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FERTILITY RESTORATION EFFICIENCY OF THREE CONTRASTING MANURE ON AN ERODED WATERSHED ECOSYSTEM

Nweke I.A.[1], Nnabude P.C.[2], Ekwealor K.U.[2] and Igwe A.C.[1]

[1]Department of Soil Science Chukwuemeka Odumegwu Ojukwu University

[2]Department of Soil and Land Resource Management, Nnamdi Azikiwe University, Awka, Nigeria

Email: ikechukwunweke48@yahoo.com

ABSTRACT: *The maintenance of fertility of soils is the first condition for any permanent system of agriculture. Fertility restoration evaluation was studied in field and pot experiments to ascertain the effect of compost, poultry manure and NPK as amendment options in reclamation of a degraded watershed. The field studies were conducted on 4 slopes of the watershed in an experiment arranged in a randomized complete block design (RCBD). The pot experiments were carried out on the soils of the unmanaged practice and were arranged in a complete randomized design (CRD) with three replicates. The treatments comprised of compost and poultry manure at the rate of 0tha^{-1}, 10th^{-1}, 20tha^{-1}, 30tha^{-1} respectively and NPK fertilizer (15:15:15) at the rate of 150kg/ha. Tomato was used as test crop. The data obtained were subjected to analysis of variance and significant mean differences were detected using the least significant difference (LSD). The results of the study showed that fertility restoration of the eroded watershed with different rates (10, 20, and 30tha^{-1}) of compost and poultry manure respectively and 150kg/ha NPK as amendment increased. The amended plots had the best performance and among the rates of manure 30tha^{-1} rate of poultry manure show 'superior' performance. In slope 1 and 2 composts at 10tha^{-1} produced no significant increase in plant growth, but in slope 3 and 4 composts at 20tha^{-1} and 30tha^{-1} produced increases in the number of fruits and fruit length of tomato compared with the control. Amendment with NPK produced higher productivity of tomato in slope 1, 2, 3 and 4 (plain) of the eroded watershed. The findings of the study prove that most watershed require proper management and maintenance if they are to function properly over long term, to strengthen the natural resource base (soil, vegetation cover) and to increase agricultural productivity.*

KEYWORDS: Fertility Restoration, Vegetation, Deforestation, Degraded Watershed, Slope Gradients, Tomato.

INTRODUCTION

Healthy ecosystem means a better quality of life since wildlife, fish, and aquatic life rely on clean rivers and streams for food and shelter. Unfortunately, human activities often have negative impacts. Deforestation of vegetation reduces the carrying capacity or ability of watershed to trap moisture thereby increasing the amount of runoff and destabilizes stream banks. The type and amount of vegetation and plant community structure, can greatly affect the storage capacity in any water shed. The root mass associated with healthy vegetation cover makes the soil more permeable and allows moisture to percolate deep into the soil for storage. Land use system result in approximately 1.7% change in soil erosion for each 1% change in total precipitation under climate change (Pruski and Nearing 2002). The traditional approach to runoff has been to remove it as quickly as possible from developed areas. The cumulative result of such changes throughout the watershed is an increase in the volume of runoff to the stream wetland and rivers. The increased volumes of runoff also travel more quickly to surface waters, which in turn produce higher peak flows and velocities. Flooding may occur as flows exceed natural, designed or available system capacities, threatening homes and businesses located along the stream (Ghuman and Lal 1992). Erosion reduces the value of property and the resultant sediments load the streams degrading the stream quality, fish habitat and diversity of macro-invertebrate. Lager sediment particles may clog spawning gravels and also reduce the hydraulic effectiveness of the surface water system as they settle into ditches, creek beds and culverts. Paying attention primarily to the riparian zone and area critical to watershed's release function will not make-up for lack of attention to the watershed's uplands. They played an equally important role in the watershed in capturing and storing of water.

An important factor responsible for low yield is the neglect, misuse and mismanagement of soil resources and resulting wide spread degradation of soil and environment. Substantial amounts of nutrients harvested annually must be replaced (Mwakubo et al., 2004). Re-vegetating barren land to assist in the control of runoff introducing sustainable agriculture practices for hilly areas to improve soil and water management and constructing water reservoirs for irrigation are some of the conservation measures (Montgomany, 2007). The addition of organic amendment enhances soil structure and availability of plant nutrients but they may eliminate the need for balanced fertilizer because large amount of nutrients is required in easily available form to produce economic returns. Organic manure a bound and are of divergent origin and composition. They include those from plants, animals, industrial, agricultural, municipal and households. As these organic refuses contain substantial amounts of plant nutrients, they can be harnessed through compositing to produce useful organic fertilizer to enrich soil and increase yield of crop as reported in the works of Nweke and Ijearu (2018) and Nweke, (2019). Manure contributes to the fertility of soil by adding OM and nutrients such as nitrogen that is trapped by bacterial in the soil. Manure from different animals has different qualities, textures, nutrient content and therefore require different application rates. Poultry manure is the most desirable organic manure as it improves soil fertility by adding both major and essential plant nutrients as well as soil OM which improve moisture and nutrient retention. Soil productivity and fertility can as well be maintained by the use of inorganic fertilizer that is mainly applied to supplement the amount of plant nutrients present in the soil. The problem with the use of chemical fertilizer on Nigerian soil and south-eastern soil in particular is that the fertilizers are not obtained at the right time in addition to the huge cost of procurements. This scenario has inadvertently resulted to improper chemical fertilizer application of which has ruined southeast soils through its abuse. According to the work of Stefano et al. (2004), chemical fertilizer exerts strong influence on plant growth, development and yield. Among the chemical fertilizer, the most important inorganic fertilizer is NPK. This stemmed from the fact that the fertilizer is able to supply three major plant nutrients which are nitrogen that speed up vegetative growth of stem and leaves responsible for greenness of leaves. Phosphorus increases root development and growth, while potassium assists in building up and storing of food reserves which is very beneficial to root crops. Therefore, replenishments of nutrients and improvement in quality of nutrients depleted and acid soils could be achieved through the application of inorganic fertilizers, composts, poultry manure or a combination of both poultry and NPK fertilizer (Adeniyan and Ojeniyi 2005, Nweke et al., 2014, 2013). Thus, the essences of this study are to evaluate the restoration capacity of three different manure on an eroded watershed ecosystem in southeast, Nigerian

MATERIALS AND METHODS

The study was conducted in Anambra State Market Garden, Amawbia. 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). Annual rainfall 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 the non-management system (i.e. degraded watershed). The managed system was characterized with terraces separated by earth bunds and stabilized by permanent trees forming hedge rows. 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 non-management system site of the experiment was subdivided into 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 $150kgha^{-1}$ 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 are rich in essential plant nutrient elements and in available P. The pH values of the two manures tend to be almost neutral. OC, TN, and Ca content were higher in compost than their content in poultry. It is expected that the application of the manures will benefit the studied soil

Table 1: Property of Compost and Poultry Manure

Manure	pH H_2O	OC gkg^{-1}	TN gkg^{-1} →	Avail. P $Mgkg^{-1}$ ←	Ca $Cmolkg^{-1}$	K
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 Tomato to Main Effect of Treatment in Slope one

Apart from the result of fresh weight, dry weight and number of fruits that were non-significant every other parameter indicated significant differences ($P < 0.05$) among the main treatment (Table 2). Poultry recorded higher value in plant height (52.25cm) stem girth (1.62cm) number of leaves (136.80), fresh weight (88.18g) dry weight (47.85g) respectively, while compost showed higher value in leaf area (19.16cm^2), number of fruits (2.80) and fruit length (2.73cm) respectively.

Table 2: Response of Tomato to Main Effect of Treatment in Slope one

Treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruit length cm
Compost	31.56	1.29	62.80	19.16	86.65	46.82	2.80	2.73
Poultry	52.25	1.62	136.80	13.22	88.18	47.85	2.40	1.95
LSD0.05	16.55	0.93	63.0	4.45	NS	NS	NS	0.77

Response of Tomato to Main Effect of Sub-treatment in the Slope one

The result of the main effect of sub treatment on tomato in Table 3 indicates significant differences ($P < 0.05$) among the sub treatments in all the parameters measured in the study. Among the rates of the manure yield values increased as the rates of application of manure increased. The result obtained from NPK indicated higher value in number of leaves (138), leaf area (24.03cm^2), fresh weight (164. 14g), dry weight (95.04g), number of fruits (4.0), and fruit length (3.80cm) respectively compared to the other sub treatments studied. The value of the parameter obtained from control soil was poor compared to their values recorded in other sub treatments.

Table 3: Response of Tomato to Main Effect of Sub-Treatment in Slope one

Sub treatment	Plant Height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruit length cm
$30tha^{-1}$	66.05	1.82	78.0	21.02	113.50	75.08	3.67	3.03
$20tha-^{1}$	43.32	1.78	38.0	13.31	60.25	25.63	3.33	2.62
$10tha-^{1}$	32.55	1.42	34.0	11.55	25.0	13.53	2.0	2.18
NPK	49.50	1.60	138.0	24.03	164.14	95.04	4.0	3.80
Control	18.10	0.67	26.0	11.12	25.06	10.11	2.0	1.58
LSD0.05	10.77	1.12	20.0	9.45	53.25	14.52	1.67	1.18

Response of Tomato to Combined Effect of Treatment and Sub-treatment in Slope one

The result presented in Table 4 showed significant differences among main and sub treatment except for the result of stem girth and number of fruits. For the main treatment compost and poultry, compost showed higher values in leaf area (20.25cm), number of fruits (3.31) while poultry result indicated higher value in plant height (64.56cm) stem girth (1.94cm), number of leaves (173.33), fruit weight (70.55) and dry matter weight (44.74g). In both compost and poultry rates of application, values recorded showed increased values as rates of application increased. However, $30tha^{-1}$ rate of poultry recorded the highest value in all the parameters measured in this study. Except for the result of leaf area, number of fruits and fruit length where $30tha^{-1}$ rate of compost recorded higher compared to $30tha^{-1}$ rate of poultry. When sub-treatment effects are compared, NPK recorded higher value in leaf area ($24.11cm^2$), fresh weight (164.13g), dry matter weight (95.04g) and fruit length (3.81cm) respectively relative to other sub treatments. The result of these tested parameters obtained from the control was generally very poor when compared to the treatment values.

Table 4: Responses of tomato to combined effect of treatment and sub-treatment in slope one

Treatment	Sub-treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm2	Fresh weight g	Dry weight g	Number of fruits	Fruit length cm
Compost	30tha-1 20tha-1 10tha-1	42.23 28.61 19.69	1.52 1.51 1.25	78.0 38.0 34.0	22.61 18.83 19.32	91.18 70.26 25.14	58.05 30.18 11.26	4.0 4.0 2.0	3.62 3.12 3.19
Mean of rates	30tha-1	30.18	1.43	50.0	20.25	62.19	33.16	3.33	3.31
Poultry	20tha-1 10tha-1	90.1 58.03 45.54	2.13 2.07 1.63	196.0 180.0 144.0	19.41 7.80 3.82	136.08 50.52 25.06	92.11 26.09 16.03	3.33 2.67 2.0	2.47 2.23 1.23
Mean of rates		64.56	1.94	173.33	10.34	70.55	44.74	2.67	1.98
NPK Control		49.52 18.11	1.60 0.67	138.0 26.0	24.11 11.14	164.13 25.01	95.04 10.16	4.0 2.0	3.81 1.21
LSD0.05		22.73	NS	48.0	7.72	35.26	18.01	NS	1.62

Response of Tomato to Main Effect of Treatment in Slope two

The main effect of treatment (compost/poultry) on tomato in slope two indicated significant differences ($P < 0.05$) among the treatments in all the parameters considered in this study. Except for the result of leaf area that showed non-significant different among the treatments (Table 5). The recorded values for the two-treatment showed that poultry when compared with compost recorded the highest value in all the parameters measured except for the fruit length result. The percentage increase in value of fresh weight and dry weight obtained as against compost were 43.49% and 63.11% respectively.

Table 5: Response of tomato to main effect of treatment in slope two

Treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruit length cm
Compost	46.78	1.40	100.40	15.62	73.63	39.93	4.20	3.28
Poultry	63.82	1.87	179.40	17.08	105.65	65.13	3.20	2.47
LSD0.05	15.80	0.43	37.50	NS	16.50	7.02	1.17	0.37

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Response of Tomato to Main Effect of Sub Treatment in Slope two

Among the rates of manure values obtained increased as the rate of application increased (Table 6). Among the sub-treatment NPK recorded the highest value in fresh weight (168.35g), dry weight (105.67g), number of fruits (7.33) and fruit length (4.21cm) respectively and their percentage increase relative to the control soil were 295.83%, 376.85%, 266.50% and 108.42% respectively. This simply indicated that NPK gave almost over 3-fold increase in the tested parameters compared to the other sub treatments. The result variation for plant height and leaf area showed 30tha^{-1}>NPK>20tha^{-1}>10tha^{-1}>control and NPK>30tha^{-1}>20tha^{-1}>10tha^{-1}>control respectively.

Table 6: Response of tomato to main effect of sub-treatment in slope two

Sub-treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruit length cm
30tha-^{1}	79.25	1.92	192.0	19.95	96.51	59.05	3.0	3.15
20tha^{-1}	57.50	1.77	185.50	13.04	80.11	41.55	3.67	2.63
10tha^{-1}	33.65	1.57	148.0	11.85	61.52	34.53	2.50	2.53
NPK	73.30	2.20	136.0	24.32	168.35	105.67	7.33	4.21
Control	32.80	0.73	38.0	11.53	42.53	22.16	2.0	2.02
LSD0.05	23.85	0.63	44.0	4.35	19.51	19.55	3.67	0.53

Reponses of Tomato to Combined Effect of Treatment and Sub-Treatment in Slope two

The result of combined effect of treatment (compost and poultry) and sub-treatment on tomato presented in Table 7 showed that except for the result of stem girth, number of fruit and fruit length, poultry showed higher values in all the parameters assessed in this study. In some parameters over 2-fold increase compared to recorded values from compost treatment. The percentage increase in fresh weight and dry weight of tomato in poultry relative to compost were 101.12% and 173.75% respectively. Among the sub treatment NPK fertilizer recorded higher value in fresh weight, dry weight, number of fruits and length of tomato relative to the rate of compost and poultry applied. When the rate of compost and poultry are considered, higher values were observed on rates of poultry compared to rates of compost. The control soil result indicated poor values in these tested parameters (Table 7)

Table 7: Response of tomato to combine effect of treatment and sub-treatment in slope two

Treatment	Sub-treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruits length cm
Compost	30tha-1 20tha-1 10tha-1	53.50 47.0 37.30	1.57 1.47 1.03	132.0 131.0 65.0	21.43 13.86 4.88	65.35 50.12 43.07	25.28 25.25 22.15	4.0 4.67 3.0	3.80 3.25 4.20
Mean of rates		45.93	1.36	109.33	13.39	52.85	24.23	3.89	3.75
Poultry	30tha-1 20tha-1 10tha-1	105.0 68.0 33.01	2.27 2.07 2.10	252.0 240.0 231.0	18.54 12.26 18.94	128.40 110.31 80.16	93.08 58.60 47.0	2.0 2.67 2.0	2.28 2.07 1.87
	Mean of rates	68.7	2.15	241	16.58	106.29	66.33	2.22	2.07
	NPK Control	83.32 32.85	2.22 0.73	136.0 38.0	24.32 11.53	168.52 42.42	105.67 22.0	7.33 2.0	4.22 2.12
LSD 0.05		21.75	0.83	27.0	6.96	18.54	12.50	4.33	0.47

Responses of Tomato to Main Effect of Treatment in Slope three

The main effect of treatment in slope 3 presented in Table 8 indicated higher value in compost for stem girth (1.33cm), dry weight (54.33g), number of fruit (7.60) and fruit length (5.54cm). The Table 8 indicated higher values for poultry compared to compost in plant height (65.72cm), number of leaves (122.6), leaf area (17.64cm^2) and fresh weight (90.62g) respectively.

Table 8: Response of Tomato to Main Effect of Treatment in Slope three

Treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruit length cm
Compost	56.16	1.33	120.6	17.12	74.06	54.33	7.60	5.54
Poultry	65.72	1.02	122.6	17.14	90.62	52.80	6.27	3.93
LSD 0.05	10.20	0.53	NS	NS	17.80	NS	NS	1.93

Response of Tomato to Main Effect of Sub Treatment in Slope three

The effect of sub-treatment in slope three on tomato presented in Table 9 showed significant differences (P > 0.05) among the sub treatments. The recorded values for the parameters studied increase as the rate of manure application increased. Apart from the result of plant height (93.53cm) and number of leaves (206) NPK recorded higher values in all the parameters studied in this study of which are stem girth **(**2.50cm), leaf area (24.42cm^2) fresh weight (169.32g) dry weight (105g) number of fruits (15) and fruit length (7.10cm) respectively. The control soil recorded lower values in all the parameters tested.

Table 9: Response of Tomato to Main Effect of Sub Treatment in Slope three

Sub treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruits length cm
30tha-^{1}	93.53	1.83	206.0	2137	83.28	78.33	6.17	5.54
20tha-^{1}	57.45	1.67	157.0	16.05	67.54	35.04	5.67	4.60
10tha-^{1}	45.70	1.33	82.0	13.60	49.11	23.50	3.83	3.52
NPK	72.50	2.50	128.0	24.42	169.32	105.0	15.0	7.10
Control	35.50	0.82	35.0	11.50	43.51	26.03	4.0	3.0
LSD 0.05	15.05	0.87	29.0	5.32	33.81	54.84	2.33	165

Response of Tomato to Combined Effect of Treatment and Sub Treatment in Slope three

The result of leaf area, dry weight and number of fruits showed non-significant different ($P < 0.05$) as against significant differences ($P < 0.05$) among the treatments and sub treatments indicated in the other parameters tested (Table 10). In comparison of the treatments, compost recorded higher value in number of leaves (166.67), dry weight (46.93g), number of fruits (6.33) and fruit length (5.90cm) respectively, while poultry recorded higher value against compost in plant height (70.19cm), stem girth (2.10cm), leaf area (17.47cm^2) and fresh weight (80.34g). For sub treatments values increased as the rates of compost and poultry applied increased although 30tha^{-1} and 20tha^{-1} rates of poultry recorded the same value for number of leaves (184) while 30tha^{-1} and 20tha^{-1} rates of compost recorded the same value for number of fruits (7.0) respectively. When sub treatment effects are considered, NPK fertilizer recorded the highest value in stem girth (2.50cm), leaf area (24.40cm^2), fresh weight (169.18g), dry weight (105.37g), number of fruits (15.0cm) and fruit length (7.15cm) respectively relative to the rates of compost and poultry applied. Lower values were recorded by the control soil in all the parameters tested compared to the values obtained from NPK fertilizer, rates of poultry and compost (Table 10).

Table 10: Response of tomato to combine effect of treatment and sub treatment on slope three

Treatment	Sub-treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruits length cm
Compost	$30tha^{-1}$ $20tha^{-1}$ $10tha^{-1}$	84.50 49.70 48.60	1.40 1.07 0.87	228.0 190.0 82.0	24.22 12.96 12.63	162.54 50.14 45.82	91.67 27.05 22.08	7.0 7.0 5.0	6.33 6.54 4.82
Mean of rates		60.93	1.11	166.67	16.60	66.17	46.93	6.33	5.90
Poultry	$30tha^{-1}$ $20tha^{-1}$ $10tha^{-1}$	102.57 65.20 42.80	2.23 2.27 1.80	184.0 184.0 82.0	18.53 19.25 14.62	104.0 84.35 52.68	65.04 43.16 25.18	5.33 4.33 2.67	4.6 2.78 2.33
Mean of rates		70.19	2.10	150.0	17.47	80.34	44.46	4.11	3.25
NPK Control		82.50 35.50	2.50 0.82	128.0 35.0	24.40 11.54	169.18 43.56	105.37 26.58	15.0 4.0	7.15 3.08
LSD 0.05		11.75	0.48	46.0	NS	23.55	NS	NS	1.09

Response of Tomato to Main Effect of Treatment in Slope four

The result presented in Table 11 indicated that with exception of number of fruits and fruit length result, poultry recorded the highest value in plant height (87.42cm), stem girth (2.09cm), number of leaves (192), leaf area (34.99cm^2), fresh weight (126.83g) and dry weight (77.57g) respectively compared to their recorded values in compost. The effect of compost and poultry were however statistically similar in the recorded values of plant height, number of leaves, leaf area, and fresh weight and dry weight respectively.

Table 11: Response of Tomato to Main Effect of Treatment in Slope four

Treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Length of fruits cm
Compost	81.01	1.53	179	34.42	113.55	75.53	13.4	6.62
Poultry	87.42	2.09	192	34.99	126.83	77.57	9.67	4.91
LSD 0.05	NS	0.52	NS	NS	NS	NS	2.67	1.15

Responses of Tomato to Main Effect of Sub-Treatment in Slope four

The effect of sub treatment in slope four on tomato parameters indicated significant differences ($P < 0.05$) among the sub-treatments (Table 12). The control soil showed very much lower values in the tested parameters compared to the values obtained from the other sub-treatments. NPK fertilizer recorded the highest value in number of leaves (268), leaf area (68.40cm^2), fresh weight (191g), dry weight (126.53g) number of fruits (17) and fruit length (7.2cm) respectively compared to the other sub-treatment (Table 12). The result of number of fruits showed that 10tha^{-1} and 20tha^{-1} rates of manure recorded the same value (10.67) while in most of the parameters tested 30tha^{-1} merely showed marginal increase against the 20tha^{-1}.

Table 12: Response of tomato to main effect of sub-treatment in slope four

Sub treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruits length cm
30tha-^{1}	114.67	2.05	233.50	38.42	130.75	84.18	11.33	6.05
20tha-^{1}	87.85	1.92	203.16	35.47	131.75	86.92	10.67	6.14
10tha-^{1}	59.65	1.53	135.0	19.05	79.32	47.70	10.67	5.15
NPK	110.50	2.60	268.0	68.40	191.0	126.53	17.0	7.20
Control	48.40	0.97	88.0	12.20	68.0	39.04	8.0	4.80
LSD 0.05	26.82	0.38	34.50	16.42	51.43	37.48	3.33	2.05

Responses of Tomato to Combined Effect of Treatment and Sub Treatment in Slope four

The recorded value of plant height, number of leaves, fresh weight and dry weight in Table 13 showed statistically similar for both main treatment and sub treatments. For the main treatment compost indicated higher value in number of leaves of tomato (179.66), number of fruits of tomato (14) and fruit length (7.07cm) respectively compared to their values in poultry. While poultry showed highest value in plant height (92.73cm), stem girth (2.30cm), leaf area (31.47cm^2), fresh weight (125.07g) and dry weight (74.32g) respectively as against their recorded values in compost. When the effect of the sub treatments is considered, NPK fertilizer recorded the highest value in stem girth (2.60cm), number of leaves (268), leaf area (68.41cm^2), fresh weight (191g) dry weight (126.05) and number of fruits (17) respectively as against their obtained values in other treatments. The same yield value for stem girth (2.53cm) and number of fruits (7.33) were recorded in 30tha^{-1} and 20tha^{-1} rate of poultry respectively. While 30tha^{-1}, 20tha^{-1} and 10tha^{-1} rates of compost recorded the same value in number of fruits (14.0) of tomato. The control soil recorded lower values in all the tested parameters as against their obtained values in the other treatments.

Table 13 Response of Tomato to Combine Effect of Treatment and Sub Treatment in Slope four

Treatment	Sub-treatment	Plant height cm	Stem girth cm	Number of leaves	Leaf area cm^2	Fresh weight g	Dry weight g	Number of fruits	Fruits length cm
Compost	$30tha^{-1}$ $20tha^{-1}$ $10tha^{-1}$	106.93 88.10 51.10	1.57 1.30 1.23	211.0 205.0 123.0	40.22 39.75 11.68	115.18 115.32 78.57	83.17 83.24 43.45	14.0 14.0 14.0	7.62 7.26 6.38
Mean of rate		82.04	1.37	179.66	30.55	103.02	69.95	14.0	7.07
Poultry	$30tha^{-1}$ $20tha^{-1}$ $10tha^{-1}$	122.40 87.60 68.20	2.53 2.53 1.83	156.0 210.33 147.0	36.61 31.23 26.56	146.55 148.53 80.13	82.22 90.63 50.11	8.67 7.33 7.33	4.57 4.03 4.12
Mean of rate		92.73	2.30	171.11	31.47	125.07	74.32	7.78	4.24
NPK Control		110.50 48.40	2.60 0.97	268.0 88.0	68.41 12.24	191.0 68.52	126.05 39.16	17.0 8.0	7.21 4.83
LSD 0.05		NS	0.57	NS	19.36	NS	NS	5.67	2.41

DISCUSSION

Fertility Restoration of an Eroded Watershed

Reclamation of the unmanaged plot with compost manure, poultry manure and NPK fertilizer using tomato as a test crop resulted in improvement with regard to the nutrient content of the unmanaged plots and various responses of the growth and yield parameters of the test crop to different levels of applied amendments. Poultry manure amendments to the soil produced higher growth and yield parameters than compost. The main effect of treatment showed that the nutrients released from poultry manure are higher than that of compost. Therefore, poultry manure improved the soil property through its ability to stabilize soil structure and improve porosity and moisture content. Oladotun (2002) reported that poultry manure contains macro and micro nutrients such as N, P, K, S, Ca, Mg, Cu, Mn, Zn, Bo, and Fe. Aluko and Oyedele (2005) also indicated that poultry waste incorporation enhanced the structure and stability of soil aggregates. Compared with the control soil, $30tha^{-1}$ and $20tha^{-1}$ amendment of compost and poultry manure produced significant increase in the growth and yield parameters of tomato in the entire slope studied. It was found that $10tha^{-1}$ amendment of compost produced no significant increase in plant growth. This may be attributed to the inability of low rate of organic manure application to recover the highly eroded soil of the watershed plot. Mbagwu and Ekwealor (1990) reported that it takes massive application of organic waste to make substantial improvements in the stability of high degraded soil. Akanni (2005) reported $30tha^{-1}$ poultry manure gave the most growth and highest fruit yield in tomato among all levels. Akanni and Ojeniyi (2007) in their study carried out in the rain forest zone of southwest Nigeria recommended 20tha^{-1} poultry manure for tomato production. Adediran et al. (2003) also found that poultry manure at 20tha^{-1} gave the highest tomato yield in the rain forest region of south western Nigeria. Ewulo et al. (2008) indicated that excess N in the soil and soil acidity could cause nutrients imbalance in tomato crop and reduction in uptake of certain nutrients. Agele (2001) also found that poultry manure litters resulted in better growth and yield of tomato than NPK alone. Compost amendment recorded significant increase in nutrient status of the degraded area compared to the control. Increase in leaf area, number of fruits and fruit length were recorded in compost amendment at 30tha^{-1} more than in poultry. This may be due to increase in microbial activity stimulated by the application of compost. Epstein et al. (1976) reported that compost may affect the release of nutrients to plants directly through the nutrients in them or indirectly by their effect on caution-exchange capacity. Apart from 30tha^{-1} poultry manure, NPK produced significantly higher growth and yield parameters of tomato considered than other levels of compost and poultry amendment in slope one, two and three. Studies conducted in tropics showed significant increase in nutrient status and yield of tomato due to application of inorganic fertilizer (Sabulo eta. 1975, Saxena et al. 1975). Abdel –Mawgood et al. (2007) reported that two management practices which greatly influence tomato fruit yield are spacing and fertilizer application. In slope four, higher growth parameters were obtained in compost, NPK and poultry manure amendments even in the control more than other slopes (slope1, 2 and 3)

CONCLUSION

The findings of this study have shown that reclamation of the eroded (unmanaged) watershed showed significant improvement under poultry, NPK and compost manure in decrease order of impact. Amendment with poultry manure produced significant increase in the four slopes of the watershed studied and positive response in the tomato plant. Highest productivity value in all the growth and yield parameters of tomato were obtained in the four slopes (1, 2, 3, 4) amended with poultry manure with marked increases down the slopes. Amendment of the upper slopes (slope1 and 2) of the watershed were not as effective in compost and NPK as in poultry manure. The result of this study exceedingly demonstrated the ability of organic manure to significantly improve the productivity of degraded watersheds. The farmers are advised to utilize the technology in reclaiming, rejuvenating and restoration of their degraded watershed and marginal lands.

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