EFFICACY ASSESSMENT OF GARLIC EXTRACT AND RABBIT URINE AS A NATURAL APHID CONTROL AGENT ON INFESTED TOMATO PLANTS

DAVID BECKHAM ISOOBA

S20B26/007

A DISSERTATION SUBMITTED TO THE FACULTY OF AGRICULTURAL SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A BACHELOR OF AGRICULTURAL SCIENCE AND ENTREPRENEURSHIP OF UGANDA CHRISTIAN UNIVERSITY

April, 2025

UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

ABSTRACT

This experiment aimed to assess the effectiveness of garlic extract and rabbit urine concoction as a natural aphid control agent on infested tomato plants (*Solanum lycopersicum*). The study investigated the impact of different doses of garlic extract on plant height, leaf damage, Number of aphids and Number of flowers at the flowering stage. The garlic extract was prepared by crushing garlic bulbs and sieved to achieve the desired concentrations after mixing it with the desired concentrations of rabbit urine. The experiment employed a randomized complete block design with four treatment groups each replicated three times: a control group (0%), low dose (10%), medium dose (30%), and high dose (50%) of the mixture concentration of rabbit urine and garlic extract concoction. The treatments were applied using a handheld sprayer, and the plants were monitored for aphid populations using visual inspection. Data collected were subjected to statistical analysis, including analysis of variance (ANOVA), to determine significant differences between treatments. The results revealed that higher doses of garlic extract and rabbit Urine concoction led to increased plant height, decrease in leaf damage caused by aphids, , and reduced number of aphids as well as increased number of flowers. The control group exhibited the lowest values for all parameters, while treatments with garlic extract and rabbit urine concoction showed significant improvements. The highest yields were observed in Treatment 50%, where plants treated with the highest dose of garlic extract and rabbit urine concoction had the highest plantt height, least number leaves damaged by aphids and highest number of flowers at flowering stage. These findings demonstrate the potential of garlic extract and rabbit urine concoction as an effective aphid control agent, capable of enhancing tomato crop health and growth and economic returns for farmers.

DECLARATION

I, **ISOOBA DAVID BECKHAM,** declare that; I am the author of this research report and any assistance I received in its preparation is fully acknowledged and disclosed in the report. I have also cited any sources from which I used the information, ideas or words, either quoted directly or paraphrased. I also certify that this paper was prepared by me specifically for the partial fulfillment for the award of degree in Bachelor of Agricultural Science and Entrepreneurship at Uganda Christian University.

Signed…..…………………….

Date……………...….

APPROVAL

This is to certify that this dissertation has been submitted for examination with my approvals as the academic supervisor as a requirement for the award of a degree in Bachelor of Agricultural Science and Entrepreneurship.

Signature …………………………………………………. Date…………………………………

MISS NAKANWAGI MILDRED JULIAN

Special Project Supervisor

DEDICATION

I delicate this research report to my family, for their endless love and support towards my academic journey.

ACKNOWLEDGEMENTS

Above all, special praises and thanks go to the Most High, Almighty God for enabling me to write this Dissertation.

I acknowledge the Department of Agricultural Sciences for offering a good platform and foundation that has enabled me to complete my research. Thanks go to my supervisor; Ms. Nakanwagi Mildred Julian for her invaluable guidance and encouragement throughout this study. In the same regard, I endlessly thank my aunt Namuswa Margret & Isooba Betty plus my lovely Mother for their unconditional support mentally, financially and emotionally towards pursuing this course. Heartfelt thanks go to my dear son Isooba Gabriel Ethan and the mother Nagawa Fatuma for their encouragement and endurance throughout my course of study.

I also appreciate my class mates which include Muzaki Lillian,Gunghima Emmanuel, Rojo Charity, Jimmy Ocen, Dranzoa Daisy Drabe, Ojok Boniface, Owili oscar jimmy, Gonzaga Mayengo for their and support, encouragement during my academic journey.

Finally, I appreciate my parents Mr Bukoosi Godfrey and Mrs. Mutunda Sophie for the constant prayers, love, and strength. May you live to share the golden fruits of my life!

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FAO:	Food and Agriculture Organization
FAOSTAT:	Food and Agriculture Organization Statistics
MAAIF:	Ministry Of Agriculture, Animal Industry and Fisheries
MUZARDI:	Mukono Zonal Agricultural Research and Development Institute
NaCRRI:	National Crops Resources Research Institute
NARO:	National Agricultural Research Organization
RCBD:	Completely Randomized Design
UNBS:	Uganda National Bureau of Standards
UGX:	Uganda shillings
LVCAZ:	Lake Victoria Crescent Agro-ecological Zone

CHAPTER ONE

1.0 Introduction

This chapter comprises of the background of the study of the topic, problem statement, main objective, specific objectives, hypothesis, justification, significance and scope of the study.

The tomato, *Lycopersicon esculentum L.*, is a widely favored vegetable for home gardens and ranks as the second most commonly consumed vegetable globally, right after potatoes (Solanum tuberosum L.). Originally hailing from South America, particularly Peru and Ecuador, the tomato was first cultivated and domesticated in Mexico (Benton, 2007). During the middle of the 16th century, the tomato made its way to Europe. It was mainly showcased in early herbals for its visual appeal, but it wasn't commonly consumed, except in Italy and Spain. In fact, many people believed the fruit to be poisonous, and it took until 1800 for it to be recognized as a valuable vegetable. Fast forward to today, the tomato is now extensively cultivated across the globe due to its delightful taste, vibrant color, rich flavor, and nutritious qualities. Tomatoes are a versatile food that can be enjoyed in various ways, either straight from the garden or after undergoing processing. Including tomatoes in your diet can be beneficial for maintaining a healthy and balanced eating plan. Not only do they contain very few calories, but they are also packed with essential nutrients like vitamin A, vitamin C, and various minerals. Additionally, tomatoes provide small but valuable amounts of vitamins from the B complex, including thiamin, riboflavin, and niacin, as noted by Sainju and Dris 2006.

1.1 Background of the study

Tomato (*Lycopersicon esculentum L*) belongs to the Solanaceae family and is an important and lucrative vegetable crop grown around the world including Uganda for fresh market and processing. It is ranked as the third most important vegetable worldwide (Shiberu *et al.*, 2018). In

Uganda, tomatoes are among the most important and prominent horticultural crops grown for both home consumption, domestic market and for export (Kennedy, 2008). Globally, tomato production is at 177.04 million metric tons while in Uganda is at 38,234 metric tons (FAOSTAT, 2016). Tomatoes are a good source of iron and contain lycopene, an antioxidant that may protect against cancer. Yellow tomatoes have more vitamin A than red ones (Naika et al., 2005). Research indicates that lycopene, a compound found in tomatoes, may lower the chances of prostate cancer (Miller et al., 2002). Additionally, consuming tomatoes can potentially decrease the likelihood of gastroenteric diseases like colon, rectal, and stomach cancer. Moreover, tomatoes are easily digestible and their vibrant color can boost your appetite (Sainju and Dris, 2006).

Plant diseases and pests can cause significant economic losses in agricultural production. A study conducted by Tolman et al. (2004) found that insect damage led to a loss of approximately 30% in tomato yield. Detecting infested plants at an early stage, before visual symptoms appear, is crucial for implementing effective management strategies and pest control measures to prevent the spread of diseases (Zee et al., 2001; Park et al., 2016). Currently, we rely heavily on insecticides to control aphids. However, this has led to some aphid species, like the peach, tomato, and potato aphid, becoming resistant to these chemicals. To address this issue, we need alternative methods of aphid control. One potential solution is using plant extracts that repel aphids or discourage them from feeding. This could help decrease the number of aphids on plants without relying solely on insecticides (Bizzaro et al., 2005; Van Toor et al., 2008; Imbaya et al., 2018).

1.2 Aphids control in Tomatoes

Several control methods against aphids have been put forward and these include cultural, chemical and biological means. However, none of the control measures has been validated as such that even under increased chemical spray cycles; they experience massive losses due to aphids (Zekeya *et al.*, 2018).

Most local farmers use chemical means by use of synthetic pesticides for example Rocket, dudu acelmectine… Resource poor farmers on the other hand use cultural methods like crop rotation, removing of infested plants, and proper disposal of plant debris at the end of season (Retta *et al.*, 2015). The other control is use of biological control method. This method is potentially a very beneficial tactic to develop the biological control agents (living antagonists-natural enemies: predators, parasitoids and pathogens) are considered as one possible solution to most tomato pests Oztemiz, 2013). This strategy offers a more sustainable and less expensive alternative to chemicals (Vivan *et al.*, 2003; Bale *et al.*, 2008). Use of garlic extracts and rabbit urine is a cheap, valuable, safe and environmentally friendly alternative for insect pest management (Shiberu *et al.*, 2018). These plant extracts naturally contain pest repellant attributes which have the ability to repel or kill the insect pest at all stages including eggs, larvae, pupae nymphs and adults. However, in Uganda the using of these garlic extracts and rabbit urine to control pests such as aphids on tomato has not been fully explored yet there is still a need to improve crop protection against these pests and in the same way reducing the use of inorganic pesticides (Shiberu and Getu, 2018).

1.3 Statement of the problem

Tomato has a lot of importance however, its production is threatened by destructive pests *(*Zekeya *et al*., 2018). They destroy the leaves, stem, roots and fruits, resulting into low- and poor-quality yield and even death of plants or rotten fruit (Visser *et al*., 2017). For example, in the case of aphids, the economic losses range from 50-100% yield loss in other countries depending on the tomato variety (Zekeya *et al*., 2018). The pest has been observed on tomatoes and other Solanaceae crops as well as the Brassica family crops in Uganda,

Current management of tomato pests has been based on inorganic pesticides such as Belt Expert, Abamectin, Dudu acelamectin which are very expensive and not affordable to resource poor farmers. The use of synthetic pesticides is also complicated by the fact that most farmers do not observe the prescribed dosages and pre-harvest intervals which results into chemical residues in the fruits affecting export trade and posing health risks to the consumers and drastic effects on the environment (Klieber *et al.,* 2015; Retta *et al.,* 2015). In addition, biopesticides also have the ability to provide some required nutrients for plant growth hence making pesticides a better option. Limited studies have however been conducted to determine the effect of rabbit urine and Garlic biopesticide on aphid control. Therefore, eeffective pest control is no longer a matter of heavy application of limited insecticides, because continuous use of pesticides promotes development of insecticidal resistance in the target pests, pest resurgence, emergence of secondary pests, affects non-target insects' species, affects the environment through air pollution, killing of beneficial organisms, as well as causing human health complications such as skin cancer.

Chemical pesticides are also quite expensive to most of the farmers which has led to economical loss due to the reduced yields.

Farmers mostly affected are the horticultural farmers in this case (Dilawar Hussaina, 2023). Therefore, the growing need for alternative, environmentally friendly methods of aphid control. (Sarwar, 2015 and Grzywacz et al., 2010)

Therefore, this study aimed at evaluating the effectiveness of rabbit urine and Garlic biopesticide against aphid control and determine the pest infestation on different growth stages of tomato

1.4 Objectives

1.4.1 Main objective

To evaluate the effectiveness of garlic, extract and rabbit urine as natural alternative of controlling aphid infestations on tomato plants.

1.4.2 Specific objectives

i. To assess the effect of rabbit urine and garlic concentration on aphid population and aphid damage on tomato plants

ii. To determine the effect of rabbit urine and garlic extract concentration on growth response of tomatoes (Plant height & Number of flowers).

iii. To determine if there is a relationship between aphid damage and growth of tomato plants.

1.5 Hypotheses

i. Aphid population and aphid damage in tomatoes are independent of the concentrations of the rabbit urine and garlic extract concoctions.

ii. Rabbit urine and garlic extract concoction do not affect the growth response of tomatoes.

iii. There is no relationship between aphid damage and growth of the tomatoes.

1.6 Scope of the study

The experiment to evaluate the effectiveness of the stinging nettle and garlic based biopesticides in the control of aphids in tomatoes was carried out at Uganda Christian university’s field trial plots located in mukono during the period of January 2024 to March 2024. During this study

Asole tomato variety was used and a homemade organic pesticide acquired from a rabbit urine and garlic extract was also used as a pesticide during this experiment.

1.7 Significance

Tomato growing is one of the most promising areas for horticultural expansion and development in Uganda (MAAIF, 1998). The biggest tomato producers are the districts of Mbale, Mpigi, Hoima, Mbarara, Wakiso, and Mukono. Uganda produces 38,234 metric tons of tomatoes per year (FAOSTAT 2016) of which about 3,000 small-scale farmers grow fresh vegetables including tomatoes for export while more than 20,000 small-scale farmers grow vegetables particularly tomatoes for income (Sonko *et al*., 2005). Since the tomato aphid is threatening the tomato growers in Uganda, the plant extracts can provide an alternative control, it is important to evaluate their efficiency. The findings of this study will contribute to improved management of the tomato pests while protecting the environment, reducing the risks associated with use of synthetic insecticides and reducing the cost of controlling the pest. This will improve farmers' incomes and their livelihoods through increased yields and safety of the tomatoes for consumption while protecting the environment.

1.8 Justification

Tomatoes are a good source of iron and contain lycopene, an antioxidant that may protect against cancer. Yellow tomatoes have more vitamin A than red ones (Naika et al., 2005). Research indicates that lycopene, a compound found in tomatoes, may lower the chances of prostate cancer (Miller et al., 2002). Additionally, consuming tomatoes can potentially decrease the likelihood of gastroenteric diseases like colon, rectal, and stomach cancer. Moreover, tomatoes are easily digestible and their vibrant color can boost your appetite (Sainju and Dris, 2006).

Plant diseases and pests can cause significant economic losses in agricultural production. A study conducted by Tolman et al. (2004) found that insect damage led to a loss of approximately 30% in tomato yield. Detecting infested plants at an early stage, before visual symptoms appear, is crucial for implementing effective management strategies and pest control measures to prevent the spread of diseases (Zee et al., 2001; Park et al., 2016).

Tomato production in Uganda contributes to economic development and poverty alleviation since tomatoes are a source of foreign exchange earnings, and also generates income locally for economic growth (Andre *et al*, 2005). Since tomato production is reduced by pest infestation. Use of mechanical methods such as removal of infested leaves have been suggested but can only be successful on very small plots. Inorganic pesticides are another alternative but the cost of these pesticides makes tomato production non-profitable. Controlling aphids is not an easy practice although synthetic pesticides are apparently available for use. Effective pest control is no longer a matter of heavy application of limited insecticides, because continuous use of pesticides promotes development of insecticidal resistance in the target pests, pest resurgence, emergence of secondary pests, affects non-target insects' species, affects the environment and human health (Sarwar, 2015 and Grzywacz et al., 2010). Therefore, the use of alternatives including botanicals, bio-pesticides, and new generation synthetic insecticides is essential to growing healthy crops. The use of different botanical insecticides such as a mixture concentration of rabbit urine and garlic extract to protect plants from pests is very promising because of several distinct advantages (Marbet and Aurea, 2008). Insecticidal plants are generally much safer than conventionally used synthetic insecticides. It prevents development of insecticide resistance. Botanical insecticides are used by small-scale farmers at low cost or zero cost of extraction and are highly degradable. The use of natural and easily biodegradable crop protection inputs like a mixture of Rabbit urine and Garlic (Allium sativum) can be a useful component of an integrated pest management (IPM) strategy since the compounds are known for their low toxicity against beneficial insects (Koona and Njoya, 2004). Therefore, tomato farmers urgently need a cheaper but effective alternative which can be easily acquired and home made such the these locally made garlic extract and rabbit urine since they are locally available materials.

CHAPTER TWO

2.0 Literature review

2.1 Introduction

The literature reviewed under this chapter provides an evaluative assessment of the pests affecting tomatoes, classification, origin and economic importance. Challenges faced in controlling some of these pests particularly aphids as of this case by tomato farmers using garlic extracts and rabbit urine in tomato production in Uganda.

2.1.1 Tomato production

Tomato (*Lycopersicon esculentum*) belongs to Solanaceae family. It is an important and remunerative vegetable crop grown around the world including Uganda for fresh market and processing. It is ranked as the third vegetable worldwide (Shiberu *et al. 2018*). Statistics currently shows that the production of tomato globally is at 177.04 million metric tons (FAOSTAT 2016). And Uganda produces 38,234 metric tons of tomatoes per year (FAOSTAT 2016). In Uganda, tomatoes are among the most important and prominent horticultural crops grown for both home consumption, domestic market and for export. Production of tomatoes in rural areas of the country has increased employment and improved farmers' livelihoods (Kennedy, 2008). However, tomato production is threatened by the exotic invasive insect pest tomato leaf miner (*T. absoluta) (*Zekeya *et al*. 2018).

2.1.2 Aphids

The green peach aphid (*Myzus persicae*) is a major agricultural pest that is found worldwide. While the exact origin is debated, it is likely native to Asia, much like its favorite food source, the peach tree. (Prunus persica)

2.1.3 Origin and distribution of aphids

The exact origin of aphids is still under debate, but fossil evidence suggests they emerged sometime in the Permian period, roughly 299 to 252 million years ago. Their long evolutionary history has resulted in a vast array of species, with estimates ranging from 4,000 to 10,000 However most experts believe the green peach aphid originated in Asia, like its primary host plant, the peach tree. The green peach aphid is now found almost everywhere in the world except for areas with extreme temperatures or humidity. They are adept at travelling long distances by wind, storms, and even on young plants that are transported between locations. This explains their global reach and ability to survive in various climates. While they don't prefer greenhouses, they can easily invade them, further contributing to their spread.

2.1.4 Growth of Aphids

An aphid's lifecycle typically involves four stages: egg, nymph (several instars), pupa (in some species), and adult. Parthenogenesis: During warm weather, female aphids can reproduce asexually, giving birth to live young without needing a male (Shree *et al.,* 2017). This allows for rapid population growth when conditions are favorable.

Winged and Wingless Forms: Aphid populations often contain both winged and wingless individuals. Winged aphids can disperse long distances to find new host plants, while wingless aphids focus on feeding and reproduction. The specific duration of each stage can vary depending on the species and environmental factors. However, the overall lifecycle can be remarkably fast, allowing for rapid population growth under ideal conditions. (Hughes *et al.,* 2013 and (Balzan, 2015).

2.1.5 Economic importance of Aphids in tomato production

Tomato production is in danger due to the invasion by green peach aphid *(*Zekeya *et al*., 2016).

Several authors have consistently reported that, no effective control including use of chemicals is available for farmers. (Nesreen *et al.*, 2017). They pierce plant tissue with their needle-like mouthparts to suck out sap. This weakens the plant, stunts growth, and can cause leaves to curl or turn yellow and as they feed, aphids excrete a sugary substance called honeydew which h attracts ants and promotes the growth of sooty mold, a black fungus that further reduces photosynthesis and weakens the plant. In severe infestations, aphids can even transmit viruses between plants, posing a significant threat to your tomato crop.

Tomato growing farmers in Africa are currently stranded due to lack of effective control options as even under increased spray cycles, they experience massive losses due to increased aphid infestation levels *(*Zekeya *et al.*,2016).

This however has opened a new window for research and development of new and alternative control measures. The most recommended and promising approaches include application of biological control options such as parasitoids and nematodes (Alabern *et al.,* 2013; and Arnaouty *et al.*, 2014), entomopathogenic fungi and bacteria (Keikotlhaile *et al.*, 2010) and pheromone traps for monitoring population as well as detection of their presence (Zekeya *et al*., 2016).

2.1.6 Control of Aphids

Different management options exist for aphids are already in place and these include use of insect chemicals, cultural methods, physical controls and biological methods (Retta *et al.,* 2015*)*

2.2 Synthetic insecticides

Conventional pesticides are commonly applied to control insect pests includingAphids. Reports show the effect of chemical sprays mainly harming untargeted organisms as well as environment and not the Aphids (Klieber *et al.,* 2015). The nature of infestation especially by the Aphids hiding underneath the tomato plant leaves and resistance to different chemicals limit control efforts (Wilcockson *et al.*, 2014).

Common chemicals that aphids have been reported to develop resistance are Cartap, pyrethroids, organophosphates, spinosad, Emamectin benzoate, Abamectin, chloride channel activators, benzoylureas and diamide (Zekeya *et al.*, 2016). Synthetic chemicals have serious drawbacks, including reduced profits from high insecticide costs, destruction of natural enemy populations (Campbell *et al*., 1991), buildup of insecticide residues on tomato fruits (Walgenbach *et al.*, 1991) and in the environment and fundamentally the rapid development of insecticide resistance. Pest resistance has been reported to cause increased use of chemical pesticides applications against Aphids in many parts of the world including Uganda (Roditakis *et al.*, 2015).

In countries such as Tunisia, more than 18 chemicals were introduced during 2009-2011 for the control of Aphids but none of them seemed efficient in solving the pest problem (Abbes *et al*., 2012). However, chemical pesticides are very expensive and are applied frequently to the extent that most smallholder farmers in Africa cannot afford to purchase regularly (Zekeya *et al.*, 2016).

2.2.1 Use of plant extracts (Garlic)

Allium sativum, commonly known as garlic, has been widely utilized in culinary practices and traditional medicine for more than 4000 years. It possesses various beneficial properties such as antiseptic, anti-inflammatory, antioxidant, cardioprotective, and anticancer effects. The antimicrobial activity of garlic is attributed to its prominent organ sulfur compounds, including ajoenes, allicin, alliin, allyl sulfide, and 1,2- vinyldithiin (Lanzotti 2006; Corzo Martinez et al., 2007; Martins et al., 2016). For instance, Gong et al. (2013) conducted a study on the impact of 2% raw garlic straw extracts on root- knot nematodes (Meloidogyne incognita) in tomato plants. The researchers observed that the garlic extracts inhibited the growth of nematodes and led to an increase in tomato yield. Similarly, Jess et al. (2017) explored the potential use of garlic oil in controlling Megaselia halterata (a species of phorid fly) in commercial mushroom production. The researchers found that low concentrations (ranging from 0.1% to 20%) of garlic solutions effectively repelled adult female M. halterata. A commonly recommended recipe for a garlic solution involves using 25 grams of chopped garlic in 10 liters of water. This solution can be applied to the soil and plants, exhibiting effectiveness against various pathogens such as fungi and bacteria, as well as pests including mites, aphids, larvae of Lepidoptera, and small bedbugs (Ministerio de Agricultura. Servicio Agrícola y Ganadero, 2013). Garlic (Allium sativum L.) is a highly effective plant-based bio-pesticide known for its ability to control seed-borne diseases. It contains allicin, a compound that gives garlic its distinctive smell and taste while providing biological properties. Studies have shown that garlic possesses insecticidal and fungicidal properties, making it effective against pests like mites, ticks, nematodes, and worms. These characteristics make garlic a valuable resource for pest management and disease control in agriculture and veterinary applications. Therefore, the appropriate use of eco-friendly microbial pesticides can be engaged in recreation of sustainable organic crop production by providing a stable pest management program.

Biological control method is potentially very beneficial tactic to develop (Savino*et et al.*, 2012). The biological control agents (living antagonists-natural enemies: predators, parasitoids and pathogens) are considered as one possible solution of the aphid's crisis (Desneux *et al.*, 2010; Oztemiz, 2013). This strategy offers a more sustainable and less expensive alternative to chemicals (Vivan *et al*, 2003; Bale *et al.*, 2008).

2.2.3 Rabbit Urine

Rabbit urine has been used as a natural pesticide for centuries, and there is some scientific evidence to support its effectiveness against aphids. Studies have shown that rabbit urine can repel aphids, reduce their egg-laying ability, and even kill them outright because of it's Components

Rabbit urine contains several components that are thought to be responsible for its insecticidal properties. These include:

Ammonia: Ammonia is a pungent gas that can repel aphids and other insects. It can also damage their delicate respiratory systems.

Urea: Urea is a nitrogen-rich compound that can disrupt the hormonal balance of aphids and other insects. It can also interfere with their ability to reproduce, it as well dehydrates the aphids when in close contact (Diana Kemunto,2022)

Creatinine: Creatinine is a waste product of muscle metabolism. It is not directly harmful to aphids, but it can make rabbit urine more attractive to beneficial insects, such as ladybugs and lacewings, which prey on aphids.

Several studies have explored the insecticidal properties of rabbit urine and garlic individually. Rabbit urine diluted with water at a ratio of 1:10 has been shown to effectively control aphids on kale plants (Petrović et al., 2013). Rabbit urine is a readily available substances which has demonstrated insecticidal properties. Rabbit urine contains high levels of nitrogen, which can act as a fertilizer and also possesses insecticidal activity (Petrović et al., 2015) Therefore Combining rabbit urine and garlic could potentially create a synergistic natural pesticide with enhanced insecticidal efficacy against aphids.

CHAPTER THREE

3.0 Methods and materials

3.1 Experimental site

The experiment was carried out in Mukono district at Mukono at Kyawambogo village from January 2024 to March 2024. Kyawambogo village s located about 28km from Uganda's capital and main city, Kampala, along Jinja road. The village has wooded savannah vegetation characterized by tall trees and tall grasses. According to FAO 1992, Mukono has two main soils categories namely; Ferralitic soils and Ferrisols, a high plateau (1000-1300) above sea level and mean annual rainfall is 11,000mm distributed over 106 rain days, with peaks in March – June and September – November. Temperatures range between 16^0C and 28^0C throughout the year.

3.2 Materials

Garden infested with Aphids for samples, Rabbit urine, fresh Garlic bulbs,hand sprayer,Tomato seeds for cultivar MV were used in this study. The seedlings were raised in a nursery bed and transplanted at three weeks after germination with the starter dose of 20g of NPK fertilizer per plant. Our bio pesticide of rabbit urine and garlic were used and a untreated control was also included for comparison.

3.3 Soil Sampling

A composite soil sample was collected randomly from the 0-20 cm depth at the field station in January 2024. Physical properties of the soil were analyzed at the UCU laboratory

3.4 Experimental design

The experimental field was laid in a Randomized Complete Block Design (RCBD) with three replications.

3.5 Agronomic practices

During the experiment, the following agronomic practices were carried out;

Land clearing, ploughing and harrowing was done by use of a hand hoe to break down soil particles and remove unwanted objects, and the plots were demarcated in of size 3m× 3m with a total of 12 plots.

Transplanting was done in February 2024 by placing one seedling at spacing of 60 by 60cm.

Watering by use of a watering can was done occasionally whenever there was need especially if there was no rain, watering was done twice a day

Weeding was done whenever weeds emerged by hand pulling and use of a hand hoe.

Plots were uniformly mulched 2 weeks after planting with dry grass to avoid evaporation of water and nutrients.

Staking was done one month after planting to prevent the plant from being disturbed by wind and also encourage straight growth.

Spraying of the bio pesticide was done weekly as indicated in 3.6 (application of pesticides) was done to control pests specifical the aphid. This was carried out using a hand sprayer.

3.7 Making of the extract

The organic pesticide extract was made following the procedure below;

The garlic extract was obtained by crushing fresh garlic bulbs and extracting the juice. It was diluted with water to achieve the desired concentrations for each treatment whereas the rabbit urine was used immediately after being mixed

3.8 Treatments and bio pesticide extract application

The treatments were sprayed once in 1 week in each assigned plot apart from the control plot,

Treatment T1 (control): No mixture concentration was applied (0%).

Treatment T2: Low Dose - A diluted concentration of garlic & rabbit urine was prepared by mixing 5(ml) of garlic extract and 5(ml) of rabbit urine to make 10(ml) with 90 ml of water (10%).

Treatment T3: Medium Dose - A moderately concentrated rabbit urine & garlic extract was prepared by mixing 30 ml made up of 15(ml) garlic extract, 15(ml) of rabbit urine with 70 ml of water (30%).

Treatment T4: High Dose - The highest concentration of garlic extract was prepared by mixing 50 ml made up of 25(ml) garlic extract, 25(ml) of rabbit urine of garlic extract with 50 ml of water (50

3.9 Data collection

In every week data was collected once. This was followed by tagging of ten plants in each plot. To identify the level of infestation of the pest, Inspections were done on entire plant, and the areas considered were leaves damaged, plant height, number of aphids at the different growth stages of the plants (FAO 2006).

3.9.1 Data analysis

All data collected were entered and sorted using Microsoft Excel (version2013). The sorted data was thereafter imported into GenStat (12^{th} Edition) to obtain the means, standard errors, Coefficient of Variation and P-values by running the One-Way Analysis of Variance (ANOVA), (Diana Kemunto,2022) and separated means using a Boniferi's test to determine significant differences between the treatments and evaluate the efficacy of garlic extract and rabbit urine concoction as an aphid control agent on tomato plants. In addition to assessing aphid control, the study also considered several parameters as part of the investigation, including plant height, leaf damage caused by aphids, Number of aphids and Number of flowers at flowering stage. These parameters provided a comprehensive evaluation of the effects of garlic extract and rabbit urine concoction on the tomato plants and their potential as a natural aphid control measure. (Diana Kemunto,2022)

CHAPTER FOUR

4.0 Objective 1

4.1 About number of aphids

Table 1 below shows the means and standard deviations of aphid population and aphid damage uunder different treatments. The results showed that there was significant difference in the aphid population and aphid damage on the number of damaged leaves per plant, and number of aphids per plants.

From the table below, Treatment (T4) turned out to be the most effective between the aphid population and the aphid damage with the least number of damage leaves per plant and number of aphids per plant compared to Treatments (T2, T3) and the control which presented the higher damaged leaves per plant and more number of aphids per plant.

Table 5. Means and standard deviation

Treatment	Week one		Week two		Week three	
T1	18.44	0.507	9	0.819	10.5	1.352
T2	16.26	0.566	13.55	0.871	12.6	1.536
T3	17.47	1.557	10.2	0.802	10.7	1.221
T4	14.16	0.668	10.25	0.773	7.2	1.562

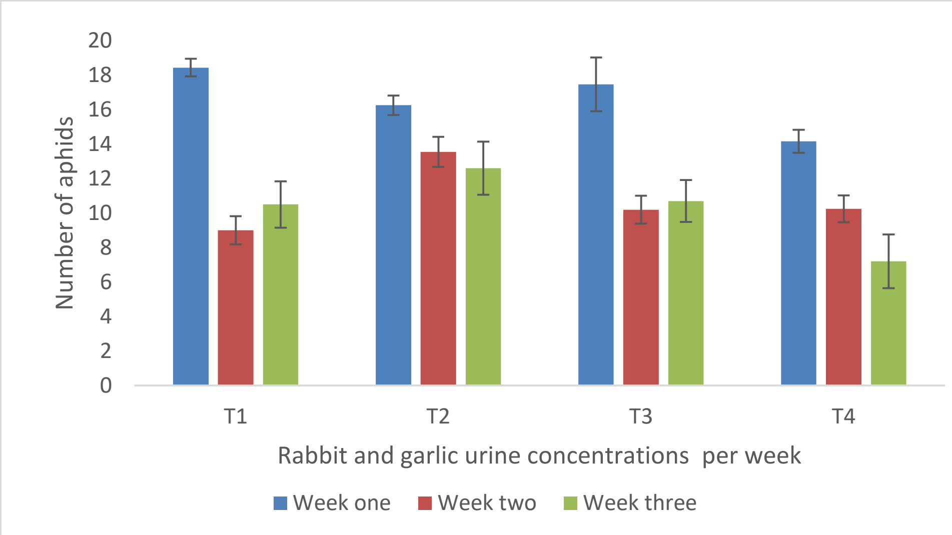

Figure 1.Showing means and standard deviations weekly

Table 6.Aphid Damage

Rabbit urine and garlic concentration	Week one		Week two		Week three	
T1	6.937	1.1849	15.805	0.8676	21.9	1.4333
T2	4.487	0.1899	10.85	0.7246	17.5	1.3271
T3	3.638	0.2664	9.875	0.5686	13.7	0.9315
T4	2.437	0.6419	3.35	0.4811	2.1	0.3786

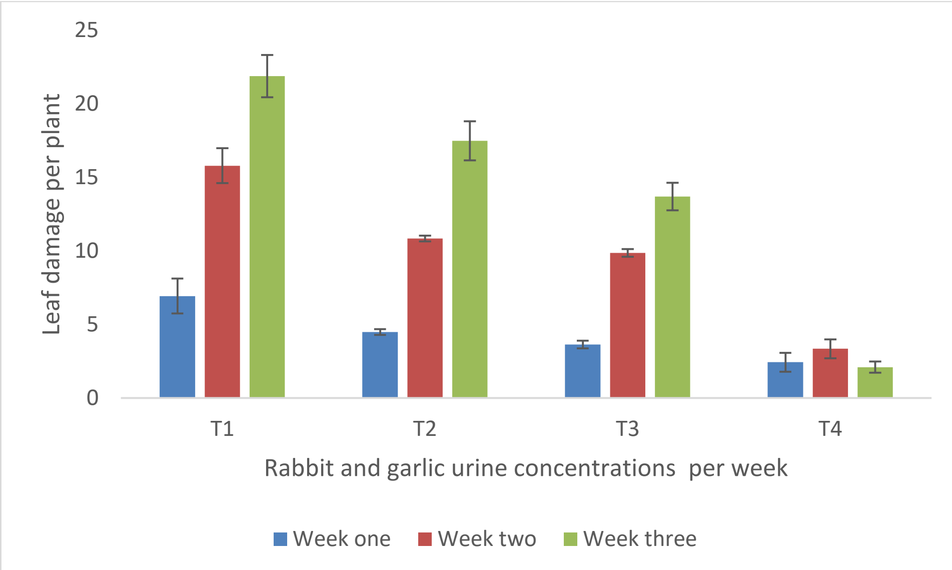

Figure 2. A graph showing weekly aphid damage

Table 7. A table showing general means

Overall means of the Treatments on aphid population		
Treatments	Number of aphids	Leaf damage per plant (cm)
T1	15.89±6.51[b]	10.85±10.2[c]
T2	15.13±5.35[b]	7.46±5.19[b]
T3	14.72±11.83[ab]	6.34±4.58[b]
T4	12.42±6.02[a]	2.7±4.85[a]

l.s.d.	1.782	1.405
pValues	0.009	0.001

Figures donated with different letters were highly significantly different at ($P < 0.05$)

Table 8.Analysis of variance of leaf damage

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
WEEKS stratum	2	5502.95	2751.47	82.75	
WEEKS stratum					
TREATMENTS	3	4399.12	1466.37	44.1	<.001
Residual	514	17090.36	33.25		
Total	519	26992.43			

The difference leaf damage per weeks were highly significantly different at ($P < 0.001$)

4.2 Ojective 2

From the experiment, very low response was observed at Treatments (T1), with 0.969 number of flowers. Whereas for the other treatments T2,T3 and T4 revealed relatively higher responses of 1.292, 1.769 and 2.631 respectively. The experiment also exhibited higher responses for plant height in plants under treatment T4 with 58.36cm and lower responses were observed in other treatments of T1 with the least response of 22.27cm as it is highest plant height followed by treatments T2, and T3 respectively.

Table 5. Tomato growth response by number of flowers

TREATMENTS	Mean	Variance	s.d.	s.e.mean	Pv	l.s.d
T1	0.969	2.464	1.57	0.1377	0.001	0.616
T2	1.292	4.286	2.07	0.1816		
T3	1.769	8.055	2.838	0.2489		
T4	2.631	17.677	4.204	0.3687		

Table 6. Tomato growth response on Plant height

TREATMENTS	Mean	Variance	s.d.	s.e.mean	Pvalue	l.s.d
T1	22.27	830.5	11.82	2.528	0.003	4.746
T2	32.52	127.1	15.27	0.989		
T3	34.62	182.9	18.52	1.186		
T4	58.36	437.7	20.92	1.835		

4.3 Objective 3

The results exhibit that the "Leaf Damage per Plant" is denoted (-0.256). This indicates that as the number of leaves damaged by aphids increases, there's a trend for tomato growth to decrease. However, the table shows a statistically significant constant effect on tomato growth (t pr. < .001). This implies there's likely a baseline level of growth independent of aphid damage therefore this shows that there is a relationship between aphid damage and growth of tomato plants.

Table 7. Relationship between aphid damage and tomato growth

Estimates of parameters				
Correlations between parameter estimates				
Parameter	estimate	s.e.	t(518)	t pr.
Constant	26.69	1.21	22.07	<.001
LEAF_DAMAGE_PER_PLANT	-0.256	0.122	-2.1	0.036

4.4 Results and Discussion

The results of the efficacy assessment of garlic extract as a natural aphid control agent on infected tomato plants are presented in Table 6. The measurements taken include plant height, damage to leaves per plant, number of flowers per plant, and number of aphids per treatment.

4.5 Objective 1 (Aphid population & Aphid damage)

The severity of leaf damage caused by aphids was assessed for each treatment. The control group (T1) had the highest damage score, denoted by the mean of 10.85±10.2 since it also exhibited the highest number of aphids. However, all treatments with garlic extract and rabbit urine (T2, T3, and T4) exhibited lower damage scores, suggesting the potential of garlic extract and rabbit urinein reducing leaf damage caused by aphids. In a study conducted by Gravel et al., 2007, it was demonstrated that daily disulphide, a component found in the essential oil of garlic, possesses insecticidal characteristics that exhibit efficacy against various pests, including the Alternaria Solani species.

4.6 Objective 2 (Plant height & Number of flowers)

The tomato plants treated with different doses of rabbit urine and garlic extract exhibited varying heights. The control group T1 had a plant height of 22.27cm while the plants treated with in T2, T3, and T4 doses of garlic extract and rabbit Urine showed heights of 32.52cm, 34.62cm, 58.36cm respectively. The highest value was observed in T4, indicating a positive correlation between garlic extract and rabbit urine concentration dose and plant height. The control group exhibited the least number of flowers at flowering stage with a mean of 0.969±0.1377 while the plants treated with in T2, T3 and T4 doses of garlic and rabbit urine showed highest number of flowers according to a study reported by Arora et al. (2014), they found that using a combination of garlic is more effective in pest control compared to using only garlic. Garlic acts as a natural pesticide, inhibiting the growth of pests and insects, while also improving plant growth parameters such as height.

4.7 Objective 3 (Relationship between aphid damage & growth of tomato plants)

The results exhibit that the "Leaf Damage per Plant" is denoted (-0.256). This indicates that as the number of leaves damaged by aphids increases, there's a trend for tomato growth to decrease. However, the table shows a statistically significant constant effect on tomato growth (t pr. < .001). This implies there's likely a baseline level of growth independent of aphid damage. Factors like tomato variety, soil nutrients, and overall plant health could contribute to this constant effect. According to a study conducted by P., & Manicardi, G. C. (2005). Effect of Garlic on Green Peach Aphid (Myzus persicae) on Pepper (Capsicum annuum)39, 1968–1977 where they found that using a combination of garlic is more effective in pest control compared to using only garlic. Garlic acts as a natural pesticide, inhibiting the growth of pests and insects.

CHAPTER FIVE

5.0 Conclusions and Recommendations

5.1 Conclusions.

In conclusion, the efficacy assessment of garlic extracts and rabbit urine concoction as a natural aphid control agent on infested tomato plants revealed promising results. The study examined the effects of different doses of garlic extract and rabbit urine concoction on various parameters, including plant height, damage to leaves per plant, Number of aphids and number of flowers. The treatments with garlic extract and rabbit urine concoction exhibited positive effects on most of parameters, with higher doses demonstrating greater efficacy. The results showed the potential of garlic extract and rabbit urine concoction in improving tomato crop yield and economic returns for farmers. Based on the findings,

5.2 Recommendations.

Since this experiment only focused on one dry season, its recommended that the rabbit urine and garlic extract concoction can be used for many other seasons because in a rainy season the aphids can be washed away. Other parameters such as yield per plant and overall yield can also be taken into consideration in order to tell if the concoction affects the yields of these tomatoes in any way. The Rabbit urine and Garlic extract concoction should also be tested on other pests rather than aphids

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APPENDICES

Appendix 1: Budget

ITEM	UNITS	UNIT PRICE (Shs.)	AMOUNT(Shs.)
Rabbits	2 pairs	40,000 each	80,000
Hand hoe	2pcs	10,000	20,000
Watering can	4pcs	15,000	60,000
Garlic	4 kgs	10,000	40,000
Fertilizers	1 sack	30,000	30000
Labour	4 sets	50,000	200,0000
Report printing	1 pc	50,000	50,000
Transport	Lupsum	50,000	50,000
Miscellaneous	Lumpsum	100,000	100,000
TOTAL	**-**	**-**	**630,000 shillings**

Appendix II: Time Line / Work Plan 2023 -2024

ACTIVITIES	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APRI
Proposal development								
Land preparation & planting.								
Spraying and data collection and staking								
Data collection and spraying.								
Spraying & Data collection.								
Dissertation completion & handing in.								

Appendix III: Data Sheet Table

STAGE	GENOTYPE	TREATMENT	REPLICATION	INDIVIDUALS	NUMBER OF APHIDS	LEAF DAMAGE PER PLANT	PLANT HEIGHT	NUMBER OF FLOWERS
	MV	T1		1				
		T1		2				
		T1		3				
		T1		4				
		T1		5				
		T1		6				
		T1		7				
		T1		8				
		T1		9				
		T1		10				
		T2		1				
		T2		2				
		T2		3				
		T2		4				
		T2		5				
		T2		6				
		T2		7				
		T2		8				
		T2		9				
		T2		10				
		T3		1				
		T3		2				
		T3		3				
		T3		4				
		T3		5				
		T3		6				
		T3		7				
		T3		8				
		T3		9				
		T3		10				
		T4		1				
		T4		2				
		T4		3				
		T4		4				
		T4		5				
		T4		6				
		T4		7				
		T4		8				
		T4		9				
		T4		10				