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Effects of Animal Based Manures (Bone Meal, Earthworm Cast and Crab Shell) on the Growth of Groundnut (*Arachis Hypogaea* L.)

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Abstract

This study was carried out to determine the effect of selected animal based organic manures namely: bone meal (BM), earthworm cast (EC) and crab shell (CS) on the germination and growth of groundnut varieties. Manure treatments at different levels (2g and 4g) were prepared and applied singly and in combined forms in an experimental set up of randomized complete block design. The total experimental unit was 108. Data were collected and analyzed using ANOVA on the Minitab 16.0 software. In bone meal, 2g of treatment gave the highest seedling vigour in variety IT06K-111 while 4g level gave the highest number of leaves (137.17) and widest stem in IT07K-243-1-2. Response to crab shell showed that the highest plant spread (8.61 cm) was obtained in IT06K-134 treated with 2g of crab shell while 4g level produced the largest leaf sizes (2.85 cm) in IT06K-111. Earthworm cast at 4g produced large quantity of leaves (132.67) in variety IT07K-243-1-2 Combined effects of BM+EC+CS also produced significant changes on the growth parameters notably the large quantity of leaves produced at 2g combined level in IT07K-243-1-2. The three groundnut varieties grew better under the influence of the three manure types used compared with the control and NPK fertilizer. Performances were highest in the bone meal treatments. The combined effect of the three of manure showed higher growth performance than the single effect of the manures. Therefore, application of the highlighted organic treatments would enhance groundnut production. It would also provide a solution to land pollution as result of wastes generated from animals slaughter houses which could be utilized in organic farming. The use of inorganic fertilizer would be limited in the long run to ensure safety of the environment.

Keywords

Animal Wastes, Manure, Groundnut, Productivity, Environmental Management

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1. Introduction

Groundnut (*Arachis hypogaea* L.) is the most important food legume in Nigeria in terms of consumption and area under production [1]. As a crop of nutritious and economic importance, groundnut seeds contain 40-50% fat, 20 - 50% protein and 10 - 20% carbohydrate depending on the variety [2, 3]. Despite being an important oil crop in Nigeria, groundnut yield is still low [4]. Such low yield has been attributed to abiotic and socio- economic factors [5] including low fertility status of soils, poor agronomic practices irregular rainfall patterns as well as availability and access to fertilizer resources Although groundnut is the most widely cultivated legume and a major cash crop

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in Northern Nigeria, it is faced with major challenges including diseases and pests' occurrence, erratic rainfall distribution pattern, poor quality seed and poor soils [6]. This has resulted in low yields of groundnut which can be ascribed to the emerging problem of empty pods (pops) prevalent countrywide. Declining soil fertility, particularly calcium and phosphorus deficiency, has been implicated as possible cause of the low yield problem in groundnut [7].

Calcium deficiency leads to a high percentage of empty pods with aborted seeds as well as improperly filled pods [8]. It also leads to aborted or shriveled fruit, including darkened plumules and production of pods without seed [9]. Phosphorus a key constituent of adenosine triphosphate (ATP) in plants and also plays various roles in seed formation. Although legumes can fix their own nitrogen, they often need phosphorus and potassium for good seed formation [10]. Phosphorus also promotes root growth, enhances nutrient and water use efficiency and increases yield. The requirement of phosphorus in nodulating legumes is higher compared to non-nodulating crops [11]. However, phosphorus a major nutrient is deficient in most Nigerian soils [12].

Unsustainable agronomic practices such as little or no fertilizer use in the absence of standard soil test is a major abiotic factor affecting soil productivity, crop yield and subsequently farmers' income at household level [13]. The continual use of inorganic fertilizers has been criticized among environmentalists due to the inimical effects of synthetic fertilizers on the environment. Majorly, it is associated with aquatic pollution through eutrophication and ozone layer depletion thereby causing loss of biodiversity [14]. Organic sources of manure using plant and animal wastes are cheaper and environmentally friendly. Besides, waste pollutants would be removed from land thus providing an avenue for waste utilization and environmental management.

The need to improve crop yield without causing harm to the nature of the soil is of paramount interest. The use of organic inputs such as crop residues, manures and compost has great potential for improving soil productivity and crop yield through improvement of the physical, chemical and microbiological properties of the soil as well as nutrient supply [12]. However, the use of organic fertilizers has not been sufficiently explored. The extent to which organic fertilizers could increase the efficiency of applied mineral fertilizers in sustaining soil and crop productivity has not received much research attention. The test materials in this present study (bone meal, crab shell and earth worm cast) are readily available materials which can be used as organic fertilizer in groundnut production. The present study was therefore undertaken to determine the response of groundnut to the application of bone meal, crab shell and earthworm cast as organic amendment for soil fertility and compare the results with the effect of inorganic fertilizer.

2. Materials and Methods

2.1. Study Area

This study was carried out in the Botanical garden of the Department of Botany, University of Agriculture Makurdi. It town lies between Latitude 7°44′N and Longitude 8°32′E covering an area of 820 km² with an estimated population of 348,990 people, "National Population Commission of Nigeria" (2011). The vegetation type in Makurdi is guinea savannah with annual rainfall between 150-180 m and temperature of 26°C – 29°C [15]. Some parts of the university soil are swampy and therefore a rich habitat for earthworms and crabs.

2.2. Sample Collection and Preparation

Three groundnut varieties (IT07K-243-1-2, IT06K-111 and IT06K-134) were obtained from the seed store of the University for planting. Materials used in the treatment were obtained from various sources such as abattoir (bone meal) and the moist swampy area of the University of Agriculture Makurdi (crabs and earthworm cast). Sufficient samples were processed into fine particles using mortar and pestle [16]. Soil of the same type was collected from an abandoned farm land within the university campus. Preliminary experiment confirmed it was sandy-loam. Prior to filling of the soil into the perforated polythene bags, it was carefully sorted to remove all plant or dead animal particles that might cause changes in the experiment.

2.3. Experimental Design

Pot experimentation was carried out in a randomized complete block design of 108 experimental units. There were 6 treatments (earthworm cast, bone meal, crab shell, combined forms, NPK fertilizer and control treatment) each at two levels (2g and 4g except at the control) blocked by three varieties of groundnuts. Each set up was replicated thrice. After planting, watering was done twice daily (morning and evening) [17]. Data on growth parameters was collected and recorded weekly throughout the period of the experiment.

2.4. Data Analysis

Data was analyzed using appropriate descriptive and inferential statistics basically the analysis of variance. Mean separation was done using the LSD method on the Gensat software (17 version)

3. Results

3.1. Effect of Bone Meal (BM) on Germination and Growth of Groundnut

The three groundnut varieties used in this experiment showed different levels of performance in response to different levels of BM (Table 1). Significant differences ($p<0.05$) were obtained in all the parameters under study. The highest germination count and germination percentage (100%) was recorded in all the varieties planted under the NPK (4g). Seedling vigour on the other hand, showed significant differences across the different varieties and manure types. Highest seedling vigour was recorded with variety IT06K-111 in BM (2g). Plant height was highest (18.30 cm) in IT07K-243-1-2 treated with BM (2g). Number of leafs was highest (137.17) in IT07K-243-1-2 under 4g of BM while it was lowest in IT06K-111 in the control experiment. Highest plant spread (8.00) was obtained in IT06K-1343 under NPK (4g). Leaf length was highest (3.01 cm) in IT07K-243-1-2 at 2g of BM. Stem was widest in IT07K-243-1-2 at 4g of BM (Table 2).

Table 1. Effect of Bone Meal on Germination of Groundnut.

Varieties	Treatments	Germination count	%germination	Seedling vigour
	BM (2g)	3.00	100.00	6.53
	BM (4g)	2.50	75.00	7.62
IT07K-243-1-2	NPK (2g)	2.00	50.00	7.05
	NPK (4g)	2.50	75.00	6.14
	CLT	1.00	33.33	5.87
	BM (2g)	3.00	100.00	7.48
	BM (4g)	2.00	50.00	8.73
IT06K_111	NPK (2g)	2.50	75.00	8.32
	NPK (4g)	2.00	50.00	7.05
	CLT	2.50	75.00	2.64
	BM (2g)	1.00	33.33	8.86
	BM (4g)	3.00	75.00	6.47
IT06K-134	NPK (2g)	2.00	50.00	5.93
	NPK (4g)	2.50	75.00	9.03
	CLT	2.0	50.00	7.45
LSD (≤0.05)		0.1234	0.8431	0.06342

Table 2. Effect of Bone Meal on Growth of Groundnut.

Varieties	Treatments	Plant height			NL		PSP		LLT	Stem CF	Leaf BR
		2WAP	3WAP	5WAP	3WAP	5WAP	3WAP	5WAP			
	BM (2g)	8.59	13.34	16.27	33.34	131.07	4.05	7.11	3.01	1.20	1.40
	BM (4g)	9.17	12.75	18.30	37.20	137.17	3.25	6.34	2.99	1.70	1.20
IT07K-243-1-2	NPK (2g)	8.34	12.75	17.17	35.25	127.00	3.15	7.37	2.00	1.20	1.30
	NPK (4g)	9.34	13.42	17.00	36.50	124. 00	3.10	8.00	2.11	1.30	1.00
	CLT	8.54	21.75	16.96	31.00	121.33	3.07	7.81	2.00	0.45	1.05
	BM (2g)	8.42	13.09	16.25	38.00	131.00	3.75	7.67	2.17	1.10	1.61
	BM (4g)	9.50	13.17	17.00	38.00	126.00	3.25	6.92	2.44	1.50	1.20
IT06K-111	NPK (2g)	8.25	13.50	17.83	31.00	131.34	3.75	5.85	2.15	1.20	1.30
	NPK (4g)	8.67	14.34	16.58	38.00	126.00	3.15	7.00	2.11	1.30	1.00
	CLT	9.22	13.96	17.04	39.34	117.00	3.10	7.81	2.00	1.50	1.00
	BM (2g)	9.00	13.50	17.83	38.00	126.00	3.07	7.67	2.35	1.00	1.50
	BM (4g)	8.83	14.59	15.75	31.00	131.33	3.15	7.67	2.50	1.20	1.20
IT06K-134	NPK (2g)	8.50	11.50	17.00	38.00	126.00	3.10	6.92	2.11	1.50	1.30
	NPK (4g)	9.09	14.17	17.17	39.34	126.00	3.25	5.00	2.00	1.20	1.00
	CLT	9.17	13.23	17.00	39.34	131.34	3.75	6.81	2.17	1.30	1.00
LSD (≤0.05)		0.4317	0.4251	0.1155	0.067	0.3371	0.0899	0.0600	0.0771	1.2117	0.3951

Legend:
NL= Number of leaves; PSP= Plant spread; LL=Leaf length; LB= Leaf breadth; Stem CF= Stem circumference.

3.2. Effect of Crab Shell (CS) on Germination and Growth of Groundnut

Groundnut varieties performed differently in response to different levels of crab shell (CS) (Table 3). Significant differences ($p<0.05$) were obtained in all the parameters under study. The highest germination count and germination percentage (100%) was recorded across all varieties but at different treatments. It was highest in IT07K-243-1-2 and IT06K-111 both @2g of CS; IT06K-134@4g of CS and NPK@4g. Seedling vigour however showed significant differences cross the different varieties and manure types. Highest seedling vigour (9.03) was recorded in IT06K-134 under NPK at 4g. Plant height was highest (17.83 cm) in IT06K-134 at 4g of CS. Number of leafs was highest (131.34) in IT06K-134 treated with NPK (2g) at 5 weeks after planting while it was lowest (121.33) in IT07K-243-1-2

under the control experiment. Highest plant spread (8.61 cm) was obtained in IT06K-134 with 2g application of CS. Leaf length was highest (2.85 cm) in IT06K-111 under CS (4g). Stem circumference and leaf breath were highest (1.43 cm and 1.51 cm) in IT07K-243-1-2 under CS treatment at 4g and NPK application at 2g (Table 4).

Table 3. Effect of Crab Shell on Germination of Groundnut.

Varieties	Treatments	Germination count	%germination	Seedling vigour
	CS (2g)	3.00	100.00	6.53
	CS (4g)	2.50	75.00	7.62
IT07K-243-1-2	NPK (2g)	2.00	50.00	7.05
	NPK (4g)	2.50	75.00	6.14
	CLT	1.00	33.33	5.87
	CS (2g)	3.00	100.00	7.48
	CS (4g)	2.00	50.00	8.73
IT06K_111	NPK (2g)	2.50	75.00	8.32
	NPK (4g)	2.00	100.00	7.05
	CLT	2.50	75.00	2.64
	CS (2g)	2.50	75.00	8.86
	CS (4g)	3.00	100.00	6.47
IT06K-134	NPK (2g)	2.00	50.00	5.93
	NPK (4g)	3.00	100.00	9.03
	CLT	2.0	50.00	7.45

Table 4. Effect of Crab Shell on Growth Performance of Groundnut.

Varieties	Treatments	Plant height			Number of leaves		Plant spread		LL	Stem CF	LB
		2WAP	3WAP	5WAP	3WAP	5WAP	3WAP	5WAP			
	BM (2g)	8.59	13.34	17.17	33.34	129.67	4.415	7.37	2.08	1.43	1.00
	BM (4g)	9.17	12.75	17.50	31.00	121.67	3.25	6.34	2.16	1.00	1.05
IT07K-243-1-2	NPK (2g)	8.34	12.75	17.17	38.00	127.00	3.915	7.37	2.00	1.20	1.51
	NPK (4g)	9.34	13.42	17.00	39.34	126.00	3.50	8.00	2.10	1.10	1.00
	CLT	8.54	21.75	16.96	35.25	121.33	3.27	6.81	2.00	0.45	1.05
	BM (2g)	8.42	13.09	16.25	36.50	126.00	3.75	7.67	2.17	1.10	1.21
	BM (4g)	9.50	13.17	17.00	31.00	126.00	3.25	6.92	2.85	1.05	1.20
IT06K-111	NPK (2g)	8.25	13.50	17.83	38.00	131.34	3.75	6.85	2.15	1.20	1.00
	NPK (4g)	8.67	14.34	16.58	39.34	126.00	3.50	8.00	2.20	1.10	1.05
	CLT	9.22	13.96	17.04	35.25	127.00	3.50	8.00	2.20	1.40	1.21
	BM (2g)	9.00	13.50	17.83	31.00	126.00	3.50	8.61	2.35	1.00	1.00
	BM (4g)	8.83	14.59	15.75	38.00	121.33	3.27	6.34	2.50	1.20	1.05
IT06K-134	NPK (2g)	8.50	11.50	17.00	31.00	126.00	3.75	7.37	2.20	1.10	1.20
	NPK (4g)	9.09	14.17	17.17	38.00	126.00	3.25	8.00	2.20	0.55	1.00
	CLT	9.17	13.23	17.00	39.34	131.34	3.75	6.81	2.35	1.30	1.00

Legend:
NL= Number of leaves; PSP= Plant spread; LL=Leaf length; LB= Leaf breadth; Stem CF= Stem circumference.

3.3. Effect of Earthworm Cast (EC) on the Growth of Groundnut

Significant differences ($p<0.05$) were observed across the parameters measured possibly due to the effect of the earthworm cast treatment levels (Table 5). At 5WAP (five weeks after planting), the highest height (18.87 cm) was recorded in IT07K-243-1-2 treated with EC (2g). The shortest plant height was recorded in variety IT07K-243-1-2 (14.00 cm) under the NPK treatment of 4g. Number of leafs was highest (132.67) in variety IT07K-243-1-2 at five weeks after planting treated with EC (4g). Highest plant spread (8.42 cm) was obtained in IT06K-111 with 4g application of NPK. Leaf length was highest (3.20 cm) in IT07K-243-1-2 under EC (2g). Stem circumference and leaf breath were highest (1.63 cm and 1.5 cm) in IT07K-243-1-2 under EC (4g and 2g respectively) as given in Table 6.

3.4. Combined Effect of Bone Meal, Earthworm and Crab Shell on the Germination and Growth of Groundnut

Groundnut varieties performed differently in response to the combined effect of bone meal (BM), earthworm cast (EC) and crab shell (CS) as shown in Table 7. Significant differences ($p<0.05$) were obtained in all the parameters under study. Highest percentage germination (100%) was recorded across the different interaction of verities and manure application. The highest recorded in all varieties under (NPK (4g). Seedling vigour on the other hand, showed significant differences cross the different varieties and manure types. Highest seedling vigour (11.55) was recorded in IT07K-243-1-2 at 2g and 4g of BM+EC+CS. The interaction of the different groundnut varieties with the manure types also resulted in significance changes on the

growth parameters. Plant height was highest (19.87 cm) in IT07K-243-1-2 at 2g of BM+EC+ CS. Number of leafs was highest at IT07K-243-1-2 under the same treatment combination (2g) as given in Table 8. All other parameters showed significant difference across different treatments. However the combined effect of the three manure type showed reduction in the growth of the plant compared to the single effects of the manures.

Table 5. Effect of Earthworm Cast on Germination of Groundnut.

Varieties	Treatments	Germination count	%germination	Seedling vigour
	EC (2g)	2.00	50.00	7.73
	EC (4g)	2.50	75.00	7.32
IT07K-243-1-2	NPK (2g)	2.00	50.00	7.85
	NPK (4g)	3.00	100.00	7.64
	CLT	2.00	75.00	8.86
	EC (2g)	2.50	75.00	9.48
	EC (4g)	2.50	75.00	8.89
IT06K_111	NPK (2g)	1.50	50.00	5.93
	NPK (4g)	3.00	100.00	11.55
	CLT	2.50	75.00	9.10
	EC (2g)	2.00	50.00	7.41
	EC (4g)	2.50	75.00	9.37
IT06K-134	NPK (2g)	1.00	33.33	3.93
	NPK (4g)	3.00	100.00	11.03
	CLT	2.0	50.00	7.45
LSD (≤0.05)		0.0234	0.02431	0.0342

Table 6. Effect of Earthworm Cast on Growth Performance of Groundnut.

Varieties	Treatments	Plant height			Number of leaves		Plant spread		Leaf LT	Stem CF	Leaf BT
		2WAP	3WAP	5WAP	3WAP	5WAP	3WAP	5WAP			
	EC (2g)	8.59	14.34	18.87	31.44	132.67	4.10	7.37	3.20	1.30	1.51
	EC (4g)	9.17	11.75	14.50	29.30	124.07	3.00	6.34	2.80	1.63	1.35
IT07K-243-1-2	NPK (2g)	8.34	12.15	17.01	32.00	117.53	3.91	7.37	2.12	1.42	1.00
	NPK (4g)	9.34	12.52	14.00	33.14	123.10	3.20	8.02	2.22	1.33	1.00
	CLT	8.54	13.25	16.96	35.25	130.33	3.27	6.81	2.35	1.15	1.05
	EC (2g)	8.42	13.00	16.25	33.50	126.00	3.75	7.67	2.21	1.11	1.33
	EC (4g)	9.50	12.17	16.10	31.00	126.00	3.25	6.92	2.15	1.05	1.15
IT06K-111	NPK (2g)	8.25	13.11	17.13	31.00	131.34	3.27	6.85	2.35	1.20	1.22
	NPK (4g)	8.67	12.15	16.58	38.00	123.00	3.75	8.42	2.21	1.10	1.15
	CLT	9.22	12.52	17.04	39.34	127.00	3.25	8.34	2.15	1.40	1.00
	EC (2g)	9.00	15.25	15.31	33.14	123.10	3.75	6.81	2.15	1.33	1.20
	EC (4g)	8.83	13.00	15.96	35.25	130.33	3.50	6.34	2.20	1.15	1.22
IT06K-] 134	NPK (2g)	8.50	12.15	16.25	31.00	126.00	3.50	7.37	2.20	1.11	1.15
	NPK (4g)	9.09	14.02	16.00	38.00	126.00	3.00	8.00	2.35	1.05	1.00
	CLT	9.17	13.23	17.00	39.34	131.34	3.91	6.81	2.21	1.40	1.00
LSD (≤0.05)		0.1217	0.1251	0.3155	0.2317	0.2371	0.293	0.0745	0.0271	1.2117	0.3951

Legend:
NL= Number of leaves; PSP= Plant spread; LL=Leaf length; LB= Leaf breadth; Stem CF= Stem circumference.

Table 7. Combined Effect of Bone Meal, Earthworm Cast and Crab Shell on the Germination of Groundnut Varieties.

Varieties	Treatments	Germination count	%germination	Seedling vigour
	BM+EC+ CS (2g)	2.50	75.00	3.93
	BM+EC+ CS (2g) (4g)	3.00	100.00	11.03
IT07K-243-1-2	NPK (2g)	2.00	50.00	7.45
	NPK (4g)	3.00	100.00	5.93
	CLT	2.00	50.00	11.55
	BM+EC+ CS (2g)	2.50	75.00	9.70
	BM+EC+ CS (2g) (4g)	2.50	75.00	7.41
IT06K-111	NPK (2g)	1.50	37.50	5.93
	NPK (4g)	3.00	100.00	11.55
	CLT	2.50	75.00	9.70
	BM+EC+ CS (2g)	2.00	50.00	7.41
	BM+EC+ CS (2g) (4g)	2.50	75.00	9.47
IT06K-134	NPK (2g)	2.00	50.00	3.93
	NPK (4g)	3.00	100.00	11.03
	CLT	2.0	50.00	7.45

Table 8. Combined Effect of Bone meal, Earthworm Cast and Crab Shell on the Growth of Groundnut Varieties.

Varieties	Treatments	Plant height			NL		PS		LL	Stem CF	LB
		2WAP	3WAP	5WAP	3WAP	5WAP	3WAP	5WAP			
IT07K-243-1-2	BM+EC+ CS (2g)	9.34	15.34	19.87	36.00	129.67	3.75	8.37	2.80	1.10	1.22
	BM+EC+ CS (4g)	8.54	12.45	16.50	23.30	114.17	3.25	6.34	2.40	1.40	1.15
	NPK (2g)	8.42	12.15	18.01	35.00	111.03	3.25	8.37	2.22	1.33	1.00
	NPK (4g)	9.50	13.12	15.00	34.14	123.10	3.75	6.42	2.62	1.15	1.20
	CLT	9.22	13.25	16.58	35.25	130.33	3.50	8.00	2.00	1.11	1.22
IT06K-111	BM+EC+ CS (2g)	9.00	14.40	17.04	35.50	126.00	3.50	6.81	3.17	1.05	1.33
	BM+EC+ CS (4g)	8.83	11.17	15.31	31.00	126.00	3.00	6.34	2.44	1.05	1.15
	NPK (2g)	8.50	15.25	15.96	36.00	131.34	3.27	7.37	2.15	1.20	1.22
	NPK (4g)	8.67	13.00	16.58	23.30	123.00	3.75	8.00	2.11	1.10	1.15
	CLT	9.22	12.15	17.04	35.00	114.17	3.25	6.42	2.00	1.40	1.00
IT06K-134	BM+EC+ CS (2g)	9.00	14.02	15.31	34.14	111.03	3.75	6.81	2.35	1.33	1.20
	BM+EC+ CS (4g)	8.83	12.15	15.96	35.25	123.10	3.50	6.34	2.20	1.15	1.22
	NPK (2g)	8.50	13.12	16.26	31.00	130.33	3.50	7.37	3.20	1.11	1.15
	NPK (4g)	9.09	13.25	16.25	38.00	126.00	3.00	8.00	2.35	1.05	1.00
	CLT	9.17	14.40	16.10	30.34	131.34	3.41	6.81	2.21	1.40	1.00
LSD (≤0.05)		0.2117	0.3951	0.2455	0.2117	14.71	74.29	NS	14.71	1.2117	0.3951

Legend:
NL= Number of leaves; PSP= Plant spread; LL=Leaf length; LB= Leaf breadth; Stem CF= Stem circumference.

4. Discussion

In this present experiment, the effect of the single and combined effect of bone meal, crab shell and earthworm cast on the germination and growth of groundnut seeds were reported.

The interaction of the different varieties with the manure types also resulted in variation in the growth parameters. The best performing treatment was bone meal and crab shell. The combination of this manures showed significant improvement in the growth compared to the NPK fertilizer and the control experiment. Variation in parameters such plant height or spread could be due to the type of variety but not necessarily due to the effects of treatments. In the work of Olasan *et al.* [4], groundnut varieties inherently had different growth habits ranging from erect to decumbent or procumbent type.

The improved growth performance recorded in this present research can be explained by the fact that organic fertilizers have higher nutrient content compared to the NPK fertilizer. This result agrees with the findings of Bucheyeki *et al.* [18] that reported improved soil physical properties by adding farmyard manure to the farm lands and also improved growth. This better performance of seeds with organic manure compared to the other treatment might be due to optimum and continuous supply and availability of nutrients through organic source which help in better uptake of nutrient that ultimately enhancing cell division and thereby increased all the growth attributes. These findings are in accordance with the results of Ramanatha [19]. The combined effect of the three manure types produced a better germination and growth compared to the single effect of the manure. Similar finding was reported in soybean where the authors attributed the responses to adequate supply of nutrient element at the right time from inorganic sources which helped optimum dry matter partitioning from the source to sink during reproductive stage of plant consequently increase the seed yield of soybean [20]. In this work, better germination, vigour and growth responses was obtained under the influence of the single and combined effect of the manure types as compared to the control experiment.

The results of this experiment also agree with the findings of Aguoru *et al.* [14] who recorded the highest number of leaves in lettuce plants amended with 60 t ha^{-1} chicken manure compared to the control. Similarly, FAO [21] was of the view that organic fertilizers are crucial in enhancing soil fertility. Organic fertilizers releases nutrients more slowly but store them longer in the soil, thereby ensure a long residual effect. In comparing the growth performance of the plant in response to the three different organic fertilizer, it was observed that plants in the bone meal treatment had the best growth performance, this implies that bone meal had more nutrient than the other two organic manures (crab shell and earthworm cast) and could be explored in groundnut production.

5. Conclusion

Groundnuts grew better under the influence of the three manure types used compared with the control and NPK fertilizer. Performances were highest in the bone meal. The combined effect of three of manure showed higher growth performance than the single effect of the manures. Therefore, the use of these animal based manure are recommended to enhance groundnut production. It would also provide a solution to land pollution as result of wastes generated from

animals slaughter houses which could be utilized in organic farming. The use of inorganic fertilizer would be limited in the long run to ensure safety of the environment.

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