EFFECTS OF THREE RATES OF MUCUNA LIVE-MULCH IN THE PRODUCTION OF PLANTAIN IN OWERRI AREA OF SOUTHEASTERN NIGERIA.

EMMA-OKAFOR, L.C., OKOLI, N.A., ALAGBA, R.A., IBEAWUCHI, I.I., OBIEFUNA, J.C. and KEYAGHA, E.R
DEPARTMENT OF CROP SCIENCE AND TECHNOLOGY,
FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
Corresponding author e-mail: lilianokafor35@yahoo.com

Abstract
Mulching is a critical cultural practice in plantain production. However, mulch limitations (availability, bulk, transportation, seasonality etc) constrain mulching. This paper exploited the biological aspects (rapid vegetal cover and heavy biomass, soil fertility and biological life enhancement) of mucuna (climber) as a sustainable live mulch in conventional plantain orchard. The experiment was conducted at the university research farm, Federal University of Technology, Owerri from May 2013-March 2016. The treatments consisted of three mucuna mulch populations (20,000, 10,000 and 5000 ha^{-1})in plantain/mucuna intercrop manured with three poultry manure rates (0.0, 10.0 and 20 tha^{-1} respectively. The sole plantain manured with 20 tha^{-1} poultry manure was the control. The 3 x3 factorial experiment was laid in a randomized complete block design of three replicates in 5.0 x 5.0m plots. Pre- and post-experimental core soil samples were analyzed for soil physio-chemical properties. Plantains mulched and manured with poultry manure rates developed superior growth and yield attributes to the control. These plantains attained 50% vegetal coververy early, (4-6WAP) suckering (4-7 MAP), matured early (10-12 MAP).Plantcrop plantain producedheavy bunches (12-18kg/plant), with an earlier rationing cycle 9-12months than the control. Mucuna populations of 20,000 and 10,000 manured with 10-20 tha^{-1} poultry manure produced heaviest plant crop plantain bunches (15-18kg/plant) and (12-16kg/plant) ratoon plantains. Soil fertility improvement was superior to those of the unmanured plantain/mucuna (5000) and the control. Plantain/mucuna 20000 ha^{-1}mulch intercrop manured with 10 tha^{-1} poultry manure isadvocated for stable plantain yields in southeastern Nigeria.

Keywords: *Plantain, Mucuna live much, Poultry manure Environment.*

Introduction

Plantain (*Musa AAR*) represent the world's second largest fruit crop with annual production of 129,906, 098 metric tons (FAOSTAT, 2010) and rank fourth most important global food commodity after rice, wheat and maize (INIBAP, 1992). Nigeria is one of the world's largest producers of plantain (FAO, 2006). Despite plantain prominence, Nigeria least features among plantain exporting nations because of high local consumption (Akinyemi, *et al.* 2010). National per capita consumption figures validate the importance of plantains relative to other staples (FAO, 1986, 2006).

However, the tropical environmental factors (Nwosu and Adeniyi, 1980)(temperature, rainfall, humidity)aggravate rapid biodegradation of organic crop residues to organic matter which sustains crop productivity including plantain in the low fertility of tropical ultisol (Lal, 1975, Obiefuna *et al.* 2014). Mulching is an established agronomic practice for sustainable plantain production systems in tropics (Swennen, 1990, Obiefuna, 1986). The concept has been successfully derived from backyard plantain production system (Onwuzu and Nweke, 1983). However, the major constraints to wide application of mulching in plantain production remains in sustainable source of mulch supply (Swennen, 1990).

The in-situ grass production for plantain production had limited success (Swennen, 1990). Plantain cropping with some hedge crops was successful but labour intensive (Shinyam*et al*, 2010). Though the beneficial effects of mulch on plantain is understood, farmers still resist mulching plantains. The major hindrance is the high labour requirement associated with procurement, transportation etc as available in any locality. To circumvent these deterents, determination of on-farm mulch system(s) in which the mulch source is grown in close proximity with plantain is advocated for. Mucuna (*Mucunapuriens)* a heavy foliage proliferating climber and continuous biomass production was exploited for mulch potentials.

Materials and Methods

The experiment was conducted at the Teaching and Research farm, Federal University of Technology, Owerri,. located at longitude $7^0 7$' E, latitude 5^0 27' N and altitude 55.7m above sea level. The climate of the area is characterized by two distinctive rainy (March-Oct) and dry (Nov. –March) seasons which are influenced by the effect of the humid maritime air mass. The mean annual rainfall is about 2500mm and is bimodal with peaks in July and September. It has a temperature range of 20^0C and 32^0C. The soil is ultisol, acidic and low in mineral nutrients (Onweremadu *et al.* 2007)The five year old fallow farm was slashed, burnt and mapped out into 5.0x5.0m plots with 2.0m alleys between plots and blocks. Pre-planting and post harvest core soil samples (0-30cm depth) were collected and analyzed for physio-chemical properties. The treatment swere three plantain/mucuna (*Mucuna puriens)* populations 5000, 10000 and 20,000 mixtures manured with 0, 10 and 20 tha^{-1} of poultry manure respectively. Monoculture plantain manured with 20 tha^{-1} poultry manure was the control.

Sword suckers were collected from the university plantain orchard, pruned to 30.0cm height and established at 3.0 x 2.0m in 60.0cm planting holes. The mucuna seeds were planted at 2seeds for each population and thinned to one plant per hill two weeks after emergence. The 3.0 x 30 factorial experiment was laid in a randomized complete block design of three replicates. After the second ratoon plantain harvest the incidence of black sigatoka disease was scored (Ihejirika*et al,* 2009) while quadrat dry weed sample and biological life index were recorded. Plantain plant and ratoon growth, yield and associated data were statistically analyzed using Genstat Release 4.24DEVersion of 2005. Means were separated for significance with Fishers Least Significance Difference (FLSD) at 5% probability level and reported.

Results

The application of increasing poultry manure 10-20tha^{-1} to plantain intercropped with increasing mucuna populations significantly (p=0.05) enhanced the height of plant crop plantain (Table 1). Plantains mulched with low mucuna populations (5,000) without poultry manure application developed shortest plant crop plantains than the control other manured mixtures. Plantain height was significantly (p=0.05) short in the first ratoon plantains, especially when mulched with mucuna populations without poultry manures while the height increased in the second ratoon plantains. However, the plantain of the first and second ratoon plantain were of equal heights.

Furthermore, plantains intercropped with high density mucuna and manured with 10-20 tha^{-1}were harvested early, produced superior bunch weights compared to other mixture production system and the control. The 50% rapid vegetal cover achieved by combined growth of mucuna populations and plantains was fastest in plantain mulched with 20,000 mucuna plants manured with 20 tha^{-1} and slowest in the unmulched plantains.

Table 1: Growth and yield characteristics of plant crop plantain.

Treatments			**Time of 50%**			
Poultry manure (tha^{-1})	**Mucuna population (ha^{-1})**	**Height (m)**	**Harvest (months)**	**Number of suckers**	**Bunch weight kg/plantain**	**Vegetal cover (weeks)**
0	5,000	1.86	14.62	2.18	9.60	7.66
	10,000	2.42	13.08	2.66	9.82	6.49
	20,000	2.54	13.56	3.28	10.68	5.28
	$\bar{x}$	**2.27**	**13.74**	**2.71**	**10.03**	**6.48**
10	5,000	3.52	12.82	3.66	12.82	6.68
	10,000	3.50	12.46	3.58	14.58	5.84
	20,000	3.56	12.42	4.68	15.64	4.36
	$\bar{x}$	**3.53**	**12.57**	**3.97**	**14.35**	**5.63**
20	5,000	3.54	12.32	6.84	17.82	6.48
	10,000	3.62	12.12	6.52	17.84	5.62
	20,000	3.68	12.08	6.58	18.28	4.18
	$\bar{x}$	**3.61**	**12.17**	**6.65**	**17.98**	**5.43**
Control		3.66	12.45	4.08	12.80	18.62
$LSD_{0.05}$ manure		**0.86**	**1.02**	**0.24**	**1.28**	**0.24**
$LSD_{0.05}$ population		**0.54**	**0.52**	**0.16**	**1.06**	**0.06**
$LSD_{0.05}$ manure x population		**0.60**	**0.62**	**0.44**	**0.09**	**0.00**

The bunch weight dropped when plantains were mulched with mucuna without poultry manure application resulting in low total stool productivity (29.26kg) for 3 consecutive harvests (plant x 2 ratoon plantain). The total stool productivity increased with increasing mucuna population and application of 10-20 tha^{-1} poultry manure. Plantain/mucuna (20,000) with 20 tha^{-1} poultry manure produced the highest stool productivity. The control had the least. Plantains mulched with heavy mucuna populations and manured with 10-20 tha^{-1} significantly ($p \geq 0.05$) haboured more biological life(index) than the control.

Table 2: Growth and yield of two consecutive ratoon plantain crops first ratoon(R_1) and second ratoon(R_2) total yield of plant crop yields and two consecutive ratoon and biological life index after second ratoon crop harvest.

Treatments		**Height (m)**		**Bunch weight (kg)**		**Total yield kg/plant**	**Biological life index /plot**	**Weed dry weight g/plot**
Poultry manure (tha^{-1})	**Mucuna populations (ha^{-1})**	**First ratoon**	**Second ratoon**	**First ratoon**	**Second ratoon**	**Stool**		
0	5,000	1.68	1.82	10.02	9.84	29.26	5.16	852.66
	10,000	2.56	2.69	10.62	10.04	30.48	5.26	609.42
	20,000	2.60	3.02	12.52	12.08	35.28	5.24	258.52
	$\bar{x}$	**2.28**	**2.51**	**11.05**	**10.65**	**32.01**	**5.22**	**573.62**
10	5,000	3.22	3.48	12.84	12.26	37.92	5.04	486.02
	10,000	3.52	3.68	13.52	15.60	43.70	5.20	460.58
	20,000	3.28	3.69	15.82	16.48	47.94	5.28	562.60
	$\bar{x}$	**3.34**	**3.62**	**14.06**	**14.78**	**43.19**	**5.17**	**355.08**
20	5,000	2.86	3.54	16.96	18.48	53.26	5.12	336.44
	10,000	3.12	3.60	17.50	18.62	53.96	5.60	301.26
	20,000	3.42	3.68	18.86	19.48	56.18	5.62	366.52
	$\bar{x}$	**3.17**	**3.61**	**17.78**	**18.06**	**55.21**	**5.45**	**416.02**
Control		3.22	2.95	12.54	12.06	37.40	2.14	146.52
$LSD_{0.05}$ manure		**6.55**	**7.48**	**1.05**	**1.02**	**1.48**	**2.06**	**11.50**
$LSD_{0.05}$ population		**5.40**	**6.58**	**0.64**	**0.46**	**1.06**	**2.54**	**8.60**

LSD $_{0.05}$ manure x population	**5.04**	**6.08**	**0.52**	**0.48**	**1.40**	**1.08**	**6.08**

Table 3: Mucuna biomass poultry manure pre and post soil (0-30cm) analysis of the experimental location

Pre-planting soil			**Percentage**				**Available P**			**Cmolkg^{-1}**			
	Sand	**Silt**	**Clay**	**OM**	**N**	**BS**	**(ppm)**	**K**	**Mg**	**Ca**	**Na**	**CEC**	**pH**
Soil biomass	77.86	13.28	8.86	1.29	0.23	63.35	11.76	0.10	1.10	1.10	0.32	4.73	5.20
Mucuna leaves	NA	NA	NA	NA	0.79	NA	0.06	0.08	0.24	3.18	NA	NA	504
Poultry manure	**Mucuna population**												
0.0	5,000			1.01	0.20	41.50	10.12	0.14	0.45	0.42	0.20	2.98	5.50
	10,000			2.01	0.25	44.30	9.58	0.15	0.47	0.45	0.21	3.50	5.00
	20,000			2.10	0.24	44.50	8.76	0.23	0.46	0.45	0.22	3.55	5.00
5.0	5,000			1.12	0.21	45.60	10.98	0.00	0.52	0.50	0.20	3.26	5.50
	10,000			2.09	0.35	49.70	10.78	0.37	0.54	0.66	0.34	3.80	5.80
	20,000			2.19	0.35	49.80	10.78	0.38	0.58	0.53	0.29	3.87	5.86
10.0	5,000			1.95	0.22	49.70	10.12	0.25	0.53	0.51	0.27	3.74	6.62
	10,000			3.01	1.24	55.20	11.00	1.32	0.55	1.54	0.29	3.95	6.98
	20,000			3.01	2.25	55.25	12.32	1.84	0.58	1.56	0.34	3.90	6.98
Control				1.22	0.21	4.50	10.78	0.41	0.48	0.50	0.20	3.00	4.94

Discussion

Plantain has three distinct growth phases; pre-floral, floral initiation and reproductive phrases (Ndubuizu*et al.*, 1983). Each growth phase responds differently to a given environmental stress (Ndubuizu and Okafor, 1976) stress in time, magnitude and space. The floral and reproductive phases are the most sensitive to any form of stress particularly drought (Ndubuizu and Okafor, 1976). Mucuna mulch provides all season mulch which minimized adverse stress effects on any plantain growth phase and yields in time.

Beneficial effects of mulching in plantain production have been attributed mainly to increased soil organic matter due to nutrient content of the mulch in use (Obiefuna, 1987, Swennem and Wilson, 1983. Although soil temperature is a factor in yield decline in plantain (Braide and Wilson, 1980), its effects is minimal (Maurya and Lal, 1981). Mucuna mulch and poultry manure application inplantain production systems simulate backyard production system which organic mulch is continually applied (Nweke*et al* 1988). Mulching plantain at the onset of the dry season is common but unsustainable since only ratoon plantain yield is favoured (Swennen, 1990). However, mucuna mulch covered both rainy and dry seasons of the year.

Mulching encourages populations of soil biota (Alagba*et al*,2013, Obiefuna*et al*, 2014). Mucuna mulch (Table 2) stimulated rapid multiplication and activities of the soil biota improving biofertility indicators which under favourable environmental factors, quickened continuous nutrient release from mucuna (Table 1) and also made available to plantain (Alagba*et al.* 2013). Mucuna mulch essentially satisfied the added value of continuous nutrient availability and environmental moderation in plantain production through regeneration and self re-seeding which mimicked compound production system (Onwuzu and Nweke, 1988, Bayeri*et al*, 2004).

Conclusion

The on-farm mucuna mulch generation is practicable and sustainable in time, space, and location. The practice minimized the tedious labour demand for mulch collection, transportation and application. The biomass generated is rapidly enhanced by poultry manure application. The high mucuna nutrient release on decay sustains all season plantain growth and yield and enhanced biological life habitat.

Acknowledgements

The authors are grateful to the Vice-Chancellor Federal University of Technology, Owerri Prof. F.C. Eze, Dean, School of Agriculture and Agricultural Technology, Prof. B.O. Esonu, Ag. Head, Department of Crop Science and technology for the research facilities used and the farm staff for technical assistance rendered.

References

Akinyemi, S.O.S., I.O.O, Aiyelagbe and Akyeampong, E. (2010). Plantain *(Musa spp.)* cultivation in Nigeria: A review of its production, marketing and research in the last two decades. *Proceedings of the International Conference on Banana and Plantain in Africa. Acta Horticultural, 879.*

Alagba, R.A., Obiefuna, J.C., Ibeawuchi, I.I. and Okoli, N.A. (2013) Soil macro biological life as influenced by trench depth and mulch sources in late season plantain production. *Paper presented at the National Conference of the Organic Agriculture project for Tertiary Institution in Nigeria (OAPTIN),* held at University of Agriculture, Abeokuta, Ogun State, Nigeria, November, 2013.

Baiyeri, K.P., Tenkouano, A., Mbah, B.N. and Mbagwu, J.S.C. (2004). Phonological andyield evaluation of Musa genotypes under alley and sole cropping systems in southeastern Nigeria. *Tropical and Subtropical Agroecosystem, 4(3), 137-1.*

Braide, J.O. and Wilson, G.F. (1980).*Plantain decline: A look at possible causes. Paradisiacal,* 4, 3-7.

FAO(Food and Agricultural Organization) (1986).*Production Yearbook 1986*.FAO Rome.

FAOSTAT (Food and Agricultural Organization of the United Nations) (2010).Online statistical database, FAO Rome.*Retri*eved from http://faostat.fao.org/.

Genstat Release 4:24DE (2005). *Genstat discovery edition.*Laws Agricultural Trust, Rothamsted Experimental station.

Ibeawuchi, I.I., Fialoke, S.A., Ogbedeh, K., Ihejirika, G.O., Nwokeji, E.M., Chigbundu, I.N. (2007). Influence of yam cassava based intercropping systems with legume in weed suppression and diseases pest incidence reduction. *Journal of American Science, 3(1), 49-59.*

Ihejirika, G.O., Ibeawuchi, I.I., Obiefuna, J.C., Obilo, O.P. and Nwokocha, W.I. (2009). Organic soil amendments as a protectant for kola seedlings transplant against some field diseases. *International journal of Agriculture and rural development, 12,* 100-109.

INIBAP (International Network for the Improvement of Banana and Plantain).(1982). *Annual Report 1992.*Montepeller, France, pp. 48.

Lal, R. (1975). Role of mulching techniques in tropical soil and water management.*Technical bulletin No. 7,* IITA Ibadan Nigeria.

Maurya, P. R. and Lal, R.A. (1981). Effect of different mulch materials on soil properties and on the root growth and yield of maize *(Zea mays)* and cowpea (*Vignaunguiculata*). *Field crops, 4, 33-45.*

Ndubizu, T.O.C., Obiefuna, J.C. and MAnufor, A.E. (1983). Studies on floral initiation in Bini (false horn) plantains in Nigeria. *ActaHorticulturae, 123:137-145.*

Ndubizu, T.O.C. and Okafor, E.I. (1976). Growth and yield patterns of Nigeria plantains *(Musa spp.). Fruits, 31, 672-677.*

Nweke, F.I., Njoku, J.E and Wilson, G.F. (1988). Productivity and limitations of plantain *(Musa spp, cv AAB)* production in compound gardens in southeastern Nigeria. *Fruits, 43(3), 161-166.*

Nwosu, A.C. and E.O. Adeniyi (1980).Imo State. A survey of resources for development NISER Ibadan, 310p.

Obiefuna, J.C. (1986). The effect of monthly planting on yield pattern and yield decline of plantain(*Musa AAB). Scientia Horticulturae, 29, 47-54.*

Obiefuna, J.C. (1987). The effect of different plant mulch materials on soil temperature, late season orchard establishment and yield of plantain *(Musa AAB). The Nigerian agricultural journal, 23(1) 79-89.*

Onweremadu, E.U., Eshett, E.T., Osuji, G.E., Unamba-Opara, I., Obiefuna, J.C. and Onwuliri, C.O.E. (2007). Anisotropy of edaphic in slope soils of a university farm in Owerri southeastern Nigeria. *Journal of American Science, 3(4).52-61.*

Onwuzu, C.F. and Nweke, F.I. (1983). The productivity of small holder plantain production systems in southeastern Nigeria: A case study of Egbema and Ohaji Areas of Imo State. *Proceedings of West African Regional Co-operative for Research on Plantain (WARCORP).*properties

Shiyam, J.O., Oko, B. F. D., Obiefuna, J.C. and Ofor, M.C. (2010). Optimizing the productivity of plantain/cocoyam mixture by mulching and fertilizer application. *Libyan Agriculture Research Centre Journal International, 1(6), 358-361.*

Swennen, R. and Wilson, G.F. (1983). Response of plantain to mulch and fertilizer. *International institute of tropical agriculture. Annual Report: IITA, Ibadan, Nigeria .p.187.*

Swennen, R. (1990). Plantain cultivation under West African Conditions:*A reference manual. International Institute of Tropical Agriculture* Ibadan, Nigeria. Thailand: Amarin printing group.