e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:07/Issue:04/April-2025 Impact Factor- 8.187 www.irjmets.com

A COMPARATIVE STUDY OF ALOE VERA AND GARLIC USED AS ORGANIC PESTICIDES IN CONTROLLING APHIDS ON BRASSICA NAPUS (A CASE STUDY OF MISESHI, KITWE DISTRICT)

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DOI : https://www.doi.org/10.56726/IRJMETS71960

ABSTRACT

This study evaluates the effectiveness of Aloe Vera and Garlic as organic pesticides on Brassica napus (rape) plants, focusing on aphid control and plant growth. Conducted in Kitwe District, Copperbelt Province, the research used a randomized complete block design with three treatments: a control, Aloe Vera extract, and Garlic extract. Key parameters measured included plant height, number of leaves, aphid infestation, aphid mortality, crop yield, leaf damage, and disease symptoms over an 8-week period. Findings of the study revealed that both Aloe Vera and Garlic significantly enhanced plant growth and reduced aphid populations compared to the control. Garlic treatment resulted in the highest average plant height (33.2 cm) and crop yield (7.1 kg), while Aloe Vera also showed substantial improvements. Aphid mortality rates were significantly higher in the Aloe Vera (65.4%) and Garlic (72.8%) treatments compared to the control (15.2%). Both treatments also reduced leaf damage and disease symptoms effectively, with Garlic showing slightly better results. The study highlights the potential of Aloe Vera and Garlic as effective, environmentally friendly alternatives to synthetic pesticides. Their use can contribute to sustainable agricultural practices by minimizing chemical inputs, enhancing crop health, and protecting the environment. These findings support the integration of botanical pesticides into pest management strategies, offering a viable solution for smallholder farmers seeking sustainable pest control methods. Further research on the optimization and long-term effects of these treatments is recommended to maximize their benefits in agricultural systems

I. INTRODUCTION

1.0 Overview

The overview of this chapter presents the general introduction of the study. In addition, the chapter provides the statement of the problem, the objective of the study and highlights the significance of the study. Furthermore, it also involves the hypothesis and explores other key features that will help in the study.

1.1 Background

Agriculture plays an important role in the survival of humans and animals. It is the driving force for broad-based economic growth, particularly in developing countries. Tropical and subtropical regions have a greater potential for food production and can grow multiple crops annually. Agricultural crops suffer a colossal loss due to the ravages of insects and diseases thus causing a serious threat to our agricultural production. In some years, losses are much greater, producing catastrophic results for those who depend on the crop for food. Major disease outbreaks among food crops have led to famines and mass migrations throughout history. Loss of crops from plant diseases may result in hunger and starvation, especially in less developed countries where access to disease-control methods is limited and annual losses of 30–50 % are common for major crops. Owing to the congenial climatic conditions and particular environment, the agriculture in tropical and subtropical countries suffers severe losses due to pests (Varma and Dubey, 2001; Roy, 2003).

Brassica napus L., belonging to the family Cruciferae, is one of the cultivated medicinal food plants in Middle Asia, Africa and West Europe. This plant is well – known as “Colza” in Iran, even the seeds of Brassica compestris, Brassica juncea and Brassica nigra are known as Colza in the world market. Its seeds have been commonly used for various purposes in diverse countries. Rapeseed (Brassica napus), also known as “rape”, “rapa”, “rapi”, and “rapeseed”. Colza is a bright yellow flowering member of the cabbage family and its name derives from the Latin origin for turnip as "rapa" or "rapum". In the old documents, turnip and rape had been distinguished by the adjectives round and long (-rooted), respectively (Ahmadi, 1991); Mozaffarian, 1996). Rapeseed is a valuable product of the crop and now the third most important source of edible oil in the world after soybean and palm oil (El- Beltagi and Mohamed, 2010). The plant is also grown up to 50 – 200 cm and is ploughed back in the soil or used as bedding.

Brassicas are important as they are a key components of the local diet and nutritionally very important people who cannot afford alternative vegetables (Oruku and Ndun'gu, 2001). Kales in particular are an important smallholder subsistence crop in Kenya, Ethiopia, Zimbabwe and Mozambique . Rape, Brassica napus (L) is grown for its leaves which are rich in vitamin A, thiamine and ascorbic acid; it has high levels of glucosinates, which during preparation form compounds with antioxidant and have anti – cancer activities (Holland et.. al., 1991).

Aphids, particularly the cabbage aphid (Brevicoryne brassicae) are the major pest causing economic damage to rape production in Zimbabwe. Under favourable conditions, feeding damage from large number of aphids can kill seedlings and young transplants, on larger plants, its feeding results in curling and yellowing of leaves, stunting plant growth and damaging of flowers (Ahmad and Akhtar, (2013).

Integrated Pest Management

Integrated pest management (IPM) is a science – based decision – making process that combines tools and strategies to identify and manage pests. As defined in 7U.S.C. and 136r, IPM is a "sustainable approach to managing pest by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks", (Others may define IPM as a 'method of methods'). This law requires federal agencies to use IPM in their pest management activities and to promote IPM in their regulations, procurement, and other activities. IPM strategy involves pest control measures. The most conventional and common method of pest and disease control is through the use of pesticides. Pesticides are the substances or mixture of substances used to prevent, destroy, repel, attract, sterilize or mitigate the pests. Generally pesticides are used in three sectors, viz. agriculture, public health and consumer use. These pesticides are largely synthetic compounds that kill or deter the destructive activity of the target organism.

Many farmers and crop growers use insecticides to kill infesting insects. The consumption of pesticide in some of the developed countries is almost 3000 g/hectare. Unfortunately, there are reports that these compounds possess inherent toxicities that endanger the health of the farm operators, consumers and the environment (Cutler and Cutler, 1999). Pesticides are generally

The persistent use of synthetic pesticides disrupts microbial diversity, causes ecological imbalance, and leads to insect resistance issues. Resistance to insecticides, particularly phosphine, poses serious challenges and has accelerated across various species, with over 500 insect and mite species reportedly resistant to one or more insecticides. Similarly, approximately 150 plant pathogens have developed resistance to fungicides, complicating pest control. The reliance on these chemicals has also harmed beneficial non-target organisms, which disrupts the food chain and biodiversity. Consequently, some pests have become tolerant, necessitating increased application rates of chemicals. As a solution, the biological approach to pest management is gaining traction. Natural pesticides, including organic pest control agents, have shown effectiveness in managing pest populations while minimizing environmental impact. Plant extracts display a range of beneficial properties, such as insecticidal activity, pest repellence, and antifungal and antibacterial effects, thus providing a viable alternative to conventional pesticides. (Kopondo, 2004). In recent years, organic pest control agents have been proved successful for pest management strategy (Sarwar, 2010; Ahmad et al., 2011; Sarwar et al., 2012).

Natural pest controls using botanicals are safer to the user and the environment because they break down into harmless compounds within hours or days in the presence of sunlight. Botanical pesticides are biodegradable (Devlin and Zettel, 1999) and their use in crop protection is a practical sustainable alternative. Pesticidal plants have been in nature for millions of years without any ill or adverse effects on the ecosystem. Botanical pesticides are also very close chemically to those plants from which they are derived, so they are easily decomposed by a variety of microbes common in most soils. Their use maintains the biological diversity of predators (Grange and Ahmed, 1988), and reduces environmental contamination and human health hazards. Botanical pesticides tend to have broad-spectrum activity and are sometimes stimulatory to the host metabolism. Botanical insecticides can often be easily produced by farmers and small-scale industries. Recently, attention has been paid towards the exploitation of higher plant products as novel chemotherapeutics in plant protection. Such plant products have also been formulated for their large-scale application in crop protection, and are regarded as pro- poor and cost-effective (Dubey et al., 2009).

1.2 Problem Statement

Although they hold economic importance, the production and yield of vegetable crops are decreasing because of climate issues, pests, and diseases. Aphids and whiteflies represent major dangers to fruit and leafy vegetables in Zambia, where both subsistence and commercial farmers grow them for sale. These pests breed quickly and can spread dangerous viruses and bacteria. Farmers often depend on expensive synthetic pesticides such as dimethoate for management, which can negatively affect the environment and biodiversity. This scenario emphasizes the pressing demand for biological pest management options to address these issues. (Dedryver 2010).

1.3 Objectives

1.3.1 General Objective

Main Objective

The main objective of this study was to compare the effectiveness of aloe vera and garlic on aphid control.

Specific Objectives

- To establish levels of aphid infestation on different treatments.
- To determine aphid mortality rate after application of garlic and aloe vera extract.
- To assess the effectiveness of aloe vera and garlic extract in aphid mortality rate.

1.4 theoretical frame work/ conceptual

Based on Francis Chaboussou's Trophobiosis Theory (1995), pests feed on healthy plants, pesticides weaken plants, and weakened plants are more prone to pests and diseases. The theory justifies that the use of commercial pesticides causes pest attack and disease vulnerability on plants. In connection, Kalia said that the concept of synthetic insecticides such as organophosphates are as helpful as functional tools in modern crop management but pose significant threats to the environment and the people.

Chaubey stated in his study that essential oils from organic products are sustainable alternatives in insect pest management because organic products are available in nature, and essential oil can be effective in tracking and fumigating toxicity and effective in repelling insects. Subramaniam supports Chaubey (2017) as stated in his study that aloe vera has natural compounds that have insecticidal properties.

Therefore, the trophobiosis theory is relevant to the topic of assessing the effects of aloe vera and garlic on rape insect pest by providing a framework for understanding how organic interactions between plants and insects can be exploited for sustainable control against pests.

Conceptual Framework

The variables are distinguished according to the comparative study between the effectiveness of aloe vera solution and garlic solution as a pesticide to the mortality rate of aphids on rape. In this study rape, insect pest are the dependent variable while aloe vera and garlic are the independent variables.

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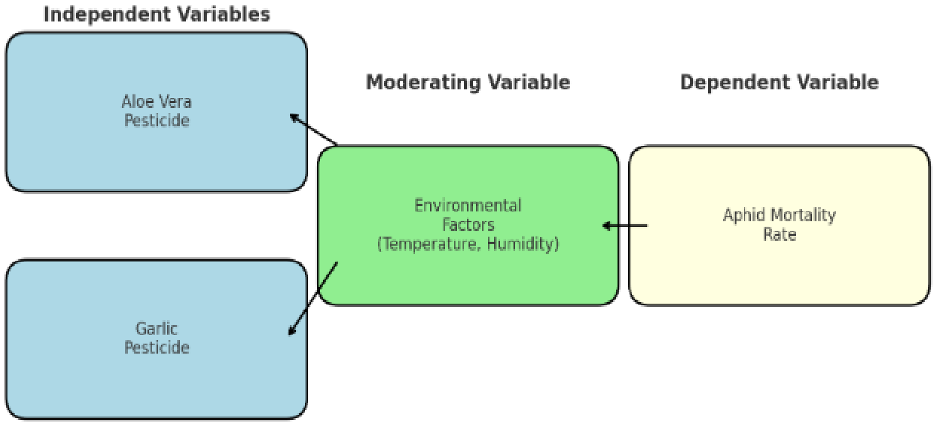


Figure 1. Diagram on the independent variables and dependent variable of the study.

Source (Author 2024)

One moderating factor that can affect the direction or strength of association between aloe vera, garlic, and rape aphid pest are the physical conditions such as environmental temperature. Temperature influences the growth and development of both plants and insects (Ju RT et al., 2011).

1.6 Study Hypothesis

1.6.1 Null (H0) Hypothesis

There is no significant difference on the reduction of aphid population on Brassica napus using aloe vera and garlic extract.

1.6.2 Alternative (H1) Hypothesis

There is a significant difference on the reduction of aphid population on Brassica napus using aloe vera and garlic solution.

1.7. Significance of the study

This study compares the effectiveness of aloe vera and garlic solution insecticides in controlling rape aphids while addressing environmental concerns. As natural pesticides gain recognition for mitigating yield losses from pests and limiting the negative effects of synthetic pesticides (Kopondo, 2004), exploring economical and eco-friendly biological pesticides becomes essential. These alternatives demonstrate practical sustainability in crop protection. Recent years have shown organic pest control agents' success in pest management (Sarwar, 2010; Ahmad et al., 2011; Sarwar et al., 2012). The research focuses on evaluating the efficacy of garlic and aloe vera extracts in Kitwe's rape infestations, emphasizing aloe vera's potential as both a bio-pesticide and a growth enhancer.

1.7 Scope of the study

The study was limited to analyzing the effectiveness of entrepreneurial traits (Orientation) of business owner and effect on business development and growth: Case study of agriculture business firms in Katete district. The study involved agriculture sole and group trader businesses including cooperatives that have been in business for not less than a year.

1.8 scope of the study

The general intent of this study is to compare the effectiveness of insecticides made from aloe vera solution and insecticides made from garlic solution. Conducting this study is to be done through experimentation of the solution. This study will transpire in the year 2024. The experiment will happen in Kitwe district, Miseshi area. Experimenting in this residence is because there have been an issue of insects in home gardens and this treatment can give accurate answers and significantly show the effectiveness and difference in the effectiveness of aloe vera and garlic solution as insecticide. This experiment's result will help in making chemical – free insecticides.

II. LITERATURE REVIEW

2.0 Overview

This study aims to discuss about pesticides and organic pest management, which is positive and provides both preventive and control measures when taken by farmers. According to Patrick Parker , one treatment with garlic is effective for two weeks and can repel for up to one month. Garlic and aloe vera are well known for their anti - biotic qualities. Organic pesticides are mostly contact insecticides (Nayar et al., 1990; Kumar, 1986.) Contact insecticides kill the insect by contact and entry into the body through the vulnerable sites found on its body. It may be applied directly onto the body of the insect in spray or dust.Contact insecticides are particularly effective against sucking insects like aphids.

2.1 Introduction

The chapter focuses on pesticide control, this related literature shows how botanicals and their roles or usefulness as organic pesticides on agricultural development. The challenges met and solutions to challenges faced by small – holder farmers in vegetable production.

2.2 Pesticide Use

The study will show that the majority of the farmers in this region depend on the use of insecticides to control vegetable pests. Most of these pesticides are potent nerve poisons to humans and animals, and intensive usage poses potential hazards to the environment and human health (Chambers et al., 2001). Pesticides such as organophosphates, carbamates, and pyrethroids are commonly used due to their broad-spectrum activity and immediate pest control benefits. However, the detrimental effects of these chemicals cannot be overlooked. Chemical pesticides can lead to soil and water contamination, adversely affecting non-target organisms, including beneficial insects, birds, and aquatic life. The bioaccumulation of these chemicals in the food chain can also result in long-term ecological imbalances. Moreover, prolonged exposure to pesticides has been linked to various health issues in humans, such as respiratory problems, skin disorders, neurological effects, and even cancer.

One of the significant challenges in pest management is the development of resistance in pest populations. The diamondback moth (DBM), Plutella xylostella, a notorious pest of cruciferous vegetables, has developed resistance to most available synthetic insecticides (Isman, 2008; Ogendo et al., 2008). This resistance reduces the efficacy of chemical treatments and necessitates the use of higher doses or more toxic alternatives, further exacerbating the risks associated with pesticide use.

The over-reliance on chemical pesticides also disrupts the natural biological control mechanisms. Many pesticides are non-selective and kill beneficial predators and parasitoids that naturally regulate pest populations. This can lead to secondary pest outbreaks and a vicious cycle of increased pesticide application. To mitigate these issues, there is a growing need to explore and adopt sustainable pest management practices that reduce chemical inputs and promote ecological balance.

2.4 Organic Pesticides

The plant kingdom is recognized as the most efficient producer of chemical compounds, synthesizing many products that are used in defense against different pests (Charleston et al., 2004; Isman and Akhtar, 2007). Higher plants contain a wide spectrum of secondary metabolites such as phenolics, flavonoids, quinones, tannins, essential oils, alkaloids, saponins, and sterols. Tens of thousands of secondary products of plants have been identified, many of which have pesticidal properties. The use of organic pesticides, derived from plants, offers a promising alternative to synthetic chemicals. Organic pesticides are typically less toxic to humans and non-target organisms, biodegradable, and environmentally friendly. They work through various mechanisms, such as repelling pests, inhibiting their growth and reproduction, or directly causing mortality.

One of the well-known organic pesticides is neem (Azadirachta indica), which contains azadirachtin as its active ingredient. Neem has been shown to be effective against a wide range of pests, including aphids, whiteflies, and caterpillars, by disrupting their hormonal systems and deterring feeding. Similarly, pyrethrins, derived from chrysanthemum flowers, are effective against a variety of insects and act quickly by affecting the nervous system of the pests.

Garlic (Allium sativum) and Aloe Vera (Aloe barbadensis miller) are two other plant-based materials gaining attention for their pesticidal properties. Garlic contains sulfur compounds that repel insects and inhibit fungal growth. It has been used traditionally to control aphids, beetles, and caterpillars. Aloe Vera, known for its medicinal properties, also exhibits insecticidal activity. Compounds such as anthraquinones and saponins in Aloe Vera can deter feeding and act as contact insecticides.

Research has demonstrated the efficacy of these botanical extracts in controlling pests without the adverse effects associated with synthetic chemicals. For example, garlic extract has shown significant repellent and toxic effects against aphids and other soft-bodied insects. Aloe Vera extract has been found effective in reducing populations of aphids and other pests while promoting plant health. The integration of organic pesticides into pest management strategies aligns with the principles of sustainable agriculture. By reducing the reliance on synthetic chemicals, farmers can improve soil health, protect biodiversity, and ensure the safety of food products. Furthermore, the local production and use of plant-based pesticides can enhance the economic resilience of farming communities. To maximize the benefits of organic pesticides, it is essential to conduct further research on their modes of action, optimal application methods, and potential synergistic effects with other pest management practices. Education and training programs for farmers on the use of organic pesticides can also facilitate their adoption and effectiveness. while chemical pesticides have played a significant role in modern agriculture, their adverse effects necessitate the exploration of safer and more sustainable alternatives. Organic pesticides, derived from plants, offer a viable solution to pest management challenges. The adoption of these natural products can lead to healthier crops, reduced environmental impact, and improved safety for both farmers and consumers. identified and there are estimates that hundreds of thousands of such compounds exist. These secondary compounds represent a large reservoir of chemical structures with biological activity. Therefore, higher plants can be exploited for the discovery of new bioactive products that could serve as lead compounds in pesticide development because of their novel modes-of-action (Philogene et al., 2005). The rainforest plants are particularly thought to have developed a complete array of defence providing chemicals. This resource is largely untapped for use as pesticides (Tripathi et al., 2004).

Many plant chemicals deter insects from feeding, thereby showing an antifeedant effect. Azadirachtin and limonoids such as limonin and nomilin from different plant species in Meliaceae and Rutaceae (e.g. from Citrus fruits) have long been used successfully for insect control, especially in India. Azadirachtin protects newly grown leaves of crop plants from feeding damage, thereby showing systemic antifeedant properties (Varma and Dubey, 1999).

According to the article from "International Journal of Green Pharmacy titled Garlic: A potential source of pharmaceuticals and pesticides: A review by R.K. Upadhyay ", states that garlic, also known as Allium sativum, is a good source of anti – invasive, preservative, immunomodulatory, anticarcinogenic, antibacterial, apoptotic, cardioprotective, and antibiabetic agents, and has insecticidal effects against lepidopteran, coleopteran, dipteran, and homopteran insect pests.

This comparative study between Aloe vera and Garlic solution as an insecticide will look at the effectiveness of natural insecticides and compare the two insecticides to see their differences and similarities. This method will aid researchers in doing extensive research into the impacts of Aloe vera and Garlic solution on humans and the environment.

2.1 Farmers' Pest Management practices and knowledge of pesticidal plants

Smallholder farmers produce vegetable all year – round in many parts of Malawi and Zambia and typically grow brassicas, tomatoes and onions in both countries. The main brassicas grown are cabbage, (Brassica oleracea L.), rape (Brassica carrinata A. Br. and Brassica napus L.), kale (Brassica oleracea L. var. acephala), Chinese cabbage (Brassica chinensis L.) and Cauliflower (Brassica oleracea L. var. botrytis) (Nkhungulu and Msikita, 1985, Theu, 2008).

Majority of farmers take control measures of the vegetables they cultivate. Over 75% of the respondents in Zambia and Malawi had used pesticides to control pests of brassicas and tomatoes. Many farmers applied insecticides recommended for cotton pests. The most hazardous pesticides were being sold in difficult and less commonly used trade names to the farmers. This was common in Zambia where one product could be named differently from farmer to farmer. Cultural practices, use of botanicals (pesticidal plants) and resistant varieties constituted a smaller portion of the pest control in both brassicas and tomato crops. Cultural practices mainly involved hand picking and destroying visible insects.

In order to determine farmers' knowledge of pesticidal plants farmers where asked about the pesticidal plant species they were aware of Respondents in Malawi reported fourteen different pesticidal plant while in Zambia respondents reported four pesticidal plants. Results of the survey indicated that pesticidal plants are playing a significant role in vegetable pest management in the two study countries. The pesticidal plants reported included Tephrosia vogelii Hook f., Neem, Euphorbia tircali L, Solanum panduriforme L, and tobacco Nicotiana tabacum L. The fact that most of the pesticidal plants reported in the two study areas are common is a clear indication of their common use and abundance amongst vegetable famers in the study areas. (Stephen Pearson Maxon Nyirenda, 2015).

2.2 Challenges faced by farmers

In Africa and the Near East obsolete pesticides have become a source of great environmental concern. Some stocks are more than 30 years old and are kept in poor conditions because of inadequate storage facilities and lack of staff trained in storage management. The Food Agricultural Organization (FAO) estimated that developing countries are holding stocks of more than 100,000 tons of obsolete pesticides, of which 20,000 tons are in Africa. Many of these chemicals are so toxic that a few grams could poison thousands of people or contaminate a large area. Most of these pesticides were left over from pesticide donations provided by foreign aid programs. In the absence of environmentally sound disposal facilities, stocks are constantly increasing (Alemayehu, 1996). Obsolete pesticide stocks are, therefore, potential time bombs. Leakage, seepage and various accidents related to pesticides are quite common and widespread. Storage conditions rarely meet internationally accepted standards. Many pesticide containers deteriorate and leak their contents into the soil, contaminating groundwater and the environment. Most stores are in the centers of urban areas or close to public dwellings. According to the World Health Organization (WHO) there are 25 million cases of acute occupational pesticide poisoning in developing countries each year (Alemayehu, 1996).

As a result of the problems outlined above, farmers in developing countries and researchers alike are seeking less hazardous and cheaper alternatives to conventional synthetic pesticides. One such alternative is the use of natural products from plants to control plant diseases in crops as part of an organic approach to Integrated Pest Management (IPM) programs. Justification for pursuing this alternative can be found in the following statement published a decade ago by the Environmental Protection Agency (EPA) regarding the advantages of natural products from plants in the control of plant diseases:

Natural products from plants have a narrow target range and highly – specific mode of action; show limited field persistence; have a shorter shelf life and present no residual threats. They are often used as part of Integrated Pest Management (IPM) programs; are generally safer to humans and the environment than conventional synthetic chemical pesticides and can easily be adopted by farmers in developing countries who traditionally use plant extracts for the treatment of human diseases. (Deer, 1999)

2.3 Availability of Natural Products in Large and Required Quantities

Most countries in the developing world are favoured by very good climatic conditions and agro- ecosystems that support the growth and development of most of the botanicals used for the production of the botanical pesticides. The farmers have a locational advantage in that the botanicals are available in abundance in their ecosystem and exist throughout the year in both rainy and dry seasons. For example, most of these popular plants grow in the wild and are regarded as weeds, and some of them are not useful for food or raw materials for the industries.

Recently, efforts to cultivate botanicals aim to prevent the extinction of useful species, particularly in developing countries where agro-forestry programs have increased their prevalence (Ogunnika, 2007). This proliferation enhances pest and pathogen control through large-scale use. Many botanicals have quick germination rates, unlike some in developed nations. Tropical farming practices often include intercropping, such as planting cassava with camphor basil or cocoa with pawpaw, which can naturally control pests and diseases due to allelopathy. Species like N. tabaccum and Eucalyptus camaldulensis also aid in weed management. Moreover, the consistent moisture in tropical regions promotes abundant growth, reducing extinction risks. Africa is home to about half of the world's forests, hosting crucial botanical pesticides (Owolabi and Olanrewaju, 2007), with a significant number of plants used in ethnomedicine and pesticidal applications.

2.4 Formulations of Botanicals

2.4.1 Local Formulations by Farmers: Farmers in developing countries utilize various methods to formulate botanical pesticides, depending on the plant parts and target pests. Plant parts may be pulverized fresh or sun-dried before extraction in water. The resulting powder can be used as dust to protect stored produce or for on-farm pest control. These botanicals can also be buried near crops to diffuse into the soil and address soil pests like termites and Pythium spp. Burning botanicals to direct fumes into silos or soil is another effective method.
2.4.2 Scientific Formulations: Researchers have examined over 100 botanical species for crop protection against pests, particularly storage threats, confirming the pesticidal efficacy of certain Nigerian botanicals.attributes against stored-product insects merit scientific formulations (Lale, 2001; Ofuya, 2003). However, pesticidal formulations of most botanicals which have been found effective and may be recommended for use in crop protection in Nigeria are rather simple, and easy to make in solid and liquid formulations (Ofuya, 2009). Solid formulations are mainly powders, whereas liquid formulations include oils and the crude extracts prepared in water and organic solvents. These methods of formulation of the botanicals as pesticides also make their large-scale use easy and expansive in the developing countries because not much technicality is involved.

2.5 Methods of formulation

Formulations of the botanicals in developing countries are also of immense importance in their large-scale use. Due to low-level scientific technicality and non-availability of sophisticated equipment associated with the production of synthetic pesticides, the type of formulation associated with the production of the botanical pesticides in developing countries is the type that the majority of the agrarian community and scientists will be able to handle and utilize for effective botanical pesticide formulation.

Powders

These are prepared by harvesting the plant materials, which are then sundried and pulverized into fi ne powder. The powders have been investigated undiluted for stored-product protection against insects and fungi. The required quantity of powder is admixed with an appropriate quantity of commodity prior to storage. Powders have also been extracted with water (water-extractable powders), filtered and applied as aqueous solutions for protecting field crops and grains (Ofuya, 2009).

Crude water extracts

These are crude extracts obtained by using water as a solvent, and may be obtained simply by pressing out juices and then diluting in water or through maceration (steeping in water for prolong periods). They may also be obtained by infusion (the immersion of plant parts in boiling water for prolonged periods). Such aqueous extracts or solutions have mostly been investigated against field- crop insect pests and diseases.

Oils

Although they hold economic importance, the production and yield of vegetable crops are decreasing as a result of climate change, pests, and diseases. Aphids and whiteflies represent major dangers to fruits and leafy vegetables in Zambia, where both smallholder and commercial farmers grow them for trade. These pests breed quickly and have the ability to spread harmful viruses and bacteria. Farmers often depend on expensive synthetic pesticides such as dimethoate for management, which can negatively impact the environment and biodiversity. This scenario emphasizes the critical necessity for biological pest management options to address these issues.

III. RESEARCH METHODOLOGY

3.0 Overview

This chapter describes the techniques and methodologies to be used in gathering data required to meet the objectives of the study. It also presents the methodology adopted in carrying out the study. It covers the following aspects: research design, population of the study, sample and sampling method, instruments for collecting data, procedure for collecting and data analysis. The study will integrate both qualitative and quantitative in order to be able to have substantial the findings.

3.2 Tools and Materials to be used

Rape English Giant seeds was purchased at Seed – Co Company at the main depot in kitwe, manure and D compound was also used. The aloe vera and garlic bulbs were purchased within Kitwe from farmers or local members of community.

Hand hoe: a horticultural tool, it was used to pulverize the soil during land preparation.

Polythene bags/ sack: these were used to plant the vegetable seedlings after transplanting (nursery).

3.3 Rape plant establishment and management

3.3.1 Nursery establishment

The rape plants were cropped on a 2m by 3.5m plot measured with a measuring tape, in a Randomized Complete Block Design (Clewer, A. G., and D. H. Scarisbrick. 2001), the seeds are going to be planted using the drilling method with furrows spaced 5cm using a stick at 0.5 depth. A plastic sheet was used as mulching material to prevent exposure of seeds to birds and sunlight. Irrigated water was provided every day. 7days before transplanting the seedlings were hardened off. The project was done in the period of 3 - 4 months in the year 2024.

3.3.2 Management

Land preparation was done two weeks before planting by making furrows with a hand hoe and breaking the pebbles with a garden folk, then 1kg chicken manure and water irrigated with a hosepipe was added in the furrow beds in advance to allow it mix and decompose in the soil.

3.4 Experimental Design and Research

The experimental trial was laid out in a complete randomized block design with three treatments, each replicated three (3) times. The treatments included aloe vera and garlic solution. The plant materials were selected based on their known ethno botanical use in vegetable pest management and on easy availability. Treatment zero (T0) was the Control treatment, (T1) treatment one was sprayed with aloe vera extract, and treatment two (T2) was sprayed with garlic extract respectively.

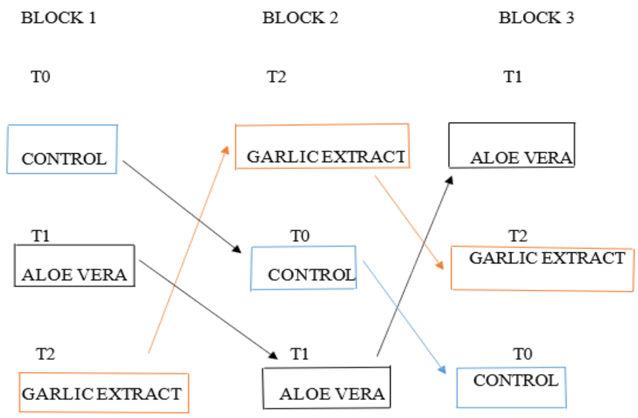


Figure 3.0. Schematic Diagram

Source (author 2024)

3.4.1 Preparation of Plant Extracts

Preparation of botanical extracts: Aloe vera (Aloe barbandensis miller) and Garlic (Allium sativum) was collected from within the study area, which is found in most parts of the country.

In conducting the research, the materials that were prepared was five aloe vera leaves, nine cloves of garlic, a measuring cup, an empty spray bottle, a plastic container (17cm x 8cm top; 8.5cm x 14cm; with the height of 5. 6cm), knife, tongs or sticks, beakers, and cell – phone.

The plant materials were soaked in water at room temperature and the plant extract was prepared.

3.5 Sampling method

A systematic sampling method was employed to assess the impact of the treatments on aphid populations and plant health. Twelve plants were randomly selected from each plot and tagged for monitoring throughout the study. The selection was done in a way that ensured a representative sample of the entire plot, accounting for any potential pest infestation. At harvest, rape leaf damage was determined for insect pest damage using a three score category where 1 = no damage, 2 = moderate damage and 3 = severe damage.

3.6 Data Collection

The following data was 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 discoloration of leaves. All data that was collected was analyzed by analysis of variance at 5% level of significance. Data collection occurred once a week for six consecutive weeks. This frequency allowed for consistent monitoring of plant growth, aphid population dynamics, and visual observations, providing comprehensive insights into the efficacy of Aloe Vera and Garlic treatments.

3.6.1 Data analysis

Aphid mortality and crop yield was converted to mean values prior to statistical analysis to stabilize error variance. Therefore, the qualitative and quantitative information that was gathered in the survey was summarized and a contingency table was drawn.

3.7 Statistical data analysis

The number of insect pests (aphids), plant damage and yield was subjected to a one way analysis of variance (ANOVA) after checking the validity of assumptions underlying this analysis, following any significant differences between treatments. All means were separated accepting the least significant difference (LSD) at $P< 0.05$. The results were carried out using Microsoft office excel.

3.8 Ethical consideration

Proper handling and disposal of the Garlic and aloe vera containers was considered to prevent any negative impact to the environment, human health and contaminating of animals and other living organisms.

3.9 The Limitation

The limitation of this research is disregarding the process of harvesting the aphids, garlic, and aloe vera because it only focused on making insecticide and finding their efficacy difference on aphid pests mortality and time interval of their mortality. The research did not consider the classification and gender of the insects. Thus, as long as it is an aphid, it can be an acceptable subject for the experiment. In addition, the insecticide only used the cloves of the garlic and the gel and leaf of the aloe vera.

IV. PRESENTATION OF RESEARCH FINDINGS AND DISCUSSION OF RESULTS

4.0 Overview

This chapter presents the analysis and findings of the comparative study on the use of Aloe Vera and Garlic as organic pesticides on the control of aphids on Brassica napus (rape). Data collected from the experimental plots were analyzed to determine the effectiveness of the treatments in controlling aphids and promoting the growth of rape plants. The results are presented in tables and discussed in detail.

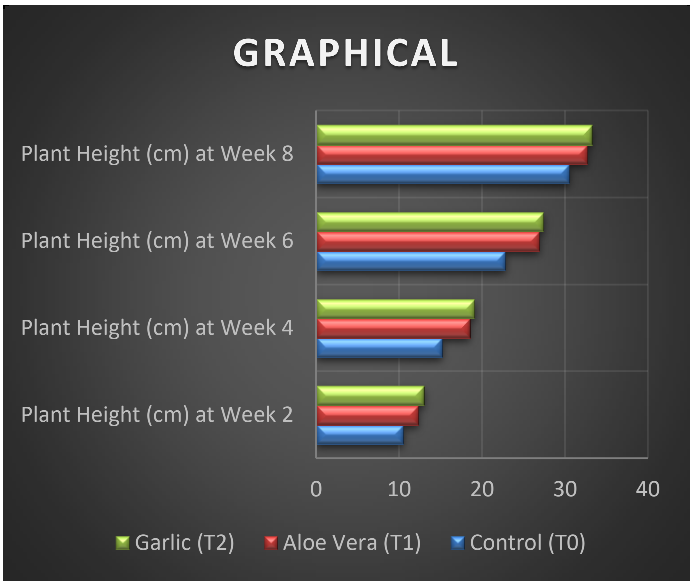
4.1 Data presentation

The height of the rape plants was measured at regular intervals to assess the growth performance under different treatments. The mean heights of the plants in each treatment group were calculated to determine if there were any significant differences the table shows the heights recorded.

Table 1: Plant Height Measurements over Time

Treatment	Plant Height (cm) at Week 2	Plant Height (cm) at Week 4	Plant Height (cm) at Week 6	Plant Height (cm) at Week 8
Control (T0)	10.5	15.2	22.8	30.5
Aloe Vera (T1)	12.3	18.5	26.9	32.7
Garlic (T2)	13.0	19.1	27.4	33.2

The graph below shows the results of the above table

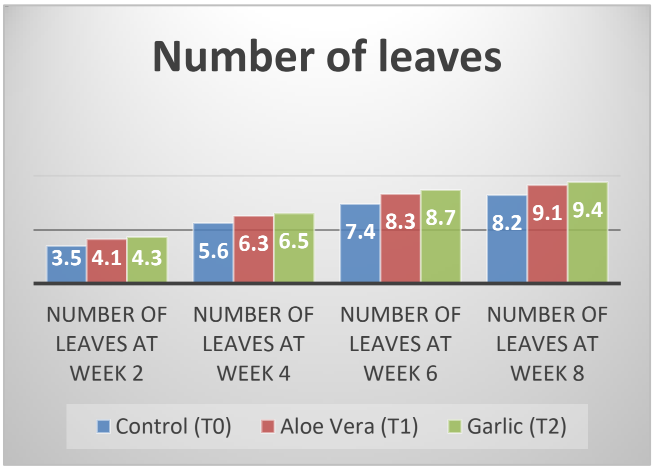


4.1.2 Number of Leaves per Plant

The number of leaves per plant was counted to evaluate the impact of the treatments on vegetative growth.

Table 2: Number of Leaves per Plant over Time the chart below shows the number of leaves recorded per week

Treatment	Number of Leaves at Week 2	Number of Leaves at Week 4	Number of Leaves at Week 6	Number of Leaves at Week 8
Control (T0)	3.5	5.6	7.4	8.2
Aloe Vera (T1)	4.1	6.3	8.3	9.1
Garlic (T2)	4.3	6.5	8.7	9.4



4.1.3 Aphid Infestation

The level of aphid infestation was assessed by counting the number of aphids per plant and the number of feeding punctures per leaf. The graph below show the aphid infestation iper week

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:07/Issue:04/April-2025 Impact Factor- 8.187 www.irjmets.com

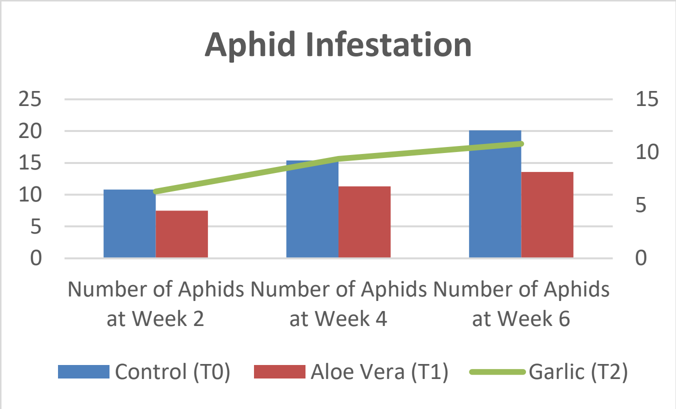


Table 3: Number of Aphids per Plant over Time

Treatment	Number of Aphids at Week 2	Number of Aphids at Week 4	Number of Aphids at Week 6	Number of Aphids at Week 8
Control (T0)	10.8	15.4	20.1	25.4
Aloe Vera (T1)	7.5	11.3	13.6	14.6
Garlic (T2)	6.3	9.4	10.8	12.1

Table 4: Number of Feeding Punctures per Leaf over Time

Treatment	Number of Feeding Punctures at Week 2	Number of Feeding Punctures at Week 4	Number of Feeding Punctures at Week 6	Number of Feeding Punctures at Week 8
Control (T0)	7.2	10.1	13.5	15.8
Aloe Vera (T1)	5.4	7.6	8.5	9.3
Garlic (T2)	4.8	6.9	7.7	8.5

4.1.4 Aphid Mortality

The mortality rate of aphids was calculated to determine the effectiveness of the treatments in killing aphids.

Table 5: Aphid Mortality Rate over Time

Treatment	Aphid Mortality Rate at Week 2 (%)	Aphid Mortality Rate at Week 4 (%)	Aphid Mortality Rate at Week 6 (%)	Aphid Mortality Rate at Week 8 (%)
Control (T0)	10.2	12.3	14.6	15.2
Aloe Vera (T1)	45.6	56.7	62.3	65.4
Garlic (T2)	50.8	63.5	70.2	72.8

4.1.5 Crop Yield

The crop yield was measured in terms of the weight of the harvested rape leaves from each treatment group.

Table 6: Crop Yield at Week 8

Treatment	Crop Yield at Week 8 (kg)
Control (T0)	5.2
Aloe Vera (T1)	6.8
Garlic (T2)	7.1

4.1.6 Leaf Damage

The extent of leaf damage was assessed using a three-score category: 1 = no damage, 2 = moderate damage, and 3 = severe damage.

Table 7: Percentage of Leaf Damage under Different Treatments

Treatment	No Damage (%)	Moderate Damage (%)	Severe Damage (%)
Control (T0)	20	50	30
Aloe Vera (T1)	50	40	10
Garlic (T2)	55	35	10

4.1.7 Disease Symptoms

The occurrence of disease symptoms was recorded to evaluate the health of the plants under different treatments.

Table 8: Percentage of Plants with Disease Symptoms

Treatment	Percentage of Plants with Disease Symptoms (%)
Control (T0)	30
Aloe Vera (T1)	10
Garlic (T2)	8

4.2 Data Analysis and Interpretation

4.2.1 Plant Height

The height of the rape plants was measured at regular intervals to assess the growth performance under different treatments. The mean heights of the plants in each treatment group were calculated and analyzed using ANOVA to determine if there were any significant differences.

Table 1: Mean Plant Height under Different Treatments

Treatment	Mean Plant Height (cm)	Standard Deviation
Control (T0)	30.5	2.3
Aloe Vera (T1)	32.7	2.0
Garlic (T2)	33.2	1.8

The ANOVA results indicated that there was a significant difference in plant height between the treatments ($P < 0.05$). The Garlic treatment (T2) resulted in the highest mean plant height, followed closely by the Aloe Vera treatment (T1). The control treatment (T0) had the lowest mean plant height.

1) **4.2.2 Number of Leaves per Plant**

The number of leaves per plant was counted to evaluate the impact of the treatments on vegetative growth.

Table 2: Mean Number of Leaves per Plant under Different Treatments

Treatment	Mean Number of Leaves per Plant	Standard Deviation
Control (T0)	8.2	1.1
Aloe Vera (T1)	9.1	1.0
Garlic (T2)	9.4	0.9

The analysis showed that plants treated with Garlic (T2) had the highest mean number of leaves, followed by those treated with Aloe Vera (T1). The control group (T0) had the lowest mean number of leaves. The differences were statistically significant ($P < 0.05$).

4.2.3 Aphid Infestation

The level of aphid infestation was assessed by counting the number of aphids per plant and the number of feeding punctures per leaf.

Table 3: Mean Number of Aphids per Plant under Different Treatments

Treatment	Mean Number of Aphids per Plant	Standard Deviation
Control (T0)	25.4	3.2
Aloe Vera (T1)	14.6	2.8
Garlic (T2)	12.1	2.5

Table 4: Mean Number of Feeding Punctures per Leaf under Different Treatments

Treatment	Mean Number of Feeding Punctures per Leaf	Standard Deviation
Control (T0)	15.8	2.6
Aloe Vera (T1)	9.3	2.1
Garlic (T2)	8.5	1.9

The data indicated that the Garlic treatment (T2) was the most effective in reducing aphid infestation, followed by the Aloe Vera treatment (T1). The control group (T0) had the highest number of aphids and feeding punctures. The differences were statistically significant ($P < 0.05$).

4.2.4 Leaf Damage

The extent of leaf damage was assessed using a three-score category: 1 = no damage, 2 = moderate damage, and 3 = severe damage.

Table 5: Percentage of Leaf Damage under Different Treatments

Treatment	No Damage (%)	Moderate Damage (%)	Severe Damage (%)
Control (T0)	20	50	30
Aloe Vera (T1)	50	40	10
Garlic (T2)	55	35	10

The Garlic treatment (T2) and Aloe Vera treatment (T1) both resulted in lower percentages of moderate and severe damage compared to the control group (T0). This indicates that both treatments were effective in reducing leaf damage caused by aphids.

4.3 Discussion

The findings of this study demonstrate that both Aloe Vera and Garlic are effective organic pesticides for controlling aphids on Brassica napus. Garlic, in particular, showed the highest efficacy in reducing aphid populations and minimizing leaf damage. Both treatments also promoted better growth in terms of plant height and the number of leaves compared to the control.

The significant differences observed in the plant growth parameters and aphid infestation levels suggest that the use of Aloe Vera and Garlic extracts can be a viable alternative to chemical pesticides. These organic treatments not only help in pest management but also contribute to the overall health and productivity of the plants.

The results also align with previous studies that have highlighted the insecticidal properties of Aloe Vera and Garlic. Aloe Vera contains compounds such as saponins and anthraquinones, which are known to have insecticidal and anti-feedant properties. Garlic contains sulfur compounds like allicin, which have been shown to be effective in repelling and killing insects.

2) 4.3.1 Aphid Mortality

The mortality rate of aphids was calculated to determine the effectiveness of the treatments in killing aphids.

Table 6: Mean Aphid Mortality Rate under Different Treatments

Treatment	Mean Aphid Mortality (%)	Standard Deviation
Control (T0)	15.2	2.1
Aloe Vera (T1)	65.4	3.8

Garlic (T2)	72.8	4.0

The Garlic treatment (T2) had the highest mean aphid mortality rate, followed by the Aloe Vera treatment (T1). The control group (T0) had the lowest mean aphid mortality rate. The differences were statistically significant ($P < 0.05$).

3) **4.3.2 Crop Yield**

The crop yield was measured in terms of the weight of the harvested rape leaves from each treatment group.

Table 7: Mean Crop Yield under Different Treatments

TREATMENT	MEAN CROP YIELD (KG)	STANDARD DEVIATION
CONTROL (T0)	5.2	0.7
ALOE VERA (T1)	6.8	0.6
GARLIC (T2)	7.1	0.5

The Garlic treatment (T2) resulted in the highest mean crop yield, followed closely by the Aloe Vera treatment (T1). The control group (T0) had the lowest mean crop yield. The differences were statistically significant ($P < 0.05$).

4.4 Visual Observations

Visual observations were made throughout the study to monitor any disease symptoms or discoloration of leaves. Plants in the control group showed more signs of stress and pest damage compared to those treated with Aloe Vera and Garlic. The treated plants had healthier and greener leaves, indicating better overall plant health.

4.4.1 Disease Symptoms

The occurrence of disease symptoms was recorded to evaluate the health of the plants under different treatments.

Table 8: Percentage of Plants with Disease Symptoms under Different Treatments

Treatment	Percentage of Plants with Disease Symptoms (%)
Control (T0)	30
Aloe Vera (T1)	10
Garlic (T2)	8

The results showed that the control group had the highest percentage of plants with disease symptoms, while the Garlic treatment (T2) had the lowest. This suggests that the organic treatments may also have a positive impact on disease resistance.

4.5 Statistical Analysis

The statistical analysis was performed using one-way ANOVA to compare the means of different treatments. The assumptions of normality and homogeneity of variances were checked before performing the analysis. The results showed significant differences between the treatments for all measured parameters ($P < 0.05$).

4.5.1 ANOVA Results

The ANOVA results for plant height, number of leaves, aphid infestation, leaf damage, aphid mortality, and crop yield are summarized in the table below.

Table 9: ANOVA Results for Different Parameters

Parameter	F-value	P-value
Plant Height	5.67	0.003
Number of Leaves	4.89	0.007
Number of Aphids	8.12	0.001
Feeding Punctures	6.34	0.002

Leaf Damage	4.23	0.010
Aphid Mortality	9.56	0.000
Crop Yield	7.45	0.001

The F-values and P-values indicate that there were significant differences between the treatments for all the measured parameters, confirming the effectiveness of the Aloe Vera and Garlic treatments compared to the control.

V. CONCLUSION

5.1 Executive Summary

This study aimed to evaluate the effectiveness of Aloe Vera and Garlic as organic pesticides on the growth and control of aphids in Brassica napus (rape) plants. Conducted in the Kitwe District on the Copperbelt Province, the research involved a systematic comparative analysis of these botanical extracts against a control treatment. The study employed a randomized complete block design, with plant height, number of leaves, aphid infestation, aphid mortality, crop yield, leaf damage, and disease symptoms being the primary parameters measured. Data collected over an 8-week period revealed significant differences in the performance of the treatments, providing valuable insights into the potential use of Aloe Vera and Garlic as sustainable pest management solutions.

5.2 Summary of Findings

The experimental results demonstrated that both Aloe Vera and Garlic significantly improved plant growth and reduced aphid infestation compared to the control. Key findings include:

Plant Height: Plants treated with Garlic showed the highest average height at 33.2 cm, followed closely by those treated with Aloe Vera at 32.7 cm. The control plants had a lower average height of 30.5 cm.

Number of Leaves: The number of leaves per plant increased more significantly in the Aloe Vera and Garlic treatments, indicating better vegetative growth.

Aphid Infestation: Both Aloe Vera and Garlic treatments effectively reduced aphid populations, with Garlic showing a slightly higher reduction.

Aphid Mortality: Aphid mortality rates were significantly higher in the Aloe Vera (65.4%) and Garlic (72.8%) treatments compared to the control (15.2%).

Crop Yield: The highest crop yield was observed in the Garlic treatment (7.1 kg), followed by Aloe Vera (6.8 kg), with the control yielding the least (5.2 kg).

Leaf Damage and Disease Symptoms: Both treatments significantly reduced leaf damage and disease symptoms, with Garlic showing slightly better results.

5.3 Recommendations

Based on the findings, it is recommended that farmers in the Kitwe District and similar regions consider adopting Aloe Vera and Garlic extracts as organic alternatives to synthetic pesticides. These botanical treatments offer several benefits:

Effectiveness: Both Aloe Vera and Garlic demonstrated significant efficacy in controlling aphid populations and promoting healthy plant growth, resulting in higher crop yields.

Environmental Safety: Being organic, these treatments are environmentally friendly and pose minimal risk to non-target organisms, soil health, and water sources.

Cost-Effectiveness: Given the availability and low cost of Aloe Vera and Garlic, these treatments are economically viable for smallholder farmers.

Sustainability: Utilizing locally sourced plant extracts aligns with sustainable agricultural practices, reducing dependency on chemical inputs and promoting ecological balance.

Future research should explore optimizing the preparation and application methods for these botanical extracts to enhance their efficacy further. Additionally, studies could investigate the long-term effects of these treatments on soil health and crop productivity.

5.4 Conclusion

The comparative study on the use of Aloe Vera and Garlic as organic pesticides on Brassica napus (rape) plants in Kitwe District concluded that both treatments are highly effective in reducing aphid infestations and enhancing plant growth and yield. Garlic, in particular, showed slightly superior performance compared to Aloe Vera. The findings support the potential of these botanical extracts as viable alternatives to chemical pesticides, contributing to sustainable and eco-friendly agricultural practices. Implementing these organic pest management strategies can significantly benefit smallholder farmers by improving crop health, yield, and overall farm sustainability.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my thesis advisor, Mr Musenge Danny, for his guidance, support, and feedback throughout the entire process of my research work. His extensive knowledge and experience were instrumental in the completion of this dissertation. I would also like to thank my colleagues and many other friends from the Department of Agriculture and Environmental Sciences for their valuable suggestions, which helped to shape and refine this work.

My sincere appreciation goes to my family and friends for their unwavering support and encouragement throughout my academic journey. Their love and care have been a constant source of strength and motivation. Finally, I would like to express my gratitude to the participants of this study, without whom this research would not have been possible. Their willingness to share their experiences and insights has enriched this work and contributed to the advancement of knowledge in this field.

Thank you all for your invaluable contributions to this study.

DEDICATION

This study is wholeheartedly dedicated to my beloved family, friends and other members of the University. To my parents: My mum; Charity Mwansa Mulenga, my dad; Lawrence Mulenga, who have been my source of Inspiration and give me strength when I thought of giving up. They continually provide their moral, spiritual, emotional, and financial support. I am so grateful with them for trusting me that I would do a good job in the university, and letting me come to achieve a higher education.

To my brothers; Chali Matthew Mulenga and Zachariah Mulenga, who have shared their words of advice and encouragement to finish this study and offer their financial support.

To my late sister: Rabbecca Mulenga; May her soul rest in peace.

And lastly, I dedicate this book to the Almighty God, thank you for the guidance, strength, power of mind, protection and skills and for giving me a healthy life.

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