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Effect of Organic Manure and Agricultural Lime on Growth and Yield of Two Bean Varieties

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Authors' contributions

This work was carried out in collaboration among all authors. Author EAE performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author AAJM designed the study. Author BAN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: This study evaluates the effects of soil amendment with organic manure-OM and agricultural lime-AL on the growth and yield of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils with 3 different pH (locations) in Southern Cross River State.
Study Design: The study was laid in randomized complete block design (RCBD) with three replications.
Place and Duration of Study: This study was carried out at the Greenhouse, Department of Plant and Ecological Studies, University of Calabar for a period of 3 months.
Methodology: The three locations were: Akamkpa with pH 4.0, Calabar Municipality with pH of 7.0 and Odukpani with pH of 9.0. The treatments were; control (0 g), OM_1 (100 g organic manure), OM_2 (200g organic manure), AL_1 (100 g agricultural lime), AL_2 (200 g agricultural lime), OM_1 + AL_1 (50 g organic manure + 50 g agricultural lime) and OM_2 +AL_2 (100 g organic manure and 100 g agricultural lime.
Results: Results obtained from the physico-chemical properties of the soil before treatment application revealed low nutrients and minerals which increased after treatment application. Six

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weeks after planting, there were significant increase in plant height ($p<0.05$) of *P. vulgaris* and *V. aconitifolia* on soil from Akamkpa (169.66 cm) and Odukpani (146.63 cm) treated with OM_2 + AL_2 compared to 43.77 cm and 71.77 cm from control. Leaf area, petiole length, number of leaves were all significantly improved especially at 8 weeks after planting. Fresh weights of leaf, stem and root revealed higher yield ($p<0.05$) at the final harvest recorded as 8 weeks after planting than the amount at 4 weeks after planting. The results obtained from the pod number, pod weight and number of seed showed significant improvement after treatment application.

Conclusion: The findings of this study strongly support the use of organic manure and agriculture lime as affordable and accessible sources of manure especially for our local farmers.

Keywords: Phaseolus vulgaris; Vigna aconitifolia; agricultural lime; organic manure; pH.

1. INTRODUCTION

Beans are globally important leguminous vegetables that have been used for centuries as food for humans and feed for animals [1,2]. The origin of beans is traced to America, but are now cultivated all over the world due to their nutritional and culinary values. Furthermore, beans contain high amount of protein and vitamins [3]. Dry bean (*P. vulgaris*) and moth bean (*V. aconitifolia*) are popular beans species eaten in Nigeria because of their distinctive and appetizing taste [3]. Plant growth and yield have been hampered by many factors among which are climatic changes, pests and diseases that have reduced performance and productivity.

The threat of acidic and alkaline soil to the global biosphere is another environmental problem of global interest. If plants are to grow to their maximum potential, the soil must provide a satisfactory environment that support their performance and yield. Most soil processes including nutrient availability and microbial activity that facilitate plant growth are favoured by soil pH range of 5.5 – 8.0. Acid soil, particularly in the subsurface will restrict root access to water and nutrients. When soil pH drops, aluminum becomes soluble, thereby giving rise to poor growth, yield reduction and smaller grain sizes [4]. Acidic soil caused significant losses in production and where the choice of crops is restricted to acid tolerant species and varieties, profitable market opportunities are reduced and some legume species may fail to persist. In addition to affecting how nutrients are dispensed to growing plants, soil acidity also influence micro organic activity that contributes to the decomposition of organic materials. The characteristics of soil therefore play an important role in plants ability to absorb water and nutrients [5].

Farmers have used inorganic fertilizers to address this problem of nutrient deficiency. Unfortunately, this technique of soil amendment is expensive and environmentally destructive [6]. The quest to explore alternative means of addressing this problem led to the development of soil amendment through liming and application of organic materials. These are considered to be cost-effective, environmentally friendly and long-term with high yield [7,8,9]. The value of organic amendment in crop production is centered on the ability of animals and plants to provide nutrients and to improve the chemical, physical and biological properties of soils [10,11]. Soil amendment with agricultural lime and organic manure improves soils tilt; infiltration rate and soil water holding capacity and thus reduces bulk density [12]. The beneficial effect of soil amendment with agricultural lime and organic manure on crop productivity is a function of so many factors, which include greater vigor of plant, improvement of soil properties and greater uptake of nutrients [13]. Soil in most parts of Southern Cross River have been reported to be acidic and crops cultivated on such soil grow and yield poorly [14]. Addition of substances such as agricultural lime and organic manure are known to reverse the trend and many authors have reported on yield improvement in crops after amendment of soil with organic manure [8, 9,13,15,16,17,18]. In this study therefore, the effect of organic manure and agricultural lime on the growth and yield of two bean varieties (*P. vulgaris* and *V. aconotifolia*) grown on acidic, neutral and alkaline soils were evaluated.

2. MATERIALS AND METHODS

2.1 Study Location

The experimental site for this study was at the Greenhouse, Department of Plant and Ecological Studies, University of Calabar with an average temperature of 25±3ºC. Calabar is located between latitudes 4º78' and 5º09' N and longitudes 8º15' and 8º26' E and lies between the valleys of two rivers: The Great Qua River on

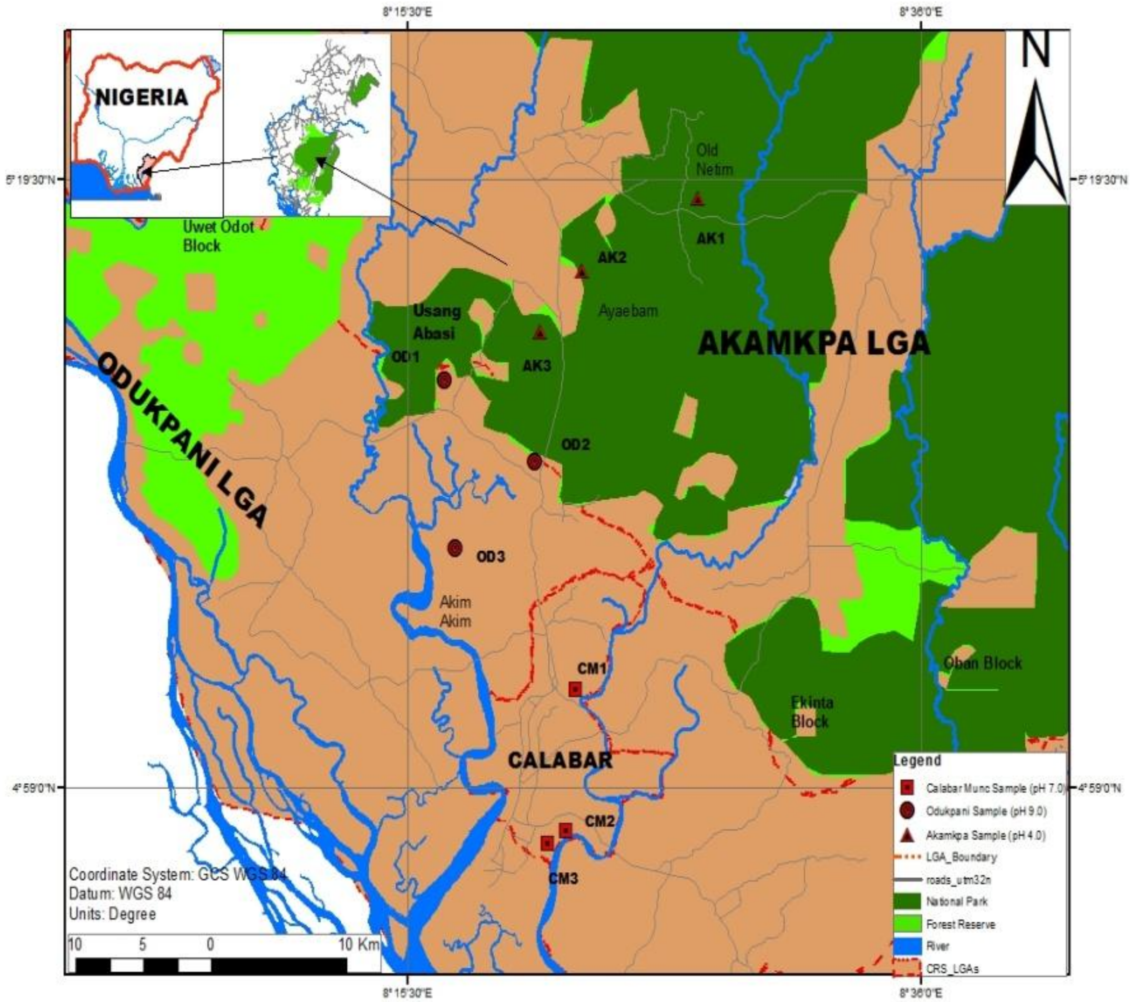

Fig. 1. Map of Southern Cross River showing geographical locations of soil samples

the Eastern side and the Calabar River on the West. The total annual rainfall for the area is between 2109.5 mm and 4168.7 mm.

2.2 Seeds Collection and Planting Materials

Seeds of *P. vulgaris* and *V. aconitifolia* were obtained from Institute of Agricultural Research and Training (IAR and T) Moor Plantation in Ibadan, Nigeria. Polythene bags (planting bags) were obtained from Ministry of Agriculture, Calabar. Agricultural lime was obtained from Cross River Agricultural Development Project while organic manure was obtained from the Department of Soil Science, Faculty of Agriculture, University of Calabar, Calabar.

2.3 Soil Sampling, Collection and Preparation

Soil samples (0-20 cm) depth were collected from three Local Government Areas of Southern Cross River State. Soils with pH 4.0 were collected from three villages in Akamkpa (Old Netim, Ayaebam and Awi), soils with pH 7.0 were collected from Calabar Municipality in designated locations (Forestry and Wild-Life Plantation, University of Calabar, Esuk Atu Community, Lemna dumpsite – Itung Effanga) and soils with pH 9.0 were collected from three villages in Odukpani Local Government Area (Akpan 18 Community, Akim-Akim and Okoyong-Usang Abasi) using an auger. Soils from the same Local Government area with same pH were properly mixed to give a composite soil sample. The map of Southern Cross River showing the geographical locations of the soil samples is shown in Fig. 1. Soil for germination and growth of plants were bulked air dried for three days, sieved through a 2 mm mesh to remove debris and were taken to Soil Science Laboratory, University of Calabar for the physico-chemical analysis.

2.4 Experimental Design and Layout

The experiment was conducted using a 2x3x7 factorial experimental layout in a Randomized Complete Block Design (RCBD) with 3 replicates. Factor one were the two plant varieties (*P. vulgaris* and *V. aconitifotia*), factor two were the three locations where soil samples were collected (Akamkpa-AK, Calabar Municipality-CM and Odukpani-OD) while factor three were the seven levels of treatment: control (0 g), OM_1 (100 g organic manure), OM2 (200 g organic manure), AL1 (100 g agricultural lime), AL2 (200 g agricultural lime), OM1 + AL1 (50 g organic manure + 50 g agricultural lime) and OM2 +AL2 (100 g organic manure and 100 g agricultural lime).

2.5 Planting Procedure and Treatment Application

One hundred and twenty-six experimental polybags (16 cm internal diameter) perforated at the bottom were filled with 5 kg of each soil sample. These were divided into three groups of 42 polybags based on the three soil samples. In each soil sample, there were 21 polybags each for the two plant varieties using randomized complete block design (RCBD) replicated three times. The soils were treated with agricultural lime (AL) and organic manure (OM) singly and in combinations. The treated soils were allowed to stay for two weeks before seed sowing. This time lapse before planting was to allow for microbial activities and interaction within treatment combinations. Each polybag was sown with three seeds each of P. vulgaris and V. aconitifotia at a depth of 2 cm. Following germination, seedlings stalk were watered and grown for 8 weeks.

2.6 Statistical Analysis

Data obtained on the growth and yield parameters were taken as the mean measurements of three replicates. Statistical analysis was performed using the statistical package for social sciences (SPSS) version 20.0 under a two-way analysis of variance (ANOVA). Significant means were separated using the Duncan multiple range test at p<0.05.

3. RESULTS

3.1 Physico-chemical Properties of Soil Samples

Results of physico-chemical properties of composite soil samples from the three locations, before and after treatment are presented in Table 2. Results revealed that before treatment of soils with agricultural lime (AL) and organic manure (OM), organic carbon, total nitrogen, available phosphorous, base saturation and percentage of sand were highest in soil sample from Calabar Municipality with values of 2.05%, 0.18%, 28.12 mg/kg, 96.0% and 83.3%, respectively. Calcium was highest in soil from Odukpani (15.2 cmol/kg) followed by Calabar Municipality (5.0 cmol/kg) and Akamkpa (3.0 cmol/kg). Magnesium (5.4 cmol/kg), potassium (0.15 cmol/kg), sodium (0.12 cmol/kg), aluminum (1.20 cmol/kg), ECEC (22.31 cmol/kg), clay (24.7%) and silt (31.0%) were also highest in Odukpani soil. Hydrogen content was highest in soil from Akamkpa (0.78 cmol/kg) followed by Odukpani (0.76 cmol/kg) and Calabar Municipality (0.24 cmol/kg). After treatment, results showed that organic carbon (8.10%), total nitrogen (2.17%) were high in Odukpani soil. Calcium (145.00 cmol/kg) was high in Calabar Municipality soil. Magnesium (30.00 cmol/kg), potassium (5.20 cmol/kg) and sodium (0.16 cmol/kg) were high in Odukpani soil. Aluminum ion (1.40 cmol/kg) was high in Calabar Municipal soil while hydrogen ion (0.92 cmol/kg) was highest in Akamkpa soil. ECEC (35.48 cmol/kg), base saturation (98.00%), clay (30.71%) and silt (31.00%) were all high in Odukpani soil while percentage of sand (73.30%) was highest in Calabar Municipality soil (Table 1).

3.2 Effect of Agricultural Lime and Organic Manure on Plant Height

Results of the effect of agricultural lime and organic manure on plant height of *P. vulgaris* and *V. aconitifolia* are presented in Table 2. There was no significant (P<0.05) difference in the height of the plants in all the treatment across the three soil locations compared to the control at 2 weeks after planting. 4 weeks after planting, there was significant (P<0.05) increase in the height of plants grown on acidic soil from

Akamkpa. *P. vulgaris* treated with OM_1 recorded 87.80 cm when compared to the control value of 28.53 cm. At 6 WAP, *P. vulgaris* grown on Akamkpa soil treated with OM_2 + AL_2 showed significant (P<0.05) increase in height of 169.60cm when compared to control (43.77 cm). Plants grown on soils (treated and control) from Calabar Municipality did not show significant different in height across the different weeks. However, plants grown on soil from Odukpani treated with OM_2 + AL_2, AL_1, AL_2 and OM_1 showed significant (P<0.05) increase in heights when compared to the control (Table 2).

3.3 Effect of Agricultural Lime and Organic Manure on Petiole Length

The highest petiole length for *V. aconitifolia* grown on Calabar Municipality treated with OM_2 was 4.87 cm 4 WAP and OM_2 + AL_2 at 6 WAP was 3.97 cm against 1.93 and 1.73 cm for the control (Table 3). There was no difference in petiole length of plants grown on treated and untreated CM soils at 8 WAP. *V. aconitifolia* grown on OD treated soil had significant increase in petiole length across the treatments with the highest petiole length obtained with AL_1 (8.60 cm) 8 WAP as against value of 5.60 cm for the control. *P vulgaris* grown on AK with OM_1 + AL_1 and OD with AL_2 at 8 WAP had highest petiole lengths with mean increase of 8.77 and 8.93 cm compared to control values of 6.63 and 7.77 cm.

3.4 Effect of Agricultural Lime and Organic Manure on Leaf Area (cm^2)

Results on leaf area of *P. vulgaris* and *V. aconitifolia* grown on acidic AK, neutral CM and alkaline OD soils showed significant (P<0.05) increase at 4 WAP, 6 WAP and 8 WAP. At 2 WAP, leaf area of *P. vulgaris* grown on AK soil treated with OM_2 had the highest leaf area of 52.77 cm^2 as against control value of 42.60 cm^2. The leaf area of *P. vulgaris* grown CM and OD did not differ from the control. At 4 WAP the leaf area of *P. vulgaris* grown on AK, CM and OD were comparable with the control. At 6 WAP leaf area of the plants grown on soil from the three locations was significantly (P<0.05) higher compared to the control. The highest leaf area for *P. vulgaris* grown on AK and OD soils were obtained from OM_1 and OM_2 + AL_2 as 88.61 cm^2 and 102.34 cm^2 as against control values of 44.32 and 71.59 cm^2. Leaf area of plants grown on CM soil treated with AL and OM were not different from the control. At 4 WAP leaf area of *V. aconitifolia* grown on soil from AK and CM treated with AL_1 and OM_1 were comparable with the control. The highest leaf area were obtained for the plant grown on AK treated with OM_2 + AL_1 (61.11 cm^2) and OD soils treated with OM_2 (94.12 cm^2) compared to the control (76.62 cm^2 and 74.17 cm^2) 6WAP- Table 4.

3.5 Effect of Agricultural Lime and Organic Manure on Number of Leaves

There were no observed statistical differences in the number of leaves of both plants 2 WAP (P>0.05). At 4 WAP, plants grown on soils from AK and OD did not differ statistically in leaves number production except for *P. vulgaris* grown on CM treated with OM_2 which had the highest leave number of 6.33 compared to the control value of 4.33. The highest number of leave produced at 6 WAP by *P. vulgaris* grown on soils from AK was 12.33 with OM_2 + AL_2 while CM was 5.00 with OM_2 compared to control (4.33 and 2.67). At 8 WAP *P. vulgaris* grown on AK soil treated with OM_1 produced the highest number of leaves (12.67) compared to the control (4.67). *P. vulgaris* grown on amended OD soil at 6 WAP and 8 WAP produced lesser number of leaves than *P. vulgaris* grown on untreated soil. The number of leaves produced by *V. aconitifolia* grown on soils from AK, CM and OD were comparable to the control at 2 WAP and 4 WAP. However, at 6 WAP, *V. aconitifolia* grown on soils treated with AL_2, $OM_{2,}$ OM_2 + AL_2 produced the highest leaves number of 11.00, 6.00 and 21.33.The overall highest number of leaves (32.00) was obtained from *V. aconitifolia* treated with OM_2 8 WAP (Table 5).

3.6 Effect of Agricultural Lime and Organic Manure on Leaf Fresh Weight (g/plant^{-1})

Results of the leaf fresh weight (LFW) obtained for *P. vulgaris* and *V. aconitifolia* grown on soils from AK, CM and OD at 4 WAP (initial weight) and 8 WAP (final weight) showed significant (P<0.05) increase in weight except for CM which showed no statistical difference in all the treatments studied. It was revealed that the highest initial LFW was obtained for *P. vulgaris* grown on AK soil treated with OM_2 + AL_2 as 7.88 and on soil treated with OM_2 as 24.05 g compared to control (1.87 and 6.50). Initial LFW for *V. aconitifolia* grown on AK and OD soils treated with OM_1 + AL_1 and OM_2 had the highest LFW with values of 11.60 g and 24.05 g compared to control (1.23 g and 13.67 g). Final LFW for *P. vulgaris* and *V. aconitifolia* grown on AK soil treated with OM_1 + AL_1 and OM_2 had the highest LFW of 15.77 g and 23.20 g. The highest final LFW for both plants were from OD soil treated with (OM_2) as 48.10 g (Table 6).

3.7 Effect of Agricultural Lime and Organic Manure on Stem Fresh Weight (g/plant^{-1})

The stem fresh weight (SFW) of *P. vulgaris* and *V. aconitifolia* grown with $OM_{1,}$ OM_1 + $AL_,$ $OM_{2,}$ OM_2 + AL_2 soils at 4 WAP and 8 WAP revealed significant (P<0.05) increase compared to the control. *P. vulgaris* and *V. aconitifolia* grown on Akamkpa soil treated with OM_1 and OM_1 + AL_1 at 4 WAP had SFW increase of 6.23 g and 6.86 g compared to control values of 1.50 g and 1.32 g. *P. vulgaris* and *V. aconitifolia* grown on AK with OM_1 and OM_1 + AL_1 produced the highest SFW values of 12.47 and 13.67 g at 8 WAP compared to controls at 2.67 g and 4.00 g. On OD soil, *V. aconitifolia* grown with OM_2 produced the highest SFW of 19.65 g 4 WAP. At 8 WAP, *V. aconitifolia* grown on OD soil treated with OM_2 produced the highest SFW of 39.30 g compared to control value of 18.40 g (Table 7).

3.8 Effect of Agricultural Lime and Organic Manure on Root Fresh Weight (g/plant^{-1})

Results revealed that the highest root fresh weight (RFW) of 4.53 g and 3.50 g produced by *V. aconitifolia* grown on AK and OD soils treated with OM_2 at 8 WAP compared to control values of 0.67 g and 1.77 g. *P. vulgaris* grown on AK and OD soils did not show any difference (P>0.05) from the control. The RFW of *P. vulgaris* and *V. aconitifolia* grown on treated and untreated soils of CM did not differ statistically at 4 WAP and 8 WAP (Table 8).

3.9 Effect of Agricultural Lime and Organic Manure on Number of Pods

Results revealed that the pod number of *P. vulgaris* treated with OM_1, OM_2 and OM_2 + AL_2 were the highest in Akamkpa which were statistically similar to *V. aconitifolia* treated with OM_1 + AL_1. Other treatments showed similar effects on pod production, however, OM_1 + AL_1, OM_1, OM_2 and OM_2 + AL_2 resulted in higher number of pods when compared to other treatments and control. There was no significant (P>0.05) difference in the number of pods produced by both plants grown on soil from Calabar Municipality among the treatments. There were significant (P<0.05) increase in pod production for both plants grown on soil from Odukpani. *P. vulgaris* and *V. aconitifolia* grown on OM_2 + AL_2 and OM_2 treated soils had the highest number of pods with mean values of 5.67 and 5.33, respectively (Table 9).

3.10 Effect of Agricultural Lime and Organic Manure on Weight of Pods (g/plant^{-1})

Pod weight of *P. vulgaris* and *V. aconitifolia* grown on acidic, alkaline and neutral soils treated with agricultural lime and organic manure was significantly (P<0.05) higher than pod weight of plants grown on untreated soils. *P. vulgaris* grown with OM_1 + AL_1 on AK soil produced the highest pod weight of 5.87 g compared to 0.90 g from the control. From OD soil treated with OM_2 + $AL_{2,}$ the highest pod weight of 7.00 g was produced by *P. vulgaris*. There was no significant (P>0.05) difference in pod weight of *P. vulgaris* and *V. aconitifolia* grown on soil from CM in all treated and untreated soils. *V. aconitifolia* grown on soil from Akamkpa treated with OM_1 had the highest pod weight of 2.89 g compared to the control value of 0.13 g. The highest pod weight value for *V. aconitifolia* grown on OD soil was 5.97 g obtained from OM_2 treatment compared to 0.90 g from control. Generally, soil amendment $OM_{1,}$ OM_2, OM_1+ AL_1 and OM_2 + AL_2 produced significant and higher (P<0.05) pod weight when compared to plants grown without soil amendment (Table 10).

3.11 Effect of Agricultural Lime and Organic Manure on Number of Seeds

There were significant (P<0.05) increase in the number of seeds produced by *P. vulgaris* and *V. aconitifolia* grown on AK with OM_1 + $AL_{1,}$ $OM_{2,}$ OM_2 + AL_2 and OM_1 treated soils with mean values of 37.00, 37.33, 31.33, 27.67 and 19.67, 11.67, 13.6, 9.67 g, respectively compared to control soil mean values of 5.33 and 1.00. Results revealed no impact of AL_1 on number of seeds produced by *V. aconitifolia*. There was no significant (P>0.05) difference in the number of seeds produced by *P. vulgaris* and *V. aconitifolia* grown on CM in all the treatments. *P. vulgaris* and *V. aconitifolia* grown on soil from OD produced higher number of seeds in all the treatments compared to the control. The highest mean number of seed produced by *P. vulgaris* on OM_2 + AL_2 treated soil was 49.00 compared to untreated soil value of 21.67 (Table 11).

4. DISCUSSION

Effects of soil amendment on the physico-chemical properties, growth and yield parameters of two beans varieties grown on soils from three different locations were evaluated in this study. Results on physico-chemical properties before treatment of composite soil samples revealed percentage carbon in the range of 1.91-2.05 % across the three soil (pH) levels. This is similar to the report of Bello and Ukut [19] and earlier findings of a low to moderate organic carbon content in soils from Odukpani Local Government Area [14]. This range of carbon is enough to support plant growth. Low carbon could be attributed to the ability of clay soil to hold and retain humus. The nitrogen content of acidic, neutral and alkaline soils was low. According to nitrogen rating Landon [20], nitrogen content of 0.1-0.2 cmol/kg is rated as low. Results of nitrogen contents were low across the three soil types, suggesting that crop cultivation on this soils will require the application of basic manure to boost nitrogen content and support plant growth and yield.

The report by [20] rated phosphorus content of the soil thus: 34 mg/kg as low, 34-68 mg/kg as medium and >68 mg/kg as high. The phosphorus content of the soils from the three locations used in this study were low. Exchangeable cations (calcium, magnesium, potassium, sodium, aluminum and nitrogen) contents indicated low to medium activities of these cations in the three soils except for calcium in Odukpani soil which was classified as high [20]. The effective cations in soils used were medium and in line with earlier report by Bello and Ukut [19]. This suggests that there was sufficient cation exchange capacity to prevent leaching in the soil. Effective cation exchange capacity (ECEC) is important in balancing soil acidity and basicity thereby enhancing soil fertility. From the base saturation classification, a base saturation greater than 60% is rated as high, 20-60% as medium and less than 20% as low [20]. Thus, the base saturation of the soil samples from Akamkpa and Odukpani were high. This indicates high nutrient reserves in soils from Akamkpa and Odukpani except for Calabar Municipality which showed low nutrient reserves. The current findings corroborates the reports of [14, 21]. The physico-chemical properties after treatment of the soils revealed significant improvement on majority of the tested parameters. Results showed increase in soil pH in Akamkpa and Calabar Municipality soils from 4.00-7.00 and 4.50-7.50. Similar trend was observed for the available phosphate, calcium, potassium, aluminum, ECEC in Calabar Municipality. The increase in the soil physico-chemical properties in this study may be attributed to the neutralizing effect of the treatments after soil amendment. This is in line with the findings of Duruigbo et al. [22] who documented that poultry manure significantly increased the soil pH from 4.14 to 5.20. They attributed this increase in soil pH to ion exchange reactions which occurred when terminal OH^- of

Table 1. Physico-chemical properties of soil sample from three different locations before and after treatment

	Akamkpa		Calabar Municipality		Odukpani	
	BT	**AT**	**BT**	**AT**	**BT**	**AT**
Organic carbon (%)	1.91	4.50	2.05	7.50	1.97	8.10
Total nitrogen (%)	0.16	1.39	0.18	1.87	0.17	2.17
Available phosphorus (mg/kg)	0.12	5.12	28.12	0.16	0.19	6.75
Calcium (cmol/kg)	3.0	3.12	5.00	145.00	15.20	3.12
Magnesium (cmol/kg)	1.00	3.20	1.00	15.60	5.40	30.00
Potassium (cmol/kg)	0.11	0.40	0.12	0.80	0.15	5.20
Sodium (cmol/kg)	0.09	0.09	0.10	0.14	0.12	0.16
Aluminum ion (cmol/kg)	0.44	0.62	1.20	1.40	0.68	0.20
Hydrogen ion (cmol/kg)	0.78	0.92	0.24	0.25	0.76	0.28
ECEC (cmol/kg)	5.30	5.42	6.65	16.63	22.31	35.48
Base saturation BS (%)	77.00	71.00	36.00	45.00	93.00	98.00
Clay (%)	15.70	22.70	6.70	12.70	24.70	30.71
Silt (%)	32.00	23.00	10.00	14.00	31.00	31.00
Sand (%)	52.30	54.30	83.30	73.30	54.30	38.30

Key: ECEC: Effective cation exchange capacity, cmol/kg: Centimole per kilogram, mg/kg: milligram per kilogram, BT: Before treatment, AT: After treatment

Table 2. Effect of agricultural lime and organic manure on plant height (cm) of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	2 WAP			4 WAP			6 WAP			8 WAP		
		AK	CM	OD	AK	CM	OD	AK	CM	OD	AK	CM	OD
Phaseolus vulgaris	Control	$21.70^{a}\pm3.52$	$28.8^{a}\pm1.70$	$21.60^{a}\pm2.60$	$28.53^{ab}\pm1.67$	$35.77^{a}\pm3.62$	$59.23^{a}\pm22.72$	$43.77^{c}\pm23.67$	$37.93^{a}\pm4.47$	$71.77^{b}\pm55.42$	$54.37^{e}\pm40.56$	$0.00^{a}\pm0.00$	$120.60^{ab}\pm64.11$
	AL_1	$22.47^{a}\pm4.65$	$8.93^{a}\pm15.47$	$24.03^{a}\pm2.82$	$36.46^{ab}\pm18.58$	$11.40^{a}\pm19.75$	$46.50^{a}\pm25.60$	$64.93^{c}\pm56.53$	$10.53^{a}\pm18.24$	$45.47^{d}\pm20.80$	$103.23^{cd}\pm25.53$	$0.00^{a}\pm0.00$	$34.40^{c}\pm4.25$
	AL_2	$11.77^{a}\pm10.19$	0.00 ± 0.00	$20.33^{a}\pm1.86$	$15.43^{c}\pm13.41$	$0.00^{a}\pm0.00$	$67.13^{a}\pm24.27$	$39.50^{c}\pm49.19$	$0.00^{a}\pm0.00$	$135.50^{a}\pm59.29$	$43.37^{e}\pm56.53$	$0.00^{a}\pm0.00$	$140.53^{ab}\pm68.18$
	OM_1	$24.20^{a}\pm7.11$	$23.03^{a}\pm3.00$	$25.03^{a}\pm0.67$	$87.80^{a}\pm41.66$	$31.33^{a}\pm6.07$	$35.90^{a}\pm2.62$	$165.97^{a}\pm36.38$	$40.33^{a}\pm18.26$	$54.83^{c}\pm11.04$	$184.87^{ab}\pm49.19$	$0.00^{a}\pm0.00$	$54.53^{c}\pm12.04$
	OM_1+ AL_1	$19.73^{a}\pm3.25$	$9.80^{a}\pm16.97$	$12.90^{a}\pm11.17$	$55.53^{ab}\pm21.87$	$16.13^{a}\pm27.94$	$32.33^{a}\pm34.01$	$135.73^{ab}\pm21.40$	$19.20^{a}\pm33.26$	$80.17^{bc}\pm89.67$	$171.03^{ab}\pm6.71$	$0.00^{a}\pm0.00$	$100.43^{ab}\pm102.78$
	OM_2	$21.99^{a}\pm2.81$	$23.87^{a}\pm10.62$	$22.93^{a}\pm1.59$	$63.60^{ab}\pm49.21$	$35.07^{a}\pm17.60$	$37.43^{a}\pm8.52$	$123.10^{ab}\pm85.67$	$44.33^{a}\pm20.15$	$60.60^{c}\pm7.80$	$142.37^{bc}\pm107.28$	$0.00^{a}\pm0.00$	$53.50^{c}\pm18.15$
	OM_2 + AL_2	$20.10^{a}\pm1.73$	$3.93^{a}\pm6.81$	$20.20^{a}\pm3.50$	$50.77^{ab}\pm2.38$	$3.53^{a}\pm6.12$	$61.93^{a}\pm27.00$	$169.60^{a}\pm35.6$	$0.00^{a}\pm0.00$	$146.63^{a}\pm10.90$	$187.10^{ab}\pm44.40$	$0.00^{a}\pm0.00$	$161.63^{a}\pm62.38$
Vigna aconitifolia	Control	$20.40^{a}\pm4.44$	$3.60^{a}\pm6.24$	$18.33^{a}\pm2.90$	$24.73^{b}\pm5.60$	$7.07^{a}\pm12.24$	$30.70^{a}\pm1.51$	$40.97^{c}\pm19.32$	$20.93^{a}\pm36.26$	$40.93^{c}\pm31.35$	$83.97^{dc}\pm31.35$	$0.00^{a}\pm0.00$	$140.73^{ab}\pm93.04$
	AL_1	$21.80^{a}\pm5.4$	$17.97^{a}\pm8.49$	$19.13^{a}\pm1.06$	$24.57^{b}\pm5.25$	$20.97^{a}\pm9.64^{a}$	$54.93^{a}\pm44.06$	$29.97^{c}\pm1.48$	$21.97^{a}\pm19.58$	$76.20^{a}\pm34.15$	$67.37^{e}\pm34.15$	$0.00^{a}\pm0.00$	$181.93^{a}\pm66.27^{a}$
	AL_2	$21.43^{a}\pm2.57$	$10.73^{a}\pm8.60$	$16.53^{a}\pm5.56$	$23.27^{b}\pm2.02$	$14.40^{a}\pm24.94$	$45.53^{a}\pm40.89$	$28.53^{c}\pm1.33$	$23.77^{a}\pm41.17$	$97.27^{abc}\pm80.71$	$68.23^{e}\pm80.71$	$0.00^{a}\pm0.00$	$133.63^{ab}\pm13.15$
	OM_1	$22.43^{a}\pm1.21$	$13.40^{a}\pm11.70$	$21.63^{a}\pm3.10$	$26.03^{ab}\pm1.70$	$28.07^{a}\pm24.76$	$45.70^{a}\pm22.38$	$31.40^{c}\pm2.30$	$42.10^{a}\pm43.90$	$119.50^{a}\pm82.00$	$47.97^{e}\pm82.00$	$0.00^{a}\pm0.00$	$164.13^{a}\pm117.90^{a}$
	OM_1+ AL_1	$18.87^{a}\pm4.54$	$3.53^{a}\pm4.36$	$20.90^{a}\pm2.78$	$38.93^{ab}\pm15.67$	$1.27^{a}\pm2.19$	$30.97^{a}\pm2.41$	$158.47^{ab}\pm58.79$	$1.60^{a}\pm2.77$	$80.47^{b}\pm64.10$	$218.60^{a}\pm36.80$	$0.00^{a}\pm0.00$	$162.60^{a}\pm10.51$
	OM_2	$22.13^{a}\pm1.93$	$11.10^{a}\pm3.40$	$18.93^{a}\pm1.60$	$28.33^{ab}\pm3.00$	$16.23^{a}\pm2.70$	$63.73^{a}\pm50.30$	$37.30^{c}\pm11.10$	$19.63^{a}\pm1.63$	$139.53^{a}\pm36.80$	$67.57^{e}\pm61.15$	$0.00^{a}\pm0.00$	$150.50^{a}\pm5.35$
	OM_2 + AL_2	$21.71^{a}\pm1.21$	$11.73^{a}\pm1.40$	$19.90^{a}\pm1.35$	$29.37^{ab}\pm1.91$	$17.60^{a}\pm4.58$	$35.03^{a}\pm7.72$	$98.17^{abc}\pm56.82$	$27.97^{a}\pm18.58$	$63.73^{c}\pm44.81$	$160.37^{abc}\pm27.80$	$0.00^{a}\pm0.00$	$90.30^{bc}\pm38.56$

Results are presented in mean ± standard deviation, mean values with different superscript along the same vertical axis are significantly different ($P<0.05$) according to Duncan's Multiple Range Test, WAP – Weeks after planting, Control - 0g, AL_1 -Agricultural lime , OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpani

Table 3. Effect of agricultural lime and organic manure on petiole length (cm) of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	2 WAP			4 WAP			6 WAP			8 WAP		
		AK	CM	OD	AK	CM	OD	AK	CM	OD	AK	CM	OD
Phaseolus vulgaris	Control	$5.90^{a}\pm0.44$	$5.60^{abc}\pm0.66$	$6.17^{ab}\pm0.61$	$6.60^{ab}\pm0.36$	$5.70^{ab}\pm0.36$	$7.17^{a}\pm0.96$	$6.50^{ab}\pm0.26$	$3.53^{b}\pm2.22$	$7.57^{a}\pm1.46$	$6.63^{ab}\pm0.40$	$0.00^{a}\pm0.00$	$7.77^{ab}\pm1.45$
	AL_1	$6.03^{ab}\pm1.19$	$2.07^{e}\pm3.58$	$6.90^{a}\pm0.82$	$6.70^{ab}\pm0.79$	$2.10^{bc}\pm3.64$	$7.17^{a}\pm0.45$	$6.83^{ab}\pm0.55$	$1.40^{c}\pm2.43$	$7.07^{a}\pm0.49$	$5.83^{b}\pm2.28$	$0.00^{a}\pm0.00$	$6.73^{ab}\pm1.15$
	AL_2	$3.63^{b}\pm3.16$	$0.00^{e}\pm0.00$	$6.23^{ab}\pm0.35$	$3.93^{bc}\pm3.42$	$0.00^{c}\pm0.00$	$8.43^{a}\pm1.21$	$4.60^{b}\pm4.13$	$0.00^{c}\pm0.00$	$9.07^{a}\pm0.59$	$4.10^{b}\pm4.13$	$0.00^{a}\pm0.00$	$8.93^{a}\pm0.50$
	OM_1	$5.60^{a}\pm2.02$	$6.70^{e}\pm0.61$	$6.30^{ab}\pm0.26$	$7.83^{a}\pm0.47$	$6.33^{a}\pm0.45$	$6.47^{a}\pm0.15$	$8.43^{a}\pm2.08$	$6.23^{a}\pm1.05$	$6.53^{a}\pm0.55$	$8.40^{a}\pm2.27$	$0.00^{a}\pm0.00$	$6.33^{ab}\pm0.21$
	OM_1+ AL_1	$5.97^{ab}\pm0.38$	$2.10^{e}\pm3.64$	$4.97^{b}\pm4.33$	$8.10^{a}\pm1.04$	$2.00^{bc}\pm3.46$	$6.33^{a}\pm4.73$	$8.90^{a}\pm1.47$	$2.10^{c}\pm3.64$	$6.43^{a}\pm5.90$	$8.77^{a}\pm2.00$	$0.00^{a}\pm0.00$	$5.70^{c}\pm5.03$
	OM_2	$6.20^{a}\pm0.72$	$6.17^{ab}\pm1.64$	$6.83^{a}\pm0.15$	$7.10^{ab}\pm0.40$	$6.17^{a}\pm1.59$	$7.43^{a}\pm0.29$	$7.30^{ab}\pm0.50$	$6.17^{a}\pm1.55$	$7.67^{a}\pm0.15$	$7.53^{ab}\pm0.23$	$0.00^{a}\pm0.00$	$7.60^{ab}\pm0.46$
	OM_2 + AL_2	$6.33^{a}\pm0.46$	$0.33^{e}\pm0.58$	$6.77^{a}\pm0.40$	$8.43^{ab}\pm0.25$	$0.73^{c}\pm1.27$	$8.43^{a}\pm1.70$	$8.30^{a}\pm0.46$	$0.00^{c}\pm0.00$	$9.33^{a}\pm1.18$	$8.33^{a}\pm0.35$	$0.00^{a}\pm0.00$	$7.77^{ab}\pm0.85$
Vigna aconitifolia	Control	$3.53^{b}\pm0.21$	$1.43^{e}\pm2.48$	$5.53^{ab}\pm0.15$	$4.87^{bc}\pm0.32$	$1.93^{c}\pm3.35$	$6.97^{a}\pm1.25$	$4.73^{b}\pm0.31$	$1.73^{c}\pm3.00$	$8.57^{a}\pm1.57$	$4.40^{b}\pm0.46$	$0.00^{a}\pm0.00$	$5.60^{c}\pm2.16$
	AL_1	$3.43^{b}\pm0.67$	$3.67^{bcd}\pm1.72$	$5.47^{ab}\pm0.06$	$4.53^{bc}\pm0.75$	$3.93^{bc}\pm1.69$	$7.93^{a}\pm0.76$	$5.00^{b}\pm0.56$	$3.43^{b}\pm2.97$	$8.77^{a}\pm0.75$	$4.77^{b}\pm0.70$	$0.00^{a}\pm0.00$	$8.60^{a}\pm1.82$
	AL_2	$4.23^{ab}\pm0.71$	$1.63^{e}\pm2.83$	$4.03^{b}\pm3.23$	$4.97^{bc}\pm0.25$	$1.67^{c}\pm2.89$	$7.09^{a}\pm2.21$	$4.40^{b}\pm0.36$	$1.37^{c}\pm2.37$	$7.53^{a}\pm1.86$	$4.63^{b}\pm0.49$	$0.00^{a}\pm0.00$	$7.60^{ab}\pm1.80$

Plant species	Treatment	2 WAP			4 WAP			6 WAP			8 WAP		
		AK	CM	OD	AK	CM	OD	AK	CM	OD	AK	CM	OD
	OM_1	3.37^{b}±0.70	2.87^{de}±2.50	6.63^{ab}±0.78	5.20^{bc}±0.87	3.67^{bc}±3.33	7.33^{a}±2.08	7.97^{ab}±0.10	3.63^{b}±3.32	7.97^{a}±2.42	5.60^{b}±1.08	0.00^{a}±0.00	6.97^{ab}±1.48
	OM_1+ AL_1	46.7^{ab}±0.49	0.63^{e}±1.10	5.80^{ab}±0.26	7.10^{ab}±1.65	0.17^{c}±0.29	7.20^{a}±0.20	6.07^{ab}±2.65	0.37^{c}±0.64	8.33^{a}±1.68	4.63^{b}±3.07	0.00^{a}±0.00	8.40^{a}±1.65
	OM_2	3.53^{ab}±0.42	2.97^{cd}±1.66	6.20^{ab}±0.26	5.83^{abc}±0.21	4.87^{ab}±0.75	7.80^{a}±0.80	6.83^{ab}±1.35	3.87^{b}±1.48	8.53^{a}±0.75	6.17^{ab}±1.23	0.00^{a}±0.00	8.10^{a}±0.66
	OM_2 + AL_2	5.23^{ab}±0.21	3.47^{e}±0.50	5.60^{ab}±0.78	6.67^{ab}±0.55	4.00^{ab}±1.83	7.10^{a}±0.66	5.83^{b}±0.76	3.97^{b}±2.01	7.47^{a}±0.93	6.50^{ab}±0.62	0.00^{a}±0.00	7.2 ^{ab}±1.17

Results are presented in mean ± standard deviation, mean values with different superscript along the same vertical axis are significantly different (P<0.05) according to Duncan's Multiple Range Test, WAP – Weeks after planting, Control - 0g, AL_1 -Agricultural lime , OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpani

Table 4. Effect of agricultural lime and organic manure on leaf area (cm^2) of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	2 WAP			4 WAP			6 WAP			8 WAP		
		AK	CM	OD	AK	CM	OD	AK	CM	OD	AK	CM	OD
Phaseolus vulgaris	Control	42.60^{b}±9.42	30.10^{a}± 4.84	38.49^{ab}±1.91	43.36^{dc}±6.54	25.09^{a}±6.53	66.50^{ab}±14.92	45.39^{bc}±2.53	8.58^{ab} ± 5.19	76.62^{bc}±14.11	44.32^{cd}±1.25	0.00^{a}±0.00	71.59^{b}±7.43
	AL_1	38.12^{b}±12.16	9.58^{d}±5.87	49.11^{ab}±4.77	43.47^{dc}±4.77	9.74^{ab}±4.40	52.28^{b}±2.70	39.75^{c}±14.42	8.62^{ab}±2.78	54.46^{bc}±9 .95	44.70^{cd}±14.65	0.00^{a}±0.00	49.63^{c}±1.90
	AL_2	26.11^{b} ±4.63	0.00^{d}±0.00	42.20^{ab}±2.11	22.98^{dc}±19.91	0.00^{b}±0.00	72.01^{ab}±6.38	34.19^{c}±4.05	0.00^{b}±0.00	7.48^{bc}±9.97	33.24^{cd}±8.02	0.00^{a}±0.00	72.78^{b}±9.64
	OM_1	46.97^{b}±18.26	22.92^{a}±5.73	48.97^{ab}±0.90	77.81^{a}±6.56	23.32^{ab}±07.66	56.94^{ab}±12.79	83.27^{a}±8.21	26.60^{a}±6.00	62.68^{bc}±22.30	88.61^{a}±14.07	0.00^{a}±0.00	63.68^{b}±8.18
	OM_1+ AL_1	38.80^{b}±2.13	12.04^{d}± 8.54	27.69^{ab}±23.99	68.47^{ab}±23.13	11.55^{ab}±6.08	71.03^{ab}±14.72	74.86^{ab}±2.63	12.48^{ab}±7.68	43.34^{ac}±28.66	85.74^{a}±34.37	0.00^{a}±0.00	47.17^{c}±22.93
	OM_2	52.77^{a}±2.33	28.45^{abc}±13.82	49.00^{ab}±10.97	66.21^{ab}±12.45	27.30^{ab}±10.9	63.43^{ab}±7.25	70.88^{ab}±4.68	26.15^{a}±9.92	74.04^{bc}±2.17	76.12 ^{a}±8.74	0.00^{a}±0.00	72.69^{b}±3.65
	OM_2 + AL_2	40.25^{b}±4.28	2.43^{d}±0.21	49.89^{ab}±1.45	55.48^{ab}±11.11	0.00^{b} ± 0.00	36.55^{c}±19.77	70.92^{ab} ±4.20	0.00^{b}±0.00	88.74^{a} ±29.03	73.10^{a}±9.74	0.00^{a}±0.00	102.34^{a}±32.12
Vigna aconitifolia	Control	19.39^{b}±4.32	7.28^{d}±2.60	37.97^{ab}±4.97	24.43^{de}±3.12	7.37^{ab}±5.23	60.58^{c}±34.34	26.52^{c}±4.82	10.23^{ab}±3.33	74.17^{bc}±17.10	26.47^{d} ±4.06	0.00^{a}±0.00	76.20^{b}±21.94
	AL_1	20.18^{b}±0.12	11.33^{d}±2.58	35.38^{ab}±1.42	20.36^{e}±3.12	16.47^{ab}±9.0	43.96^{c}±12.30	27.61^{c}±11.42	14.85^{ab}±3.41	11.24^{bc}±29.02	27.06^{d} ±8.51	0.00^{a}±0.00	65.48^{b}±24.69
	AL_2	29.30^{b}±4.76	8.69^{d}±5.08	25.47^{b}±16.47	29.37^{de}±5.96	6.92^{ab}±1.62	48.52^{b}±29.12	30.71^{c}±6.46	5.25^{ab}±3.28	63.26^{bc}±27.38	35.85 ^{cd}±4.44	0.00^{a}±0.00	64.81^{b}±30.46
	OM_1	21.63^{b}±8.98	11.45^{d}±7.91	51.60^{a}±10.74	34.34^{cde}±3.43	12.29^{ab}±5.62	65.20^{ab}±22.17	42.01^{bc}±8.59	12.08^{ab}±10.47	72.17^{bc} ±36.12	40.26 ^{cd}±8.22	0.00^{a}±0.00	75.84^{b}±31.88
	OM_1+ AL_1	29.46^{b}±6.93	1.89^{d}±0.55	38.92^{ab}±2.87	46.88^{bcd}±16.03	0.79^{b}±0.37	56.37^{b}±11.32	61.11^{ab}±11.24	0.69^{b} ±0.03	81.16^{a}±26.99	66.03^{ab}±20.16	0.00^{a}±0.00	86.54^{b}±15.91
	OM_2	35.70^{b}±3.29	9.27^{d}±5.97	44.34^{ab}±4.93	46.32^{bcd}±10.22	16.86^{ab}±11.73	76.36^{a}±25.60	58.99^{bc}±13.74	18.84^{ab}±8.11	94.12^{a} ±31.67	64.74^{ab}±20.18	0.00^{a}±0.00	95.96^{b}±30.08
	OM_2 + AL_2	34.51^{b}±2.91	15.26^{d}±10.25	39.87^{ab}±1.31	42.73^{dc}±5.68	17.94^{ab}±14.66	53.34^{b}±7.54	54.18^{bc}±10.21	21.54^{ab}±14.27	78.90^{ab}±16.01	60.20^{ab}±11.25	0.00^{a}±0.00	72.12^{b}±14.97

Results are presented in mean ± standard deviation, mean values with different superscript along the same vertical axis are significantly different (P<0.05) according to Duncan's Multiple Range Test, WAP – Weeks after planting, Control - 0g, AL_1 -Agricultural lime , OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpa

Table 5. Effect of agricultural lime and organic manure on the number of leaves of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	2 WAP			4 WAP			6 WAP			8 WAP		
		AK	CM	OD	AK	CM	OD	AK	CM	OD	AK	CM	OD
Phaseolus vulgaris	Control	4.00^{a}±0.00	5.00±1.00^{a}	4.00^{a}±0.00	3.67^{a}±0.58	4.33^{ab}±1.16	6.33^{a}±0.58	4.33±1.53^{cd}	2.67^{ab}±2.31	12.00^{bc}±3.61	4.67^{c}±2.08	0.00^{a}±0.00	12.00^{bc}±2.65
	AL_1	4.00^{a}±0.00	1.67^{a}±2.89	4.00^{a}±0.00	3.33^{a}±0.58	2.00^{ab}±3.46	4.67^{a}±0.58	6.00^{bc}± 2.65	1.67^{ab}±2.89	7.00^{c}±1.33	8.33^{bc}±2.52	0.00^{a}±0.00	6.67^{d}±1.53
	AL_2	4.00^{a}±0.00	0.00^{a}±0.00	4.00^{a}±0.00	2.00^{a}±1.73	0.00^{b}±0.00	6.00^{a}±1.00	4.00±4.00^{cd}	0.00^{b}±0.00	10.33^{bc}±2.52	3.33^{c}±4.16	0.00^{a}±0.00	8.67^{dc}±2.08
	OM_1	4.00^{a}±0.00	5.00^{a}±1.00	4.00^{a}±0.00	6.67^{a}±0.58	5.00^{ab}±1.73	5.00^{a}±1.00	10.33^{ab}±3.79	4.67^{ab}±0.58	7.33^{c} ±1.53	12.67^{ab}±5.86	0.00^{a}±0.00	4.67 ^{d}±0.58
	OM_1+ AL_1	2.67^{a}±2.31	1.67^{a}±2.89	2.67^{a}±2.31	5.33^{a}±0.58	2.33^{ab}±4.04	3.67^{a}±3.22	11.67^{ab}±2.08	3.00^{ab}±5.20	11.00^{bc}±0.58	7.67^{bc}±4.04	0.00^{a}±0.00	5.67^{d}±4.93

Plant species	Treatment	2 WAP			4 WAP			6 WAP			8 WAP		
		AK	CM	OD	AK	CM	OD	AK	CM	OD	AK	CM	OD
	OM_2	$3.67^a±0.58$	$4.67^a±0.58$	$3.67^a±0.58$	$6.33^a±1.53$	$6.33^a±1.53$	$5.67^a±0.58$	$8.67^{ab}±4.04$	$5.00^{ab}±2.65$	$7.00^c±5.69$	$9.33^{ab}±5.03$	$0.00^a±0.00$	$6.00^d±1.00$
	$OM_2 + AL_2$	$4.00^a±0.00$	$1.00^a±1.73$	$4.00^a±0.00$	$5.00^a±1.00$	$1.00^{ab}±1.73$	$7.33^a±1.16$	$12.33^a±1.53$	$0.00^b ±0.00$	$7.67^c±0.58$	$11.33^{ab}±4.04$	$0.00^a±0.00$	$10.67^{bc}±4.16$
Vigna aconitifolia	Control	$3.00^a±0.00$	$4.337^a±2.89$	$4.00^a±0.00$	$3.33^a±0.58$	$2.23^{ab}±4.64$	$5.67^a±1.16$	$4.67^{cd}±2.08$	$3.00^{ab}±5.20$	$10.67^{bc}±5.03$	$8.00^{bc}±3.61$	$0.00^a±0.00$	$15.67^b±9.50$
	AL_1	$3.00^a±0.00$	$1.67^a±0.58$	$3.67^a±0.58$	$3.33^a±1.16$	$5.00^{ab}±3.00$	$6.00^a±1.00$	$4.67^{cd}±0.58$	$3.67^{ab}±3.51$	$12.67^{bc}±3.06$	$8.33^{bc}±3.06$	$0.00^a±0.00$	$16.33^b±9.29$
	AL_2	$3.00^a±0.00$	$1.67^a±2.89$	$4.00^a±0.00$	$4.00^a±0.00$	$2.67^{ab}±4.62$	$6.33^a±2.31$	$3.67^d±0.58$	$2.00^{ab}±3.46$	$12.33^{bc}±7.57$	$6.00^{bc}±1.00$	$0.00^a±0.00$	$16.00^b±12.29$
	OM_1	$3.00^a±0.00$	$3.00^a±2.65$	$4.00^a±0.00$	$5.67^a±0.58$	$4.67^{ab}±4.16$	$6.33^a±0.58$	$7.33^{cd}±0.58$	$3.33^{ab}±3.06$	$13.33^b±7.64$	$7.67^{bc}±2.08$	$0.00^a±0.00$	$17.67^b±11.50$
	OM_1+ AL_1	$3.00^a±0.00$	$1.00^a±1.00$	$4.00^a±0.00$	$5.33^a±2.08$	$4.67^{ab}±1.53$	$5.33^a±0.58$	$11.00^{ab}±3.61$	$1.33^{ab}±2.31$	$9.33^{bc}±2.89$	$15.67^a±5.13$	$0.00^a±0.00$	$13.00^{bc}±7.94$
	OM_2	$3.00^a±0.00$	$4.33^a±0.58$	$4.00^a±0.00$	$5.67^a±0.58$	$5.00^{ab}±1.00$	$7.67^a±1.16$	$7.00^{bc}±1.73$	$5.67^{ab}±1.16$	$21.33^a±9.85$	$8.33^{bc}±4.51$	$0.00^a±0.00$	$32.00^a±25.12$
	$OM_2 + AL_2$	$3.00^a±0.00$	$4.00^a±0.00$	$3.67^a±0.58$	$4.67^a±0.58$	$5.00^{ab}±1.00$	$6.00^a±1.00$	$7.67^{bc}±1.53$	$6.00^a ±1.00$	$9.00^{bc}±1.00$	$10.67^{ab}±2.52$	$0.00^a±0.00$	$11.00^b±4.58$

Results are presented in mean ± standard deviation, mean values with different superscript along the same vertical axis are significantly different (P<0.05) according to Duncan's Multiple Range Test, WAP – Weeks after planting, Control - 0g, AL_1 -Agricultural lime , OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, $OM_1 + AL_1$ – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, $OM_2 + AL_2$ – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpa

Table 6. Effect of agricultural lime and organic manure on leaf fresh weight (g/plant^{-1}) of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	Locations		
		AK	CM	OD
			4WAP	
Phaseolus vulgaris	Control	$1.87^b±0.48$	$0.77^a±0.15$	$6.50^{ef}±5.20$
	AL_1	$0.95^b±0.45$	$0.22^a±0.38$	$2.60^e±1.67$
	AL_2	$0.37^b±0.40$	$0.00^a±0.00$	$4.80^{ef}±5.24$
	OM_1	$4.85^b±1.70$	$0.70^a±0.18$	$14.18^{bcdf}±1.66$
	OM_1+ AL_1	$6.42^b±4.41$	$0.63^a±1.10$	$3.98^f±3.88$
	OM_2	$4.75^b±2.15$	$1.55^a±0.97$	$24.05^b±0.48$
	$OM_2 + AL_2$	$7.88^{ab}±2.69$	$0.35^a±0.61$	$10.10^{cdef}±4.25$
Vigna aconitifolia	Control	$1.23^b±0.78$	$0.28^a±0.49$	$13.67^{bcdef}±13.40$
	AL_1	$2.62^b±0.88$	$0.40^a±0.46$	$10.65^{cdef}±11.16$
	AL_2	$1.62^b±1.20$	$0.50^a±0.87$	$4.00^{ef}±1.56$
	OM_1	$5.00^b±1.86$	$0.17^a±0.25$	$14.18^{bcdef}±9.01$
	OM_1+ AL_1	$11.60^{ab}±4.48$	$0.10^a±0.17$	$22.22^{bcd}±6.95$
	OM_2	$4.15^b±1.57$	$0.78^a±0.46$	$24.05^{bc}±2.10$
	$OM_2 + AL_2$	$6.90^b±3.29$	$1.87^a±1.37$	$9.48^{def}±2.54$
			8 WAP	
Phaseolus vulgaris	Control	$3.73^b±0.95$	$1.53^a±0.31$	$27.33^b±6.81$
	AL_1	$1.90^b±0.90$	$0.00^a±0.75$	$21.30^{bcd}±22.32$
	AL_2	$0.73^b±0.81$	$0.00^a±0.00$	$8.00^{de}±3.12$
	OM_1	$9.70^{ab}±3.40$	$1.40^a±0.36$	$28.37^b±22.02$
	OM_1+ AL_1	$12.88^{ab}±8.82$	$1.27^a±2.19$	$44.43^a±3.90$
	OM_2	$9.50^{ab}±4.30$	$3.10^a±1.95$	$48.10^a±44.19$
	$OM_2 + AL_2$	$15.77^{ab}±3.80$	$0.70^a±1.21$	$18.97^{bcde}±5.09$

Plant species	Treatment	Locations		
		AK	CM	OD
Vigna aconitifolia	Control	$2.47^{b}\pm1.56$	$0.57^{a}\pm0.96$	$27.33^{b}\pm6.81$
	AL_1	$5.23^{b}\pm1.76$	$0.80^{a}\pm0.92$	$21.30^{bcd}\pm22.32$
	AL_2	$3.22^{b}\pm2.40$	$1.08^{a}\pm1.73$	$8.00^{def}\pm3.12$
	OM_1	$5.00^{b}\pm1.86$	$0.33^{a}\pm0.49$	$28.37^{b}\pm22.03$
	OM_1+ AL_1	$10.00^{ab}\pm3.72$	$0.20^{a}\pm0.35$	$44.43^{a}\pm3.90$
	OM_2	$23.20^{a}\pm6.96$	$1.57^{a}\pm0.93$	$48.10^{a}\pm44.19$
	OM_2 + AL_2	$13.80^{ab}\pm6.58$	$3.73^{a}\pm2.74$	$18.97^{bcde}\pm5.09$

Results are presented in mean ± standard deviation. Mean values with different superscript along the same vertical axis are significantly different ($P<0.05$) according to Duncan's Multiple Range Test, Control - 0g, AL_1 -Agricultural lime , OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime.
AK: Akamkpa, CM: Calabar Municipality, OD: Odukpani

Table 7. Effect of agricultural lime and organic manure on stem fresh weight (g/plant^{-1}) of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	Locations		
		AK	CM	OD
			4 WAP	
Phaseolus vulgaris	Control	$1.50^{b}\pm0.88$	$0.88^{a}\pm0.10$	$5.05^{de}\pm2.69$
	AL_1	$1.47^{b}\pm0.05$	$0.32^{a}\pm0.55$	$2.58^{e}\pm1.15$
	AL_2	$1.38^{b}\pm1.48$	$0.00^{a}\pm0.00$	$4.09^{de}\pm4.13$
	OM_1	$6.23^{ab}\pm1.29$	$1.05^{a}\pm0.35$	$1.40^{e}\pm0.87$
	OM_1+ AL_1	$4.95^{ab}\pm1.55$	$0.57^{a}\pm0.98$	$3.61^{de}\pm3.19$
	OM_2	$3.38^{b}\pm1.33$	$1.08^{a}\pm0.43$	$1.33^{e}\pm0.53$
	OM_2 + AL_2	$6.03^{ab}\pm2.70$	$0.20^{a}\pm0.35$	$6.17^{de}\pm3.03$
Vigna aconitifolia	Control	$1.32^{b}\pm0.28$	$0.42^{a}\pm0.72$	$9.20^{cde}\pm9.62$
	AL_1	$1.52^{b}\pm0.59$	$0.57^{a}\pm0.51$	$8.60^{cde}\pm5.64$
	AL_2	$1.57^{b}\pm0.46$	$0.57^{a}\pm0.98$	$3.22^{d}\pm0.86$
	OM_1	$6.25^{ab}\pm1.40$	$0.68^{a}\pm0.82$	$9.00^{cde}\pm5.34$
	OM_1+ AL_1	$6.86^{ab}\pm4.55$	$0.00^{a}\pm0.17$	$10.52^{cde}\pm2.25$
	OM_2	$5.17^{ab}\pm3.50$	$0.83^{a}\pm0.15$	$19.65^{bc}\pm21.56$
	OM_2 + AL_2	$4.33^{ab}\pm1.24$	$0.98^{a}\pm0.86$	$6.53^{de}\pm1.88$
			8 WAP	
Phaseolus vulgaris	Control	$4.00^{ab}\pm0.89$	$1.77^{a}\pm0.21$	$10.10^{cde}\pm5.38$
	AL_1	$2.93^{b}\pm0.95$	$0.63^{a}\pm1.10$	$5.17^{dc}\pm2.30$
	AL_2	$2.77^{b}\pm2.58$	$0.00^{a}\pm0.00$	$8.17^{de}\pm8.27$
	OM_1	$12.47^{a}\pm3.10$	$2.10^{a}\pm0.70$	$2.80^{e}\pm1.73$
	OM_1+ AL_1	$10.23^{ab}\pm3.15$	$1.13^{a}\pm1.96$	$7.23^{de}\pm1.39$
	OM_2	$6.77^{ab}\pm3.40$	$2.17^{a}\pm0.85$	$2.67^{e}\pm1.05$
	OM_2 + AL_2	$12.07^{a}\pm4.56$	$0.40^{a}\pm0.69$	$12.33^{bcd}\pm6.07$
Vigna aconitifolia	Control	$2.67^{b}\pm1.16$	$0.83^{a}\pm1.44$	$18.40^{bc}\pm19.25$
	AL_1	$3.03^{b}\pm0.93$	$1.13^{a}\pm1.03$	$13.20^{bcd}\pm11.28$
	AL_2	$3.13^{b}\pm0.81$	$1.13^{a}\pm1.96$	$6.43^{de}\pm1.72$

Plant species	Treatment	Locations		
		AK	CM	OD
	OM_1	12.47[a] ±3.10	1.37[a] ±1.65	18.00[bc]±10.68
	OM_1+ AL_1	13.67[a] ±8.99	0.00[a] ±0.00	21.03[b]±4.51
	OM_2	10.33[b] ±6.48	1.67[a] ±0.31	39.30[a]±43.13
	OM_2 + AL_2	8.67[ab] ±3.48	1.97[a] ±1.72	11.40[cde]±1.93

Results are presented in mean ± standard deviation. Mean values with different superscript along the same vertical axis are significantly different (P<0.05) according to Duncan's Multiple Range Test, Control - 0g, AL_1 -Agricultural lime , OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpani

Table 8. Effect of agricultural lime and organic manure on root fresh weight (g/plant^{-1}) of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	Locations		
		AK	CM	OD
			4 WAP	
Phaseolus vulgaris	Control	0.42[b]±0.25	0.18[a] ±0.08	0.78[c]±0.18
	AL_1	0.37[b]±0.06	0.07[a] ±0.12	0.42[c]±0.15
	AL_2	0.30[b]±0.26	0.00[a] ±0.00	0.70[c]±0.35
	OM_1	0.65[b]±0.05	0.22[a] ±0.08	0.33[c]±0.14
	OM_1+ AL_1	0.57[b]±0.19	0.17[a] ±0.29	0.42[c]±0.40
	OM_2	0.48[b]±0.80	0.28[a] ±0.03	0.30[c]±0.05
	OM_2 + AL_2	0.65[b]±0.18	0.05[a] ±0.09	0.74[c]±0.67
Vigna aconitifolia	Control	0.33[b]±0.06	0.07[a] ±0.12	0.88[c]±0.58
	AL_1	0.40[b]±0.15	0.10[a] ±0.10	1.00[bc]±0.91
	AL_2	0.19[b]±0.16	0.07[a] ±0.12	0.55[c]±0.33
	OM_1	0.65[b]±0.05	0.18[a] ±0.16	1.18[bc]0.75
	OM_1+ AL_1	0.63[b]±0.46	0.03[a] ±0.06	0.70[c]±0.10
	OM_2	0.60[b]±0.20	0.12[a] ±0.08	1.75[bc]±1.08
	OM_2 + AL_2	0.37[b]±0.10	0.42[a] ±0.33	0.68[c]±0.12
			8 WAP	
Phaseolus vulgaris	Control	0.83[b]±0.49	0.37[a]±0.15	1.57[bc]±0.35
	AL_1	0.73[b]±0.12	0.13[a]±0.23	0.80[c]±0.30
	AL_2	0.60[b]±0.52	0.00[a]±0.00	1.40[bc]±0.70
	OM_1	1.30[b]±0.10	0.43[a]±0.15	0.67[c]±0.29
	OM_1+ AL_1	1.13[b]±0.38	0.33[a]±0.58	0.83[c]±0.80
	OM_2	0.97[b]±0.15	0.57[a]±0.06	0.60[c]±0.10
	OM_2 + AL_2	1.30[b]±0.36	0.10[a]±0.17	1.63[bc]±1.10
Vigna aconitifolia	Control	0.67[b]±0.12	0.13[a]±0.23	1.77[bc]±1.16
	AL_1	0.87[b]±0.40	0.20[a]±0.29	2.00[b]±1.82
	AL_2	0.37[b]±0.23	0.13[a]±0.23	1.10[bc]±0.66
	OM_1	1.30[b]±0.10	0.37[a]±0.32	2.37[ab]±1.50

Plant species	Treatment	Locations		
		AK	CM	OD
	OM_1+ AL_1	1.27^b±0.93	0.07^a±0.12	1.40^{bc}±0.20
	OM_2	4.53^a±6.12	0.23^a±0.15	3.50^a±2.16
	OM_2 + AL_2	0.73^b±0.21	0.50^a±0.46	1.37^{bc}±0.25

Results are presented in mean ± standard deviation, Mean values with different superscript along the same vertical axis are significantly different (P<0.05) according to Duncan's Multiple Range Test, WAP – Weeks after planting, Control - 0g, AL_1 -Agricultural lime , OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpani

Table 9. Effect of agricultural lime and organic manure on the production of pods (Number of pods) of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	Locations		
		AK	CM	OD
Phaseolus vulgaris	Control	0.67^b±0.68	0.00^a±0.00	2.00^b±2.15
	AL_1	1.00^b±1.00	0.33^a±0.58	5.00^a±1.00
	AL_2	1.00^b±1.00	0.00^a±0.00	4.67^a±2.08
	OM_1	4.33^a±1.53	0.67^a±0.58	3.67^{ab}±0.58
	OM_1+ AL_1	4.67^a±3.01	0.00^a±0.00	3.67^{ab}±3.51
	OM_2	5.00^a±2.65	0.33^a±0.58	4.00^a±1.00
	OM_2 + AL_2	3.67^a±1.16	0.00^a±0.00	5.67^a±1.53
Vigna aconitifolia	Control	0.33^b±0.58	0.00^a±0.00	1.67^b±0.58
	AL_1	0.00^b±0.00	0.00^a±0.00	2.00^b±0.28
	AL_2	0.67^b±0.38	0.00^a±0.00	1.67^b±0.28
	OM_1	1.33^b±0.58	0.00^a±0.00	5.00^a±1.00
	OM_1+ AL_1	3.00^a±1.00	0.00^a±0.00	1.67^b±30.58
	OM_2	1.00^b±1.00	0.33^a±0.58	5.33^a±4.06
	OM_2 + AL_2	2.00^b±1.00	0.00^a±0.00	4.00^a±1.00

Results are presented in mean ± standard deviation, Mean values with different superscript along the same vertical axis are significantly different (P<0.05) according to Duncan's Multiple Range Test, Control - 0g, AL_1 -Agricultural lime, OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpani

Table 10. Effect of agricultural lime and organic manure on pods weight (g/plant^{-1}) of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	Locations (g)		
		AK	CM	OD
Phaseolus vulgaris	Control	0.90^b±0.85	0.00^a±0.00	2.47^b±1.10
	AL_1	1.20^b±1.31	0.37^a±0.58	5.40^a±1.21
	AL_2	1.10^b±0.96	0.00^a±0.00	5.93^a±2.18
	OM_1	4.43^a±1.60	0.60^a±0.60	4.53^a±1.25
	OM_1+ AL_1	5.87^a±1.01	0.00^a±0.00	3.57^b±2.17
	OM_2	5.43^a±2.95	0.30^a±0.25	5.37^a±1.70
	OM_2 + AL_2	4.73^a±1.00	0.00^a±0.00	7.00^a±1.56

Plant species	Treatment	Locations (g)		
		AK	CM	OD
Vigna aconitifolia	Control	0.13^{b}±0.03	0.00^{a}±0.00	0.90^{b}±0.85
	AL_1	0.00^{b}±0.00	0.00^{a}±0.00	2.27^{b}±0.25
	AL_2	0.80^{b}±0.75	0.00^{a}±0.00	1.05^{b}±1.13
	OM_1	$2.89.43^{b}$±0.49	0.00^{a}±0.00	4.83^{a}±1.94
	OM_1+ AL_1	2.83^{b}±0.74	0.00^{a}±0.00	1.90^{b}±0.46
	OM_2	1.83^{b}±0.85	0.50^{a}±0.08	5.97^{a}±2.34
	OM_2 + AL_2	2.03^{b}±0.76	0.00^{a}±0.00	4.33^{b}±1.47

Results are presented in mean ± standard deviation, Mean values with different superscript along the same vertical axis are significantly different (P<0.05) according to Duncan's Multiple Range Test, Control - 0g, AL_1 -Agricultural lime, OM_1 -Organic manure, AL_2 - Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpani

Table 11. Effect of agricultural lime and organic manure on number of seeds of *Phaseolus vulgaris* and *Vigna aconitifolia* grown on soils from three different locations

Plant species	Treatment	Locations		
		AK	CM	OD
Phaseolus vulgaris	Control	5.33^{de}±1.61	0.00^{a}±0.00	21.67^{c}±5.69
	AL_1	8.33^{d}±1.05	3.00^{a}±1.96	32.67^{c}±5.86
	AL_2	7.00^{de}±1.08	0.00^{a}±0.00	36.00^{b}±14.93
	OM_1	27.67^{c}±12.01	5.00^{a}±4.36	26.33^{bcd}±11.06
	OM_1+ AL_1	37.00^{a}±13.07	0.00^{a}±0.00	23.33^{bcd}±20.21
	OM_2	37.33^{a}±13.97	2.67^{a}±0.62	31.33^{abc}±11.02
	OM_2 + AL_2	31.33^{ab}±8.51	0.00^{a}±0.00	49.00^{a}±13.90
Vigna aconitifolia	Control	1.00^{e}±1.00	0.00^{a}±0.00	7.67^{d}±6.81
	AL_1	0.00^{e}±0.00	0.00^{a}±0.00	14.67^{cd}±3.21
	AL_2	6.33^{de}±1.69	0.00^{a}±0.00	10.00^{d}±4.90
	OM_1	9.67^{c}±5.69	0.00^{a}±0.00	32.33^{abc}±10.2
	OM_1+ AL_1	19.67^{abc}±4.51	0.00^{a}±0.00	15.67^{cd}±6.81
	OM_2	11.67^{bcd}±2.04	3.33^{a}±0.00	40.00^{ab}±12.08
	OM_2 + AL_2	13.6^{bcd}±6.69	0.00^{a}±0.00	29.33^{bc}±6.56

Results are presented in mean ± standard deviation, Mean values with different superscript along the same vertical axis are significantly different (P<0.05) according to Duncan's Multiple Range Test, Control - 0g, AL_1 -Agricultural lime, OM_1 -Organic manure, AL_2 -Agricultural lime, OM_1 - Organic manure, OM_1 + AL_1 – 50 g organic manure + 50 g Agricultural Lime, OM_2 - Organic manure, OM_2 + AL_2 – 100 g organic manure + 100 g Agricultural Lime. AK: Akamkpa, CM: Calabar Municipality, OD: Odukpani

AL or Fe^{2+} hydroxyl oxides were replaced by organic anions which were decomposition products of the manure such as malate, citrate and tartrate. The present findings also agreed with reports by Madukwe et al. [23] that the application of manure increased the soil pH and other soil physico-chemical properties after treatment. Higher pH values at harvest was earlier attributed to application of phosphorus fertilizer and the positive effect of liming which neutralized soil acidity [24].

Plant growth and yield are important agronomic traits that must be given adequate attention if farmers are to meet the food demand of the populace and make robust economic gains. Application of manure to enhance these traits is important and farmers need to be provided with useful information on application rate, timing and method of application. Results of increase in plants growth parameters due to soil amendment in this study were not significant at initial growth periods (2 WAP), but increased significantly with progressing periods (4 WAP, 6 WAP and 8 WAP) compared to the control plants. Results of plant heights revealed no significant differences 2 WAP. This is due to poor seedlings establishment at this early stage or initial growth period. The seedlings require time to grow and two weeks is a short period for plants to attain a meaningful height. This is in agreement with the work of Adeoye et al. [18] who reported the short growth period to allow for manifestation of any genetic trait. However, as the number of weeks increased, there was resultant increase in plant height with the different treatments. This is in accordance with the work of Opala [25] who reported that liming increase plant height as the number of weeks increased. A similar trend of increase in plant height as the number of weeks increased after application of poultry manure was reported in cowpea [26]. It was observed in this study that at eight weeks after planting (8 WAP), the highest plant height was obtained with plants on soil from Akamkpa treated with a combination of organic manure and agricultural lime. This was higher than all other plant heights with the same treatment. However, plants heights from Odukpani soil were consistence across the treatments. This may suggest that the use of organic manure and agricultural lime as sources of fertilizer could exert more effect on seedling development and growth of *P. vulgaris* and *V. aconitifolia* grown on alkaline than acidic environments.

The petiole length had significant variation at 2 weeks after planting. As the number of weeks increased, there was corresponding increase in petiole length. However, at 4 WAP and 6 WAP, plants from Odukpani soil had similar petiole lengths. It is possible that the plant physiological development at these stages does not support petiole development. However, at 8 WAP, plants grown on soil from Odukpani had improved petiole length. It was earlier reported that soil acidity decreases petiole length in plant [27]. This is worrisome considering the critical role that the petiole length plays in supplying photosynthetic products from leaves to other parts of the plant and also acting as a transport medium of water from xylem cells to the leaves. It was rather observed in this study that the application of organic manure and agricultural lime to the plants enhanced the petiole length for plants grown on soil from Akamkpa and Odukpani. Thus, the two treatments could have the potential to mitigate the acidic and alkaline effect of soil pH to support the growth of *P. vulgaris* and *V. aconitifolia.* The leaf area of plant is an important growth parameter. The leaf area provides the surface area for photosynthesis to take place. A larger leaf area will provide sufficient surface area for trapping of sunlight for photosynthesis. This will in turn result in high food manufacturing for plant utilization and improved yield. In this study, the treatments improved the leaf area of both plants which generally increased with progressive periods of development. Organic manure produced a more consistence effect than agricultural lime on the leaf area improvement of both plants, especially when they were used singly. This disagrees with the earlier research findings of Adeoye et al. [18] that, combination of organic manure and other nutrients gave better leaf area compared to the use of either of the manure alone. This difference could be attributed to the dosage effect or probably due to other environmental factors that were not considered in the study. Acidity of the soil hampers availability of nutrient in the soil as well as reduced leaf area as reported by Ekpo et al. [28]. To mitigate this effect, manure application is required to enhance soil nutrient and improve plants leaf area. The improvement of leaf area in this study could suggest better chances of photosynthetic activities in these two plants following the application of treatments. The number of leaves in plants is a function of factors such as petiole development and availability of nutrients in the soil. It has been noted that, lack of nutrients in the soil as a result of high soil acidity has a detrimental effect on the number of leaves in plants. In this study, the number of leaves increased significantly from 6 WAP to 8 WAP following application of treatment. The treated plants were higher in leaf number than the control. This may be attributed to the improvement in petiole length which may have given rise to higher leaf production. This corroborates the report of [28] that enhancing the availability of nutrients in the soil is critical in leaf number development which will in turn enhance food production via photosynthesis.

Plant fresh weight is an indicator of the nutrients that are available in the plant with water. The amount depends mostly on plant growth and development. Often, plants that have proper growth yield more fresh weights than plants with poor growth. Results of this study revealed that *V. aconitifolia* grown on soil treated with 200 g organic manure produced higher LFW compared to the control at the final harvest. The leaf fresh weights of plant grown on Odukpani soil showed statistical differences among the treatments. Organic manure at 100 g in combination with agricultural lime and organic manure at 200 g (OM_2 + AL_2) produced significant leaf fresh weight. It is possible that these manure had significant influence in enhancing soil nutrients needed for growth and leaf development in the plants. Application of organic manure and agricultural lime to plant enhances cytokinins, riboflavin, vitamins which interact with the roots of leguminous and non-leguminous plants to improve the overall plant health [29]. Stem fresh weight was again higher in organic matter treated plants (OM_1 and OM_2) and organic matter in combination with lime (OM_1 + AL_1 and OM_2 + AL_2) were higher than plants treated with only agricultural lime, especially in *V. aconitifolia.* It was similarly observed that organic manure at 200 g produced more root fresh weight in *V. aconitifolia* at 8 WAP. *V. aconitifolia* had a higher fresh matter of leaf, stem and root than *P. vulgaris*. These results are in consonance with earlier findings of Badar and Qureshi [30] that root and shoot fresh weight of cowpea was increased following application of biofertilizers.

The pod of any seed bearing plant is key to the number of seed yield. In the current study, *P. vulgaris* grown on acidic pH 4.0 Akamkpa soil treated with organic manure produced higher number of pods than the control. In this soil, it is expected that acidity of the soil would negatively influence the plants ability to produce any reasonable number of pods, however, the application of organic manure would have supplied the soil with the required nutrients for pod yield. In Akamkpa soil, *P. vulgaris* produced more number of pods than *V. aconitifolia*. Increase in number of pods produced by both plants grown on soils treated with agricultural lime may be attributed to soil acidity neutralizing effect of agricultural lime which in turn increases availability of nutrients essential for growth and yield. This result is in agreement with previous result by [3] who stated that the number of pods produced by haricot bean increased with increase in lime. It was also reported that organic manure increased the number of pods in bush bean, winged bean and long bean [31]. It also agrees with the report of improved pod number of cowpea following treatment with organic manure [32]. Pod weights were higher in *P. vulgaris* grown on soil from Akamkpa treated with organic manure than those treated with agricultural lime, while in Calabar Municipality soil (neutral pH), all treatments showed similar effects on pod weight. There was a corresponding increase in pod weight of plants grown on soil from Odukpani. This may suggest that, alkalinity could support weight gain in pod of beans over acidity. The result obtained from the present study showed that *P. vulgaris* grown on Odukpani soil treated with organic manure yielded higher number of pods, pod weight and produced more number of seeds which further affirms that alkaline soil may have the potential to support yield in cowpea than acidic soil. The findings revealed that higher number of pods and pod weights result in higher seed number. This is in agreement with the report of [18,32].

5. CONCLUSION

From the result of the physico-chemical properties of the soil earlier reported, one would expect the yield of the plants in this study to be very poor since the macro and micro elements in the soil were generally very low. However, the enhancement of growth and yield of the beans varieties in this study is an indication of the inherent ability of organic manure and agricultural lime to improve soil fertility and thus enhance growth and yield components of the plants. Comparatively, organic manure was more potent in enhancing the growth and yield parameters than agricultural lime.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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