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Original Article

Canary melon (*Cucumis melo* L. *var. Inodorus*) response to lime-amended acid soil in the humid tropical rainforest of Nigeria

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Abstract

Preliminary field experiments were conducted to examine the influences of lime ($CaCO_3$) rate (0, 1, 2, 3, 4, and 5 t ha^{-1}) on the production of canary melon (*Cucumis melo* L. *var.* Inodorus) on acidic soil of Calabar, Nigeria. Canary melon production is presently limited to the northern part of Nigeria. The southern part of Nigeria has the potential to support its production, but for low soil pH. The experiment was laid out in a randomised complete block design with three replicates. The initial soil pH (1:2.5 H_2O), 4.13, was improved to 4.69 (1 t ha^{-1}) – 5.93 (5 t ha^{-1}). There was no significant difference ($p > 0.05$) in soil pH increase after 2 t ha^{-1} of $CaCO_3$. Liming significantly ($p \leq 0.05$) increased available P, total N, Ca^{2+}, Mg^{2+}, K^+, effective cation exchange capacity, and base saturation of the soil, but reduced exchangeable acidity. Increased lime rates increased ($p \leq 0.05$) seedling emergence, leaf (area, area index), vine (length and thickness), and fruit and seed yields. However, fruits sweetness was inconsistent. $CaCO_3$ had significant ($p \leq 0.001$) linear relationships and correlations with growth and yield traits of canary melon. Canary melon can be cultivated in Calabar with an application of 2 – 5 t ha^{-1} of $CaCO_3$.

Keywords: *Cucumis melo,* cucurbits, lime, soil acidity, yield traits

1. Introduction

Acidic soils negatively impact crop productivity (McLaren & Cameron, 1996). Soil acidity affects a third of the global land mass (Sumner & Noble, 2003); 50% is arable land suitable for food production (Dai *et al*., 2017). Climatic, agricultural and industrial processes encourage soil acidity (Fageria & Nascente, 2014; Holland *et al.*, 2018). There is disproportionate dependence on synthetic chemicals (von Uexküll & Mutert, 1995) e.g., inorganic fertilizers (Smil, 2002) which influences soil acidity. Plant-soil-microbe interactions vastly influence plant nutrient uptake (Fageria & Baligar, 2008; Haynes, 1984). Population pressure leads to a progressive rise in acid soil cultivation (Tully, Sullivan, Weil, & Sanchez, 2015), therefore, soil management is important. Soil acidity is a challenge in sub-Saharan Africa (SSA) and a third of SSA is affected (Pauw, 1994). Acidic soil can be improved by liming (Fageria & Baligar, 2008; Kunhikrishnan, 2016). This neutralises excess hydrogen ions (Bolan, Adrian, & Curtin, 2003), reduces Al^{3+} toxicity at low pH (Fageria & Baligar, 2008) and increases essential nutrients at higher pH (Thomas & Hargrove, 1984). Low nutrient capital reserves, Al^{3+} toxicity and higher P fixation are key constraints of acid soil in SSA (Sanchez, Palm, & Buol, 2003; Tully *et al.*, 2015). These influence fruit and leafy vegetable productivity (Imathiu, 2021). Soil pH and plant nutrient availability are associated. Soil pH also affects soil microbial activity e.g. the decomposition of organic matter for nutrient release, particularly nitrogen release. Soil degradation in the humid areas of SSA is associated with derelict soils (Tully *et al.*, 2015); nutrient outputs are lower than inputs, draining soil nutrient stores, and resulting in poor crop performance.

Optimal soil pH for plant growth varies by crop. The majority of plants grow well at a pH ≥ 5.5 and ≤ 6.5, and melon requires 5.0 – 6.5. Africa and Southwest Asia are homes of canary melon (*Cucumis melo* L. var. Inodorus) (Adeyeye, 2017; Sabo, Wailare, Aliyu, Jari, & Shuaibu, 2013). In the late 15th Century, it was introduced to Italy (Goldman, 2002; Hedrick, 1919; Jeffrey, 2001; Pitrat *et al.*,

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2000). It is a commercial crop in temperate regions (Zulkarami, Ashrafuzzaman, & Razi, 2010).

Cyprus is the world-leading producer of melons (612.9 t ha^{-1}); Africa had 224.50 t ha^{-1} and its key producers are Morocco (30.0 t ha^{-1}), Egypt (27.5 t ha^{-1}), Sudan (24.0 t ha^{-1}), South Sudan (22.6 t ha^{-1}) and Niger (22.4 t ha^{-1}) (FAOSTAT, 2022). Global production is concentrated in hot and warm regions with 70 to 85 growing days between 21°C and 27°C. They can thrive in moist and semi-arid environments but are frequently challenged by fungal diseases in wetlands.

Canary melon is mostly grown by subsistence farmers in Northern Nigeria: Gombe, Taraba, Bauchi and other neighbouring states (Villanueva *et al.*, 2004). Canary melon is rich in flavonoids, carbohydrates, minerals, and has low fat and high dietary fibre contents (Shafeek, Aisha, Asmaa, Magda, & Fatima, 2015; Tamer, Needayi, Parseker, & Copur, 2010). There is no documented data on canary melon production in southern Nigeria: it is an under-exploited fruit vegetable in Nigeria. Its production in southern Nigeria has the potential to supplement that in northern Nigeria. However, soil acidity is a problem that affects most soils in southern Nigeria and this can adversely affect canary melon production. Basically, soil pH measures the molarity of hydrogen ions in a soil solution (Moody & Cong, 2008). This determines soil chemical reactions and influences nutrient availability, toxicity, soil flora composition, and root activities.

In Calabar, a humid tropical rainforest in southern Nigeria, soil pH ranges from 4.0 to 5.0. Soil pH can be amended by using appropriate liming materials, such as ground agricultural limestone and wood ash. Wood ash contains large amounts of potassium and calcium, along with low amounts of phosphate, boron and other nutrients. Although they are not as effective as limestone, they can significantly increase the pH of the soil through repeated use. In addition to ammonium fertilizers and organic matter, aluminium sulphate and sulphur are also used to reduce soil pH. Aluminium sulphate has a rapid effect as a result of aluminium, but in excess it is poisonous to the plants. Sulphur produces a slow effect as sulphuric acid is converted by the S-oxidizing soil bacteria. Overall, adequate and appropriate liming increases the availability of plant nutrients (Rastija, Zebec, & Rastija, 2014). Thus, the purpose of this study was to assess the response of *Cucumis melo* L. var. *Inodorus* cv. 'Juan' to lime-amended acid soil of Calabar, southern Nigeria.

2. Materials and Methods

The experiment took place at the Department of Crop Science Farm, University of Calabar, Nigeria between September 2020 and January 2021. Calabar ((latitude 4.5° and 5.2° N and longitude 8.0° and 8.3° E, 39 masl) Ibanga & Armon, 1992) has a bimodal annual rainfall (3,000 to 3,500 mm) (Manamu, 1975), short dry period (December to February), separating the long (March and August) and short (September to November) rainy periods. Before and after lime application, topsoil samples (20 cm depth) were obtained, grouped, air dried and sifted (2 mm mesh) for the following analysis: soil pH (IITA, 1982), particle size distribution (Gee & Bauder, 1986), total N (Bremner & Mulvaney, 1982), organic carbon (Nelson & Sommers, 1982), and available P (Bray & Kurtz, 1945; Murphy & Riley, 1962), exchangeable bases and exchangeable acidity (Anderson & Ingram, 1993). Effective cation exchange capacity (ECEC) was determined as the sum of exchangeable bases and acids.

Fruits of *Cucumis melo* L. *var. Inodorus* were identified using the melon crop descriptors (International Plant Genetic Resources Institute **[**IPGRI**]**, 2003). These were sourced from farmers in Jalingo, Taraba, during harvest (August – September, 2020). Seeds were extracted, air dried and sorted for uniformity. Agricultural lime ($CaCO_3$) (Quest Two Enterprise Ltd, Kogi State, Nigeria) was procured from the Cross River State Agricultural Development Program Office, Calabar, Cross River state. The $CaCO_3$ had a neutralizing value of 99% and 95% purity. The experiment was laid out in a randomized complete block (RCBD) design with six rates of $CaCO_3$ (0 t ha^{-1} (control), 1 t ha^{-1}, 2 t ha^{-1}, 3 t ha^{-1}, 4 t ha^{-1} and 5 t ha^{-1}) in three replications. Elevated beds of 4.0 m (length) × 2.5 m (width) × 0.3 m (height) with 1 m furrows were raised. $CaCO_3$ was uniformly applied by broadcasting and incorporated into the soil by minimal tillage (15 - 20 cm depth). After 7 days of lime application, seeds (3 – 5 per hole) were planted at a spacing of 50 cm × 100 cm. At 10 – 14 DAP the seedlings were thinned to two per hill giving a population of 40,000 stands ha^{-1}. A net plot of 1 m × 1 m, with six tagged plants, was earmarked for data collection.

NPK 20:10:10 (80 kg N ha^{-1}) was applied at 2 WAP, followed by Urea (46% N) (40 kg N ha^{-1}) (as topdressing) at 6 WAP; after first and second weeding, respectively. Data on seedling emergence (%) (EM) was collected at 7 DAP. The following data were collected at maturity (harvest): vine length (cm) (VL), number of leaves per plant (NL), vine thickness (mm) (VT), leaf length (cm) (LL), leaf breadth (cm) (LB), leaf area (cm^2) (LA), leaf area index (LAI), number of fruits per plant (NF), fruit weight (g) (FW), fruit yield (t ha^{-1}) (FY), fruit volume (ml) (FV), rind thickness (mm) (RT), fruit diameter (mm) (FD), and number of seeds per fruit (NS) and °Bx (%).

Data were subjected to a two-way analysis of variance (ANOVA) using Genstat 16th Edition. Duncan's New Multiple Range Test (DNMRT) was used for the *post hoc* ($\alpha = 0.05$) testing. Simple linear regression ($\alpha = 0.05$) modelled the relationships between lime rates and growth characters. Pearson correlation analysis ($\alpha = 0.05$) was performed between yield and yield-related characters.

3. Results and Discussion

3.1 Soil properties

The soil texture was sandy loam (Table 1). Available phosphorus (22.90 – 26.70 mg kg^{-1}) and total nitrogen (0.09 – 0.13%) showed significant differences ($p \leq 0.05$) by lime rate. Available phosphorus increase was directly proportional to lime rate in concordance with Alemu *et al.* (2017), Buni (2014), Kebede and Dereje (2017), and Tamene, Anbessa, and Adisu (2017). There was no significant difference ($p > 0.05$) in organic carbon content between the control (0.61%) and 5 t ha^{-1} (0.97%). Organic matter followed the same trend. Organic carbon contents (0.60 – 0.97%) were below the critical level (1.0%) recommended by Agboola *et al.* (1987). Organic carbon and total nitrogen were within medium and low levels, respectively (Ethiosis, 2016; Murphy,

Table 1. Physical and chemical properties of the experimental soil before planting and after harvest

Lime (t ha^{-1})	Sa	St	Cl	STx	P	N	OC	OM	Ca	Mg	K	Na	EA	ECEC	BS
After harvest															
0	798	82	120	SL	24.03 ab	0.09 c	0.61 a	1.05 a	3.20 d	1.07 b	0.08 ab	0.16 a	1.07 ab	6.52 c	83.23 de
1	758	102	140	SL	24.12 ab	0.10 bc	0.62 a	1.06 a	4.87 cd	1.18 b	0.12 b	0.17 a	0.93 bc	7.41 c	85.73 cd
2	759	102	130	SL	24.43 ab	0.12 b	0.79 a	1.35 a	5.60 bc	1.20 b	0.12 b	0.20 a	0.85 bcd	7.64 c	88.50 bcd
3	738	82	180	SL	24.70 ab	0.13 ab	0.84 a	1.55 a	7.13 ab	1.40 b	0.15 b	0.22 a	0.77 cd	9.73 b	92.05 abc
4	708	116	176	SL	24.97 ab	0.13 ab	0.91 a	1.58 a	7.93 a	2.07 a	0.23 ab	0.22 a	0.69 cd	10.99 ab	93.66 ab
5	798	91	111	SL	26.70 a	0.13 ab	0.97 a	1.67 a	8.53 a	2.33 a	0.32 a	0.28 a	0.59 d	12.00 a	95.06 a
Before planting															
No lime	769	99	131	SL	22.90 b	0.09 c	0.60 a	1.04 a	3.18 d	0.87 b	0.07 b	0.16 a	1.28 a	5.78 c	77.85 e

Sa = Sand (g kg^{-1}); St = Silt (g/kg); Cl = Clay (g kg^{-1}); STx = Soil Texture; SL = Sandy Loam; P = Available Phosphorus (mg kg^{-1}); N = Nitrogen (%); OC = Organic Carbon (%); OM = Organic Matter (%); Ca = Calcium (cmol (+) kg^{-1}); Mg = Magnesium (cmol (+) kg^{-1}); K = Potassium (cmol (+) kg^{-1}); Na = Sodium (cmol (+) kg^{-1}); EA = Exchangeable Acidity (cmol (+) kg^{-1}); ECEC = Effective Cation Exchange Capacity (cmol (+) kg^{-1}); BS = Base Saturation (%). Values with the same letter(s) are not significantly different using the Duncan New Multiple Range test ($\alpha = 0.05$).

1968; Tadesse, Haque & Aduayi, 1991). Contrary to our findings, Dawid and Hailu (2017), Dinkecha and Tsegaye (2017), and Kassa, Yebo, and Habte (2014), reported that organic carbon and total nitrogen variations were not significant irrespective of liming material, rates and application methods. There was a significant difference ($p \leq 0.05$) in exchangeable acidity between lime rates; decreasing with increasing lime rates in agreement with Alemu, Selassie, and Yitaferu (2022).

There was no significant difference ($p > 0.05$) between effective cation exchange capacity (ECEC) before planting (5.78 cmol (+) kg^{-1}) and after harvest at 0 t ha^{-1} (6.52 cmol (+) kg^{-1}), 1 t ha^{-1} (7.41 cmol (+) kg^{-1}) and 2 t ha^{-1} (7.67 cmol (+) kg^{-1}). There was a significant difference ($p \leq 0.05$) between base saturation (BS) before planting (77.85%) and after harvest (1 – 5 t ha^{-1}) with exception of 0 t ha^{-1} (83.23%). The initial soil pH of 4.13 (extremely acidic soil) (Figure 1) was significantly increased ($p \leq 0.05$) after the lime-amendments (2 – 5 t ha^{-1}). Soil pH at 2 t ha^{-1} was not significantly different from 3 t ha^{-1} (5.63), 4 t ha^{-1} (5.80) or 5 t ha^{-1} (5.93) of lime.

At soil pH < 5.5 Al^{3+} toxicity could occur. Liming can mitigate this by lowering exchangeable acidity. Our results confirmed the inverse relationship between exchangeable acidity and lime rate in conformity with Alemu *et al.*, (2017), Buni (2014), Chimdi, Gebrekidan, Kibret, and Tadesse (2012), and Tamene *et al.*, (2017). A soil test in the study area before planting revealed that the soil had a sandy texture with a pH (in water) of 4.13. This textural class is attributable to low clay and silt contents in the study area. After the application of lime, the highest pH was 5.93. It is suitable for crop production in Nigeria, as pointed out by Lawal, Ojanuga, Tsado, and Mohammed (2013).

Base cations (Ca^{2+}, Mg^{2+}, K^+, Na^+) differ from acid cations (H^+ and Al^{3+}). At pH ≤ 5.4, Al^{3+} is high in concentration, hindering the growth of most plants. Our Na^+ was low (0.1 – 0.3 cmol (+) kg^{-1}), K^+ was very low (0 – 0.2 cmol (+) kg^{-1}) to moderate (0.3 – 0.7 cmol (+) kg^{-1}), Ca^{2+} was low (2 – 5 cmol (+) kg^{-1}) to moderate (5 – 10 cmol (+) kg^{-1}) and Mg^{2+} was low (0.3 – 1.0 cmol (+) kg^{-1}) to moderate (1 – 3 cmol (+) kg^{-1}) according to Metson (1961). Whereas the report of Alemu *et al.* (2022) indicated that exchangeable Ca^{2+}, Mg^{2+}, K^+, and Na^+ showed significant differences due to liming, our Na^+ increase was not significant with liming.

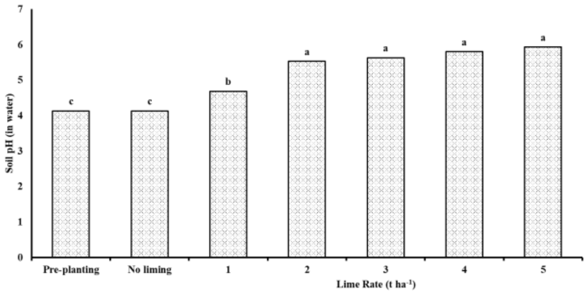

Figure 1. Pre-planting and post-harvest soil pH. Bars with the same letters are not significantly different using Duncan New Multiple Range test ($\alpha = 0.05$).

The effective cation exchange capacity (ECEC) (6.52 – 12.00 cmol (+) kg^{-1}) significantly ($p \leq 0.05$) increased with lime rate. Cation exchange capacity (CEC) is a measure of the total negative charges within the soil that adsorb plant nutrient cations. In general, CEC is lowest at pH 3.5 – 4.0, but could increase with liming according to Legesse, Robi, Gebeyehu, Bultosa and Mekbib (2013); Holland *et al.* (2018); Dawid and Hailu (2017) and Alemu *et al.* (2017). Base saturation (BS) (83.23 – 95.06%), the proportion of the CEC occupied by base cations, increased ($p \leq 0.05$) with lime rate. A BS range of 70 – 100% indicates that exchangeable bases can very weakly be leached (Hazelton & Murphy, 2016). Nonetheless, the value of soil does not hinge on its ability to supply suitable nutrients alone but the nutrients must be in the precise amount required by plants as stated by Ayeni *et al.*, (2011).

3.2 Growth and yield traits of canary melon influenced by lime

Liming influenced ($p \leq 0.05$) seedling emergence (EM) in canary melon (Table 2). There was no significant difference ($p > 0.05$) between 0 t ha^{-1} (87.0%) and 1 t ha^{-1} (87.0%) and between 3 t ha^{-1} (95.0%) and 4 t ha^{-1} (96.67%) of lime. Overall, the highest EM was recorded at 5 t ha^{-1} (98.0%). Lime at 5 t ha^{-1} significantly ($p \leq 0.05$) increased leaf length (LL) (10.67cm) over other rates (8.09 – 9.76 cm). LL at 0 t ha^{-1} (8.09cm) was similar ($p > 0.05$) to 1 t ha^{-1} (8.56cm). LL did not differ ($p > 0.05$) at 2 t ha^{-1} (8.88 cm) and 3 t ha^{-1} (9.11 cm).

The application of lime had a significant ($p \leq 0.05$) influence on leaf breadth (LB) of canary melon (9.34 – 13.66 cm). LB followed a similar trend as LL. Leaf Area (LA) and LAI followed the same trend as LB. The influence of lime (t ha^{-1}) on LB, LA and LAI followed the order: $0 \leq 1 < 2 \leq 3 < 4 < 5$. The number of leaves per plant (NL) significantly ($p \leq 0.05$) increased with lime rate. NL ranged from 32.48 (0 t ha^{-1}) to 80.49 (5 t ha^{-1}). Vine length (VL) and vine thickness (VT) also increased with the lime application with controls being significantly different from lime-amended soil. Lime at 5 t ha^{-1} produced plants with the highest VL (222.69 cm) and VT (7.11 mm).

The number of fruits per plant (NF), fruit volume (VL), fruit weight (FW), fruit yield (FY), Brix (°Bx), rind thickness (RT), fruit diameter (FD) and the number of seeds per fruit (NS) were significantly ($p \leq 0.05$) influenced by the lime rate (Table 3). The higher the lime rate the higher the yield and yield-related traits except for °Bx. United Nations Economic Commission for Europe (UNECE) sets a standard for Charentais type melons (*Cucumis melo* var. cantalupensis) soluble solid content (SSC) to be ≥ 10°Bx and 8°Bx for other melons including *Cucumis melo* var. Inodorus (UNECE, 2006). The latter agreed with our results. We recorded decrease in °Bx decrease in the order: 20.09% (3 t ha^{-1}) ≥ 19.64% (4 t ha^{-1}) ≥ 15.01% (1 t ha^{-1}) ≥ 13.66% (2 t ha^{-1}) ≥ 11.51% (5 t ha^{-1}). Ca, Mg, and K imbalance could have been the cause of this at higher soil pH. K is important in the accumulation of fruit sucrose (Lin, Huang, & Wang, 2004), sugar richness in date palm (Assirey, 2015), total sugar in pear fruit (Shen *et al.*, 2017), soluble solid levels of apple (Zhang *et al.*, 2018), total sugar and soluble solids in muskmelon (Lin *et al.*, 2004) and total soluble solids of the yellow melon (Moreira *et al.*, 2022). K deficiency has a direct impact on plant growth, resulting in reduced crop yield and production, implying that additional K fertilisers are necessary for sustainable agricultural practices (Shen *et al.*, 2017). The availability of K is crucial to the improvement of melon quality in terms of sweetness.

Table 2. Growth traits of canary melon on lime-amended acid soil

Lime (t ha^{-1})	Emergence (7DAP) (%)	Leaf length (cm)	Leaf breadth (cm)	Leaf area (cm^2)	Leaf area index	Number of leaves per plant	Vine length (cm)	Vine thickness (mm)
0	87.00 d	8.09 e	9.34 e	50.51 e	0.0101 e	32.48 e	107.61 e	5.03 e
1	87.00 d	8.56 de	10.13 d	58.14 d	0.0116 d	44.13 d	130.06 d	5.83 d
2	91.67 c	8.88 cd	10.82 c	64.27 c	0.0129 c	54.00 c	158.94 c	6.20 cd
3	95.00 b	9.11 c	11.31 c	68.96 c	0.0138 c	66.51 b	172.01 bc	6.52 bc
4	96.67 ab	9.76 b	12.21 b	79.87 b	0.0160 b	70.04 b	188.57 b	6.67 ab
5	98.00 a	10.67 a	13.66 a	97.49 a	0.0195 a	80.49 a	222.69 a	7.11 a

DAP = Days after planting. Values with the same letter(s) are not significantly different using the Duncan New Multiple Range test ($\alpha = 0.05$).

Table 3. Yield and yield-related traits of canary melon on lime-amended acid soil

Lime (t ha^{-1})	Number of fruits per plant	Fruit volume (ml/fruit)	Fruit weight (g/fruit)	Fruit yield (t ha^{-1})	Brix (%)	Rind thickness (mm)	Fruit diameter (cm)	Number of seeds per fruit
0	2.11 b	984.07 b	198.96 b	3.19 c	8.86 a	12.27 f	71.47 f	460.67 f
1	3.67 ab	1089.57 a	225.06 b	4.50 bc	7.53 ab	14.32 e	75.72 e	475.56 e
2	3.22 ab	1067.59 a	199.91 b	4.00 bc	7.65 ab	16.65 d	79.04 d	500.11 d
3	3.44 ab	1053.43 ab	202.87 b	4.12 bc	7.08 b	18.17 c	81.97 c	530.00 c
4	2.89 b	1056.25 ab	255.28 ab	5.17 ab	7.12 b	21.09 b	89.20 b	534.22 b
5	4.67 a	1136.85 a	320.89 a	6.41 a	7.84 ab	30.09 a	92.45 a	604.33 a

Values with the same letter(s) are not significantly different using the Duncan New Multiple Range test ($\alpha = 0.05$).

Table 4. Correlation of yield traits of canary melon on lime-amended acid soil

Variables	Fruit weight (g)	Fruit yield (t ha^{-1})	Brix (%)	Rind thickness (mm)	Fruit diameter (cm)	Number of seeds per fruit
Fruit volume (ml)	0.71***	0.75***	-0.06	0.26	0.24	0.05
Fruit weight (g)		0.85***	-0.03	0.39**	0.47***	0.17
Fruit yield (t ha^{-1})			-0.17	0.41**	0.52***	0.29*
Brix (%)				-0.09	-0.23	-0.18
Rind thickness (mm)					0.79***	0.64***
Fruit diameter (cm)						0.61***

* = $p \leq 0.05$, ** = $p \leq 0.01$, *** = $p \leq 0.001$.

Liming of acid soils mostly improves their chemical properties, aids nutrient mobility and uptake by plants (Bolan *et al*., 2003; Chan and Heenan, 1998; Jaskulska, Jaskulski, & Kobierski, 2014). Nonetheless, crop species do differ in sensitivity and response to soil pH (Holland *et al.*, 2018; Li, Cui, Chang, & Zhang, 2019; Ossom & Rhykerd, 2007). Our study found a directly proportional relationship between liming (≥ 2 t ha^{-1}) and increase in soil pH, cation exchange capacity, base saturation and improvement in the performance of canary melon. These agreed with El-Habbasha *et al.*, (2005) and Kumar and Matta (1997). Therefore, there is a high potential for canary melon production in Calabar with adequate liming.

3.3 Regression and correlation analyses

There was a highly significant ($p < 0.001$) relationship between lime rates and EM, LL, LB, LA, LAI, VT, NL and VL; every unit increase in lime rate significantly increase the growth of attributes (Figures 2 and 3). These agreed with Kumar and Matta (1997) and El-Habbasha *et al.* (2005). There were highly significant ($p < 0.001$) correlations between fruit volume and fruit weight ($r = 0.71$) and fruit yield ($r = 0.75$). Fruit weight correlated with fruit yield ($r = 0.85$), rind thickness ($r = 0.39$) and fruit diameter ($r = 0.47$). Fruit yield correlated with rind thickness ($r = 0.41$), fruit diameter ($r = 0.52$) and number of seeds per fruit ($r = 0.29$). There was no significant association between °Bx and yield traits of canary melon on lime-amended acid soil of Calabar.

4. Conclusions

Liming acidic soil of Calabar with $CaCO_3$ at 2 – 5 t ha^{-1} decreased EA, increased soil pH, ECEC, BS and growth and yields of canary melon (*Cucumis melo* L. *var. Inodorus*). These findings are the first to demonstrate that liming could improve canary melon production in acidic soil of Calabar.

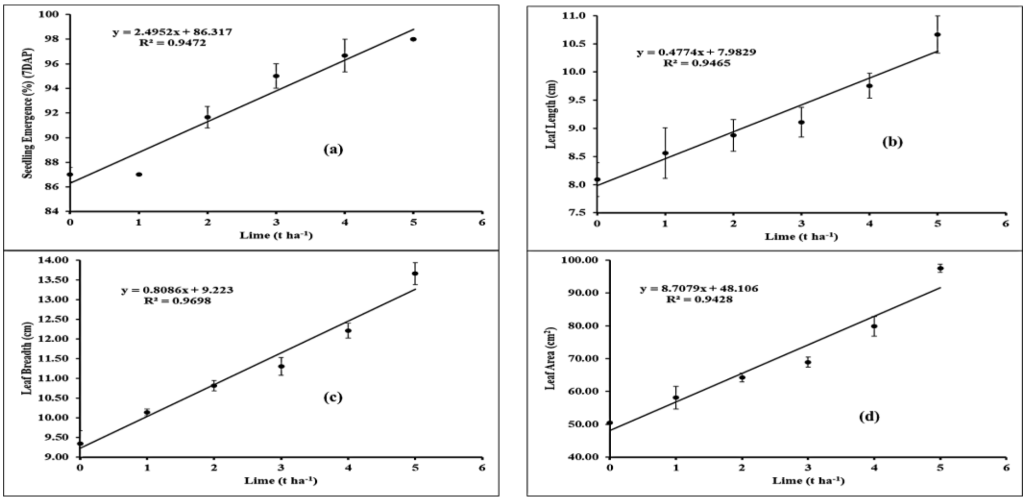

Figure 2. Linear relationships (with standard error bars) between lime rates and (a) seedling emergence, (b) leaf length, (c) leaf breadth, and (d) leaf area of canary melon

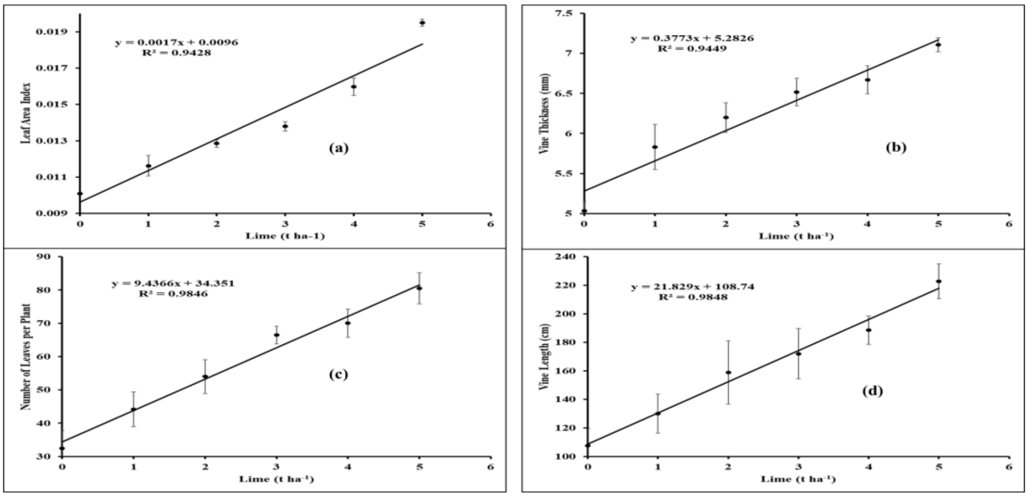

Figure 3. Linear relationships (with standard error bars) between lime rates and (a) leaf area index, (b) vine thickness, (c) number of leaves per plant and (d) vine length of canary melon.

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