

DEBRE MARKOS UNIVERSITY

COLLEGE OF NATURAL AND COMPETITIONAL SCIENCE

DEPARTMENT OF BIOLOGY

**EVALUATION OF AQUEOUS EXTRACTS OF *MELIA AZEDARACH* AND
ALLIUM SATIVUM AGAINST CABBAGE APHID, *BREVICORNE
BRASSICAE* (HOMOPTERA:-APHIDIDAE) IN ILLALA, MEKELLE
TOWN, SOUTH TIGRAY, ETHIOPIA**

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**A THESIS SUBMITTED TO IN PARTIAL FULLFILLMENT OF THE
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THESIS APPROVAL

The thesis titled on “Evaluation of aqueous extracts of *Melia azedarach* and *Allium sativum* against cabbage aphid, *Brevicorne brassicae* (Homoptera:-Aphididae) in Illala, Mekelle town, South Tigray, Ethiopia. As thesis research advisors, we hereby certify that we have read and evaluated this thesis prepared, under our guidance “By Mr. Gebrelibanos Weldehaweria is approved for the degree of Master of Science in Biology. As member of the board of examiners of the M.Sc. thesis open defense examination, we certify that we have read, evaluated the thesis prepared by Gebrelibanos Weldehaweria and examined the candidate. We recommended that the thesis be accepted as fulfilling the thesis requirement for the Degree of Master of Science in Biology.

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DECLARATION

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LIST OF ACRONYMS

SPP	Species
G	Gram
L	Litter
ML	Milliliter
M	Meter
%	Percentage
DF	Degree of freedom
Sig	Significance
STD deviation	Standard deviation
LSD	Least significance difference
ANOVA	Analysis of variance
IPM	Integrated pest management
SPSS	Statistical packages and social science

ABSTRACT

Cabbage (*Brassica oleracea*.Var. capital) is the second most important vegetable crop in Ethiopia with respect to production next to red pepper (*Ceposicum spp*). Cabbage aphid (*Brevicoryne brassicae* .L.) (Homoptera: Aphididae) is grayish-green insect which feeds primarily on the cabbage phloem and deforms the plants and reduce the yields. It is one of the key pests affect the quality and market value of cabbage. Botanical extracts are increasingly attracting research attention as they offer novel modes of action. The objective of this study was to evaluate the efficacy of dry fruit of *Melia azedarach* and bulb of *A. sativum* extracts against cabbage aphid infestation on cabbage leaves. The effects of *M. azedarach*, *A. sativum* extracts and mixed extracts were evaluated in the laboratory and in the field against *B. brassicae* to determine their efficiency by comparing with controlling groups. In this experiment botanical extracts at concentration of 5%, 10% and water and Dimethoate 40% EC were used experimental, negative and positive control groups respectively both under laboratory and field conditions. Mortality was observed, counted and recorded after 24, 48 and 72 hours in both experimental conditions. Plant extracts at (5%, 10%) caused the highest mortality of aphid where its population reduce per each treatments application over the population of pretreatment. The aphid treated with *M. azedarach*, *A. sativum* and *M. azedarach* ± *A. sativum* extracts showed a 82.2%,76.8% and 84.2% average mortality at 5 % extract concentration respectively, but these extracts revealed 83.3%,80%,85.8% average mortality at 10 % concentration respectively. The one way of ANOVA for the mean mortality of cabbage aphid on cabbage leaves treated with the all types of treatments at both doses of plant extracts used in the experiment and the control revealed that there was significant difference (P<0.05). Botanical pesticides showed high efficacy against aphid and spray with mixed extracts effectively for control aphid population followed by *M. azedarach* extract and *A. sativum* extracts remained least effective against cabbage aphid. This study leads to further investigation of the bioactive compounds from *M. azedarach* and *A. sativum* for the management of (*B. brassicae*) with mode of action on cabbage leaves.

Key words: Botanical extracts, Mortality, Synthetic insecticides

1. INTRODUCTION

1.1. Background of the study

Brassica oleracea . var. capital is the second most important vegetable crop in Ethiopia with respect to production next to red pepper (*Ceposicum spp*) (Feyissa Begna and Tebkaw Damtew, 2015).Cabbage is an important temperate vegetable that grows in range climatic region. Despite the importance of cabbage, there are number biotic constraints, including insect pests, which hamper its production and consumption. *B. brassicae* L. Homoptera; aphidae) is an important insect pest cabbage globally. Aphid at different stages it feeds the phloem, their feeding results in weak, wrinkled leaves that are cupped both out ward and inward, resulting in a deformed plants with lower yields. Indirect damage from cabbage aphid their feeding result from excreta (honeydew) that supports the growth of sooty mould (Grainge, 2000).

Botanical insecticides are effective against crop pests and remain safer to natural enemies. They have been in use for centuries by farmers in developing countries to control insect pests of both field crops and stored produced. Some of these plants species possess one or more useful properties such as repellency, anti -feeding, flushing action and fast knock down (Feyissa Begna and Tebkaw Damtew, 2015).

According to Seif and Nyambo (2013), IPM defined as pest management strategy that focuses on long-term prevention or suppression of pest problems through a combination of techniques. These methods include cultural, mechanical, physical, clean environmental, pesticides (bio-pesticides and synthetic molecules) and biological control (the use of natural enemies of arthropod pests).The insecticidal properties of some plants have been discovered long ago. They possess one or more useful properties such as biodegradability, broad spectrum of activity and ability to reduce insect resistance. High cost of chemical insecticide leads to search alternative sources for pest management (Jangam *et al.*, 2014).

Extract of any plant product by mix with cow urine increases the potency of drug to many folds. Kernel extracts in cow urine, *M. azedarach* oil and their combination with insecticides were evaluated against incidence of mustard aphid (Gupta, 2005). The botanical insecticidal such as (*A. indicia* A. Jess.) and (*A. sativum*) which are active against specific target spp. Another alternative botanical extracts preparation has been to use the *M. azedarach* leaf combined with *A. sativum* to enhance insecticidal effects as both plant materials have the potential to reduce insect pest population. However, the efficacy of *M. azedarach* leaf combined with *A. sativum* on phloem-feeding insect is not documented (Nzanza and Mashela, 2012).

The cabbage aphid belongs to the genus *Brevicoryne*. Its name is derived from the two Latin words “*brevi*” and “*coryne*” and which loosely translates as “small pipes”. In aphids, there are two small pipes called cornicles or siphunculi (tailpipe-like appendages) at the posterior end that can be seen with a hand lens. The cornicles of the cabbage aphid are relatively shorter than those of other aphids with the exception of the turnip aphid, *Lipaphis erysimi* (Kaltenbach). These short cornicles and the waxy coating found on cabbage aphids help differentiate cabbage aphids from other aphids that may attack the same host plants. The cabbage aphid (*B. brassicae*), is found throughout the world. Its appearance differs from other species, with a powdery, waxy covering over its body. Its body is grayish-green. This aphid feeds primarily on cabbage, collard and kale, and seldom feeds on mustard or turnip. *B. brassicae* is the most common and destructive pest of cole crops. The cabbage aphid is difficult to control and should be monitored closely when it is discovered colonizing. The thresholds for treatments should be made if populations spread beyond the small initial colonies (Carter and Sorensen, 2013).

Devanand and Rani (2008), investigated that the use of botanical insecticides is more sustainable and has a lower environmental impact than synthetic insecticides. However, current commercially extracted botanical insecticides such as pyrethrum and azadirachtin tend to be relatively expensive and difficult for most smallholder farmers to offer them. Botanical insecticides that are cheap and readily available and be simply prepared rather than requiring organic solvents and complex apparatus for the local people.

M. azedarach, Family (Meliaceae) is the best known species. It has derived its name from the classical Greek word Melia for the manna ash, referring to the similarity of the leaves to that plant and azedarach from the name of an ancient poisonous tree, but azadirachta, now is unknown (Nahak, and Sahu, 2010). Persian lilac or Chinaberry tree (*M. azedarach* L. (Meliaceae), a close relative to the (*A. indica*) presents a promising approach for integrated pest management. The insecticidal properties of *M. azedarach* extracts could be equivalent to that of (*A. indica*) extracts based on the source of material and the type of pest in question (Wabale and Kharde, 2010).

M. azedarach extracts considering insects with various feeding strategies, including agricultural and sanitary pests, with emphasis on tests using extracts to control insects for act as repellent and oviposition deterrent effects. A variety of preparations from crude extracts of different parts of *M. azedarach* plants have been applied to assess anti-feedant activity. Leaf and fruit extracts of *M. azedarach* showed anti-feedant activity on insects of various Orders, including Saltatoria, Heteroptera, Homoptera, Coleoptera, Lepidoptera and Diptera (Ascher *et al.*, 1995).

A. sativum .L. which is commonly known as *A. sativum* belongs to the onion family Alliaceae and is closely related to the onion, shallot, leek, chive and rakkyo. It has been used throughout the world for both culinary and medicinal purposes. It has a pungent and spicy flavor, which is mainly related to sulfur containing compounds such as allicin, alliin, ajoene, diallyl disulfide, dithiin and s-allylcysteine. Allicin is the component responsible for the spiciness in the raw *A. sativum* and has powerful antibiotic and antifungal properties. It derives from the precursor alliin in fresh *A. sativum* tissue through the enzymatic action of alliinase (Block, 1992).

The aphid settling deterrent activity of extract obtained from *A. sativum L.* against aphid. Aphid control depends mainly on the use of insecticides. Therefore, an alternative method of aphid control is needed. One of possible approaches is the use of plant extracts which can repel aphids or deter their feeding, and in consequence, reduce their number on plants. Botanical extracts as applied different dilution were found to be effective in causing significantly different rate of mortality to treated aphids population (Abebe Megersa, 2016).

1.2. Statement of the Problem

It is very important to investigate on evaluation the efficacy of plant pesticides for protection from various insect pests. *M. azedarach* and *A. sativum* used for controlling of cabbage aphid, because they have wide harmful effects on economic aspects by damaging field agricultural crops such as cabbage. Aphids feed by sucking sap from tender plant leaves. This often causes the plants to become deformed and, in consequence reduce its production, so that is one of the most key pests affect the quality and market value of cabbage in and around of the study area.

B. brassicae (L.) Homoptera; Aphididae) is an important insect pest cabbage globally. Aphids at different stages feed the phloem and results in weak, wrinkled leaves that are cupped both outward and in-ward, resulting in a deformed plant with lower yields (Grainge, 2000).

In recent years, the use of synthetic pesticides, particularly of insecticides, has become a very common. Excessive and indiscriminate use of these toxicants has unlimited hazards for human beings and every naturally growing population. However, extracts from plant origin containing insecticidal properties are indigenously available and are considered comparatively safe for environment and public health. The use of botanical pesticides it maintains biological diversity of predators, and reduces environmental contamination and human health hazards. Plant natural products that constitute effective safer alternatives to synthetic insecticides without producing adverse effects on the ecosystem have been tested in the management of stored-product and other plant pests (Isman, 2006).

There are concerns about the risks of chemicals to the vegetable producer, consumer and the environment. Chemicals are expensive and harmful to both man and the environment. The risks emanate from shortcomings in chemical handling practices, likely large deviations from recommended chemical doses, and chemical drift to non-targets and run off into the soil and ground water (Sibanda *et al.*, 2000; Williamson *et al.*, 2008).

In order to protect the pests in vegetable, the local farmer's insists to use synthetic pesticides, which are causing health and environmental problems. Moreover, the synthetic pesticides are more expensive and cannot obtain easily by the smallholder farmers. Therefore, the effectiveness selected botanical extracts were evaluated against cabbage aphid both in laboratory and on field conditions at Mekelle agricultural research center, Illala, Mekelle town, south Tigray, Ethiopia.

1.3. Objectives of the study

1.3.1. General objective

- ❖ The general objective of this study was to evaluate the bioactivities of aqueous extracts of *M. azedarach* and *A. sativum* against cabbage aphid on head cabbage leaves.

1.3.2. Specific objectives

The study specifically focused on achieving the following objectives:

- To assess the effect of *M. azedarach* and *A. sativum* extracts on mortality rate for protection of cabbage aphid on head cabbage under laboratory and on field conditions.
- To determine concentration levels of the effect bulbs of *A. sativum*, fruit of *M. azedarach*) and their combination against cabbage aphid.
- To evaluate the combination effect of *M. azedarach* and *A. sativum* extracts against cabbage aphid on head cabbage.
- To compare the efficacy of *M. azedarach*, *A. sativum*, and their combination extracts on aphid in laboratory and field.

1.4. Significance of the study

The research were conducted, it providing or initiates to use various botanical insecticides for local small holder farmers and easily available to apply them. To achieve maximum control insect pest with, less costs of plant extract. After study conducted vegetable growers need to utilize plant extract specially the *M. azedarach* and *A. sativum* to control aphid on cabbage. The importance of the study is to provide an alternative way of controls insect pests for local people.

This helps to be reduce or eliminate toxic effect occurs due to repeated use of synthetic chemical insecticides treatment (spray) for protection of pests in stored crop products and on the field of plant. When the small holder farmers uses a chemical extraction from plants, it does not have any side effects on health of other non-target animals and not pollute environment and it enhance the biological diversification around the study area. Therefore, the use biopesticides have multi-purpose example cost effective and easily available local areas.

Botanical pesticides are attractive alternatives to conventional chemicals for a variety of reasons. The most use of the solely chemical-based technologies is likely to have limited worth, as insects build up resistance after a few years. Conversely, the use of natural resources is more sustainable and cost effective, as there is less chance of resistance build-up by the pests. The strategy seems more stable and sustainable from the technical, ecological, economically and environmental viewpoint. The research outcome would have positive impacts on the environment by reducing the use of chemical pesticides, help maintain biodiversity, and conserve plant species for their pesticidal value.

1.5. Scope of the study

The study was performed on the evaluation of selected botanicals extracts for controlling cabbage aphid at both under laboratory and on field conditions at Mekelle town, Mekelle agricultural research institution. The study is restricted to mature fruit *M. azadarach*, bulbs of *A. sativum* and mixed those equal proportion to evaluate their efficacy on cabbage aphid in head cabbage. The stock solution was prepared from the selected plant extracts and compared two concentration levels at 5% and 10% in 100ml for one spray within 24 hours interval in three days. The efficacies of all treatments were assessed and compared the mortality rate of cabbage aphid. In laboratory about 12 containers were used and the first six of them for 5% and the remains are six for 10% of botanical extracts. On the field also tested all the six treatments by plotted small area of cabbage field randomly block design from the line sowed cabbage.

2. REVIEW OF RELATED LITERATURE

2.1. Cabbage (*Brassica oleracea*)

Brassica oleracea var. *capitata* L. (Cruciferae) is a member of the Brassicaceae (Mustard) family; this family includes broccoli, Brussels sprouts, cauli-flower, kale, mustard (greens), and collards. Collectively, these crops are referred to as cole crops or crucifers. It is an important temperate vegetable crop that grows well in other climatic regions throughout the world. Despite the importance of cabbage, there are a number of biotic constraints, including insect pests, which hamper its production and consumption (Waiganjo *et al.*, 2011).

Cabbage, beside tomato and onion, is one of the most popular vegetable crop worldwide, with total annual production around 62 million metric tons. Cabbage heads used for processing are larger than those for storage or fresh market, with weight ranging from 5 up to 8 kg and diameter from 20 to 40 cm. They are frequently mechanically harvested while smaller size heads for long storage purpose weighted within 2–3 kg are recommended to be harvested manually. The new trend for many European and United States fresh markets is a preference of head weights of 1–2 kg. Reduced head size may be achieved mainly by the use of high density planting. The cultivars choice and under application some of other factors such as method of cultivation, the rate of water supply, and fertilization level (Rubatzky and Yamaguchi, 1997).

B. oleracea L is a member of Cruciferae and a useful vegetable, belongs to the genus *Brassica*. Cabbage and is related to turnips, cauliflowers and brussels sprout. The Food and Agricultural Organization has identified cabbage as one of the top twenty vegetables and an important source of food globally. It has been domesticated and used for human consumption since the earliest antiquity, and now Cabbage is one of the most popular vegetable being grown globally in more than 90 countries. Cabbage crop is much preferred by the growers because of assured yield and transportable capacity. Cabbage is a rich source of vitamin A and C. The green outer leaves of cabbage are richer in vitamin A, calcium and iron than the white inner leaves. Headed cabbage are usually consumed as a cooked vegetable, or eaten fresh as an ingredient of coleslaws and mixed salads (Sawant *et al.*, 2010).

B. oleracea is an important leafy vegetable in both small and large scale sectors in most African countries. The significance of cabbage lies in its high nutritive value, variety of dishes that can be prepared from it as well as the creation of employment through the labor required for producing the crop. The high nutritive value of cabbages in the form of protein, vitamin, calcium, iron and carotene makes it susceptible to insect pest attack. The pests that attack cabbages include aphids (*Aphis brassicae*), diamondback moth (*Plutella xylostella*), the cabbage webworm (*Hellula undalis*), the cabbage looper (*Trichoplusia spp*) (Mochiah *et al.*, 2011).

2.1.1. Cabbage growth stages

Presently there is no standard terminology for describing cabbage growth stages. Although terminology such as "head formation" and "cupping" does exist, it can be ambiguous and confusing if not properly defined. More accurate descriptions and precise terminology of cabbage growth stages is use-full to those involved in cabbage production to standardize the timing of agronomic and pest control events relative to crop growth. Accurate cabbage growth stage descriptions are particularly useful for pest management programmers, since plant susceptibility to cabbage pests varies with the crop stage and pesticide treatments must be applied accordingly (Anonymous, 1981).

Growth stages of cabbage are useful in monitoring crop performance and in making decisions or planning for plant protection activities to reduce costs while maintaining acceptable market quality. The quantitative description of crop growth is both desirable and useful for several applications. Plant growth models based upon accurate phenological and growth information can provide much needed information to agriculturists (Landsberg, 1977).

Simple quantitative descriptions of crop growth can also be useful to the grower and in practical integrated pest management (IPM) programs. Growers can use simple information on growth and development to monitor crop performance and to help manage the crop. In IPM programs, data on crop growth and development can be used to formulate plant protection strategies, make decisions, and determine program intensities. Consideration of cabbage growth and development may also be of value in estimating maturity and harvest dates of cabbage (Isenberg *et al.*, 1975 and Strandberg and White, 1979).Harcourt (1970), determined the growth stages of cabbage to formulate a life table approach to documenting pest damage. Various growth stages of cabbage

are commonly referred to in pest control and cultural recommendations and scientific reports but usually have not been described in detail.

Stage 1: Cotyledons (seed leaves): Flea beetles are the most important problem during the cotyledon stage, causing small "shot" holes in the cotyledons and stems and sometimes cutting the stem. Stage 2: Seedling: Flea beetle feeding may still be damaging. Cabbage maggot injury to the roots or hypocotyls region is likely to appear at this stage. Stage 3: 6 to 8 true leaves: Flea beetle feeding becomes less important as the plants get larger. Cabbage maggots could still cause serious root injury. Stage 4: 9-12 true leaves: Flea beetle feeding damage is usually not harmful to the plant at this and succeeding stages. Diamondback moth, imported cabbageworm, and cabbage looper (Lepidoptera) larvae may be present and could require control measures (Andaloro *et al.*, 1983).

Stage 5: Precupping: Approximately 10-12 leaves. The innermost heart leaves are growing in an upright fashion and begin to curve in-wards. They are visible without moving any of the surrounding leaves. At this stage and succeeding stages, cabbage maggots will only reduce yield if the infestation is severe or if plants are under drought stress. Lepidopterous larval population densities may reach treatments threshold. Stage 6: Cupping: Approximately 12-16 leaves. The innermost heart leaves, which are still growing in an upright fashion, are concealed by the larger, older leaves surrounding them. All visible leaves will later become the frame leaves (leaves not touching the mature head) of the mature plant. Stage 7: Early Head Formation: Record the circumference around the head. Firm head can easily be felt when squeezing, 3-10cm head circumference. The inner heart leaves are now quickly developing as a ball-like structure of overlapping leaves, and are concealed by the surrounding larger leaves. These surrounding leaves do not press tightly against the developing head and will later unfold to become frame leaves (Soto-Ortiz, 2006).

Stage 8: Head Fill: Head diameter will be approximately 10 - 20 cm. Thrips can reproduce in the head where they are protected from insecticides. A firm round head is visible within the wrapper leaves (the 4 outer loose leaves that touch the mature head). The head has not yet fully developed and thus, is not of harvestable size. Stage 9: Mature: Head diameter will be approximately 15 - 30 cm. Storage and fresh market cabbage must be protected from alternaria downy mildew, sclerotinia, and foliage feeding insects. Black rot symptoms are inconsequential to yield, but may

affect the marketability of cabbage. Yield or grade of processing cabbage is affected only by a severe infestation of any pest. The head is ready for harvest and may split if not harvested in time (Andalaro *et al.*, 1983).

2.1.2. Susceptibility of growth stages to cabbage aphid

Various pest species (insects and diseases) that attack cabbage may or may not cause economic injury depending on the growth stage of the plant. Whether various pest and disease species that attack cabbage plants will cause yield loss depends partly on the growth stage of the plant. Injury to the older leaves at a late stage in crop development for example, will not influence the final yield but cause at lower stage of cabbage (tender leaves). Aphids are vector of fungi and spraying a fungicide to control a slight alternaria leaf spot infection occurring at the older leaves is simply a waste of money. Some pests are present throughout the season and can affect cabbage at any growth stage and they affect the quality or yield at susceptible growth stages. Damage, and impact of damage on yield, will also depend on the cabbage variety grown, and other elements of the ecosystem like natural enemies, weather conditions, fertilizer, water availability and so on (Shelton *et al.*, 1982).

2.2. Cabbage aphid (*Brevicoryne brassicae*)

B. brassicae L. is also an important insect pest of cabbage globally. The four nymphal stages and the adult aphid are phloem feeders. Their feeding results in weak, wrinkled leaves that are cupped both out-ward and in-ward, resulting in a deformed plant with lower yields. Indirect damaging from their feeding result from the excreta (honeydew) and it supports the growth of sooty mould. In addition, the cabbage aphid is a vector of 23 virus diseases of Cruciferae (Hughes, 1963).

B. brassicae is one of the key pests that affect the quality and market value of cabbage (Birhanu *et al.*, 2011). It is a pest of economic importance since it arrests crop growth seriously and has a tendency to contaminate the crop, rendering it un-marketable. These pests are source for transmitting 20 plant viruses to cause damage to many plant species belongs to the family Cruciferae. The estimated annual damage caused by these pests in an average of about 30% in USA even though pest control technologies are available and in Turkey the potential is higher, averaging 50% or more (Roberson, 1999).

Aphids are considered by most farmers in Zimbabwe as the most common pest of rape. The most common species that attack rape plants is the cabbage aphid (*B. brassica*). The aphids feed by sucking the sap from the plants and if in large numbers they remove sufficient sap leads to kill the leaves and the growing tip. An infested seedling becomes stunted and distorted. Continued feeding on mature plants causes wilting, yellowing and generally, the plants have stunting growth (Hill, 1983).

2.2.1. Distribution of Cabbage aphid

The cabbage aphid is native to Europe, but now has a world-wide distribution. Severe damage to various plants in the family Brassicaceae has been reported in many areas including Canada, the Netherlands, South Africa, India and China. The cabbage aphid is wide distributed throughout the U.S. and has been found to be more of a pest in the southern state. Cabbage aphid are widely distributed and found in all states of Australia. They are very common as a pest of canola, with peak abundance typically during spring. Number of cabbage aphids in canola crops are on the rise in some regions as temperatures gradually become warmer. The cabbage aphid is an introduced and widespread pest of canola, with peak abundance typically in spring (Carter and Sorensen, 2013).

2.2.2. Identifications of Cabbage aphid

The cabbage aphid is difficult to distinguish from the turnip aphid (*Lipaphis erysimi* (Kaltenbach)). The cabbage aphid is 2.0 to 2.5 mm long and covered with a grayish waxy covering, but the turnip aphid is 1.6 to 2.2 mm long and has no such covering. Aphids sit deep inside cabbage heads, which makes it difficult to control them. Aphids are soft pear-shaped insects. They are easily damaged and killed by their natural predators including lady-bird beetles, lacewings, spiders and small parasitic wasps (Carter and Sorensen, 2013).

Cabbage aphids are grey-green in color and have a white waxy coating. They appear in dense colonies and they feed mostly under young tender leaves. Green peach aphids do not form dense colonies. The cabbage aphid and green peach aphid (*Myzus persicae* (Sulzer)) can be confused when they are both found feeding on cabbage plants. The cabbage aphid is waxy with short cornicles. On the other hand, the green peach aphid lacks a waxy covering, and has long cornicles. Moreover, green peach aphids mainly attack cabbage before heading (after

transplanting, the cabbage seedling starts producing leaves, and eventually the cabbage plant begins to produce a small, tight head at the center of the group of leaves) begins, but cabbage aphids may attack the crop at any stage (Elwakil and Mossler, 2013).

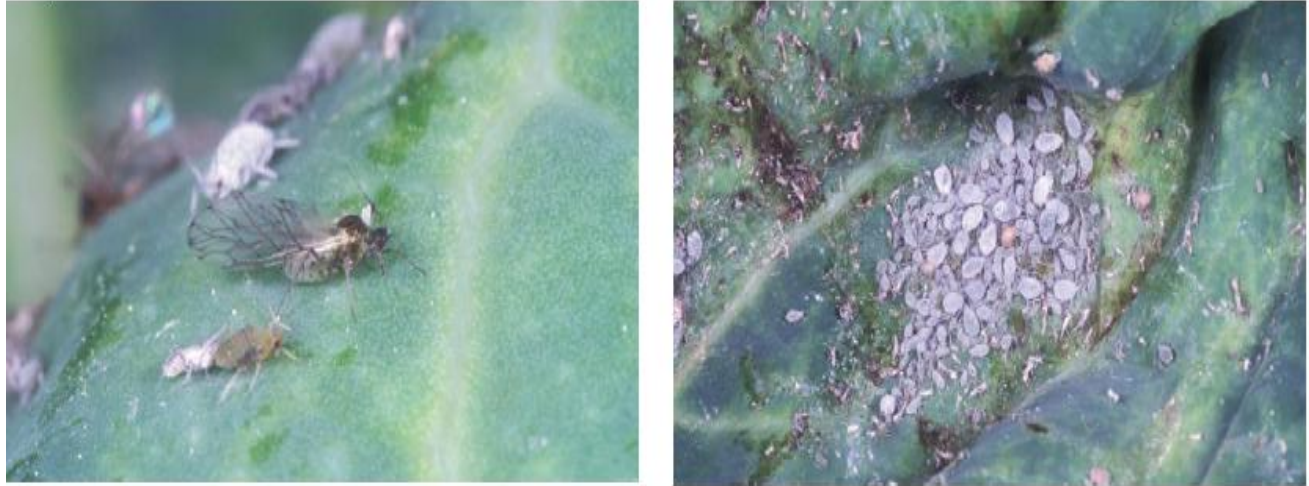


Figure 1: Cabbage aphid, *Brevicoryne brassicae* Linnaeus, winged (alate), nymphs and colony or cluster on a cabbage leaf. Source by: (Elwakil and Mossler, 2013).

2.2.3. The hosts for Cabbage aphid

The cabbage aphid has a host range restricted to plants in the family Brassicaceae (Cruciferae), which include both cultivated and wild cruciferous crops. Major economically important host crops where significant losses have been found include cauliflower (*Brassica oleracea* L. var. botrytis L.), brussels sprouts (*B. oleracea* L. var. gemmifera DC), broccoli (*B. oleracea* L. var. italica Plenck), cabbage (*B. oleracea* L.), oilseed rape (*Brassica napus* L.) and other members of the genus *Brassica* (example, Indian mustard (*Brassica juncea* L.), white mustard (*Sinapis*) (*Brassica alba* L.)), black mustard (*Brassica nigra* L.), toria (*Brassica rapa* L.). It also attacks Chinese broccoli, Chinese cabbage (*Brassica rapa*, subspecies *pekinensis* and *chinensis*), radish (*Raphanus sativus* L.) and kale (*Brassica alboglabra* L.H. Bailey) (Kessing and Mau, 1991).

2.2.4. Biology of aphid

Aphids can reproduce in two ways. In warm climates (example, in Florida and Hawaii), females give birth to female nymphs without mating. In this case, an aphid colony consists of females only. This occurs during warmer periods in temperate climates as well. However, in temperate climates the mode of reproduction changes during the autumn as temperatures begin to drop. In response to low temperature or decrease in photoperiod, males are also produced (Blackman and Eastop, 1984).

Mating takes place and females lay eggs. The total life cycle duration ranges between 16 to 50 days depending on temperature. Aphids can reproduce both asexually and sexually. Aphids reproduce asexually whereby females give birth to live young. Temperatures during autumn and spring are optimal for aphid survival and reproduction. Populations peak in late winter and early spring and development rates are particularly favored when daily maximum temperatures reach 20-25°C. Cabbage aphids are more tolerant to cold weather than the turnip aphid and will continue to develop slowly at temperatures around 5-9°C. Plants can become sticky with honeydew excreted by the aphids. When plants become unsuitable or overcrowding occurs, so the population produces winged aphids which can migrate to other plants or crops (Hines and Hutchison, 2013).

Aphid infestations can easily get out of hand due to the nature of the aphid lifecycle. Aphids survive through winter in the form of eggs. The eggs are black and are covered by thick shells which can survive extreme temperatures. During spring, the eggs hatch into females. The females are capable of producing several generations of female offspring without mating in a process called parthenogenesis. In this manner, colonies grow exponentially in a short period of time. During cold weather, most offspring is killed by cold, which makes aphid populations more manageable in winter. For aphid, their eggs in temperate climates, eggs overwinter in plant debris near the soil surface. Eggs are not laid in warm climates, females produce female nymphs directly. Nymphs differ from adults (including wingless adults, known as apterae) in having less developed caudae and siphunculi. The nymphal period varies from seven to ten days. Winged forms develop and start migrating to new host plants only when plant quality deteriorates or when a plant becomes overcrowded (Kessing and Mau, 1991).

The Adults of Aphids are soft-bodied and oval or pear shaped with a posterior pair of tubes called cornicles, which project backward. Aphids have piercing-sucking mouthparts. Adult cabbage aphids can take on two forms, those are winged and wingless. Wingless adults' are 1/10 inches long, oval-shaped and appears grayish-green or grayish-white due to their waxy covering. The behavior of Cabbage aphids often that form dense colonies on floral parts of plants, especially at the maturing, terminal flowering spike. This is occasionally occurs in association with the turnip aphid. It is Similar with other type of aphids, in particular the turnip aphid and green peach aphid (Herrick and Huntgate, 1911).

2.2.5. Damage by cabbage aphid

Aphids damage plants by piercing soft plant tissues and sucking sap out of them using well adapted mouth parts. The sharp mouth used for piercing and sucking plant parts is called the proboscis. The aphids also transmit viruses which further arrest plant growth. Aphids excrete a sugary substance called honey-dew after digesting the sugar-rich plant sap. Honeydew is sought after by ants' uses as a food source. They feed on honey-dew left behind by aphids on plant surfaces. The presence of ants on plants is usually the indicator of aphid infestation. This fungus blocks light from reaching the leaves and this negatively affects photosynthesis, hence reducing yield. Severely infested plants become covered with a mass of small sticky aphids which can eventually lead to leaf death and decay. The cabbage aphid is an agricultural concern because it is a vector of at least 20 viral pathogens that can cause diseases in crucifers and citrus. Both wingless (apterae) and winged (alate) forms are able to transmit viruses, but the wingless aphids demonstrate a higher rate of transmission (Natwick, 2009).

2.2.5.1. Direct feeding damage

Cabbage aphids feed on the underside of the leaves and on the center of other cabbage head. They prefer feeding on young leaves and flowers and often go deep into the heads of brussels sprouts and cabbage. Colonies of aphids are found on upper and lower leaf surfaces, in leaf folds, along the leaf-stalk, and near leaf axils. Infestations start when winged aphids fly into crops from autumn weeds. Cabbage aphid infestations occur most frequently in canola from early flowering to late pod development. Adults and nymphs suck sap from plants and high numbers can result in yield loss by reducing pod set, pod fill and grain quality. Colonies often become evident by the distortion and discoloration (yellowing) of infested parts (Jones and Hawkes, 2002).

2.2.5.2. Indirect damage (virus transmission)

Cabbage aphids cause indirect damage by spreading plant viruses. Aphids spread viruses between plants by feeding and probing as they move between plants and paddocks. This influences the likelihood of plant infection. Cabbage aphids are important vectors of plant diseases including beet western yellows virus, turnip yellows virus, cauliflower mosaic virus and turnip mosaic virus all of which cause damage in plants. Cauliflower mosaic virus (CaMV) and turnip mosaic virus (TuMV) are non-persistent viruses and are only retained in the aphid mouthparts for less than four hours. Secretion of honey-dew by aphids can cause secondary fungal growth, which inhibits photosynthesis and can decrease plant growth (Jones and Hawkes, 2002).

2.2.6. Management (control measure) methods

Aphids are serious pests under cool and dry conditions. Cultural and biological control strategies can help reduce aphid infestation and use of pesticides while still maintaining yield and quality of produce. For large scale (commercial) production, insecticide application is considered when 2% of plants are infested with aphids. It is important to add a spreader-sticker (liquid detergent to break the surface tension of droplets) to the insecticides to increase surface contact with the waxy covering of the aphids' bodies. For small-scale vegetable growers (home growers), aphids can be repelled by planting crops with reflective mulch (Covering the surface of the soil with material such as compost or plant residues conserves soil moisture and maintains good soil structure and health)(Grifn and Williamson, 2012).

2.2.6.1. Action threshold

Fields need scouted every week for signs of aphids. Some aphid populations can be suppressed by conventional insecticides used to control Lepidoptera pests. *Bacillus thuringiensis* (Bt) products are not effective on aphids. The beneficial insect complex is maintained and that usually keeps aphid population under check. Cabbage aphids, *B. brassicae*, L.colony (cluster) on a cabbage stem. When more than 20% of leaves are infested with aphids, then an insecticide application is recommended to spray (Webb, 2010).

2.2.6.2. Cultural Control methods

These involve changing the way a crop is grown or its habitat in order to prevent and reduce pest damage. Some cultural methods are mixed/intercropping systems, sanitation, Crop rotation, early planting, avoiding dense planting, and providing conditions for growing healthy plants to better withstand pests (Seif and Nyambo, 2013).

Seed beds should be kept clean at all times. A minimum three year rotation is advised to prevent aphid infestation. The field should be plowed immediately after harvest to prevent the spread of aphids to other crops. It is important to rid the field and surrounding areas of any alternate host plants like mustards or other cruciferous weeds they attract aphids as well. Destruction of plant debris at the end of the season can help kill overwintering aphid eggs in temperate climates. Crop rotation with non-host crops is also beneficial. Avoid replanting on land where an aphid-infested crop has been recently removed. Plant spacing is not considered as an effective approach for cabbage aphid control in canola (*Brassica napus* L.) crops (Razaq *et al.*, 2012).

Cultural methods can be implemented to reduce the problems that have been caused by indiscriminate use of insecticides. Intercropping cabbage significantly reduced pest prevalence, plant death after transplanting, leaf damage and increased cabbage yield compared to sole cabbage crop. The *A. sativum* and onion when grown in intercrop repel insect pests in cabbages. It was noted that onion intercropped with cabbage between rows has a higher repellent effect than the intercrops where the *A. sativum* and the onion were planted within the cabbage rows. The planting pattern was also noted to be of significance in controlling insect pests. It clearly showed that *A. sativum* and onion are capable of repelling insect pests on leaf crops (Katsaruware and Dubiwa, 2014).

Crop species grown together in an intercrop system interact and influence each other. These relationships can be beneficial or detrimental. Intercropping takes an advantage of the benefits of growing plants together. Combining the right vegetable crops and herbs can reduce the need for chemical pesticides in the garden by repelling insects and limiting the spread of diseases. The benefits of intercropping include better use of growing area, increased insect pest and disease resistance, and increased predator insect populations, trap cropping for pest control. A nurse cropping which means one crop sacrificing for another and better long term soil use. Intercropped plants grow to their maximum potential, live and grow in a minimum of stress and

provide the healthiest crop. Unstressed plants are therefore more able to resist insect attack. Herbs such as onion (*Allium cepa*) and *A. sativum* have been used in the intercropping systems because of their ability to repel insects. Cole crops grown next to *A. sativum* and onion are less prone to insect pest attacks. Onion and *A. sativum* plants produce excretions from their roots as well as aromas from their leaves. These excretions and aromas have beneficial effects on surrounding plants. They will discourage insects, and are therefore regarded as insect repellent plants (McCallum, 2007).

Natural pesticides are safer and eco-friendly. The Onion (*Allium cepa*) and *A. sativum* as pest control intercrops in cabbage based reduce artificial interference and cut down on the use of synthetic pesticides. In addition, they reduce cost of health management on farms because they reduce inhalation of toxic fumes of synthetic chemicals. *A. sativum* and onion (*A. cepa*) is widely grown and is easy to cultivate in gardens. *A. sativum* in particular, is reportedly effective against a wide range of disease-causing pathogens and insect pests at different stages in their life cycles. Allicin is a compound obtained from *A. sativum*. The compound is a colorless liquid which has a distinctively pungent smell which reveals anti-bacterial and anti-fungal properties. Allicin in *A. sativum* important to defense mechanism against attacks by insect pests (Moran, 1992).

2.2.6.3. Biological Control

Biological control refers to the use of a living organism to control insect pests and diseases. Parasites and predators are important for regulating aphid populations. Aphids have a large number of natural enemies or predators. Unfortunately, they are killed due to excessive use chemical pesticides. It is important to keep pesticide use to a minimum so that natural enemies can thrive. The parasitic wasp, *Diaeretiella rapae* (M'Intosh) (Hymenoptera: Aphidiidae) lays eggs within half-grown nymphs (preferring 2nd to 4th instars over 1st instar nymphs and adults) and mummifies them, forming a light brown, hard shell around the aphid. Protecting habitat that will foster the population and survival of natural enemies can help reduce the need for pesticides. There are many effective natural enemies of aphids. Syrphid fly maggots, Hoverfly larvae, lacewings (aphid lions), ladybird beetles (both adult and larvae) and damsel bugs are known predators that can suppress populations. Aphid parasitic wasps lay eggs inside bodies of aphids and evidence of parasitism is seen as bronze-coloured enlarged aphid 'mummies'.

As mummies develop at the latter stage of wasp development inside the aphid host, it is likely that many more aphids have been parasitized that indicated the proportion of mummies. Naturally occurring aphid fungal diseases (*Pandora neoaphidis* and *Conidiobolus obscurus*) can suppress aphid populations. When the parasitism trend increases over time, there are good prospects that aphid populations will be controlled naturally (Baidoo and Adam, 2012).

Biological control is rarely considered adequate, to the extent that vegetable growers frequently apply synthetic insecticides to manage cabbage aphid and other prevalent insect pests of cabbage. Synthetic insecticides work relatively quickly, are easy to apply and are not labor intensive. However, an increase in resistance to insecticide making for cabbage aphid management is difficult. And also it associated with health hazards to humans and animals, environmental pollution, pest resistance, and is unavailable to many peasant farmers. Insecticides are mishandled and misapplied especially by inexperienced farmers' (Immaraju, 1998).

2.2.6.4. Chemical Control

Synthetic insecticides are important tools in pest control although they have been used excessively with negative consequences such as toxicity towards farmers, consumers, and wild animals. It also interruption of the natural control and pollination, water pollution, and the evolution of resistance pests have acquired to these products (Perry *et al.*, 1998). Many insecticides are effective against aphids. Care must be taken that sprays thoroughly wet the plants, because of the waxy nature of the pest and crop. Aphids have been managed using insecticidal soaps (example Safer Soap). Application timing is very important to keep aphids under control while conserving populations of natural enemies. A study on insecticide resistance in cabbage aphid carried out in Pakistan reports that aphids developed resistance to chemicals including methomyl, emamectin benzoate, and pyrethroids (cypermethrin, lambda-cyhalothrin, bifenthrin and deltamethrin) and neonicotinoids (imidacloprid, acetamiprid, and thiamethoxam). Their resistance level was also found to increase progressively in concurrence with regular use on vegetables (Ahmad and Akhtar, 2013).

The use of insecticide seed treatments can delay aphid colonization and reduce early infestation, aphid feeding and the spread of viruses. Pirimicarb is registered against cabbage aphids. Pirimicarb has little impact on beneficial insects compared with broad-spectrum of some synthetic chemicals. Rotating chemical groups and taking advantage of biological control are

essential to extend the useful life of the available chemistries. Application of pesticides to control pests has disturbed the natural balance, caused monetary losses through the need for more pesticide purchases. This in turn has led to further outbreaks of secondary pests and increasing concern about environmental hazards. Pesticides are responsible for some 20,000 accidental deaths each year, and 200,000 suicide deaths. They also account for about three million cases of acute poisoning each year (Ahmad and Akhtar, 2013).

The most smallholder farmers are predominantly used synthetic pesticides to control aphids. The decision to apply the pesticide is mostly based on noticing the presence of a pest on the plant (Obopile *et al.*, 2008). Some farmers, who grow vegetables for home consumption, fail to use the commercial chemicals due to their high costs, unavailability in local shops and end up losing their vegetables to insects and virus diseases. Those who afford synthetic pesticides face challenges of accessing appropriate chemical applicators and end up using some less orthodox application methods (Sibanda *et al.*, 2000).

2.2.6.5. Botanical insecticides

As plants and insects have co-evolved over many years, plants have accumulated specific secondary plant chemicals to counter act insect damage. These bioactive chemicals have effects such as anti-feedants, insect growth regulators and repellents. Among the other botanicals, *M. azedarach* derivatives are the most effective against insects (Awasthi, 2007). The effect of five different botanical extracts of tobacco, *M. azedarach*, *A. sativum*, eucalyptus and mahogany on aphid population on yard long bean was assessed in field, and laboratory conditions. Aphids were deliberately exposed to the above botanical extracts and then the number of live and dead aphids is counted. A synthetic insecticide usually provides quick and adequate control for the time being. But they are usually expensive and leave long lasting residues over the exposed surface of crops, in soil, water. In addition, due to other problems such as health hazards, undesirable side effects and environmental pollution. Botanical products like *M. azedarach* oil extract can be easily and cheaply collected in rural areas. Different botanical extracts have significant effect on aphid numbers (Habibullah *et al.*, 2007).

Increasing concern about the risks from synthetic insecticides to the environment and human health has led to a major trend in current pest management, which involves searching for less hazardous chemicals or biologically based products. Many plants have allelochemicals that shown anti-feeding or oviposition deterrent, repellent and growth regulating activity. Plant natural products that constitute effective and safer alternatives to synthetic insecticides without adverse effects on the whole ecosystem have been tested in the management of stored-product pests (Isman, 2006).

Plant extracts are commonly promoted for use in home gardens, there is growing interest in their potential for farmers in developing countries. In Ghana, for example, chili (*Capsicum frutescence* (Solanaceae)) extract concentrations of 15, 20 and 30g/L of water gave a significant reduction in *B. brassicae* numbers compared to λ -cyhalothrin. Other work, in Uganda, demonstrated that crude aqueous extracts of tobacco, *Nicotiana tabacum* (Solanaceae) and *Tephrosia spp.* (Fabaceae) were as efficacious as the synthetic insecticides, Cypermethrin and Fenitrothion in reducing emergence of bruchid beetle, *Callosobruchus spp.*(Kawuki *et al.* ,2005)

Similarly, in Nigeria, extracts of *A. sativum* (Asparagales: Amaryllidaceae) chili pepper, ginger (*Zingiber officinale*) (Zingiberales: Zingiberaceae)), (*A. indica*) (Sapindales: Meliaceae) tobacco and sweetsop (*Annona squamosal*) (Magnoliales: Annonaceae) have been successfully used to control pests of cowpea. In Ghana, crude leaf and seed extracts of *M. azedarach* tree have been used extensively in managing pests of crops such as cabbage, lettuce and cowpea (Obeng and Ankrah, 2002).A given the need for alternatives to conventional insecticides and the potential utility of extracts from locally-growing plants. A field cage experiment was conducted to screen crude water plus detergent extracts of nine such plants against *P. xylostella* and *B. brassicae*. (Devanand and Rani, 2008).

Indiscriminate and injudicious use of insecticides has led to a number of adverse effects in the environment. The uses of biological materials especially, plant materials are highly favored, since the materials can easily be applied without any technical knowledge. The effectiveness of botanical insecticides has been demonstrated in many studies (Aslan *et al.*, 2005).

Plant materials with insecticidal properties are one of the most important locally available, biodegradable and inexpensive methods for the biological control of pests. Provide small-scale farmers with locally available, biodegradable and inexpensive method for the control of pests of stored products. Considering the importance of plant insecticides, the farmers of in Ethiopia treat their stored products with local herbs to reduce storage losses due to pests (Yemane Kidane and Yilma Habte, 1998).

An aphid control depends mainly on the use of insecticides. Due to the repeating applications, many aphid species, especially the peach potato aphid, have developed resistance to several chemical aphicides. Therefore, an alternative method of aphid control is needed. One of the possible approaches is the use of plant extracts which would repel aphids or deter their feeding, and in consequence, reduce their number on plants. Plant extracts obtained from *A. sativum* wormwood (*Artemisia absinthium* L.) and tansy (*Tanaceum vulgare* L.) has a broad spectrum of biological activity. Their anti-inflammatory, antibacterial and antifungal activities are well known extracts from these plants possess also anti-insect properties. Methanolic extracts of *A. sativum* have been reported to be larvicidal against larvae of several species of mosquitoes, cluster caterpillar, *Spodoptera litura* (Fabricius), and the lymantriid (*Euproctis spp.*). Water extracts of tansy have anti-feedant and insecticidal effect on larvae and adults of some species of Lepidoptera and Coleoptera. Also wormwood is famous for its anti-feedant properties. In addition, *A. sativum* and wormwood extracts have been reported to exhibit insecticidal activity against aphids, *M. persicae* and *B.brassicae* (Bizzaro *et al.*, 2005).

Botanical insecticides have been used in agriculture for at least two thousand years in Asia and the Middle East. The interest for new botanical compounds for pest control is based on their bio-efficiency, bio-degradability and physiological activity. Plant extracts obtained from *A. sativum* L. have broad spectrum of biological activity. Methanolic extracts of *A. sativum* have effect on larvae of several species of mosquitoes, cluster caterpillar (Katarzyna and Beata, 2008).

Generally, the use of botanical insecticides is more sustainable and has a lower environmental impact than synthetic insecticides. However, current commercially extracted botanical insecticides such as pyrethrum and azadirachtin tend to be relatively expensive and difficult to smallholders to obtain locally available. Botanical insecticides must be based on plant materials that are cheap and readily available and be simply prepared rather than requiring organic solvents. Though simple plant extracts are commonly promoted for use in home gardens (Zehnder, 2007).

Botanical insecticides are increasingly attracting research attention as they offer novel modes of action that may provide effective control of pests that have already developed resistance to conventional insecticides. They potentially offer cost effective pest control to small holder farmers in developing countries in highly active extracts can be prepared simply from readily available plants (Weinberger, 2009). According to Clark and Yamaguchi (2002), cabbage aphids are developed quicker and stronger resistance to increased application of insecticide than any other insects. In addition, aphid population levels are not significantly reduced by insecticide treatment due to the toxicity to natural enemies as well as the slow generation times and genetic variability of the aphid. To overcome this problem botanical pesticides are one of the safer alternative sources to suppress some threatening pests. Botanicals are practiced since time immemorial recent time scientific communities showing great interest to identify potential bioactive plants for pest control program due to environmental pollution and health hazard (Xu *et al.*, 2009).

Most of the plants thrive in rough environmental conditions, so they have developed a multitude of defense mechanisms against natural enemies in the course of evolution. Among these are morphological and subtle chemical defense mechanisms against insects and other pests that do not generally cause immediate death but interfere with their vital biochemical and physiological functions. Synthetic insecticides such as organophosphates are important and effective tools in modern crop management. However, these pose serious threats to the environment and to

peoples. Humans come in contact with dangerous pesticides on food, in water and in the air near farms. Almost ninety eight percent of sprayed pesticides do not reach to their target pests. They penetrate to groundwater, pollute streams and harm wildlife, including natural predators of the targeted pests. In short, global ecology is facing severe threat from the use of pesticides so the search for ecologically safe methods to control insect pests of crops and stored food products is an awe inspiring field of research (Sarwar and Sattar, 2012)

The importance of *Melia azedarach* extract

The tree *M. azedarach* (Family: Meliaceae) is known locally as bakain or drek (Hindi), Persian lilac or China tree (English), and Fleurs lilas (French). In South America is commonly known as “paraiso” or paradise, and in the US as Indian lilac or white cedar. The whole plant or its specific parts (leaves, stem, and roots) are known to have medicinal properties and have a long history of use by indigenous and tribal people in India. *M. azedarach* is used as an ayurvedic medicine in India and Unani medicine in Arab countries as an antioxidative, analgesic, anti-Inflammatory, insecticidal, rodenticidal, antidiarrhoeal, deobstruent, diuretic, and antidiabetic. An effort to give a detailed survey of the literature on its botanical details, phytochemical reports, pharmacological studies and its therapeutic importance. *M. azedarach* is a small to medium deciduous tree attaining a height up to 45 m tall (Deepika and Yash, 2013).

Persian lilac or Chinaberry tree, *M. azedarach* L. (Meliaceae) presents a chemical extract promising approach for integrated pest management. The insecticidal properties of *M. azedarach* extracts could be equivalent to that of *M. azedarach* extract based on the source material and the type of pest in question. This plant extract inhibits 99.41% on the development of sugarcane woolly aphid, *Ceratovacuna lanigera* (Wabale and Kharde, 2010). It is more toxic to cabbage armyworm, *Pseudaletia impuncta* and sweet potato whitefly, *Bemisia tabaci* (Aktar *et al.*, 2009). It protects 88.3% feeding by cabbage white fly, *Pieris brassicae* and induces 100% mortality on *Ocneridia volxemi* which is feeding on cereal and other crops. And also 76.9 % causes mortality on *B. brassicae* and 90% mortality in *Drosophila melanogaster* (Zaki *et al.*, 2008).

Application of farmyard manure and nitrogenous fertilizers are commonly used agricultural practices to improve the soil fertility and plant growth respectively. The organic matter availability in the soil enhances the level and diversity of soil micro- and macro-biota which indirectly support plant health by various processes. However, larger infestation of flea beetles and some cases cabbage aphids was noticed in nitrogenous fertilizer applied broccoili, *B. oleraceae*. Therefore, farmers failed to achieve below their expected yield in fertilized field and again advocates of organic agriculture often assert that plants supplied exclusively with nutrient from biological materials are more resistant to insects than those grown using chemical fertilizers (Mochiah *et al.*, 2011).

The various parts of *A. indica* tree have been used in various agricultural fields for their effective insecticidal properties. Kernel extract of *A. indica* was reported to show inhibited stages of development when sprayed. The derivatives of *A. indicca* are often used to protect harvested grains kept in bags and stores in India. The use of *A. indica* can confer significant economic advantage and exploit to rural areas in tropical developing countries (Coptrell, 2002).

Plant insecticides may be suitable for use in integrated pest management programs. The current interest in pesticides derived from the *M. azedarach* tree due to selectivity to phytophagous insects. Laboratory trials may help determine the long term or sub lethal effects of *M. azedarach* on natural enemies of aphids, also under field conditions. The effect of *M. azedarach* on non-target organisms is particularly important consideration for management of aphid population. Effectiveness of different doses of *M. azedarach* extracts and a synthetic organic insecticide against mustard aphid, *Brassica spp*, was studied. The *M. azedarach* seed extracts in different doses, the high aphid population reduction over pretreatment (81%) from 50g *M. azedarach* seed / L of water treated plots and 80% from 75 g *M. azedarach* seed /L treated plots having reduction (Biswas , 2013).

The analyze effects of *M. azedarach* extracts considering insects with various feeding strategies, including agricultural and sanitary pests. It has anti-feedant, repellent and Oviposition deterrent effects. A variety of preparations from crude extracts of different parts of *M. azedarach* plants have been applied to assess anti-feedant activity. Leaf and fruit extracts of *M. azedarach* showed anti-feedant activity on insects of various Orders, including Saltatoria, Heteroptera, Homoptera, Coleoptera, Lepidoptera and Diptera (Ascher *et al.*, 1995).

The insecticide activity of *M. azedarach* is due to biologically active triterpenoids with an anti-alimentary effect, i.e., it inhibits the feeding of phytophagous insects producing death and malformations of subsequent generations. The bioactivity of azadirachtin (a tetranortriterpenoid) from *A. indica* has allowed research on natural insecticides in most similar types, including melia. The main reason for the scarce development of *M. azedarach* as a commercial insecticide in comparison to *A. indica* lies in that the fruits of the former contain meliatoxin, a triterpenoid that is toxic for mammals. The chemical composition of *M. azedarach* varies notably between its wild and cultivated state. The fruits developed in Argentina have triterpenoids instead of melia toxin, mainly meliartenin which is a strong insect anti-alimentary that could be useful for pest and disease management. *M. azedarach* is a moderate sized deciduous tree. It grows to a height of 9-12 meters. The bark is dark-grey having shallow longitudinal furrows. Leaves are bipinnate or occasionally tripinnate with ovate or lanceolate, serrate leaflets. It can tolerate a colder climate than *A. indica* (Carpinella *et al.*, 2003;2005).

The farmers are looking for effective, economically viable, safe and ecologically friendly alternatives to chemical pesticides. These alternatives in the form of plants are available in every village. But the most effective plant parts, its methods of preparation, accurate doses (concentration) and interval of spraying for effective pest management still need to be identified through farm level research. Development of effective organic insect pests' management method and adoption of this technology in farmers' fields will improve the economic condition and social value of farmers (Lohar and Budhathoki, 1992).

The *A. indica* A. Juss and the Chinese (*M. azedarach* L.) (Meliaceae) are native trees of Asia and southern Australia with important insecticidal properties. Both species have been used mainly as ornamental trees and have been naturalized in tropical and subtropical countries. Leaf and fruit extracts have been evaluated on diverse pests with promising results (Vergara *et al.*, 1997 and Carpinella *et al.*, 2003).

The importance of *Allium sativum* extract

A. sativum which is commonly known as garlic belongs to the onion family, Alliaceae and is closely related to the onion, shallot, leek, chive, and rakkyo. It has been used throughout the world for both culinary and medicinal purposes. It has a pungent and spicy flavor, which is mainly related to sulfur containing compounds such as allicin, alliin, ajoene, diallyl disulfide, dithiin and s-allylcysteine. Allicin and other degradation products from alliin also give *A. sativum* a characteristic flavor (Block, 1992).

A. sativum essential oil is extracted by a process of steam distillation of the *A. sativum* cloves using solvents such as n-hexane or petroleum ether. *A. sativum* oil contains a variety of sulfide such as diallyl disulfide and dilly tri-sulfide. Due to the pungency odor of *A. sativum* essential oil, the commercial *A. sativum* oil capsules generally contain vegetable oil and a small amount of *A. sativum* oil. Other *A. sativum* supplements are dehydrated *A. sativum* powder; *A. sativum* oil macerate and aged *A. sativum* extract (Amagase, 2001). *A. sativum* has been cultivated since ancient times all over the world especially in Asia. It compared commercial botanical sprays to determine if any were consistently effective enough to meet pesticide registration requirements. Results suggested that batch inconsistency, leading to variation in effectiveness, could prevent *A. sativum* pesticides from becoming mainstream (Ahmad *et al.*, 1996).

The aphid settling deterrent activity of extracts obtained from *A. sativum* L. against aphid. Aphid control depends mainly on the use of insecticides. Due to repeating applications, many aphid species have developed resistance to several chemical aphidcides. Therefore, an alternative method of aphid control is needed. One of possible approaches is the use of plant extracts which can repel aphids or deter their feeding, and in consequence, reduce their number on plants. *A. sativum* bulbs prepared at 5 and 10% dilutions was tested for their effect on aphids under laboratory condition. Both levels of *A. sativum* and 5% *M. azedarach* have induced mortality similar to endosulfan 35% within 24 hours of treatment application. Though not significantly different, endosulfan 35% had caused 100% mortality and *A. sativum* 5% (93.3%). Botanicals extracts as applied different dilution were found to be effective in causing significantly different rate of mortality to treated aphids population (Abebe Megersa, 2016).

3. MATERIALS AND METHODS

3.1. Description of the study area

The study was conducted in Mekelle agriculture research center, at Illala Mekelle town. Mekelle is the capital city and commercial center of the Tigray National Regional State in the northern Ethiopia (Figure 1). Illala is geographically located in the south east of Tigray along Mekelle – Adigrat main road. According to Gebremedhin Berhane (2010), the town situated in the extension of the central high lands of Ethiopia, Mekelle found 852 kilometer away from Addis Ababa, capital city of Ethiopia. The town is located at 39° 33'E longitude and 13° 32'N latitude, situated in the extension of the central highlands of Ethiopia. The altitude of Mekele is between 1965m and 2220m above sea level. The town is bounded by mountain ranges in the east and north.

Climatically, the area is classified as "Woina-Dega" (temperate) with an effective temperature between 14⁰C and 20⁰C, which for most of the time is comfortable. It has a moisture index ranging in between 0.25 and 0.5, which indicates moderately dry area. Mekelle lies between 600mm to 700mm rainfall region. The mean annual temperature ranges between 16⁰C and 20⁰C. The altitude varies from 2220 m at eastern side to 1965 m in the northwestern side of the town (lower reach of Illala River). The town has an overall tilt from eastern to western and northwestern side. Most streams and tributaries are controlled by this tilt while others are controlled by geological structures and underlying geology (Gebremedhin Berhane, 2002).

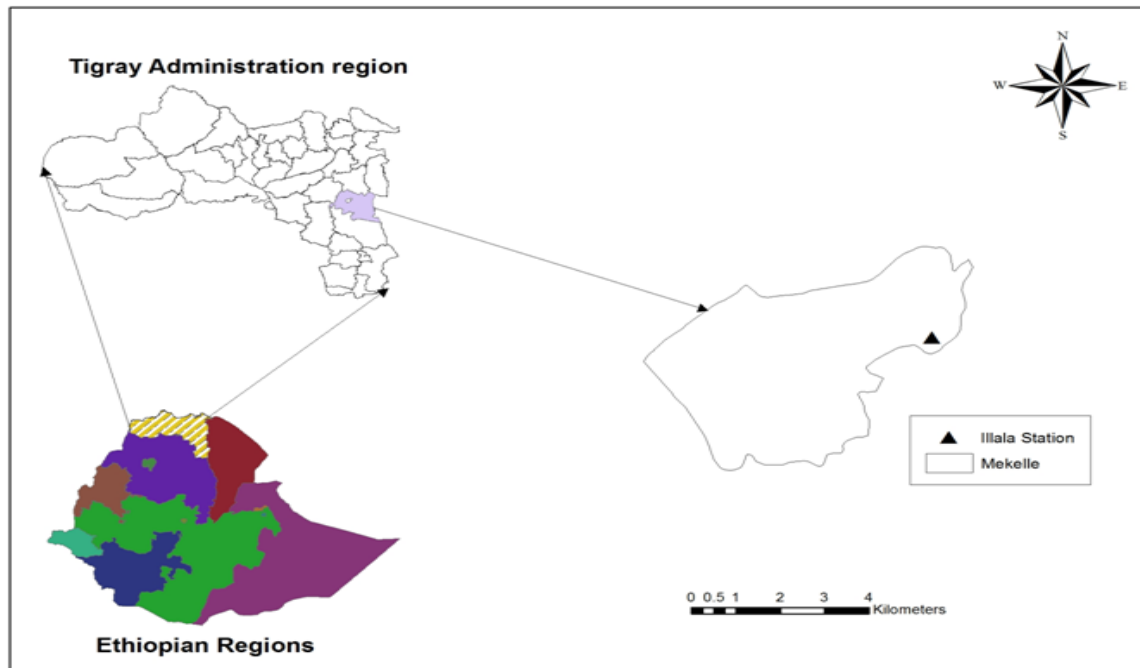


Figure 2: Map of the study area.

3.2. Materials requirement

3.2.1. Infestation of cabbage leaves with cabbage aphid

Cabbage aphid was colonized on cabbage leaves presented in (Plate 2).Cabbage Aphids feed by sucking sap from their cabbage leaves. When continued feeding by cabbage aphids causes yellowing, wilting and stunting growth of cabbage leaves. It causes severely infested cabbage leaves become covered with a mass of small sticky aphids (due to honey-dew secretions), which can eventually lead to leaf death and decay. Cabbage Aphids have different stages of growth that causes potential damaging on the leaves of cabbage its productivity. The researcher was observed critically on the field by comparing physical appearance of the infected cabbage one with none infected ones using morphological characteristics of cabbage. Cabbage aphids feed on the underside of the leaves and on the center other cabbage head and preferably feed on young leaves.



Figure 3: The infested cabbage leaves with cabbage aphid on the field.

3.2.2. Plant materials collection and extraction

The plants were collected from Mekelle town and surrounding and they were identified by agriculturists in the agriculture research center. After that which are deposited in laboratory. The mature parts of plants are important to increase the effects against targeted pest. The collected botanicals were seen on (**Table1**).

Table : The collected botanicals for extraction with family name scientific name, Common name and their local name.

Number	Family name	Scientific name	Common name	Local name	Part use
1.	Meliaceae	<i>M.azadarach</i>	Neem (Persian lilac or Chinaberry tree)	Niyeme	Mature fruit extract
2.	Alliaceae	<i>A. sativum</i>	Garlic	Tsada shinkurt	Bulbs extract



A) Mature Fruit of *M. azedarach*



B) Mature seed of *A. sativum*

Figure 4: The images of collected botanical for extraction as bio- pesticides.

After collection of fruit of *M. azedarach* and bulbs of *A. sativum* were washed thoroughly by clean water to avoid dust particles and microorganisms that are inhibit on them and were dried in well- ventilated areas under shade for fifteen days under laboratory until completely dry. The dried forms of botanicals were grinded by mortal and micro plant grinding machine to obtain uniform fine powder and sieved for solvent extraction. An electronic weighing balance was used to weigh out 5g, 10g of powdered extracted from *M. azedarach* fruit, *A. sativum* seed and also their combination of both to test against cabbage aphid. Biswas (2013), *M. azedarach* seed extract prepared at doses 50g/L and 75g/L shows high mortality of aphid. Sohail *et al.* (2012), evaluate the efficacy of *M. azedarach*, *A. sativum* and tobacco extracts each at 2% were tested against aphid, *Toxoptera aurantii* on tea (*Camellia sinensis* L.). 50 gram dried *A. sativum* is grinded in grinding machine and kept in water for 24 hours, by using muslin cloth the solution was filtered and sprayed at the rate of 50 ml of solution in 2.5 L of water.

The two aqueous extracts fruit of *M. azedarach* and seed of *A. sativum* were obtained as filtrate of mixture by fine sieve filter and final volume were adjusted to 100 ml; this gave 5g and 10g aqueous extracts. The extracts were considered as stock solution. And also, Dimethoate 40% EC also were diluted in water to make 0.25% based on the recommended field application rate and distilled water alone were served as positive and negative controls, respectively. Those solutions were prepared to treat by hand spray. The efficacy of all the above treatments was tested on cabbage aphid in laboratory and in the field.

3.3. Treatments application and experimental designs

3.3.1. Treatments test in laboratory

The experiment was carried out at the agricultural research farm of Mekelle research center at Illala. Aphids were collected (complete randomized design) together with the infestation cabbage leaves by cut and brought in to laboratory from the farmer's field near Mekelle agriculture research center. About 12 plastic cups were prepared and used to rear the cabbage for both concentration levels of plant extracts. Each of the plastic cups was used to keep for one infested cabbage leaf and the number of aphid ranges from 30-40 in each cups. The aphids maintained carefully, they were allowed to feed on the fresh cabbage leaves. The cabbage aphids were also counted at the end of the experiment.

The observations and data were recorded at morning hours (8-10 am) the population of the insect. Experiment was laid out in a randomized complete block design having 03replications. The population of aphid before spraying the botanical pesticides on tea cutting was recorded, while the post treatment observations on population of aphid were also observed by the same procedure after 24 hours, 72 hours (Sohail *et al.*, 2012). The observations and data were recorded at morning hours (1-2hour local time). Spray preferably in early morning to prevent possible sun damage to the stock solutions. The treatments are as under: T₁ (first time of treatment after 24 hours), T₂ (for second time of treatment after 48 hours), and T₃ (for third time treatment after 72 hours).



Figure 5: An aqueous extraction prepared from plants as type of treatments test in laboratory.

3.3.2. Selection of infested cabbage in the field for test treatments

Similar to laboratory, the experiment was carried out at the agricultural research farm of Mekelle research center at Illala, in small hold farm area. The field was covered with infested cabbage by cabbage aphid and it were selected Randomized Block Design (RBD). An experimental field was conducted to test all treatments on cabbage aphid. The cabbage was line sown in the plotted area in the field. About six infested cabbage were selected for each of those treatments and for the two dose levels of plant extracts from the field. The treatments were tested on cabbage aphid and compared % of mortality with 24hrs interval for three replication. The observations and data were recorded at morning hours (1-2hour local time). The treatments are as under: T1 (first time treatment after 24 hours), T2 (for second time treatment after 48 hours), T3 (for third time treatment after 72 hours)



Figure 6: Line sowed the infested cabbage on the field for treatments spray on their leaves.

3.4. Methods of Data collection for cabbage aphid

Mainly the data were collected through laboratory and from field experiment by counting and observing quantitative measurements mortality of aphids. The number of dead of cabbage aphid in each concentration levels were counted and recorded accurately after 24, 48 and 72 hours of exposure in laboratory experiment and also exposure on the field experimental condition respectively. The time of spraying and counting was performed usually at the morning (1-2hours local time).

4. RESULTS

4.1. Efficacy of *Melia azedarach* and *Allium sativum* extracts with 24 hours interval of spray in laboratory

Aqueous extracts of *M. azedarach*, *A. sativum* and combination of both was tested in two concentrations level (5%, 10%) against cabbage aphid (Table 2). Accordingly, the highest after 72 hours the mortality rate of cabbage aphid at 10% of *M. azedarach*+ *A. sativum* (96.6%) and relative lowest was recorded at 5% of *A. sativum* (90%). The insect population showed that was a significance ($P=0.01$, $p < 0.05$) in mortality of aphid in case of different botanical pesticides after 72 hours of treatment.

The result present in (figure 9) indicates that the average mortality rate of cabbage aphid in both concentrations. The highest at 5% (94.7) and at 10% (96.6%) of *M. azedarach* mixed with *A. sativum*. Generally, the high mortality of aphid appeared next of Dimethoate 40% EC (99%) is *M. azedarach* mixed with *A. sativum* at 10 % (96.6%). Analysis of Variance (ANOVA) for the mean mortality of aphid on cabbage leaves treated with the all types of treatments at both doses plant extracts used in the experiment and the control revealed that there was significant difference ($P=0.01$, $p < 0.05$). The mortality of all botanical extracts significant higher than the negative control, but extracts had significant lower mortality rate than the positive control. There was significant difference between the mortality of caused by botanical extracts application when compared with the controller (untreated) and negative control (water). The result indicates that there was no significant difference in the mean mortality recorded between the various plant extracts with each other and positive control ($P > 0.05$) on (appendices) of multiple comparison.

Table : % Mortality rate of aphid in fruit of *M. azedarach* and *A. sativum* at two dosage levels (5%, 10%) with in laboratory with in 24 hours interval.

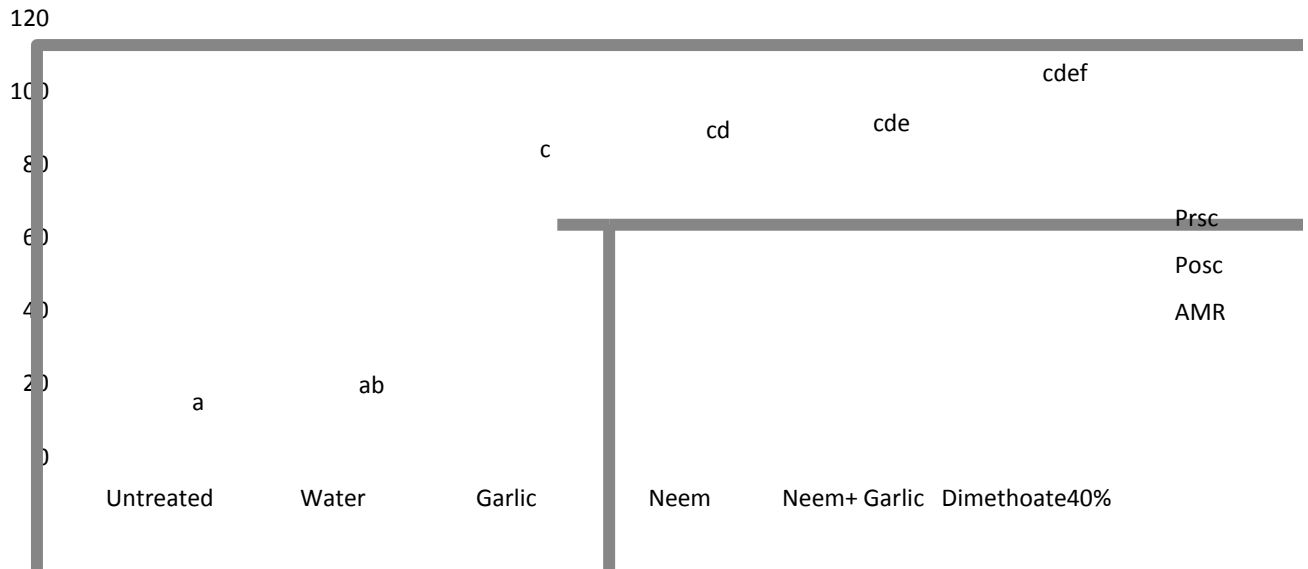
No.	Treatments	Dose in %	Pre spray count	%Mean \pm SD mortality rate		
				24 hours	48 hours	72 hours
1	<i>M. azedarach</i>	5	30	66.6 \pm 13cd	86.6 \pm 12.5cd	93.3 \pm 10.2cd
		10	36	69.4 \pm 12.8cd	86.1 \pm 8cd	94.11 \pm 11cd
2	<i>A. sativum</i>	5	32	59.4 \pm 9.07c	81 \pm 9c	90 \pm 3.4c
		10	40	87.5 \pm 15.7c	87.5 \pm 8c	92.5 \pm 73c
3	<i>M. azedarach</i> + <i>A. sativum</i>	5	38	68.4 \pm 8.cde	89.5 \pm 11cde	94.7 \pm 9cde
		10	33	69.7 \pm 3.7cde	90.9 \pm 5cde	96.9 \pm 4cde
4	Dimethoate40%		31	93.5 \pm 16cdef	100 \pm 14cdef	100 \pm 11cdef
			36	97.2 \pm 12cdef	100 \pm 9cdef	100 \pm 13cdef
5	Water		36	0 \pm 8.6ab	8.3 \pm 14ab	29 \pm 7ab
			30	0 \pm 8ab	6.6 \pm 6ab	16.6 \pm 5ab
6	Untreated		34	0 \pm 9a	5.9 \pm 4a	17.6 \pm 3a
			32	0 \pm 5a	9.4 \pm 2a	18.7 \pm 11a
F- calculated value =29.409, and F-critical value =3.89, sig=0.001 at 5%						
F- calculated value = 36.735 and F-critical value =3.89, sig 0.001at 10%						

The application and spraying with caused highest mortality in botanical extract and Dimethoate 40% EC have significant difference with water and untreated ($p < 0.05$). The efficacy of aqueous botanical extracts near to synthetic insecticides, i.e. no more significant difference in the mortality of aphid recorded between the plant extract and Dimethoate 40% EC ($P > 0.05$). The highest % MR after 72 hours was at Dimethoate 40%EC (100) and next with *M. azedarach* +*A. sativum* at 5% (94.7) and at 10% (96.9). *M. azedarach* at 5% (93.3,) and and 10% (94). The results were also expressed by figures. At 5g treatments (Figure 7), at 10g treatments (Figure 8) and both dose level (Figure 9).

4.1.1. Mortality after 72 hours treatments application at 5% dosage

The average mortality rate after 72 hours were recorded more efficacies the botanical water extract against cabbage aphid. The treated groups were highest %MR than negative controller and untreated one. The results present on (Table 2) that were rearranged as at 5%, 10% (in treatments, %MR at 72 hours . At 5% in *M. azedarach*, (93.3), in *A. sativum* (90), in *M. azedarach*+*A. sativum* ,(94.7), in Dimethoate 40% EC, (100), in water, (29,12.4), and in untreated, (17.6,7.8).

The analysis of variance (ANOVA), were used to compared the mean mortality rate number of aphids present in (Table 4) after 72 hours spray between treatments at 5% in laboratory. There was significant difference among treatments in the mean % mortality rate of aphids after three days spray ($F = 29.409$, $p < 0.05$ and F -calculated value greater than F -critical value).



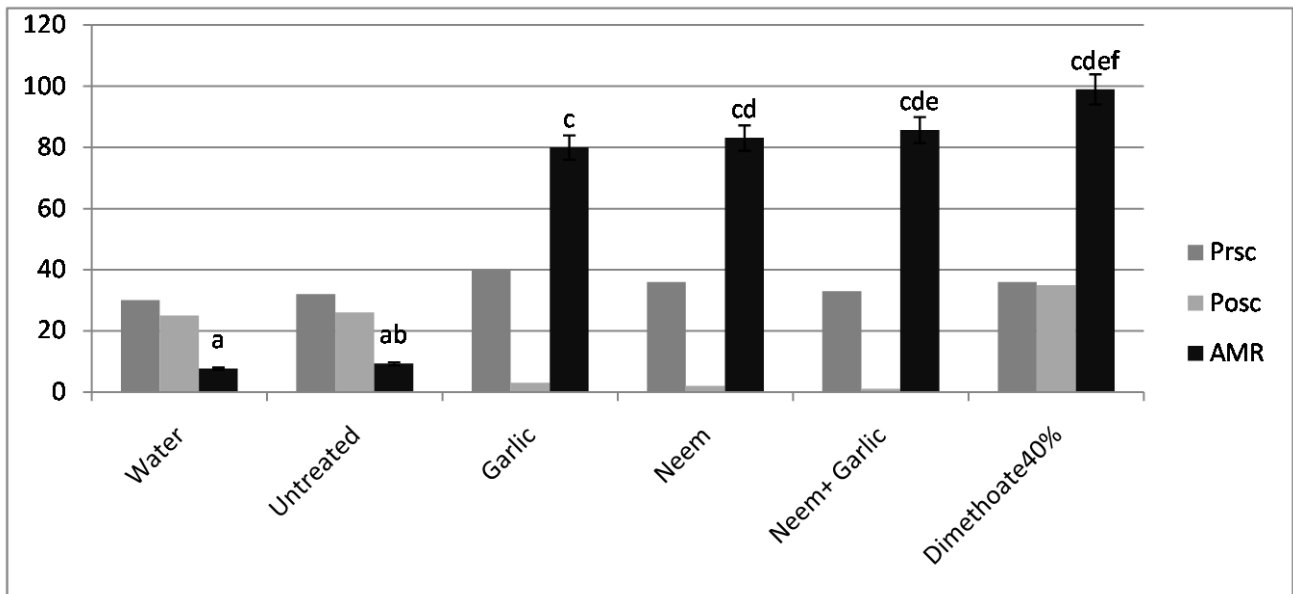
Where, prsc = pre spray count, Posc = post spray count , AMR= Percentage Average Mortality Rate.

Figure 7: Efficacy of various botanical pesticides the average mortality rate at 5% after 72 hours in laboratory.

The mortality rate of aphids at 5% present after the third spray between treatments. Letters above bars refer LSD highly significant difference test results among treatments. When treatments that share a letters in common are not have significantly difference from one another ($p > 0.05$), but when treatments that not share a letters in common, they have significantly different from one another ($p < 0.05$).

4.1.2. Mortality after 72 hours treatments application at 10% dosage

The effects of solutions at two dose level there were calculated their %MR with 24hours interval which are found as follows: The average mortality rate after 72 hours were recorded more efficacies the botanical water extracts against cabbage aphid. The treated groups were highest %MR than negative controller and untreated one. The results were rearranged as at 10% (in treatments, %MR after 72 hours was in *M. azedarach*, 94, in *A. sativum* ,92.5 in *M. azedarach*+*A. sativum* ,96.9, in Dimethoate40%EC, 100, in water,16.6 and in untreated,18.7.

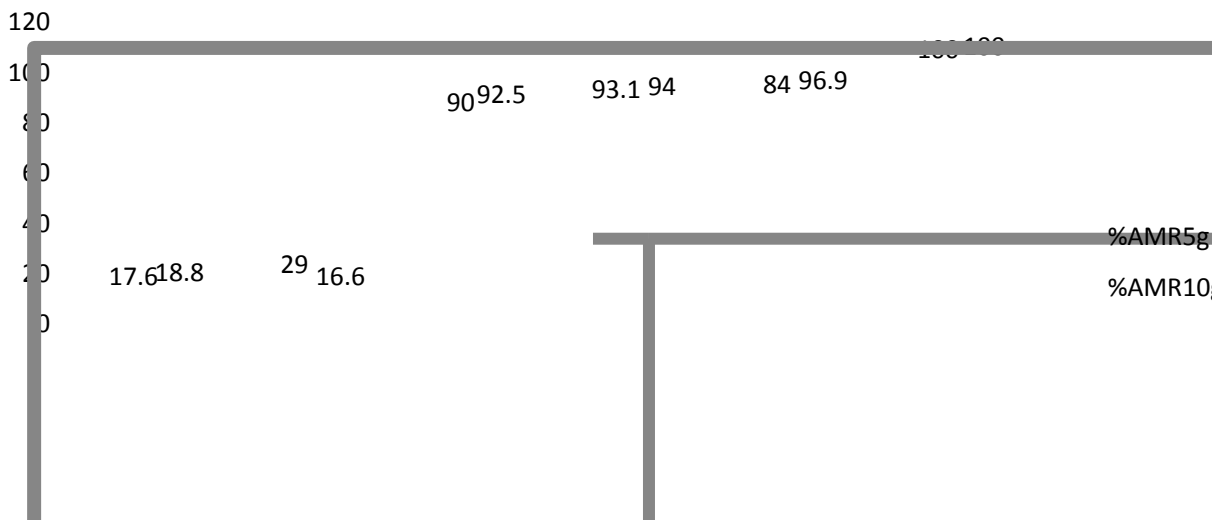


prsc = pre spray count, Posc = post spray count , AMR= Percentage Average Mortality Rate

Figure 8: At 10% botanicals extract treatments on average mortality rate of aphid after 72 hours in laboratory.

The Mortality Rate of aphids at 10% present after the third spray between treatments. Letters above bars refer LSD highly significant difference test results among treatments. When treatments that share a letters in common are not have significantly difference from one another ($p>0.05$), but when treatments that not share a letters in common, they have significantly different from one another ($p<0.05$)

The mean mortality rate number of aphids present in (Table 2) after 72 hours spray between treatments at 10% in laboratory. There was significant difference among treatments in the mean % mortality rate of aphids after three days spray ($F = 36.735$, $p < 0.05$ and F -calculated value greater than F -critical value (tabulated value). Letters above Table 4 refer LSD highly significant difference test results among treatments. When treatments that share a letters in common are not have significantly difference from one another ($p > 0.05$), but if treatments that not share a letters in common, they have significantly different from one another ($p < 0.05$).



Where, %AMR= Percentage Average Mortality Rate

Figure 9: At 5% and 10% botanicals extract treatments on average mortality rate of aphid after 72 hours in laboratory

4.2. Efficacy of *Melia azedarach* and *Allium sativum* extracts with 24 hours interval in field experiment

Aqueous botanical extracts of *M. azedarach*, *A. sativum* and combination of both was tested in two concentrations level (5%, 10%) against cabbage aphid on the field, it is shown in Table 3. The result that the mortality of cabbage aphid recorded in field experiment was it has resemblance with the result of laboratory experiments. The application and spraying with caused highest mortality in botanical extracts and Dimethoate 40% EC, significant difference with water and untreated ($p = 0.001$, $p < 0.05$). However, the mortality of cabbage aphid was not significant difference between the botanical extract with each other and Dimethoate 40% EC. The results shown in (Table 3) accordingly the mortality of aphid with *M. azedarach* at 5% in 24 hrs, 48 hrs and 72 hrs was (60.2, 85.5 and 91.8) at 10% (62.7, 86.6 and 94) respectively. The results shown in (Table 3) accordingly the mortality of aphid with *A. sativum* at 5% in 24 hrs, 48 hrs and 72 hrs was (57.8, 83 and 90) at 10% (58, 82 and 89.5) respectively.

The average mortality rate after 72 hours were recorded more efficacies the botanical water extract against cabbage aphid highest with *M. azedarach* + *A. sativum* at 5% (92.5%) and at 10% (91.2%). *M. azedarach* at 5% (90%) and 10% (89.5%). The observation on infestation of aphid after 72 hours was also recorded and results are presented in Table 3. The insect population showed that there was a significance ($p = 0.001$, $P < 0.05$) in mortality of aphid in case of different botanical pesticides after 72 hours of treatment.

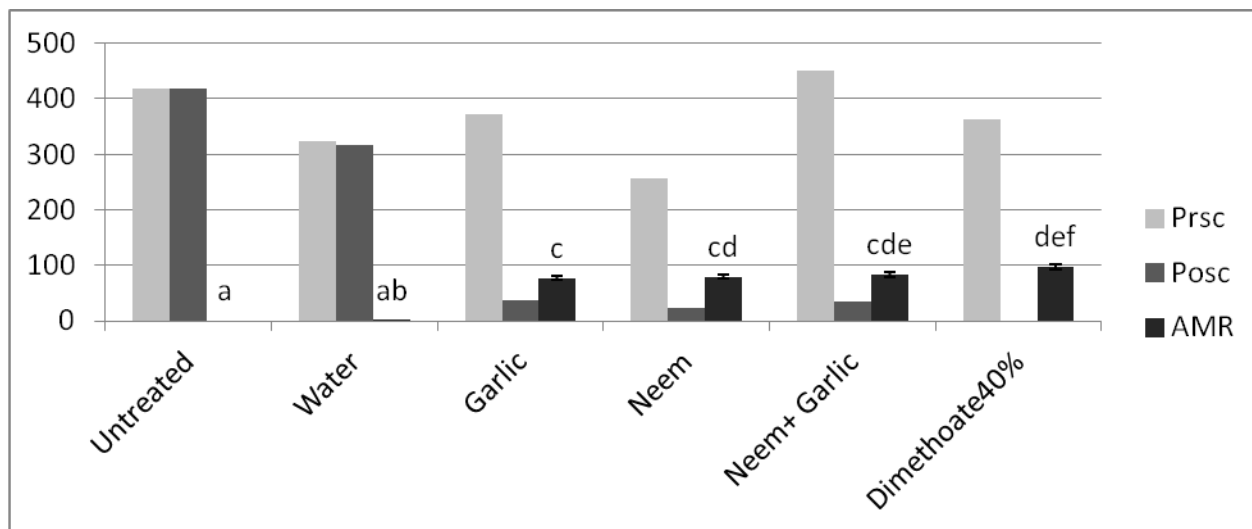
Particularly the highest mortality rate were appeared next of Dimethoate 40% EC (99%) is *M. azedarach* + *A. sativum* at 5% (92.2%). Analysis of Variance (ANOVA) for the mean mortality of aphid on cabbage leaves treated with the all types of treatments at both doses plant extract used in the experiment and the control revealed that there was significant difference ($P = 0.001 < 0.05$). There was significant difference between the mortality of caused by botanical extract application when compared with the untreated and negative control (water). Analysis of Variance (ANOVA) result indicates that there was no significant difference in the mortality recorded between the various plant extract ($P > 0.05$) in multiple comparison.

Table 3: % Mortality rate of aphid in fruit of *M. azedarach* and *A. sativum* at two dosage levels (5%, 10%) in the field with 24 hours interval.

No.	Treatments	Dose in %	Pre spray count	%Mean \pm SD mortality rate		
				24 hours	48 hours	72 hours
1	<i>M. azedarach</i>	5	256	60.2 \pm 9.7cd	86 \pm 11.2cd	91.8 \pm 8.5cd
		10	306	62.7 \pm 12cd	86.6 \pm 6cd	94.7 \pm 4.9cd
2	<i>A. sativum</i>	5	372	57.8 \pm 9.7c	83 \pm 4.1ce	90 \pm 4.9ce
		10	402	58 \pm 6.7c	82 \pm 5.8ce	89.5 \pm 7.8ce
3	<i>M. azedarach</i> + <i>A. sativum</i>	5	450	70 \pm 6.66cde	86.6 \pm 6.7cde	92.2 \pm 9.7cde
		10	285	70.9 \pm 9.1cde	87.7 \pm 8.7cde	91.2 \pm 6.8cde
4	Dimethoate40%		364	92.8 \pm 1.2def	100 \pm 1.1def	100 \pm 0.4def
			259	93.8 \pm 3.1def	100 \pm 2.8def	100 \pm 0.7def
5	Water		324	0 \pm 0.6ab	1.5 \pm 0.9ab	2.1 \pm 1.0ab
			432	0 \pm 1.0ab	1.6 \pm 0.55ab	1.6 \pm 1.6ab
6	Untreated		419	0 \pm 0.00a	0 \pm 0.00a	0 \pm 0.00a
			263	0 \pm 0.09a	0 \pm a	0 \pm 0.01a
F-calculated value =47.8, F-critical value =3.89 at 5 % , p=0.001						
F-calculated value = 51.5, F-critical value =3.89 at 5% , p=0.001						

The Highest mortality, was recorded in aphids which is significantly different in both levels (5%, 10%), among treatments except water and the untreated one. It was recorded in aphids treated with both levels of *M. azedarach* %MR at T₃ (91.8), *A. sativum* (90), *M. azedarach*+*A. sativum* (92.2), Dimethoate 40%EC (100), water(2.1), untreated (0) for 5% and 10% respectively) within third days of treatment application (Table 3). It was after 72 hours of treatment application that the highest mortality was recorded for Dimethoate 40%EC at 5%, 10 % (100%) and *M. azedarach* 10% (94%) and least water and also untreated one.

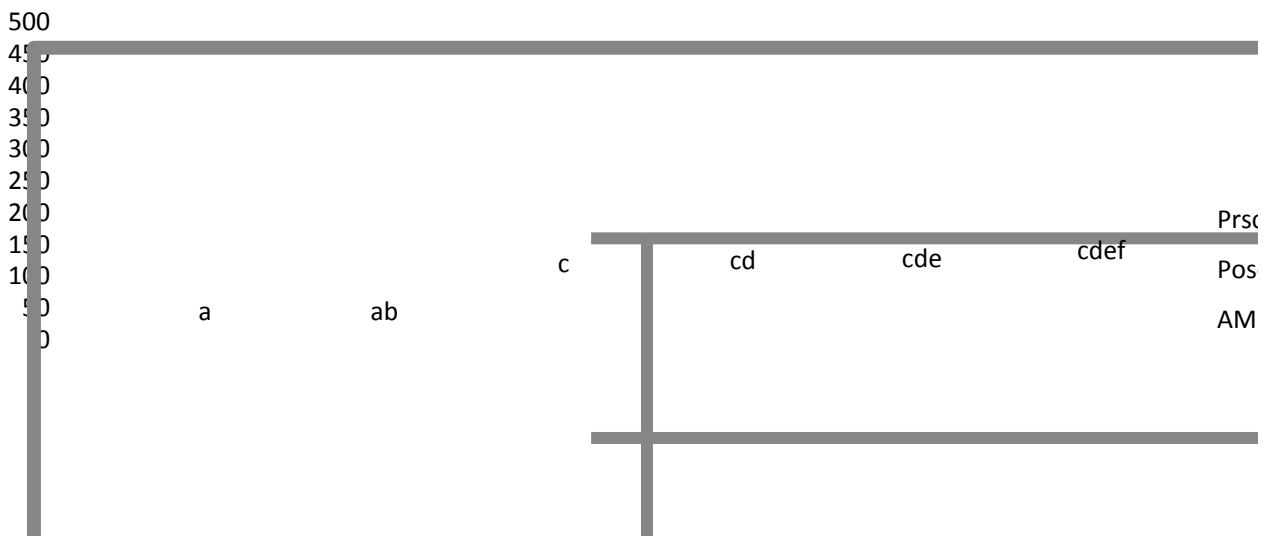
The results of the effects of the plant water extracts on the mortality of cabbage aphid within three days are shown in Table 3. Letters above Table 3 refer LSD highly significant difference test results among treatments in the field. When treatments that share a letters in common are not have significantly difference from one another ($p > 0.05$), but if treatments that not share a letters in common, they have significantly different from one another ($p < 0.05$). The mean % mortality rate number of aphids present after the 72 hours spray between treatments at 5% and 10% the field. There was significant difference among treatments in the mean % mortality rate of aphids after three days spray ($F = 47.820$, $p < 0.05$ and F -calculated value greater than F -critical value (tabulated value)). And also at 10% ($P = 0.001$, F -calculated value = 51.5, F -critical value = 3.89)



Where, prsc = pre spray count, Posc = post spray count , %AMR= Percentage Average Mortality Rate

Figure 10: Efficacy of various botanical pesticides at 5% after 72 hours on field.

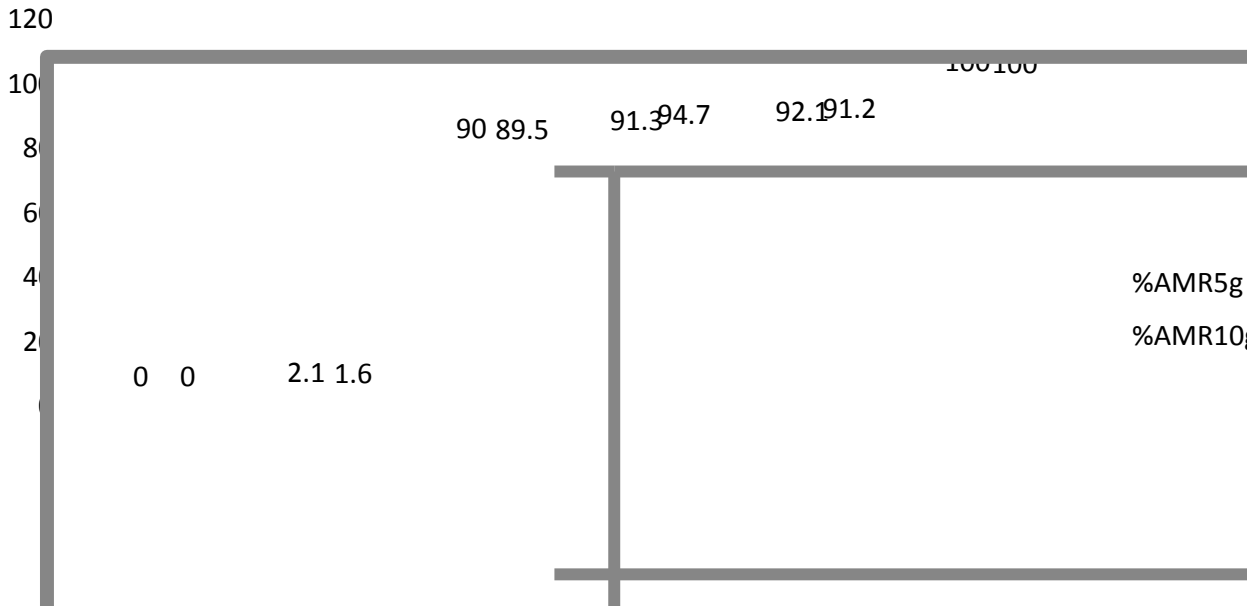
The percentage average mortality rate of aphids at 10g present after the third spray between treatments. Letters above bars refer LSD highly significant difference test results among treatments. When treatments that share a letters in common are not have significantly difference from one another ($p>0.05$), but when treatments that not share a letters in common, they have significantly different from one another ($p<0.05$) on appendix of multiple comparison.



Where, prsc = pre spray count, Posc = post spray count, AMR= Percentage Average Mortality Rate

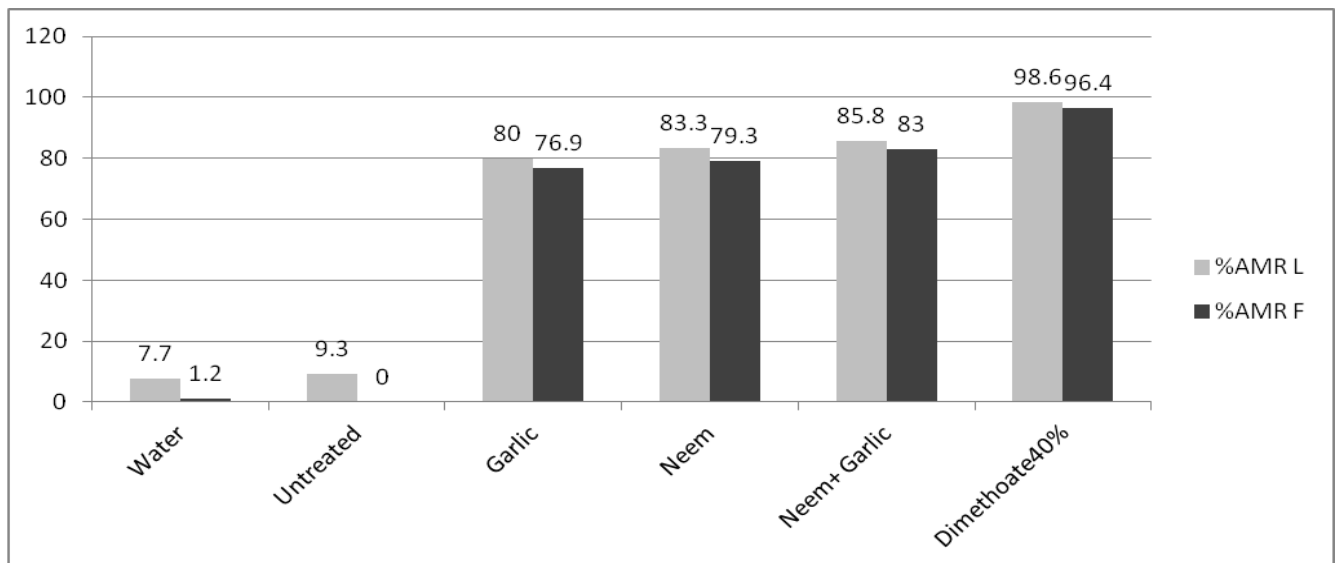
Figure 11: Efficacy of various botanical pesticides at 10% after 72 hours on field.

The percentage average mortality Rate of aphids at 10g present after the third spray between treatments. Letters above bars refer LSD highly significant difference test results among treatments. When treatments that share a letters in common are not have significantly difference from one another ($p>0.05$), but when treatments that not share a letters in common, they have significantly different from one another ($p<0.05$).



Where, %AMR= Percentage Average Mortality Rate

Figure 12: Shows the efficacy of various botanical pesticides at 5% and 10% after 72 hours on field.



%AMR=Percentage average mortality (laboratory and field respectively).

Figure 13: The efficacy of various botanical pesticides at 5% after 72 hours in the laboratory and field

5. DISCUSSION

Evaluation of bioactive medicinal plant against vector and insect pest management program is one of the eco-friendly approaches because they are easily biodegradable in nature. Naturally plants are rich store houses for potential bioactive compounds which are gaining appreciation in recent times among the scientific communities. Mekuaninte *et al.*, (2011) reported that, to find out alternative pest control strategies for small holder farmers, the efficacy of solvent extract of *M. azedarach* leaves, seed and *Mentha piperita* against aphid. The mortality of aphid related with toxic odor due to suffocation and avoids from foliage for longer time and under starvation the insects' leads to death.

The results showed that the application of plant extracts (*M. azedarach* and *A. sativum*) on cabbage aphid significantly ($p=0.001$, $p<0.05$) reduced the population compared to the negative control suggesting the importance of this technology in the management of insect pests. The use of plants, plant material for the protection of crops from insect pests has been recorded as one of the oldest crop protection methods. The ability of these plants extracts to protect from severe aphid attack of the leaf of cabbage. They possess one or more useful properties such as biodegradability, broad spectrum of activity and ability to reduce insect resistance. High cost of chemical insecticide leads to search alternative sources for pest management (Jangamet *al.*, 2014).

The use botanical extracts are alternative pest control, for example, it has been to use the *M. azedarach* leaf combined with *A. sativum* to enhance insecticidal effects as both plant materials have the potential to reduce insect pest population. However, the efficacy of *M. azedarach* leaf combined with *A. sativum* on phloem-feeding insect is not documented (Nzanza and Mashela, 2012). However, in this study, it was evaluated the insecticidal properties of mixed application of *M. azedarach* and *A. sativum* and against cabbage aphid on cabbage leaves, under laboratory conditions and on field. Aqueous extract of *M. azedarach* dry fruit was effective in reducing the population of cabbage aphid. The repeated application of botanical spray was important to achieve maximum suppression of pest population.

Plant natural products that constitute effective safer alternatives to synthetic insecticides without producing adverse effects on the ecosystem have been tested in the management of stored-product pests (Isman, 2006). Many scientists have developed ways of making their own extracts (sprays) from plant such as *M. azedarach* extract, *A. sativum* , and many others. From the present study it may be concluded that the application of plant extracts (*M. azedarach* extract, *A. sativum* extracts) to reduce the aphid population. The scale up studies are required to understand the mechanism(s) of solvent extracted from plants and used against aphid which will be helpful in replacing the pesticides harmful to the environment and the human beings.

The result of this recent study showed that aqueous extract of *M. azedarach* and *A. sativum* caused mortality of cabbage aphid compared to the control. This indicates *M. azedarach* and *A. sativum* possess insecticidal property. This is in line with previous reports Ascher *et al.*, 1995 on a variety of preparations from crude extracts of different parts of *M. azedarach* plants have been applied to assess anti-feedant activity. Leaf and fruit extracts of *M. azedarach* showed anti-feedant activity on insects of various Orders, including Homoptera.

The present result in laboratory revealed that the mean mortality of *M. azedarach* was 82.1% and 10% 83.1% at 5% and 10% respectively. This results agreed with Biswas (2013) reported that, showed 81% and 75% at the concentration of 50g/L and 75g/L seed extract of *M. azedarach* respectively.

It was recorded in aphids treated with both levels of *M. azedarach* %MR at T3, (91.8, and 94.7,), *A. sativum* (90, and 89.5,), *M. azedarach*+*A. sativum* (92.2, and 91.). In agreement with this study Abebe Megersa (2016) reported that, *A. sativum* bulbs prepared at 5 and 10% dilutions was tested for their effect on aphids under laboratory condition both level of *A. sativum* and 5% *M. azedarach* have mortality rate similar to endosulfan 35% within 24 hours of treatment application.

In this study the highest mortality was recorded after three days experimentation was due to *A. sativum* , *M. azedarach* *A. sativum* +*M. azedarach* and commercial insecticide (Dimethoate 40% EC). This indicates that these botanicals are efficient enough to be utilized during critical time of aphid infestation to gain economic advantage of their cheapness and early

reduced pest population for gaining the yield advantage of timely protected field cabbage plant. Jastad *et al.*, (2009), revealed that most plants species which are used in phytomedicine contains ingredients which inhibit the development of insect, hinder their feeding (anti-feedants) or act as repellents and confessants.

A recent study indicates plant pesticides are important regarding of economically, ecologically and can replace the toxic chemicals for pest control. The efficacy of aqueous botanical extracts were near to synthetic insecticides, i.e. no more significant difference in the mortality of aphid. Aslan *et al.* (2005) and Yemane Kidane and Yilma Habte(1998), discussed the uses of biological materials especially, plant materials are highly favored, since the materials can easily be applied without any technical knowledge. The effectiveness of botanical insecticides has been demonstrated in many studies. Provide small-scale farmers with locally available, biodegradable and inexpensive method for the control of pests of stored products. Considering the importance of plant insecticides, the farmers of in Ethiopia treat their stored products with local herbs to reduce storage losses due to pests.

6. CONCLUSIONS AND RECOMMENDATIONS

6. 1.CONCLUSIONS

The result of study showed that the natural pesticides have potential for use to protection of pests. The selected botanical extracts in this study have efficacy against cabbage aphid causes death of aphid. The results also indicated that these plant extracts have the potential value near to synthetic insecticides in pest management. The botanical pesticides showed high efficacy against aphid and spray with combined plant extracts effectively control aphid population followed by *M. azedarach* and *A. sativum* extract effective against aphid. The cost benefit of the botanical material used proved economical for the end users. This has to be encouraged since they are available to poor resource farmers, friendly to environment, relatively cheap and easy to apply by local farmers. Botanicals reasonable act as insecticidal properties against insects and have shown promising effects for managing insects on cabbage head. *M. azedarach* and *A. sativum* extract studied under the laboratory and field condition are showed promising results against aphid and also a lot of scientific reports confirmed the bioactivity of the selected plant. As a result, the vegetable growers can prepare any one of the plants extract to protect the cabbage aphid on cabbage leaves and cut down use of toxic chemical insecticides for pest control programs.

6.2. RECOMMENDATIONS

- ❖ Plant derived extracts have long been a subject of research in an effort to develop alternatives to conventional insecticides and to reduced the impact health of life and environmental.
- ❖ The identification of botanical insecticidal is the current issue, an important research area needed to enhanced (inspiring) a younger scientists to work on it.
- ❖ A wide range of doses of botanical extracts test is important to fix the concentration for narrow range test that helps to determine the concentration level which is effective for protection the targeted pests.
- ❖ The source materials are locally available and methodology is effortlessly adoptable to the farming community, so that it should create awareness for farming communities around the study area about the importance of local resources and their utilization.
- ❖ There is need to carry out more research on homemade organic pesticides to come up with information on the chemistry and toxicology of the pesticides. More research has to be carried out to test other known plants with pesticidal effects and to identify new plants with pesticidal properties in different areas. However, not extensively studied in most plants.
- ❖ Further research is required to find an effective concentration and application frequency of homemade organic pesticides spray for use on the cabbage aphid. For effective pest control may require a combination of practices.
- ❖ So, it is better to use of their various body parts of plants (leaves, stems, barks, flowers, fruits, roots, seeds) as alternative to conventional insecticides is recommended due to their relative abundance and accessibility throughout the year.
- ❖ A further investigation for the isolation of individual components of plant parts to determine their exacts the mode of action of the active components, and their effect on target organisms should explored.

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APPENDICES

Appendix Table 1: The mean mortality rates of aphid with various types of treatments at 5 % their Descriptive statistics results in laboratory.

Treatments	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
<i>M. azedarach</i>	3	82.167	13.8911	8.0200	47.659	116.674	66.6	93.3
<i>A. sativum</i>	3	76.800	15.7264	9.0796	37.733	115.867	59.4	90.0
<i>M. azedarach</i> + <i>A. sativum</i>	3	84.200	13.9280	8.0414	49.601	118.799	68.4	94.7
Dimethoate40%	3	97.833	3.7528	2.1667	88.511	107.156	93.5	100.0
Water	3	12.433	14.9353	8.6229	-24.668	49.535	.0	29.0
Untreated	3	7.833	8.9579	5.1718	-14.419	30.086	.0	17.6
Total	18	60.211	38.5213	9.0796	41.055	79.367	.0	100.0

Appendix Table 2: The mea mortality rates of aphid with various types of treatments at 10 % their Descriptive statistics results in laboratory.

Treatments	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
<i>M. azedarach</i>	3	83.167	12.5596	7.2513	51.967	114.366	69.4	94.0
<i>A. sativum</i>	3	80.000	17.5000	10.1036	36.528	123.472	60.0	92.5
<i>M. azedarach</i> + <i>A. sativum</i>	3	85.733	14.1747	8.1838	50.521	120.945	69.7	96.6
Dimethoate40%	3	99.067	1.6166	.9333	95.051	103.082	97.2	100.0
Water	3	7.733	8.3578	4.8254	-13.029	28.495	.0	16.6
Untreated	3	9.367	9.3500	5.3983	-13.860	32.593	.0	18.7
Total	18	60.844	39.7778	9.3757	41.063	80.626	.0	100.0

Appendix Table 3: The mean mortality rates of aphid with various types of treatments at 5% their Descriptive statistics results on the field condition.

Treatments	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower	Upper Bound		
<i>M. azedarach</i>	3	79.300	16.8021	9.7007	37.561	121.039	60.2	91.8
<i>A. sativum</i>	3	76.933	16.9356	9.7778	34.863	119.004	57.8	90.0
<i>M. azedarach</i> + <i>A. sativum</i>	3	82.933	11.5453	6.6657	54.253	111.613	70.0	92.2
Dimethoate 40%	3	97.600	4.1569	2.4000	87.274	107.926	92.8	100.0
Water	3	1.200	1.0817	.6245	-1.487	3.887	.0	2.1
Untreated	3	.000	.0000	.0000	.000	.000	.0	.0
Total	18	56.328	42.1259	9.9292	35.379	77.277	.0	100.0

Appendix Table 4: The mean mortality rates of aphid with various types of treatments at 10 % their Descriptive statistics resultson the field condition.

Treatments	N	Mean	Std.Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
<i>M. azedarach</i>	3	81.333	16.6374	9.6056	40.004	122.663	62.7	94.7
<i>A. sativum</i>	3	76.500	16.4545	9.5000	35.625	117.375	58.0	89.5
<i>M. azedarach</i> + <i>A. sativum</i>	3	83.267	10.8519	6.2653	56.309	110.224	70.9	91.2
Dimethoate 40%	3	97.933	3.5796	2.0667	89.041	106.825	93.8	100.0
Water	3	1.067	.9238	.5333	-1.228	3.361	.0	1.6
Untreated	3	.000	.0000	.0000	.000	.000	.0	.0
Total	18	56.683	42.3586	9.9840	35.619	77.748	.0	100.0

Appendix Table 5: A Multiple Comparisons of treatments at 5% their efficacies to % of mortality rate of aphid with one way of ANOVA using LSD test results in laboratory.

(I) Treatments	(J) Treatments	Mean Difference (I-J)		Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
<i>M. azedarach</i>	<i>A. sativum</i>	5.3667	10.2830	.611	-17.038	27.771
	<i>M. azedarach</i> + <i>A. sativum</i>	-2.0333	10.2830	.847	-24.438	20.371
	Dimethoate40%	-15.6667	10.2830	.154	-38.071	6.738
	Water	69.7333*	10.2830	.000	47.329	92.138
	Untreated	74.3333*	10.2830	.000	51.929	96.738
<i>A. sativum</i>	<i>M. azedarach</i>	-5.3667	10.2830	.611	-27.771	17.038
	<i>M. azedarach</i> + <i>A. sativum</i>	-7.4000	10.2830	.486	-29.805	15.005
	Dimethoate40%	-21.0333	10.2830	.063	-43.438	1.371
	Water	64.3667*	10.2830	.000	41.962	86.771
	Untreated	68.9667*	10.2830	.000	46.562	91.371
<i>M. azedarach</i> + <i>A. sativum</i>	<i>M. azedarach</i>	2.0333	10.2830	.847	-20.371	24.438
	<i>A. sativum</i>	7.4000	10.2830	.486	-15.005	29.805
	Dimethoate40%	-13.6333	10.2830	.210	-36.038	8.771
	Water	71.7667*	10.2830	.000	49.362	94.171
	Untreated	76.3667*	10.2830	.000	53.962	98.771
Dimethoate40%	<i>M. azedarach</i>	15.6667	10.2830	.154	-6.738	38.071
	<i>A. sativum</i>	21.0333	10.2830	.063	-1.371	43.438
	<i>M. azedarach</i> + <i>A. sativum</i>	13.6333	10.2830	.210	-8.771	36.038
	Water	85.4000*	10.2830	.000	62.995	107.805
	Untreated	90.0000*	10.2830	.000	67.595	112.405
Water	<i>M. azedarach</i>	-69.7333*	10.2830	.000	-92.138	-47.329
	<i>A. sativum</i>	-64.3667*	10.2830	.000	-86.771	-41.962
	<i>M. azedarach</i> + <i>A. sativum</i>	-71.7667*	10.2830	.000	-94.171	-49.362
	Dimethoate40%	-85.4000*	10.2830	.000	-107.805	-62.995
	Untreated	4.6000	10.2830	.663	-17.805	27.005
Untreated	<i>M. azedarach</i>	-74.3333*	10.2830	.000	-96.738	-51.929
	<i>A. sativum</i>	-68.9667*	10.2830	.000	-91.371	-46.562
	<i>M. azedarach</i> + <i>A. sativum</i>	-76.3667*	10.2830	.000	-98.771	-53.962
	Dimethoate40%	-90.0000*	10.2830	.000	-112.405	-67.595
	Water	-4.6000	10.2830	.663	-27.005	17.805

*The mean difference is significant at the 0.05 level.

Appendix Table 6: A Multiple Comparisons of treatments at 10% their efficacies to % of mortality rate of aphid with one way of ANOVA using LSD test results in laboratory.

(I) Treatments	(J) Treatments	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
<i>M. azedarach</i>	<i>A. sativum</i>	3.1667	9.5731	.747	-17.691	24.025
	<i>M. azedarach</i> + <i>A. sativum</i>	-2.5667	9.5731	.793	-23.425	18.291
	Dimethoate40%	-15.9000	9.5731	.123	-36.758	4.958
	Water	75.4333*	9.5731	.000	54.575	96.291
	Untreated	73.8000*	9.5731	.000	52.942	94.658
	<i>M. azedarach</i>	-3.1667	9.5731	.747	-24.025	17.691
	<i>M. azedarach</i> + <i>A. sativum</i>	-5.7333	9.5731	.560	-26.591	15.125
<i>A. sativum</i>	<i>M. azedarach</i> + <i>A. sativum</i>	-19.0667	9.5731	.070	-39.925	1.791
	Dimethoate40%	72.2667*	9.5731	.000	51.409	93.125
	Water	70.6333*	9.5731	.000	49.775	91.491
	Untreated	70.6333*	9.5731	.000	49.775	91.491
	<i>M. azedarach</i>	2.5667	9.5731	.793	-18.291	23.425
	<i>A. sativum</i>	5.7333	9.5731	.560	-15.125	26.591
	<i>M. azedarach</i> + <i>A. sativum</i>	-13.3333	9.5731	.189	-34.191	7.525
Dimethoate40%	Water	78.0000*	9.5731	.000	57.142	98.858
	Untreated	76.3667*	9.5731	.000	55.509	97.225
	<i>M. azedarach</i>	15.9000	9.5731	.123	-4.958	36.758
	<i>A. sativum</i>	19.0667	9.5731	.070	-1.791	39.925
	<i>M. azedarach</i> + <i>A. sativum</i>	13.3333	9.5731	.189	-7.525	34.191
	Water	91.3333*	9.5731	.000	70.475	112.191
	Untreated	89.7000*	9.5731	.000	68.842	110.558
Water	<i>M. azedarach</i>	-75.4333*	9.5731	.000	-96.291	-54.575
	<i>A. sativum</i>	-72.2667*	9.5731	.000	-93.125	-51.409
	<i>M. azedarach</i> + <i>A. sativum</i>	-78.0000*	9.5731	.000	-98.858	-57.142
	Dimethoate40%	-91.3333*	9.5731	.000	-112.191	-70.475
	Untreated	-1.6333	9.5731	.867	-22.491	19.225
	<i>M. azedarach</i>	-73.8000*	9.5731	.000	-94.658	-52.942
	<i>A. sativum</i>	-70.6333*	9.5731	.000	-91.491	-49.775
Untreated	<i>M. azedarach</i> + <i>A. sativum</i>	-76.3667*	9.5731	.000	-97.225	-55.509
	Dimethoate40%	-89.7000*	9.5731	.000	-110.558	-68.842
	Water	1.6333	9.5731	.867	-19.225	22.491

Appendix Table 7: A Multiple Comparisons of treatments at 5% their efficacies to % of mortality rate of aphid with one way of ANOVA using LSD test results on field.

(I) Treatments	J) Treatments	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
<i>M. azedarach</i>	<i>A. sativum</i>	2.3667	8.9497	.796	-17.133	21.866
	<i>M. azedarach</i> + <i>A. sativum</i>	-3.6333	8.9497	.692	-23.133	15.866
	Dimethoate 40%	-18.3000	8.9497	.063	-37.800	1.200
	Water	78.1000*	8.9497	.000	58.600	97.600
	Untreated	79.3000*	8.9497	.000	59.800	98.800
<i>A. sativum</i>	<i>M. azedarach</i>	-2.3667	8.9497	.796	-21.866	17.133
	<i>M. azedarach</i> + <i>A. sativum</i>	-6.0000	8.9497	.515	-25.500	13.500
	Dimethoate 40%	-20.6667*	8.9497	.040	-40.166	-1.167
	Water	75.7333*	8.9497	.000	56.234	95.233
	Untreated	76.9333*	8.9497	.000	57.434	96.433
<i>M. azedarach</i> + <i>A. sativum</i>	<i>M. azedarach</i>	3.6333	8.9497	.692	-15.866	23.133
	<i>A. sativum</i>	6.0000	8.9497	.515	-13.500	25.500
	Dimethoate 40%	-14.6667	8.9497	.127	-34.166	4.833
	Water	81.7333*	8.9497	.000	62.234	101.233
	Untreated	82.9333*	8.9497	.000	63.434	102.433
Dimethoate 40%	<i>M. azedarach</i>	18.3000	8.9497	.063	-1.200	37.800
	<i>A. sativum</i>	20.6667*	8.9497	.040	1.167	40.166
	<i>M. azedarach</i> + <i>A. sativum</i>	14.6667	8.9497	.127	-4.833	34.166
	Water	96.4000*	8.9497	.000	76.900	115.900
	Untreated	97.6000*	8.9497	.000	78.100	117.100
Water	<i>M. azedarach</i>	-78.1000*	8.9497	.000	-97.600	-58.600
	<i>A. sativum</i>	-75.7333*	8.9497	.000	-95.233	-56.234
	<i>M. azedarach</i> + <i>A. sativum</i>	-81.7333*	8.9497	.000	-101.233	-62.234
	Dimethoate 40%	-96.4000*	8.9497	.000	-115.900	-76.900
	Untreated	1.2000	8.9497	.896	-18.300	20.700
Untreated	<i>M. azedarach</i>	-79.3000*	8.9497	.000	-98.800	-59.800
	<i>A. sativum</i>	-76.9333*	8.9497	.000	-96.433	-57.434
	<i>M. azedarach</i> + <i>A. sativum</i>	-82.9333*	8.9497	.000	-102.433	-63.434
	Dimethoate 40%	-97.6000*	8.9497	.000	-117.100	-78.100
	Water	-1.2000	8.9497	.896	-20.700	18.300

Appendix Table 8: A Multiple Comparisons of treatments at 10% their efficacies to % of mortality rate of aphid with one way of ANOVA using LSD tests results on field.

(I) Treatments	(J) Treatments	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
<i>M. azedarach</i>	<i>A. sativum</i>	4.8333	8.6858	.588	-14.091	23.758
	<i>M. azedarach</i> + <i>A. sativum</i>	-1.9333	8.6858	.828	-20.858	16.991
	Dimethoate 40%	-16.6000	8.6858	.080	-35.525	2.325
	Water	80.2667*	8.6858	.000	61.342	99.191
	Untreated	81.3333*	8.6858	.000	62.409	100.258
<i>A. sativum</i>	<i>M. azedarach</i>	-4.8333	8.6858	.588	-23.758	14.091
	<i>M. azedarach</i> + <i>A. sativum</i>	-6.7667	8.6858	.451	-25.691	12.158
	Dimethoate 40%	-21.4333*	8.6858	.030	-40.358	-2.509
	Water	75.4333*	8.6858	.000	56.509	94.358
	Untreated	76.5000*	8.6858	.000	57.575	95.425
<i>M. azedarach</i> + <i>A. sativum</i>	<i>M. azedarach</i>	1.9333	8.6858	.828	-16.991	20.858
	<i>A. sativum</i>	6.7667	8.6858	.451	-12.158	25.691
	Dimethoate 40%	-14.6667	8.6858	.117	-33.591	4.258
	Water	82.2000*	8.6858	.000	63.275	101.125
	Untreated	83.2667*	8.6858	.000	64.342	102.191
Dimethoate 40%	<i>M. azedarach</i>	16.6000	8.6858	.080	-2.325	35.525
	<i>A. sativum</i>	21.4333*	8.6858	.030	2.509	40.358
	<i>M. azedarach</i> + <i>A. sativum</i>	14.6667	8.6858	.117	-4.258	33.591
	Water	96.8667*	8.6858	.000	77.942	115.791
	Untreated	97.9333*	8.6858	.000	79.009	116.858
Water	<i>M. azedarach</i>	-80.2667*	8.6858	.000	-99.191	-61.342
	<i>A. sativum</i>	-75.4333*	8.6858	.000	-94.358	-56.509
	<i>M. azedarach</i> + <i>A. sativum</i>	-82.2000*	8.6858	.000	-101.125	-63.275
	Dimethoate 40%	-96.8667*	8.6858	.000	-115.791	-77.942
	Untreated	1.0667	8.6858	.904	-17.858	19.991
Untreated	<i>M. azedarach</i>	-81.3333*	8.6858	.000	-100.258	-62.409
	<i>A. sativum</i>	-76.5000*	8.6858	.000	-95.425	-57.575
	<i>M. azedarach</i> + <i>A. sativum</i>	-83.2667*	8.6858	.000	-102.191	-64.342
	Dimethoate 40%	-97.9333*	8.6858	.000	-116.858	-79.009
	Water	-1.0667	8.6858	.904	-19.991	17.858

*. The mean difference is significant at the 0.05 level.