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GROWTH AND YIELD RESPONSE OF SESAME (*SESAMUM INDICUM* L.) TO BITTER LEAF (*VERNONIA AMYGDALINA* DEL.) LEAF, STEM AND ROOT AQUEOUS EXTRACTS

***[1]ALEGE, Gbenga Olorunshola, [2]YAKUBU, Musa Ozigi, [2]EGILLA, Deborah Tini, [1]IGATA, David Franklin, [1]ALIYU, Usman Ibrahim and [1]DAUDA, Danlami**

[1]Department of Biotechnology, Federal University Lokoja, Kogi State.
[2]Department of Biological Sciences, Federal University Lokoja, Kogi State.

*Corresponding author's email: gbenga.alege@fulokoja.edu.ng.

ABSTRACT
This study was carried out to assess the effect of leaf, stem and root aqueous extracts of *Vernonia amygdalina* on seed germination, growth and yield performance of *Sesamum indicum*. The aqueous extracts of the three plant parts were applied at concentrations of 25%, 50%, 75%, and 100% to sesame seeds in petri dish and compared with seeds treated with distilled water (control). The percentage of germinated seeds and lengths of radicle and plumule were measure within 10 days of sowing. The different concentrations of leaf, stem and root extracts of *Vernonia amygdalina* were applied to the seedlings of *Sesamum indicum* grown in pots and arranged in Complete Randomized Design (CRD). Data were obtained for number of germinated seeds, lengths of plumule and radicle while number of leaves, height of plant, stem girth, leaf length and leaf breadth were taken at 2,4, 6 and 8 Weeks After Planting (WAP). All data pooled were subjected to one way Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) is used to separate means. Significant reduction in germination percentage of sesame seeds was recorded in sesame grown with 100% concentration of aqueous stem extracts of *Vernonia amygdalina* (78.33%) which indicates inhibitory effect of the extract at the concentration. 25% aqueous root extracts of *Vernonia amygdalina* significantly stimulated early growth of the shoot (1.70cm) and root (1.60cm) in sesame seed. In this study, growth and yield of sesame were enhanced by 50% root extract of *Vernonia amygdalina*. This suggests that intermediate concentrations of aqueous root extract could be suitable alternative to chemical fertilizer for optimum production of sesame.

Keywords: *Vernonia amygdalina*, *Sesamum indicum*, Extracts, Germination, Yield.

INTRODUCTION

Sesamum indicum L. commonly known as sesame is an ancient oilseed crop cultivated across the globe (Abubakar and Abdu, 2021; Tesfaye *et al*., 2021). Sesame is a multipurpose crop use as raw materials in the production of confectionery and bakery products; while the oil is use in the industry to produce soap, perfume, carbon paper, pharmaceuticals and edible vegetable oils (Oloniruwa *et al.*, 2021). The crop provides food for human beings, folder for livestock and poultry as well as an organic fertilizer (Anguria *et al.*, 2020). Sesame according to Alege (2019) is an under-utilized crop with a great economic potential. In spite the nutritional, medicinal and cultural importance of sesame, its yield is still below optimum in Nigeria compared to other countries (Alege, 2019; Oloniruwa *et al*., 2021). Ndor and Nasir (2019) reported an annual sesame production of 300kg/ha in Nigeria which is very low compared to the 517kg/ha, 1,083kg/ha and 1,960kg/ha produced annually in Ivory Coast, Saudi Arabia and Venezuela respectively. Warkad *et al*. (2021) reported that lack of improved varieties, lack of production input like improper management and cultural practices have contributed to poor sesame yield in Nigeria. Ndor and Nasir (2019) attributed the low production of sesame in Nigeria to the fact that sesame is grown on low fertile soils. In line with this assertion, Oloniruwa *et al.* (2021) ascribed the low production output of sesame in Nigeria to decline in soil fertility across sesame growing areas in the country.

Despite the efforts of research institutes with mandate to improve sesame like National Cereal Research Institute (NCRI) Badeggi annual production of sesame in Nigeria is still below average compared with other countries. This statement was buttressed by Abdulmaliq *et al.* (2020) that despite the use of improved varieties there are decline in yield of agricultural products in Nigeria. They attributed this decline to rapid depletion in soil fertility brought about by continuous cropping and lack of soil amendment.

As a result of this decline in soil fertility, efforts are been made by peasant farmers to enhance yield of sesame by applying inorganic and organic fertilizers (Akinola and Ojeniyi, 2000). However, use of inorganic fertilizers is restricted by its cost and scarcity, as well as the potential to increase soil acidity which adversely affects nutrients uptake (Abdulraheem *et al.*, 2012). As a result of this, Gautam *et al.* (2021) emphasized urgent need to switch research focus towards enhancing growth and yield of crops using botanical approach.

Several studies on the effects of plant extract on agricultural crops have shown inhibitory effects (Jabeen and Ahmed, 2009; Islam *et al.*, 2021; Motmainna *et al.*, 2021). Alege *et al*. (2016) revealed promontory effect of leaf extracts of *Vernonia amygdalina* on seed germination and seedling establishment of sesame while growth inhibitory effect of *Moringa oleifera* leaf was reported in the same study. As a result of this growth promontory effects of the leaf extract of bitter leaf (*Vernonia amygdalina*) on sesame, study on the response of sesame to leaf, stem and root extracts of *Vernonia amygdalina* is germane since Maharjan *et al.* (2007) affirmed that different parts of plants (such as stem, bark, roots, leaves, flowers, inflorescence, fruits and seeds) contained allelochemicals that can affect growth at different concentrations. According to Godlewsks *et al.* (2021b) presence of bioactive products in different plant parts such as leaves, stems, roots, flowers and seeds help to formulate effectual and environmentally safe growth promoting approach to sustainable agriculture. The findings of this study will help to initiate the use of environment friendly approach for optimum production of sesame. Against this background, this study was aimed at investigating the growth and yield responses of sesame (*Sesamum indicum*) to leaf, stem and root aqueous extracts of bitter leaf (*Vernonia amygdalina*).

MATERIALS AND METHODS

Sample Collections

Improved Sesame (*Sesamum indicum*) variety (01M) obtained from National Cereal Research Institute (NCRI) Badeggi and maintained by a generation of self-fertilization was considered for this study. Leaves, stems and roots of Bitter leaf (*Vernonia amygdalina*) were harvested from the Biological Garden of Biological Sciences, Federal University, Lokoja, Kogi State, Nigeria. The study was conducted in the greenhouse of the Department.

Preparation of Extracts from the Plant Samples

Aqueous extracts of leaves, stems and roots of *Vernonia anygdalina* were prepared according to the method outlined by Mousavi *et al.* (2018) with some slight modifications. Fresh leaves, stems and roots of the plant were washed, air-dried at room temperature at the Herbarium of the Department of Biological Sciences. The air dried plant parts were ground to powder. Stock solution of each plant parts were prepared by soaking 50g of the ground leaf, stem and root separately into three beakers containing 250ml of distilled water each. The solutions were allowed to macerate by leaving them overnight in air tight plastic bottle and thereafter centrifuged at 1,200r.p.m. The centrifuged infusions were filtered into 100ml volumetric flask using Whatman filter paper (number 2). The filtrates were then considered for studies. The raw undiluted filtrate served as 100% concentration while distilled water served as the control. Aqueous extract from the three plant parts were serially diluted to obtain 25%, 50% and 75%

concentrations. The simple floatation method was employed for seed viability test. The seed were poured into water and allowed to settle for about 30mins in a beaker. The seed that sank were taken as viable seeds while the non-viable seeds floated. Only viable seeds were considered for this study.

Seed Germination Test and Shoot/Root Length Measurements

The method described by Gatti *et al.* (2010) was employed for the seed germination and growth study. Ten viable sesame seeds were put into different filter paper in petri dishes and each petri dish was treated with 5ml of fresh preparations of different concentrations of leaf, stem and root extract of *Vernonia amygdalina***.** The control seeds were treated with distilled water. The number of germinated seeds was counted every day for 10 days while the length of the plumules (shoot) and radicles (root) were measured for five germinating seeds per treatment 6 days after germination in petri dishes. The set up was arranged in Complete Randomized Design (CRD) with three replicates.

Measurement of Growth and Yield Parameters

This aspect of the study was carried out in the greenhouse of Biological Sciences Department, Federal University Lokoja. Soil within the depth of 0-5cm were collected at the Research Garden and properly mixed before filling 7kg of steam-sterilized soils into each polythene bags. Each treatment was replicated five times, properly labeled and arranged in Complete Randomized Design (CRD). Three viable sesame seeds were planted in each bag and later thinned to two seedlings per bags. The plants were watered with 200mL of corresponding freshly prepared aqueous plant extract every five days according to method described by Talukder *et al.* (2015). Plant height, stem girth, number of leaves, leaf length and leaf breadth were measured at 2, 4, 6, and 8 Weeks After Planting (WAP) according to the method outlined by Alege *et al.* (2016). Data on yield characteristics like maturity period, number of pods, pod length, pod breadth and number of seeds per pod were taken.

Phytochemical Screening

The amount of Alkaloids, Saponins, Resins, Tannins, Flavonoids, Carbohydrates and Phenols were qualitatively assessed in the leaf, stem and root extracts of *Vernonia amygdalina*.

Data Analysis

Data obtained were analyzed using one way Analysis of Variance (ANOVA) and treatments with significant means were separated using Duncan Multiple Range Test (DMRT) using SPSS version 21 software.

RESULTS

Table 1 shows the germination percentages, shoot and root characteristics of sesame treated with different concentrations of aqueous leaf, stem and root extracts of *Vernonia amygdalina.* Tables 2, 3, 4 and 5 show results of the effects of aqueous extracts of leaf, stem and root of *Vernonia amygdalina* on vegetative growth of sesame at 2, 4, 6 and 8 Weeks After Planting respectively. The results of the effects of aqueous extracts of leaf, stem and root of *Vernonia amygdalina* on yield characteristics and phytochemical screening of the three parts of aqueous extracts of leaf, stem and root of *Vernonia amygdalina* studied is shown in tables 6 and 7 respectively. The result revealed significant differences ($P<0.05$) for percentages germination, shoot and root attributes (table 1). Treating sesame seeds with aqueous stem extracts of *Vernonia amygdalina* at 100% concentration significantly reduced the number of sesame seeds that germinated (78.33% germination). Aqueous root extract of *Vernonia amygdalina* at 25% concentration significantly increased the lengths of shoot (1.70cm) and roots (1.60cm) of treated sesame seeds. Growth of plumule and radicle was observed to be significant in sesame seeds treated with 25% and 75% leaf extract, 50% stem extract, 25%, 75% and 100% root extract as well as the control plants. The shoot/root ratio of 1.00 was recorded in sesame treated with 50% stem extract of *Vernonia amygdalina*. The shoot/root ratio of 1.06 was recorded for 25% leaf and root extracts.

Table 1: Germination percentage, shoot and root lengths of sesame (*Sesamum indicum*) treated with different concentrations of leaf, stem and root extracts of bitter leaf (*Vernonia amygdalina*)

Plant Part	Conc. of Extracts	Germination Percentage (%)	Shoot Length (cm)	Root Length (cm)	Shoot/Root Ratio
Water	Control	100.00 ± 0.10^{a}	1.00 ± 0.10^{c}	0.87 ± 0.58^{cd}	1.12 ± 0.13^{c}
Leaf	25%	95.00 ± 5.00^{a}	0.70 ± 0.10^{d}	0.60 ± 0.10^{e}	1.06 ± 0.18^{c}
Leaf	50%	96.67 ± 5.77^{a}	1.10 ± 0.10^{c}	0.70 ± 0.10^{de}	1.61 ± 0.38^{a}
Leaf	75%	100 ± 0.00^{a}	1.50 ± 0.10^{b}	1.00 ± 0.10^{bc}	1.50 ± 0.56^{ab}
Leaf	100%	96.64 ± 2.89^{a}	0.80 ± 0.10^{d}	0.70 ± 0.10^{de}	1.15 ± 0.15^{c}
Stem	25%	100.00 ± 0.00^{a}	1.10 ± 0.10^{c}	0.90 ± 0.01^{c}	1.23 ± 0.12^{bc}
Stem	50%	100.00 ± 0.00^{a}	1.10 ± 0.10^{c}	1.10 ± 0.10^{b}	1.00 ± 0.01^{c}
Stem	75%	100.00 ± 0.00^{a}	1.20 ± 0.10^{c}	0.90 ± 0.01^{c}	1.35 ± 0.13^{abc}
Stem	100%	78.33 ± 7.64^{a}	1.20 ± 0.10^{c}	0.90 ± 0.01^{c}	1.35 ± 0.13^{abc}
Root	25%	93.33 ± 2.89^{b}	1.70 ± 0.20^{a}	1.60 ± 0.10^{a}	1.06 ± 0.06^{c}
Root	50%	86.67 ± 5.77^{b}	1.10 ± 0.10^{c}	0.90 ± 0.10^{c}	1.23 ± 0.14^{bc}
Root	75%	86.67 ± 7.64^{b}	1.10 ± 0.10^{c}	1.10 ± 0.10^{b}	1.01 ± 0.13^{c}
Root	100%	95.00 ± 5.00^{a}	1.20 ± 0.10^{c}	1.10 ± 0.10^{b}	1.09 ± 0.10^{c}
LSD Value		7.50	0.27	0.95	1.21

❖ Means with the same superscripts in the same column are not significantly different at $P<0.05$

Tables 2, 3, 4 and 5 revealed that all the five quantitative vegetative growth characteristics considered in sesame in this study responded significantly ($p < 0.05$) to treatments with leaf, stem and root aqueous extracts at 2, 4, 6 and 8 Weeks After Planting (8WAP). Growing sesame with 50% concentration of *Vernonia amygdalina* significantly increased the height of plants at 2 (11.76cm), 4 (26.70cm), 6 (54.40cm) and 8(61.16cm) Weeks After Planting (8WAP) compared to other treatments (tables 2, 3, 4, 5 and plates 1-4). Also sesame grown with 50% concentration of aqueous root extract of *Vernonia amygdalina* produced the highest number of leaves (7.60) at 2WAP (table 2) and the widest stems (1.38cm) at 4WAP (table 3) and (1.96cm) 6WAP (table 4). Leaf extract of *Vernonia amygdalina* at 25% concentration significantly enhanced stem girth (1.00), number of leaves (7.40), length of leaves (4.18cm) and breadth of leaves (22.2cm) at 2WAP (table 2).

Table 2: Vegetative Morphological Attributes of sesame (*Sesamum indicum*) grown with different concentrations of leaf, stem and root extracts of bitter leaf (*Vernonia amygdalina*) at 2 Week After Planting

Plant Part	Conc. of Extracts	Plant Height (cm)	Stem Girth (cm)	No. of Leaves	Length of Leaves (cm)	Breath of Leaves (cm)
Water	0% Control)	8.32 ± 0.73^{ef}	0.72 ± 0.11^{bc}	7.11 ± 1.09^{ab}	3.16 ± 0.52^{cd}	2.28 ± 0.36^{a}
Leaf	25%	9.32 ± 0.73^{bcde}	1.00 ± 0.10^{a}	7.40 ± 0.89^{a}	4.18 ± 0.39^{a}	2.22 ± 0.08^{a}
Leaf	50%	9.42 ± 0.29^{bcde}	0.76 ± 0.15^{bc}	6.60 ± 0.89^{ab}	3.28 ± 0.36^{cd}	1.72 ± 0.32^{bcd}
Leaf	75%	8.14 ± 1.29^{ef}	0.68 ± 0.13^{bc}	7.20 ± 1.09^{ab}	3.24 ± 0.46^{cd}	1.54 ± 0.23^{d}
Leaf	100%	7.26 ± 1.42^{f}	0.68 ± 0.11^{bc}	6.40 ± 0.89^{ab}	2.96 ± 0.43^{d}	1.56 ± 0.21^{d}
Stem	25%	8.32 ± 1.52^{ef}	0.56 ± 0.17^{c}	7.20 ± 1.09^{ab}	2.96 ± 0.26^{d}	1.68 ± 0.23^{bcd}
Stem	50%	8.52 ± 1.32^{def}	0.76 ± 0.17^{bc}	7.12 ± 1.09^{ab}	3.24 ± 0.71^{cd}	1.56 ± 0.26^{d}
Stem	75%	8.92 ± 1.49^{cde}	0.74 ± 0.01^{bc}	6.00 ± 0.00^{b}	3.16 ± 0.46^{cd}	1.60 ± 0.14^{cd}
Stem	100%	8.26 ± 0.99^{ef}	0.80 ± 0.00^{b}	6.00 ± 0.03^{b}	2.92 ± 0.48^{d}	1.66 ± 0.35^{bcd}
Root	25%	10.42 ± 0.38^{abc}	0.80 ± 0.00^{b}	6.80 ± 0.09^{ab}	3.86 ± 0.19^{abc}	2.02 ± 0.18^{ab}
Root	50%	11.76 ± 1.01^{a}	0.84 ± 0.17^{ab}	7.60 ± 0.81^{a}	4.08 ± 0.66^{ab}	2.24 ± 0.38^{a}
Root	75%	10.76 ± 1.18^{ab}	0.72 ± 0.23^{bc}	6.80 ± 1.09^{ab}	4.09 ± 0.45^{ab}	1.96 ± 0.30^{abc}

Root	100%	9.96±0.51^{bcd}	0.76±0.22^{bc}	7.60 ±0.85^{a}	3.48 ±0.41^{bcd}	1.90 ±0.22 ^{abcd}
LSD Value		9.18	0.76	0.99	0.62	1.84

❖ Means with the same alphabets in the same column are not significantly different at P<0.05

Table 3: Vegetative Morphological Attributes of sesame (*Sesamum indicum*) grown with different concentrations of leaf, stem and root extracts of bitter leaf (*Vernonia amygdalina*) at 4 Week After Planting

Plant Part	Conc. of Extracts	Plant Height (cm)	Stem Girth (cm)	No. of Leaves	Length of Leaves (cm)	Breath of Leaves (cm)
Water	0% (Control)	17.16±1.49^{e}	1.18±0.27^{abcd}	9.20±1.79^{de}	5.08±1.41^{d}	3.26±1.09^{bc}
Leaf	25%	19.96±1.78^{cde}	1.12±0.13^{bcde}	8.80±1.09^{e}	5.68±0.58^{cd}	3.32±0.26^{bc}
Leaf	50%	21.28±3.46^{bcd}	0.96±0.09^{de}	9.20±1.08^{de}	4.78±0.82^{d}	2.66±0.62^{c}
Leaf	75%	18.74±3.78^{de}	0.96±0.08^{de}	10.40±1.67^{bcde}	5.00±0.44^{d}	3.06±0.19^{bc}
Leaf	100%	19.34±1.43^{cde}	0.98±0.15^{de}	9.60±1.89^{cde}	4.92±0.71^{d}	3.24±0.56^{bc}
Stem	25%	20.46±2.79^{cde}	1.10±0.17^{bcde}	10.80±1.09^{bcd}	4.82±0.35^{d}	3.10±0.26^{c}
Stem	50%	21.16±3.08^{e}	1.02±0.09^{cde}	10.40±1.67^{bcde}	5.90±0.75^{bcd}	3.22±0.39^{bc}
Stem	75%	19.16±3.85^{de}	0.96±0.07^{de}	8.80±1.07^{e}	5.02±0.36^{d}	2.96±0.29^{c}
Stem	100%	20.70±1.67^{cde}	0.94±0.09^{e}	10.00±1.41^{bcde}	5.18±0.41^{d}	2.98±0.13^{c}
Root	25%	24.54±2.29^{ab}	1.22±0.11^{abc}	11.20±1.09^{bc}	6.72±0.81^{abc}	4.52±0.56^{a}
Root	50%	26.70±2.89^{a}	1.38±0.30^{a}	11.60±1.67^{ab}	7.20±1.17^{a}	4.44±0.90^{a}
Root	75%	23.12±2.29^{abc}	1.24±0.11^{abc}	13.20±1.09^{a}	6.28±0.36^{abc}	4.44±0.88^{a}
Root	100%	24.90±2.58^{ab}	1.30±0.14^{ab}	13.20±1.08^{a}	6.84±1.13^{ab}	4.06±1.11^{a}
LSD Value		3.60	0.03	1.87	1.09	0.86

❖ Means with the same alphabets in the same column are not significantly different at P<0.05

Table 4: Vegetative Morphological Attributes of sesame (*Sesamum indicum*) grown with different concentrations of leaf, stem and root extracts of bitter leaf (*Vernonia amygdalina*) at 6 Week After Planting

Plant Part	Conc. of Extracts	Plant Height (cm)	Stem Girth (cm)	No. of Leaves	Length of Leaves (cm)	Breath of Leaves (cm)
Water	0% Control)	33.30±3.11^{e}	1.30±0.45^{bcd}	13.60±1.67^{cd}	7.50±3.33^{a}	4.04±0.74^{ab}
Leaf	25%	40.88±6.92^{bcde}	1.58±0.37^{abc}	14.40±1.45^{cd}	5.90±1.15^{abc}	3.12±0.69^{abc}
Leaf	50%	40.26±6.51^{cde}	1.18±0.16^{cd}	13.60±0.89^{cd}	5.36±0.77^{bc}	2.98±0.46^{abc}
Leaf	75%	38.42±5.26^{de}	1.02±0.45^{d}	14.00±2.82^{cd}	5.26±0.76^{bc}	2.70±0.50^{c}
Leaf	100%	37.92±1.76^{de}	1.00±0.02^{d}	14.00±2.83^{cd}	5.04±0.65^{bc}	3.08±0.59^{abc}
Stem	25%	39.34±5.75^{de}	1.30±0.41^{bcd}	14.80±2.82^{bcd}	5.78±0.55^{abc}	2.88±0.29^{bc}
Stem	50%	37.10±7.73^{de}	1.26±0.13^{bcd}	12.40±1.67^{d}	5.82±0.94^{abc}	3.00±0.63^{abc}
Stem	75%	37.50±6.42^{de}	1.32±0.33^{bcd}	13.20±1.20^{cd}	6.02±0.84^{abc}	3.18±0.72^{abc}
Stem	100%	36.40±7.03^{de}	1.22±0.26^{cd}	12.40±3.29^{d}	4.78±0.81^{c}	3.17±0.70^{abc}
Root	25%	50.40±5.81^{a}	1.80±0.31^{a}	15.40±2.19^{bcd}	6.46±1.16^{abc}	3.96±0.92^{ab}
Root	50%	54.40±5.81^{a}	1.96±0.30^{a}	16.40±2.22^{cd}	6.52±1.06^{abc}	4.18±0.50^{a}
Root	75%	45.58±13.82^{abcd}	1.80±0.17^{a}	17.60±2.97^{ab}	6.70±0.57^{ab}	3.52±0.61^{abc}
Root	100%	49.72±7.85^{abc}	1.68±0.50^{ab}	18.80±2.68^{a}	6.16±0.89^{abc}	3.94±1.01^{ab}
LSD Value		8.79	0.41	2.76	1.34	0.87

❖ Means with the same alphabets in the same column are not significantly different at P<0.05

Table 5: Vegetative Morphological Attributes of sesame (*Sesamum indicum*) grown with different concentrations of leaf, stem and root extracts of bitter leaf (*Vernonia amygdalina*) at 8 Week After Planting

Plant Part	Conc. of Extracts	Plant Height (cm)	Stem Girth (cm)	No. of Leaves	Length of Leaves (cm)	Breath of Leaves (cm)
Water	0% (Control)	46.24±1.86^{bcd}	1.74±0.32^{a}	17.20±1.79^{ab}	5.86±0.34^{abcd}	3.26±0.24^{cde}
Leaf	25%	39.58±14.49^{d}	1.48±0.36^{abc}	14.80±3.03^{abcd}	6.08±1.14^{abcd}	3.32±0.71^{cde}
Leaf	50%	47.72±10.59^{bcd}	1.36±0.40^{bc}	18.40±4.56^{a}	6.86±1.39^{a}	3.24±0.47^{cde}
Leaf	75%	46.96±4.41^{bcd}	1.38±0.13^{bc}	12.00±0.00^{d}	5.68±0.41^{bcd}	2.88±0.37^{de}
Leaf	100%	44.08±5.72^{cd}	1.30±0.12^{c}	13.20±3.03^{bcd}	5.42±0.43^{d}	3.06±0.46^{cde}
Stem	25%	45.76±8.38^{bcd}	1.32±0.33^{c}	17.20±5.40^{ab}	6.06±0.25^{abcd}	3.04±0.27^{cde}
Stem	50%	42.28±8.89^{cd}	1.38±0.08^{bc}	12.80±1.09^{ab}	6.22±0.53^{abcd}	3.54±0.33^{cde}
Stem	75%	42.68±10.92^{cd}	1.60±0.20^{abc}	14.00±2.00^{bcd}	6.24±0.99^{abcd}	3.20±0.53^{cde}
Stem	100%	43.24±10.50^{cd}	1.58±0.15^{abc}	16.00±3.16^{abcd}	5.48±0.29^{cd}	2.78±0.41^{e}
Root	25%	56.02±5.78^{ab}	1.46±0.13^{abc}	16.40±3.29^{abc}	6.90±0.34^{a}	4.34±0.76^{ab}
Root	50%	61.16±5.42^{a}	1.70±0.22^{ab}	15.20±1.79^{ab}	6.98±0.80^{a}	4.42±0.79^{a}
Root	75%	53.72±4.54^{abc}	1.50±0.10^{abc}	15.20±2.68^{abcd}	6.64±0.54^{abc}	3.64±0.54^{bcd}
Root	100%	57.38±4.31^{ab}	1.64±0.21^{abc}	15.60±1.67^{abcd}	6.80±0.99^{ab}	3.70±0.80^{abc}
LSD Value		9.78	0.26	3.20	0.89	0.69

❖ Means with the same alphabets in the same column are not significantly different at P<0.05

It can be observed from result of yield attributes in table 6 that no sesame plant grown with different concentrations of stem extracts of *Vernonia amygdalina* matured earlier than plants from the control. Also, sesame grown with 50% root extract showed significant early maturity (55days) and produced highest number of pods when compared to plants grown with other treatments. Although, pods produced by sesame grown with 50% root extract were observed to be very thin (1.94cm), result in table 6 revealed significant increase (P<0.05) in number of pod for sesame grown with the same concentration (50.30). The average number of seeds produce in the pods did not show significant response to different concentrations of leaf, stem and root extracts of *Vernonia amygdalina* considered in this study.

Table 6: Vegetative Morphological Attributes of sesame (*Sesamum indicum*) grown with different concentrations of leaf, stem and root extracts of bitter leaf (*Vernonia amygdalina*) at 8 Week After Planting

Plant Part	Conc. of Extracts	Maturity Period	Number of Pods	Pod Length (cm)	Pod Breath (cm)	Number of Seeds
Water	0% (Control)	70.00±1.58^{de}	40.60±1.14^{c}	2.16±0.02^{b}	1.77±0.03^{de}	73.80±2.86
Leaf	25%	68.80±2.58^{e}	45.80±2.86^{ab}	2.20±0.16^{b}	2.01±0.05^{a}	73.40±6.39
Leaf	50%	66.60±2.41^{ef}	42.60±1.11^{bc}	2.28±0.08^{b}	1.97±0.03^{a}	73.20±4.92

Leaf	75%	68.20±2.17^{ef}	42.60±1.14^{bc}	1.67±0.01^{b}	1.50±0.12^{h}	73.00±1.87
Leaf	100%	72.60±1.95^{bcd}	44.40±3.21^{c}	1.72±0.03^{b}	1.63±0.02^{f}	73.00±4.30
Stem	25%	78.80±3.42^{a}	44.80±4.66^{c}	2.12±0.11^{b}	1.56±0.04^{g}	73.20±1.30
Stem	50%	75.80±0.84^{ab}	45.20±3.56^{bc}	2.04±0.02^{b}	1.84±0.03^{c}	73.20±3.83
Stem	75%	73.80±1.30^{bc}	44.20±3.96^{bc}	3.68±2.74^{a}	1.66±0.05^{f}	74.00±4.30
Stem	100%	72.20±2.39^{cd}	44.80±5.76^{bc}	2.24±0.06^{b}	1.89±0.02^{b}	73.60±6.35
Root	25%	65.00±1.58^{f}	47.00±2.92^{ab}	2.16±0.05^{b}	1.82±0.04^{cd}	73.60±3.21
Root	50%	55.40±1.82^{h}	50.30±2.24^{a}	1.94±0.03^{b}	1.67±0.03^{f}	73.20±7.50
Root	75%	61.40±5.03^{g}	44.20±2.77^{bc}	2.13±0.04^{b}	1.77±0.02^{de}	73.40±2.89
Root	100%	57.00±2.24^{h}	45.40±2.61^{b}	2.13±0.05^{b}	1.75±0.03^{e}	73.80±3.35
LSD Value		7.14	0.45	0.84	0.15	NS

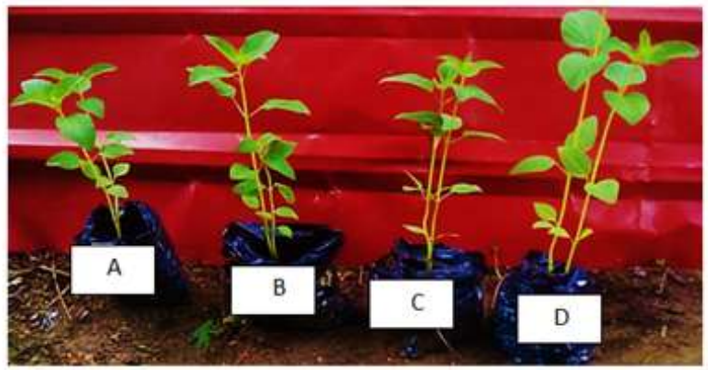
❖ Means with the same alphabets in the same column are not significantly different at P<0.05. **KEY: NS = Not Significant at p>0.05**

Table 7 showed result of phytochemical screening of leaf, stem and root extracts of *Vernonia amygdalyna* considered in this study. Alkaloid and Tannins occurred in high concentrations in leaf, moderately present in the stem and present in trace amount in the root. Flavonoids are moderately present in the leaf and occurred in trace amount in the stem and root. Saponin and Phenol occurred in high concentrations in the root while leaf and stem of *Vernonia amygdalina* contained moderate amount of phenol and saponin respectively. Carbohydrate is only present in trace amount in the leaf but absent in the stem and root.

Table 7: Phytochemical Composition of the leaf, Stem and Root Extracts of *Vernonia amygdalina*

Phytochemical Components	Leaf	Stem	Root
Alkaloid	+++	++	+
Saponin	+	++	+++
Resin	++	+	+
Tannins	+++	++	+
Flavonoid	++	+	+
Carbohydrate	+	-	-
Phenol	++	+	+++

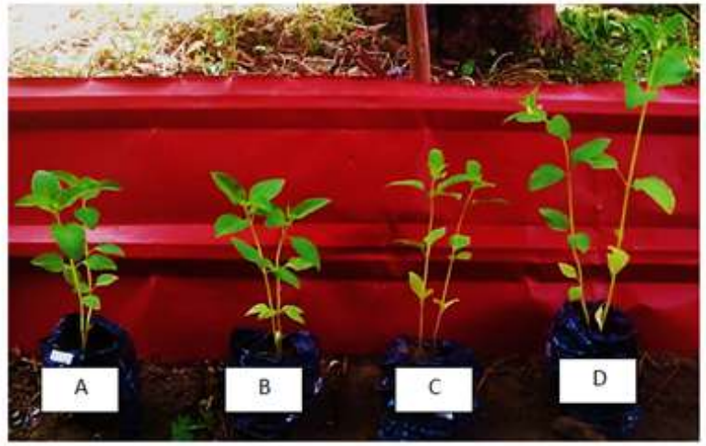
Keys:
+++ = Highly Present
++ = Moderately Present
+ = Present in trace amount
- = Absent



Plates 1: Morphological appearance of control plants and sesame grown with 25% concentrations of leaf, stem and root aqueous extracts of *Vernonia amygdalina* at 4WAP.

Plates 2: Morphological appearance of control plants and sesame grown with 50% concentrations of leaf, stem and root aqueous extracts of *Vernonia amygdalina* at 4WAP.

Plates 3: Morphological appearance of control plants and sesame grown with 75% concentrations of leaf, stem and root aqueous extracts of *Vernonia amygdalina* at 4WAP.



Plates 4: Morphological appearance of control plants and sesame grown with 100% concentrations of leaf, stem and root aqueous extracts of *Vernonia amygdalina* at 4WAP.

Key: A- Control Plants, B- Sesame grown with aqueous leaf extracts of *Vernonia amygdalina*, C- Sesame grown with aqueous stem extracts of *Vernonia amygdalina*, D- Sesame grown with aqueous root extracts of *Vernonia amygdalina*, 4WAP- 4 Week After Planting

DISCUSSION

The need to substitute inorganic farming with organic approach was emphasized by Iduh and Oghale (2013) because of its sustainability and potentials in providing eco-friendly strategy to crop improvements. In this study, the significant reduction in germination percentage of sesame seeds treated with 100% concentration of aqueous stem extracts of *Vernonia amygdalina* compared to other treatments indicates that the concentration inhibits metabolic activities in treated seeds. According to Ferreira and Áquila (2000), alterations in germination percentage can be attributed to changes in the permeability of cell membranes, transcription and translation of RNA, integrity of secondary messengers, respiration, conformation of enzymes and receptors, or a combination of these changes. This finding contradicts the report of Gatti *et al.* (2010) that leaf and stem aqueous extracts of *Aritistolochia esperanzae* did not cause any changes in the germination percentage of the sesame seeds at any of the concentrations considered.

In this study, early growth of shoot and root in sesame seeds were stimulated when treated with 25% aqueous root extracts of *Vernonia amygdalina*. This was also supported by the shoot/root ratios of 1.06 (close to 1) produced by sesame treated with the same concentration which indicates even distribution of growth hormone to the two apices. This finding disagree with the report of Pina *et al.* (2009) that roots of sesame respond more to aqueous leaf extracts of *Eugenia dysenterica* than the shoots. But, Radwan *et al.* (2019) reported that aqueous extract of *Calotropis procera* had inhibitory effect on seed germination and seedling growth of wheat. This discrepancy may be as a result of differences in the biochemical compositions of these plants which affected the physiological and metabolic processes associated with growth and development of the study plants.

In this study, sesame plants grown with 50% concentration of *Vernonia amygdalina* root extract generally had promontory effects on height of plants, stem girth and leaf attributes across weeks. This indicates that root extracts of *Vernonia amygdalina* at moderate concentration will enhance vegetative growth of sesame. The application of crude extract of *Gleicheni linearis* leaves at 100 mg/L had growth and yield promontory effects on maize (Aulya *et al.*, 2018). Godlewska *et al.* (2021a) attributed the positive effects of plant extracts on growth and yield of crops to single or combinations of plant bio-products. Generally, addition of aqueous stem extract of *Vernonia amygdalina* to sesame irrespective of concentration prolonged maturity period significantly while sesame grown with root extracts significantly shortened maturity period and produced more pods irrespective of concentration. Although growing sesame with extracts from leaves, stem and roots of *Vernonia amygdalina* did significantly affect the number of seeds produced per pod invariably the ability of roots extract of *Vernonia amygdalina* at 50% to significantly enhance the number of pods produced per plant will ultimately increase the overall yield of sesame.

In this study mainly, the growth enhancing potentials of root extract of *Vernonia amygdalina* could be attributed to the sufficient amounts of saponins and phenolics compared to leaf and stem. Godlewska *et al.* (2021a) attributed the bio-stimulatory activities of plant extracts to presences of several bioactive compounds like phenolic compounds. Radwan *et al.* (2019) and Godlewsks *et al.* (2021b) reported that the growth inhibitory or promontory effect of plant extracts could be attributed to presence of different bioactive components like phenolics, flavonoids, saponins and growth-promoting hormones. Usunomena and Ngozi (2016) reported presence of flavonoids, saponins, alkaloids, cardiac glycosides and reducing sugar in leaves and roots of *Vernonia amygdalina*.

This study revealed that sesame grown with 50% root extract of *Vernonia amygdalina* performed better that other treatment for vegetative morphological and yield attributes and will therefore be suitable for optimum production of sesame.

CONCLUSION AND RECOMMENDATION

There is sufficient evidence in this study to support that the root extract of *Vernonia amygdalina* had more growth and yield enhancing potentials on sesame than the leaf and stem extracts. Also, the stimulatory effect of *Vernonia amygdalina* is concentration-dependent and when properly utilized it could lead to enhanced performance of sesame (*Sesamum indicum*). 50% root extract of *Vernonia amygdalina* is the best concentrations for promoting growth in sesame and could be used as bio-stimulants to increase growth and yield of sesame. We therefore recommend further study to ascertain the exact active ingredients in the roots of *Vernonia amygdalina* that are responsible for the observed enhanced growth and yield of sesame.

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