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EFFECTIVENESS OF NEEM SEED (AZADIRACTA INDICA) OIL AS AN ORGANIC INSECT PESTICIDE

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ABSTRACT

Neem tree is proved to be the richest in active compounds and one of potent sources of natural biocides among the studied botanicals worldwide. Crude extracts of Neem seeds showed significant results as insecticides in this study where optimum doses are recommended for several vegetable pests. The research was carried out at Chassa farm in Sinda district Eastern Province of Zambia over a period of 4 months starting from April 2018 to September to prepare Neem seed (Azadiracta Indica) Oil as an Organic insect Pesticide. In order to achieve this Matured seed was harvested from the neem tree. The process of extracting involved 6 stage in the extraction of oil from seed (Azadiracta Indica) and there were: i. Seed harvesting ii. Drying the seed, iii. soaking the dried seed & peeling, iv. pounding the seed, v. pre-heating the powder and vi. lastly extracting oil from the oil extractor machine. After preparation of neem oil, it was treated by way of spraying on two plots, one for cabbage infested with diamond back moth and the other was for tomato infested with absoluta tuta and red spider mite. Different dosage was used 20mls,30mls and 50mls and this was done to determine the correct dosage and the effectiveness on different pests. The findings of the study revealed that plant extracts of oil from neem effective in controlling insects. Further the researcher observed that the extracts of Neem, appeared to be the very effective among the two treatments. Repelling observed and recorded for neem extracts treatment was as high as 100% for diamond back moth, red spider mite and absoluta tuta. Therefore, the researcher highly recommends that the poor resource farmers are encouraged to use Neem Extracts as alternatives to the synthetic Pesticides as they have less impact to the environment and is a cheaper way for pest management for small scale farmers.

Key Words: *Azadiracta Indica, Neem Seed, Neem Oil extracts, diamond back moth, red spider mite and absoluta tuta*

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1.0: INTRODUCTION

1.1 General Introduction

Zambia agriculture activities are based on maize, livestock, and horticulture. Maize is the staple food of the country and dominated by small scale farmers and the remaining percentage is produced by the commercial farmers who are mainly located along the railway line. Small scale farmers face a number of problems in their crop production which include: climatic problems such poor rainfall pattern and management problems (Inadequate of fertilizers, tools, pesticides, adequate knowledge of the production and so forth). Such Problems has reduced the yields, quality of the produce and damage of the environment through soil and aqua sphere. Due to poor and bad management practice by man for him to produce crops especially on the use inorganic pesticides and inorganic fertilizer has been the source to poor production of the crops for him and his animals. When it comes to pest management, the long use of inorganic pesticide has drastically destroyed the microbes in the soil that helps in decomposition and pest they become resistant to the pesticide e.g. the outbreak of army worms in Zambia has become the big problem because inorganic pesticide has failed to break their life cycle. There has been great loss in crop production due high cost of inorganic compound insecticides and their toxicity level affects mammal (man and environment. Toxic level caused by inorganic pesticides has contributed to a number of diseases such as cancer to man, his animals and disturbed the ecosystem.

Attention is increasingly being paid to the use of natural compounds (such as essential oils) as a promising option to replace agrochemicals in agricultural pest control. These odoriferous substances are extracted from various aromatic plants, which are rich sources of biologically active secondary metabolites such as alkaloids, phenolics, and terpenoids (Esmaeili and Asgari, 2015), using extraction methods employing aqueous or organic solvents, or steam distillation. Their mechanisms of action can vary, especially when the effect is due to a combination of compounds (de Oliveira, 2011; Esmaeili and Asgari, 2015).

Hence, a need has risen to make use of organic pesticides which will improve the cereal, vegetables, fruits and legumes which are important major components of the diet of rural and urban Zambia as it provides carbohydrates, lipids, vitamins and minerals. It is also important to have abundant food of high quality without disturbing the environment. According to (WHO, 2001), indicated some signs and symptoms mainly from inorganic pesticide poisoning has indicated to be major source of persistence in foods has posed health hazard to the consumers. The neem tree Azadirachta indica A. Juss. (Meliaceae), is a tropical evergreen related to mahogany. Native to east India and Burma, it grows in much of Southeast Asia and West Africa; a few trees have recently been planted in the Caribbean and several Southern African countries, including Zambia.

The people of India have long revered the neem tree; for centuries, millions have cleaned their teeth with neem twigs, smeared skin disorders with neem-leaf juice, taken neem tea as a tonic, and placed neem leaves in their beds, books, grain bins, cupboards, and closets to keep away troublesome bugs. Trees will reach up to 30 m tall with limbs reaching half as wide. The shiny dark green pinnately compound leaves are up to 30 cm long. Each leaf has 10–12

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serrated leaflets that are 7 cm long by 2.5 cm wide. It will grow where rainfall is as little, and thrives in areas that experience extreme heat of up to 48°C. Even some of the most cautious researchers are saying that neem deserves to be called a "wonder plant."

The neem tree, was introduced to, Africa, in 1989 by a group of missionary settlers dedicated to organic horticulture in in different countries. In Zambia climate neem tree has well adapted due to favorable climate. However, the potential by the tree has been less paid attention by the citizen. Only recent years when seed breeder on fields day have tried to use neem leaves to control number of pest (MRI.Field day report ,2018).

1.2 Statement of the Problem

Zambia as one of the developing countries in the Southern Region of Africa has been a major importer of agricultural input such as: Farm machinery and tools, Fertilizers. Pesticides and herbicides. The country produces 40% of fertilizers then 60% is imported outside region,98% of farm machinery and implements are imported outside the region and pesticide only 5% is produced within the country and 95% is imported outside the region. *(Zambia Federation Cooperative Report, 2015). (WHO 2016)* Reported that the healthy problems among human being and his livestock, at least 10 % is as result of poison from inorganic pesticides persist on the produce. Most of inorganic pesticides have proven to have long effects on the produce which pose danger to human and his livestock. Hence, need has been given to the producer to go organic farming to improve the quality and quantity of the produce. Most of the insect have developed defence mechanism or resistance to a number of insects. For instances, the outbreak of army worms and absoluta tuta has been a yearly problem to the farmers. The use of inorganic pesticides has failed to control the breeding cycle of numbers of pests .The importation of pesticides, the low quality and quantity due to resistance of the pest and the low content value of the produce, has necessitated the researcher to fill in the gap by producing cheap organic insect pesticides from the locally grown neem tree seed in order to improve quality and quantity of the produce. Beside that to lower the prices on the market and to promote organic farming. It's against this background that the researcher embarked on this research to find an alternative and cheaper non synthetic pesticide.

1.3 Justification

Organic insecticide from neem seed oil will reduce the shortage of most effective insecticides on the market if produced locally. Zambia in specific is the major importer of Agro-Chemicals *(Agro-Coop report)*, the country inputs 95% of the pesticides outside the country. Importation of the inputs in the country poses the high chances shortages in of the time due to low supply by distributors. The production of neem oil as the organic gives more potential of increasing the supply on the market to reduce shortage. According to *Zambia Co-operative Federation report (2018)*, that most of supplies in the country, formed cartel by reducing the supply to agro dealer during E-Voucher time so that they can hike the price to the consumers who happens to be small scale farmers. The shortage of the input has forced Zambian Government going back to the old system of input distribution by 40%, which is the drawback to the economy of developing countries. The locally supply of the insect organic pesticide from neem tree has huge potential to bridge the gap and give a positive direction to the economy of the country and Africa as a whole. It may improve the quality of the crop produce, as this organic insect pesticide only

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harms the pest not mammals *(man and his animals).* It may improve the quantity of the crop as it is able to control a broad spectrum of pest including the most important ones. It helps to conserve the environment as it strikes a good balance on the eco-system by not harming other important species such mammals. It will bring income to the nation if expanded, products of this pesticide will also be exported to other countries. By encouraging farmers to plant more neem trees so that the quantity of seed can meet the production demand, it will reduce the negative impact of climate change.

1.4 Purpose

The purpose of this project is to find an alternative non synthetic and cheaper pesticide for small scale farmers for the control of agricultural pests.

1.5 Objective of the Study

1.5.1 General Objective

The general objective of this project was to determine the effectiveness of neem seed (Azadiracta indica) oil as an organic insect pesticide

In order to archive the General Objective, the study had the following specific objectives

1.5.2 Specific Objectives

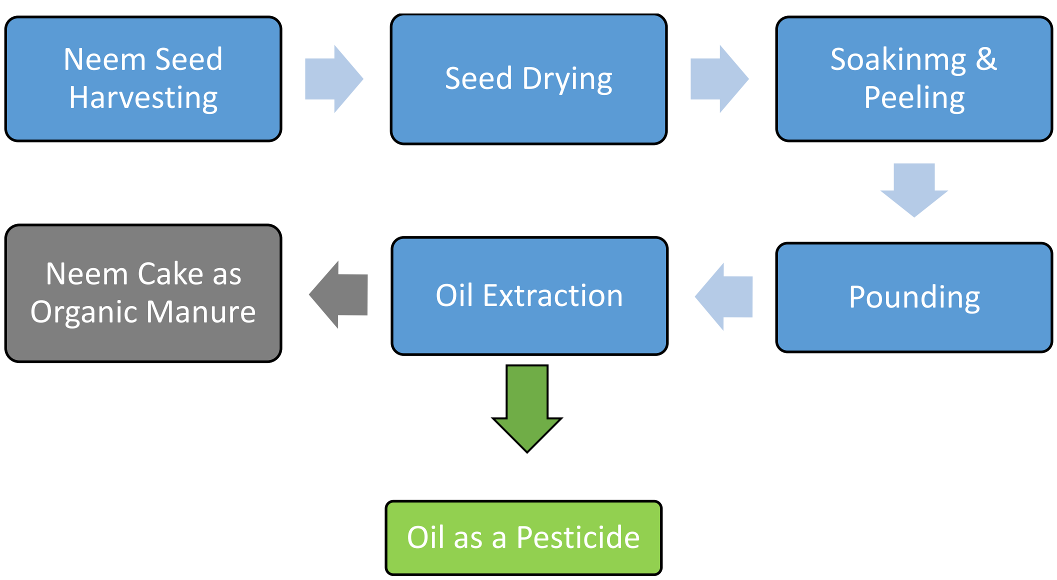
1. To find out how to prepare organic insecticide from neem seed by extracting its oil.
2. To ascertain how effective neem oil is on different insects on the field
3. To determine how neem oil organic insecticide can reduce infestation of Agricultural pest on Cabbage and Tomatoes.

1.5.3. Research questions

How can we prepare organic insecticide from neem seed oil extract?

1. How can we determine the effectiveness of neem seed oil on different insects on the field?
2. Can neem seed oil reduce the infestation of Agricultural Pests on Cabbage and Tomato

1.5.4. Conceptual Framework of Neem Oil Extraction Figure: 1



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2.0 LITERATURE REVIEW

As a scientific applied study, the researcher had applied and analysed about neem to be useful in terms of being used as organic insecticide. The neem tree is native to India and its source of hundred products including insecticides made from the leaves and bark of neem tree. The primary insecticidal extract is Azadirachta. When Azadirachta is used for pest management, it can act as insect repellent, an ant-feedant (interferes with feeding) and growth regulator *(interferes with molting and growth*) *(Schmutterer 1990).* It has also been reviewed that Neem produce have antiseptic, fungicidal and nematicidal properties. As a fungicide neem oil mainly used as non-pesticide management (NPM), providing a natural alternative to synthetic. Neem act as ant-feedant, repellent and egg-laying deterrent thus protecting the crop damage. *(The Fankaso marketing federation, 2000 Gambia).*

Insects are always present in field crops during cultivation and in storage of the produce, and can have a huge economic lose in production. Control of storage pests of agricultural products largely depend on synthetic pesticides, which has been widely since inception in 1950s. Over time, many of these chemicals have become extremely pervasive in the environment, in some cases, in consumed food as a result of their widespread repeated use *(Allsopp et al., 2014, 2015)*. In spite of their efficacy, their repeated use for several decades has disrupted biological control systems, which have led to outbreaks of resistant insect pests, undesired effects on non-target organisms and environmental and human concerns. There have been notable concerns on the persistent use of synthetic chemicals for pest control bearing direct adverse effects on humans, wildlife, aquatic life and the environment at large.

Apart from the negative effects of synthetic insecticides, in most remote rural areas their availability is unreliable, and are frequently adulterated (diluted to ineffective concentrations by unscrupulous traders), outdated (owing to their toxicity to people and the environment), and ineffective owing to rapid evolution of pesticide resistance *(Stevenson, 2014).* Exploring the potential to utilize the pesticidal properties of plants has become a key focus of research in pest control.

Ensure safety of the consumers of the treated grains and the environment. Further, the production of organic extracts of plant origin for pest control may be easier and less expensive than the synthesis of some complex chemical formations *(Shadia, 2011; Amoabeng et al., 2014; Grzywacz et al., 2014).*

The neem tree is indigenous to India. Indians have revered the neem tree for a very long time. To millions of Indians, neem has miraculous powers. Indian farmers have kept away insects with different neem extracts. The tree is considered so invaluable that it is found in every part of the country, every roadside, every field and almost every house. India has shared its “free tree” and knowledge of its utilization with the world community. The freedom of diverse species to exist and the freedom of people to exchange knowledge about them are best symbolized in the neem. After the introduction of chemical agriculture, the use of such neem-based extracts and other products has diminished to a large extent. Farmers have been made more and more dependent on chemical inputs and have lost confidence in their age-old methods.

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The preparation of these products is extremely simple, as is their application.

In terms of efficiency, these products are very good and, in certain cases, are even more efficient than the commercially available products.

These properties of the neem have been known and have been in use for centuries in India. Even the processes that have been patented are only minor modifications of those that have been used for centuries to prepare extracts. How can we protect the people's right to neem and ensure that common people continue to derive benefits from this tree centuries into the future as they have done in the past? Defending people's rights in an age of biopiracy needs a two-pronged strategy - a strategy of resistance to global monopolies and a strategy of rejuvenation of local traditions.

Research has shown that neem extracts have an effect on nearly 200 species of insects. It is significant that some of these pests are resistant to pesticides, or are inherently difficult to control with conventional pesticides (floral thrips, diamondback moth and several leaf miners).

Most neem products belong to the category of medium- to broad-spectrum pesticides, i.e., they are effective it has been observed that the various medicinal values of neem are its constituent phytochemicals present.

The seed kernels of neem yield about 90% of a fixed oil comprised primarily of glycerides. The yellow, bitter oil has a garlic principle including nimbidin, nimbrin, nimbinin, nimbidol and other related triterpense *(Windholz, 1987)*.

Neem is one of the plant species that possesses the combination of most of the pest control properties like Antifeedant, repellent, chemo sterilant, attractant, juvenile and anti-juvenile and anti-juvenile hormone, moultings and anti-moulting hormone, ovicide, nematicide, rodenticide, anti-viral, fungicide and bactericide.

From about 14 million neem trees that grow in India, 0.7 million metric tonnes of fruits and about 5 million metric tonnes of leaves, besides, 83,000 tonnes of Neem oil and 3,30,000 tonnes of Neem cake are expected to be produced annually. The action of neem products as pest control agents can be manifested at different levels and in different ways. This is a very important point to be noted since the farmer would be used to the "knock-out'' effect of chemical pesticides. Neem extracts do not exhibit this type of effect on pests but affect them in several other ways.

When the neem components, especially azadirachtin, enter the body of the larva, the activity of ecdysone is suppressed and the larva fails to moult, remains in the larval stage and ultimately dies. If the concentration of azadirachtin is not high enough, the larva will die only after it has entered the pupal stage. If the concentration is lower still, the adult emerging from the pupa will be 100% malformed, and absolutely sterile. The most important property of neem is feeding deterrence. When an insect larva sits on a leaf, it will want to feed on it. This particular trigger of feeding is given through the maxillary glands. Peristalsis in the alimentary canal is thus speeded up, and the larva feels hungry and starts feeding on the surface of the leaf. If the leaf is treated with a neem product, because of the presence of azadirachtin, salanin and melandriol, there will be an anti-peristaltic wave in the alimentary canal which produces something similar to a vomiting sensation in the insect. Because of this sensation, the insect does not feed on the neem-treated surface. Its ability to swallow is also blocked. Another way in which

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neem controls pests is by preventing the females from depositing eggs.

This property is known as oviposition deterrence, and comes in very handy when the seeds in storage are coated with neem kernel powder and neem oil. The seeds or grains obtained from the market may already be infested with some insects. Even these grains could be treated with neem seed kernel extract or neem oil. After this treatment, the insects will not feed on them. Further damage to the grains will be halted and the female will be unable to lay its eggs during the egg laying period of its life cycle. There are also other known modes of action as the formation of chitin or the hard part covering the insect *(Exoskeleton)* is inhibited; mating as well as sexual communication are disrupted;

Neem leaves and seed kernels, when incorporated into potting soil containing earthworms, increased the earthworm population by 25%.Neem products have proven to be remarkably benign to spiders and also other insects such as bees that pollinate crops and trees, ladybug beetles that consume aphids, and wasps which act as parasites on various crop pests. Neem products have to be ingested to be effective. Those insects which feed on plant tissues, there- fore, easily succumb. However, natural predators like spiders feed only on other insects while bees feed on nectar. The use of locally available plants, such as Derris, Nicotiana and Ryania, is an ancient way to control pests during prehistoric period. Pesticidal plants were used widely until 1940s, then they were alternated by synthetic pesticides as they are easier to handle and lasted longer. Pesticides are the substances or mixture of substances used to prevent, destroy, repel, attract, sterilize or mitigate the pests. The consumption of pesticide in some of the developed countries is almost 3000 g ha-1. Overenthusiastic use of synthetic insecticides led to problems unforeseen at the time of their introduction.

Pesticides are generally persistent in nature. The World Health Organization (WHO) estimates that 200,000 people are killed worldwide, every year, as a direct result of pesticide poisoning. Moreover, the use of synthetic chemicals has also been restricted because of their carcinogenicity, teratogenicity, high and acute residual toxicity, ability to create hormonal imbalance, spermatotoxicity, long degradation period and food residues (Dubey et al., 2011; Pretty, 2009; Feng and Zheng, 2007; Khater, 2011).

2.1. TRADITIONAL INSECTICIDES

Pyrethrum: Pyrethrum is the most widely and heavily used botanical insecticide worldwide and it is well known as fast knockdown household aerosols. The flowers of Tanacetum cinerariaefolium (Asteraceae) are ground to a powder and then extracted with hexane or a similar nonpolar solvent; removal of the solvent yields an orange-colored liquid that contains the active principles (Casida and Quistad, 1995).
They are more harmful to the environment than pyrethrin (Dubey et al., 2011). Mode of action: Pyrethrum is an axonic poison, as are the synthetic pyrethroids and DDT. Axonic poisons affect the electrical impulse transmission along the axons, the elongated extensions of the neuron cell body. They affect both the peripheral and central nervous system of the insect. Pyrethrum initially stimulates nerve cells to produce repetitive discharges, leading eventually to paralysis.

2.2. NEWER BOTANICAL INSECTICIDES

Neem: Neem (Azadirachta indica A. Juss: Meliaceae) is a newer botanical insecticide, native to the Indian sub-continent and well known as the ‘Botanical Marvel’ ‘Village Pharmacy’

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Biological activities: The discovery of neem is attributed to Heinrich Schmutterer, who observed that swarming desert locusts in Sudan defoliated almost all local flora except for some introduced neem trees (National Research Council, 1992).

It also exhibits immunomodulatory, anti-inflammatory, antihyperglycaemic, antiulcer, antimalarial, antiviral, antioxidant, antimutagenic and anticarcinogenic effects (Subapriya and Nagini, 2005). On the other hand, azadirachtin has systemic action in certain crop plants, greatly enhancing its efficacy and field persistence (Schmutterer, 2002a).

Neem controls gypsy moths, leaf miners, sweet potato whiteflies, western flower thrips, loopers, caterpillars and mealy bugs as well as some of the plant diseases, including certain mildews and rusts (Dubey et al., 2011). Neem is also effective against arthropods of medical and veterinary importance, such as lice, mite, tick, fleas, bugs, cockroaches and flies (Mehlhorn et al., 2011). Production: Neem seeds contain 0.2-0.6% azadirachtin by weight, so solvent partitions or other chemical processes are required to concentrate to be 10-50% as in the technical grade material used for commercial production.

Form Ecological and environmental stand points, azadirachtin is nontoxic to fish (Wan et al.,1996), natural enemies and pollinators (Naumann and Isman, 1996), birds, other wild life and aquatic organisms as azadirachtin, breaks down in water within 50B100 h. It is harmless to nontarget insects (bees, spiders and butterflies). The effect of azadirachtin on natural enemies is highly variable (Hohmann et al., 2010; Kumar et al., 2010). Timing of treatment before parasitism is less deleterious to parasitoid emergence (Hohmann et al., 2010).

Essential oils: Essential Oils (EO) are complex mixtures of volatile organic compounds produced as secondary metabolites in plants. Steam distillation of aromatic plants yields essential oils, long used as ‘. fragrances and favoring in the perfume and food industries, respectively. More recently they have become popular as agents for aromatherapy.

Action as repellents: The repellent molecules interact with the female mosquito olfactory receptors and block the sense of smell. Lactic acid plays a role in host seeking behavior. It has been found that following a blood meal, the sensitivity of lactic acid sensitive neurons drops and this drop is co-incident with the cessation of host-seeking behavior and lactic acid sensitivity returns to normal after oviposition (Davis, 1984).

2.3. RESOURCE AVAILABILITY

Regarding sustainability of botanical resources, the used plants should be abundant in nature, or produced on a commercial scale, ex., pyrethrum, rotenone, neem and aromatic plants. Neem is introduced to other Asian countries as well as tropical and subtropical areas of Africa, America and Australia for multi purposes other than medicinal and insecticidal purposes. Neem seed oil had a long history of use in India for the production of soaps and low-grade industrial oil. When extraction companies began purchasing neem seeds in bulk to produce insecticides, the price of seeds increased 10-fold. In contrast, certain plant essential oils have numerous uses as fragrances and flavorings and the massive volumes required to satisfy these industries maintain low prices that make their use as insecticides attractive (Isman, 2006).

As an alternative search strategy, waste or by-products of plant-based industries are extremely helpful, such as extraction and screening of sawdust from tropical timber operations led to the discovery of potent insecticides in the stem wood of the Malaysian tree, Azadirachta excelsa, a close relative of the Indian neem tree (Schmutterer, 2002b).

2. 4. NEEM APPLICATIONS

For centuries, neem has been used in folk medicine for the treatment of conditions such as malaria, ulcers, cardiovascular disease, and skin problems. Despite the limited existence of clinical trials to support therapeutic claims, the use of neem has expanded over time, and it is an important component of Ayurvedic medicine (medical knowledge developed in India about 7000 years ago; Girish and Shankara Bhat, 2008; Ogbuewu et al., 2011).

Neem has proven use as a fertilizer, with the organic and inorganic compounds present in the plant material acting to improve soil quality and enhance the quality and quantity of crops. The waste remaining after extraction of the oil from neem seeds (neem seed cake) can be used as a biofertilizer, providing the macronutrients essential for plant growth (Ramachandran et al., 2007; Lokanadhan et al., 2012).

2.5. Origin and Distribution of neem

Two species of Azadirachta have been reported, Azdirachta indica A. Juss-native to the Indian subcontinent and Azadirachta excels Kack. Confined to Philippines and Indonesia (Jattan et al., 1995; Hegde, 1995). It was a wild tree in India, Bangladesh, Burma, Pakistan, Sri Lanka, Malaysia, Thailand and Indonesia. The neem trees can be seen growing successfully in about 72 countries worldwide, in Asia, Africa, Australia, North, Central and South America (Ahmed et al., 1989; Sidhu, 1995; Sateesh, 1998; Fathima, 2004).

2.6. Botanical Description of Neem

It is a hardy, fast-growing tree with a straight trunk, long spreading branches and moderately thick, rough, longitudinally fissured bark. Mature trees attain a height of 7-15 m (23-50 feet) (Ogbuewu, 2008). The tree starts producing the yellowish ellipsoidal drupes (fruits) in about 4 years, becomes fully productive in 10 years and may live for more than 200 years. The leaves are compound, imparipinnate, comprising up to 15 leaflets arranged in alternate pairs with terminal leaflets. The leaflets are narrow, lanceolate, up to 6 cm long. The flowers are abundant, sweet smelling white panicles in the leaf axils. Seed propagation in nurseries followed by direct planting in the field is the accepted method to produce plantation stands. The one seed neem fruit is yellow when ripe and is about one inch long (Ogbuewu, 2008). Neem flowers mature from May to August (Koul et al., 2006) in India.

2.7. Diversity of Neem

The SRIEG (Southern Regional Information Exchange Group) meeting on „Genetic diversity in commercial forest tree plantation"concluded that genetic diversity is a fundamental tenet of the conservation ethic, and that genetic diversity is an important consideration when managing forest stands, ecosystem and landscapes (Libby et al., 1997). Genetic diversity is the most important component of biodiversity. It is the foundation of ecosystem stability and forest sustainability because genetic diversity provides raw material for evolution, survival and adaptation of the species, especially under changed environmental conditions.

2.8. Variation in seed characteristics

Fruit and seed characteristics, e.g. weight, length, width, diameter, yield and oil content are highly variable both within and between provenances of

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neem (Kumaran et al., 1993; Rengasamy et al., 1993; Rengasamy et al., 1995; Veerendra, 1995; Kundu, 1998; Rathore et al., 1998; Sridharan et al., 1998; Jindal et al., 1999). The weight, length, diameter and form (diameter/length) of neem seeds from four populations (two from Bangladesh, one from Thailand and one from Kenya) were measured and analyzed (Kundu, 1998). There were significant differences between populations in all seed parameters, and the populations from Thailand and Kenya were differentiated both from one another and the material from Bangladesh. This study had similar results to that carried out by Kumaran et al., (1993) who also found significant differences between populations of neem from Tamil Nadu, India.

2.9. Oil synthesis

The growing importance of providing crop oils for food and non-food applications has resulted in initiatives to modify both quantity and fatty acid composition of seed oils (Murphy, 2005). The application of molecular genetics and biotechnology to enhance seed oil content has been limited in many cases by our lack of knowledge of how lipid metabolism is regulated (Ohlrogge and Jaworski, 1997).

3.0 MATERIALS AND METHODS

3.1 Location of the Study

The research project was conducted in Eastern province at Chassa Farms in Chipata, Zambia. The samples of the neem seed were obtained from kawaza, Nyanja and Milanzi Communities around the Sinda township of Chassa campus.

Figure 2: Chassa Farm

Source: google earth Map

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3.2. Target Type of Pests.

Diamond backmoth, Red spider mite and Absoluta tuta.

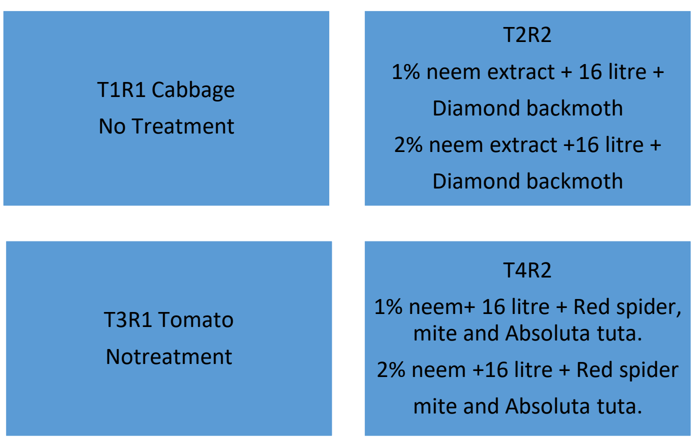
3.3. Sample Selection and Sample Size

The Sample selection was done by using random numbers, choosing 2 fields for treatment and out of sample size of 4 fields.

3.4. Experimental Design

A complete randomized design was used in all the experimental units and were assigned randomly among all treatment at start of week 1.

Figure 3: Experimental treatments for the study



Source: Author

As can be seen on the Figure above, among the two fields, 2 fields were used as a control fields in the study. While the other two fields were assigned to treatment groups (T2 and T4). The two treatments were treated with the organic pesticide Neem Oil Extract.

Neem oil treatment in the cabbage field

1. 1% neem extract + 16 litre + Diamond backmoth
2. 2 % neem extract +16 litre + Diamond backmoth
3. 3%neem extract +16 litre + Diamond backmoth

Neem oil treatment in the tomato field

1. 1% neem+ 16 litre + Red spider mite and Absoluta tuta.
2. 2% neem +16 litre + Red spider mite and Absoluta tuta
3. 3% neem +16 litre +. Red spider mite and Absoluta tuta

3.5. Neem Organic pesticide preparation steps

a. **Seed Harvesting:** Fresh neem matured seed was collected from Sinda communities; kawaza, Nyanja and Milanzi. Neem fruits they mature in the month of February to March but most of the trees, fruits do not mature at the same time. Hence, on harvesting only those that had the green to yellow peel where harvested as they had the maturity colour of the seed. About 10 kg's of seed was harvested from different trees of neem.

b. **Drying:** At this stage fresh could not be taken for extraction because the endoderm and the mesoderm of the fruit were fresh instead the loss of dry matter was needed. The only available and cheap source was sun drying. The seed was dried on the sun for period of two weeks, sun drying was used because of lack of resource but other researchers have tried to use advanced seed drying. According to (Abhijil Jadhav 2008),

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confirmed that dries are the fasted method to dry the seed as it serves time and increase the rate of trying.

c. **Soaking and Pelling:** Soaking at this stage was needed in order to remove the dry layer covering the kernel. Soaking was found to be the cheapest and easiest way of softening the coat. Many researchers on the removing the coat have been using hexane e. g (G. S Bawa 2009, India). The seeds were soaked for a day (24 hours). Thereafter, the coat soft coat was peeled by hand and the inner kernel of the seed remained naked. The hand naked kernel was taken into the next step for pounding.

d. **Pounding:** Which is defined as the breaking of large substance into small aggregate using a mortar and other machines (Collins Dictionary, 2005). The mortal was used to pound the kernel of neem seed to make them to fine aggregate. Direct extraction was feared at this stage which would have reduced the content of the oil. Instead this process stage was employed to reduce the volume of cake and increase the amount of oil during extraction. According to Jerome (1999), direct extract reduced the amount of oil by 10%. Powder.

e. **Streaming:** The neem powder is then streamed by placing it over boiling water for about 15 – 20 minutes. This exercise was necessitated to allow the formation of the dough from which oil can be readily extracted.

f. **Oil extracting using the pressing machine:** upon the formation of dough, the hot material (dough) was direct put into the oil extracting machine. About 1 kg of powder was put per interval and in total 5 kg was extracted. Each one 1 kg quantity was stored in different storage so that quantity per extract can be calculated.

3. 6. Treatment of oil in the fields

Two plot fields were used to determine the dosage rate per square meter and the effectiveness of the pesticide on the field insect. The plot sizes were 2 meters in width by 5 metres in length. The first plot was plant with cabbage and diamond backmoth was allowed to infest the field for the period of two weeks. Other management practices, such as weeding, fertilizer application, leaves pruning was carried out well to the standard except for pest control so that the field can become infested with the latter pest.

Table: 1

CABBAGE PLOT				
PLOT SIZE	*FERTILIZER*	*WEED CONTROL*	*TARGETED PEST*	*Mouth type*
2m (W)×5m (L)	*Neem cake 1 full hand per station and D compound after 2 weeks*	*Well weeded*	*Diamond back moth*	*Biting and chewing*

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In the second plot the similar approach was used but the plant in crop 2 was tomato and the infest pest target was red spider mite and absoluta tuta. This was achieved in the 14th day of growing in the field.

Table: 2

TOMATO FIELD			
PLOT SIZE	*FERTILIZER*	*WEED CONTROL*	*TARGET PEST*
2m ×5m	*-Basal Neem Cake before planting. -Super Veg top*	*Well weeded*	*- Red spider mite* *- Absoluta tuta*

Data collection;

Data was collected on presence of insect in both fields. The presence insects were counted within 7, 14 and 21 days after infected tomato and cabbage was treated by neem 1%, 2% and 3%. Absence diamond back moth, red spider mite and absoluta tuta was recorded from the treated and the control plots. The first data was taken on 7th day after the treatment application while the two later observations were taken on 14th and 21st days after the first observation

Test for Repellence

To test for repellence of each extract, improvised two plots with a connecting duct was used in two methods:

A. The treated cabbage in the field with oil on different dosage was used 1% representing 20 mls,2% representing 30 mls,3% representing 50 mls were applied in the in infested field.

B. The treated tomato the field with oil on different dosage was used 1% representing 20 mls,2% representing 30 mls,3% representing 50 mls were applied in the in infested field.

Test for Control of the Pests by the Extracts

The treated tomato and cabbage and each corresponding pest were placed together in a single transparent glass jar and the recurrence rate per day was observed and recorded for five (5) days.

Progeny Emergence Test

The treated tomato and cabbage and the control were kept in containers in conducive culture conditions for 5 days. At the end of the culture period, the number of emergent insect pest for each treated tomato and cabbage and the control were recorded and reported in bar chart.

3.7. Data Analysis

The collected data was subjected to one-way analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS (2002).

The analysis of variance showed that their significant differences ($p<0.05$) in mean percent repelling of insect among the different concentration of neem extract oil.

The treatment of neem extract (with three different rates of 10%,20% and 50% showed different potential on both tomato and cabbage with more effective using 50% oil. After 7 days of treatment, the 50% of neem extract was significant different from 30%, 20%

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4.0 RESULTS

4.1Test for Repellence

In method, despite the treatment the cabbage and tomato with the extracts, migration towards the food or oviposition source was observed to be highest within 24 hours. The insect pests moved through the interspaces of the field to the treated cabbage and tomato which could be explained by the natural drive for feeding or depositing of the fertilized eggs on the tomato and cabbage. However, movements away from the treated tomato and cabbage became obvious after 72 hours. Most insect pests of the cabbage and tomato from the treated period moved to the other untreated areas. With the trend of movements away from the treated cabbage and tomato, it seems the action of the extracts on the pests became severe after 48 hours. On the fifth day, the pests on the plots with the treated cabbage and tomato were all absent. Some of the pests in the plot treated plots were absent as well, meaning that contact with the extracts (treatments) even after migration (away from the stimulus) could result to antifeeding of the insect pests.

However, extract made from the of neem oil with 50% dosage appears to be more effective than extracts of neem oil with 20% separately. Higher migration (repellence) rates were observed across the triplicate treatments for each insect pest, with least repellence in 20 % of oil treatment.

4.2Test for Control of the Insect Pests by the Extracts

In the test for repellence, the treated period served as a migratory and an escape route for the insect pests to move to other areas. In the test for effectiveness of the extracts in the control of the insect pests, the insect pests were on the open fields control effectiveness increased with prolonged exposure to the treatments as repelling rate in each field rose with increasing number of dosages. Again, the oil extract seems less effective among the two low dosage low treatments.

A mixture of both extracts' neem and garlic, appears to be most effective among the three. Repelling observed and recorded for neem extracts treatment was as high as 100% with a for diamond back moth, red spider mite and absoluta tuta.

4.3. Test for Progeny Emergence from the Treated tomato and cabbage field

The treated tomato and cabbage, after the repellence and control tests, were stopped and left at favourable culture conditions for 7 days. At the end of the week incubation days, emergent off-springs were counted for each treated cabbage and tomato and the result. For the treated cabbage and tomato, highest progeny emergence was recorded for cabbage and tomato treated with neem oil extract. The lowest number of emergences was for 1% and 25 treated with neem oil extracts. However, emergence was low for 20 mls for cabbage and tomato treated with oil extract when compared to 50 mls in both plots. Even with repellence effectiveness of the extracts, oviposition likely took place in the first 24 hours of the experiment, as the insect pests made successive migration and tolerance to the treated cabbage and tomato until prolonged exposure resulted to effective control.

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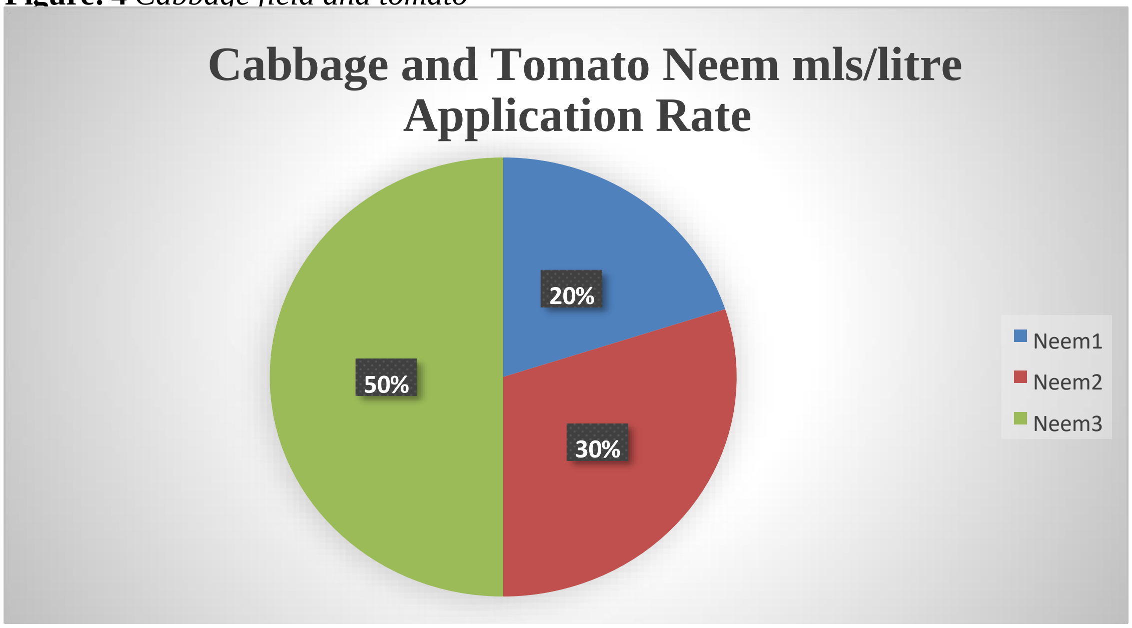
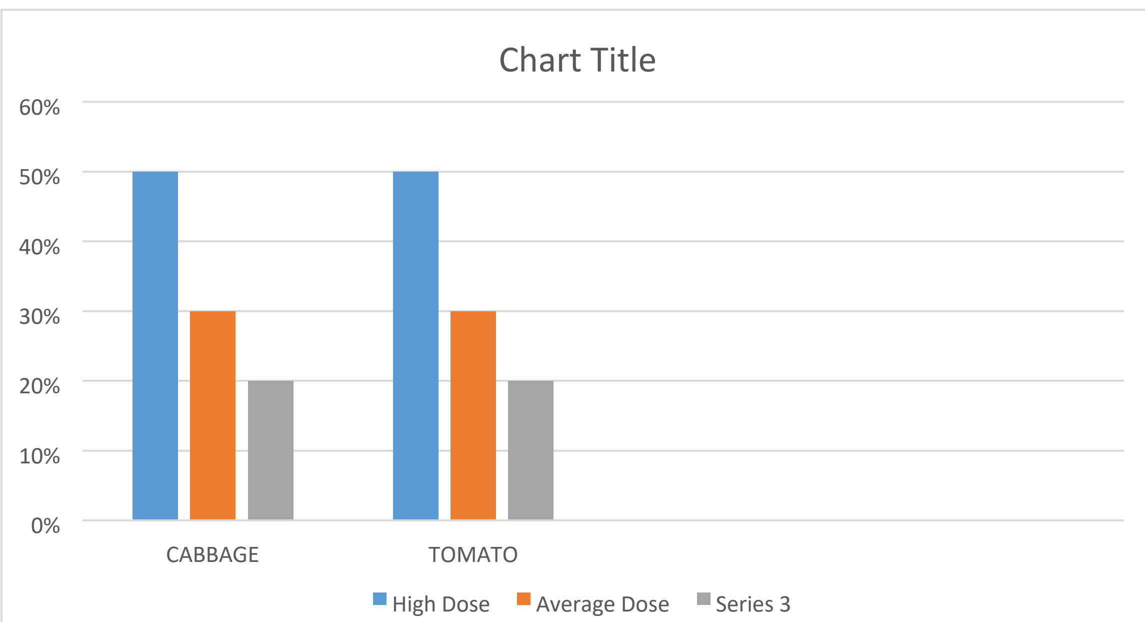
Figure: 4 *Cabbage field and tomato*



The dose of oil on the field of cabbage and tomato.3% of 50mls represented by 50%,2% of 30 mls represented by 30% and 1% of 20mls represented by 20%.

Figure: 5



Hence, the 20%, 30% and 50 concentration rates of neem extract 70%, 85% and 100% repelled insect respective, respectively through the growing fields.

ISSN: 3471-7102, ISBN: 978-9982-70-318-5

5.0 DISCUSIONS CONCLUSION AND RECOMMENDATIONS

DISCUSION

In the extraction process, the loss of water was observed in the amount of weight after harvesting through trying until to streaming stage of process so that the correct state dry matter can be determined and maintained in the future production. This was achieved by considering the Total water shrink is calculated by dividing the weight of water lost during drying by the total initial kernel weight. When the seed was harvested, the total amount of weight was 10 kgs and then moisture content was 100% The result is then multiplied by 100 and expressed as a percentage. Our first example involves 1,000g. of kernel at 25% moisture. If the kernel is 25% water, it will contain 2,50g. of water and 750g. of dry matter. How much shrinkage occurs, due to water loss alone, if the 1000g, of kernel is dried to 15.5% moisture? We can calculate it. The dried kernel still contains 750g, of dry matter, but now the dry matter is 84.5% (100% minus 15.5%) of the total weight. Therefore, the total weight of the dried kernel is 750g. divided by 0.845, or 887.57 g. After drying, the kernel contains 137.57 g. of water (887.57g minus 7500g). Therefore, 112.43g of water was removed during drying (250g. minus 137.57g) Now that the weight of water lost has been calculated, the total water shrink percentage in our example can be calculated by dividing 112.43 (lb. of water removed) by 1,000 (total initial kernel weight) and multiplying the result by 100. The total water shrink is 11.24%. Total Water Shrink = (lb. water removed divided by original weight) times 100) = (112.43/1,000) x 100 = 11.24% The kernel was dried from 25% to 15.5%. For neem seed it indicated 11.24% moisture content as an ideal for further processing and even storage.

On the drying, the process was seed slow because the complete drying took about two weeks, however, the optimum trying stage was achieved which enabled for another stage soaking and peeling. Neem dried coat becomes hard, it stinks to the kernel which holds the two cotyledons were the oil is contained. Soaking was done for just a day that is 24 hours, so that was softening the coat does not allow water reach the beans after the kernel. Instead, water was allowed to swell the kernel to easy the pounding processes.

Pounding which is the crushing of the seed into the fine so that it becomes easy during streaming and oil extracting.
The total yield of neem was 3 liters or 3000mls of unpurified oil from the 10-kilogram harvested in the tree. Implying that 3kgs was of oil in the seed, 2500 g or 2.5kgs was of moisture content and 4500grams or 4.5kgs was for neem cake.

The findings of the study revealed that there is difference in repellence and mortality rate of insects as well as difference in number of progeny emergence after 45 days from the treated grains. The difference is based on the different constituents and level of the bioactive agents present in each extract and the level of impact of each extract on the insect pest of the treated grains. The insect pests in the treated grains had their feeding, comfort, movement, growth and prolific oviposition affected as a result of the presence of the active metabolites capable of repelling and inhibiting feeding and growth thus resulting to mortality of the insect pests. The reduction in progeny emergence after six weeks was a result of the active components in the extracts disrupting the life cycle of the insects.

The findings of the study revealed that plant extracts of oil from neem effective in controlling insects. As reported by Isman (2006), the extracts contain

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limnoids such as azadirachtin, salaninmeliantriol and nimbin which are useful bioactive component for insect control. The presence of Azadirachtin has a profound effect on insects: at the physiological level, it inhibits the synthesis and release of molting hormones (ecdysteroids) from the prothoracic gland, leading to incomplete ecdysiast in the insects. In adult female insects, a similar mechanism leads to sterility thus preventing reproduction and multiplication. In addition, Azadirachtin is a potent anti-feedant to many insects while salannunand sodium nimbinate are repellent and spermicide respectively (Isman, 2006). The findings of this study are in line with that of some experts (Upadhyay, 2007; Rajendran and Sriranjini, 2008; Abdurrahman et al., 2008; Upadhyay and Ahmed, 2011; Anyanga et al., 2013; Madzimure et al., 2013; Amoabeng et al., 2014; Stevenson, 2014; Kamran et al., 2015) who reported the effectiveness of some plant extracts in pest control. The use of plants in this way as insecticides not only ensures safety of the environment and consumption of the treated produces, it is reliable, readily available for production by the farmer and economical, especially for the small scaled indigent farmers. All in all, plants of insecticidal potentials are compelling alternative to synthetic pesticides (Anyanga et al., 2013; Amoabeng et al., 2014; Stevenson, 2014).

Test for Repellence

In method, despite the treatment the cabbage and tomato with the extracts, migration towards the food or oviposition source was observed to be highest within 24 hours. The insect pests moved through the interspaces of the field to the treated cabbage and tomato which could be explained by the natural drive for feeding or depositing of the fertilized eggs on the tomato and cabbage. However, movements away from the treated tomato and cabbage became obvious after 72 hours. Most insect pests of the cabbage and tomato from the treated period moved to the other untreated areas. With the trend of movements away from the treated cabbage and tomato, it seems the action of the extracts on the pests became severe after 48 hours. On the fifth day, the pests on the plots with the treated cabbage and tomato were all absent. Some of the pests in the plot treated plots were absent as well, meaning that contact with the extracts (treatments) even after migration (away from the stimulus) could result to antifeeding of the insect pests.

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Test for Control of the Insect Pests by the Extracts

In the test for repellence, the treated period served as a migratory and an escape route for the insect pests to move to other areas. In the test for effectiveness of the extracts in the control of the insect pests, the insect pests were on the open fields control effectiveness increased with prolonged exposure to the treatments as repelling rate in each field rose with increasing number of dosages. Again, the oil extract seems less effective among the two low dosage low treatments. A mixture of both extracts of Neem, appeared to be the most effective among the three. Repelling observed and recorded for neem extracts treatment was as high as 100% with a for diamond back moth, red spider mite and absoluta tuta.

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Test for Progeny Emergence from the Treated tomato and cabbage field

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Table: 3

QUANTITY OF HERVESTED NEEM FROM TREE	*AMOUNT OF MOISTURE CONTENT*	*QUNTITY OF CAKE*	*QUANTITY OF OIL OBTAINED*
10 Kilogram	11.5%	4 Kilogram	3 Kilogram or 3000 mls
TOTAL QUANTITY OBTAINED	*2500grams*	*4000grams*	*3000mls*

The neem dosage of 3% which was 50 mls or 0.50 liter of neem. Was calculated by: 0.50 liter of neem ÷16 liters of water ×100%=3% of neem oil. The neem dosage for 2% was 30 mls or 0.30 litres, was calculated by 0.30 mls neem oil divided by 16 liters of water by 100% =2% of neem oil. Then the dosage of 1% was calculated by 0.20 liters of neem oil divided by 16 liters of water by 100%=1 % of neem oil.

Table: 4

Neem oil Content %	*Volume of water*	*Amount of spray per meter squared*	*Amount of oil mls or litre*	*Variance of Spray after each Observation*
1%	*16 litres*	*0.50 mls*	*20 mls or 0.20 litres*	*70% effectiveness*
2%	*16 litres*	*0.50 mls*	*30 mls or 0.30 litres*	*85% effectiveness*
3%	*16 litres*	*0.50 mls*	*50 mls or 0.50 litres*	*100% effectiveness*

The analysis of variance for neem extract concentration also showed statistical difference in the repelling rate of insect. After 7 days of treatment application. Therefore, the average and lowest percentage of treatment (1% and 2%) called, 70% and 85 took some time to repel the insect in the field respectively. However, this high amount recorded of the speed powder is far below than the considered the minimal effective concentration of neem oil.

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CONCLUSION

From the findings on the preparation of neem oil, the researcher concluded that producing neem oil is not a complicated procedure as people may think and costly involved in the preparation is very affordable especially for small scale farmers who are the major producers of crops in Zambia in particular. Neem oil processing is health hazard free as most people use it for medicinal purposes to cure a number of diseases. From the results of neem oil in the field of cabbage infested with diamond back moth and tomato infested with red spider mite and absoluta tuta is very good evidence that more than 300 piercing and sucking as well chewing and biting insect were controlled by neem oil organic insect pesticide. It is therefore observed that Azadirachtin can be a suitable alternative to the chemical pesticides. It acts as a repellent in feeding and oviposition, deterrent arrests growth of developing stages, cause's, sterility and also has mild direct 7 toxicity. No other plant synthetic substance is known to have such a diverse activity against insects. Neem has also has been found to possess nematicidal and fungicidal properties according to *(Zahidi, 2014)*. About a dozen nematodes have already been reported to be susceptible to Neem. Soil treatment with Neem Cake, has given effective control of meloidogyne incognita in tomato. Lands will improve the seed yield which will be a sustainable source of income for the rural people.

RECOMMENDATIONS

As the results suggested in this study on the effectiveness of neem oil in the control of Agricultural pests. The number of recommendations has been highlighted below; the tree's most use as biopesticides.

- Neem tree has more 60 valuable compounds, among which the widely used is Azadirachtin which has been identified as the key compound which acts as an insect Antifeedant, repellent and an inhibitor of ecdysis and growth.
- About 300 insect species can be managed with the Azadirachtin.
- The researcher wishes to recommend that more extracting oil machine be promoted so that the production can be done on the large scale.
- Further the farmer be encouraged to plant more trees of neem as one way of strengthening the production.
- The researcher on the other hand wishes to recommend neem oil production, which will have a contribution towards increase in tree planting to reducing the global warming which is caused by accumulation of carbon dioxide (Co_2) in the atmosphere.
- With more trees of neem, more organic insect pesticide on the market, more quantity and of high-quality produce and less risk of poison persistence on consumer and livestock.

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