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Effect of Aloe vera Foliar Spray on Control of Insect Damage and Growth of Eggplant (*Solanum melongena* L.) Seedlings

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ABSTRACT

Aim: *This experiment was conducted to assess the effect of Aloe vera extract foliar spray in the control of leaf eating insects of eggplant (Solanum melongena,* L.*) seedlings and on growth and development of eggplant seedlings.*

Study design: *The experiment was carried out using a completely randomized design with three replicates. Analysis of variance was used (P=0.05) to test treatment effects and mean comparison was by LSD.*

Place and Duration of Study: This study was conducted in the Plant Science and Biotechnology Department of the Rivers State University, Rivers State, Nigeria, between February and September 2018.

Methodology: *Water extracts of Aloe vera at three concentrations [100%, 50% and 0% -water (control)] were applied weekly as foliar spray to eggplant seedlings from three weeks after transplanting to the nursery. Plant height, number of leaves per plant and the number of insect holes (feeding punctures) per leaf were recorded.*

Results: *Eggplant seedlings sprayed with 100% and 50% Aloe vera extract were significantly (P=0.05) taller than those sprayed with water (control). Seedlings sprayed with 100% Aloe vera extract had significantly (P=.05) higher number of leaves than those sprayed with 50% extract and water (control). However, seedlings sprayed with 50% extract of Aloe vera and the control showed no significant difference in the number of leaves. The number of insect holes on the leaves of seedlings treated with 50% and 100% Aloe vera extract foliar spray were significantly less (P=0.05) than those of the control.*

Conclusion: *In this study the reduced number of holes caused by insects on leaves of eggplants treated with 50% and 100% of Aloe vera foliar spray suggests its effectiveness as a bio-pesticide. The increase in height and number of leaves of eggplants treated with 100% Aloe vera imply that it could be used as a growth promoter.*

Key words: Aloe-vera, Bio pesticide, Foliar spray, Growth promoter

INTRODUCTION

In spite of the economic importance of vegetable crops, production and yield continues to decline due to climatic, pest and disease infestation [1]. Aphids and whiteflies are some of the major insect pests attacking fruit and leafy vegetable crops grown in the nursery and main fields [2,3,4]. Adults and nymphs of these pests suck the sap from tender leaves, growing shoots, flowers and fruits which leads to loss in plant vigour, stunted growth and ultimately yield [5]. In the tropics, eggplant production is severely constrained by several insect pests. The major pests include eggplant fruit and shoot borer (Daraba laisalis; Leucinodes orbonalis), wireworms (Elateridae spp), leafhopper (Cicadellidae spp), whitefly (Aleyrodidae spp), thrip (Thysanoptera spp), green peach aphids (Myzus persicae), flea beetles (Chrysomelidae spp), leaf roller (Eublemma olivacea Wlk), stem borer, (Euzophera villosa), red spider mite (Tetranychus spp.), and little leaf disease accounting for 20-92% loss in crop yield [2,5-7]. In order to control these pests, generally farmers use synthetic chemical pesticides to reduce pest incidence in the absence of alternatives and their use has been of great importance in pest management for many years. In order to achieve effective control, farmers use double and triple applications due to the pests

becoming tolerant to the insecticides [8-11]. Farmers in certain areas of Philippines spray chemical insecticides up to 56 times during a cropping season [12]. Such excessive and prolonged use of pesticides has affected negatively the earth's ozone layer [13]. In addition, many synthetic chemical pesticides leave unwanted residues in food, ground water and the environment that are hazardous to man [14]. Indiscriminate use of pesticides is also causing health problems for farmers, as research findings have revealed that farmers spraying pesticides often suffer from heart and skin diseases, while cattle and goats are affected by consuming pesticide affected grasses [15]. Many chemical pesticides are suspected carcinogens and low doses of many of these insecticides and fungicides are toxic to mammals. Moreover, due to indiscriminate and prolonged use of chemical pesticides, some pests have developed resistance to some insecticides at several locations. This has also caused the reduction of beneficial species and non target organisms leading to undesirable changes in the biodiversity of micro fauna and outbreaks of secondary pests that are normally controlled by natural enemies [16-18]. There is therefore an urgent need to search for less hazardous alternatives to conventional synthetic chemical pesticides [19].

The search for viable alternatives to chemical pesticides, has led to the use of natural products from such plants as microbial antagonists to control pests and diseases. Many plants produce secondary metabolites which are chemical constituents that are not particularly active in the metabolic activities of the plants. They include glycosides, alkaloids and terpenoids, phenolics and amino acids, proteins and enzymes, mucilage and gums, tannins, essential oils, and pectins [20]. Many of these compounds have been confirmed to act as bio-pesticides specifically as ovicides, insecticides, fungicides, nematicides and anti-feedants, antivirals and antibacterials, pest repellents, insect growth regulators with toxicity to mites and other agricultural pests [21-23]. These secondary compounds have been a part of the plant's defence mechanisms against plant feeding insects and other herbivores. Botanicals degrade more rapidly than most chemical pesticides and are therefore considered environmentally friendly and less likely to cause harm to humans and animals than synthetic chemical pesticides with longer environmental retention. Bio-pesticides are eco-friendly, economic, target specific and biodegradable and offer effective alternatives for the control of many insect pests and diseases [24-26]. Botanical extracts have broad spectrum use in pest control and they are safe to apply, unique in action and can easily be processed [27]. Global interest in plants as sources of natural pesticide and medicine is gaining prominence due to their environmental and user-friendliness and they are cheap to grow [28-30]. They can therefore be exploited either as powder or as crude extract in water or other organic solvents [31,32]. The challenge is to develop a formulation and application method that can be implemented easily by rural farmers as well as on a commercial scale that is effective, reliable, consistent and economically feasible. Bio-pesticides can also be used primarily as prophylactics, so they may not perform as quickly as some synthetic chemical pesticides; however, they are generally less toxic to the user and non-target organisms, making them desirable and sustainable tools for pests and disease management [33,]. Among the most widely used botanicals are Neem (*Azadiracta indica*) [34], *Aloe vera* [35], Garlic (*Allium sativum L.*), [36] and Tobacco (*Nicotiana tabacum L.*). Others are Goosefoot (*Chenopodium album L*) [37]; and Glory Lily (*Gloriosa superb*) [38], etc. The choice of *Aloe vera* as a potential preventative bio-pesticide and growth enhancer is because of its reported efficacy against disease pathogens and pests in addition to its growth promoting properties [39]. The antiseptic and growth stimulant properties of *Aloe vera* are due to the presence of six antiseptic agents namely lupeol, salicylic acid, urea nitrogen, cinnamonic acid, phenols and sulphur. These compounds have inhibitory actions on fungi, bacteria, viruses and yeasts [18,40-44]. In addition, *Aloe vera's* large leaf parenchyma cells contain a yellow latex and clear gel [45-47], which is rich in essential amino acids, mono- and polysaccharides, lignin, macronutrients, micronutrients, vitamins, gibberellins and salicylic acid [48,49]. Other important phytochemical constituents of *Aloe vera* have been reported (Table 1) to include high content of phenolic compounds, glycosides (aloins), 1, 8 dihydroxyanthraquinones (aloe emodin), β- 1,4 acetylated mannan, mannose phosphate, and alprogengluco protein [50]. Aloin A (hydroxyanthrone glycoside) is the major constituent of *A. vera* [51] with smaller amounts of its C-10 epimer, aloin B. Aloin A has numerous biological activities such as antimicrobial, antifungal [52]; antibacterial, anti-oxidant, cytotoxic drug against ovarian tumour cell lines. The leaf exudate and gel of *Aloe vera* also possess antifungal, antibacterial, anticancer, antioxidant, cryoprotective, immune modulatory [53] and insecticidal activities [31]. A summary of the chemical composition of *Aloe vera* leaf pulp and gel has been compiled and provided [54,55] in their informative review in a tabular format and is presented below for easy reference.

Table 1. Summary of the chemical composition of *A. vera* leaf pulp and exudates

Class	Compounds
Anthraquinones /anthrones	Aloe-emodin, aloetic-acid, anthranol, aloin A and B (or collectively known as barbaloin), isobarbaloin, emodin, ester of cinnamic acid
Carbohydrates	Pure mannan, acetylated mannan, acetylated glucomannan, glucogalactomannan, galactan, galactogalacturan, arabinogalactan galactoglucoarabinomannan, pectic substance, xylan, cellulose
Chromones	8-*C*-glucosyl-(2'-*O*-cinnamoyl)-7-*O*-methylaloediol A, 8-*C*-glucosyl-(*S*)-aloesol, 8-*C*-glucosyl-7-*O*-methyl-(*S*)-aloesol, 8-*C*-glucosyl-7-*O*-methylaloediol, 8-*C*-glucosyl-noreugenin, isoaloeresin D, isorabaichromone, neoaloesin A
Enzymes	Alkaline phosphatase, amylase, carboxypeptidase, catalase, cyclooxidase, cyclooxygenase, lipase, oxidase, phosphoenolpyruvate carboxylase, superoxide dismutase
Inorganic compounds	Calcium, chlorine, chromium, copper, iron, magnesium, manganese, potassium, phosphorous, sodium, zinc
Miscellaneous including organic compounds and lipids	Arachidonic acid, γ-linolenic acid, steroids (campestrol, cholesterol, β- sitosterol), triglicerides, triterpenoid, gibberillin, lignins, potassium sorbate, salicylic acid, uric acid
Non-essential and essential amino acids	Alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, hydroxyproline, isoleucine, leucine, lysine, methionine, phenylalanine, proline, threonine, tyrosine, valine
Proteins	Lectins, lectin-like substance
Saccharides	Mannose, glucose, *L*-rhamnose, aldopentose
Vitamins	A, B1, B2, B6, B12, C, E, β-carotene, choline, folic acid, α-tocopherol
Hormones	Auxins and gibberellins
Sources: [47,56-60] as compiled by [54,55]	

It is for these reasons therefore that this exploratory study was conducted to investigate its efficacy as an all-in-one bio-pesticide and growth promoter as well as determine its effects on the growth of eggplant seedlings in the nursery where early damage results in stunted growth and development and ultimately low yields.

This experiment was conducted to:

1. Assess the effect of *Aloe vera* extract as foliar spray in the control of insects on the leaves of eggplant seedlings
2. Evaluate the effect of *Aloe vera* extract as foliar spray on growth and development of eggplant seedlings.

MATERIALS AND METHODS

This study was carried out in the Plant Science and Biotechnology Department of the Rivers State University, Rivers State, Nigeria.

Preparation of Aloe Vera Extract

Preparation of the *Aloe vera* extract was kept simple to ensure that rural farmers can prepare it easily. Four 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 4 litres 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. Half the quantity of this leaf extract was used directly as 100 percent concentration, while the other half was further diluted by the addition of an equal amount of water to reduce it to 50 percent concentration.

Experimental Design and Treatment Applications

The experiment was carried out using a completely randomized design with 3 replicates. Seeds of mature eggplant were extracted by squashing 2 fruits stored for 6 days to soften. Extracted seeds were washed under running tap to remove debris. Clean seeds were germinated by sowing in a perforated plastic seed tray containing top soil in the department of Plant Science and Biotechnology, Rivers State University screen house. After germination the seedlings were raised in the screen house nursery for 3 weeks. At 3 weeks, seedlings of eggplant were transplanted into 5 kg capacity perforated polythene bags containing 1.5 kg of top soil at a rate of one seedling per bag. All seedlings transplanted had 2 leaves with an average height of 6 cm. The polythene bags were placed in the experimental plot of the department. A week after the establishment of the eggplant seedlings in the perforated bags, treatments were applied as follows: Control (water), 50% *Aloe vera* extract and 100% *Aloe vera* extract were applied as foliar spray once a week for 6 weeks.

Data Collection and Statistical Analyses

The following data were collected: plant height, number of leaves per plant and the number of insect holes (feeding punctures) per leaf. Visual observation was also made of any disease symptoms or discolouration of leaves. All data

were analysed by analysis of variance at 5% level of significance. Where significant differences were observed, means were separated using the Least Significance Difference (LSD) at P=0.5.

RESULTS AND DISCUSSION

The effect of *Aloe vera* extract foliar spray on plant height is shown in Figure 1. Eggplant seedlings sprayed with 100% and 50% *Aloe vera* extract were significantly (P=.05) taller than those sprayed with water (control) at 6 weeks after transplanting. The increase in the height of plants treated with *Aloe vera* was the result of accelerated growth. The accelerated increase in plant height by seedlings sprayed with *Aloe vera* extract could be due to the action of *Aloe vera* as a botanical activator and plant growth promoter improving overall plant health including its immune defenses. This includes its ability to suppress pathogenic bacteria and fungi and insect pests thereby enabling the plant to enhance its growth and size (USA Patent application publication, 2008 Pub. No.: US 2008/0125320 A1). It has been observed [37] that plant growth due to *Aloe vera* extract treatment owing to its organic nature, remained invariably higher than in non-treated crops of Canola Brassica napus. The extract isolated from *Aloe vera* leaves was reported [61] to have increased plant height and weight, number of shoots, leaves and roots, and the root length, as well as mineral concentrations of Populus clones. Other studies have shown that Aloe leaf extract improved the vegetative growth of Okra (Abelmoschus esculentus) and Basil - Evening primrose (Oenothera biennis) [48,62,63].

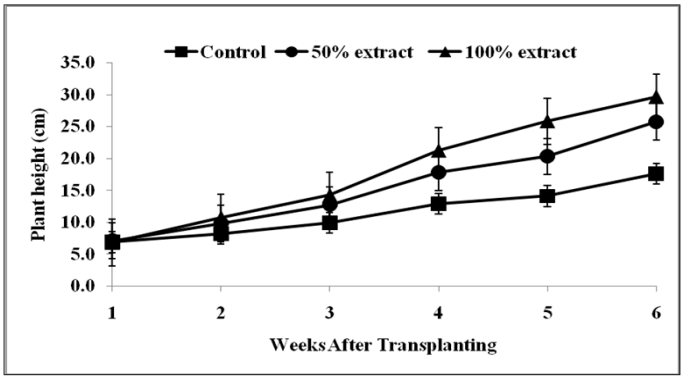

Figure 1: Effect of *Aloe vera* extract foliar spray on plant height of Eggplant seedlings

The effect of *Aloe vera* extract foliar spray on the number of leaves of eggplant seedlings at the vegetative stage taken over 6 weeks is presented (Figure 2). After 6 weeks of *Aloe vera* extract treatment the results showed that eggplant seedlings sprayed with 100% *Aloe vera* extract had significantly (P=.05) higher number of leaves than those sprayed with 50% extract and water (control). There was however no significant difference in the number of leaves of seedlings sprayed with 50% extract of *Aloe vera* and the control. *Aloe vera* has been reported to have growth promoting effects on plants [37] and is even used as a bio-stimulant at certain concentrations. It was found [64] that *Aloe vera* extract especially at high concentration (40 ml/L) significantly increased the plant height, number of leaves, number of branches, yield and essential oil percentage as well as enhancement of the leaf anatomical structure of Sage (*Salvia officinales* L). In this study, the growth promoting effect of *Aloe vera* was manifest at both concentrations of 50% and 100% for plant height, but for leaf growth was only demonstrated at 100% concentration meaning that the efficacy of its full growth promoting effect was at the 100% concentration of *Aloe vera* extract.

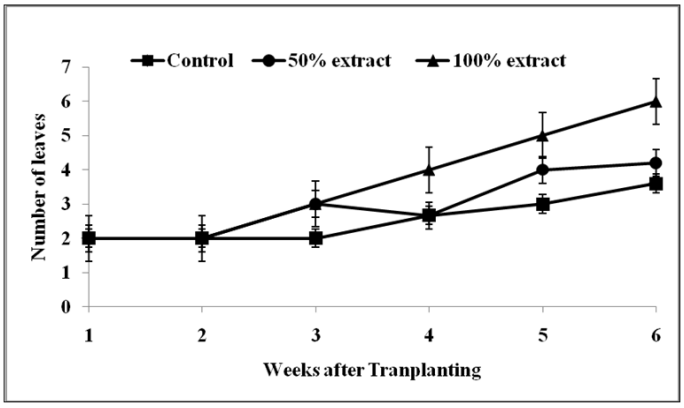

Figure 2: Effect of *Aloe vera* extract foliar spray on number of leaves of Eggplant seedlings

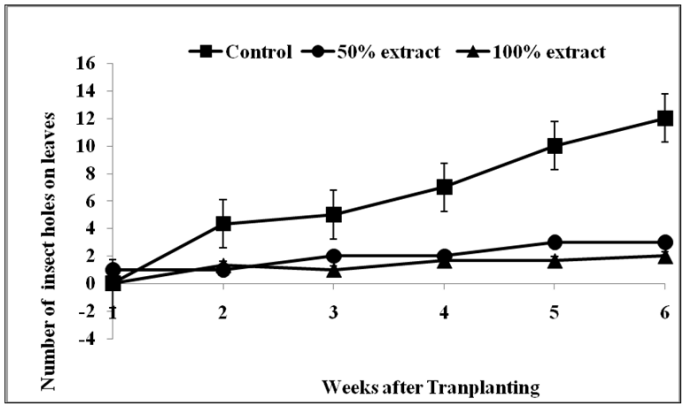

Figure 3: Effect of *Aloe vera* foliar spray on number of insect holes on leaves of Eggplant

In Figure 3 number of insect holes on the leaves of eggplant seedlings (Figure 4) treated with 50% and 100% *Aloe vera* extract foliar spray were significantly less (P=.05) than those of the control indicating that the *Aloe vera* extract had prevented and reduced insect feeding on the leaves of eggplant seedlings. *Aloe vera* has been reported [37] to be effective in controlling insect pests of canola Brassica napus resulting in the least aphid's damage and enhanced yields. Previous study showed [35] that *Aloe vera* extract exhibited contact action, repellent, fumigant, and oviposition inhibition property in the control of carmine spider mite. It has also been stated [65] that one of the major metabolites in *Aloe vera*, aloin A, exhibited insect pest contact toxicity and strong repellent activity. They further noted that the level of repellent activity and toxicity of *Aloe vera* varies with geographical location, plant parts, major metabolite, concentration and exposure time while recommending further studies for its development as an effective bio-repellent.

Figure 4: Effect of *Aloe vera* extract foliar spray on eggplant seedlings six weeks after transplanting

CONCLUSION

Eggplant (*Solanum melongena,* L.) is an economically important fruit vegetable that is attacked and damaged severely in the nursery and field by insect pests and diseases. The use of synthetic pesticides in control of disease and insect pests of the eggplant is responsible for extensive pollution of the environment, a serious health hazard due to the presence of their residues in food, development of resistance in targeted insect pest populations, a decrease in biodiversity, and outbreaks of secondary pests that are normally controlled by natural enemies. Biopesticides, in contrast, are inherently less toxic to humans and the environment, do not leave harmful residues, and are usually more specific to target pests.

In this study the reduced number of holes caused by insects on leaves of eggplants treated with 50% and 100% of *Aloe vera* foliar spray suggests its effectiveness as a bio-pesticide. In addition, the increase in height and number of leaves of the eggplants treated with 100% *Aloe vera* also showed that it could be used as a growth promoter. It is recommended that further research should be done on the use of *Aloe vera* extract as a one-stop bio-pesticide on crops.

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COMPETING INTERESTS

Author has declared that no conflict of interests exists.

AUTHORS' CONTRIBUTIONS

Author designed the study, performed the statistical analysis, wrote the protocol, and wrote 'and read the manuscript."

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