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The Profitability of Weed Management Options and Compost Manure in Plantain Production in Afaha-Nsit, Akwa Ibom State

BY

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Abstract

Economic returns of different weed management systems and soil nutrient status are the challenges currently facing plantain growers in Nigeria. Consequently, field experiments were conducted in 2016/2017 and 2017/2018 to examine the profitability of weed management systems integrated with compost manure in plantain production in Agricultural Research Farm, College of Education, Afaha Nsit, Akwa Ibom State, Nigeria. Ten treatments were laid-out in Randomized Complete Block Design with three replicates. The treatments were sweet potato (cover crop: 10,000 plants/ha) plus three levels of compost manure (30, 35 and 40 t/ha); hand-slashing at two months interval plus the same three levels of compost manure; primextra (1.5kg ai/ha) plus egusi-melon (cover crop: 10,000 plants/ha) and sweet potato (integrated weed management) plus the same three levels of compost manure and control (weedy and no compost manure). Analysis of variance was carried out on data obtained on weed characteristics and plantain performance. Means were separated using Duncan Multiple Range Test at 5% probability level while partial budget analysis was used to assess the profitability of each weed management strategy integrated with compost manure. The results showed that the slashed treatment plot treated with compost manure (40t/ha) excluding the control produced the least values in average total gross return (N303,500/ha) net benefit (N177,250/ha) and marginal rate of returns (2.2). The highest average total gross return (N720, 500/ha), net benefit (N593,000/ha) and MRR (5.7) were obtained from the integrated weed management plot treated with compost manure (40t/ha) hence it is recommended.

Keywords: Plantain, Compost-manure, Hand-slashing, Cover crops, Net-benefit

Introduction

Plantain production in Nigeria has been on the increase since the past decade and currently the country ranks first in Africa (FAO, 2011). There is also greater awareness of the profitability of plantain production in Nigeria (Emma-Okafor *et al.*, 2017). It is the cheapest staple to produce in terms of cost/ha, per tonne and per unit of food energy (Swennen. 199[illegible]. Indeed, the crop is an important source of livelihood for the farmers and their households with economic, nutritional and medicinal potentials (Agom *et al.*

2018).

Despite these advantages, the constraints to plantain production in Nigeria include inadequate land, weed infestation, low soil fertility, pests, diseases, low quality suckers, low production technology and wind disaster. Akobundu and Ekeleme (2002) observed that many farmers in the tropics hardly weed their farms timely, they are usually not aware of the yield losses that occur because of untimely weeding. Consequently, individual crop losses due to weed infestation vary from 0 to 100% but the yield losses vary from crop to crop and region to region (Akobundu, 1987). Nwagwu (2004) reported zero bunch yield and income from the weedy treatment plot and also reported a higher bunch yield and net benefit in the treatment plot of melon with two hand-weeding per year in plantain production than with three hand-weeding in Laoso, Ibadan.

Similarly, Ibedu *et al.* (1993) obtained 27% greater net income from integrated use of chloramben and egusi-melon (20,000 plants/ha) for weed control in plantain than the traditional practice of three-weeding in the first year of plantation established in southeastern Nigeria. Monetary benefit of integrated weed management was also reported by Ekpo *et al.* (2011a) when primextra 1.5kg integrated with vegetable cowpea (70,000 plants/ha) in maize production produced economic net benefit of N128,330 higher than N79,630 obtained from the treatment plot of hand-weeded (twice) in the rainforest zone of southeastern Nigeria.

On this basis, edible cover crop is highly recommended in traditional intercropping system and this intercrop suppressed weeds satisfactorily, increased land use efficiency and generated reasonable additional income (Ekpo and Ndaeyo, 2011). However, the resource poor farmers who constitute the bulk of plantain growers in Nigeria deploy hand-slashing in their plantation but this weed management approach increased cost, reduced yield and thereby reduced profit remarkably (Nwagwu, 2004).

Another threat to plantain production in Nigeria is soil fertility decline. Naturally, the predominant coastal plain soils and the sandy ultisols in southeastern Nigeria are no more supporting profitable crop production (Law-Ogbomo and Kemison, 2007). At present, the available arable land in Nigeria has been over-cropped over the years in the Niger Delta region in Nigeria (Ekpo and Ekpo, 2016); such soils are relatively low in exchangeable cations and tend to produce annual grasses which are cumbersome and costly to control (Ekpo *et al.*, 2019). However, yields can be improved significantly when large quantities of manure or inorganic fertilizer are applied (Udo and Udo, 2018). In Akwa Ibom State application of 200-400kg/ha of NPK 15:15:15 fertilizer to plantain production has been recommended (Udo *et al.*, 2005). This chemical fertilizer is sometimes not available and affordable; besides it creates human health hazards and adversed effects on physical environment (Ndukwe *et al.*, 2012).

Therefore, meritorious benefits of organic manure on the physico-chemical properties of soils have gained prominence in renewed interest in organic farming (Adeoye, 2005). Positive effects

of poultry manure on plantain growth and development were reported by Emma-Okafor *et al.* (2017). Currently, the price of poultry manure is increasing and sometimes the product is scarce and adulterated; yet the resources for making compost manure are readily available but report on the effects of compost manure on arable crops is scarce. Therefore advocation for the application of cheap and available organic manure associated with efficient but economical weed management becomes necessary for a rewarding business in plantain production.

In the light of the above this research was undertaken to examine the profitability of weed management system and compost manure in plantain production in Afaha Nsit, Akwa Ibom State, Nigeria.

Materials and Methods

Experimental Site: The study was conducted at Afaha Nsit, Akwa Ibom State, Nigeria. The state lies between latitude 04°50¹N and 05° 20¹S and longitude 07°16¹ and 08°10¹E. The mean annual rainfall of the experimental area is about 1800mm/ annum with a bimodal distribution; while mean daily temperature ranges from 24°c - 26°c.

Experimental Design and Layout: The experiment was laid out in Randomized Complete Block Design with three replicates each with ten treatments. The treatments were sweet potato (10,000 plants/ha) plus three levels of compost manure (30, 35 and 40 t/ha); hand-slashing plus the same three levels of compost manure; primextra (1.5kg ai/ha) plus *egusi*-melon (10,000 plants/ha) and sweet potato plus the same three levels of compost manure and control (weedy and no compost manure).

Land Preparation: The land area was measured 450m^2; while the net experimental plot was 300m^2. It was then cleared and tilled manually.

Planting and Cultural Operations: Plantain suckers and sweet potatoes vines (purple cultivar) were procured from seed multiplication centre of Akwa Ibom State Development project at Ikot Ekan, Etinan. Plantain suckers were planted 3m x 2m apart in holes dug 40cm x 40cm x 40cm. The plant population contained five stands per plot and only three were used for data collection.

Equsi-melon (*Colocynthes citrullus*) seeds were sown three per hole and later thinned to one per stand. This gave 10,000 plants/ha while the vine of sweet potatoes (*Ipomea batatas*) were planted 1m x 1m but three per hole and thinned to one per stand giving a population of 10,000 plants/ha. In plot p+m+sw *egusi*-melon and plantain were planted after primextra application while sweet potatoes were planted 15 weeks after the planting of *egusi*- melon in the same treatment plots.

Slashing using matchet was carried out at 2, 4,6 and 8 months after planting of plantain as recommended by Nwagwu (2004). Compost manure was applied at the rate of 30, 35 and 40t/ha at planting. One follower-sucker was maintained after flowering as the ratoon crop. At every four weeks, desuckering was repeated. Bunch bearing plants were propped against wind damage. At maturity (15 months after planting) plantain bunches were harvested and the fresh weight recorded. However,

only the representative samples of the fresh fruit were used for collection of data.

Composting of Weed Biomass: The fresh weed biomass was composted within two months and turned at two weeks interval to produce compost manure. The starter was mainly poultry droppings. The fresh broadleaves and grasses ratio was 3:1

Soil Sampling and Analysis: The soil samples were taken at three metres interval and composited for routine soil analysis to determine the physico-chemical properties of the soil.

Compost Manure: The compost manure was analyzed to determine the level of nutrients status.

Weed Studies: Weed data were collected at 2, 4, 6, and 8 months after planting. The weed studies included weed density, dry weed biomass and weed flora percentage.

Plantain Data: Data on agronomic characteristics were collected on Plantain at 2, 4, 6 and 8 Months after Planting

Data Analyses: Analysis of variance was used while the means were separated by Duncan Multiple Range Test. A partial budget analysis for each treatment was carried out.

Results and Discussion

Experimental Soil and Compost Manure: Weeds and decline in soil fertility are serious threats to plantain production. This could be as a result of shallow rooted nature of the crop, wide spacing and the low growth rate in low soil fertility. Proper weed management practices Nwagwu (2004) and maintenance of soil fertility using organic manure are fundamentals for improving the yield status of plantain (Emma-Okafor, Obiefuna, Iwuanyanwu, Okoli, Ibeawuchi & Alagba, 2017) The experimental soil was moderate in soil fertility (table 1).

Table1: Pre-planting Soil Physical and Chemical Properties of the Experimental Site.

Soil Properties	Values
P^H 1:1 (H_2O)	5.1
Organic carbon (gkg^{-1})	26.0
Soil organic matter (gkg^{-1})	48.3
Total Nitrogen (gkg^{-1})	5.1
P ($Mg\ kg^{-1}$)	28.6
Exchangeable cations	($cmol\ kg^{-1}$)
Ca	15.5
Mg	1.7
Na	0.9
K	0.5
Exchangeable acidity	0.2
Extractible micro nutrients	Mg (kg^{-1})
Mn	180.2
Fe	17.5
Cu	0.9
Zn	11.2
Particle size	g (kg^{-1})
Sand	711.0
Silt	199.8
clay	89.2

However, plantain is a heavy feeder and requires additional nutrients, hence the application of compost manure. This compost manure was relatively higher in exchangeable cations than their availability in the experimental soil (table 2).

Table 2: Chemical Properties of Compost Manure

pH	7.80
Ec(u/m)	569.0
Organic carbon%	28.49
Total N	2.63
C/N	10.00
← Mg/kg →	
Ca	16000.00
Mg	4000.00
K	2145.00
Na	1045.50
P	583.28

Weed Studies: In this study the percentage ground cover of *egusi*-melon increased from 25.6% at 4WAP to 100% at 12WAP thereafter declined (table 3).

Table 3: Percentage Ground Cover of Egusi-Melon, Egusi-Melon/ Sweet Potato and Sweet Potato in Plantain Plot.

2016/2017

Planted crop

Weeks After Planting (WAP)

	4	8	12	16	20	24	28	32
M	25.6a	89.7a	100.0a	56.5b	27.9c	0.0	0.0	0.0
Sw	22.7a	69.16	90.0a	100.0a	100.0a	100.0a	88.3b	75.5b
	←	M	→		m+sw	←	sw	→
M+Sw	26.0a	90.1a	100.0a	57.7b	55.3b	65.1b	100.0a	100a

2017/2018

Ratoon crop

Weeks After Planting (WAP)

	4	8	12	16	20	24	28	32
M	24.2a	89.7a	100.0a	56.5b	27.9c	0.0	0.0	0.0
Sw	22.7a	69.16	92.0a	100.0a	100.0a	100.0a	88.3b	75.5b
	←	M	→		m+sw	←	sw	→
M+Sw	26.0a	90.1a	100.0a	57.7b	55.3b	65.1b	100.0a	100a

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.
Sw_1 = sweet potato (10,000 plants/ha), M = *egusi*-melon (10,000plants/ha), Sw_1 = sweet potato (10,000 plants/ha) + M = *egusi*-melon (10,000plants/ha)

This cover crop is a fast growing crop and within two months reached its peak growth and thereby smothered weeds and deprived the weed seeds of sunlight and moisture necessary for germination as reported by Udosen *et al.* (2017). However, sweet potato suppressed weeds better than *egusi*-melon and at the same time has more longevity (100% ground coverage at 24WAP) thus provided relatively prolong seasonal weed control (Table 3).

This could be attributed to having large leafy material and extricated light more than those with less leafy material (Teasdale, 1996). Eneji, Agboola & Isiola (1995) reported relatively low weed density and dry weight with sweet potato (10,000 plants/ha).

The initial integration of primextra (1.5kgai/ha) contributed tremendously in the initial establishment of the crop as the plot produced the lowest values of weed density (Table 4) and dry biomass (table 5).

Table 4: Weed Density (number m^{-2}) on Plantain Treatment Plots

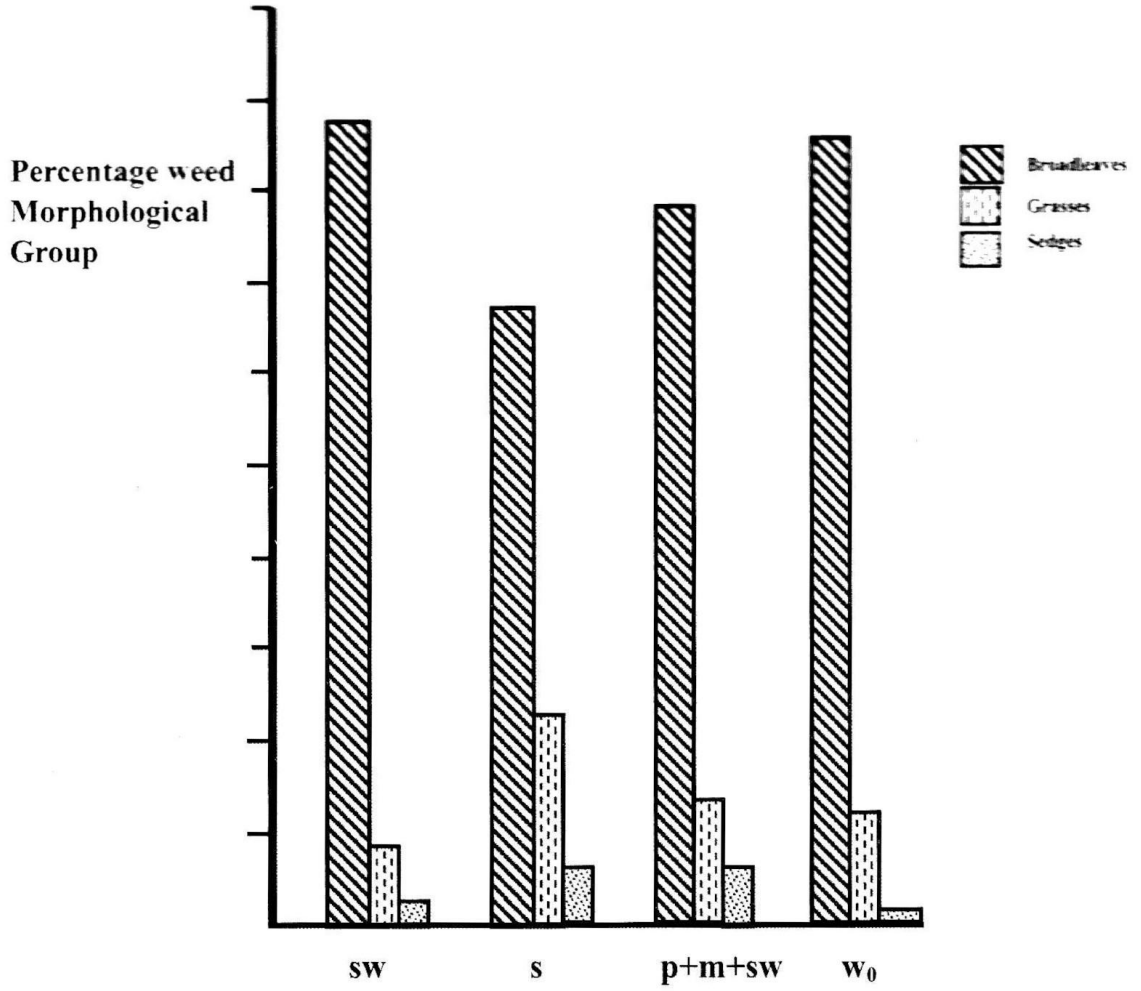
2016/2017 Planted crop

	← Months After P lanting (MAP) →			
Treatments	**2**	**4**	**6**	**8**
Sw + C_1	16.2b	4.0c	8.1bc	14.9bc
Sw + C_2	15.9b	3.8c	7.2bc	15.2bc
Sw + C_3	16.0b	4.1c	9.0bc	15.0bc
S + C_1	49.1a	30.8b	17.0b	28.0b
S + C_2	50.9a	31.0b	16.9b	27.0b
S + C_3	52.8a	30.6b	16.6b	26.9b
P+m+sw_2+ C_1	3.8c	2.0c	10.2bc	9.0c
P+m+sw_2+ C_2	4.1c	2.1c	9.8bc	9.1c
P+m+sw_2+ C_3	3.6c	2.2c	10.1bc	8.2c
Wo+ Co	54.8a	79.8a	68.3a	60.2a

2017/2018 Ratoon crop

	← Months After P lanting →			
Treatments	**2**	**4**	**6**	**8**
Sw + C_1	14.8b	5.1c	6.5bc	12.0bc
Sw + C_2	14.6b	4.8c	7.0bc	11.8bc
Sw + C_3	15.0b	5.0c	6.8bc	12.1bc
S + C_1	50.8a	28.2b	17.7b	30.2b
S + C_2	51.0a	28.0b	18.0b	29.8b
S + C_3	50.6a	27.9b	17.5b	30.5b
P+m+sw + C_1	2.7c	4.5c	8.8bc	8.9c
P+m+sw + C_2	3.0c	4.7c	9.1bc	8.7c
P+m+sw + C_3	2.8c	4.3c	8.5bc	9.1c
Wo+ Co	50.5a	82.1a	71.5a	62.8a

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level., P = Primextra (1.5kg ai//ha), Sw = sweet potato (10,000 plants/ha), S =slashing at 2months interval, M = Egusi-melon (10,000 plants/ha), 100Sw =sweet potato (10,000 plants/ha) but planted at 16WAP (senescence of egusi – melon, C_1 = Compost manure (30t/ha), C_2 = Compost manure (35t/ha) and C_3 = compost manure (40t/ha), Sw = sweet potato (10,000plants/ha), C_1 = compost manure (30t/ha), C_2 = compost manure (35t)ha), C_3 = compost manure (40t/ha), S=slashing at 2months interval, p = primextra (1.5kg)ha), M = egusi-melon (10,000 plants Iha), Wo + Co = weedy and no compost manure (control)



P = Primextra (1.5kg ai//ha), Sw = sweet potato (10,000 plants/ha), S =slashing at 2months interval, M = Egusi-melon (10,000 plants/ha) Wo = weedy (control). **Figure 1:** Contribution of different weed morphological groups to the weed population in plantain plots using different weed management system.

Table 5: Weed Management Strategies on Dry Weed Biomass (Kg/ha) in the Plots of Plantain Production.

	2016/2017 Planted crop			
	Months After Planting (MAP)			
Treatments	**2**	**4**	**6**	**8**
Sw + C_1	118b	211b	82c	59c
Sw + C_2	120b	209b	81c	59c
Sw + C_3	119b	211b	81c	58c
S + C_1	170a	163bc	155b	149b
S + C_2	173a	165bc	158b	148b
S + C_3	171a	162bc	156b	150b
P+m+sw+ C_1	70c	143c	70d	51cd
P+m+sw+ C_2	72c	140c	71d	50cd
P+m+sw+ C_3	69c	141c	70d	49cd
Wo+ Co	170a	1200a	310a	510a

	2017/2018 Ratoon crop			
	Months After Planting			
Treatments	**2**	**4**	**6**	**8**
Sw + C_1	107.0b	199.3b	68.2c	55.5c
Sw + C_2	106.5b	200.0b	68.0c	56.0c
Sw + C_3	107.1b	198.7b	66.8c	55.7c
S + C_1	170.8a	154.8bc	134.8b	121.8b
S + C_2	171.0a	155.0bc	136.0b	122.0b
S + C_3	170.6a	154.6bc	136.1b	121.2b
P+m+sw + C_1	67.8c	139.0c	65.4c	48.8cd
P+m+sw + C_2	67.6c	137.8c	66.8c	49.0cd
P+m+sw+ C_3	70.0c	137.6c	65.0c	49.2cd
Wo+ Co	168.8a	1188a	279.a	410a

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.
P = Primextra (1.5kg ai//ha), Sw = sweet potato (10,000 plants/ha), S =slashing at 2months interval, M = *Egusi*-melon (10,000 plants/ha), Sw =sweet potato (10,000 plants/ha) but planted at 16WAP (senescence of *egusi* – melon)
C_1 = Compost manure (30t/ha), C_2 = Compost manure (35t/ha) and C_3 = compost manure (40t/ha)

Sw = sweet potato (10,000plants/ha), C_1 = compost manure (30t/ha), C_2 = compost manure (35t)ha), C_3 = compost manure (40t/ha), S=slashing at 2months interval, p = primextra (1.5kg)ha), M = *egusi*-melon (10,000 plants Iha), Wo + Co = weedy and no compost manure (control)

Primextra has been the most popular used pre-emergence herbicide in the humid-rainforest zone and its effectiveness was reported by Ekpo, Ndaeyo, Udosen & Udounang (2011a). The plot treated with primextra integrated with egusi-melon and sweet potato effected prolonged and effective weed suppression. This could be attributed to the early weed suppression by the herbicide followed by smothering of the weeds by egusi-melon and thereafter by sweet potato. Effectiveness and benefits of integrated weed management has been reported by Udosen *et al.* (2017). The hand-slashing at two months interval was also effective in weed control. This method of weed control is very common among plantain growers in Nigeria because it requires little skill and sometimes the labour is available in some rural areas in Nigeria. Timely initiation of hand-slashing at two months interval effectively suppressed the first flush of weeds and enhanced the competitive ability of plantain over subsequent weeds that emerged thus resulting in better vegetative performance and yield of plantain as reported by Nwagwu (2004).

Broadleaf weeds (*Calapogonium mucunoides* and *Alternanthera bezzickiana*) generally dominated the experimental plots including the control for both the plant and ratoon crops of plantain. However the weed management techniques affected the morphological weed group. The dominance of broadleaves (82-86%) (Figure 1) in cover crop plots was associated with their reproductive, adaptive and survival mechanisms to tolerate shade as reported by Teasdale (1996) while the emergence of grasses in slashed plots (Figure 1) was relatively high probably the approach exposed the plot to direct sunlight which might favour grass emergence.

The least weed flora across the experimental plots were the sedges this could be linked with insignificant number of the seeds or propagules in the soil seed bank of this ecosystem. In addition, changes in weed morphological groups due to weed management strategies were observed by Ekpo *et al.* (2011a).

Plantain Agronomic Studies: The application of 40t/ha of compost manure and associated with suitable weed management system accelerated the time for flowering significantly for both plant and ratoon crops, hence reduced the flowering time by 27.6% and 27.2% for plant and ratoon crops of plantain respectively compared with the values obtained from the control (table 6).

Table 6: Weed Management Strategies and Compost Manure on 50% Flowering of Plantain.

	2016/2017 Plant crop	2017/2018 Ratoon crop
Sw + C_1	10.6b	10.5b
Sw + C_2	10.4b	10.0b
Sw + C_3	9.2c	9.0c
S + C_1	10.5b	10.4b
S + C_2	10.5b	10.3b
S + C_3	9.3c	9.2c
P+m+sw + C_1	10.5b	10.4b
P+m+sw + C_2	10.2b	10.1b
P+m+sw + C_3	9.0c	8.9c
Wo+ Co	12.7a	12.5a

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.
P = Primextra (1.5kg ai//ha), Sw = sweet potato (10,000 plants/ha), S =slashing at 2months interval, M = *Egusi*-melon (10,000 plants/ha), Sw =sweet potato (10,000 plants/ha) but planted at 16WAP (senescence of *egusi* – melon
C_1 = Compost manure (30t/ha), C_2 = Compost manure (35t/ha) and C_3 = compost manure (40t/ha)
Sw = sweet potato (10,000plants/ha), C_1 = compost manure (30t/ha), C_2 = compost manure (35t)ha), C_3 = compost manure (40t/ha), S=slashing at 2months interval, p = primextra (1.5kg)ha), M = *egusi*-melon (10,000 plants Iha), Wo + Co = weedy and no compost manure (control)

This is attributed to favourable growth environment that enhanced flowering development due to the improvement of the soil physico-chemical properties as supported by Emma-Okafor *et al* (2017).

Plantain Yield: The high quantity of compost manure (40t/ha) in an uninterrupted weed environment might influence the agronomic characters due to release of available exchangeable cations; thereby influence the agronomic characters and produced the highest yield components and bunch yield than the lower levels (table7).

Table 7: The Weed Management Strategies and Compost Manure on Plantain Bunch Yield Components at 15map

Treatments	Number of fingers Bunch^{-1}	Finger Length (cm)	Finger Girth (cm)	Number of Hands Bunch^{-1}
		2016/2017 Planted Plantain		
Sw+c_1	24.6b	22.5b	9.5b	5.9b
Sw+c_2	28.8ab	24.6ab	10.9ab	6.3ab
Sw+c_3	34.3a	25.0a	11.7a	6.8a
S+c_1	24.8b	22.7b	9.4b	6.0b
S+c_2	29.0ab	24.5ab	10.9ab	6.2ab
S+c_3	34.3a	25.2a	11.9a	6.7a
P+m+sw+c_1	25.0b	22.4b	9.5b	6.0b
P+m+sw+c_2	29.1ab	24.6ab	11.0ab	6.3ab
P+m+sw+c_3	34.5a	25.3a	11.8a	6.8a
Wo+co (control)	10.3c	6.8c	5.7c	5.1c
		2017/2018 Ratoon Crop		
	←	**Months After Planting**	→	
Treatment	**14**		**16**	**18**
Sw + C_1	28.8b	23.7b	10.1b	6.2b
Sw + C_2	31.7ab	24.7ab	10.8ab	6.8ab
Sw + C_3	33.8a	26.8a	12.0a	7.6a
S + C_1	29.0b	24.0b	9.8b	6.4b
S + C_2	32.0ab	25.0ab	11.0ab	7.1ab
S + C_3	33.6a	26.5a	11.9a	7.7a
P+m+sw + C_1	28.8b	23.8b	10.0b	6.4b
P+m+sw + C_2	32.0ab	24.0ab	10.9ab	7.0ab
P+m+sw + C_3	34.0a	26.8a	12.1a	7.9a
Wo+ Co	9.8c	6.5c	6.3c	5.5c

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.
P = Primextra (1.5kg ai//ha), Sw = sweet potato (10,000 plants/ha), S =slashing at 2months interval, M = *Egusi*-melon (10,000 plants/ha), Sw =sweet potato (10,000 plants/ha) but planted at 16WAP (senescence of *egusi* – melon
C_1 = Compost manure (30t/ha), C_2 = Compost manure (35t/ha) and C_3 = compost manure (40t/ha)
Sw = sweet potato (10,000plants/ha), C_1 = compost manure (30t/ha), C_2 = compost manure (35t)ha), C_3 = compost manure (40t/ha), S=slashing at 2months interval, p = primextra (1.5kg)ha), M = *egusi*-melon (10,000 plants Iha), Wo + Co = weedy and no compost manure (control)

Similar result of high yield of plantain bunch was also obtained from the application of 20t/ha of poultry droppings than the lower levels by Ndukwe *et al.* (2012). The agronomic characters and bunch yield of plantain obtained with 30t/ha of compost manure in cover crop and hand-slashed treatments plot were significantly lower than the values obtained from the plot fertilized with 40t/ha (table 8). This is attributed to the limited exchangeable cations available for the crop since it is a heavy feeder and competes for environmental nutrients per

unit area as noted by Emma-Okafor *et al* (2017). Similarly, 35t/ha of compost manure was medium quantity hence the agronomic characters, yield components and bunch yield were intermediate between the values obtained from the high (40t/ha) and low (30t/ha) quantities of compost manure. The controlled treatment plot reduced an average plantain bunch yield (t/ha) by 93.3% in plant and ratoon crops (table 8).

The low yield is attributed to the low soil fertility and weed infestation.

Nwagwu (2004) reported zero bunch yield of plantain in weedy plots. Similarly, Etim *et al.* (2010) reported 75.8% reduction in grain yield of maize; and 80.57% reduction in cassava tuber yield (Ekpó *et al.*, 2011b). Generally, low organic matter, low reserves of essential plant nutrients and high soil acidity constitute the main agricultural lands of south-eastern Nigeria (Udo *et al* 2005) and regular application of fertilizers especially organic has been recommended (Law-Ogbomo and Remission, 2008).

Table 8: Plantain Bunch Yield (T/h a) And Components Crop Yields (t/ha)

Treatment	Planted crops (2016/2017)	Ratoon crops 2017/2018	Average bunch yield(t/ha)	Average Sweet Potato tubers yield (t/ha) (2016/2017 (2017/2018)	Average Egusi-melon unshelled dry seed yield (kg/ha) (2016/2017) (2017/2018)
$Sw + C_1$	5.8b	6.3b	6.05	1.7	-
$Sw + C_2$	7.9ab	8.8ab	8.35	1.7	-
$Sw + C_3$	9.1a	10.3a	9.7	17	-
$S + C_1$	5.7b	6.4b	6.05	-	-
$S + C_2$	8.0ab	9.1ab	8.55	-	-
$S + C_3$	9.0ab	10.4a	9.70	-	-
$P+m+sw+C_1$	6.0b	6.5a	6.25	1.4	101.85
$P+m+sw+C_2$	8.8ab	9.0ab	9.80	1.4	101.85
$P+m+sw+C_3$	9.2a	10.6a	9.90	1.4	101.85
Wo + Co	0.61c	0.66	0.64	-	-

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.

P = Primextra (1.5kg ai/ha), Sw_1 = sweet potato (10,000 plants/ha), S = slashing at 2months interval, M = Egusi-melon (10,000 plants/ha), Sw_2 = sweet potato (10,000 plants/ha) but planted at 15WAP (senescence of egusi-melon), C = Compost manure (30t/ha), C_2 = Compost manure (35t/ha) and C_3 = Compost manure (40t/ha).

Table 9: Summary of Partial Budget Analysis of Planted Crop, Ratoon Crop and Component Crops/ha (2016/2017 And 2017/2018)

Treatments	Average total variable cost/ ha (₦'000)	Average gross returns/ha (N'000)			Average total gross return (₦'000/ha)	Net benefits (₦'000/ha)	Marginal rate of returns
		Planted plantain and ratoon crops	Sweet potato	Egusi-melon			
$Sw + C_1$	113.50	230.80	288.00	-	518.80	405.30	4.6
$Sw + C_2$	114.25	255.00	288.00	-	543.00	428.75	4.8
$Sw + C_3$	116.00	304.80	288.00	-	592.80	476.80	5.1
$S + C_1$	140.60	243.25	-	-	243.25	102.65	1.7
$S + C_2$	142.00	289.85	-	-	289.85	147.85	2.0
$S + C_3$	143.25	320.50	-	-	303.50	177.25	2.2
$P+m+sw_2+C_1$	125.85	242.50	240.00	175.00	657.50	531.65	5.2
$P+m+sw_2+C_2$	126.60	288.80	240.00	175.00	703.80	577.20	5.6
$P+m+sw_2+C_3$	127.50	305.50	240.00	175.00	720.50	593.00	5.7
Wo + Co	45.5	5.5	-	-	5.50	-40	-0.12

Means in a column followed by the same letter(s) are not significantly different by DMRT at 5% probability level.

P = Primextra (1.5kg ai/ha), Sw_1 = sweet potato (10,000 plants/ha), S = slashing at 2months interval, M = Egusi-melon (10,000 plants/ha), Sw_2 = sweet potato (10,000 plants/ha) but planted at 15WAP (senescence of egusi-melon), C_1 = Compost manure (30t/ha), C_2 = Compost manure (35t/ha) and C_3 = Compost manure (40t/ha).

The partial budget analysis (table 9) shows that the highest average production cost (N141,670/ha) was obtained from the slashed plot and the same plot produced the least net benefit and marginal rate of return (MRR) excluding the control table 9). This could be attributed to sole planting of plantain without component crop or crops in addition to relatively high cost of production. Similarly, Nwagwu (2004) reported the highest total average cost, least values in net benefit and MRR with hand-slashed treatment plot at three months interval in plantain production in Western Nigeria.

The unfertilized weedy plot resulted in unprofitable plantain enterprise by incurring a loss of forty thousand naira (N40,000/ha only) (table 9). This could be attributed to the poor yield and there was no intercropping of low growing economic crops. Similar trend was observed by Udosen *et al.* (2017) in weedy cocoyam production in Uyo, Akwa Ibom State.

The plots treated with primextra

integrated with egusi-melon, sweet potato and the application of 40t/ha of compost manure produced the highest gross income (N720,500/ha), net benefit (N593,000/ha) and marginal rate of returns (5.2) (table 9). This is also attributed not only to the relatively high yield of plantain bunch but also to the economic returns of the component crops (egusi-melon and sweet potato) (table 9). Ekpo *et al.* (2011as) also reported the highest average gross returns and net benefit from the treatment plot of cassava plus vegetable cowpea than from the hand-weeded treatment plots. The highest net benefit from integrated weed management (IWM) associated with edible component crops in humid rainforest zone in Nigeria were reported by Ibedu *et al.* (1993), Ekpo *et al.* (2010b) and Udosen *et al.* (2017).

Recommendation and Conclusion

Primextra plus *egusi*-melon integrated with sweet potato, and compost manure (40t/ha) produced the highest average total gross return (N720, 500/ha), net benefit (N593,000/ha) and MRR (5.7). The study recommends the integration of primextra, *egusi*-melon, and compost manure (40t/ha) for profitable plantain production.

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