Sudan University of Science and Technology
College of Agricultural Studies
Department of Plant Protection

Effect of neem(*Azadirachta indica*)water extract against cotton mealy bug (*phenacocus solenopsis*)

أثر مستخلص النيم المائي علي البق الدقيقي في القطن

A graduation project submitted in partial fulfillment of the reguirements For the degree of B.Sc Agric in plant protection

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الآيـة

قال تعالي:

إِنَّمَا أَمْرُهُ إِذَا أَرَادَ شَيْئًا أَنْ يَقُولَ لَهُ كُنْ فَيَكُونُ ﴿٨٢﴾

فَسُبْحَانَ الَّذِي بِيَدِهِ مَلَكُوتُ كُلِّ شَيْءٍ وَإِلَيْهِ تُرْجَعُونَ ﴿٨٣﴾

صدق الله العظيم

سورة يس الايات ﴿٨٢﴾ و ﴿٨٣﴾

Dedication

I would like to dedicate this study to my parents brothers my friends and my husband.

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Abstract

Lab experiments were carried out in the laboratory of Entomology and Agricultural Zoology, Collage of Agricultural studies, department of plant protection Sudan University of Science and technology (SUST) in summer season 2019 to evaluate the effect of neem water extract with the addition of drop of sesame oil against cotton mealy bug Adult (*phencoccus solenopsis*) . The experiments included three treatments with concentration (5%.10%.20 %.) in addition to water control.

All concentrations gave significant results compared to control.

The hair concentration (5%) gave the best result. Neem water extract is recommended for control of mealy bug in the future.

ملخص البحث

اجريت هذه التجربة تحت ظروف المعمل بعمل الحشرات والحيوان الزراعي قسم وقاية النبات-كلية الدراسات الزراعية ،جامعة السودان للعلوم والتكنولوجيا (شمبات) في موسم 2019 م لدراسة تأثير وفعالية مستخلص النيم المائي مع اضافة قطرات من زيت ألسمسم علي حشرة البق الدقيقي في القطن .

تم استخدام ثلاثة تركيزات من مستخلص النيم المائي وهي(5%10%20%)بالاضافة الي الشاهد.

كل التركيزات اعطت نتائج متفاوتة مقارنة بالشاهد، ويوصى بأن يكون من المستخلصات الواعدة في المستقبل لمكافحة البق الدقيقي.

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CHAPTER ONE

1.1: INTRODUCTION

The Mealy bug species are widespread throughout the world. The cotton Mealy bug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae)has been described as a serious and invasive polyphagous pest with a vast host range by several authors. It has wide geographical distribution with its origin in Central America followed by reports of the Caribbean and Ecuador and Brazil (Mark and Gullan 2005). *P. solenopsis*has been described as a serious and invasive pest of shoe flower in Pakistan and India on Hibiscus rosa-sinensis in Nigeria (Akintola and Ande, 2008) Latest report by the authors on the invasiveness of *P. solenopsis* has been from the Eastern region of Sri Lanka on ornamentals, vegetable crops, and weeds, and in China (Wang et al. 2009; Wu and Zhang, 2009) on shoe flower.*P.solenopsis*is identified as one of the major damage causing and firstly spreading invasive Mealy bugs of Sri Lanka next to Papaya Mealy bug *Paracoccusmarginatus.*

Being a poly phagous pest, the *P. solenopsis* has been recorded to feed on a number of cultivated crops including weeds (Prishanthini and Vinobaba, 2011*) P.solenopsis* has been reported from 28 host plant species comprising 10 families in Sri Lanka. This includes the major field crops of family Malvaceae, Solanaceae and Amaranthaceae .Farmers are currently using some toxic chemical insecticides against cotton mealy on large and small scale cultivations of Okra, Brinjal, Tomato and Amaranthus.

Reliance on synthetic chemicals to control pests has also given rise to a number of problems such as destruction of beneficial non-target organisms (parasitoids and predators) thereby affecting the food chain and impacting on biological diversity. The injudicious use of synthetic pesticides can lead to secondary outbreaks of pests that are normally under natural control resulting in their rapid proliferation. There

have also been cases of pests becoming tolerant to insecticides, resulting in the use of

double and triple application rates. In addition, due to other problems such as health hazards, undesirable side effects and environmental pollution caused by the continuous use of synthetic chemical pesticides (Nas, 2004), there is renewed interest in the application of botanical pesticides for crop protection. Botanical pesticides are biodegradable and their use in crop protection is a practical sustainable alternative. It maintains biological diversity of predators , and reduces environmental contamination and human health hazards. Botanicals are safe for home gardens and green houses. Therefore the present study attempts to evaluate the efficacies of some native botanicals against cotton Mealy bugs.

Mealy bugs (Hemiptera: Pseudococcidae) are small, soft-bodied, plant sucking insects which embrace the second largest family of scale insects(Pseudococcidae) and comprises approximately 2000 species belonging to 300 genera. Their common name is due to the waxy material which covers the bodies of adult female Mealy bugs are sexually dimorphic, the female is wingless and does not experience complete meta morphs sis, i.e. do not have papal stage on the other hand males are winged and have complete metamorphosis. Males have two long pairs of white waxy tails. They have nonfunctional mouth parts and live for only 2-4 days . Male passes through four developmental stages, i.e. egg, larva, pupa and adult while female passes through three developmental stages of egg, larva and adult. The fully grown adult females covered with white waxy powder and have yellowish white color with some black spots on the dorsal side of the body.

Mealy bugs of genus Phenacoccus attack a wide variety of crops, fruits, vegetables, *ornamentals* and weeds but cotton is the prime target. In the initial stage it breeds on all types of weeds round the year and then migrates to cotton crop. Mealy bugs have been reported to appear and survive on poorly grown cotton crop. The insect damage at initial

stage appears in small pockets and then spreads to whole field.

All over the world scientists are working for development and establishment of plant based pesticide, usually called as phytopesticide, botanical pesticide, bio pesticide or natural pesticides(Siddiqui, et al 2009). Exposure of mealy bug eggs to sun, removal of alternative host plants and conservation of natural enemies by using garlic oil or neem seed extract around the trunk of trees and applicationof alkathane bands can eradicate mango Mealy bug population . Biological activities of neem based insecticides are known for more than 400 pest insects, which has minimal toxicity to non-target organisms such as parasitoids, predators and pollinators .

Although, there are a number of chemical control strategies to overcome the yield losses in crop plants due to mealy bug attack .The use of synthetic insecticides is extremely toxic to natural enemies of mealy bugs. The natural enemies include predators such as*Chrysoperlacarnea,Hippodemiaconvergens,Coccinellaseptempunctata,Brumussaturalus* and*Cryptolaemusmontrouzieri.*Azadirachtin and numerous other compounds derived primarily from *Azadiracht aindica*. Juss have insecticidal, anti-feed ant, and toxicological properties for pest insects control. These biological activities of neembased insecticides are known for more than 400 pest insects. Plant derivatives can be used as an alternative approach to synthetic chemicals which are cost effective, easily available and safe to environment and bio control agents. In this paper, it has been highlighted the use of insecticides to control mealy bugs and its side effects to bio-control agents. Similarly, olfactory studies show that odors emitted from plant and mealy bug itself can also be used in pest management strategies.

1.2:The Objectives of study

- To study effect of the leaf water extract of the Neem plant (Azadirachta indica)on the cotton *mealy bug (Pseudococcuscalceolariae***:**Hemiptera: Pseudococcidae).

CHAPTER TWO

LITERATURE REVIEW

2.1:Cotton mealy bug (*Phenacoccussolenopsis* Tinsley)

2.1.1: Classification :-

Class: Insecta

Order: Homoptera

Suborder: Sternorrhyncha

Super family: Coccoidea

Family: Pseudococcidae

Genus: Phenacoccus

S.N: *Phenacoccussolenopsis* Tinsley

Other Scientific Names

PhenacoccuscevalliaeCockerell 1902

Phenacoccusgossypiphilous (Abbas et al. 2005; 2007)

Common Names

Cotton mealy bug, Solenopsis mealy bug

2.1.2: Taxonomy and Nomenclature:-

Pheanococcus solenopsis was initially described by Tinsley (1898) from specimens infesting the roots and stems of Boerhaviaspicata and Kallstroemiacalifornica within the nests of ants, Solenopsisgeminata, in New Mexico, USA. Later, Tinsley (1898) provided a brief description of the adult female collected on the roots of Atriplexcanescens. Cockerell (1902) described the species *Phenacoccuscevalliae* from specimens on the host plant Cevalliasinuata obtained at Roswell, New Mexico, USA. This species name was listed by Fernald (1903), but later synonymized with *P. solenopsis* by Ferris (1950). The taxonomy of this species was documented by Ben-Dov (1994). The adult female has since been

redescribed by Ferris (1950), McKenzie (1967), Kosztarab (1996), Williams and Granara de Willink (1992), and Hodgson et al. (2008).

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Recently, specimens on cotton [Gossypium spp.] in India with morphological traits

that differed from *P. solenopsis* were referenced as a new species, *Phenacoccusgossypiphilous* (Ghulam Abbas et al., 2005) recognized the morphological variations within *P. solenopsis*, inferring that it may consist of two sexual species. The presence of morphological variations among specimens of *P. solenopsis* in different regions of India often led to misidentification of the mealy bug species (Asha and Ramamurthy, 2008). However, because no type specimens were named, Hodgson et al. (2008) concluded from a comprehensive morphological study that there were no significant differences in specimens from the Indian subcontinent compared to those from the Entropic; and thus, considered the name *P. gossypiphilous* to be a synonym of *P. solenopsis*.

2.1.3: Description:-

Pheanococcus solenopsis is a bisexual species with multiple generations annually. Like other mealy bugs, this species is distinguished by the morphology of the adult female. Adult females are covered with a powdery, waxy secretion with six pairs of transverse, dark bands that are located across the pro- to meta-thoracic segments. A series of waxy filaments extend from around the margin of the body with the pair of terminal filaments longest. The ovisac is composed of fluffy, loose-textured wax strands (McKenzie, 1967;Kosztarab, 1996). Adult females range from 2 to 5 mm long and 2 to 4 mm wide.

Slide-mounted females are distinguished ventrally by the presence of nine-segmented antennae, five-segmented legs with translucent pores on meta-femur and meta-tibia, each claw with a minute tooth, two sizes of oral collar tubular ducts, absence of quinquelocular pores, a large circulus, and a series of multilocular pores concentrated around the vulva and submarginal areas of abdominal segments (McKenzie, 1961; 1967; Kosztarab, 1996; Hodgson et al., 2008). On the dorsum, 18 pairs of cerarii, each with two spinose setae, are located around the marginal area, with evenly distributed trilocular pores, and minute circular pores. Also, oral rim ducts, oral collar tubular ducts, and multilocular pores are absent on the dorsum. Upon hatching, female development consists of first (crawler), second, and third instars and the adult, whereas males undergo first, second, prepupa, pupa and adult stages of development. Hodgson et al. (2008) provided comprehensive descriptions and illustrations for the immature stages of the solenopsismealybug. First

instars are separated from the other stages by possessing six-segmented antennae, lack of circulus, and quinquelocular pores on the head, thorax and abdomen. Second-instar

nymphs are distinguished by having 18 pairs of distinct cerarii around the margin of the body, the lack of quinquelocular pores on the body and the claw with a distinct denticle. The third instar nymph differs by having seven-segmented antennae and a circulus. Females of this bisexual species are capable of producing 150-600 pale-yellow eggs in a white, waxy ovisac. The first instar nymphs (crawlers) disperse to settle primarily on the leaves as well as the stems, leaf petioles, and bracts of fruiting cotton (Ben-Dov, 1994). Development from crawler to adult ranges from 25 to 30 days, depending upon the temperature. This mealybug has been reported to be capable of surviving temperatures ranging from 0-45°C, throughout the year (Sharma, 2007). The location on the plant appears to be influenced by humidity as Hodgson et al. (2008) concluded that *P. solenopsis* occurred more commonly on the roots, stems and foliage close to the soil line in dry climates compared to settling on the upper foliage of the plant in more humid areas. The mealybugs damage the plant by extracting sap, which stresses the plant, resulting in leaves becoming chlorotic and shedding over time, as well as fruit bodies being aborted. Flowers or fruit not shed often take on an abnormal shape, reducing yield. Infested leaves of sunflowers were reported to become curled, crinkled and acquiring a rosette pattern with the plant appearing bushy and stunted (Jagadish et al., 2009). In addition, the high numbers of developing mealybugs produce large amounts of honeydew that fall onto the lower leaves producing a substrate for the development of sooty mould, which inhibits photosynthesis within the plant. The honeydew attracts ants that collect the material rich in carbohydrate, sugars, amino acids and minerals to feed to their brood. The foraging ants enter into a mutualistic association with the mealy bugs by collecting the honeydew and keeping the area clean of the excess waste product, while protecting the mealy bugs from potential natural enemies. The production of honeydew and its occurrence on the lint can also interfere with the processing of the cotton by making the ginning process more difficult.

2.1.4: Spread and Distribution :-

Pheaonococcus solenopsis was discovered in 1898 by Tinsley (1898) in New Mexico, USA. This mealy bug was later reported to have spread to Arizona, California, Colorado, Mississippi, Washington D.C., and Texas, USA (McKenzie, 1967) and then mealy bug was recorded from infestations in 18 USA states.

This mealy bug species has the ability to increase rapidly in population size and spread to cover vast areas where host plants occur, in a relatively short period of time. It has been

reported from over 200 hosts. . With the increase in international trade over the last few

decades, this invasive pest has been collected and identified on host material at international ports and in greenhouses outside its native range (Jansen, 2004). As such, *P. solenopsis* has become established in the Afrotropical, Australasian, Nearctic, Neotropical, and Oriental regions.

The occurrence of *P. solenopsis* is widespread with the species damaging plants in a variety of habitats ranging from dry arid areas to tropical regions. . In 2005, *P. solenopsis* was reported to be seriously infesting cotton plants in the Punjab and Sindh regions of Pakistan .Dhawan et al. (2009) reported that the population density of this invasive pest varied on cotton (Gossypiumspp) in surveyed regions in Pakistan.

Based on the range of climates and high number of hosts available on which the Solenopsis mealy bug can survive and the damage inflicted on the host plants, this species poses the serious threat of expanding its range. The hydrophobic waxy test, cryptic small size, feeding on all parts of the plant, multiple overlapping generations and high reproductive rates, allow *P. solenopsis* the opportunity to disperse over extended areas.

The *P. solenopsis* also has the ability to spread rapidly to un infested areas by natural carriers such as the wind, rain and water-ways, on farm equipment, and by clinging to clothing and animals. International trade plays a major role in the spread of this pest to new regions of the world. Hodgson et al. (2008) inferred that material from all infested regions of Asia may have originated from international commerce. The species may be dispersed internationally over vast areas by transporting infested plants into new areas by air or sea cargo. Hodgson et al. (2008) inferred that the infestation of ornamentals in Nigeria may have originated from South America.

2.1.5: Host Plants and Habitats:-

The cotton mealy bug has been recorded on 202 host plant species representing 55 families with a distribution in Africa, Asia, North America and South America and Oceanic regions including the Caribbean nations. Specimens from the various regions exhibit similar morphological characteristics (Hodgson et al., 2008). Host plants include field crops, ornamentals, trees and vegetables. In Pakistan, *P. solenopsis* obtained the status of a serious pest on a wide host range. In a field survey, Arif et al. (2009) identified the mealy

bug from 154 plant species, the majority of which belong to the families Malvaceae, Solanaceae, Asteraceae, Euphorbiaceae, Amaranthaceae and Cucurbitaceae.

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Significant economic damage was determined to occur on cotton (Gossypium spp.), brinjal

(Solanummelongena), okra (Abelmoschusesculentus), tomato (Solanumlycopersicum), sesame (Sesamumindicum), sunflower (Helianthus annuus) and China rose. Hodgson et al. (2008) noted a significant difference in the ecology of *P. solenopsis* from the hot, dry climate of southwestern USA. Here the mealy bug occurs primarily on the roots and underside of the foliage and stems, compared to the higher humid regions of India and Pakistan, where it is found almost entirely on the upper portions of the foliage, well above the soil line.

2.1.6: Symptoms and damage:-

As an introduced species, *P. solenopsis* has the capability to cause direct economic and ecological damage to native fauna and flora with heavy infestations reducing plant vigor and causing plant death.

The extraction of sap by the mealy bug results in the leaves of the plant turning yellow and becoming crinkled or malformed, which leads to loss of plant vigor, foliage and fruit-drop, and potential death of the plant, if not treated. Phloem feeding affects the growing regions of the plant often resulting in bunched and stunted growth (Dhawan et al., 2009b and Jagadish et al., 2009a), with plants producing smaller fruit or flowers, which ultimately leads to a reduction in seed or fruit yields.

The solenopsis mealy bug is an important plant pest worldwide (Williams and Granara de Willink, 1992and Hodgson et al., 2008). The presence of the *solenopsis* mealy bug has the potential to inflict significant damage to field crops (i.e. cotton (Gossypiumspp) and tobacco (Nicotianaspp) in all growing regions. This mealy bug caused serious damage to cotton in Pakistan in 2005 this invasive pest was responsible for a 44% reduction in seed-cotton yields (Dhawan et al., 2009a,b) Also, it is a pest of commercial crops including a variety of vegetables.

Sharma (2007) documented a seasonal outbreak of *P. solenopsis* on okra (Abelmoschusesculentus) in 2007, which developed into a heavy infestation on the crop by the end of the season and resulted in a 90% loss of seeds. Wang et al. (2009) recorded 17 provinces and 11 regions in China where this invasive species could spread and cause significant economic and environmental damage. Based on the international pest risk

analysis for *P. solenopsis*, Wang et al. (2009) classified this mealy bug as a high risk invasive species to China.

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2.1.7: Biology and Life cycle:-

Females of this ovoviviparous, bisexual species have been reported as capable of producing from 150 to 600 eggs, protected within a waxy ovisac. Upon hatching, females undergo three immature stages prior to reaching adulthood, whereas males undergo first, second, prepupa and pupa stages prior to adulthood. The period of development from crawler to adult stage is approximately 25-30 days, depending upon the weather and temperature. This species is capable of producing multiple generations annually.

2.1.8: Nutrition:-

The mealy bugs feed on the plant by extracting sap from cells in the leaves or stems. The sap contains soluble sugars, phenols, proteins and other potential nutrients. Mealy bug-infested leaves produce high quantities of sugars and proteins compared to the amounts produced in uninfested leaves (Jagadish et al., 2009a). Conversely, he reported a decline in the phenol content in infested sunflower plants.

2.1.9: Ecology and Environmental Requirements:-

From studies on the influence of weather on population growth, concluded that maximum temperature and sunshine hours had a positive influence, whereas relative humidity and rainfall had a negative influence on the mealy bug.

2.1.10: Management and control :-

2.1.10.1: Cultural control and sanitary measures:-

It is important to prune or cut infested stems or branches from plants and destroy the infested plant material. Also stalks and crop residue in infested field sites should be removed and destroyed as such residue left in the field can harbor mealy bugs, which can survive to invade the new crop. Attention should be given to the field borders for plants that can serve as an alternate host for the mealy bug. Such plants should be removed to prevent the mealy bugs from overwintering and infesting crops in the future. Trap plants may be planted that initially attract the mealy bugs and can be targeted for control treatments to protect the primary crop.

Handpicking the specimens from newly-infested plants and Soap applications are often effective against targeted, small populations of the mealy bug.

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2.1.10.2: Biological control:-

The use of biological control agents represents an effective means of suppressing exotic pest populations of mealy bugs providing a non-toxic, self-perpetuating control tactic. Several parasitoids and predators have been identified that attack *P. solenopsis*. The incorporation of parasitoids into the management system provides the opportunity to control pest populations at low densities. Established parasitoids have been recorded to parasitize over 70% of the cotton mealy bug populations . Tactics suggested to suppress populations of the invasive mealy bug on crops include allowing the parasitoid to build-up in population numbers prior to applying chemical insecticides; to attach plant parts with parasitoid-infested mealy bugs (mummies) on the host plant to be protected; mass releasing parasitoids into mealy bug-infested areas; or using a combination of natural enemies to control the exotic pest (Pala Ram et al., 2009). The use of beneficial predators provides the opportunity to control *P. solenopsis* on cotton (Gossypiumspp) in several countries. The predator, Cryptolaemusmontrouzieri, has been imported in India and released in cotton-infested fields as a means of controlling *P. solenopsis*.

To provide a higher probability of success by implementing natural control agents, several species of ants that are often associated with honeydew-producing mealy bugs and protect the population from natural enemies would need to be eradicated (Helms and Vinson, 2002 and Tanwar et al., 2007).

2.1.10.3: Chemical control:-

The *solenopsis* mealy bug was considered to be a secondary pest of cotton in Pakistan and India, maintained at low population levels by chemical applications to control the primary pest, Helicoverpaarmigera. With the emergence of transgenic cotton and the reduced need for chemical applications, the mealy bug has emerged as a major pest requiring chemical applications to manage it. The use of insecticides is the most effective control against the mealy bug when applications are timed to coincide with the crawler stage. The toxicity of a variety of insecticides (Dhawan et al., 2008; 2009a) was evaluated for efficacy against *P. solenopsis*. Such as Orthene, Malathion, Carbaryl and Diazinon.(Noe Ronald,2012).

2.1.10.4: Integrated Pest Management (IPM):-

A management strategy to control *P. solenopsis* in India that incorporates cultural, mechanical, biological and chemical control factors has recently been developed (Tanwar et al., 2007). They recommend a survey for the mealy bug prior to planting, targeting and

chemically treating small populations, removal of alternate host plants and ant colonies,

using recommended insecticides for optimal effectiveness on the plants and around their root system, providing an attractive habitat for native and exotic natural enemies, and using a variety of sanitation methods to prevent spread of the pest to new fields.

2.2: Neem (*Azadirachtaindica*):-

Azadirachtaindica, commonly known as neem, has attracted worldwide prominence in recent years, owing to its wide range of medicinal properties. Neem has been extensively used in Ayurveda, Unani and Homoeopathic medicine and has become a cynosure of modern medicine. Neem elaborates a vast array of biologically active compounds that are chemically diverse and structurally complex. More than 140 compounds have been isolated from different parts of neem. All parts of the neem tree- leaves, flowers, seeds, fruits, roots and bark have been used traditionally for the treatment of inflammation, infections, fever, skin diseases and dental disorders. The medicinal utilities have been described especially for neem leaf. Neem leaf and its constituents have been demonstrated to exhibit immunomodulatory, anti-inflammatory, antihyperglycaemic, antiulcer, antimalarial, antifungal, antibacterial, antiviral, antioxidant, antimutagenic and anticarcinogenic properties.

2.2.1: Classification:-

Kingdom: Plantea

Sub Kingdom: Streptophyta

Superdivison: Embryohyta

Divison: Tracheophyta

Subdivison: Spermatophytia

Class: Magnoliopsida

Superorder: Rosanea

Order: Sapindales

Family: Meliaceae

Genus: *Azadirachta*

Species: *Indica*

Source(The Plants database, databaseversion 4.0.4)

2.2.2: Description:-

Neem (*Azadirachtaindica A. Juss*.) is a multipurpose tree that is highly popular in India, where it provides food and insecticide,and is used for its great number of ethnomedicinal properties. Neem leaves and the oil cake resulting from oil extraction can beused for livestock feeding, but the raw cake is poorly palatable, toxic and requires processing.



2.2.3: Morphology:-

Neem is a medium-sized tree, reaching 15 to 30 m in height, with a large rounded crown up to 10-20 m in diameter. It is mainlyevergreen but sometimes shed its leaves during the dry season (Orwa et al., 2009; Puri, 1999). Neem has a deep taproot andis a mycorrhizal-dependent species. The bark is grey, becomes fissured and flakes in old trees. A sticky foetid sap exudatesfrom old trees in humid climates (Orwa et al., 2009; Puri, 1999). The branches are numerous and spreading. The leaves arealternate, petiolated, clustered at the end of the branches, unequally pinnate, glabrous and dark glossy green at maturity, 20-40 cm in length and bearing 10-20 leaflets (FAO, 2015). The leaflets are 5-10 cm long x 1.2-4 cm broad, sickle-shaped andslightly denticulate (FAO, 2015; Orwa et al., 2009; Puri, 1999). The flowers are numerous, fragrant, white and borne in largeclusters (up to 30 cm long). Neem fruits are 1-2 cm long drupes, smooth and green with white milky juice when unripe, turningto yellow to brown when mature. They have a thin epicarp, a mucilagenous fleshy mesocarp and a hard endocarp. Theycontain a variable number of ovoid (1-2 cm) oil seeds (Orwa et al., 2009; Puri, 1999).

2.2.4: Utilisation:-

Neem is a multipurpose tree. People consume its fruits raw or cooked, and sometimes eat the young twigs and flowers asvegetables (Orwa et al., 2009). Neem leaves, bark and seed

extracts have been used for centuries in India in ethnomedicineand ethnoveterinary medicine (Biswas et al., 2002; Subapriya et al., 2005). The seeds are an important source of azadirachtin,a limonoid compound (triterpenoid) present in the seeds, and also to some

extent in leaves and other tissues. It acts as aninsect repellent, inhibiting them from feeding, thus disrupting their growth, metamorphosis and reproduction (Orwa et al., 2009).Extracts or crude parts of the tree are often mixed with stored seeds such as maize, rice and beans, in order to protect themagainst insects (Boeke et al., 2004). In India, neem-based pesticides have been developed (Orwa et al., 2009). Neem extractscan protect plants from foliage-eating insects without affecting pollinating insects such as honeybees. Other neem limonoidshave various properties. Melantriol and salannin act as antifeedants for insects. Nimbin and nimbindin (the latter a bittercompound present in the seed at 2%) were reported to have antiviral activity (Bostid, 1992). The oil extracted from the seedshas industrial uses and is widely used in ethnomedicine in India. However, it contains various toxic substances (including someadded to increase its alleged therapeutic effect) and has been the cause of the death of children (Jindal et al., 2012;Sundaravalli et al., 1982). Neem provides valuable firewood, makes good charcoal and provides various environmentalservices (Orwa et al., 2009) (see Environmental impact below).
The use of neem products for animal feeding remains limited. While neem leaves can be an occasional forage for ruminants and rabbits, neem seed oil cake, resulting from oil extraction of whole seeds (neem seed cake), or decorticated seeds (neem seed kernel cake), is usually considered as a non-edible oil cake only to be used as organic nitrogenous fertilizer(Ramachandran et al., 2007). Neem seed cake is a protein-rich ingredient and its use by farmers has been recorded, forinstance in Southern India (Christopher, 1970). However, its unpalatability and toxicity have prevented its widespread use inlivestock feeding. This product has been described as a promising potential feed ingredient since the 1970s and there havebeen a considerable number of attempts at rendering it suitable for livestock. While some detoxification processes do work inthe laboratory, the most recent review considered that there were still many technical, economical and food safety issues to besolved before these products could be recommended for livestock (Dutta et al., 2012).

2.2.5: Distribution:-

Neem is native of dry areas of the Indian subcontinent, Myanmar and China (Rojas-Sandoval et al., 2014). It was naturallydistributed in Thailand, Malaysia and Indonesia and has become one of the most widespread trees in tropical and subtropicalareas. It has become invasive in the Caribbean (Puerto Rico, Dominican Republic), sub-Saharan Africa (Kenya, Gambia,Senegal, Guinea Bissau, Ghana, Tanzania), and the Pacific (Australia, Fiji, Marshall Islands) (Rojas-Sandoval et al., 2014).Neem naturally occurs in dry deciduous and thorn forests, or acacia forests. In its exotic range, it has become invasive in anumber of habitats including fallow agricultural land, savannah, and dry arid forests

(coastal forest in Ghana, lowland monsoonforest in Indonesia, evergreen and dry deciduous forest in Africa) (Orwa et al., 2009). Neem can be found from sea level up toan

altitude of 1500 m in places where average annual rainfall ranges from 400 to 1200 mm and where average annualmaximum temperatures may be as high as 40°C. Adult trees tolerate some frost but seedlings are sensitive to it. Neem cangrow on a wide range of soils, from acidic to alkaline pH, but it does better on shallow, stony, sandy, poor soils, in marginalsloping places or on rocky crevices (Puri, 1999). Neem is a full sunlight species but it can withstand some shade in its firstyears (Orwa et al., 2009). Neem is able to extract nutrients from highly leached sandy soils and can survive extreme pHconditions, from 3 to 9 (Rojas-Sandoval et al., 2014). In well-drained soils, neem withstands up to 2500 mm rainfall. Neem hassome tolerance of salinity and has been used in sugarcane plantations with a significant soil salinity (Orwa et al., 2009; Ahmedet al., 1997).

2.2.6: TOXICOLOGICAL EFFECTS:

2.2.6.1: ACUTE TOXICITY:-

The acute oral toxicity in rats fed technical grade azadirachtin ranged from greater than 3,540 mg/kg to greater than 5,000 mg/kg, the highest dose tested when administered undiluted to albino rats (Thomson Publications:1992,Azadirachtin:1993).

The acute inhalation toxicity study in rats exposed to technical azadirachtin showed that the acute inhalation LD50 is greater than 2.41 mg/L per animal, the highest dose tested. Although this figure is below the 5.0 mg/L limit test dose for an acute inhalation study, the reported concentration was the maximum dose possible under the test conditions. No deaths occurred during the course of the study. Azadirachtin was given a toxicity classification of Category III (Azadirachtin:1993).

2.2.6.2: CHRONIC TOXICITY:-

A 90-day oral toxicity study in rats fed levels of 500, 2500, and 10,000 ppm of azadirachtin showed no signs of overt systemic toxicity at any dose level after 90 days of feeding. Mean body weight was significantly decreased in the 10,000 ppm males and females at weeks 3 and 4, respectively. This persisted for the duration of the 90-day feeding period (Agri Dyne 1995).

3-CHAPTER THREE

MATERIAL and METHOD

3.1: Laboratory Experiment:-

The experiment was conducted in Entomology and Agricultural Zoology Laboratory, Department of Plant Protection, College of Agricultural Studies (Shambat), Sudan University of Science and Technology, during August, 2019.The average of temperature and relative humidity is 30°C and 60%, respective.

3.2: Insects Collection and Rearing:-

The mealy bug (*P. solenopsis*) was collected from infested Okra from Shambat area. The insects was reared in plastic cages covered with muslin cloth(Plate 1).The insects were fed on the fresh Okra fruits . The culture was kept under laboratory condition till experiment.

3.3: Collection of Plant Materials:-

The leaves of the Neem plant ware collected from the college of Agricultural studies, Shambat- North Khartoum, Sudan. The leaves of plant were washed and dried under shade for 5-7 days under room condition, and then powdered by using electrical blender. The prepared powder o f Neem was kept safe in plastic bags until used.

3.4: Preparation and Extraction Method:-

Twenty grams of Neem Leaf (*Azadirchta indca*) powders was mixed with 100 ml of water to obtain 20% concentration, also other concentrations (10% and5 %)were prepared using same method. The mixture was kept in plastic containers and left for 24 hrs before treatment (Plate 3).

3.5: The Treatments:-

Three concentrations of Neem water extracts were plus one drop of sesame oil used in this experiment (5 %, 10 % and 20 %) in addition control untying only water. Twenty adults of *P. solenopsis* were placed inside plastic cups containing two pieces of treated okra fruits (Plate 4). Each treatment was replicated four times. One day post treatment the insects provided with fresh okra fruits for feeding. The mortality data were recorded after 1day, 2

days, 3day,4days . Four plastic cups each contains 20 adults were used as untreated control.

3.6: Statistical Analysis:-

The experiment was designed in a Complete Randomized Design (CRD) and the data was statistically analyzed according to analysis of variance (ANOVA) using Statistic 8.0 program. LSD test was used for means separation.

Plate 1. Insects Rearing cage

Plate2 .The plant extract

Plate 4.the treatment

Plate4. Azadirachta indica powder

4-CHAPTER FOUR

RESULTS

4-1Effects of water extract of neem (Azadirachta indica) against the adult of the cotton mealy bug (phenacoccus solenopsis).

As seen in table (1),figure (1).the leaves extract of A.indica gave high significantly different on morality of cotton mealy than the control after 1day ,2day,3day,4day, of exposure.

While no significant difference was observed between concentrations after the same periods of exposure.

4.2 Mortality (%) among Mealy bug (*Pheanococcus solenopsis*) adult treated with *Azadirchta indca* water extract plus one drop of sesame oil .

These results gave clear indication of bioactivity of neem water extract as alternative method for control of phenacoccussolenopsis,also the results showed that tested plant could be one of the promising biocontrol candidates.

Table (1) indicates to the not significantly different from one another of mortality of Mealy bug in all experimental.

Table (1): Mortality (%) among mealy bug (Pheanococcus solenopsis) treated with *Azadirchta indca* water extract plus sesame oil:

Concentration	1st	2st	3st	4st
5%	5%	25%	10%	5%
10%	75%	85%	70%	70%
20%	85%	75%	90%	100%
Control	0	0	0	0

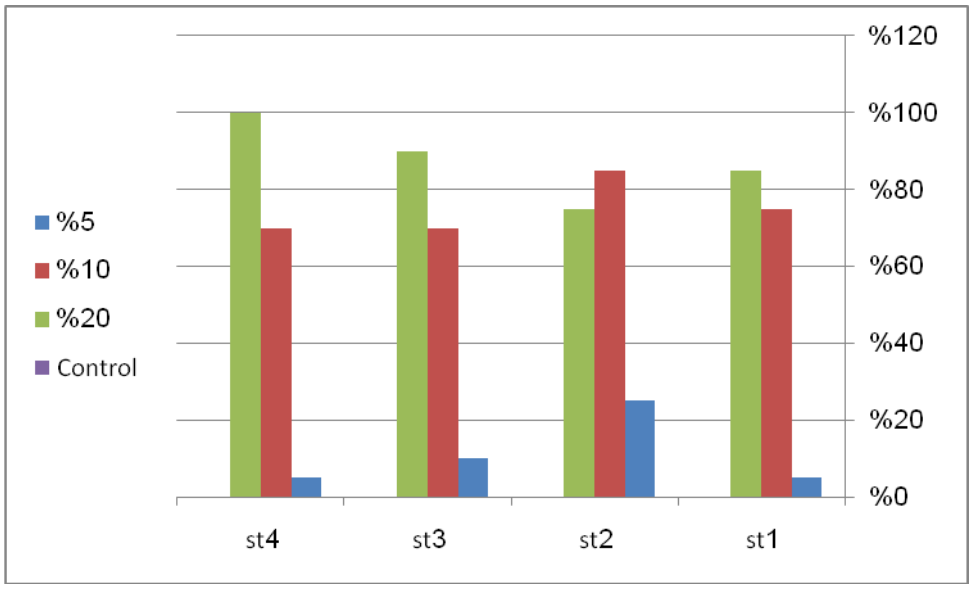

Figure (1): Mortality (%) among mealy bug (Pheanococcus solenopsis) treated with *Azadirchta indca* water abstract plus sesame oil .

5-CHAPTER FIVE

5.1: Discussions and Conclusion:-

The above mentioned result demonstrate that neem leaf extract have a lethal effect against *Phenacoccus solenopsis* .

The present result agreed with *(*Akintola, A.J.andAnde, A.T. (2008) , *)* Ahmed, S. ; Idris, S.,(1997) Christopher, J., (1970)) . the this result disagree(- Cockerell TDA, (1902) ; Krishnamoorthy, K. A. , (1982) , Dhawan AK, Kamaldeep Singh and Ravinder Singh, (2009))this different cud be du different session ,Application method ,different temperature**.**

5.2: Recommendations:-

The leave extract of neem can be recommended to be used for controlling mealy bug *Phenacoccus solenopsis*.

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