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PRODUCTIVITY RECLAMATION OF THE UNMANAGED WATERSHED ECOSYSTEM

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ABSTRACT: *Watersheds are naturally productive but most ecologically vulnerable section of the landscape. A field study and pot experiment were conducted under randomized complete block design (RCRD) and complete randomized design (CRD) respectively to evaluate productivity reclamation efficiency of compost, poultry and NPK using okra as test crop. The treatments comprised 0tha^{-1}, 10tha^{-1}, 20tha^{-1} and 30tha^{-1} rates of compost and poultry respectively and NPK fertilizer 15: 15:15 at 150kgha^{-1}. These experiments were carried out on a sandy loam typic paleudult in Amawbia Anambra State south east, Nigeria. Data generated from the study were subjected to analysis of variance and significant mean differences were separated using least significant difference (LSD). Result of the study indicated that productivity reclamation of unmanaged watershed with three different rates (10tha^{-1}, 20tha^{-1}, and 30tha^{-1}) of compost and poultry respectively and NPK at 150kgha^{-1} had great improvement in the fertility status of the unmanaged watershed. With best performance in three rates of poultry manure though with highest in 30tha^{-1}. Compost at the rate of 10tha^{1} was observed to have no significant increase in plant growth in slope 1 and 2 respectively. However, in slope 3 and 4, compost at the rate of 20tha^{-1} and 30tha^{-1} significantly increased the yield values of the number of fruits and fruit length of okra compared with the control. In slope 1 amendment with NPK were found to be non- significant in growth parameter of okra, but in slope 2, 3, and 4 amendment with NPK produced higher productivity of okra in the unmanaged watershed. Watershed deemed suitable for food crop production should be managed by conservation – effective cropping system as management system affect water content and the efficiency of soil – water uptake by plant.*

KEYWORDS: Compost, Degradation, Fertility, Okra, Poultry, Reclamation, NPK, Watershed.

INTRODUCTION

The maintenance of fertility of soils is the first condition for any permanent system of agriculture. Agriculture provides a major share of national income and export earnings in many developing countries such as Nigeria. While ensuring food security, income and employment to a large proportion of the population. Many people in developing countries rely on the land to sustain their livelihood. The soil quality comprises a range of chemical, physical and biological factors which together affect the productive potential of the land. The qualities of soil especially with the tropical soils like Nigeria, however, have been seriously

affected by the land degradation factors. Salati and Vose (1985) reported that degraded landscape units due to previous mismanagement affect soil productivity and emphasised that it should be reverted back to planted fallows or quick growing man-made forest for restoration of their biological and ecological integrity. Increase in population and declining availability of cultivable land and a very high rate of soil erosion affect soil quality for agricultural activities. Soil cultivation, changes in land use and other soil management practices have been reported to have profound effect on soil productivity (Nweke, 2015; Majaliwa et al., 2010; Chandran et al., 2009; Holepless 2004; Lemenin and Itana, 2004). Soil nutrient depletion due to degradation has also been identified by Henao and Baanante (2006) as major causes of decreased crop yield per capita food production. The fragile nature of soils in tropical Africa contribute to their low nutrient levels with a high propensity towards nutrient loss (Lal, 1993) and cultivated high weathered soils in the tropics commonly suffer from multiple nutrients deficiency. Thus AGRA (2007) observed that soils in Africa are typically highly variable in fertility and in their response to inputs. Soil, is a major factor that strongly affect agricultural crop production. Hence Mulugeta and Karl (2010) reiterated that it is a core resource for all land uses and the most ideal component of sustainable agriculture. The review has shown that a change in land use, poor soil management and even the topographic nature of an area as well as the socioeconomic activities of the people can negatively affect the potential use of an area. This ultimately will lead to land and soil degradation and loss of productivity.

The loss of arable land in Nigeria as a result of soil degradation is now a wide spread phenomenon especially in the south east Nigeria. The trend needs to be addressed with good soil management practices for increased crop production and general wellbeing of the populace. The recycle of organic wastes have been reported to improve the structural stability of the degraded soil, its nutrient contents through improvement in soil properties which enhances the productivity of the soil (Eghareyba and Ogbe, 2002; Maritus and Vleic, 2001; Sidhu and Baire, 1999, Nweke, 2019). These wastes produced by the communities, towns, and states consist of organic substances most of which are heaped on open ground and most often on undesignated areas contain substantial amounts of plant nutrients. They can be harnessed according to FAO (1987) through compositing to produce useful organic fertilizer. Organic fertilizers are of divergent origin and composition. They include those from plants; animals, industrial, agricultural, municipal and households. Decomposable household wastes can be converted into compost. A number of studies on the use of organic wastes of different kinds, as well as their integration with mineral fertilizer as soil amendments, have shown remarkable improvement in soil physical, chemical and biological properties, as well as overall yield of the tested crops (Nnabude et al., 2015; Nsoanya and Nweke, 2015; Okoli and Nweke, 2015; Nweke and Nsoanya, 2015; Liu et al., 2007; Heeb, et al., 2006, Gharibarian et al., 2008; Gar and Babla, 2008; Bhat and Berri; 2001; Adeniyan and Ojeniyi 2005; Ayoola and Adeniyan; 2006). Soil quality indices are useful tools for assessing agronomic/biomass productivity and ascertaining the temporal changes in soil properties in relation to land use and management. In highly weathered soils like Nigeria, for soil management practices to be effective; it should be targeted to amelioration of degraded soil properties through boosting and conserving of soil organic matter. Thus, the present study is to evaluate the fertility and productivity restoration efficiency of compost, poultry and NPK fertilizer when used on unmanaged water shed ecosystem.

MATERIAL S AND METHODS

The study was conducted in Anambra State Market Garden. The area is a watershed, which lies between latitude 06°181 north and longitude 070°41 east. The temperature of the area is uniformly high with mean monthly minimum average of 26°C, maximum temperature of 30°C - 35°C ± 1°C is obtained in March but temperature may reduce to 24°C - 27°C in October (AMA, 2006). Amawbia receives an annual rainfall which ranges between 1500mm to 2500mm with its peaks in the months of July and September. The soil used for this experiment is a well-drained sand-loam (typic paleudult) that was under heavy agricultural activities resulting to erosion of the watershed and loss of vegetation. Parts of this watershed in recent past have come under some kind of management programme initiated by Anambra State Government leaving the adjacent watershed area unmanaged. Hence, the watershed areas can be clearly categorized into managed and non-managed watershed systems. This study was carried out under non-managed watershed.The managed system was characterized with terraces separated by earth bunds and stabilised by permanent trees forming hedgerows. This plot was established in June, 1995, and has been under management for over 20 years. The non-managed system is neither terraced nor ridged for erosion control. The two management systems were subdivided into four different slope gradients (slope 1, 34.8% gradient; slope 2, 29.6% gradient; slope 3, 23.8% gradient; slope 4 or plain, 0.52% gradient). Reclamation programme for the unmanaged system was conducted using pot experiment where by perforated polythene bags of dimension 25cm x 30cm containing soil sample weighing 5kg were used. Compost manure and poultry manure were applied at the rates of $0tha^{-1}$, $10tha^{-1}$, $20tha^{-1}$ and $30tha^{-1}$ and NPK was applied at the rate of $150kgha^{-1}$ (rate recommended for okra Singh, 1995) considering the low fertility status of the soil. Plant height, stem girth and leaf area were measured using ropes and ruler while fresh weight and dry weight were determined using electric oven and electric weighing balance. The field experiments were arranged in a randomized complete block design (RCBD) while the pot experiments were arranged in a completely randomized design (CRD). Results were subjected to analysis of variance (ANOVA) and significant differences among treatment means were separated using least significant difference (LSD).

RESULTS

Properties of Compost and Poultry Manure

The result in Table 1 showed that compost and poultry manure varied in their nutrient content. OC, TN, and Ca content were higher in compost than their content in poultry; both were equally relatively rich in available P. Hence the two manures are considered rich in these essential plant nutrient elements. Therefore, it is expected that the studied soil will benefit from their application. The pH values of the two manures were slightly acidic; in fact, their pH values tend to be almost neutral.

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Table 1: Property of Compost and Poultry Manure

Sample	pH H_2O	OC gkg^{-1}	TN gkg^{-1}	Avail. P $Mgkg^{-1}$	Ca $Cmolkg^{-1}$	K $Cmolkg^{-1}$
Compost	6.62	36.5	2.63	12.11	16.65	0.52
Poultry	6.86	15.15	3.48	12.42	15.13	0.66

Response of Okra to Main Effect of Treatment in Slope 1

Compost and poultry statistically show similar results in stem girth number of leaves and number of fruits by virtue of their non- significant differences in the considered parameters (Table 2). The highest recorded value in plant height (59.59cm), leaf area (293.14cm^2); fresh weight (173.60g); dry weight (77g) and fruit length (6.82cm) respectively were obtained from poultry. Their percentage increase as against compost values were; 19.06%; 15.55%; 20.56%; 17.02% and 21.57% respectively.

Table 2: Response of Okra to Main Effect of Treatment in Slope 1

Treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of fruits	Fruit length cm
Compost	50.05	3.62	13.8	175.80	144.0	65.8	4.27	5.61
Poultry	59.59	3.52	12.8	203.14	173.60	77.0	4.23	6.82
LSD0.05	8.87	NS	NS	43.10	31.50	9.0	NS	1.60

Response of Okra to Main Effect of Sub-Treatment in Slope 1

The effect of the sub-treatment in slope 1 on okra indicated significant differences ($P<0.05$) among the sub-treatments (Table 3). The results of rates of manure showed increased value as the rates of application increased. The 30tha^{-1} rate of manure gave the highest value in all the parameters of okra tested compared to the other sub-treatments values. The recorded values of the tested parameters obtained from NPK indicated lower values compared with the rates of manure applied, though significantly different from the result obtained from control soil. The result variation in plant height, stem girth, number of leaves, leaf area and number of fruits of okra however, showed 30tha^{-1} > 20tha^{-1} > NPK > 10tha^{-1}.

Table 3: Response of Okra to Main Effect of Sub-Treatment in Slope 1

Sub-Treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
30tha^{-1}	84.40	5.80	20.0	335.65	268,54	98.53	6.83	8.85
20tha^{-1}	69.65	4.05	19.50	253.02	202.58	89.51	6.33	8.45
10 tha^{-1}	40.50	2.0	7.0	104.32	171.07	75.03	2.0	7.25
NPK	49.37	4.60	14.0	209.91	112.05	69.05	6.0	6.53
CONTROL	20.20	1.40	6.0	44.55	40.12	25.16	1.33	4.16
LSD 0.05	14.75	1.75	7.0	82.65	97.51	23.50	4.83	2.35

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Response of Okra to Combined Effect of Treatment and Sub-Treatment in Slope 1

The effect of treatment and sub-treatment on okra presented in Table 4 indicated non-significant different in stem girth, number of leaves, number of fruits and fruit length, while it showed statistically significant ($P < 0.05$) difference in plant height, leaf area, fruit weight and dry weight respectively. The $30tha^{-1}$ rate of poultry recorded the highest value among the sub-treatments in all the parameters assessed in this study except for the result of number of leaves. Higher values were more observed in the rates of poultry compared to NPK and rates of compost. The recorded values increased as the rates of compost and poultry applied increased. In comparison of the main treatment, poultry showed highest value in plant height (69.47cm); leaf area (253.82cm2); fresh weight (238.84g); dry weight (83.90g) and fruit length (9.24cm) respectively; while compost only indicated highest value in stem girth (4.06cm), number of leaves (14.67) and number of fruits (5.11) respectively

Table 4: Response of Okra to Combined effect of Treatment and Sub-Treatment in Slope 1

Treatment	Sub-treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
COMPOST	$30tha^{-1}$	78.50	5.72	22.0	261.33	215.13	89.06	6.67	8.41
	$20tha^{-1}$	69.20	4.23	21.0	259.25	193.05	83.15	6.67	7.63
	$10tha^{-1}$	33.0	2.22	6.0	104.14	160.02	63.61	2.00	5.52
	Mean	60.23	4.06	16.33	208.24	189.4	78.61	5.11	7.19
POULTRY	$30tha^{-1}$	90.30	5.91	18.0	410.11	322.12	108.52	7.0	9.33
	$20tha^{-1}$	70.10	3.94	18.0	246.83	212,32	56.02	6.0	9.33
	$10tha^{-1}$	48.0	1.88	8.0	104.52	182.08	87.15	2.0	9.06
	Mean	69.47	3.91	14.67	253.82	238.84	83.90	5.0	9.24
	NPK	49.37	4.61	14.0	209.93	112.16	69.05	6.0	6.54
	control	20.20	1.43	6.0	44.54	40.05	25.18	2.0	3.58
LSD 0.05		29.17	NS	NS	59.82	72.02	14.52	NS	NS

Response of Okra to Main Effect of Treatment in slope 2

The result presented in Table 5 indicated significant differences ($P < 0.05$) among the treatments. The result obtained indicated that poultry compared with compost recorded highest value in all the parameters of okra studied. In some parameters over 2-fold increase are recorded as against the value obtained from compost. The percentage increase in plant height, leaf area, fresh weight and dry weight of okra in poultry relative to compost were; 88.70%, 43.43%; 311.53% and 245.79% respectively.

Table 5: Response of Okra to Main Effect of Treatment in Slope 2

Treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
COMPOST	53.26	3.44	14.07	175.0	147.40	70.06	5.60	6.50
POULTRY	100.50	5.78	17.07	251.0	606.0	242.26	8.20	8.70
LSD 0.05	30.40	1.35	2.33	39.10	136.60	61.51	1.50	1.30

Response of Okra to Main Effect of Sub-Treatment in Slope 2

The result of the effect of sub-treatment presented in Table 6 indicated significant difference ($P < 0.05$) among the sub-treatments in all the parameters studied. The $30tha^{-1}$ rate of manure recorded the highest in all the parameters except for the result of fruit length. In most of the parameters the observed increased value was observed to be over 2-fold increase compared to their values obtained from NPK and control soil respectively. The Table 6 showed result variation of $30tha^{-1} > 20tha^{-1} > 10tha^{-1} >$ NPK > control in most of the parameters except for stem girth, number of leaves, leaf area, number of fruit length respectively. The recorded value for fruit length indicated that $30tha^{-1}$ and $10tha^{-1}$ gave the same value.

Table 6: Response of Okra to Main Effect of Sub-Treatment in Slope 2

Treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
$30tha^{-1}$	119.05	7.20	26.50	322.30	738.10	317.51	10.50	8.0
$20tha^{-1}$	110.50	5.60	22.0	340.0	674.10	256.11	6.50	7.0
$10tha^{-1}$	68.60	3.45	9.03	102.50	301.50	191.56	5.50	8.0
NPK	58.38	4.80	11.33	214.20	120.30	87.68	8.0	9.0
CONTROL	27.93	2.0	9.0	87.0	50.44	28.84	4.0	6.0
LSD 0.05	30.40	2.15	10.67	111.8	64.04	63.52	2.50	2.0

Response of Okra to Combined Effect of Treatment and Sub-Treatment in Slope 2

The result of main treatment, compost and poultry indicated that in all the parameters of okra considered in this study poultry recorded the highest value compared to the value obtained from compost. Among the sub-treatments values obtained from $30tha^{-1}$ rate of poultry were observed to be highest compared to the values obtained from the other sub treatments. Also, higher values were recorded in all the rates of poultry applied compared to the NPK and the rates of compost applied. The values recorded from control were very poor in all these parameters (Table 7).

Table 7: Response of Okra to Combined Effect of Treatment and Sub-Treatment in Slope 2

Treatment	Sub-treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
Compost	$30tha^{-1}$	78.10	5.90	22.0	262.0	226.0	85.06	8.05	6.05
	$20tha^{-1}$	73.0	3.20	22.0	237.90	198.0	92.24	5.0	6.26
	$10tha^{-1}$	29.0	1.30	6.0	73.80	143.0	58.33	3.0	5.30
	Mean	60.03	3.47	16.67	191.23	183	78.54	5.33	5.87
Poultry	$30tha^{-1}$	160.0	8.50	31.0	382.50	1250.0	551.0	13.0	10.32
	$20tha^{-1}$	148.0	8.0	22.0	442.0	115.0	420.0	8.0	8.21
	$10tha^{-1}$	108.0	5.60	12.0	131.10	460.0	125.0	8.0	9.73
	Mean	138.67	7.37	21.67	318.53	608.33	365.33	9.67	9.42
	NPK	58.30	4.80	11.33	214.20	120.0	87.32	8.0	9.40
	Control	27.90	2.0	9.0	87.0	50.50	28.05	4.0	6.03
LSD 0.05		40.75	1.45	15.0	127.20	70.0	59.23	4.0	3.42

Response of Okra to Main Effect of Treatment in Slope 3

The main effect of treatment in slope three indicated significant difference ($P < 0.05$) among the treatments except for the result of number of fruits and fruit length respectively (Table 8). Poultry manure indicated higher values compared to the compost values in all the parameters assessed except for the recorded value of number of fruits where the two treatments recorded the same value (8.13).

Table 8: Response of Okra to combined effect of treatment and sub-treatment in slope 3

Treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
COMPOST	53.25	2.54	8.20	176.02	254.35	115.64	8.13	8.43
POULTRY	86.32	4.14	13.40	226.30	317.68	160.57	8.13	9.23
LSD 0.05	26.82	1.65	5.20	50.28	63.61	44.97	NS	NS

Response of Okra to Main Effect of Sub-Treatment in Slope 3

The effect of sub-treatment on okra in slope three indicated significant differences ($P < 0.05$) among the sub-treatments in all the parameters of okra studied (Table 9). The $30tha^{-1}$ rate of manure recorded the highest value in all the parameters except for the result of dry weight of okra (226g), number of fruits (12.67) and fruit length (10.73cm) where NPK recorded the highest value. The result variation for plant height, leaf area and fresh weight of okra showed; $30tha^{-1}$ > $20tha^{-1}$ >$10tha^{-1}$ > NPK > control, $30tha^{-1}$ > $20tha^{-1}$ > NPK > $10tha^{-1}$ > control, and $30tha^{-1}$ > NPK > $20tha^{-1}$ > $10tha^{-1}$ > control respectively. The result in Table 9 equally showed that values recorded increased as rates of application increased. Also, the value obtained from the control for all the parameters studied showed much lower values compared to their recorded values in rates of manure and NPK fertilizer.

Table 9: Response of Okra to Combined Effect of Treatment and Sub-Treatment in Slope 3

Treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
$30tha^{-1}$	121.60	4.95	18.0	360.65	431.50	180.42	12.0	9.55
$20tha^{-1}$	84.0	4.82	13.0	249.40	335.43	169.50	7.50	9.35
$10tha^{-1}$	57.02	2.55	9.0	159.55	210.08	91.50	4.50	8.20
NPK	56.10	3.12	10.0	196.50	400.0	226.0	12.67	10.73
CONTROL	30.21	1.43	5.0	39.70	52.15	23.10	4.0	6.30
LSD 0.05	25.90	1.15	2.50	36.95	31.53	45.58	3.0	1.90

Response of Okra to Combined Effect of Treatment and Sub-Treatment in Slope 3

Apart from the result of fruit length in Table 10 the effect of treatment and sub-treatment on okra in slope three recorded significant differences ($P < 0.05$) among the treatments and sub-treatments. Values obtained from poultry were observed to be highest compared to the compost in all the parameters assessed the percentage increase in plant height, leaf area, fresh weight and dry weight of okra in poultry as compared to compost were; 91.83%; 39.01%; 38.86% and 68.16% respectively. Higher values were also observed in all the rates of poultry compared to compost and in most parameters of recorded values of NPK. When the sub-treatment values are compared, it was observed that $30tha^{-1}$ rate of poultry recorded the highest value in all the parameters of okra assessed in the study. The result of the control soil showed very much lower values compared to the other treatments and sub-treatments.

Table 10: Response of Okra to Combined Effect of Treatment and Sub-Treatment in Slope 3

Treatment	Sub-treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
Compost	$30tha^{-1}$	98.24	3.60	11.0	397.98	410.23	142.38	10.0	8.40
	$20tha^{-1}$	42.23	2.90	8.0	152.73	250.15	125.0	8.0	8.50
	$10tha^{-1}$	39.53	1.80	7.0	93.36	158.03	62.45	6.0	8.20
	Mean	60.0	2.77	8.67	214.69	272.80	109.94	8.0	8.37
Poultry	$30tha^{-1}$	145.00	6.30	24.0	323.40	453.14	218.83	14.0	10.70
	$20tha^{-1}$	125.80	6.70	17.0	346.10	420.21	214.26	7.0	10.20
	$10tha^{-1}$	74.50	3.30	11.0	225.81	263.06	121.50	3.0	8.20
	Mean	115.10	5.43	17.33	298.43	378.80	184.89	8.0	9.70
	NPK	56.10	3.0	10.0	196.55	400.52	226.04	13.0	10.73
	Control	30.20	1.40	5.0	39.70	52.31	23.05	4.0	6.30
LSD0.05		27.92	1.95	3.0	52.93	65.15	56.54	5.20	NS

Response of Okra to Main Effect of Treatment in Slope 4

The result of the effect of compost and poultry in slope 4 on okra indicated significant differences ($P < 0.05$) among the treatments except for the result of number of fruits and fruit length (Table 11). Poultry compared to compost showed highest value in all the parameters tested except for leaf area result. These parameters and their recorded values from the poultry are plant height (136.44cm); stem girth (7.50cm); number of leaves (30.40); fresh weight (1003.33g), dry weight (536.16g); number of fruits (14.60) and fruit length (10.26cm) respectively.

Table 11: Response of Okra to Combined Effect of Treatment in Slope 4

Sub-treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
COMPOST	105.81	5.70	20.60	371.07	443.40	254.38	13.33	10.19
POULTRY	136.44	7.50	30.40	348.68	1003.33	536.16	14.60	10.26
LSD 0.05	14.98	1.35	6.50	28.87	372.33	291.51	NS	NS

Response of Okra to Main Effect of Sub- Treatment in Slope 4

The main effect of sub-treatment on okra in slope 4 showed significant differences ($P < 0.05$) among the sub-treatments in Table 12 apart from the result of leaf area, NPK recorded the highest value in all the parameters of okra tested in this study. The result variation for the rates of manure showed $30tha^{-1} > 20tha^{-1} > 10tha^{-1}$ in all the parameters assessed, though for the result of number of fruits the $20tha^{-1}$ and $10tha^{-1}$ recorded the same value (13.0). The overall result indicated that values increased as the rates of manure application increased.

Table 12: Response of Okra to Combined Effect of Sub-Treatment in Slope 4

Sub-treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
$30tha^{-1}$	149.12	8.25	29.0	395.67	789.67	422.30	17.83	11.12
$20tha^{-1}$	121.94	6.62	22.50	388.80	766.50	375.50	13.0	10.61
$10tha^{-1}$	95.63	5.25	22.0	348,23	744.10	374.50	13.0	10.0
NPK	164.10	9.60	36.0	391.52	1162.0	720.0	18.0	11.22
CONTROL	74.90	3.60	18.0	275.24	154.67	84.16	8.0	8.21
LSD 0.05	27.22	1.65	4.50	47.47	395.50	297.70	4.83	2.92

Response of Okra to Combined Effect of Treatment and Sub-Treatment in Slope 4

The result presented in Table 13 showed significant differences ($P < 0.05$) among the treatments and sub-treatments except for the result of number of fruits and fruit length. Poultry compared with compost recorded the highest value in plant height (147.74cm), stem girth (8.42cm); number of leaves (32.67); fresh weight (1233.40g); dry weight (625.38g), number of fruits (15.67) and fruit length (10.63cm) respectively. When the sub-treatments are compared, NPK recorded the highest value in dry weight (720.18g) compared to its value

from the other sub-treatments. The result variation for the rates of compost and poultry in all the parameters indicated $30tha^{-1}$ > $20tha^{-1}$> $10tha^{-1}$ except in the number of fruits result where $20tha^{-1}$ and $10tha^{-1}$ rates of compost (12) and poultry (14) recorded the same value respectively as well as in number of leaves (32) for poultry rates. Also, $20tha^{-1}$ rate of poultry and NPK recorded the same value (9.60cm) in stem girth. The result obtained from the control indicated lower values relative to treatments and sub-treatments.

Table 13: Response of Okra to Combined Effect of Treatment and Sub-Treatment in Slope 4

Treatment	Sub-treatment	Plant height cm	Stem girth cm	No. of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	No. of Fruit	Fruit length cm
COMPOST	$30tha^{-1}$	113.73	7.11	24.0	406.33	321.33	218.63	16.67	11.73
	$20tha^{-1}$	88.60	4.20	13.0	395.90	291.04	126.0	12.0	10.50
	$10tha^{-1}$	87.74	4.30	12.0	391.50	288.16	124.52	12.0	9.30
	Mean	96.68	5.20	16.33	387.91	300.18	156.38	13.56	10.51
POULTRY	$30tha^{-1}$	184.51	9.42	34.0	385.0	1258.0	626.07	19.0	10.50
	$20tha^{-1}$	155.20	9.60	32.0	381.72	1242.12	625.0	14.0	10.71
	$10tha^{-1}$	103.50	6.25	32.0	310.11	1200.08	625.06	14.0	10.69
	Mean	147.74	8.42	32.67	358.94	1233.40	625.38	15.67	10.63
	NPK	164.10	9.60	36.0	391.54	1162.14	720.18	18.0	11.20
	Control	74.93	3.62	18.0	275.20	154.67	84.61	8.0	8.24
LSD 0.05		26.31	4.65	7.0	43.31	418.15	290.56	NS	NS

DISCUSSION

Productivity Reclamation of the Unmanaged Watershed

The productivity reclamation of unmanaged watershed with compost manure, poultry manure and NPK using okra resulted in great improvement in fertility status of the unmanaged watershed that are noted with various positive responses of the growth and yield parameters of the test crop - okra to different levels of applied amendments. The main effect of treatment produced greater growth parameters in poultry than in compost in the four slopes of the degraded watershed plot. Compost was found to have increased stem girth, number of leaves and number of fruits non-significantly. Growth parameters increased down the slope with the same level of amendment, compost and poultry. Slope four produced the highest growth parameters in both compost and poultry as well as in the control. This may be attributed to the action of erosion which brought about increase in nutrient content of the watershed down the stream. Increases in plant height, leaf area, dry weight and fresh weight were higher in poultry amendment than in compost. Adenawola and Adejoro (2005) reported that the total biomass yield, marketable and edible yield of jute (Corchorus olitorus L.) improved tremendously with increase in soil and plant nutrients such as N, P, K Ca and Mg resulting from the application of poultry manure. Also, Nwaigwe et al. (2013) observed increases in yield of sweet potato of different varieties after soil amendment with goat manure. The main effect of sub-treatments (rates) increased plant productivity with highest increase in $30tha^{1}$ although Alasiri and Ogunkayode (1999) recommended poultry manure at $10\text{-}20tha^{-1}$ for the

optimal production of okra seeds. 10tha^{-1} which was the least rate in the sub-treatment doubled the value of the plant height produced in the control. In the combined effect of treatment (compost and poultry) and sub- treatments (rates), poultry manure recorded highest productivity in its rates (30tha^{-1}, 20tha^{-1} and 10tha^{-1}) than compost and NPK. When compared within the sub-treatments, the interaction significantly produced higher stem girth, number of leaves, leaf area, number of fruits and fruit length in 20tha^{-1} compost than 20tha^{-1} poultry. NPK compared with the control produced higher growth parameters than the control. In stem girth, number of fruit and pod length, NPK increased productivity more than 10tha^{-1} of both compost and poultry manure. NPK fertilizer has been reported to give a yield increase in okra (Babalola, 2006). Several workers have reported linear increase in given pod yield of okra with the application of N from 56 to 150kgha^{-1} (Majanbu et al., 1985 and Singh, 1995). Phosphorous fertilization can influence fruiting and fruit development of okra. Phosphorous is called the key to life because it is directly involved in most of the living process. It is also a key constituent of Adenosine triphosphate (ATP) and has significant role in energy transformation in plants and also in various physiological processes. Sultana (2002) reported that $P_2 0_5$ up to 60kgha-^{1} increased okra yield.

CONCLUSION

The use of compost manure, poultry manure and NPK in the productivity reclamation of unmanaged watershed showed significant improvement in the fertility status of watershed evidence on the positive responses recorded in the growth and yield parameters of okra. Higher productivity in plant height, stem girth, number of leaves, leaf area, fresh weight, dry weight, number of fruits and fruit length were obtained in the four slopes amended with poultry manure with marked increases down the slope.

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