overline{X}$	157.22	285.93	194.39	8.06	25.09	3.04	1.86
Lafiagi	0	165.402	246.52	198.64	6.25	18.26	0.94	1.10
	5	140.42	212.40	238.72	8.48	24.56	2.62	1.08
	10	150.05	214.54	340.50	10.56	28.54	3.56	1.56
	$\overline{X}$	151.96	224.49	259.29	8.43	23.79	2.37	1.25
Mokwa	0	180.54	261.42	112.84	8.24	21.64	1.02	1.45
	5	154.52	218.50	248.60	19.46	26.08	2.00	2.64
	10	168.50	214.06	260.18	12.65	30.42	3.45	2.54
	$\overline{X}$	167.85	231.32	207.21	13.45	25.99	2.16	2.21
Nsukka	0	166.45	226.62	226.04	9.42	26.54	1.84	1.66
	5	138.50	208.00	260.46	10.26	28.08	3.28	2.44
	10	156.00	206.14	268.52	13.56	32.42	4.59	2.64
	$\overline{X}$	153.63	213.59	251.67	11.08	29.01	4.23	2.25
Egbu	0	166.48	236.40	245.04	9.48	28.52	1.68	1.16
	5	140.50	208.56	288.64	9.82	30.66	3.80	1.68
	10	166.08	210.42	345.40	12.56	38.84	4.96	2.40
	$\overline{X}$	157.69	218.46	295.02	10.62	32.67	3.48	1.75
$LSD_{0.05}$ for accession		**12.06**	**2.04**	**2.48**	**3.42**	**3.62**	**1.08**	**NS**
$LSD_{0.05}$ for manure		**10.52**	**1.04**	**2.51**	**2.06**	**2.42**	**1.14**	**NS**
$LSD_{0.05}$ for accession x manure		**8.16**	**0.84**	**1.62**	**2.42**	**2.08**	**1.04**	**NS**

Accessions manured with poultry manure matured early and produced quality fruits and fruit components ranging from fruit size (length and girth), to fruit seediness of moringa of each moringa accession. The application of different poultry manure rates to different moringa accessions resulted in significant growth and fruit yields. Poultry manure is a valuable source of crop nutrients and organic matter which improve the soil physio-chemical and biophysical condition thereby making the soil more productive and sustainable for crop production including moringa (Obiefuna, 1990).

Similar observations were reported for moringa grown in high fertility home gardens and distant farms of southeastern Nigeria respectively (Akobundu, *et al* 1991). Poultry manure is very high in nitrogen which enhanced growth to the detriment of flowering. (Adeley, *et al* 2010). The significant growth and fruit yield of Nsukka and Egbu accessions may be attributed to agroecological advantages including climatic adaptation (Ugwuoke *et al*, 2011) while the photoperiodic response may be confirmed with monitoring of the accession in the field.

Table 3: Poultry manure effects on reproductive attributes of *Moringa oleifera* accession planted in the field

Accessions	Manure t ha^{-1}	Fruits length (cm)	Fruit girth (cm)	Fruit yield (t ha^{-1})	Seeds/fruit	Percentage abortion per tree	
						flowers	fruits
Ilorin	0	11.00	3.05	2.12	18.40	48.58	42.66
	5	36.36	6.57	11.86	28.03	46.58	38.42
	10	35.33	6.72	12.64	25.33	31.56	28.62
	$\overline{X}$	27.23	5.44	8.87	23.92	42.24	36.57
Lafiagi	0	20.00	3.44	1.06	10.52	38.56	18.26
	5	27.22	4.42	8.48	16.33	25.06	10.50
	10	30.60	5.86	8.54	11.60	20.60	12.04
	$\overline{X}$	25.74	4.57	6.02	12.82	28.07	13.60
Mokwa	0	20.00	3.45	1.84	16.05	32.86	20.50
	5	22.67	4.80	10.02	18.84	26.50	15.50
	10	27.43	6.03	10.62	14.52	18.08	10.44
	$\overline{X}$	23.37	4.76	7.29	16.47	25.81	15.48
Nsukka	0	42.45	7.06	2.48	24.64	28.54	18.64
	5	46.24	8.24	10.28	25.04	20.06	15.06
	10	45.06	8.22	12.68	25.02	18.58	12.48
	$\overline{X}$	44.58	7.84	8.48	24.90	22.29	15.39
Egbu	0	44.52	7.82	1.44	28.65	28.04	9.42
	5	50.08	8.54	10.46	36.06	22.14	8.62
	10	54.86	9.02	8.26	31.45	22.08	8.01
	$\overline{X}$	49.82	8.46	6.72	32.05	24.09	8.68
$LSD_{0.05}$ for accession		**3.73**	**2.18**	**2.08**	**4.56**	**6.48**	**12.54**
$LSD_{0.05}$ for manure		**2.02**	**0.82**	**1.42**	**1.22**	**2.16**	**8.12**
$LSD_{0.05}$ for accession x manure		**1.22**	**1.04**	**1.06**	**0.84**	**1.08**	**3.54**

Conclusion

The climatic factors of the southeastern agroecology favoured the production of *Moringa oleifera* accessions. However, the positive response of moringa accessions to poultry manure is a positive indicator of poor soil (ultisoil) of southeastern agroecology. Further work on optimum production of moringa through balanced manurial practices on an ultisoil continues at the university.

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