



Studies on the Comparative Effects of Cow Dung, Goat Dung and Poultry Manure in the Restoration of Gully Eroded Soil Using *Amaranthus hybridus* as Test Plant

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Authors' contributions

This work was carried out in collaboration among all authors. Author KUE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors CAA and TPE managed the analyses of the study. Author HNE managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Gully erosion presents a serious challenge to the fertility of the agricultural soil. This experiment was conducted at the permanent site of Nnamdi Azikiwe University behind botany laboratory. The efficacy of cow dung, goat dung and poultry manure on the restoration of gully eroded soil was tested. The experiment was laid in a Randomized Block Design (RBD) with five treatments replicated thrice. Five kilogram of eroded soil was mixed uniformly with 1.5 kg of the different manure treatments. This treatment or amendment include goat dung, poultry mature, cow dung mixed with goat dung and poultry manure weighing 0.5 kg respectively to make up the 1.5 kg required treatment. Also another one was set without treatment to serve as control. Each of these treatments was replicated thrice making a sum total of 15 perforated polythene bags. Stem height, leaf area, number of leaves and stem girth of the test plant (*A. hybridus*) were checked and measured weekly as the plant germinates and grows. Collection of soil analysis of the samples to

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determine the amounts of carbon and nitrogen was carried out at the end of the practical. The data collected were subjected to analysis of variance (ANOVA) to test the significance of treatment. It was observed that the highest carbon and nitrogen content were observed from gully eroded soil treated with Cow dung mixed with goat dung and poultry manure (0.205 ± 0.001 and 1.397 ± 0.006) while the least was observed from the control (0.065 ± 0.000 and 0.673 ± 0.001) respectively. There was a significant difference in the effect of the different treatments on all the parameters checked except on the stem girth and number of leaves. The inference of this study suggests that the mixture of cow dung, goat dung and poultry droppings can be used to restore the fertility of gully eroded soil.

Keywords: Gully erosion; cow dung; goat dung; poultry manure; *Amaranthus hybridus*.

1. INTRODUCTION

Erosion is a deterioration of soil by the physical movement of soil particles. In agriculture, soil erosion refers to the wearing away of a field's topsoil by the natural physical forces of water and wind or through forces associated with farming activities such as tillage [1]. Erosion, whether it is by water, wind or tillage, involves three distinct actions – soil detachment, movement and deposition [2]. Topsoil, which is high in organic matter, fertility and soil life, is relocated elsewhere “on-site” where it builds up over time or is carried “off-set” where it fills in drainage channels. Soil erosion reduces cropland productivity and contributes to the pollution of adjacent watercourses, wetlands and lakes [3].

The nature of water erosion may involve sheet, rill or gully movement. Irrespective of nature of erosion, the consequences are severe and frequently hazardous to humans and their environment. Gully erosion occurs when water flows in narrow channels during or immediately after heavy rain. This is particularly noticeable in the formation of hollow ways. By 1990, gullies occupy 4% of the land area of Anambra, Imo, Abia and Enugu states. Recently the erosion damage in Imo and Anambra states of Nigeria has been estimated as causing loss of over 20 tons of fertile soil per annum. Gully erosion results in significant amounts of land being taken out of production and created hazardous conditions for the operators of farm machinery.

In developing countries like Nigeria, the population growth rate is so high that improved technologies including rational use of fertilizers must be employed to meet the food requirement of the people [4]. Improved soil fertility through the application of fertilizer is an essential factor enabling the world to feed the billions of people that are added to its population. Soil fertility is

usually maintained by the application of organic and inorganic fertilizers. Where soil fertility is high, there is usually adequate soil cover and favorable soil conditions that minimize erosion and soil degradation [4]. Organic manure harbours a rich microbial diversity, containing different species of bacteria (*Bacillus* spp., *Corynebacterium* spp. and *Lactobacillus* spp.), protozoa and yeast (*Saccharomyces* and *Candida*) [5].

Furthermore, where organic fertilizers are used, fertility is usually maintained and there is also improvement in the physical and biological properties of gully eroded soil. Organic manure which includes compost, animal manure and green manure etc are organic matter obtained from the waste and residues of plants and animals excrement [6]. Elements necessary for growth in plants like carbon, potassium, calcium, magnesium, phosphorus are contained in organic manure. The structure of soil treated with organic manure is usually improved by the action of bulky diluents in compacted soil or directly when the waste products of animals or microorganism bind soil particles together [7]. Organic manure improves aeration and drainage and encourages good growth of the roots by providing enough pores of right sizes. It also helps the soil from becoming too rigid when dry or waterlogged.

However, there are certain misconceptions about organic manure such as harboring of pest and disease organism, bulkiness, which can demand large storage space, high transportation and labor cost [8,9]. Incorporation of organic manure into the soil has been found to be an effective soil management measure aimed at improving soil fertility [10]. The primary concern of this study is to show the comparative effect of cow dung, goat dung and poultry manure in restoration of gully eroded soil using *Amaranthus hybridus* as test plant.

Amaranthus hybridus, commonly called smooth amaranth, smooth pigweed, red amaranth or green amaranth is a weedy species of annual flowering plant growing to 2 m. The flowers are monoecious and are pollinated by wind. The plant is self –fertile. It is a common species in waste places, cultivated fields and barnyards. In Nigeria, *A. hybridus* leaves combined with condiments are used to prepare soup [11].

Amaranthus leaves and stems are commonly eaten after cooking in a manner similar to spinach. It has been reported to be highly nutritious herbage and a potentially valuable forage crop. Ekop, [12] have reported the compositional evaluation and functional properties of various types of edible wild plants which includes *A. hybridus* in use in the developing countries. *A. hybridus* contains large amount of squalene, a compound that has both health and industrial benefits [13,14].

In Nigeria, organic manures are applied to the soil [15]. Although their efficacy in increasing the fertility of the soil has been acknowledged, there is still dearth of information on its potency in controlling soil erosion. It is on this note that this project was conducted.

2. MATERIALS AND METHODS

The seeds of pigweed were obtained from Eke-Awka market. The cow dung used was collected from Ameni slaughter house, Amansea Awka while the poultry manure was collected from Agricultural Development Program (ADP), Kwata Awka. The goat dung was obtained from a goat rearing house inside market II, Ifite Awka. Gully eroded soil was used for this work. The soil samples for gully eroded soil were collected from an erosion site situated at Ifite market II, in Awka.

2.1 Site Description

The experiment was conducted at the permanent site of Nnamdi Azikiwe University behind Botany laboratory. The area lies in moderately humid tropics with the mean annual rainfall of about 1805 mm while the maximum and minimum temperatures are 32.1°C and 23.5°C respectively.

2.2 Experimental Design

The experiment was laid out in a Randomized Block Design (RBD) with five treatments

replicated thrice. This design generally assumed that while the general level of the results may be different in the different blocks, the relative effects of the treatment are the same in all blocks apart from the experimental error.

2.3 Planting

Planting was done on the 22nd of June, 2015. Four seeds were sown per bag with a spacing of 60 x 60 cm. The polythene bags used were perforated to avoid water logging.

2.4 Methods

Five kilogram of the collected eroded soil was measured with the aid of a weighing balance and mixed uniformly with 1.5 kg of the different manure treatments and were filled in perforated polythene bags. This treatments or amendment include goat dung, poultry mature, cow dung mixed with goat dung and poultry manure weighing 0.5 kg respectively to make up the 1.5 kg required treatment. Also another one was set without treatment to serve as control. Each of these treatments was replicated thrice making a sum total of 15 perforated polythene bags.

The fifteen bags were arranged vertically according to each treatment i.e. three bags amended with cow dung followed by the ones amended with goat droppings, poultry manure and cow dung mixed with goat droppings and poultry manure and finally the non-treated bags which serves as control. Then four seeds of green were sown in each of these bags. Soil analysis of the samples was carried out to determine amount of carbon and nitrogen after the six weeks experiments was concluded.

2.5 Data Collection

The following parameters were noted weekly as the plant germinates and grows.

Stem height of *A. hybridus*, leaf area of *A. hybridus*, number of leaves of *A. hybridus* and stem girth of *A. hybridus*. Collection of soil analysis of the samples to determine the amounts of carbon and nitrogen was carried out at the end of the practical. The data collected was analyzed using statistical software for social scientists (SPSS) version 21.0 and Analysis of Variance (ANOVA) was used to test the significance of treatment.

2.6 Cultural Practices

The cultural practices adopted during the experiment include the following weeding and watering.

3. RESULTS

The effects of cow dung, goat dung, poultry manure, and cow dung mixed with goat dung and poultry manure on biometric parameters such as plant height, leaf area, number of leaves, stem girth and percentage germination as well as soil nutrients were analyzed statistically and their treatments were compared.

From Table 1, it was observed that the carbon content of gully eroded soil treated with several organic manure in the study had the following order of increase; control, poultry manure, goat dung cow dung, and cow dung mixed with goat dung and poultry manure. While the nitrogen content had the following order of increase in gully eroded soil treated with several organic manure; control, cow dung, poultry manure, goat dung, and cow dung mixed with goat dung and poultry manure.

Table 1 shows the effect of cow dung, goat dung, poultry manure and cow dung mixed with goat

dung and poultry manure on primary soil nutrient. The table indicates that cow dung mixed with goat dung and poultry manure gave the highest soil nitrogen (1.397±0.006) followed by goat dung (1.133±0.015) while lowest in the control (0.673±0.001). It also showed that cow dung mixed with goat dung and poultry manure gave the highest soil carbon (0.205±0.001) followed by cow dung (0.184±0.001) while lowest in the control (0.065±0.000). However there was a significant difference in the effect of the different manure on the soil nitrogen and soil carbon (P<0.05).

Table 2 shows the effect of cow dung, goat dung, poultry manure and cow dung mixed with goat dung and poultry manure on plant height. The table indicates that cow dung mixed with goat dung and poultry manure gave the highest plant height from 1.667 ± 0.289 in week 1 to 27.00±6.764 in week 6.

This was followed by Goat dung which increased from 2.167±0.289 in week 1 to 21.833±1.258 in week 6 while poultry manure gave the least plant height from 0.067 ± 0.116 in week 1 to 7.333±1.041 in week 6. There was a significant difference in effect of the different treatment on plant height (P<0.05).

Table 1. Effect of cow dung, goat dung and poultry manure on primary soil nutrient

Sample	Soil nitrogen	Soil carbon
Control	0.673±0.001 ^a	0.065±0.000 ^a
Cow dung	0.896±0.002 ^b	0.184±0.001 ^d
Goat dung	1.133±0.015 ^d	0.162±0.000 ^c
Poultry manure	1.007±0.001 ^c	0.143±0.003 ^b
Cow dung mixed with goat dung and poultry manure	1.397±0.006 ^e	0.205±0.001 ^e
P-value	**	**

Columns with different superscripts are significantly different at P<0.05
** indicates significant

Table 2. Effect of cow dung, goat dung and poultry manure on the plant height of *Amaranthus hybridus*

Treatments	Weeks					
	1	2	3	4	5	6
Control	3.167±2.363	5.833±7.943	2.333±0.289	3.167±1.041	3.167±1.041	4.60±0.854
Cow dung (CD)	0.833±0.289	1.667±0.289	4.167±0.764	7.667±2.255	9.833±1.528	13.667±0.57
Goat dung (GD)	2.167±0.289	3.833±0.289	10.667±3.05	15.833±2.56	18.50±2.180	21.833±1.25
Poultry manure (PM)	0.067±0.116	0.600±0.100	1.167±0.289	2.833±1.041	4.667±1.756	7.333±1.041
CD+ GD+PM	1.667±0.289	3.533±0.577	12.667±1.15	20.50±2.784	19.50±8.261	27.00±6.764
P-value	0.04	0.46	0.00	0.00	0.00	0.00

** indicates significantly different; NS indicates not significant

Table 3. Effect of cow dung, goat dung and poultry manure on stem girth of *Amaranthus hybridus*

Treatments	Weeks					
	1	2	3	4	5	6
Control	0.100±0.000	0.167±0.058	0.300±0.100	0.400±0.100	0.700±0.000	0.700±0.000
Cow dung (CD)	0.103±0.006	0.20±0.1000	0.400±0.100	0.767±0.577	1.133±0.058	1.200±0.100
Goat dung (GD)	0.10±0.0002	0.267±0.058	0.500±0.100	0.967±0.058	1.200±0.100	1.267±0.116
Poultry manure (PM)	0.100±0.000	0.133±0.058	0.300±0.100	0.400±0.100	0.633±0.473	1.033±0.153
CD+ GD+PM	0.102±0.003	0.333±0.058	0.600±0.100	1.233±0.578	1.367±0.289	1.767±0.153
P-value	0.70	0.03	0.02	0.02	0.00	0.02
	NS	**	**	**	**	**

** Means significantly different; NS means not significant

Table 4. Effect of cow dung, goat dung and poultry manure on the number of leaves of *Amaranthus hybridus*

Treatments	Weeks					
	1	2	3	4	5	6
Control	2.333±0.578	4.00±0.00	4.00±0.00	7.00±1.00	7.333±1.155	8.333±0.578
Cow dung (CD)	2.333±0.578	4.00±0.00	7.33±0.577	8.333±1.528	8.667±2.082	11.00±0.00
Goat dung (GD)	2.667±0.578	5.00±1.00	8.333±1.155	9.667±0.577	9.667±0.577	12.333±0.577
Poultry manure (PM)	2.000±0.00	3.00±0.00	3.667±0.577	8.333±0.577	9.333±1.15	10.333±2.082
CD+ GD+PM	2.000±0.000	6.00±0.00	6.00±0.00	9.667±1.528	10.667±1.155	15.667±4.509
P-value	0.57	0.00	0.00	0.08	0.96	0.03
	NS	**	**	NS	**	**

** Indicates significantly different; NS indicates not significant

Table 5. Effect of cow dung, goat dung and poultry manure on leaf area of *Amaranthus hybridus*

Treatments	Weeks					
	1	2	3	4	5	6
Control	0.040±0.010	0.730±0.715	1.300±0.805	1.757±0.422	2.407±0.636	3.153±1.663
Cow dung (CD)	0.030±0.00	1.733±0.029	3.400±1.473	6.890±2.072	8.877±1.811	19.733±4.13
Goat dung (GD)	0.190±0.37	2.50±0.100	9.967±3.086	11.250±0.00	13.00±1.090	22.717±4.66
Poultry manure (PM)	0.020±0.00	0.007±0.02	0.210±0.28	1.253±0.15	4.947±2.06	11.230±7.0
CD+ GD+PM	0.097±0.133	3.333±1.531	16.833±3.350	17.627±7.528	25.58±4.773	44.847±9.640
P-value	0.10	0.00	0.00	0.00	0.00	0.00
	**	**	**	**	**	**

** Indicates significantly different; NS indicates not significant

Table 3 shows the effect of cow dung, goat dung, poultry manure, and cow dung mixed with goat dung and poultry manure on stem girth. The table indicates that cow dung mixed with goat dung and poultry manure gave the highest stem girth from 0.102 ± 0.003 in week 1 to 1.767 ± 0.153 in week 6 while poultry manure gave the least stem girth from 0.100 ± 0.00 in week 1 to 1.033 ± 0.153 in week 6. There was no significant difference in the effect of the different manure on stem girth ($P > 0.05$).

Table 4 shows the effect of cow dung, goat dung, poultry manure, and cow dung mixed with goat dung and poultry manure on number of leaves. The table indicates that cow dung mixed with goat dung and poultry manure gave the highest number of leaves 2.000 ± 0.000 in week 1 to 15.667 ± 4.509 in week 6. Next to this was Goat dung which had 2.667 ± 0.578 in week 1 and 12.333 ± 0.577 in week 6 while poultry manure gave the least number of leaves (2.000 ± 0.00 in week 1 and 10.333 ± 2.082 in week 6). There was

no significant difference in the effect of the different manure on the number of leaves ($P>0.05$).

Table 5 shows the effect of cow dung, goat dung, poultry manure and cow dung mixed with goat dung and poultry manure on leaf area. The table indicates that cow dung mixed with goat dung and poultry manure gave the highest leaf area 0.097 ± 0.133 in week 1 to 44.847 ± 9.640 in weeks 6. Next to this was Goat dung which increased 0.190 ± 0.347 in weeks 1 to 22.717 ± 4.66 in week 6 while poultry manure gave the least leaf area (0.020 ± 0.00 in week 1 and 11.230 ± 7.170 in week 6). There was a significant difference in the effect of the different manure on the leaf area ($P<0.05$).

4. DISCUSSION

Analysis of gully eroded soil showed that cow dung mixed with goat dung and poultry manure increased carbon in the soil by 0.206, cow dung by 0.184, goat dung by 0.162, poultry manure by 0.146 and finally control without amendment by 0.065 according to Table 1. Poultry manure has the least value for carbon analysis in gully eroded soil while cow dung mixed with goat dung and poultry manure showed the highest value.

Nitrogen analysis in gully eroded soil showed that cow dung mixed with goat dung and poultry manure has the highest value that is, 1.40 while cow dung has the least value, 0.896 which is significantly different from their control value, 0.672. Soil nutrient like organic matter, total nitrogen and phosphorus are lost mostly in gully erosion system than in sheet and rill erosion [16]. therefore, results from Table 2 show that these lost nutrient can be restored by amendment of gully eroded soil with organic manure such as cow dung mixed with goat dung and poultry manure which has the highest increase for carbon and nitrogen content as observed from the soil treated with cow dung mixed with goat dung and poultry manure to show higher plant height, leaf area, stem girth and number of leaves compare to *A. hybridus* growing on gully eroded soil amended with other treatments. But *A. hybridus* grown on gully eroded soil treated with poultry manure showed the least development in the growth parameter mentioned above.

A. hybridus that grew on gully eroded soil with no amendment that is control treatment, showed no growth in the first week, and slow progressive growth as the plant progresses with age. It also

had small leaves, thin and weak stem due to inadequate essential soil nutrients. Soil mineral deficiency often limits the growth of crops and may even cause soil failure [17].

There was a significant difference in the effect of the different treatments on plant height and leaf area while growth parameters such as stem girth and number of leaves of *Amaranthus hybridus* showed no significant difference.

5. CONCLUSION AND RECOMMENDATION

The study showed that cow dung mixed with goat dung and poultry manure application had significant effect and therefore is best for the restoration of gully eroded soil which resulted in both the buildup of carbon and nitrogen in plant height, stem girth, leaf area and number of leaves next to goat dung.

The results obtained revealed that *A. hybridus* responded well to the application of cow dung mixed with goat dung and poultry manure compared to other organic manure and control treatment in the study as a result of the combined nutrients available in cow dung, goat dung and poultry manure. Cow dung and poultry manure did not increase the essential soil nutrient in gully eroded soil well enough to boost the performance of growth of *A. hybridus*.

Based on findings of this study, it may be recommended that cow dung mixed with goat dung and poultry manure is adequate for the amendment of gully eroded soil for absolute restoration. Goat dung which also performed favourably in gully eroded soil may also be applied in the absence of cow dung mixed with goat dung and poultry manure for greater growth parameter.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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