International Journal of Environment and Pollution Research
Vol.8, No.4 pp.21-30, October 2020
Published by ECRTD-UK
Print ISSN: 2056-7537(print), Online ISSN: 2056-7545(online)

PRODUCTIVITY EVALUATION OF TWO CONTRASTING WATERSHED USING OKRA AS A TEST CROP

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ABSTRACT: *Bioproductivity of two contrasting watershed management system were evaluated in pot and field experiment to ascertain the effect of management and slope on the productivity of okra. The field studies were conducted on four slope gradients of watershed in an experiment arranged in a randomized complete block design (RCBD). The pot experiments were carried out on the soils of the two management practices (managed and unmanaged) and were arranged in a complete randomized design (CRD) with three replicates. NPK fertilizer 15:15:15 at the rate of 150kg/ha was applied as blanket treatment and okra used as test crop. The experiment was carried out on a sandy loam typic paleudult in Amawbia Anambra state southeast Nigerian. The data generated from the study were subjected to analysis of variance and significant mean differences were separated using least significant difference (LSD). The result of the study showed that natural environments of the four slopes in managed plots significantly increased the growth and yield parameters of okra than the unmanaged plots. Slope 4 (plain) of the managed watershed recorded statistically similar productivity with the unmanaged plots by virtue of their non-significant difference ($P < 0.05$) exhibited in most of the parameters assessed. The NPK fertilizer result indicated that the treatment boasted the productivity of both managed and unmanaged watershed ecosystem.*

KEYWORDS: Ecosystem, depth, management system, NPK, okra, watershed.

INTRODUCTION

Okra is grown for its pod used as vegetable and as soup thickener. In Nigeria 1-2 million hectares of land are under okra production (FPDD, 1989) indicating the importance of the crop to the Nigerian famers. It is widely cultivated all over Africa hence can be found in almost every market all over Africa (Shippers, 2000). The nutritional constituents of okra include oil, carbohydrate, others are magnesium and phosphorous. The crop grows to a height between 20-100cm and pod diameter of between 5-15cm irrespective of the species (Nweke et al 2013ab) the matured fruits which contain a mucilaginous substance is useful as blood volume expanders or plasma replacement and also in the manufacture of paper (Majanbu et al., 1985). The stem is used in increasing intestinal peristalses due to its high crude fibre content and the oil in the seed could be as high as poultry eggs and soybeans (Oyolu 1980). The root juice is used to treat cuts, wounds and boils while its seed serve as stimulants. The crop is shallow feeder with regard to soil nutrients demand, uptake and depth of root proliferation in soil. The plant however is tolerant and sensitive to varying soil and climatic conditions. Therefore soil deemed suitable for intensive production of

the crop should be managed by conservation – effective cropping system, because management can affect water content and the efficiency of soil water uptake by plants.

Management as well affects off-site impact of agriculture by influencing infiltration, run-off and erosion. A watershed should be managed as a single unit. Each small piece of landscape has an important role in the overall suitability of water shed. An important factor responsible for low yield is the neglect, misuse and mismanagement of soil resources and the resulting widespread degradation of soil and environment. Substantial amount of nutrients harvested annually must be replaced (Mwakubo et al., 2004). Conservation measures include re-vegetating barren land to assist in the control of run-off introducing sustainable agricultural practices for hilly areas to improve soil and water management and constructing water reservoirs for irrigation (Montgomery, 2007). Soil conservation, water harvesting, increasing vegetation cover and safe disposal of excess water are basic management technologies. Soils are an integral component of agriculture and serve as medium for numerous eco-biological, chemical and physical processes due to its widely varied application in the maintenance of human life activities. Therefore the need to effectively manage soil resources in order to achieve optimal productivity in soil is obvious. Thus the essence of this present study is to evaluate the productivity of two contrasting watershed using okra (Abelmoschus esculentus).

MATERIALS AND METHODS

Location of experiment

This study was conducted in Anambra state market golden, Amawbia. The area is a watershed which lies between latitude $06^0$15'north and longitude $07^0$4' east. The temperature range between 26^oC - 35^0C, the soil used for this experiment is a well drained sandy loam (typic paleudult) that was under heavy agricultural activities resulting to erosion of the water shed and loss of vegetation. Part of this watershed in recent past has come under some kind of management performance initiated by Anambra state government leaving adjacent watershed areas unmanaged. Hence the watershed area can be clearly categorized into managed and non managed system. This experiment was carried out under these two management systems (managed and unmanaged). The managed system was characterized by terraces separated by earth bands and stabilized by permanent trees forming hedgerows. This plot was established in June 1995 and has been under management for 26years. The non- managed system is neither terraced nor ridged for erosion control. These two managements were further sub-divided into deferent slope gradients slope1 (34.8%) gradients, slope2 (29.6%) gradient, slope3 (23.8 %) gradient, slope4 or plain (0.52%) gradients.

Treatment1 - land management types (2)
Treatment2 - length/gradients of slope (4)
Control 3 - NPK fertilizer (15:15:15).
The biological productivity of two managed system was conducted using 25x30cm perforated polythene bags containing soil sample weighing 5kg the productivity of the natural environment of the managed plot and the unmanaged plot were monitored in the polythene bags without treatment also NPK, 15:15: 15 was applied at the rate of 150kg/ha in the polythene bags containing

soil samples of both the managed and unmanaged systems to serve as control. Test crop okra used to assess the biological productivity of the two different land management was sourced from agricultural development program (ADP), plant height stem girths and leaf area were measured using ropes and ruler while fresh weight and dry matter weight were determined using electric oven and electric weighing balance. Data obtained from the study were subjected to analysis of variance (ANOVA) and significant difference among treatment means were separated using least significant difference (LSD)

RESULTS

Effect of slope on the growth and yield of okra

The result presented in Table1 showed that apart from the result of number of leaves, slope has effect on tested parameters by their significant difference ($P < 0.05$) among the slope gradients. The value recorded for stem girth, number of leaves and dry matter weight indicated decrease as the slope gradients increased. Also the forth (4) slope that is plain recorded the highest value in all the parameters of okra tested except for the fruit length result were slope1(34.8%) recorded the highest fruit length (7.58cm) value among the slope gradients. The plant height result show that the value obtained from slope 1 and slope 3, slope 2 and slop 3 were statistically similar also the stem girth result indicated that the result of slope 2, 3 and 4 were at par but significantly better than the slope 1 result. The leaf area variation showed slope 4 > slope 1 > slope 2 > slope 3. The percentage decrease in number of fruits, fruit length and fresh weight of fruits in slope 2 relative to slope 4 were; 68%, 15.62% and 21.10% respectively while the percentage decrease in dry matter weight of okra in slope 1 relative to the plain (slope 4) is 13.79%.

Table 1 main effect of slope on the growth and yield of okra

Scope	Plant height cm	Stem girth cm	No of leaves	Leaf area cm^2	No of fruits	Fruits length cm	Fresh weight g	Dry weight g
1 (34.8%)	96.4	4.0	15.25	329.75	7.0	7.58	290.25	180.73
2 (29.6%)	101.89	4.88	16.75	315.0	6.0	6.53	260.58	184.20
3 (23.8%)	101.5	5.38	17.08	298.88	8.25	7.23	320.94	215.95
4 (0.52%)	119.25	5.43	17.25	407.38	10.08	7.55	315.55	205.65
LSD 0.05	5.50	0.88	NS	14.73	1.83	0.70	24.90	10.33

Effect of management on growth and yield of okra

The recorded result in Table 2 showed significant difference ($P < 0.05$) among the treatments on parameters tested. The values of the parameters obtained from the managed ecosystem were by far greater than the value obtained from the unmanaged ecosystem. For example the decrease in value of plant height, leaf area, number of fruits, fresh weight and dry matter weight in the unmanaged

relative to the managed ecosystem were; 251.56%, 197.63%, 191.75%, 202.80% and 284% respectively.

Table 2 main effect of management on growth and yield of okra

Management	Plant height cm	Stem girth cm	No of leaves	Leaf area cm^2	No of fruits	Fruits length cm	Fresh weight g	Dry weight g
Managed	163.13	6.71	23.04	505.62	11.67	9.41	446.48	312.0
Unmanaged	46.39	3.13	10.38	169.88	4.0	5.03	147.45	81.25
LSD 0.05	27.83	2.34	11.33	108.50	4.08	1.03	54.98	35.23

Effect of treatment on okra growth and yield

The result of okra growth and yield presented in Table 3 showed significant difference ($P < 0.05$) among the treatments in all the parameters of okra assessed in the study. The result indicates that treatment studied has effect on the growth and yield of okra. The NPK (15:15:15) recorded higher values compared to natural environment in all the parameter assessed. The percentage increase in plant height, leaf area, fresh weight and dry matter weight of okra in NPK relative to natural environment were; 25.66%, 40.43%, 25.63% and 22.73% respectively while the percentage decrease in value of number of leaves, number of fruits and fruit length in natural environment relative to the NPK treatment were; 19.15%, 34.93% and 6.73% respectively.

Table 3 effect of treatment on okra growth and yield

Treatment	Plant height cm	Stem girth cm	No of leaves	Leaf area cm^2	No of fruits	Fruits length cm	Fresh weight g	Dry weight g
Natural Environment	89.36	4.15	15.25	252.20	6.67	6.98	253.30	171.40
NPK	120.20	5.68	18.17	423.40	9.0	7.45	340.60	221.80
LSD 0.05	17.33	1.43	2.92	171.20	2.25	0.33	87.30	31.75

Combined effect of slope and management on the growth and yield of okra

The result presented in Table 4 indicates significant difference ($P < 0.05$) among the slope gradients and management systems studied. The recorded values of okra growth and yield showed that values obtained from managed system were much greater than the recorded value in unmanaged system. Also the recoded values decreased as slope gradient increased though in some parameters the decreases were inconsistent as increased values were observed in some higher slope gradients. Slope 4 (0.52%) and managed ecosystem recorded the highest value in plant height (173.93 cm), number of fruits (14.20), fruit length (10 cm) and dry matter weight (316.3 g) okra among the slope gradients and management system studied. The higher slope gradient (34.8%)

which is slope 1 and managed ecosystem recorded highest value in stem girth (7.75%cm) of okra, number of leaves (24.5), leaf area (532.3cm^2) and fresh weight of okra (505g). Most of the least among ecosystem and slops recorded values were observed in an unmanaged ecosystem of slope 3, 2, and 1.

Table 4 combined effect of slope and management on the growth and yield of okra

Slope	Management system	Plant height cm	Stem girth cm	No of leaves	Leaf area cm^2	No of fruits	Fruits length cm	Fresh weight g	Dry weight g
1(34.8%)	Managed	158.0	7.75	24.50	532.30	10.0	9.70	505.0	314.20
	Unmanaged	34.0	3.0	10.00	127.20	4.00	5.50	76.30	47.25
2(29.6%)	Managed	160.65	7.45	23.00	479.20	9.00	9.10	436.60	310.30
	Unmanaged	43.13	3.40	10.50	150.90	3.00	4.00	85.55	58.10
3(23.8%)	Managed	159.85	5.80	24.00	479.70	13.00	8.90	415.90	307.20
	Unmanaged	43.15	2.20	7.50	118.10	3.50	5.60	226.00	124.70
4(0.52%)	managed	173.93	5.85	20.67	531.40	14.70	10.00	429.20	316.30
	Unmanaged	64.5	3.90	13.50	283.40	5.50	5.10	202.00	94.95
LSD0.05		5.10	1.38	1.33	14.73	3.08	1.30	60.37	31.75

Combined effect of slope and treatment on okra growth and yield

The result presented in Table 5 showed that slope and treatment effect on the assessed parameters were not effective, except for leaf area, fresh weight and dry weight of okra that indicated significant difference ($P < 0.05$) among the treatments and slope gradients studied. The result of plant height indicated increased value as slope gradient decreased while the recorded values in NPK were much higher compared to natural environment values in each of the slope gradients. This trend is almost true for all the recorded result of NPK and natural environment of the parameters assessed. The NPK and slope 4 recorded the highest value in plant height and leaf area while NPK and slope 3 recorded highest value in fresh weight and dry weight of okra among other slope gradients and treatments.

Table 5 combined effect of slope and treatment on okra growth and yield

Slope	Treatment	Plant height cm	Stem girth cm	No of leaves	Leaf area cm^2	No of fruits	Fruits length cm	Fresh weight g	Dry weight g
1 (34.8%)	Natural environment	78.10	4.35	15.50	238.50	5.0	7.40	245.00	162.50
	NPK	114.70	6.40	19.00	421.00	9.0	7.80	336.30	198.90
2(29.6%)	Natural environment	86.58	4.40	15.50	216.30	5.0	6.90	235.70	164.20
	NPK	117.20	6.45	18.00	413.70	7.0	7.20	285.50	204.20
3 (23.8%)	Natural environment	85.70	3.30	14.50	195.50	8.0	7.30	236.30	166.70
	NPK	117.30	4.70	17.00	402.30	8.50	7.20	405.60	265.20
4(0.52%)	Natural environment	107.50	4.55	15.50	358.40	8.67	7.50	296.20	192.30
	NPK	131.40	5.20	18.69	456.40	11.50	7.60	335.00	218.90
LSD 0.05		NS	NS	NS	92.38	NS	NS	54.98	21.43

Combined effect of management and treatment on the growth and yield of okra

The effect of management and treatment on the assessed parameters of okra presented in Table 6 showed significant difference ($P < 0.05$) except for the result of number of leaves. The managed ecosystem recorded higher values in all the parameters studied compared to the value obtained from the unmanaged ecosystem. In managed system the NPK treatment recorded higher values compared to the natural environment. The result trend was equally true for the values obtained from the unmanaged system (Table 6). The percentage increase in the value of plant height, leaf area, fresh weight and dry weight in NPK relative to natural environment in managed and unmanaged ecosystems were 19.59%, 36.54%, 9.66%, 5.82%and 43.98%, 48.38%, 60.96%, 67.11 respectively. The percentage increase showed much variation between the managed and the unmanaged ecosystems and depicted the impact of NPK treatment in an unmanaged ecosystem compared to the managed ecosystem.

Table 6 combined effect of management and treatment on the growth and yield of okra

Management	Treatment	Plant height cm	Stem girth cm	No of leaves	Leaf area cm^2	No of fruits	Fruit length cm	Fresh weight g	Dry weight g
Managed	Natural environment	145.40	6.20 7.23	22.75 23.33	392.60	I0.80	9.50 9.30	423.80	302.7 321.4
Unmanaged	NPK Natural environment	180.83 33.32	2.10 4.15	7.75 13.00	618.70 111.7	12.50 2.50	4.50 5.60	469.10 82.80	0 40.23
LSD 0.05	NPK	59.48 17.73	1.43	0.33	0 228.00 77.65	5.50 NS	0.30	212.10 24.90	122.30 10.33

Combined effect of slope, management and treatment on the growth and yield of okra

The slope, management and treatment effect presented in Table 7 indicated significant differences ($P < 0.05$) in all the parameters except plant height, stem girth, number of leaves and number of fruits. The values recoded for the parameters decreased as the slope gradient decreased in most of the parameters assessed. The values obtained from the managed ecosystem in all the parameters were much higher than the recorded values from the unmanaged system. The recorded values from NPK treatment were also higher compared to values recorded in natural environment. The difference between the recorded values of natural environment and NPK were much wider in unmanaged ecosystem of which the trend was the same across all gradients studied. The percentage increase in value of NPK relative to natural environment in unmanaged ecosystem using slope as example for plant height, leaf area, fresh weight and dry weight of okra were; 59.11%, 78.80%, 64.48% and 64.03% respectively, this result can be used to mirror unmanaged system of the other slope gradients.

Table 7 combined effect of slope, management and treatment on the growth and yield of okra

Slope	Management	treatment	Plant height cm	Stem girth cm	No of leaves	Leaf area cm^2	No of fruits	Fruit length	Fresh weight g	Dry weight g
1 (34.8%)	Managed	Natural environment	136.00	7.30	25.0	432.50	8.0	9.50	450.00	300.00
		NPK	180.00	8.20	24.0	632.0	12.0	9.80	560.00	328.00
	Unmanaged	Natural environment	20.20	1.40	6.0	44.50	2.0	5.20	40.00	25.00
		NPK	49.40	4.60	14.0	209.90	6.0	5.80	112.60	69.50
(29.6%)	Managed	Natural environment	145.20	6.80	22.0	345.10	8.0	9.20	420.70	300.00
		NPK	176.10	8.10	24.0	613.20	10.0	9.00	450.50	320.00
	unmanaged	Natural environment	27.97	2.0	9.0	87.50	2.0	2.50	52.00	28.40
		NPK	58.30	4.80	12.0	214.20	4.0	5.40	120.50	87.80
3(23.8%)	Managed	Natural environment	141.20	5.20	24.0	351.40	14.0	9.20	420.60	310.00
		NPK	178.50	6.40	24.0	608.30	12.0	8.60	411.20	304.00
	unmanaged	Natural environment	30.20	1.40	5.0	39.70	2.0	5.30	50.60	23.20
		NPK	56.10	3.00	10.0	196.50	5.0	5.80	400.00	226.00
4(0.52%)	Managed	Natural environment	159.60	5.50	20.0	44.50	13.0	10.20	403.70	300.00
		NPK	188.70	6.20	21.33	621.30	16.0	9.80	454.60	332.00
	unmanaged	Natural environment	54.90	3.60	11.0	275.20	4.0	4.80	188.60	84.50
		NPK	74.10	4.20	16.0	291.50	7.0	5.40	215.30	105.00
LSD0.05			NS	NS	NS	30.85	NS	1.53	30.08	24.90

DISCUSSION

Productivity of the managed and unmanaged plots of the watershed in their natural environment

The natural environment of the managed and unmanaged plots of the watershed produced different influence in the growth and yield parameters of the test crop (okra) across the slope. The main effect of slope on the productivity of okra recorded highest growth and biomass in slope 4. The impact of erosion and flooding which carried most of the nutrients in the watershed down the stream may have deposited most of the nutrients in the slope and plant closer to the stream. This invariable contributed to the result scenario that shows increased value as slope gradient decreased thus the effect of slope on plant productivity exhibited increase in the growth and biomass down

the slopes of the water shed. Higher plant height, leaf area, fresh weight and dry weight recorded at the lower slopes closer to the stream of the watershed could be attributed to the movement of plant nutrients from the upper slope in solution down the stream of the watershed. Management recorded higher productivity in the managed plots than the unmanaged plots. Management practices carried out in the managed plots may have helped in slowing down the impact of erosion through the hedgerow barriers and also maintain the nutrient level of the soil. Isaac et al. (2003) reported higher N in the soils in which *leucaena* pruning's had been mulched on the surface for seven sessions. Also the works of Sommerfeldt et al. (1988), Paull (2011), Zia et al (2012), Nweke (2018, 2019) showed that organic manure amendments to the soil can improve soil quality by increasing OM content and all the elements of fertility, activities soil organisms and aggregation. Management practices maximize biomass availability to the companion crop and minimize loss of nutrients through erosion. The productivity of okra was increased through management practices. The highest recorded values were obtained in slope four (4) of managed plots with NPK. This is an indication that NPK fertilizer application increases the vegetative growth and yield of okra. According to the work of Stefano et al (2004) chemical fertilizer exert strong influence on plant growth, development and yield. The highest productivity of okra in natural environment was equally recoded in slop 4 of managed plots.

CONCLUSION

The finding from the study is of evidence that slope and management practices influence greatly the productivity of the two watershed studied. The natural environment of managed watershed showed significantly higher productivity in all the growth and yield parameters of okra.

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