Journal of Multidisciplinary Engineering Science Studies (JMESS)
ISSN: 2458-925X
Vol. 2 Issue 11, November - 2016, Special Issue

Effective Weed Management And Income Generation In Plantain Production In The Rainforest Zone Of Nigeria

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***Abstract*—Weed is the major constraint to tropical crop production. This experiment was carried out in 2013 late planting season and continued until 2015 at the Federal University of Technology Teaching and Research Farm, Owerri to determine optimal sweet potato density and poultry manure rate for weed management and increase crop yield of plantain in the rainforest zone of Nigeria. The 4x3 factorial experiment was laid in Randomized Complete Block Design in three replicates. The treatments were three densities of sweet potato (20,000,13333 and 10000plants ha^{-1}) and four poultry manure rate(0,5,10 and 15t ha $^{-1}$) Data on sweet potato establishment and yield, weed measurement ,plantain growth and yield were collected, analysed statistically and presented in the result. The three densities drastically reduced weed growth in plantain production. However sweet potato density of 13333plants ha $^{-1}$ that received 15t ha $^{-1}$ poultry manure significantly (p=0.05) suppressed weed, improved plantain growth, yield, and income generation in Owerri Rainforest zone of Nigeria.**

Keywords—sweet potato density, weed management, income, plantain, production.

Introduction:

Plantain (*Musa AAB group*), a giant rationing perennial plant of genus Musa and of family *Musaceae* is an important food crop in the humid tropics sub Sahara Africa including high rainfall areas of South eastern Nigeria. Plantain provides more than 25% of the carbohydrate and 10% of calorie intake of approximately 70 million people thus making the crop one of the most important sources of food energy in the region[16]. Plantain and banana represents the world's second largest fruit crop with annual production of 129,906,098 metric tons and the forth most important global food commodity after rice wheat and maize in terms of production. Plantain requires large amount of minerals to maintain high yields under commercial plantation. Most of the required minerals are usually supplied by organic manure such as poultry droppings which replenish soil nutrient, improve the soil physical, chemical and biological properties needed to sustain plantain productivity. Addition of organic amendments such as poultry manure to the soil is also economical and environmentally friendly.

In the humid tropics characterized by high rainfall, weed growth is very prolific and its management is a major constraint contributing up to 14-70% loss in plantain production. Weed has been identified as the number one pest farmers must consistently contend with in over 80% of common crops in Nigeria agriculture [4]. Weed causes reduction in crop yield, crop quality, takes 30-50% of total labour budgets[5].Though it is the most underestimated pest in tropical agriculture, it accounts for about 42% of the total pest loses in field crops and 18-100% crop yield loses. Weeds compete for water, available nutrients, solar energy and act as alternate host for most crop diseases. Lack of effective weed control is a key factor that reduces yield leading to overall yield decline. Mulching one of the successful weed control methods does not provide additional income to growers in rainforest area where farm size is small and space is intensively utilized in complex cropping systems. The use of cover crops like sweet potato as a farming culture is highly welcomed as sweet potato controls weeds and adds to revenue accruable from production of plantain. The potentials of mellon[11], vegetable cowpea[12], sweet potato [3] and *Telfairia occidentalis* [2] for use in weed management have been reported. The quest for ecoagriculture for soil, crop and environmental sustainability calls for effective use of cover crops and organic manure in order to eliminate the need for herbicides and chemical fertilizers respectively in weed and nutrient management in plantain production. This research was conducted to determine the optimum sweet potato density and manure rate for effective weed management and income generation in plantain production in Owerri, South eastern Nigeria.

Materials and Method

The field experiment was conducted between 2013 – 2015 cropping season at the Teaching and Research Farm, of 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 wet and dry 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 an ultisol characterized by deep porous red soils derived from sandy deposits in the coastal plain which are highly weathered, coarse textured, low in mineral reserve and natural fertility [7], [13]. The field originally planted with cassava and maize was manually cleared stumped and mapped out at 6m x 4m plot sizes. The experiment was a 3 x 4 factorial in Randomized Complete Block Design replicated 3 times. The treatment consisted of three (3) sweet potato densities (20,000 (0.5x1m), 13,333 (0.75 x1m) and10,000 (1x1m) plant ha-^{1}) and four poultry manure rates (0, 5.0, 10.0, and 15. 0 t ha-^{1}) . The planting materials (plantain suckers and Sweet potato vine) and poultry manure used in this experiment were gotten from FUTO Crop Genetic Resource, Unit and FUTO Livestock Farm respectively. Cured poultry manure was applied in appropriate treatment plots one week before planting. The plantain late sword suckers were spaced at 3.0 m x 2.0 m while sweet potato (*TRS 97/0097*) were planted in the plantain alleys according to the specified density 6 weeks later. Growth and yield data of plantain, weed measurement, sweet potato establishment and yield were collected and statistically analyzed using Genstat 2012. Means were tested for significant difference using Fishers LSD [9] at 5% level of probability.

Result:

Plantain height (cm), number of leaves and girth (cm).

Sweet potato density and manure rate had significant effect on the height, number of leaves and girth of the treatment at 8MAP (table 1). The sweet potato of 33333 density and 15t ha^{-1} of poultry manure produced significantly (p=0.05) taller plantain than every other treatment. However, Plantain without manure developed dwarf plantains irrespective of sweet potato density used with 20,000 sweet potato densities without poultry manure application recording the least plantain height of 63.39cm which is similar to 10,000 sweet potato density without poultry manure but differed significantly from 13,333 density without poultry manure.

Sweet potato density of 13,333 and 15 t ha^{-1} poultry manure also recorded significantly (p=0.05) higher number of plantain leaves [17] than all other treatment while sweet potato density of 10,000plants with zero poultry manure recorded the least (6.33) number of plantain leaves which differed significantly (p=0.05) from other treatment except sweet potato density of 20,000 with zero poultry manure. The result gotten from plantain girth is similar to the result of the plantain height.

50% Flowering and fresh bunch weight (kg/plant)

Poultry manure rates significantly (p=0.5) influenced the number of days to 50% flowering in plantain (Table 2). Planting plantain without manure prolonged the period of flowering in plantain irrespective of sweet potato spacing adopted. The plantain planted at 13,333 sweet potato density with 5t ha^{-1} poultry manure recorded significantly lower number of days to 50% flowering than those of other treatment.

There was significant increase in yield of plantain bunch yield with increased manure rate. The plantain manured with 15t ha^{-1} poultry manure had significantly (p=0.05) heavier bunch weight (15.73kg/plant) than all others. The yield of plantain increased as manure rate increase (from 6.53, 10.60 -15.73 in 13,333 sweet potato density) but reduced significantly (p=0.05) in plantain (0.02kg/h) without manure application.

Sweet potato Establishment and yield

Sweet potato density and poultry manure rate significantly (p=0.05) influenced sweet potato establishment and yield. Sweet potato density of 13333 and 15 t ha^{-1}poultry manure recorded higher establishment and yield while less establishment and yield was obtained from 20,000 sweet potato densities without poultry manure.

Weed measurement (kg/m ^{2})

Weed growth was less vigorous in all most all the treatment. (Table 3) However sweet potato spacing of 13,333 sweet potato density with 10t ha^{-1} poultry manure recorded the least weed measurement (0.10kg/m^2) while 10,000 sweet potato density without poultry manure had the highest weed.

Table 1: Plantain height (cm), number of leaves and girth (cm) at 8 MAP as affected by sweet potato density and poultry manure rate

Treatment		8 months after planting		
Sweet potato density	Poultry rate (t ha^{-1})	Plantain Height(cm)	Number of Leaves	Plantain Girth(cm)
20000 (0,5x1m)	0.0	63.39	6.50	23.94
	5.0	112.10	11.58	36.79
	10.0	122.33	14.37	45.23
	15.0	189.89	14.47	70.18
13333 (0.5x1m)	0.0	69.94	7.43	27.09
	5.0	139.67	14.30	54.94
	10.0	180.33	15.20	59.33
	15.0	204.45	17.03	75.00
10000 (1x1m)	0.0	64.90	6.33	24.48
	5.0	140.33	15.03	41.02
	10.0	160.33	14.38	61.44
	15.0	176.89	15.23	7i.88
		0.	0.	

	Plantain height	number of leaves	plantain girth
LSD $_{(0.05)}$ for density =	1.59	0.49	0.55
LSD $_{(0.05)}$ for poultry manure rates =	1.84	0.57	0.64
LSD$_{(0.05)}$ for density x poultry manure rates=	3.81	0.98	1.10

Table 2 Days to 50% flowering and fresh bunch weight (kg/plant) of plantain and sweet potato yield as affected by sweet potato density and poultry manure rates

Treatment		Plantain		Sweet potato
Sweet potato density	Manure rate (t ha^{-1})	50% flowering	Bunch Weight(kg)	tuber Weigh(tha^{-1})
20,000	0.0	523.57	0.02	0.02
	5.0	438.33	6.5	2.93
	10.0	339.67	10.60	8.0
	15.0	347.33	15.70	99.6
13333	0.0	522.67	0.02	0.02
	5.0	331.67	6.53	2.3
	10.0	337.00	10.60	11.67
	15.0	391.67	15.73	13.33
10000	0.0	522.67	0.02	0.02
	5.0	378.67	6.53	1.19
	10.0	337.33	10.53	6.56
	15.0	360.33	15.60	9.16

	Plantain	sweet potato	
	50% Flowering	Bunch Weight	root weight
LSD $_{(0.05)}$ for potato density =	2.31	0.10	0.8
LSD$_{(0.05)}$ for poultry manure rate =	2.67	0.12	0.91
LSD $_{(0.05)}$ for density x poultry manure rate	4.62	0.21	1.61

Table 3. Sweet potato establishment, yield and weed measure in plantain production as affected by sweet potato density and poultry manure rates in late season plantain.

Treatment		Sweet potato		
Sweet potato density	Manure rate (t ha^{-1})	Establishment (%)	tuber Weight (t ha^{-1})	Weed measurement(kg/m^2)
20,000	0.0	41.67	0.02	0.26
	5.0	46,67	2.93	0.14
	10.0	46.67	8.0	0.20
	15.0	45.00	9.6	0.13
13333	0.0	51.67	0.02	0.28
	5.0	56.67	2.3	0.16
	10.0	60.00	11.67	0.10
	15.0	75.00	13.33	0.11
10000	0.0	62.00	0.08	0.30
	5.0	66.70	1.19	0.22
	10.0	66.67	6.56	0.19
	15.0	66.67	9.16	0.17

		Sweet potato	weed measurement	
		Establishment (%)	tuber weight	
LSD $_{(0.05)}$ for potato density	=	1.55	0.8	0.03
LSD$_{(0.05)}$ for poultry manure rate	=	1.79	0.91	0.04
LSD $_{(0.05)}$ for density x poultry manure rate		3.10	1.61	0.07

Table 4 Income from plantain production as affected by sweet potato density and poultry manure rates.

Treatment		Cumulative yield		Gross income	Cumulative	Income return
Sweet potato density	Manure rate (t ha^{-1})	plantain (N ha^{-1})	Sweet potato (₦ ha^{-1})	(N ha^{-1})	production (₦ ha^{-1})	N ha-1
i20,000	0.0	13863	766.67	14629.67	415236	-400606.33
	5.0	2750200	102666.67	2852866.67	469668.6	2383198.07
	10.0	5407459	276666.67	5684125.67	495612.2	5188513.47
	15.0	7234380	335000	7569380	511612.2	7057767.8
13333	0.0	13668	766.67	14434.67	355236	-340801.33
	5.0	2881320	81666.67	2962986.67	408616.4	2554370.27
	10.0	5416452	399000	5815452	434612.2	5380839.8
	15.0	7344382	459000	7803362	450418.4	7352963.6
10000	0.0	13566	2766.67	16332.67	316224	-299891.33
	5.0	2168244	74666.67	2242910.67	369664.8	1873245.87
	10.0	4854688	228666.67	5083354.67	395612.2	4687742.47
	15.0	6815200	320333,33	7135533.33	416122	6719411.33

1 kg of plantain ₦200 – ₦250(Feb. – June 2013)

3kg of sweet potato tuber = ₦100

Sourced from 3 local markets at harvest- Owerri Main Market, Ihiagwa Market and Relief Market

Price of sucker ₦70 per sucker. Source: FUTO farm gate price.

Economic returns for late season plantain production

Economic returns for late season plantain production with sweet potato density and poultry manure rate (Table 4) showed highest gross income (₦7,803,362) for plantain in the treatment of 13,333 sweet potato density and 15 t ha^{-1} poultry manure which was higher than those of other treatments. The result also showed that high income is realizable from plantain manured with 15 t ha^{-1} of poultry manure with 10,000 and 20000 sweet potato densities.

The monetary value was arrived according to the prevailing market prizes of the plantain components and sweet potato fresh root at the end of the investigation. While the actual gain was the difference between the monetary value of the treatments yield and the production cost of the various treatments.

Discussion:

Plantain growth and yield

Increasing rate of organic manure resulted in high fresh bunch yield of plantain in the various treatment of plantain production resulting in high economic yields. The absence of poultry manure impacted negatively on plant growth and yield. This suggested that poultry manure supplied the basic nutrient needed for growth and yield of the plantain. This is in line with [1], [8] who reported that poultry manure is very rich in nutrients that will boost crop growth and yield.

Weed management

Weed growth was less vigorous in all most all the treatment which showed the efficacy of sweet potato on weed control .The accelerated growth of sweet potato resulted in rapid ground cover and weed suppression [3]

Sweet potato establishment and yield

Higher yield of sweet potato tuber yield obtained in this study with increase in poultry manure rate confirmed the positive effect of poultry manure [1], [8].

Income Return

The economic return of plantain production using sweet potato densities and poultry manure clearly indicated high income / economic return with highest income return of seven million, three hundred and fifty-two thousand nine hundred and sixty-three naira sixty kobo (₦7,352,963.60) realizable from plantain grown with 13333sweet potato density and 15t ha^{-1} poultry manure. However, no income rather losses accrued when 0 poultry manure was applied in various sweet potato densities in plantain. This suggested that the use of poultry manure and sweet potato for plantain production is a profitable enterprise capable of boosting farmers' revenue at the least cost of production since poultry manure is relatively cheap, environmentally friendly and locally available to resource poor farmers. This is in line with [6] who reported high income return from plantain production using poultry manure rates in late season plantain production. Smith *et at.*[15] also reported that use of poultry manure as a means of boosting soil fertility is economically justified.

Conclusion

The application of 10-15t ha^{-1} poultry manure accelerated plantain maturity irrespective of the sweet potato density adopted. Plantain planted with the various sweet potato densities at various poultry manure rates effectively controlled weed. However 13,333 sweet potato densities with 15 t ha^{-1} poultry manure effectively controlled weeds and gave high income in plantain production in the rainforest zone of Southeastern Nigeria.

Acknowledgement

We highly appreciate and thank the University Management, Federal University of Technology Owerri for the teaching and research facilities used for the research.

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