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Influence of Simulated Erosion on Soil Properties and Maize Yield in the Southern Guinea Savanah Zone of Nigeria II

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Long-term studies have been launched to assess the influence of artificial topsoil loss and its effects on soil properties and grain yield of cultivated maize.

Place and Duration of Study: The study was conducted during the 2016 to 2019 agricultural seasons at the Federal University of Agriculture in Makurdi, Nigeria.

Methodology: Three geo- referenced sites within the Federal University of Agriculture Makurdi, Nigeria namely: Site 1, Site_2 and Site_3 was used for the experiment. Erosion levels were established in June 2016 only by the incremental removal of topsoil at various depths. The study of crop productivity using simulated erosion was carried out using Randomized Complete Block Design (RCBD) with desurfaced soil depths of 0cm (control), 5cm, 10cm, 15cm and 20cm as treatments. One profile pit was also dug in each of the three sites for soil characterization and soil

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type establishment. Data collected on soil physical and chemical properties as well as crop growth parameters and grain yield was subjected to Analysis of Variance (ANOVA) using R core Statistical Software.

Results: The study revealed that the soils of the three sites were classified as Kandic Paleustepts for Site_1, Typic Plinthustalfs for Site_2 and Typic Hapluderts for Site_3. These has brrn reported in drtail in paper I. In comparison with the 0cm (control), maize grain yield was reduced by 7%, 89%, 100% and 100% at Site_1, 5%, 64%, 82% and 85% at Site_2 and 6%, 71%, 82% and 92% at Site_3 for the 5cm, 10cm, 15cm and 20cm topsoil depth removal respectively. The topsoil loss greatly lowered the grain yield of maize. We report the effects of topsoil loss on crop productivity for two years.

Keywords: Simulated erosion; soil fertility; soil- crop productivity relations; Artificial top soil loss.

1. INTRODUCTION

Soil and water resource management and conservation are vital to human well-being since soil is a nonrenewable resource on a human time scale [1]. Soil is the most fundamental and basic resource. It is dynamic and prone to rapid degradation with land misuse (Blanco and Lal, 2008). Soil deterioration caused by increased erosion is a severe issue, particularly in developing tropical and subtropical nations [2]. Alfisols, the prevalent soil in West Africa's subhumid regions, degrade quickly under prolonged agriculture [3]. Pathak et al [4] enumerated the problems of Alfisols as crusting and sealing, rapid drying of the soil surface, poor infiltration, low soil fertility, low soil moisture storage capacity, leaching and compacted sub-soil layer. Severe soil degradation in West Africa are due to land misuse and soil mismanagement, harsh climate, the susceptibility of the soil to degradation, and the predominance of resource-based and exploitative agricultural systems based on low external input and soil-mining systems [3]. Soil degradation implies long-term decline in soil's productivity and its environment moderating capacity [3]. Soil erosion is widely considered the most serious form of soil degradation [den Biggelaar et al, 2004]. Soil erosion exacerbates soil degradation and vice versa. In some cases, decline in soil quality especially the weakening of structural units precedes erosion. In others, erosion may lead to decline in soil quality and set in motion the degradative trend (Lal, 2001).

Various research and historical evidence show that soil loss can reduce the potential soil productivity of agricultural crops [Obi, 1982; Lal, 1985; Dregne [5].

Soil loss above certain critical limits will lead to degradation of soil reserve, soil fertility and accelerate silting of dams and estuaries and, in some instance, burial of fertile agricultural soils by new sediments [6]. Neil et al [7] stated that, soil loss would lead to the soil profile being shortened, as well as to decreased rooting depth and water storage capacity.

The question then arises, what limit of soil loss from an area is 'critical" or to what extent can soil loss be tolerated without loss of productivity? Soil loss tolerance is defined as the maximum acceptable level of soil loss from an area which will allow a high level of productivity to be maintained indefinitely [8]. Mannering [9] defines the term soil loss tolerance (T value) to denote the maximum level of soil erosion that will permit a high level of crop productivity to be sustained economically and indefinitely. A modified definition of tolerable soil erosion is proposed as an actual soil erosion rate at which a deterioration or loss of one or more soil function (information, crop production function, engineering and habitat) does not occur; actual soil erosion being the amount of soil lost by all recognized types of erosion [10].

The objective of this study was to assess the effect of topsoil loss on maize productivity amongst the various soil types identified in Benue state.

2. MATERIALS AND METHODS

2.1 Field and Laboratory Methods

The experiment was carried out from 2016 through 2019 planting seasons at three locations. At each location a 17m x 28 m plot was mapped and used for the experiment. Soil samples were collected from the various desurfaced depths in each plot. A onetime artificial removal of the topsoil soil at five (5) depths was carried out in year 2016. The depths are 0 cm serving as the control, 5 cm, 10 cm, 15 cm and 20 cm topsoil removal respectively. A detailed report on the methodology is in paper I. The soil was tilled to the depth ranging from 18cm to 22cm using traditional hoes. Maize (Oba super VI hybrid variety) was used as a test crop. Soil physical and chemical properties determination have been reported in paper I. Various plant parameters were collected for both years, germination percentage, plant height at 4 weeks after planting (WAP) and 8WAP, leaf area index at 8WAP and grain yield data at harvest. The data obtained was fitted into a general linear model of R statistical software. Treatment effects was compared using ANOVA model. Significant differences among means were tested using the Tukey Honest Significant Difference Test (HSD). Simple regression and correlation analysis were conducted between depths of top soil removal(cm) **X** Location on Bulk density (g cm^3) and some selected soil properties, growth parameters and yield. The effect of topsoil removal on maize percentage seedling emergence, maize height, leaf area index (LAI), cob length, cob weight, number of grains per cob, stover yield and grain yield for the three locations (Site_1, Site_2, Site_3) for the 2016 and 2017 cropping years are presented in (Tables 1- 3) respectively. The study showed that top soil removal did not significantly (P <0.05) reduced percentage emergence count of the maize seedling for all the locations in the 2016 cropping year. The mean percentage emergence count ranged between 90 – 78%, 84 -70%, 93 – 79% for Site_1, Site_2 and Site_3 respectively. However, in 2017, percentage maize emergence was significantly (P <0.05) affected by top soil removal at deeper cuts (20cm depth) as compared to the control (0cm). Mean values were between the range of 81- 58%, 89- 66% and 89 – 66% for Site_1, Site_2, Site_3 respectively.

3. RESULTS AND DISCUSSION

3.1 Desurfacing on Plant Growth Parameters and Yield at Site

Significant portion of the results has been discussed in Paper1. Here we focus on the effect of artificial soil loss at defined levels on plant growth parameters and yield. Plant height was significantly (P <0.001) affected by soil desurfacing at 4 weeks after planting (WAP), 8WAP and through to harvest (Fig. 1). The Plant height decreased with increasing depth of topsoil removal. Top soil removal also significantly (P<0.001) influenced plant LAI at all locations. The LAI was lowest in the 20 cm desurfaced plots and highest in the undisturbed 0 cm plots (Tables 1 -3) for all the study sites and for both years. There was significant reduction in cob length, cob weight number of grains per cob and stover yield for the three location and for both years (Tables 1-3). It followed the same trend with the plant height and LAI as there was significant (P < 0.001) reduction in above ground biomass as incremental depth of top soil loss increased with major differences between the 0cm desurfaced plots (control) and that of the deeper desurfaced 10cm, 15cm and 20cm plots. There was also a proportional decreasing trend in grain yields according to the different levels of top soil removal for all the three sites and for both years. Marked differences however, were observed in the deeper cuts of 10cm, 15 cm and 20 cm depth of desurfaced plot as compared to the uneroded (0 cm) control plot for all the locations (Tables 1-3). Total crop failure occurred in 10 cm, 15 cm, 20cm desurfaced plots at one of the sites for both the 2016 and 2017 cropping year. The grain yield from the various treatments of topsoil removal, ranged between 2.06 - 0.37 tha^{-1} , 2.86 - 0.42 t $ha^{-1}$and 2.57 - 0.13tha^{-1} for Site_1, Site_2 and Site_3 respectively for the 2016 cropping year.

Highest grain yield was obtained in the uneroded (0cm) plots with Site_2 recording the highest grain yield of 2.86 t/ha for the year 2016. In 2017, the grain yield were in the range of 0.05 – 2.99 tha^{-1}, 0.38 – 3.42th^{-1}a and 0.51 – 3.55 tha^{-1} in the order Site_1, Site_2 and Site_3 respectively. The highest grain yield for the 2017 cropping season was obtained at Site_3 with a value of 3.54 t ha^{-1}. The results also showed that grain yield obtained in the 2016 cropping year were lower than that of the 2017 cropping year Fig. 1.

The removal of topsoil to a depth of 5 cm, caused a yield reduction of 7% in 2016 and 11% in 2017 as compared to the uneroded plot (0 cm) for Site_1, 5% and 10% for Site_2 while for Site_3, it was 6% and 10%. The decline in maize grain yield when 10cm of top soil was lost for the three sites and the two cropping season are 89% (2016) and 56% (2017) for Site_1, 64% (2016) and 49% (2017) for Site_2 and 71% (2016) and 48% (2017) for Site_3 respectively. Furthermore, topsoil loss to 15cm and 20 cm depth caused total crop failure at Site_1, 100%(2016) for 15 cm of topsoil loss and 100% (2016) for 20 cm topsoil removal. For the 2017 cropping year, it was 77% and 100% for 15 cm and 20cm topsoil removal for Site_1. The removals of 15cm topsoil lead to a yield reduction of 82% (2016) and 67% (2017) for Site_2 while it was 92% (2016) and 65% (2017) for Site_3. When 20cm topsoil was removed yield reductions were 85% (2016) and 89% (2017) for Site_2 while for Site_3, it was 95% for the year 2016 and 85% for year 2017 respectively. It was observed that the higher yield reduction occurred on deeper cuts from depths of 10 cm through 20 cm across the three sites for both cropping seasons as compared to the 5cm depth of topsoil loss and on the uneroded (0 cm) plots. Highest yield reductions however, were on the soil type *Kandic Paleustepts* of Site_1 for both cropping years as compared to the other two sites - Site_2 a (*Typic Plinthustalfs*) and Site_3 a (*Typic Hapluderts*). Overall, yield reductions were lower in 2017 than in 2016.

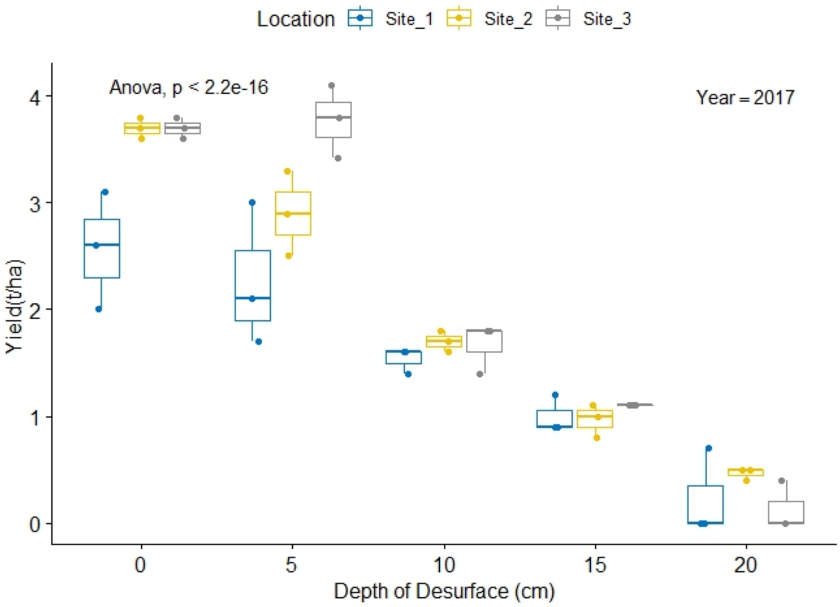

Fig. 1. Trend of mean effect of Top soil removal on grain yield across the three locations for 2016 and 2017

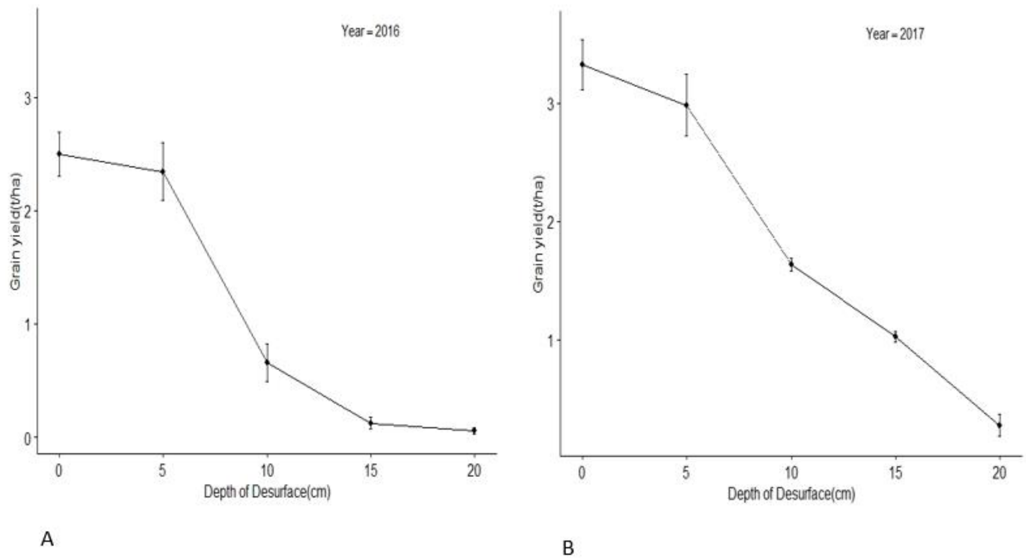

Fig. 2. Interaction effect of depth of desurface and year on grain yield

Note: Non parallel lines indicate interactions

Table 1. Mean effect of desurfacing on plant growth parameters and yield at site_1, 2016 and 2017

Treatments Depth(cm)	Emergence Count (%)	Plant Height 4WAP(cm)	Plant Height 8WAP(cm)	LAI 8WAP	Cob length(cm)	Cob Weight(t/ha)	No. of Grains/Cob	Stover Yield(t/ha)	Grain Yield(t/ha)
Year 2016									
0	89.6a	61.3a	113.9a	0.65a	25.9a	0.18a	361a	0.42a	2.06a
5	86.4a	53.5a	104.7a	0.35b	23.6a	0.17a	245a	0.28b	1.91a
10	84.1a	44.9b	72.4b	0.24b	17.3a	0.07b	147b	0.16c	0.22b
15	83.5a	36.9b	48.7b	0.18b	12.3ab	0.03b	74c	0.07d	0.0c
20	75.7a	25.2c	14.7c	0.1d	6.3 c	0.01b	43c	0.06e	0.0c
Year 2017									
0	81.21a	56.87a	146.72a	0.72a	25.62a	0.35a	353 a	0.64a	2..99a
5	79.06a	46.13a	139.4b	0.59b	24.28ab	0.26b	273a	0.54a	2.65b
10	76.52a	39.08a	97.33c	0.33c	20.67ab	0.16c	22la	0.32b	1.31c
15	70.97a	36.97ab	71.65d	0.18d	15.95ab	0.11c	165b	0.090c	0.70d
20	58.39b	23.43c	23.63d	0.12d	7.74c	0.03d	75b	0.01c	0.05e

Means with the same letters along the columns are not significantly different from each other (P<0.05)

Table 2. Mean effect of desurfacing on plant growth parameters and yield at site_2, 2016 and 2017

Treatments Depth(cm)	Emergence Count (%)	PlantHeight 4WAP (cm)	Plant Height 8WAP(cm)	LAI 8WAP	Cob Length(cm)	Cob Weight(t/ha)	No. of Grains/Cob	Stover Yield(t/ha)	Grain Yield(t/ha)
Year 2016									
0	83.9a	58.5a	116.1a	0.64a	26.1a	0.18a	355a	0.36a	2.86ha
5	80.8a	50.7a	106.8a	0.34b	23.7a	0.17a	239ab	0.22b	2.71a
10	78.5a	42.1a	74.5a	0.23b	17.4a	0.08b	141ab	0.10c	1.02b
15	77.8a	34.1b	50.8b	0.15b	12.4ab	0.03b	69bc	0.004c	0.49c
20	70.1a	22.4c	16.8c	0.11c	6.4c	0.01b	37bc	0.002c	0.42c
Year 2017									
0	88.9a	51.08a	146.47a	0.71a	26.26a	0.35a	349a	0.59a	3.42a
5	86.7a	44.88ab	139.2b	0.59b	24.92a	0.26b	269a	0.48b	3.08b
10	84.2a	39.28bc	97.08c	0.32c	21.31a	0.16c	217ab	0.26c	1.74c
15	78.6ab	37.65bc	71.40d	0.17d	16.59b	0.12c	162abc	0.04d	1.12d
20	66.1ab	29.99d	23.40d	0.11d	8.38c	0.03d	71c	0.04de	0.38e

Means with the same letters along columns are not significantly different from each other (P<0.05)

Table 3. Mean effect of desurfacing on some plant growth parameters and yield at site_3, 2016 and 2017

Treatments Depth(cm)	Emergence Count (%)	Plant Height 4WAP(cm)	Plant Height 8WAP(cm)	LAI 8WAP	Cob length(cm)	Cob Weight(g)	No. of Grains/Cob	Stover Yield(t/ha)	Grain Yield(t/ha)
Year 2016									
0	92.6a	60.8a	114.8a	0.67a	24.4a	0.19a	363d	0.34d	2.57ij
5	89.4a	52.9a	105.5a	0.37b	22.1ab	0.18a	246cd	0.19b	2.42ij
10	87.2a	44.4bc	73.2ab	0.26b	15.7b	0.08b	148bc	0.07bc	0.73ef
15	86.5a	36.5cd	49.5c	0.18b	10.7c	0.04bc	75.8ab	0.02a	0.20cd
20	78.7a	24.7cd	15.5d	0.14c	4.72d	0.02c	44a	0.02a	0.13cd
Year 2017									
0	**88.91a**	**62.14a**	**147.8a**	**0.73a**	**25.46a**	**0.37a**	**361a**	**0.75a**	**3.55a**
5	86.7ab	51.40a	140.6b	0.61b	24.12a	0.28b	281a	0.64a	3.21b
10	84.23b	44.36ab	98.4c	0.35c	20.5ab	0.18c	229ab	0.42b	1.86c
15	79.40bc	42.24c	72.7d	0.19d	15.79bc	0.14d	173c	0.19c	1.25d
20	66.10bc	28.70d	24.6d	0.13e	7.58d	0.05de	82cd	0.11cd	0.51e

Means with the same letters along the columns are not significantly different from each other (P<0.05)

Table 4. Correlation of top soil desurfacing with soil physical, chemical, maize growth parameters and yield

Parameters	Correlation Coeff. (R)	Probability > │t│
Physical Properties	**(P val.< 0.05)**	
TSD vs BD(g cm^3)	0.86	***
TSD vs Sand	- 0.57	***
TSD vs Silt	0.29	ns
TSD vs Clay	0.40	***
TSD vs Pent. Res.(kg cm^2)	0.72	***
Chemical Properties		
TSD vs N(%)	-0.90	***
TSD vs OC(%)	-0.90	***
TSD vs pH(in water)	0.32	ns
TSD vs ECEC	-0.90	***
CEC VS Clay	-0.37	*
Maize Parameter and Yield		
TSD vs Emg. Count (%)	-0.33	*
TSD vs Plt. Height(4WAP)	0.91	***
TSD vs Plt. Height(8WAP)	0.89	***
TSD vs LAI	-0.88	***
TSD vs No. of Grains/cob	- 0.84	***
TSD vs Cob-length	- 0.78	***
TSD vs Stover Yield	-0.83	***
TSD vs Grain yield	-0.90	***

*TSD= Topsoil Desurface, LAI= leaf area index, Plt = Plant, No.= Number, Emg.= Emergence, N= Nitrogen, OC= organic carbon; BD= Bulk density, ECEC= Effective Cation Exchange Capacity: ns= Non-Significant *= (p=0.05), **= (p= 0.01), ***=(P = 0.001)*

Table 5. Regression model of yield and depth of top soil desurfaced with location

Regression Equation:		Year
Y = 2.56 *** – 0.14x	($r^2 = 0.74$; ($p < 0.001$)	------2016
Y= 3.46 - 0.16x	($r^2 = 0.95$; $p < 0.001$)	-------2017
Adding Location of Study as a Regressor/Predictor:		
Y= 2.63 - 0.14 - 0.51 $_{(Site\_1)}$ + 0.29$_{(Site_2)}$		
($r^2 = 0.81$; $p < 0.001$)		------2016
Y= 3.69 - 0.16 – 0.55$_{(Site\ _1)}$ - 0.13$_{(Site\ _2)}$		
($r^2 = 0.87$; $p < 0.001$)		-------2017

*Y= Grain yield; ***= significant at 0.001*

3.2 The Relation of Top Soil Removal on Soil Properties, Plant Growth Parameters and Grain Yield

The correlation and regression equation of some selected soil physical and chemical properties as well as maize growth parameters on depth of surface soil removal are presented in Table 4. The results showed that there was a highly significant correlation (P < 0.001) among some of the soil physical and chemical properties as well as grain yield with top- soil removal at the various sites studied. Bulk density had a positive correlation value of 0.86, penetrometer resistance was 0.72, while sand had a negative correlation-0.57. However, silt and clay had a non-significant correlation to simulated erosion with very low values (Table 4). For some of the chemical properties studied, percentage organic carbon, cation exchange capacity (CEC) and total percentage Nitrogen showed a highly significant negative correlation with top soil removal (R= -0.90) respectively. However, the pH relation to topsoil removal was positive but non- significant. (R= 0.32). The correlation of artificial top soil removal on plant growth parameters showed a highly significant positive correlation with plant height at 4WAP and 8 WAP, LAI but revealed a negative significant (p < 0.001) relationship with percentage emergence count, stover yield, number of grains per cob, cob length and grain yield (Table 4). The regression equations for maize grain yield with respect to the location are presented in Table 5. The equation indicates a negative correlation between yield and topsoil loss across the various depths for the location. The predictive grain yield was higher in year 2017 than in 2016 when yield was regressed with topsoil loss at the three study locations (Fig. 2).

3.3 Interaction Effects of Artificial Top Soil Loss, Location and Year on Soil Properties and Plant Growth Parameters

There was significant (p<0.001) second order interactions of artificial topsoil removal with location, topsoil removal by year and location by year interactions effects at the three study sites. The interaction effect between some physical soil properties and the main factors of depth of desurface at varying incremental depths, by location and years didn't follow a pattern. For the soil physical properties tested, there was no interaction effect of incremental depth of soil removal and location on bulk density however, there was significant interaction (p < 0.001) of location and year on bulk density causing bulk density to reduce at all the sites when compared to values of bulk density when there was no interaction. Porosity followed the same trend as bulk density. The texture of the soil however, behaved differently. It was significantly affected by depth of desurface by location. Sand had no interaction effect while for the clay and silt separates, there was significant reduction (p = 0.001) in percentage silt and clay contents. Only clay and silt showed significant interaction effect across the locations with incremental depth of soil loss. Some of the chemical properties were also affected by second order interactions of either depth of desurfacing by location or with the cropping year by location respectively. There was no interaction effect of location and depth of soil loss on calcium. The interaction effect of top soil loss by location on phosphorus, potassium, organic carbon and cation exchange capacity was highly significant (P < 0.001). The interaction significantly increased phosphorus, organic carbon and cation exchange capacity across the locations. For the growth parameters studied, there were highly significant second order interaction effect of depth of desurfacing and location, location by year effect and depth of desurface by year effect on stover yield. The interaction effects caused an increase of stover yield at the various sites. Seed yield followed the same trend (Fig. 2a). There was highly significant (p < 0.001) trio interactions effect of depth of desurface by location and year on penetrometer resistance, stover yield and grain yield across both years and for the three locations. The trio interaction significantly increased grain yield for the various location (Fig. 2b). The trio interaction effect was highly evident between the depths of 5 cm and 10 cm and at 15 cm and 20 cm for year 2016 as indicative of the non-parallel lines (Fig. 2b). However for 2017, the interaction effect was evident at depths of 5 cm and 10 cm respectively.

3.4 Effect of Top- Soil loss on Growth Parameters and Grain Yield (t/ha) of Maize

The percentage emergence of maize seedling was not significantly affected by depth of soil removal for the 2016 cropping year at all the three study locations (Tables 1 - 3). However, in 2017 percentage emergence was significantly (p < 0.001) reduced for the 20 cm topsoil removal treatment when compared to the 0cm (control) plots for all the study sites, Site_1, a *Kandic Plaustepts,* Site_2, a *Typic Plinthustalf* and

Site_3, a *Typic Hapludert*. There was also observed delayed emergence of seedling on the desurfaced plots. These findings, agrees with Gollany et al*.* [11], who reported delayed emergence and reduced corn plant population for a Typic Argiustoll in the United States. There was a negative correlation of percentage emergence to depth of soil removal and it was significant ($p < 0.05$). For this study plant establishment and plant density were not significantly affected by topsoil removal depths initially notable differences of treatment effect on plant growth however, was observed after the plants had established from four weeks after planting (4WAP). Larney et al*.* [12], on an Alberta soil observed that plant density was not affected by depth of desurfacing at the onset, but that differences in plant performance subsequently were as a result of treatment effects rather than population effects.

Crop growth was generally affected by depth of topsoil removal (Tables 1-3). Plant height was reduced significantly ($p< 0.001$) on the 15 cm and 20 cm treatment at all the three locations of the study at 4WAP and at 8WAP) for both cropping years. The percentage plant height reductions at 8WAP were 8 %, 36 %, 57 % and 87 % following 5 cm, 10cm, 15 cm and 20 cm topsoil removal. It followed the same trend for the other locations. This significant reduction obtained for maize plant height after desurfacing at greater desurfaced depths (10 cm through 20 cm), may be attributed to the low organic matter content of the soil, the increased bulk density and increased penetration resistance obtained. Reductions in plant height due to simulated erosion have been previously reported [13]. The leaf area index (LAI) was significantly reduced following 5cm, 10cm, 15 cm, 20 cm of topsoil removal. There was a negative correlation of LAI with top soil removal that was highly significant ($r= -0.88$, $p < 0.001$). The LAI were lowest in the 20 cm desurfaced plots when compared with the 0 cm control plots.

The grain yield of maize was significantly reduced ($p <0.001$) at all the desurfaced treatments across the location for both years when compared to the uneroded 0cm control plots (Fig. 2a). Yield reductions were proportional to the different levels of treatment (top soil removal) smaller reductions were obtained when 5 cm topsoil was removed. This is in contrast to result obtained by (Oyedele and Aina, [14], Boli et al*.,* [15] who reported drastic percentage decreases in maize grain yield when 5cm of top soil was removed. This differences in results may be partly due to differences in soil types, statistical model used (liner as compared to power and polynomial by Oyedele and Aina, [14] and the addition of fertilizer against no fertilizer use on all the treatments by other researchers. However, for this study drastic effect of grain yield reduction occurred at 10 cm of topsoil and at deeper depths of soil removal agreeing with other reports [12,13]. Mbagwu [16], also reported a 15% reduction when 5cm of topsoil was removed on an inceptisol in sub humid Nsukka. The percentage grain yield reduction following the removal of top soil was highest at Site_1 for all depths when compared to Site_3 and Site_2 (Fig 2b). The decline in maize grain yield when 10cm of top soil was lost for the three sites and the two cropping season are 89% (2016) and 56% (2017) for t Site_1, 64% (2016) and 49% (2017) for Site_2 and 71% (2016) and 48% (2017) for Site_3 respectively. Furthermore, topsoil loss to 15cm and 20 cm depth caused total crop failure at Site_1 100% (2016) for 15 cm of topsoil loss and 100% (2016) for 20 cm topsoil removal. For the 2017 cropping year, it was 77% and 100% for 15 cm and 20 cm topsoil removal for the Site_1. The removal of 15cm topsoil lead to a yield reduction of 82% (2016) and 67% (2017) for Site_2 while, it was 92% (2016) and 65% (2017) for Site_3. When 20 cm topsoil was removed, yield reductions were 85% (2016) and 89% (2017) for Site_2 while for Site_3, it was 95% for the year 2016 and 85% for year 2017 respectively. The results reflect the findings of Lal, [17], who reported a greater than 100 percent yield reduction on an Ultisols when 7.5 cm of topsoil was removed. Mbagwu et al*.* (1984), reported 99.5 % and 93.5 % reduction in grain yield when 20 cm of topsoil was removed on an Ultisols and Alfisol respectively. The implication of the result is that, yield reduction is based on the depth to which soil erosion occurred, the soil type and the location [18,19]. The regression equation relating crop yield with incremental topsoil removal and the locations accounted for 81 % of the variation in yield for year 2016 while for 2017 it was 87 % (Table 5) [20,21].

4. CONCLUSION

There was also significant reduction ($p < 0.001$) in percentage seedling emergence count at the 20 cm depth when compared to 0 cm control plot for year 2017 while for 2016 it was not significant. There was significant reduction in plant height, stover yield and seed yield when the soils were desurfaced at the various depth with drastic decline in grain yield when 10 cm depth of topsoil was removed. The study shows the need for conservation agriculture such as green manuring, cover cropping and crop rotations to curtail soil erosion.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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