Journal Of Agriculture & Ecosystem Management

Publishing Real Time

Journal homepage: www.jonages.com

JOURNAL OF AGRICULTURE AND ECOSYSTEM MANAGEMENT

Efficacy of Indole-3-Acetic Acid, moringa leaf extract and aloe vera extract on the growth and yield of cucumber *(Cucumis sativus)* on a tropicalinceptisol, Southwest, Nigeria.

[1]*Olojugba, Michael Rotimi,[2]Adeyinka Nafisat Adebayo, and [3]Wilson, Brown Yomi

*[1]*Olojugba, Michael Rotimi,[2]Adeyinka Nafisat Adebayo, and [3]Wilson, Brown Yomi*

[1, 2 & 3]Department of Crop, Soil and Pest Management, Olusegun Agagu University of Science and Technology, Okitipupa, Ondo State, Nigeria

ARTICLE INFO

Article history:
Received February 20, 2025
Received in revised form March 3, 2025
Accepted March 25, 2022
Available online April 3,2025

Keywords:
Cucumber
Aloe vera
Soil Properties
IAA, Moringa
yield

Corresponding Author's E-mail Address:
mr.olojugba@oaustech.edu.ng

https://doi.org/10.36265/jonages.2025.03.0105
ISSN– Online **2736-1411**
Print **2736-142X**

ABSTRACT

The use of synthetic chemical fertilizers negatively impacts crop growth, soil health, and the environment. In contrast, moringa leaf extract and aloe vera extract offer eco-friendly alternatives. This study, conducted at the Teaching and Research Farm in Okitipupa from March to July and August to October 2024, aimed to evaluate the effects of Indole-3-acetic acid, moringa leaf extract, and aloe vera extract on cucumber growth and yield. A Completely Randomized Design (CRD) pot experiment was carried out with four treatments: a control (no extract), 25 ml of moringa leaf extract, 100% aloe vera extract, and 25 ml of Indole-3-acetic acid, with each treatment replicated three times. Key parameters assessed included plant height, number of leaves, stem diameter, days to flowering, fruit weight, fruit length, and fruit diameter. The results showed significant differences (P = 0.05) among the treatments. Moringa leaf extract (25 ml) resulted in the highest plant height (145.20[a] cm) and number of leaves (24.86). Indole-3-acetic acid had the highest stem diameter (0.70[a] cm) compared to control (0.30 cm). Moringa extract also produced the greatest fruit weight (4.06[a] g), fruit diameter (13.50[a] cm), and fruit length (14.96[a] cm). Soil analysis indicated that both moringa and aloe vera extracts improved soil properties.

1.0. Introduction

Cucumber *(Cucumis sativus)*, an annual trailing vine vegetable belonging to *the Cucurbitaceae* family, is the most widely grown vegetable of the family after watermelon. The demand and supply for cucumber has been expeditiously increased in the last few years and now it is grown throughout the world using fields or greenhouse culture. It has a diploid chromosome number of 14, 2n= 14 (Kadi *et al.*,2018). Although it is very watery, with little flavour and not very nutritious, it is a common ingredient of salads and pickles, being valued primarily for its crisp texture and juiciness.

The seeds are extremely enriched with nutritive compounds; protein (33.8%), fat (45.2%), carbohydrates (10.3%), and crude fibres (2.0%) and the seed oil consists of four chief fatty acids; linoleic acid (61.6%), oleic acid (15.7%), stearic acid (11.1%), and palmitic acid (10.7%) as described by Mariod*et al*. (2017). The fruits are extremely nutritive and consist of 95% water, and extremely small calories (about 15 calories per cup) reported by Mukherjee et al. (2013). The fruit also consists of calcium (20mg/100g), iron (0.7mg/100g), thiamin (0.3mg/100g), niacin (0.01mg/100) and some natural antioxidants that reduce chronic diseases (Trichopoulou*et al*., 2000; Baset Mia *et al*., 2014)

Moringa oleifera is well-documented for its rich nutrient profile, which positively influences soil health and plant development. The leaves contain high levels of essential minerals, phenolics, vitamins, and proteins that can enhance soil fertility when used as organic amendments Peñalver et al., 2022). Moringa leaf extract has been shown to improve soil moisture retention and increase microbial activity, contributing to better nutrient cycling in the soil (Rachmawatie et al., 2022). This is pivotal for crops like cucumbers, which thrive in well-aerated and nutrient-rich soils

The major problem is maleness in cucumber which greatly decreases the fruit yield (Singh *et al*., 2015). Other problems include shape distortion, untimed maturity, fruit drop, late flowering, early senescence, and so on which can be solved by the recommended dose of plant growth regulators. People are nowadays better concerned about what they eat and how they are produced or processed (Khanal, 2020). For this reason, healthy concentrations of plant growth regulators should be applied.

Plant growth regulators, commonly known as phytohormones, are those chemical compounds that control all aspects of growth and development within the plants. There are five major classical phytohormones which consist of more than 20 types of PGRs; they are auxin, cytokinins, gibberellins, abscisic acid, and ethylene. In addition, cucumber also contains a diverse variety of biologically active, non-nutritive compounds regarded as phytochemicals like alkaloids, flavonoids, tannins, phlorotannins, steroids, saponins and many others. The physiological processes like growth and development of the plant, enhancement of the fruit colour, flower differentiation, fruit ripening, tissue growth, etc. are controlled by the appropriate application of plant growth regulators (Prajapati *et al*., 2015). It also controls the vegetative growth of plants and helps to increase the plant population per area (Latimer, 2019).

Indole-3-acetic acid (IAA) is the most abundant naturally occurring auxin with a well-documented ability to regulate many aspects of plant development some of them include the differentiation of vascular tissues, elongation growth, apical dominance, lateral root initiation, fruit setting and ripening (Macdonald 1997; Woodward and Bartel 2005). Plants produce active IAA both by de novo synthesis and by releasing IAA from conjugates (Davies 1995; Bartel 1997).

A natural plant growth regulator, Zeatin is a natural form of cytokine which can be found at a high level (5 µg and 200 µg/g) in fresh moringa leaves. It was mentioned by several researchers (Makkar and Becker, 1996; Basra *et al*., 2011; Abdalla,2013; Unuigbe*et al*., 2015) that due to having zeatin in the moringa leaves, which is an effective plant growth hormone, many crop yields as soybean, maize and coffee can be improved by 25-30% using moringa juice extract.

In everyday life, synthetic growth regulators are still difficult to find, and the price is relatively expensive, so need to look for other alternatives. One of the natural plant growth regulators (bioregulators) that are easy and cheap to obtain is the leaf of aloe vera gel. The use of Aloe vera leaf gel as a bioregulator was tested on several types of plants. This is presumably because the aloe vera gel contains plant growth regulators, especially auxin, amino acids, vitamins and minerals that could encourage the growth of cuttings (Sundahri, 1994). Many researches have studied natural growth regulators on cucumber, but the individual and combined impact of moringa leaf extract, aloe vera gel and indo acetic acid (IAA) and their combined effect have not been studied in details, this study was carried out to study the impact of the three growth hormones cucumber in Nigeria.

2.0. Materials and Methods

2.1. Site Description

The study site is the Teaching and Research Farm Olusegun Agagu University of Science and Technology, Okitipupa, Ondo state, Nigeria which lies in the latitudes 6.50' N and 7.5 20' N and longitudes 4.37'E and 5.55' E, 33.22 m above sea level within the tropical rain forest zone of Nigeria. The study site falls within a tropical region and includes a diversity of land uses: forested regions, farmland and developed areas.

This study, conducted at the Teaching and Research Farm in Okitipupa from March to July and August to October 2024.

2.2. *Climate*

The climate of the study area is characteristic of southern Nigeria, where tropical humid conditions prevail. This region experiences two distinct seasons: a rainy season and a dry season. The rainy season and the dry season. The rainy season typically spans from March to November, with peaks in July and September, while the dry season occurs from December to February, characterized by reduced rainfall and higher temperatures. Average annual rainfall can range from 1,500 mm to 2,000 mm, which supports both the dense forest cover and the extensive farming activities observed in the area. The temperature in these regions is generally warm throughout the year, with average daily temperature ranging from 25 C TO 30 C. Humidity levels are also high, particularly during the rainy season, which contributes to the lush vegetation observed in the forested areas of the study site. The climate plays a crucial role in shaping the land use patterns in the study area. The abundant rainfall and warm temperatures support a diverse range of vegetation, making the region ideal for both forestry and agriculture

2.3. Vegetation and Land-use

The vegetation of the study site is diverse and reflects the region's tropical climate. The forested areas shown on the map are likely dominated by tropical rainforest species, which are known for their dense canopies and high biodiversity. These forests serve as critical ecosystems, providing habitat for wildlife, and maintaining soil fertility. The farmland areas represent a significant portion of the study site, indicating the importance of agriculture in the local economy. The farmland is likely used for growing crops such as cassava, maize, yams and vegetables, which are staples in the diets of local communities. Additionally, some areas may be used for animal husbandry, including cattle, goats and poultry.

2.4. Experimental Materials

1The following materials were used for the experiment:

2The test crop - Cucumber *(Cucumis sativus)* obtained from First Let's Farm Integrated Limited, Akure. The Cucumber species HYB. CUCUMBER SLICING, variety: DARINA F1. Young leaves and branches of moringa and aloe vera were harvested from young fully grown trees located at the University farm. Hoes, vernier caliper, measuring ruler from departmental farm warehouse Treatments **preparation**

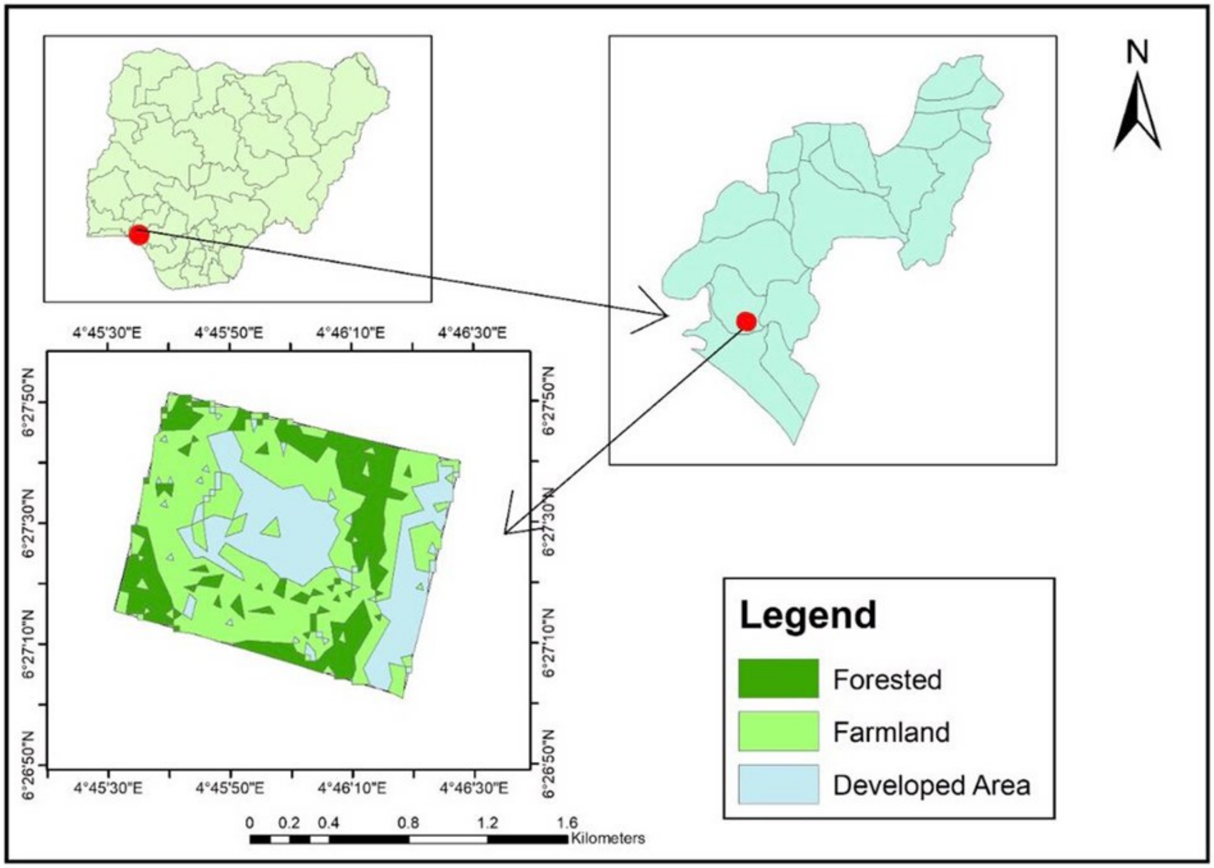

Figure 1: Map of the Study Area, Okitipupa Local Government Area, Ondo State Nigeria

3IAA solution

41g of IAA was weighed and put in a beaker. The IAA will be dissolved with 1000ml of distilled water. 10ml of the IAA solutions will be measured and then dissolved in 100ml of water, and 25ml will be extracted and sprayed per plant (Umeoka, 2024).

Moringa leaf extract

1 Fifty grams of Moringa leaves were collected, washed and ground, 500 ml of distilled water was added and filtered with a sieve. Moringa leaf extract was sprayed at the rate of 25ml per plant (Adelowo *et al*, 2022).

Aloe vera extract

1The preparation was kept simple to ensure that rural farmers could prepare it easily. One kilogram of freshly harvested Aloe vera leaves was weighed and washed under a running tap. The weighed leaves were chopped into bits with a clean knife and soaked in 1 litre of water for 72 hours in a plastic basin. At the end of the 72 hours, the extract was obtained by filtering using a piece of regular 2 mm sieve. The quantity of this extract was used directly as 100 per cent concentration. (Wilson *et al*, 2020).

2Experimental Design

3The experiment was designed using Completely Randomized Design (CRD). There were four treatments replicated three (3) times. The experiment was conducted using pots in a screen house under a controlled environment. This study, conducted at the Teaching and Research Farm in Okitipupa from March to July and August to October 2024. The treatments applied include:

1.Treatment 1: Control

2.Treatment 2: Moringa leaf extract at 25ml

3.Treatment 3: Aloe vera extract at 100% concentration

Treatment 4: Indole-3-acetic acid at 25ml

The control pot received no treatment, 25 ml of was sprayed to the moringa treated pot, 25 ml was equally sprayed to the indo acetic acid pot, the 25 ml was achieved by using syringe. Also, 25 ml of aloe vera gel was applied to the aloe vera pot. All treatments were applied after two weeks and every week thereafter for three months until after harvesting..

Pot preparation

Topsoil was collected from the experimental field and then pulverized. The inert materials, visible insects, pests, debris and weeds were removed. Then the soil was dried thoroughly. Clean and dried pots of 7-litre size were perforated and used for the experiment. Each pot was filled with 4 kg of previously prepared soil.

Sowing of seed

Seeds were sown on March and August (two seasons) 2024, with two seeds sown per pot.

Thinning and weeding

The young plants were thinned to one stand per pot after planting. Manual weeding was done as frequently as the situation demanded.

Agronomic data collection

The collection of data commenced three weeks after planting and was done at a one-week interval. A plant was randomly selected from each treatment pot as a specimen plant.

Plant sample collection

The growth parameters and yield parameters taken include:

Plant height

This was done using a measuring tape, measured from the soil level to the apex of the terminal leaf.

Number of leaves:

This was done through the physical counting of leaves on the plants.

Stem diameter:

This was done with the use of a vernier calliper to measure the stem girth.

Days to flowering

This was done by visual assessment of the cucumber plants.

Fruit weight

Fruits were harvested and recorded from the pot of each treatment and then weighed with the aid of a weighing balance.

Fruit length

The fruits were measured using the meter rule.

Fruit diameter

This was done in the middle of the fruits where it is thickest using a caliper.

Soil sample collection

A composite topsoil within a depth of 0-15 cm was collected from experimental pots with the aid of a soil auger for initial soil analysis. At harvest (end of the study) soil samples were collected from the replicated pots of each treatment and then air-dried for analysis to determine the changes that occurred due to treatment application.

Soil particle size analysis

The particle size is one of the most stable soil properties, consequently, its analyses are used as a basis of soil textural classification. Soil particle size analyses to determine the sand, silt, and clay content of each soil sample obtained from the different soil depths across the different management practices of cultivated land, regenerated land and forest land were carried out using the hydrometer method described below:

A 30-g (oven-dry weight basis) of ≥ 2 mm sieved soil sample was weighed into a 250 ml beaker and 100ml of Calgon solution was added to it, after which the mixture was transferred to a dispersing cup and stirred for about 3 minutes with the help of a mechanical stirrer and subsequently transferred to a sedimentation cylinder which was filled to the mark with distilled water while the hydrometer is in the suspension.

A plunger was then inserted which was moved up and down in a vertical rectilinear manner to mix the contents thoroughly, the stirring was completed with three slow smooth strokes, and the time of stirring completion was recorded. The hydrometer was lowered carefully into the suspension and readings were taken after 40 seconds (R40secs) and the temperature of the suspension was recorded with a thermometer. The suspension was remixed using the plunger and the 40-second reading was recorded until a reliable and constant reading was obtained. Two (2) hours after the final remixing of the suspension, another hydrometer and temperature reading were obtained (R2hrs). The percentage fractions of the suspension were calculated as follows:

% (Silt + Clay) = × 100 Eqn (1)

% Clay = × 100 Eqn (2)

% Silt = % (Silt + Clay) - % Clay Eqn (3)

% Sand = 100 – [% (Silt + Clay)] Eqn (4)

Soil chemical properties determination

The soil pH was determined by a pH meter in 1:2.5 soil: water (w/v) suspension (Anderson and Ingram, 1993). Total Organic Carbon (TOC) was determined using the Colorimetric method (Schulte and Hoskins, 2009). The Kjeldahl method was used to determine total Nitrogen (Sáez-Plaza *et al*., 2013). Available phosphorus (Av. P) content in the soil was analyzed following the Bray-1 acid method (Sahrawat*et al*., 1997). Potassium content was determined using a flame photometer (Rhoades, 1983). Effective Cation exchange capacity (ECEC) was estimated by summation of total exchangeable bases and exchangeable acidity (Al + H) determined by 1 M KCl extract and titrated with dilute sodium hydroxide solution (Anderson and Ingram, 1993).

Data Analysis

The data collected were subjected to analysis of variance (ANOVA) with one-way ANOVA. The experimental design used was Completely Randomized Design, since the plat were potted. and the means were compared using the Duncan multiple range test (DMRT) at a 5% significance level. SPSS. A proximate analysis was carried out to compare the treatments (moringa leaf extract and aloe vera extract) using T-test(Samuel et al, 2022)

3.0. Results and Discussion

Results

The result of the pre-soil analysis is presented in Table 1. This shows the percentage composition of sand to be 60.66±0.57. The texture of the soil was sandy loam, with a pH of 4.98±0.15 which is slightly acidic with total nitrogen of 0.25±0.01, total organic matter of 4.86±0.58, total carbon of 2.96±0.60. The exchangeable cations Ca2+

Mg2+, Na+ and K+ had values 4.42±0.02, 3.62±0.35, 0.72±0.02 and 1.64±0.02 respectively. Also, micronutrients like Fe and Mn with values 411±3.60 and 1.31±0.01.

T-test Comparison of Aloe vera and Moringa Proximate Composition Analysis

The result of the T-test comparison of Aloe vera extract and Moringa leaf extract proximate composition analysis is present in Table 2. This shows the result of the laboratory analysis with aloe vera extracts having a high moisture content of 87.7±0.67 than moringa leaf extract of 83.1±0.59. In the Fat content, moringa leaf extract showed a higher value of 0.79±0.39 than aloe vera extract 0.41±0.01. The crude protein content with the value 3.24±0.01 was observed high in the aloe vera extract and the lowest value 2.37±0.09 was observed in the moringa leaf extract. pH of 6.39±0.00 was high in moringa leaf extract and 6.33±0.00 was low in aloe vera extract. The Magnesium content had a high value of 44.5±0.49 in moringa leaf extract and a lower value of 36.4±0.14 in aloe vera extract. Total organic carbon showed a higher value of 0.81±0.00 in moringa leaf extract than that of aloe vera extract.

Effect of Growth IAA, Moringa and Aloe vera on growth parameters

The result presents the vegetative growth parameters of cucumber plant with treatments: moringa leaf extract, aloe vera extract, Indole-3acetic acid and a control group. The measured growth parameters are plant height, the number of leaves and stem diameter. The two seasons showed similarity in all the parameters observed.

Table 1: Physical and chemical properties before planting of the soil.

Parameters	**Composition**
Sand (%)	60.66±0.57
Clay (%)	16.20±0.10
Silt (%)	23.50±0.20
pH	4.98±0.15
Total P (%)	8.95±0.02
Na^{+} (cmol/kg)	0.72±0.02
K^{+} (cmol/kg)	1.64±0.02
Ca^{2+} (cmol/kg)	4.42±0.02
Mg^{2+} (cmol/kg)	3.62±0.35
Ex. Acidity (cmol/kg)	1.95±0.01
CEC (cmol/kg)	12.30±0.20
Base saturation (%)	84.14±0.25
Fe (mg/kg)	411±3.60
Mn (mg/kg)	1.31±0.01

Effect of IAA, Moringa and Aloe vera on the yield of Cucumber

The result for the yield parameters of the cucumber plant is presented in Table 4. The days of flowering shows that the treatments aloe vera, moringa and indole-3-acetic acid shared the superscript ‘a’ which indicates that there is no significant difference in flowering time among these three treatments although all significantly reduced flowering time compared to the control. Also, there was no significance difference in the two seasons as shown in the Table 4.

Table 5 presents some of the physiochemical properties of the soil of the experimental site after harvesting of cucumber plants. This shows the results for the analysis with the control having the highest sand content (62.80%), The soil pH with the highest value of 5.16 in indole-3-acetic acid and the lowest value of 5.04 in moringa. Total organic matter showed significant differences among all treatments, in terms of value, moringa had the highest 4.10 and the lowest value 3.19 in control. Total phosphorous was observed higher than 10.04 in moringa and the lowest value was 7.94 in control. The calcium and magnesium content had no significant variation across all treatments, indole-3-acetic acid had the highest values 4.10 and 3.47 respectively and the lowest values 3.13 and 3.25 in the control in all the two growing seasons.

Table 6highlights the relationships between soil physiochemical properties and cucumber growth metrics—plant height, number of leaves, and stem diameter. Parameters

Table 2: T-test Comparison of Aloe vera and Moringa Proximate Composition Analysis

Parameters	Aloe -vera	Moringa	T-Value	p-Value	Significance
Moisture content (%)	87.7^{a}	83.1^{b}	7.222	0.019	Yes
Fat content (%)	0.41^{b}	0.79^{a}	-13.15	0.006	Yes
Ash content (%)	0.59^{b}	0.73^{a}	-6.781	0.021	Yes
Crude fibre (%)	3.19^{a}	2.63^{a}	1.493	0.274	No
Crude protein (%)	3.24^{a}	2.37^{b}	13.64	0.005	Yes
Carbohydrate (%)	4.87^{b}	10.3^{a}	-6.387	0.024	Yes
pH	6.33^{b}	6.39^{a}	-13	0.006	Yes
K (mg/L)	75.6^{a}	68.8^{b}	18.54	0.003	Yes
Ca (mg/L)	40.3^{a}	37.9^{b}	5.367	0.033	Yes
Mg (mg/L)	36.4^{b}	44.5^{a}	-22.39	0.002	Yes
Cu (mg/L)	0.16^{b}	0.21^{a}	-93	0.000	Yes
Fe (mg/L)	0.88^{b}	1.02^{a}	-56.79	0.000	Yes
P (mg/L)	4.74^{b}	6.35^{a}	-143.55	0.000	Yes
TOC (mg/L)	0.69^{b}	0.81^{a}	-116	0.000	Yes

*Significant difference between means when $p < 0.05$.

Table 3: Effect of Growth IAA, Moringa and Aloe vera on growth parameters

		MarchtoJuly, 2024				August to October, 2024			
Parameter	**Treat-ment**	**Week1**	**Week2**	**Week3**	**Week4**	**Week1**	**Week2**	**Week3**	**Week4**
Plant Height	Control	16.00^{a}	25.06^{a}	35.66^{a}	43.66^{a}	15.00^{a}	21.06^{a}	32.66^{a}	45.67^{a}
	Moringa	118.20^{c}	127.13^{c}	137.20^{d}	145.20^{d}	108.20^{c}	117.13^{c}	137.20^{d}	145.20^{d}
	Aloe vera	117.13^{bc}	126.13^{c}	136.06^{c}	144.20^{c}	113.13^{bc}	126.13^{c}	144.06^{c}	144.20^{c}
	IAA	116.33^{b}	125.00^{b}	135.00^{b}	143.23^{b}	115.33^{b}	125.00^{b}	132.00^{b}	140.23^{b}
No of Leaves	Control	3.66^{a}	5.60^{a}	8.66^{a}	13.66^{a}	3.56^{a}	5.50^{a}	8.56^{a}	13.46^{a}
	Moringa	10.88^{d}	14.89^{d}	19.89^{d}	24.86^{d}	11.88^{d}	14.79^{d}	19.79^{d}	24.56^{d}
	Aloe vera	9.89^{c}	13.89^{c}	18.89^{c}	23.89^{c}	9.69^{c}	13.79^{c}	18.69^{c}	23.79^{c}
	IAA	9.39^{b}	125.00^{b}	18.39^{b}	23.39^{b}	9.29^{b}	125.90^{b}	18.39^{b}	22.39^{b}
Stem Diam-eter	Control	0.04^{a}	0.13^{a}	0.21^{a}	0.30^{a}	0.14^{a}	0.23^{a}	0.31^{a}	0.70^{a}
	Moringa	0.35^{c}	0.42^{c}	0.51^{c}	0.60^{c}	0.55^{c}	0.52^{c}	0.61^{c}	0.70^{c}
	Aloe vera	0.24^{b}	0.32^{b}	0.41^{b}	0.50^{b}	0.14^{b}	0.42^{b}	0.81^{b}	0.70^{b}
	IAA	0.44^{d}	0.54^{d}	0.61^{d}	0.70^{d}	0.54^{d}	0.64^{d}	0.71^{d}	0.90^{d}

Mean with same superscript along the columns are not significantly different at $p>0.05$
Week 1 = 2 weeks after planting, Week 2 = 3 weeks after planting, Week 3 = 3 weeks after planting,
Week 4 = 4 weeks after planting,

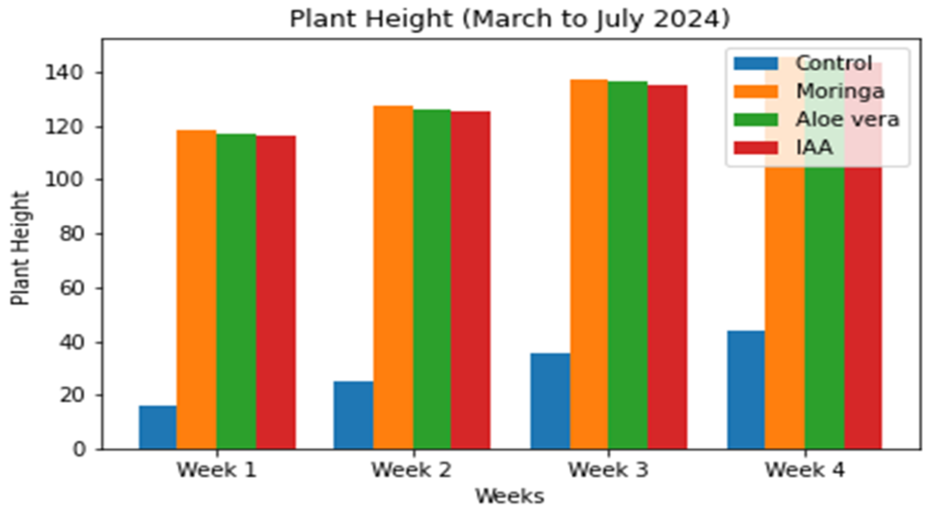

Figure 2: Bar chart comparing plant height over weeks and across treatments (March -July)

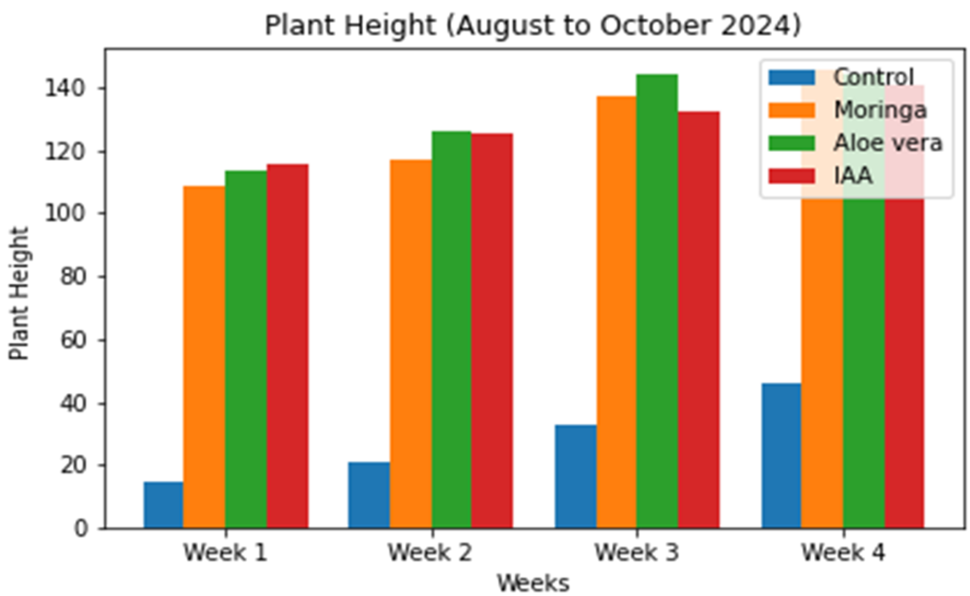

Figure 3: Bar chart comparing plant height over weeks and across treatments (August-October)

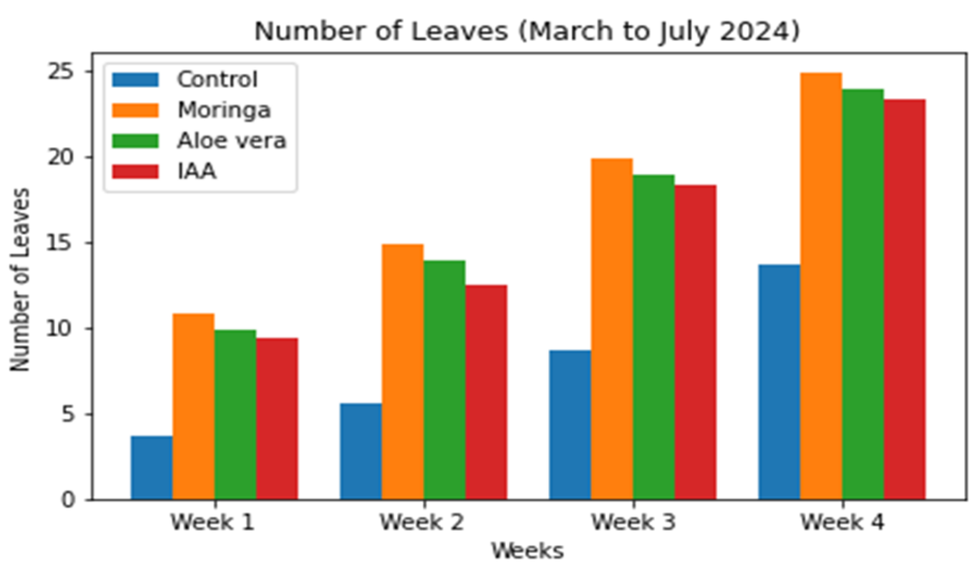

Figure 4: Bar chart comparing number of leaves over weeks and across treatments (March -July)

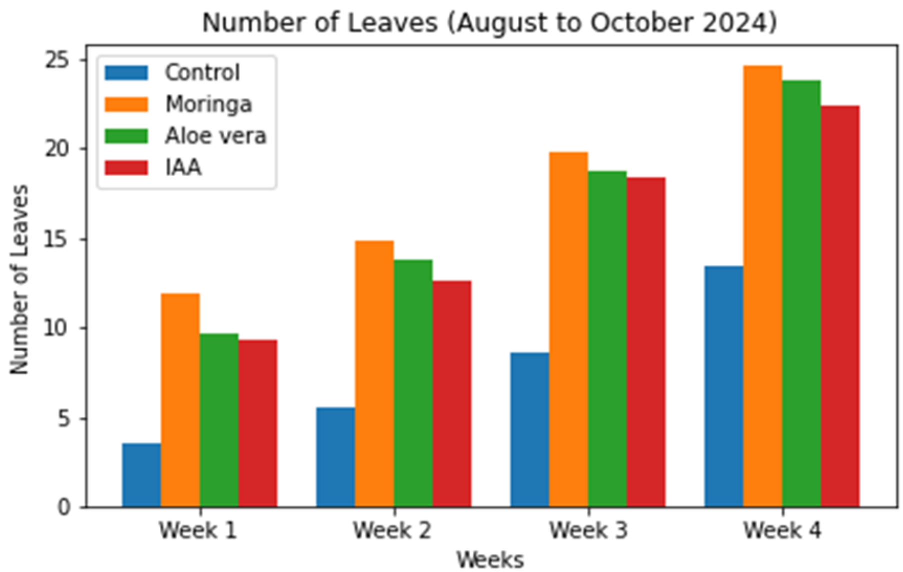

Figure 5: Bar chart comparing number of leavesover weeks and across treatments (August-October)

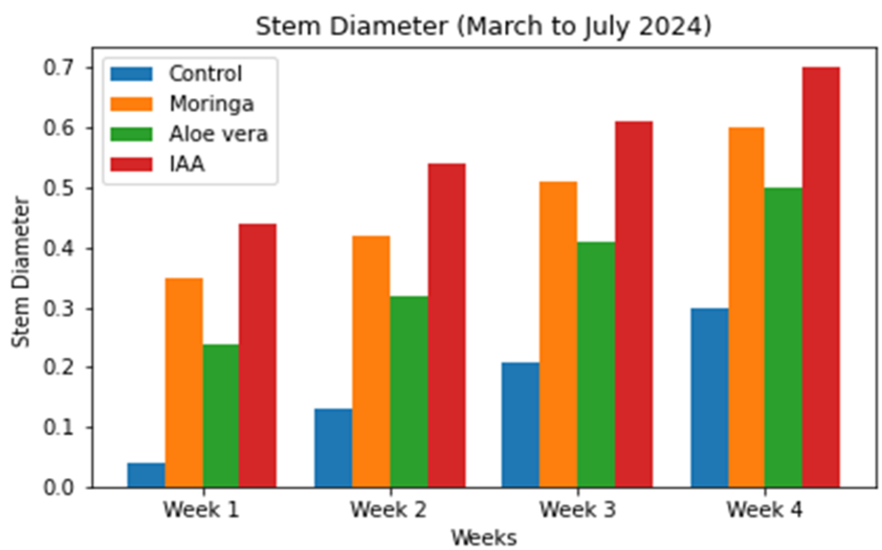

Figure 6: Bar chart comparing stem diameter over weeks and across treatments (March -July)

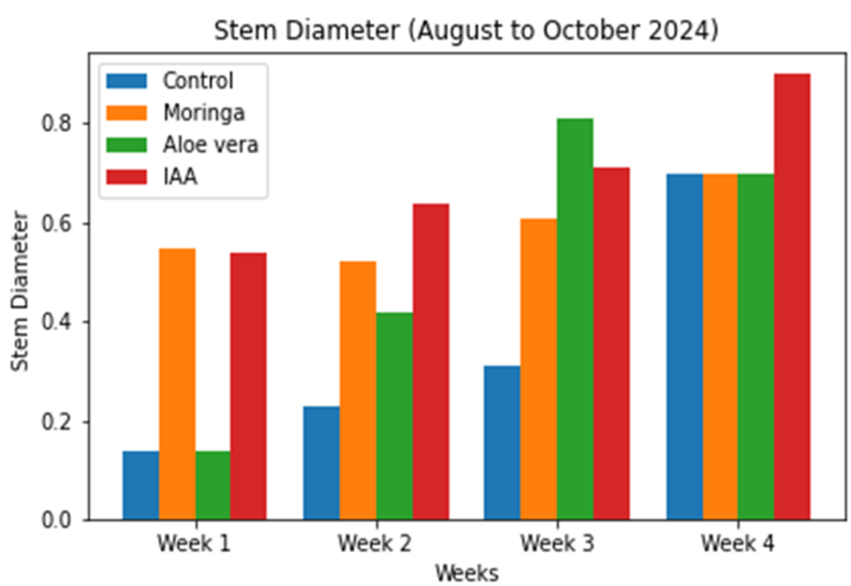

Figure 7: Bar chart comparing stem diameter over weeks and across treatments (August-October)

like silt content, total nitrogen (N), and total organic matter (TOM) are positively correlated with cucumber growth. In contrast, sand and manganese (Mn) show negative correlations, indicating their detrimental effects on growth. Certain elements, such as clay and pH, exhibit weaker or mixed correlations across growth parameters.

Table 7 shows correlations between soil properties and cucumber yield parameters. Sand content positively impacts days to flowering but negatively influences fruit size (diameter and length). In contrast, silt and organic matter (TOM, TOC) strongly support fruit size development but delay flowering. Total nitrogen, total phosphorus, and cati-

Table 4: Effect of IAA, Moringa and Aloe vera on the yield of Cucumber

	Planting seasons							
	March to July, 2024				August to October, 2024			
Parameters	Control	Moringa	Aloe Vera	Indole-3-acetic acid	Control	Moringa	Aloe Vera	Indole-3-acetic acid
Days to Flowering	36.00 ^{b}	30.66 ^{a}	29.66 ^{a}	29.00 ^{a}	32.00 ^{b}	26.66 ^{a}	25.66 ^{a}	25.00 ^{a}
Fruit Weight	3.36 ^{d}	4.06 ^{d}	3.06^{d}	2.56 ^{d}	3.36 ^{d}	4.36 ^{d}	3.66 ^{d}	2.96 ^{d}
Fruit Diameter	7.63 ^{c}	13.50 ^{d}	12.50 ^{b}	12.00 ^{a}	6.63 ^{c}	14.50 ^{d}	13.50 ^{b}	13.00 ^{a}
Fruit Length	10.06 ^{a}	14.96 ^{b}	13.96 ^{b}	13.46 ^{b}	09.06 ^{a}	16.96 ^{b}	15.96 ^{b}	15.46 ^{b}

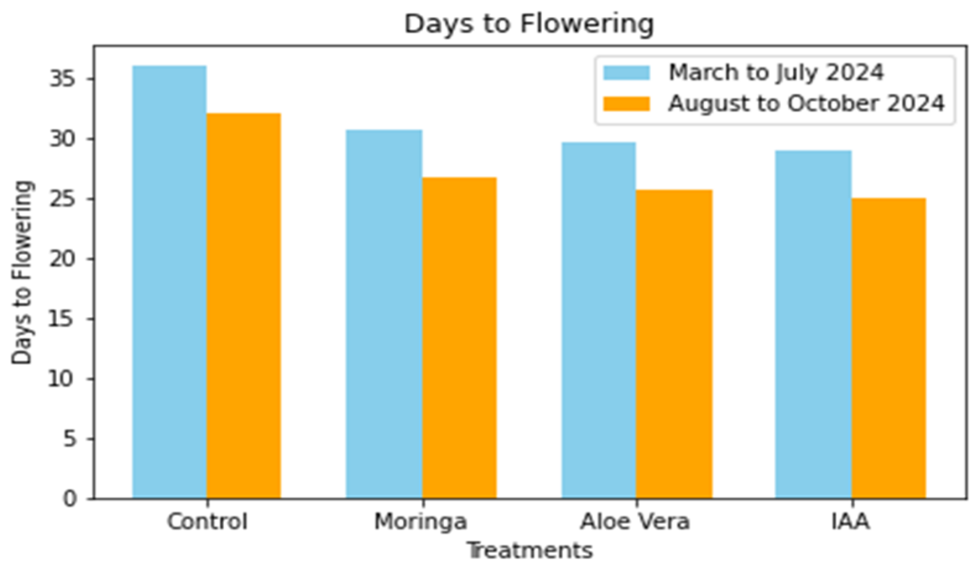

Figure 8: Bar chart comparing days of flowering over months and across treatments

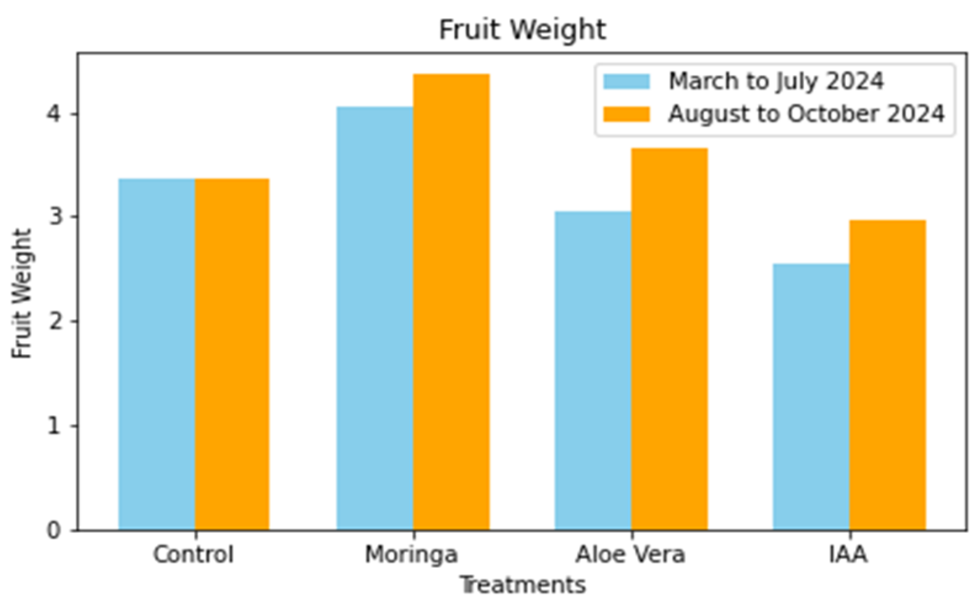

Figure 9: Bar chart comparing fruit weight over months and across treatments

on exchange capacity (CEC) play critical roles in enhancing both fruit quality (diameter and length) and yield.

4.0. Discussion

The soil texture of the study site was sandy loam.Aloe vera also contributes beneficially to soil properties, primarily through its gel, which contains polysaccharides that improve soil structure and enhance water retention capabilities (Amar et al., 2023). The site was moderately acidic (pH 4.98). The initial chemical compositions of the soil used in this study are presented in Table 1. The nitrogen was high (0.25), though the phosphorous levels (8.95) seemed moderate. Exchangeable cations, sodium (0.72), and potassium (1.64) are present in high concentrations. Calcium with a value of 4.42 seemed moderate and magnesium (3.62) was high.*Moringa oleifera* is well-documented for its rich nutrient profile, which positively influences soil health and plant development. The leaves contain high levels of essential minerals, phenolics, vitamins, and proteins that can enhance soil fertility when used as organic amendments Peñalver et al., 2022). Moringa leaf extract has been shown to improve soil moisture retention and increase microbial activity, contributing to better nutrient cycling in the soil (Rachmawatie et al., 2022). This is pivotal for crops like cucumbers, which thrive in well-aerated and nutrient-rich soils.

Table 5: Comparison of Soil Physiochemical Properties after harvesting of cucumber plants.

	March- july, 2024				August – October, 2024			
Parameters	Control	MSA	ISA	ASA	Control	MSA	ISA	ASA
Sand (%)	62.80 ^{d}	54.40 ^{b}	50.90 ^{a}	56.30 ^{c}	61.80 ^{d}	55.40 ^{b}	52.90 ^{a}	53.30 ^{c}
Clay (%)	17.70 ^{b}	18.90 ^{c}	20.00 ^{d}	16.50 ^{a}	18.70 ^{b}	17.90 ^{c}	19.00 ^{d}	18.50 ^{a}
Silt (%)	19.50 ^{a}	26.70 ^{b}	29.10 ^{d}	27.20 ^{c}	19.50 ^{a}	26.70 ^{b}	28.10 ^{d}	28.20 ^{c}
pH	5.07 ^{a}	5.04 ^{a}	5.12 ^{b}	5.16 ^{c}	5.07 ^{a}	5.14 ^{a}	5.22 ^{b}	5.76 ^{c}
Total N (%)	0.16 ^{a}	0.23 ^{a}	0.20 ^{a}	0.19 ^{a}	0.18 ^{a}	0.25 ^{a}	0.23 ^{a}	0.21 ^{a}
TOM (%)	3.19 ^{a}	4.09 ^{c}	3.65 ^{b}	3.47 ^{b}	2.84 ^{a}	4.26 ^{c}	3.83 ^{b}	3.64 ^{b}
TOC (%)	1.85 ^{a}	2.37 ^{d}	2.12 ^{c}	2.01 ^{b}	1.65 ^{a}	2.47 ^{d}	2.22 ^{c}	2.11 ^{b}
Total P (mg/kg)	7.94 ^{a}	10.04 ^{d}	8.58 ^{b}	9.05 ^{c}	7.94 ^{a}	10.14 ^{d}	8.88 ^{b}	9.25 ^{c}
Na^+ (cmol/kg)	0.57 ^{a}	0.66 ^{c}	0.62 ^{b}	0.65 ^{bc}	0.67 ^{a}	0.76 ^{c}	0.72 ^{b}	0.55 ^{bc}
K^+ (cmol/kg)	1.50 ^{a}	1.52 ^{a}	1.69 ^{a}	1.70 ^{a}	1.70 ^{a}	1.72 ^{a}	1.79 ^{a}	1.90 ^{a}
Ca^{2+} (cmol/kg)	3.13 ^{a}	3.95 ^{b}	3.36 ^{a}	4.10 ^{b}	3.23 ^{a}	3.99	3.46 ^{a}	4.20 ^{b}
Mg^{2+} (cmol/kg)	3.25 ^{c}	2.85 ^{b}	2.59 ^{a}	3.47	3.45 ^{c}	2.95 ^{b}	2.69 ^{a}	3.57
Ex.Acidity(cmol/kg)	1.77 ^{a}	1.98 ^{b}	2.10 ^{c}	1.69 ^{a}	1.97 ^{a}	2.38 ^{b}	2.30 ^{c}	1.99 ^{a}
CEC (cmol/kg)	10.20 ^{a}	10.93 ^{b}	10.47 ^{ab}	11.51 ^{c}	10.20 ^{a}	11.93 ^{b}	11.47 ^{ab}	11.91 ^{c}
Base Saturation (%)	82.54 ^{c}	81.95 ^{b}	79.73 ^{a}	85.32 ^{d}	83.54 ^{c}	88.95 ^{b}	89.73 ^{a}	88.32 ^{d}
Fe (mg/kg)	373 ^{c}	3850 ^{d}	365 ^{b}	360 ^{a}	303 ^{c}	385 ^{d}	365 ^{b}	360 ^{a}
Mn (mg/kg)	1.02 ^{d}	0.76 ^{b}	0.91 ^{c}	0.73 ^{a}	1.02 ^{d}	0.76 ^{b}	0.91 ^{c}	0.73 ^{a}

Mean with same superscript along the rows are not significantly different at $p>0.05$.
Note: MSA- moringa soil analysis, ISA- indole-3acetic soil analysis, ASA- aloe vera soil analysis

Table 6: Correlation analysis between soil physiochemical characteristics after harvesting and cucumber growth parameters

Soil parameter	**Plantheight**	**Noofleaves**	**Stemdiameter**
Sand (%)	-0.92	-0.78	-0.85
Clay (%)	0.12	0.60	0.50
Silt (%)	0.98	0.70	0.80
pH	0.35	0.02	0.27
Total N (%)	0.74	0.39	0.84
TOM (%)	0.80	0.39	0.69
TOC (%)	0.80	0.40	0.69
Total P (mg/kg)	0.76	0.08	0.54
Na+ (cmol/kg)	0.23	0.25	0.52
K+ (cmol/kg)	0.42	0.31	0.59
Ca2+ (cmol/kg)	0.73	-0.12	0.32
Mg2+ (cmol/kg)	-0.39	-0.78	-0.60
Ex.Acidity(cmol/kg)	0.37	0.53	0.83
CEC (cmol/kg)	0.74	0.14	0.59
Base Saturation (%)	0.31	0.05	0.48
Fe (mg/kg)	0.25	-0.10	0.01
Mn (mg/kg)	-0.82	-0.01	-0.39

Note: Correlation values range from -1 to 1, where values closer to ±1 indicate stronger relationships, and those near 0 suggest weak or negligible correlations.

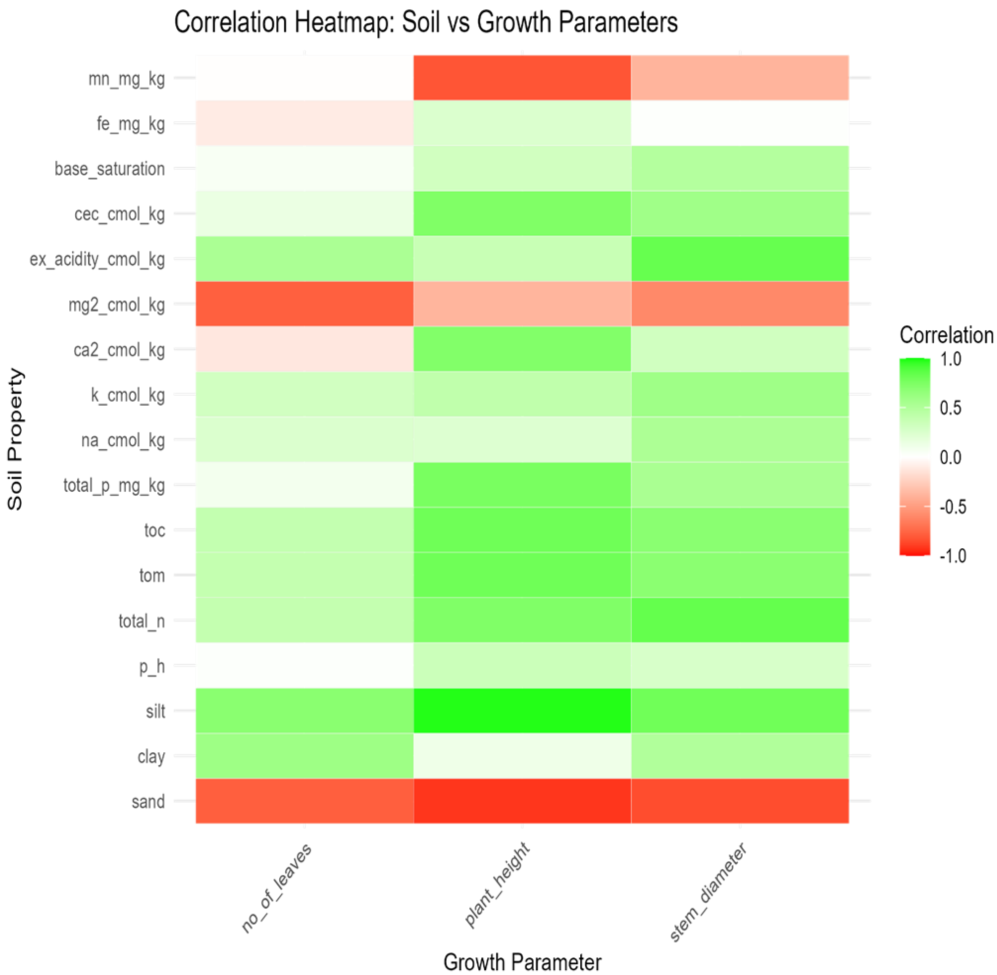

Figure 10: Heat map showing correlation between soil physiochemical parameters vs cucumber growth parameters

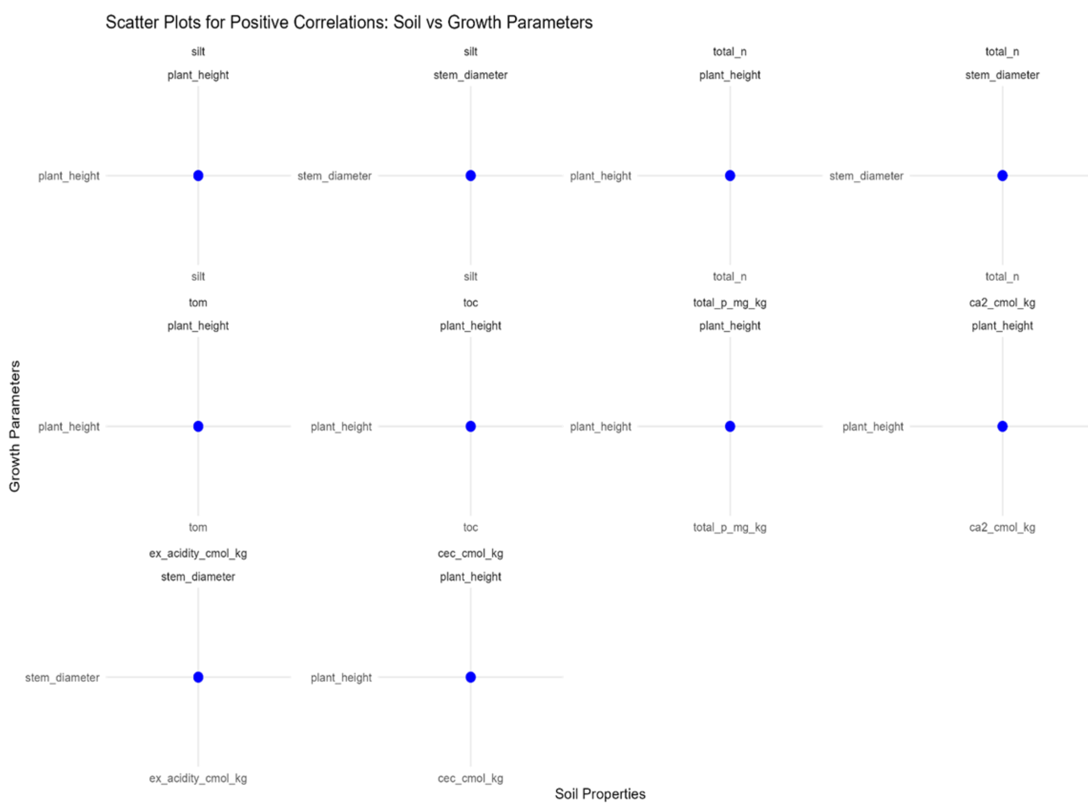

Figure 13: Scattered plot showing all positive correlations between thesoil physiochemical characteristics and cucumber growth parameters.

The high base saturation of 84.14% shows that the soil has good potential to support healthy plant development despite its acidity. The high cation exchange capacity of 12.30 cmol/kg also indicates that the soil can retain and supply essential nutrients effectively. Effectively. Micro-nutrients such as iron are present in high concentrations (411), while manganese content (1.31) is moderate, both of which are important for plant function. (Woperesis*et al*, 2009) Esu (1991).

Table 7: Correlation analysis between soil physiochemical characteristics after harvesting and cucumber yielding parameters

Soil paramter	Days toflowering	Fruitweight	Fruitdiameter	Fruitlength
Sand (%)	0.79	0.15	-0.83	-0.79
Clay (%)	-0.22	-0.25	0.04	0.03
Silt (%)	-0.81	-0.1	0.9	0.86
pH	-0.57	0.07	0.36	0.43
Total N (%)	-0.77	0.5	0.84	0.87
TOM (%)	-0.6	0.48	0.91	0.91
TOC (%)	-0.6	0.48	0.91	0.91
Total P (mg/kg)	-0.55	0.67	0.88	0.87
Na+ (cmol/kg)	-0.38	0.28	0.32	0.34
K+ (cmol/kg)	-0.82	-0.13	0.38	0.46
Ca2+ (cmol/kg)	-0.56	0.5	0.78	0.76
Mg2+ (cmol/kg)	0.24	0.18	-0.36	-0.32
Ex.Acidity(cmol/kg)	-0.67	0.25	0.47	0.56
CEC (cmol/kg)	-0.81	0.4	0.83	0.89
Base Saturation (%)	-0.7	0.33	0.45	0.58
Fe (mg/kg)	0.14	0.44	0.27	0.19
Mn (mg/kg)	0.57	-0.44	-0.86	-0.82

Note: Correlation values range from -1 to 1, where values closer to ±1 indicate stronger relationships, and those near 0 suggest weak or negligible correlations.

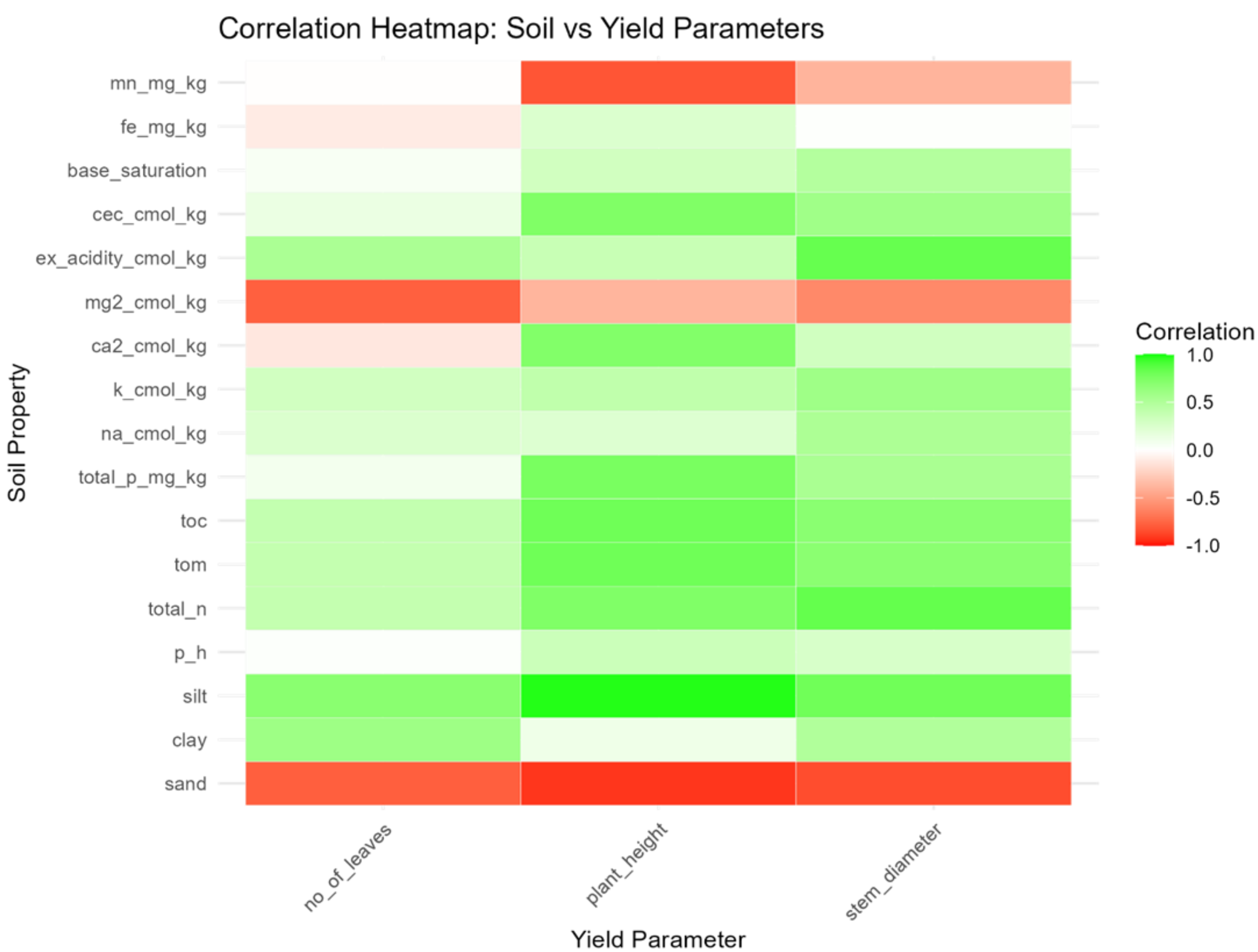

Figure 11: Heat map showing correlation between soil physiochemical parameters vs cucumber yield parameters

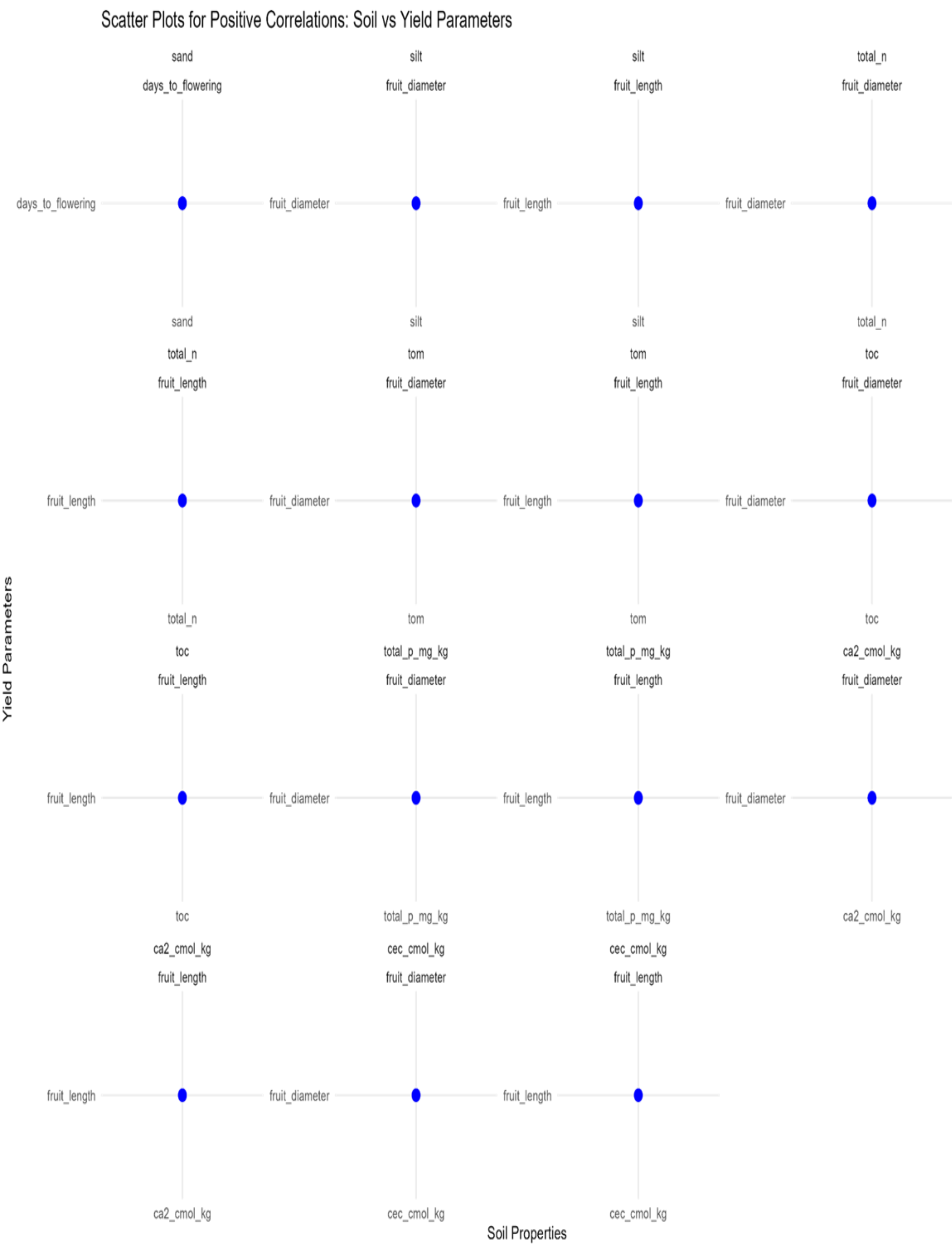

Figure 12: Scattered plot showing all positive correlations between thesoil physiochemical characteristics and cucumber yield param-

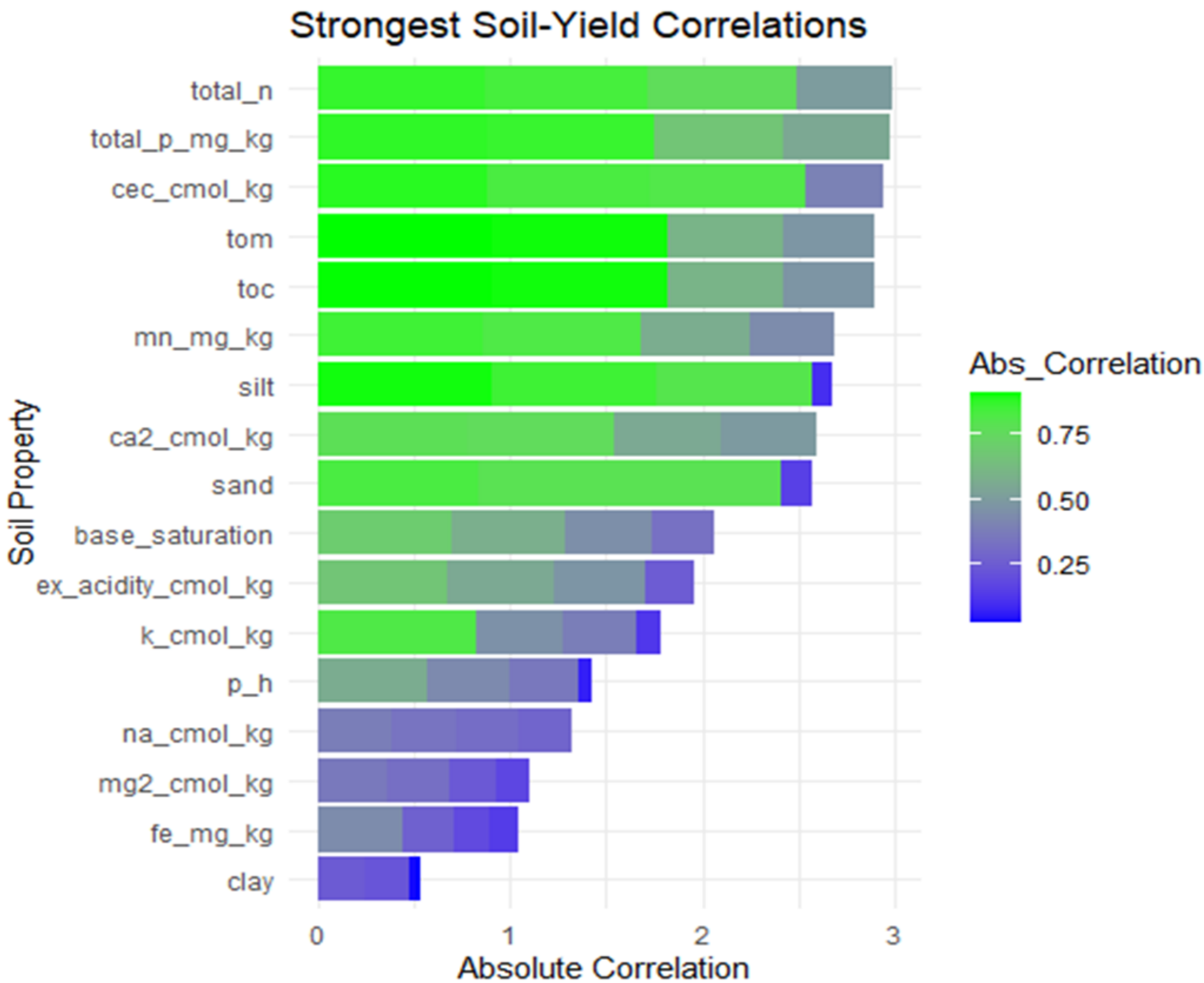

Figure 13: Bar chart showing strongest correlations between thesoil physiochemical characteristics and cucumber yield parameters.

T-Test of the Moringa and Aloe vera leaf extract used in the experiment

The data shown in Table 2 above represents the results of the proximate analysis carried out to compare aloe vera extract and moringa leaf extract using T-test. The moisture content of aloe vera extract (ALE) was significantly higher than moringa leaf extract. A moisture content of 87.7% in aloe vera extract compared to 83.1% in moringa leaf extract, suggests that aloe vera extract is more hydrated, which could make it more prone to microbial growth but may also impart a fresher texture. This difference is statistically significant (p=0.019), the higher moisture content in aloe vera extract could influence its storage and shelf life. Themoringa leaf extract fat content (0.79%) is nearly double that of aloe vera extract (0.41%), with a significant p-value (0.006). Fat content is crucial because it affects the energy value, taste, and texture of the food product. Ash content represents the total mineral content. Aloe vera extract has a slightly lower ash content (0.59%) compared to moringa leaf extract (0.73%), which is significant (p=0.021). In the results**,** while aloe vera has a higher crude fibre content (3.19%) than moringa (2.63%), the difference is not statistically significant (p=0.274). The Protein content is significantly higher in aloe vera (3.24%) compared to moringa leaf extract (2.37%) with a p-value of 0.005. The carbohydrate content of moringa leaf extract shows a significantly higher carbohydrate content (10.3%) compared to aloe vera extract (4.87%), with a p-value of 0.024. Carbohydrates are the body's primary energy source, and the higher content in AMP suggests that it could be more energy dense. The pH values of aloe vera extract and moringa leaf extract are very close (6.33 vs. 6.39), with a significant difference (p=0.006). Both values indicate a slightly acidic environment, which can influence the preservation and microbial growth. potassium, calcium, magnesium, copper, iron, phosphorous, and total organic carbon) showed significant differences in mineral content between aloe vera and moringa leaf extract suggesting that each may offer different nutritional benefits. Aloe vera extract has higher levels of potassium and calcium 75.6 and 40.3 respectively. The differences in (Mg, Cu, Fe, P and TOC) between the two samples, with moringa leaf extract generally showing higher values, suggest that AMP could be more beneficial in providing essential nutrients that support various physiological functions in plants.

Effects of Moringa leaf extract Aloe vera extract and Indole-3-acetic acid on the growth parameters of cucumber.

The increase in plant growth over the four weeks was markedly influenced by the different treatments. The control group, which did not receive any additional treatments, exhibited the slowest growth throughout the experiment. Starting from an average height of 16.00 cm in the first week, control plants increased gradually reaching 43.66 ± 0.03 cm by the fourth week. This limited growth can be attributed to the fact that control plants rely solely on the inherent nutrient availability within their growing medium also, Aloe vera and Indole-3-acetic acid (IAA) treatments also stimulated notable growth, reaching 144.00 cm and 143.23 cm, respectively, by week four, the impact of Indole-3-acetic acid (IAA) on the growth parameters such as diameter and length are as a result of a naturally occurring auxin, which facilitates hormonal regulation in plants, playing a crucial role in cell division and root elongation. The application of IAA has been noted to promote root growth in cucumbers significantly, which enables better access to soil nutrients and water (Asante et al., 2021).

Among the treatments, Moringa-treated plants showed the most substantial effect on plant height, with an initial height of 118.20 ± 0.10 cm in the first week, rising to 145.20 ± 0.02 cm by the fourth week. In contrast, foliar application of MLE at 1:32 concentration increased the plant height in maize (Biswas *et al*., 2016), tomato (Culver *et al*., 2012), beans and maize (Mvumi*et al*., 2013). This might be due to zeatin, which is the most common cytokinin in the extract, responsible for the improved plant height. These results agree with the findings of Rana*et al*. (2019), Yusuff and Abiola, (2019) and Hoque et al. (2020), who reported increased plant height, fresh weight and dry weight of shoot and better crop growth rate in different vegetable crops including tomato, eggplant, common bean, cauliflower, cucumber and cabbage respectively with foliar application of MLE compared to control. Taha (2015) reported that exogenous application of MLE at 10% concentration increased the plant height of the jojoba plant. In a related study, Kanchani et al (2019) reported that MLE used at the rate of 10% concentration at one-week intervals increased the plant height.

Leaf production is another critical indicator of plant health, reflecting the plant's ability to photosynthesize and sustain growth. The control plants, which did not receive any supplemental treatments, exhibited a relatively slow increase in leaf number. Starting with an average of 3.66 ± 0.03 leaves in the first week, the control plants produced 13.66 ± 0.01 leaves by the fourth week. The other treatments, however, significantly boosted leaf production. Moringa-treated plants of 25ml exhibited the most notable increase, with the number of leaves rising from 10.88 in the first week to 24.86 in the fourth week. Aloe vera and IAA also resulted in considerable leaf growth, ending the four weeks with approximately 23 leaves each. The results showed that Moringa not only contributed to the overall plant height but also stimulated a greater increase in leaf production compared to the other treatments. This is also consistent with the findings of Zaki and Rady (2015) who observed that MLE application increased the number of leaves, shoot length, leaf area per plant, and old dry leaf weight of Phaseolus vulgaris (common bean).

Stem diameter is a crucial parameter for evaluating the structural integrity and strength of plants. A thicker stem provides better support for leaves and branches. In the results, the control plants exhibited the smallest stem diameter, with a final measurement of 0.30 ± 0.01 cm by the fourth week. This thinner stem indicates that control plants, which lacked growth stimulants, developed less structural strength compared to the treated groups. Moringa-treated plants showed a marked improvement in stem diameter, starting at 0.35 ± 0.03 cm in the first week and increasing to 0.60 ± 0.01 cm by the fourth week. The improvement in stem diameter indicates that Moringa contributes not only to growth but also to the strengthening of the plant's structure. Aloe vera treatment resulted in a significant increase in stem diameter, from 0.24 ± 0.03 cm in the first week to 0.50 ± 0.02 cm in the fourth week. Indole -3-acetic acid-treated plants exhibited the highest stem diameter by the fourth week, measuring 0.70 ± 0.01 cm. Auxins like IAA are known to play a key role in vascular differentiation and the stimulation of cambial activity, which leads to thicker, stronger stems. Studies have shown that exogenously applied IAA affects plant root and stem growth positively (Kaya *et al*., 2013) (Nieto *et al*., 2017). The results indicate that IAA was the most effective treatment for increasing stem diameter, making the plants more structurally stable and potentially more resistant to environmental stresses.

Effects of Moringa leaf extract, Aloe vera extract and Indole-3-acetic on the yield parameters of cucumber.

The treated plants flowered significantly earlier than the control, The number of days to flowering is reduced in plants treated with Moringa (30.66 days), Aloe Vera (29.66 days), and IAA (29.00 days) compared to the Control group (36.00 days). The reduction in flowering time implies that these treatments (especially Aloe Vera and IAA) accelerate the plant's transition to the reproductive stage. This is beneficial in a farming context because faster flowering leads to earlier harvests. Aloe Vera, Moringa, and IAA indicate that there is no significant difference in flowering time among these three treatments, although all significantly reduce flowering time compared to the Control.

Moringa-treated plants of application 25ml produced the heaviest fruits significantly higher than other treatments which is a desirable trait for both commercial and subsistence farming. Heavier fruits are often associated with better market value and higher nutritional content. Moringa treatment resulted in the highest fruit weight (4.06), which was significantly greater than the Control (3.36). Aloe Vera (3.06) and IAA (2.56) produced smaller fruits compared to the Control, This might be due to the fact that moringa leaf extract (MLE) is considered to improve growth and development of field crops. Study comprised of two experiments. First experiment, freshly extracted MLE and in combination with growth-promoting substances were stored at two temperature regimes. Chemical analysis, after 1-, 2-, and 3-months', storage period, showed that phenolics and ascorbic acid concentrations decreased with increasing storage period. Fresh extracts improved speed and spread of emergence and seedling vigor. Effectiveness of MLE in terms of phenolics and ascorbate concentrations was highest up to 1 month which decreased with prolonged storage. with IAA showing the least fruit weight among all treatments. This could be due to the high nutrient content or growth-promoting hormones in Moringa, which support fruit development. These results resemble those reported by Ahmed *et al*. (2020) that the application of MLE caused a significant increase in the fruit weight of cucumber. The differences in fruit weight suggest that Moringa significantly enhances the growth and size of the fruit, likely due to the bioactive compounds- phenolic, flavonoid and saponin compounds in Moringa that promote better nutrient absorption and growth. Aloe Vera and IAA may have had less impact on fruit weight, potentially due to their mode of action or concentration used. Similarly, Emongor*et al*. (2015), El-Mageed*et al*. (2017) and Rana *et al*. (2019) found significant positive effects of MLE application on yield components and better yields of vegetables with various doses of MLE. In the Fruit Diameter**,** Moringa treatment of 25 resulted in the largest fruit dimensions, indicating that it not only promotes vegetative growth but also enhances reproductive output. Moringa again had the largest effect on fruit diameter (13.50), followed by Aloe Vera (12.50) and IAA (12.00). The Control had a significantly smaller fruit diameter (7.63). This indicates that Moringa, Aloe Vera, and IAA all help to increase fruit size. In terms of value, Moringa was higher than the other treatments. This could be attributed to the growth-promoting properties of the compounds present in Moringa, which could lead to enhanced cell division, expansion in the fruit and supporting fruit development. Therefore, moringa extract is expected to affect the yield attribute of days of flowering, fruit weight, fruit diameter and fruit length. (Rehman and Baska, 2010; Yameen, *et al*., 2012).

The longest fruits were produced with the Moringa treatment (14.96), followed by Aloe Vera (13.96) and IAA (13.46), which were all significantly longer than the Control (10.06). Like the fruit diameter, this shows that the treatments particularly Moringa stimulate better fruit development, resulting in longer fruits compared to the untreated control group. This is like the findings of Hala *et al*. (2017) who showed that all levels of MLE led to significant increases in fruit yield compared to the control treatment (Tap water) and at the same time enhanced its components, i.e., the number of fruits and plant, fruit length, diameter, fresh and dry weight as well as early and total yield. Research studies therefore suggested that the increase could be due to the presence of zeatin, and sufficient micronutrients in the moringa leaf. Also, Aloe vera gel is particularly noted for its antifungal and antibacterial properties, potentially reducing plant disease incidence, which can be detrimental to cucumber growth. The gel contains compounds like acemannan, which not only promote healing and growth but also enhance the plant resistance to stress conditions by stimulating faster root development and improving nutrient uptake (Bhatnagar et al., 2022).

The result of this investigation corresponds with the findings of Culver *et al*. (2012), that moringa leaf extract increases the growth and yield of tomatoes and the greater the frequency of application, the greater the increase in yield. Many researchers have recently focused that MLE application to plants can provide beneficial nutrient elements, improve antioxidant defence system and enhance vegetative as well as reproductive growth resulting in higher yield and economic benefits under stressed and non-stressed situations (Abohassan and Abusuwar, 2018; Aluko *et al*., 2017; Emongor, 2015; Hala and Nabila, 2017; Merwad, 2017; Ozobia, 2014; Rady and Mohamed, 2015).

The Soil Physiochemical Properties after harvesting of cucumber plants

The varying percentages of sand, clay and silt across the treatments suggest different soil textures, which can influence water retention, drainage and root penetration. For example, control has the highest sand content (62.80%), which may lead to better drainage but lower nutrient retention. Indole-3-acetic soil (ISA) with a higher clay content of 20.00% might retain more nutrients but could also impede drainage and root growth. The soil pH ranges from 5.04 to 5.16 across the treatments, indicating slightly acidic conditions. The relatively close pH values suggest that the treatments do not drastically alter soil acidity, which is beneficial for maintaining a stable growing environment. The Total N showed no significant difference among all treatments including the control. The highest value 0.23 was in the moringa soil (MSA). Total Organic Matter (TOM), Total Organic Carbon and Total Phosphorus (P), Moringa soil had the highest total organic matter 4.10% and total organic carbon 2.37% indicating richer organic content which can enhance soil fertility and microbial activity. Also, moringa soil had the highest total phosphorus 9.05 mg/kg. In terms of value, Exchangeable cations including K, Ca and Mg were observed to be higher in aloe vera soil, with potassium 1.70 cmol/kg, calcium 4.10 cmol/kg and magnesium 3.47 cmol/kg. Ex acidity had no significant difference across all treatments but in terms of value, 2.10 cmol/kg indole-3-acetic soil is higher than other treatments. The Cation Exchange Capacity (CEC) and Base saturation, shows that aloe vera soil exhibits the highest CEC (11.51 cmol/kg) and base saturation (85.32%). High base saturation indicates that a greater proportion of the soil's exchange sites are occupied by basic cations (e.g. $Ca2+$, $Mg2+$), which is generally favourable for plant growth. The concentration of micronutrients like Iron (Fe) and Manganese (Mn) varies across all treatments with moringa soil having the highest iron content (385 mg/kg), while Iron is essential for plant growth, excessive amounts can be toxic. The manganese content showed a significant difference across all treatments with was lower value (0.73 mg/kg) in aloe vera soil. High manganese content can lead to toxicity in plants. The results showed that the treatments, especially Moringa soil (MSA) and Aloe vera soil (ASA) are effective in enhancing soil properties, including nutrient content, organic matter and soil fertility.

Correlation Analysis Between Soil Physiochemical Characteristics and The Cucumber Growth Parameters

Cucumber growth is significantly influenced by various soil physiochemical properties, with positive and negative correlations indicating the importance of specific factors (figure 10). High positive correlations are observed for silt content and essential nutrients like total nitrogen (N), total organic matter (TOM), total organic carbon (TOC), and total phosphorus (P), highlighting their roles in promoting plant height, leaf development, and stem strength. These elements contribute to improved water retention, nutrient supply, and plant metabolism, which are vital for healthy growth.

Conversely, sand content and manganese (Mn) show strong negative correlations. Excessive sand hampers cucumber growth due to its poor water and nutrient retention abilities, while high manganese levels may cause toxicity or nutrient imbalances that hinder growth, particularly for stem development and plant height.

Additionally, some soil properties exhibit mixed or weak correlations. Clay content shows moderate positive effects on leaf and stem parameters, possibly due to its structural contribution to the soil. Soil pH and exchangeable acidity display variable correlations, reflecting the complex relationship between soil acidity or alkalinity and cucumber growth. Proper pH balance is necessary but not solely sufficient for optimal growth.

Nutrient-specific observations reveal that calcium (Ca^{2+}) and magnesium (Mg^{2+}) have varying impacts. While calcium positively correlates with some growth parameters, magnesium negatively correlates, likely due to competition with other essential nutrients. Furthermore, moderate correlations are seen for base saturation and cation exchange capacity (CEC), emphasizing their supportive role in soil fertility.

Correlation Analysis Between Soil Physiochemical Characteristics and The Cucumber Yield Parameters

Soil physiochemical characteristics demonstrate significant and varied effects on cucumber yield parameters, as revealed by the correlation analysis (figure 13). Positive correlations show that silt content, total nitrogen (N), total organic matter (TOM), total organic carbon (TOC), and total phosphorus (P) are pivotal for enhancing fruit diameter, length, and overall quality. These properties contribute to improved water retention, nutrient availability, and plant metabolic functions, which directly support fruit development.

Conversely, sand content and manganese (Mn) exhibit strong negative impacts. Sand correlates positively with delayed flowering but negatively with fruit size, highlighting its poor water and nutrient retention. Manganese's toxicity or nutrient imbalance effects lead to reduced fruit size and yield. Such negative traits underscore the need for careful management to limit their presence in the soil.

Some soil parameters, like clay and pH, have mixed or weak correlations, reflecting their limited or more complex roles. While clay may provide structural support, its effects on yield are less pronounced. pH balance shows moderately positive correlations with fruit diameter and length, suggesting that maintaining optimal acidity/alkalinity is essential but not the sole determinant of yield outcomes.

Other parameters, like base saturation and cation exchange capacity (CEC), play supportive roles, with base saturation showing mild positive effects on yield and CEC strongly correlating with enhanced fruit size and quality. These findings highlight the importance of well-managed nutrient cation availability in promoting productive soil conditions. Sodium (Na^{+}) shows secondary, weaker positive effects on fruit development.

5.0 Conclusion

From the findings of the present study, it can be concluded that there was significant variation among the treatments in the growth and yield of cucumber plants. Moringa leaf extract of 25 ml application foliar application exhibited the highest results concerning growth and yield compared to other treatments; control, Aloe vera extract and Indole-3-acetic acid. The control plants showed the lowest performance in terms of growth and yield.

The results of the experiment showed that the use of plant extract as a plant growth promoter had a positive impact on moringa leaf extract in the growth and yield of cucumber.

Recommendation

The excessive use of synthetic chemical fertilizers is associated with environmental pollution and soil degradation. In addition, the high cost of these fertilizers necessitates the search for alternative eco-friendly and safe natural resources of phytonutrients. Chuene victor *et al*., (2022). In this study, aqueous extraction of plant extracts was used as it is environmentally friendly and can be used by local, subsistence and commercial farmers as well as the local communities. However, there are various methods of extraction. However, the aqueous extraction is recommended because it is easy to prepare and apply by farmers. It has been investigated in this study that moringa leaf extract of 25 ml foliar application could result in a great increase in the growth and yield of cucumber.

References

Abohassan RA and AO Abusuwar (2018). Effects of *Moringa olifera* leaf extracts on growth and

productivity of three leguminous crops. Legume Research 41: 114-119.

Adelowo OL (2022). Effect of Seed Priming on Seedling Emergence and Growth of Maize *(Zea*

*mays)*Adeleke University Journal of Science (AUJS) Volume 1 Issue 1,

Ahmed, M.E., A.A. El zaawely and I.A. Al-Ballat (2020). Using of Moringa leaf extract for

stimulating growth and yield of cucumber (Cucumis sativus L.) Menoufia. J. Plant Prod., 5(2), 63

75.

Aluko M, Ayodele OJ, Gbadeola AS and Oni IH (2017). Comparative effects of varying rates of

moringa leaf, poultry manure and NPK fertilizer on the growth, yield and quality of okra

(Abelmoschus esculentus L. Moench). International journal of environment, agriculture and

biotechnology 2: 2901–2907.

Anderson, J.M., Ingram, J.S.I., 1993. Tropical Soil Biology and Fertility. A Handbook of

Methods. C.A.B. International, Wallingtonford, Oxon, UK, p. 33.

Amar, M., ibrahim, s., El-shennway, M., &ismiel, a. 2023. Management of cucumber downy mildew disease by some plant water extracts and plant essential oils. Menoufia Journal of Plant Protection, 8(7), 118-129. https://doi.org/10.21608/mjapam.2023.221682.1020

Asante, K., Abugri, S., Derkyi, N., & Akoto, D. 2021. Gypsum amendment and seasonal variability: effect on soil quality, fruit characteristics and toxicological responses of cucumber (cucumis sativus l.) in the ahafo-kenyasi mining area of ghana. World Journal of Advanced Research and Reviews, 9(3), 229-244. https://doi.org/10.30574/wjarr.2021.9.3.0053

Baset Mia, M.A., Islam, M.S. and Shamsuddin, Z.H. 2014. Altered sex expression by plant

growth regulators: an overview in medicinal vegetable bitter gourd (Momordica charantia L.).

Journal of Medicinal Plants Research, 8(8): 361–367, https://doi.org/10.5897/jmpr10.032.

Biswas, A. K., Hoque, T. S. and Abedin, M. A. 2016. Effects of moringa leaf extract on growth

and yield of maize. Progressive Agriculture, 27(2): 136-143.

Bhatnagar, N., Sharma, M., & Faridi, F. 2022. Antifungal activity of aloe vera extracts against phytopathogenic fungus aspergillus spp.. International Journal of Health Sciences and Research, 12(12), 86-91. https://doi.org/10.52403/ijhsr.20221214

Culver, M., Fanuel, T. and Chiteka, A. Z. 2012. Effect of moringa extract on growth and yield

of tomato. Greener Journal of Agricultural Sciences, 2(5): 207-211.Cucumber.pdf www.haifa

group.com

Davies, P.J. 1995. The plant hormone concept: concentration, sensitivity, and transport. In:

Davies PJ (ed) Plant hormones: physiology, biochemistry, and molecular biology. Kluwer

Academic Publishers, Dordrecht, pp 1318.

El-Mageed TA, Semida WM and Rady MM 2017. Moringa leaf extract as biostimulant improves

water use efficiency, physio-biochemical attributes of squash plants under deficit irrigation.

Agricultural Water Management 193: 46-54.

Emongor, V.E. (2015). Effects of Moringa *(Moringa oleifera)* Leaf Extract on Growth, Yield and

Yield Components of Snap Beans *(Phaseolus vulgaris).* British Journal of Applied Science &

Technology, 6(2), 114-122.

Esu, I.E 1991. Detailed soil survey of NIHORT farm at Bunkure, Kano State Nigeria. Institute

for Agricultural Research, Ahmad Bello University, Zaria.

Hala, H. A. and Nabila, A.E. 2017. Effect of *Moringa oleifera* leaf extract (MLE) on pepper seed

germination, seedling improvement, growth, fruit yield and its quality. Middle East Journal of

Agriculture, 6(2): 448-463.

Hoque TS, Rana MS, Zahan SA, Jahan I and Abedin MA 2020. Moringa leaf extract as a bio

stimulant on growth, yield and nutritional improvement in cabbage, Asian Journal of Medical and

Biological Research 6: 196-203.

Kaya C, Ashraf M, Dikilitas M, Tuna AL 2013. Alleviation of salt stress induced adverse effects onmaize plants by exogenous application of indoleacetic acid (IAA) and inorganic nutrients-a fieldtrial. Aust J Crop Sci. 7:249.

Kadi S.A., Asati, K.P., Barche, S. and Tulasigeri, R.G. 2018. Effect of different plant growth

regulators on growth, yield and quality parameters in cucumber *(Cucumis sativus L.)* under

polyhouse condition. International Journal of Current Microbiology and Applied Sciences, 7(04):

3339–3352, https://doi.org/10.20546/ijcmas.2018.704.378.

Kanchani, A.M.K.D.M and K.D. Harris 2019. Effect of foliar application of Moringa *(Moringa*

oleifera) leaf extract with recommended fertilizer on growth and yield of okra *(Abelmoschus*

esculentus). AGRIEAST, 13(2), 38-54.

Khanal, S. 2020. Consumers' willingness, behaviors, and attitudes to pay a price premium for

local organic foods in Nepal. International Journal of Environment, Agriculture and

Biotechnology, 5(3): 594-609, https://doi.org/10.22161/ijeab.53.11.

Latimer, J.G. 2019. Growth retardants affect landscape performance of zinnia, impatiens, and

marigold. HortScience, 26(5), 557–560, https://doi.org/10.21273/hortsci.26.5.557.

Mariod, A.A., Mirghani, M.E. and Hussein, I. 2017. *Cucumis sativus* cucumber. Unconventional

Oilseeds and Oil Sources, 16: 89-94, https://doi.org/10.1016/B978-0-12-809435-8.00016-0.

Mvumi, C., Tagwira, F. and Chiteka, A. Z. 2013. Effect of moringa extract on growth and yield

of maize and common beans. Greener Journal of Agricultural Sciences, 3(1): 55-62.

Nieto-Jacobo, M.F., J.M. Steyaert, F.B. SalazarBadillo, D.V. Nguyen, M. Rostás, M. Braithwaite,

J.T. De Souza, J.F. Jimenez-Bremont, M. Ohkura, A. 2017. Stewart, andA. Mendoza-Mendoza.

Environmental growth conditions of Trichoderma spp. affect indole acetic acid derivatives,

volatile organic compounds, and plant growth promotion. Frontiers in plant science. 8.

Ozobia, A. P. 2014. Comparative assessment of effect of Moringa extracts, NPK fertilizer and

poultry manure on soil properties and growth performance of *Solanum melongina*in Abuja, North

Central Region of Nigeria. Journal of Agricultural and Crop Research, 2(5): 88-93.

Prajapati, S., Jamkar, T. Singh, O.P., Raypuriya, N., Mandloi, R. and Jain, P.K. (2015). Plant

growth regulators in vegetable production: An overview. Plant Archives, 15(2): 619–626.

Rachmawatie, S., Purwanto, E., Sakya, A., & Dewi, W. 2022. Growth and content of n, p, k, fe in rice plants with liquid organic fertilizer application of moringa leaf. Iop Conference Series Earth and Environmental Science, 1114(1), 012078. https://doi.org/10.1088/1755-1315/1114/1/012078

Rady MM and Mohamed GF 2015. Modulation of salt stress effects on the growth,

physiochemical attributes and yields of *Phaseolus vulgaris L.* plants by the combined application of salicylic acid and Moringa oleifera leaf extract. Scientia Horticulturae 193: 105–113.

Rana MS, Hoque TS and Abedin MA 2019. Improving growth and yield performance of

cauliflower through foliar application of moringa leaf extract as a bio stimulant. Acta

Scientifica Malaysia 3: 7-12.

Rehman H, Baska NSA 2010. Growing *moringa oleifera* as a multipurpose tree; some agro

physical and industrial perspectives. American chronicles:

http//www.americanchronicle.com/article's/ view/159447. May 28.

Rhoades, J.D., (1983). Cation exchange capacity. Methods of soil analysis: Part 2 chemical and

microbiological properties. 9, pp. 149–157.

Sáez-Plaza, P., Navas, M.J., Wybraniec, S., Michałowski, T., Asuero, A.G., (2013). An overview ofthe kjeldahl method of nitrogen determination. Part II. Sample preparation, working scale,

instrumental finish, and quality control. Crit. Rev. Anal.Chem. 43 (4), 224–272.

Sahrawat, K.L., Jones, M.P., Diatta, S., 1997. Extractable phosphorus and rice yield in an ultisol

of the humid forest zone in West Africa. Commun. Soil Sci. Plant analysis 28 (9–10), 711–716.

Samuels ML, Witner JA, Schaffer AA 2012. Statistics for the life sciences. 4th Edition Prentice Hall, Pearson Education Inc., Boston, M.A.

Schulte, E.E., Hoskins, B., 2009. Recommended soil organic matter tests. Recommended soil

testing. Proc. Northeastern United States 63–74.

Simon, Sibu; Petrášek, Jan 2011. "Why plants need more than one type of auxin". Plant Science.

180 (3): 454–60. doi: 10.1016/j.plantsci.2010.12.007. PMID 21421392.

Singh, M.K., Dalai, S., Singh, K.V., Kumar, M. and Lodhi, S.K. 2015. Sex modification and

yield of cucumber *(Cucumis sativus L.)* as sex modification and yield of cucumber *(Cucumis*

sativus L) as influenced by different levels of auxins and gibberellins. HortFlora Research

Spectrum, 4(4): 329-332.

Peñalver, R., Martínez ‐ Zamora, L., Lorenzo, J., Ros, G., & Nieto, G. 2022. Nutritional and antioxidant properties of moringa oleifera leaves in functional foods. Foods, 11(8), 1107. https://doi.org/10.3390/foods11081107

Taha, L. S., Taie, H. A. A. and Hussein, M. M. 2015. Antioxidant properties, secondary

metabolites and growth as affected by application of putrescine and moringa leaves extract on

jojoba plants. Journal of Applied Pharmaceutical Science, 5(1): 30-36

Trichopoulou, A., Lagiou, P., Kuper, H. and Trichopoulos, D. 2000. Cancer and mediterranean

dietary traditions. Cancer Epidemiology Biomarkers and Prevention, 9(9): 869–873.

Umeh,O.A. and Onovo, J.C.2015. Comparative Study of the Germination and Morphological

Characteristics of Four Cucumber (Cucumis sativus L.) Genotypes In keffi, Nasarawa State,

Nigeria. International Journal of Current Research in Bioscience and Plant Biology ISSN:2349

8080 Vol.2(7) pp. 43-46.

Woodward, A.W., Bartel, B. 2005. Auxin: regulation, action and interaction. Ann. Bot. 95,

707735.

Yasmeen, A. 2011. Exploring the potential of moringa *(Moringa oleifera)* leaves extract as

natural plant growth enhancer. Ph.D. Thesis, Agron. Agric. Univ. Faisalabad, Pakistan.

Yusuff AQ and Abiola IO (2019). Robustness of foliar application with Moringa extracts on

Cucumber. Advanced Journal of Agricultural Research 6: 198-205.

Zaki, S.S. and M.M. Rady, 2015. *Moringa oleifera* leaf extract improves growth, physio-chemical

attributes, antioxidant defense system and yields of salt-stressed *Phaseolus vulgaris L.* plants.

International Journal of Chem. Tech. Research, 8(11): 120 -134.

Zhao, Yunde 2010. "Auxin Biosynthesis and Its Role in Plant Development". Annual Review of

Plant Biology. 61: 49–64. doi:10.1146/annurev-arplant-042809-112308. PMC 3070418. PMID

20192736