الآيـة

بسم الله الرحمن الرحيم

قال تعالى: (مَثَلُ الَّذِينَ اتَّخَذُوا مِنْ دُونِ اللَّهِ أَوْلِيَاءَ كَمَثَلِ الْعَنْكَبُوتِ اتَّخَذَتْ بَيْتًا وَإِنَّ
أَوْهَنَ الْبُيُوتِ لَبَيْتُ الْعَنْكَبُوتِ لَوْ كَانُوا يَعْلَمُونَ (41) إِنَّ اللَّهَ يَعْلَمُ مَا يَدْعُونَ مِنْ دُونِهِ مِنْ
شَيْءٍ وَهُوَ الْعَزِيزُ الْحَكِيمُ (42)

صدق الله العظيم

سورة العنكبوت الآيات (41-42)

DEDICATION

TO my dearest mother and father

To my dear brothers and sisters

To all my family

To all my teachers and friends with

love

&

respect

hend

ACKNOWLEDGMENTS

All thanks are due to Almighty Allah (SWT) who gave me health and strength, and helped me tremendously to produce this work.

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Abstract

Laboratory experiments were conducted at the College of Agricultural Studies of Sudan University of Science and Technology to evaluate the lethal effect of damas *Conocarpus lancifolius* Engl,Castor Bean *Ricinus communis L.* , and korobi *Nerium oleander* against lesser grain borer *Rhyzopertha dominica* (Fabricius) . Three concentrations from each plant (5%, 10% and 15%) were used in this study. The results showed that all concentrations of the tested plants in various formulations gave significantly higher mortality percentage than the control after 24hrsof exposure.

The highest concentration (15%) of powder and 10% concentration of aqueous and ethanolic extract of damas used in this study, caused mortality of 43.3%, 46.7% and 55% respectively after 72 hrs of exposure. Meanwhile, the highest concentrations of castor bean leaves aqueous extract and ethanolic extract generated 60% and 66.7% of mortality respectively after 72 hrs of exposure, whereas, the same concentration of damas leaves ethanolic extract caused 56.7% mortality after 72 hrs of exposure.

The obtained results also revealed that the highest concentrations of nerium leaves powder, aqueous extract and ethanolic extract induced 46.7%, 55% and 58.3% mortality respectively after 72 hrs of application.

ملخص البحث

أجريت تجارب معملية بكلية الدراسات الزراعية, بجامعة السودان للعلوم والتكنولوجيا لتقييم الأثر القاتل لنباتات الدمس *Conocarpus lancifolius* Engl، الخروع *Ricinus communis L.* و ورد الحمير *Nerium oleander* ضد ثاقبة الحبوب الصغري *Rhyzopertha dominica* تم استخدام ثلاثة تراكيز في هذه الدراسة (5%, 10% و15%).

أوضحت النتائج المتحصل عليها أن كل التركيزات المختبرة من كل النباتات بمختلف مستحضراتها أعطت نسب موت عالية مقارنة بالشاهد بعد 24 ساعة من المعاملة.

أعطى أعلى تركيز (15%) من بدرة أوراق الدمس والتركيز (10 %) من المستخلص المائى والايثانولى فقط نسبة موت 43,3%،46,7 % و55% على التوالى بعد 72 ساعة من المعاملة, في حين ان اعلى تركيز من المستخلص المائي والمستخلص الإيثانولي لأوراق الخروع أعطى نسبة موت عالية (60% ، 66,7 %) على التوالى بعد 72 ساعة من المعاملة. وفي سياق متصل, أعطى أعلى تركيز (15%) من المستخلص الايثانولى لأوراق الدمس فقط نسبة موت 56,7% بعد 72 ساعة من المعاملة.

كما أوضحت النتائج المتحصل عليها أن أعلى تركيز (15%) من البدرة، المستخلص المائي و المستخلص الإيثانولي لأوراق ورد الحمير احدث نسبة موت (46,7% ,55% , 58,3%) بعد 72 ساعة علي التوالي.

CHAPTER ONE

INTRODUCTION

Sorghum is an important staple food for many parts of the world, including Africa, Asia, and the drier parts of Central and South America (Dendy, 1995; Rooney and Waniska, 2000). Sorghum, (*Sorghum bicolor* (L.) Moench.) is the principal staple food in the Sudan. Sorghum grown for grain is grouped under many types of local names for example in Sudan these include Feterita, Dura, Wed Ahmed and Tabat.

The newly improved varieties and hybrids of grain sorghum have been produced from these types (Leonard and Martin, 1963). In Sudan sorghum crop occupies about 40% of the Sudan cropped lands. About 90% of these are rain fed areas and lies mainly in lands extending from kassala State in East to North and south Kordofan in the west (Elkhidir , 1982).

World sorghum production during 2009 was about 59 million tons of grain from 40 million ha with an average productivity of 1.4 tone/ha,with the United States, India, Mexico, Nigeria, Sudan, Ethiopia, Australia, and Brazil as major producing countries, in that order (FAO, 2011).

There is a continuous need to protect the stored products against deterioration, especially loss of quality and weight during storage, mainly due to insects and fungi, which usually work in concert. Cereal grains make up the majority of commodities maintained in storage, and represent an important component of the world food supply. After harvest, the grain is usually stored on-farm or in large commercial elevators, where it can be infested by a variety of beetles. Stored-product insects can cause postharvest losses, estimated from 9% in developed countries to 20% or more in developing countries (Phillips and Throne, 2010). Lesser grain borer, *R. dominica* is a field-to-store pest and this may cause economic damage in the store (Adedire, 2001).

R. dominica are strong fliers (Winterbottom, 1922; Hagstrum, 2001) and, therefore, populations in different habitats may mix over large spatial scales.

Presently, insect pests control in stored food products relies on the use of synthetic insecticides which has some hazards such as pollution of the environment, toxic residues on stored grains, development of resistance by target species, pest resurgence and lethal effects on non-target organisms in addition to direct toxicity to users and health hazard (Adedire and Lajide, 2003; Adedire *et al*., 2011; Ileke and Oni, 2011, Udo, 2011; Ileke and Olotuah, 2012; Ileke and Bulus, 2012).

Vegetable oils, plant powders and extracts have been used to reduce post harvest losses of cereals and grain legumes (Odeyemi, 1998; Adedire and Lajide, 1999; Ofuya *et al.,* 2007; Nwaubani and Fasoranti, 2008).

Use of plant parts with insecticidal properties have been reported from all over the world as they are convenient, less expensive, economic , easily available, highly effective and safer for the humans and environment.

These natural insecticides, so called insecticidal plants, present several advantages in relation to synthetic compounds as their rapid biodegradation reducing the risks of environment and food contamination beside the easy way of obtaining and preparation.

Recently in Sudan, many research studies were carried out using extracts of different plants as pesticides of plant origins. This is due to the ease of preparation and application of these compounds as well as their safety and harmless effects on the environment (Schumutterer, *et. al.,* 1995).

As main objective, this study was carried out to evaluate the lethal effect of various extracts of caster Bean (*Ricinus communis*), Korobi (*Nerium oleander*) and Damas (*Conocarpus lancifolius*) against lesser grain borer *R. dominica* (F).While the specific objectives are :-

1- To evaluate the lethal effect of leaves powder, aqueous extract and ethanolic extract of caster Bean (*Ricinus communis*) against lesser grain borer *R. dominica* (F).
2- To evaluate the lethal effect of leaves powder, aqueous extract and ethanolic extract of Korobi (*Nerium oleander*) against lesser grain borer *R. dominica* (F).
3- To evaluate the lethal effect of leaves powder, aqueous extract and ethanolic extract of Damas (*Conocarpus lancifolius*) against lesser grain borer *R. dominica* (F).

CHAPTER TWO

LITERATURE REVIEW

2.1 *Sorghum bicolor* (L. Moench)

2.1.1 Taxonomy

The *Sorghum* genus as currently prescribed consists of 25 species (USDA ARS, 2007), although this varies in different scientific publications confirming the dynamic nature of the classification of cultivated sorghum and its wild relatives. In 1794, Moench established the genus *Sorghum* and brought all the sorghums together under the name *Sorghum bicolor* (House, 1978; Clayton, 1961)**.** All *S. bicolor* subsp. *bicolor* have been classified into five basic races: *bicolor*, *guinea*, *caudatum*, *kafir* and *durra*, with ten intermediate races of these were also recognized (Harlan and de Wet, 1972).

Classification:

Kingdom: Plantae

Division: Magnoliophyta

Class: Liliopsida

Order: Cyperales

Family: Poaceae

S. N: *Sorghum bicolor* (L. Moench)

2.1.2 Description

This is a cane like grass, up to 6m tall with large branched clusters of grains. The individual grains are small- about 3-4 mm in diameter. They vary in colour from pale yellow through reddish brown to dark brown depending on the cultivar. Most cultivars are annuals, few are perennials. *S. bicolor* includes all cultivated sorghums as well as a group of semi wild plants often regarded as weeds. Historical records and archeological data have not been able to clearly state the origin and domestication of *S. bicolor*. Previously 571 cultivars were recognized, however these cross readily without barriers of sterility or difference in genetic balance, therefore it makes sense to group them into a single species. Wild species are characterized by distinct ring of long hairs at the nodes; they have loose inflorescence with spreading branches. The branches of the inflorescence are whorled. The leaves look much like those of maize, they sometimes roll over. A single plant may have more than two leaves. The flower head carries two types of flowers, one type has no stalk and has both male and female parts, and the other flower is stalked and is usually male (Amsalu , and Endashaw, 1998). The bicolor sorghums are characterized by long, clasping glumes at least three-fourths as long as the broadly elliptical grain (Harlan and de Wet, 1972).

2.1.3 Distribution

S.bicolor is an African crop, which is widely distributed throughout the world. Numerous varieties of sorghum were created through the practice of disruptive selection, whereby selection for more than one level of a particular character within a population occurs (Doggett, 1970). These improved sorghum types were spread via the movement of people and trade routes into other regions of Africa, India, and the Middle East and eventually into the Far East. By the time sorghum was transported to America, the diversity of new sorghum types, varieties and races created through the movement of people, disruptive selection, geographic isolation and recombination of these types in different environments would have been large (Wright, 1931;Doggett, 1970). Sorghum types exclusively cultivated for the dye in the leaf sheaths can be found from Senegal to Sudan. Different cultivars are found in different regions depending on the climate. It is adapted to a wider range of ecological conditions.

2.1.4 Ecology

Sorghum [*S. bicolor* (L.) Moench] is the fourth most important cereal crop behind wheat, rice and maize, and is grown throughout the arid and semi-arid tropics (Smith and Frederiksen, 2000). Sorghum is primarily a plant of hot, semi-arid tropical environments that are too dry for maize (Byth, 1993) . It is particularly adapted to drought due to a number of morphological and physiological characteristics, including an extensive root system, waxy bloom on leaves that reduces water loss, and the ability to stop growth in periods of drought and resume it when the stress is relieved. Sorghum tolerates water logging and can also be grown in areas of high rainfall. It tolerates a wide range of temperatures and is also grown widely in temperate regions and at altitudes up to 2300 m in the tropics. The optimum temperature is 25-31 ºC, but temperatures as low as 21 ºC will not dramatically affect growth and yield (Balole, and Legwailia, 2005). For seed germination, the minimum temperature is about 8 ºC, and optimum temperature, 21-35 ºC (Peacock, 1982).

2.1.5 Uses

Sorghum bicolor is an important crop providing food and fodder in the semi-arid tropics of the world. It is a staple food for more than 500 million people in more than 30 countries. The whole plant is used for forage, hay or silage. Sorghum is usually grown as a field crop. In Africa there are two basic types, white sorghum which is sweeter and used as a grain crop and red sorghum, which is less tasty to eat. Sorghum has various applications in African traditional medicine: seed extracts are drunk to treat hepatitis, and decoctions of twigs with lemon against jaundice; leaves and panicles are included in plant mixtures for decoctions against anaemia. The Salka people in Northern Nigeria use sorghum in arrow-poisons. The red pigment is said to have antimicrobial and antifungal properties and is also used as a cure for anaemia in traditional medicine. (Neuwinger, 2000)

2.1.6 Importance of the crop

Sorghum has been domesticated since approximately 3000 year B.C. in Ethiopia region and parts of Congo, with secondary centers region of India, Sudan and Nigeria where it is mainly used for human food (Ayana and Bekele, 1998; Berenji and Dahlberge, 2004). It is extensively grown under rain fed conditions for grain and forage production. High production may be achieved when sufficient water and nutrients are applied especially at critical stages of crop growth. Sorghum is the fifth cereal grown worldwide in terms of both protection and area planted (FAO, 2004). This cereal is known for the nutrition value of it is grains (71% starch, 10%porteins, 3% lipids), which is similar to other cereals.

2.2 Lesser grain borer (*Rhyzopertha dominica*)

2.2.1 Brief Introduction

The lesser grain borer, *R. dominica* (Fab.), is a primary pest,it is a cosmopolitan beetle of the Bostrichidae family. The Bostrychidae family of beetles, most of which are wood boring insects. Adult borers have very powerful mandibles and are voracious and destructive feeders. Lesser grain borer is most common and destructive in tropical, sub-tropical and temperate climates but can spread to any area in transported grain.

2.2.2 Taxonomy

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Super family: Bostrichoidea

Family: Bostrichidae

Genus: *Rhyzopertha*

Species: *dominica*

S.N: *Rhyzopertha dominica* (Fab.)

Common names: Lesser grain borer

2.2.3 Biology

2.2.3.1 Lifecycle (Plate .1): Optimal conditions for life span of lesser grain borer are 25 days at 34 ºC, 70 % R.h. Eggs are laid on the commodity or in tunnels bored by the adults. Potter (1935) provided a detailed description of all life stages of *R. dominica*.

2.2.3.2 Eggs

The egg is typically white when first laid, turning rose to brown before hatching. The egg is ovoid in shape, 0.6 mm in length, and 0.2 mm in diameter.

Eggs are laid singly or in clusters of up to about 20 amongst debris outside grains which may have been damaged by adult feeding. Larvae bore into the grain to complete their development. Under optimum conditions, females lay up to 500 eggs during their lifetime, which may develop to adult in 25 days. Eggs laid in stored commodities at moisture levels as low as 8% can still hatch and develop (Mason, 2003).

2.2.3.3 Larvae

The larvae are white to cream coloured, with biting mouthparts and three pairs of legs. There are usually four larval instars. The larvae are scarabaeiform, the first two instars are not recurved, the third and fourth instars have the head and thorax recurved towards the abdomen. The widths of the head from the first to the fourth instar are 0.13, 0.17, 0.26 and 0.41 mm, and the lengths of the larvae are 0.78, 1.08, 2.04 and 3.07 mm, respectively. The young larvae are mobile in grain bulks but become immobile and gradually more C-shaped as they complete their development and concealed within grain or flour. All larvae will have bored into a grain or other suitable hard substrate by the third instars. Larval development is more rapid on whole grain than on meal made from the same grain and usually takes 27 - 31 days at 28 ºC and 46 days at 25 ºC. Young larvae cannot penetrate undamaged grains (Mason, 2003, Hodges, 1986).

Both larvae and adults produce large numbers of faecal pellets. The larvae push their pellets, along with starch particles, out of infested grains. The pellets have a sweetish, musty odour that easily identifies lesser grain borer infestation.

2.2.3.4 Pupae

The mature fourth instar larva pupates within the feeding cavity inside the grain kernel and gradually assumes the form of an adult.

2.2.3.5 Adult

An adult *R. dominica* is a dark brown to black grain borer which grows up to 3 mm in length and cylindrical. The elytra are parallel-sided, the head is not visible from above, and the pronotum has rasp-like teeth at the front. When the pupal stage is complete, the newly formed adult emerges from the grain by chewing through the outer grain layers. Oviposition begins approximately 15 days after emergence and can last up to 4 months. Females survive for several days after oviposition ceases (Mason, 2003). Only after mating do *R. dominica* females produce large amounts of frass consisting of chewed undigested grains (Hodges, 1986).

2.2.4 Dispersal

R. dominica adults are strong flyers when conditions are warm and are often carried by air currents from infested storages. Adults usually migrate into bulk stored grain through air vents or cracks and crevices in the headspace. After entering a silo or bin, *R. dominica* alights on the grain surface and then gradually moves downwards through the grain mass (Vardeman *et. al*., 2007). Research has shown that these beetles can disperse at least 1000m from a common release site (Jia *et .al*., 2008).

2.2.5 Host Range

The lesser grain borer attacks a wide variety of stored foods including cereals, seeds and dried fruit; almost all grains, particularly wheat, barley, sorghum and rice, commodities such as seeds, drugs, cork, timber and paper products.

2.2.6 Distribution

R. dominica is considered to have originated from South America (Nansen and Meikle, 2002), while Jia *et al*., (2008) suggest that the pest may have originated in tropical regions of the Indian subcontinent, originally as a wood borer before expanding its host range to small grains. It is now a cosmopolitan species, occurring in all areas of the world where grain is produced and stored.

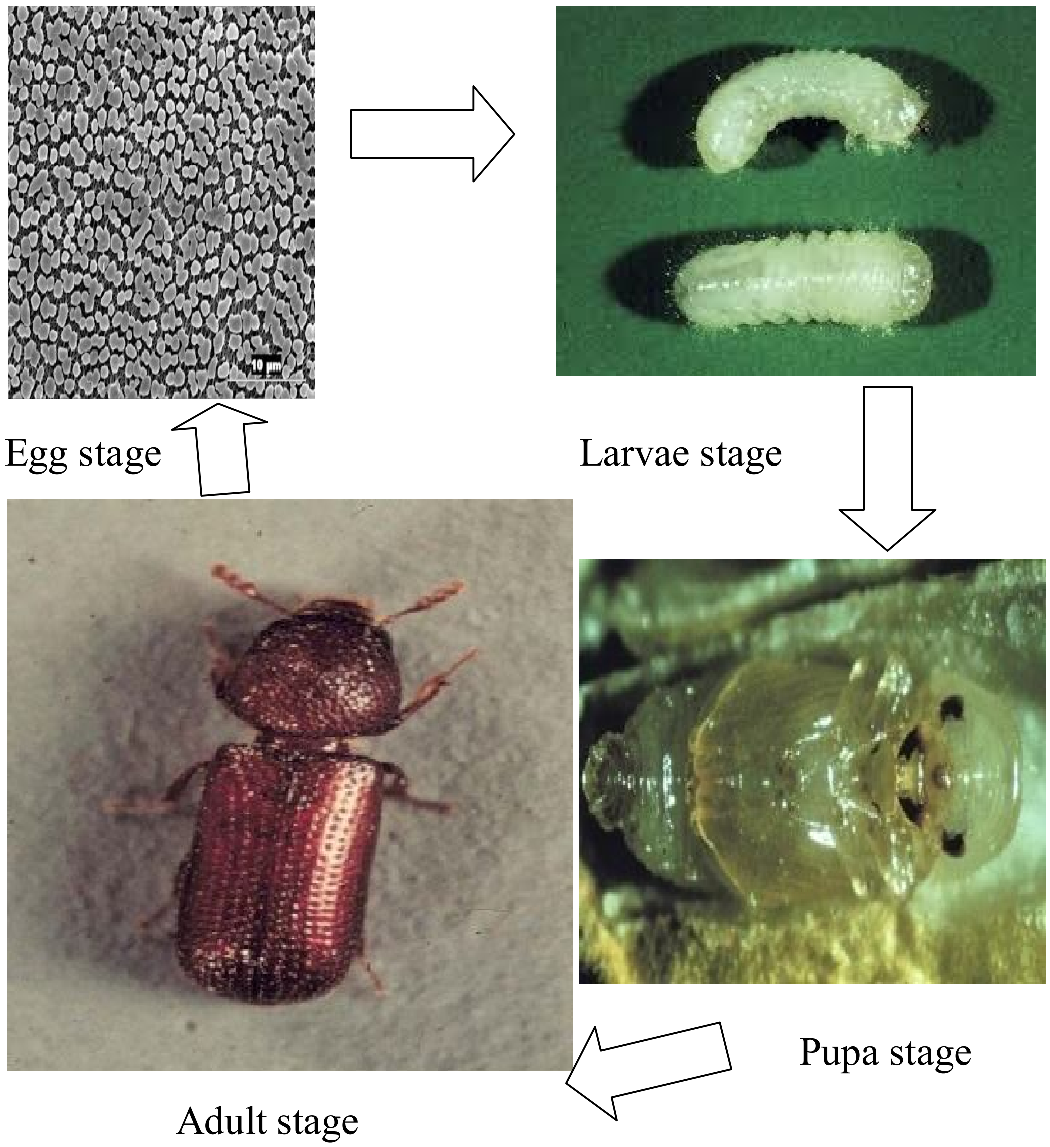

Plate (1) Lesser grain borer *Rhyzopertha dominica*

2.2.7 Commodities infested:

It is a very destructive primary pest of stored grains. While it is common in warmer regions, in temperate regions it is confined to buildings. It is one of the most injurious beetles known to attack grain and is more destructive than the rusty grain beetle and granary weevil. The lesser grain borer attacks a wide variety of stored foods including cereals, seeds and dried fruit; nearly all grains, especially wheat, barley, sorghum and rice; commodities such as seeds, drugs, cork, wood and paper products. Adults and larvae feed on the germ and endosperm which reduces sorghum kernels to shells of bran. They also cause damage by burrowing through the kernel. Signs of infestation include large amounts of flour, tunnels and irregularly-shaped holes in the commodity and a sweet odor in the grain. *R. dominica* infestations can facilitate invasion of a secondary stored product pests such as flour beetles and fungi (Mukherjee and Nandi, 1993).

2.2.8 Impact

R. dominica is pest of several stored products. It is a major pest in wheat and rice. The larvae and adults consume the seed. There are three types of costs associated with infestations of *R. dominica*; loss in quantity of seed stored, loss in quality of seed stored (Williams *et. al*., 1981) and the cost to prevent or control infestations (Brower and Tilton, 1973; Swaminathan,1977).

It is difficult to estimate the costs of *R. dominica* because it is found along with other stored-product insect pests that also cause damage, the most common and serious of these being: *Sitophilus oryzae*, *Trogoderma granarium, Sitotroga cerealella* and *Prostephanus truncatus.* These companion species change, depending upon the region and crop. Fumigation with aluminum phosphide, the most common method of control, will also control all stored-product insects in the grain bulk. The value of grain varies from country to country, as do the costs of control measures. Correspondingly. *dominica* is often the most difficult storage pest to control with grain protectants (Zettler and Cuperus,1990).

2.2.9 Pest Management

2.2.9.1 Physical Control

Manipulation of the temperature by freezing for several days and heating for 24 hours has proved to be effective control methods for stored product pests. Relative humidity, atmospheric composition by, low oxygen and carbon dioxide-enriched atmospheres can be used to control stored product pests. Sanitation, ionizing radiation and the removal of adult insects from the grain, by sieving or air classification, can eliminate infestations of insects such as *R. dominica*, or reduce populations to a tolerable level (Banks and Fields, 1995).

2.2.9.2 ChemicalControl

The insecticides Chlorpyrifos-methyl and pirimiphos-methyl, while effective against most stored grain insect pests, are not very effective against the lesser grain borer. The fumigant phosphine can be used in sealed storage facilities.

2.2.9.3 Biological Control

The use of natural enemies to control *R. dominica* and other stored grain insects has been limited in developed countries because of the low tolerance (0-2 insects/kg grain) for insects in stored grain. However, because of the interest in controlling insect pests without the use of insecticides, there is a renewed interest in predators, parasites and pathogen (Brower *et. al*., 1996). There are a few predators of *R. dominica*. The cadelle *Tenebroides mauritanicus* also feeds on grain, mites and stored-product insect eggs, including *R. dominica* (Bousquet, 1990). The predatory mites, *Cheyletus eruditus* and *Pyemotes ventricosus* feed on a wide variety of stored product insect eggs (Asanov, 1980), but their effect on populations in the field has not been determined. The fungus *Beauveria bassiana* can be used as a biological insecticide. The first report of toxicity of *Bacillus thuringiensis* (Bt) in *R. dominica* was in adults from a spore/crystal preparation of Bt var. *tenebrionis* (Btt, DSM-2803) on broken wheat (Mummigatti *et .al*., 1994), with 86% mortality after 30 days with a dose of 250 ppm.

2.2.9.4 Botanical Control

The Indian neem plant is the most well-known example and its various parts, namely, leaves, crushed seeds, powdered fruits, oil, and so forth, have been used to protect stored grain from infestation (Talukder,*et .al*., 2004), Devi and Mohandas, 1982). Indian farmers used neem leaves and seeds for the control of stored grain pests (Weaver, *et. al*., 1991). The neem oil and kernel powder gave effective grain protection against stored grain insect pests like *Rhyzopertha dominica*, and *Callosobruchus chinensis* at the rate of 1 to 2% kernel powder or oil (Pereira and Wohlgemuth, 1982). Azadirachtin is an active principle from the neem plant, which is an effective grain protectant against insect infestation (Schmutterer, 1990). In parts of eastern Africa, leaves of some plants and allelochemicals including azadirachtin, nicotine, and rotenone have traditionally been used as grain protectants (Talukder, 2006), Hassanali, *et al*., 1990). The powders of *Rauvolfia serpentina, Acorus calamus,* and *Mesua ferrea* are used as a grain protectant against *Rhyzopertha dominica* (Tiwari, 1994).

2.3 Damas

2.3.1 Brief Introduction

Family Combretaceae comprises about 20 genera and about 600 species found in tropical and subtropical regions of the world. The family has few genera with great economic value, an useful timber is obtained from some species belong to it and other species has medicinal importance. Damas *Conocarpus lancifolius* Engl is one of the most important species in this family (Pandey and Misra, 2008).

2.3.2 Classification

Kingdom: Plantae

Phylum: Tracheophyta

Class: Magnoliopsida

Order : Myrtales

Family : Combretaceae

S. N. : *Conocarpus lancifolius* Engl.

2.3.3 Botanical Description

Damas is an evergreen tree that grows up to 20 m in height and 60 - 250 cm or more in diameter. However, it is believed that the larger trees have now been almost entirely felled. Whereas it is usually a multi-branched tree in its natural habitat, trees planted in the Sudan formed a single, straight stem (NAS, 1983). Bark is grey-brown, fissured and the leaves are smooth and shiny, about 10 cm long, narrowing towards the base (lanceolate) , in dense spirals. Flowers are yellow-green, in round heads on branched stalks, slightly fragrant and its fruit exist in dry, round,

Plate (2) *Conocarpus lancifolius* plant greenish heads, cone-like, containing tiny, scale-like hard seeds (Bein *et. al*., 1996).

2.3.4 Geographical distribution

Natural stand of Damas are found beside intermittent watercourses of northern Somalia and in the southwest part of the Arabian Peninsula. Some of these streams are salty and some sulphurous. The tree is also cultivated in Somalia, as it is in Djibouti, Sudan, Kenya, North and South Yamen, and Pakistan . A small plantation has been established in Sudan-Khashm El-girba arboretum. However about 10000 trees have been planted successfully in limestone near Mombasa, Kenya (NAS, 1983).

2.3.5 Economic importance

C. lancifolius is multipurpose plant; wood which is the main product is used domestically for house construction, firewood and excellent charcoal. Commercially timber was more useful formerly; it was cut and exported from Somalia to Arabia for construction. Other potential uses include wood based board. Bark may be a useful source of tannins (Booth and Wickens, 1993).

The tree is evergreen and its foliage makes a good fodder, also it is a good shade and roadside tree. It is used as wind breaks around irrigated agricultural areas and for avenue planting. A drought-resistant species, *C. lancijolius* is one of the more promising trees for trials in arid areas. It is recommended for a variety of soil types including saline soils, and yields excellent charcoal and valuable wood (NAS, 1983).

Information on the importance of *C. lancifolius* in its native distribution areas relative to other species with similar wood, fuel and forage uses is lacking hence it is difficult to assess its importance. However Somali tribe owing the Damas (Tugs) dry river valleys (wadis) containing *C. lancifolius* have restricted cutting because of the threat of overexploitation (Booth, and Wickens, 1993).

2.3.6 Environmental Requirements

Damas grows best in areas where the mean annual temperature ranges from 20°c -30°c, but where the maximum summer temperature has reached 50°c, the tree grows from sea level up to about 1000 m. The rainfall in its natural habitat is generally between 50 mm and 400 mm, but the tree grows mainly along seasonal watercourses. It can be grown in plantations in areas with less than about 400 mm but grows well only if irrigated or within reach of groundwater. It withstands drought conditions for several months when irrigation fails. Damas does well on deep soils ranging from pure sand to clays and loams, but has difficulty on shallow soils. It will tolerate moderately saline soils (NAS, 1983).

Damas trees are often dominant in dry river valleys (wadis) in Somalia. It is now cultivated as it is one of the fastest growing trees in very dry areas. It tolerates sandy, saline and coral soils (Bein *et. al*., 1996)

2.4 Castor bean

2.4.1 Brief Introduction

The castor plant, *Ricinus communis*, is a plant species of the Euphorbiaceae and the sole member of the genus Ricinus and of the sub tribe Ricininae. Its seed is the castor bean which, despite its name, is not a true bean .Castor seed is the source of castor oil, which has a wide variety of uses. The seeds contain between 40% and 60% oil that is rich in triglycerides, mainly ricinolein (Doan, 2004).

2.4.2 Classification

Kingdom:Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order:Euphorbiales
Family: Euphorbiaceae
Genus:*Ricinus*L.
Species: *communis* L.
Common name: Castor Bean

2.4.3 Description

Coarse perennial, 10–13 m tall in the tropics, with the stem of 7.5–15 cm in diam., but usually behaves as an annual in the temperate regions 1–3 m tall; stems succulent, herbaceous, very variable in all aspects; leaves alternate, orbicular, palmately compound, with 6–11 toothed lobes, glabrous; flowers numerous in long inflorescences, with male flowers at the base and female flowers at the tips, petals absent in both sexes; fruit is a globose capsule 2.5 cm in diameter, on an elongated pedicel, usually spiny, green turning brown on ripening, indehiscent in modern cultivars, usually containing 3 seeds; seeds ovoid, tick-like, shiny, 0.5–1.5 cm long, vari-color with base color white, gray, brownish, yellow, brown, red, or black, with the outer pattern gray or brown to black, the pattern varying from fine to coarse, veined or finely dotted to large splotches, poisonous and allergenic (Reed, 1976).

2.4.4 Distribution

Probably native to Africa, Castor bean has been introduced and is cultivated in many tropical and subtropical areas of the world, frequently appearing spontaneously. Although castor is indigenous to the Southeastern Mediterranean Basin, Eastern Africa, and India, today it is widespread throughout tropical regions (Phillips, 1999). In areas with a suitable climate, castor establishes itself easily where it can become an invasive plant and can often be found on wasteland. India, China, Brazil, USSR, Argentina, Thailand, Philippines are the main countries known for castor production. This species can be growing very well in all parts of Sudan.

2.4.5 Ecological Requirements

Castor is essentially a warm season crop, cultivated in tropical, subtropical and temperate regions. It grows in tropical and subtropical regions as a perennial plant and in temperate climate as an annual plant. A moderate temperature of 20-26C° is highly favorable during crop period for obtaining higher yields. A well distributed rainfall of 500-600 mm, during growing period will yield reasonably good yields. Castor can withstand long dry spells as well as heavy rains but is highly susceptible to water logged conditions. It grows in dry and mesic habitats from sea level to 1,200 m (Smith, 1985). Seeds are toxic.

Plate (3) *Ricinus communis* plant

2.4.6 Castor bean plant contents

Ricin toxin, is one of the most toxic and easily produced plant toxins worldwide (Thomas and Steven, 1980; Bojean, 1991; Ogunniyi, 2006). However, very few studies have been conducted to investigate the pesticidal activity of *R. communis*. The very limited data on toxicity against target insects comprise mainly information on aqueous extract of castor bean products rather than on its oil. Aouinty *et al*. (2006) demonstrated high larvicidal activity of aqueous extracts from leaves of *R. communis* against four mosquito species, *Culex pipiens* (L.), *Aedes caspius* (Pallas), *Culiseta longiareolata* (Aitken) and *Anopheles maculipennis* (Meigen).

2.4.7 Uses

Castor bean is cultivated for the seeds which yield a fast-drying, non-yellowing oil, used mainly in industry and medicines. Leaves applied to the head to relieve headache and as a poultice for boils. (Duke and Wain, 1981). The oil used in coating fabrics and other protective coverings, in the manufacture of high-grade lubricants, transparent typewriter and printing inks, in textile dyeing, in leather preservation, and in the production of 'Rilson', a polyamide nylon-type fiber (when converted into sulfonated Castor Oil or Turkey-Red Oil, for dyeing cotton fabrics with alizarine). Dehydrated oil is an excellent drying agent which compares favorably with tung oil and is used in paints and varnishes. Hydrogenated oil is utilized in the manufacture of waxes, polishes, carbon paper, candles and crayons. 'Blown Oil' is used for grinding lacquer paste colors, and when hydrogenated and sulfonated used for preparation of ointments. Castor Oil Pomace, the residue after crushing, is used as a high-nitrogen fertilizer. Although it is highly toxic due to the ricin, a method of detoxicating the meal has now been found, so that it can safely be fed to livestock. Stems are made into paper and wallboard (Reed, 1976).

2.4.8 Other uses

Extract of *Ricinus communis* exhibited acaricidal and insecticidal activities against the adult of *Haemaphysalis bispinosa* Neumann (Acarina: Ixodidae) and hematophagous fly *Hippobosca maculata* Leach (Diptera: Hippoboscidae) (Zahir *et al.*,2010).

2.5 Korobi (*Nerium oleander*)

2.5.1 Brief introduction

Nerium oleander is an evergreen shrub or small tree in the dogbane family Apocynaceae, and it is toxic in all its parts. It is the only species currently classified in the genus *Nerium*. It is most commonly known as oleander, from its superficial resemblance to the unrelated olive *Olea*. It is so widely cultivated that no precise region of origin has been identified, though Southwest Asia has been suggested **(**Blum , and Rieders , 1987).

2.5.2 Taxonomy

Kingdom: Plantae

Phylum: Tracheophyta

Class: Equisetopsida

Order: Gentianales

Family: Apocynaceae

Genus: *Nerium*

Species: *oleander* (L.)

2.5.3 Description of the plant

N. oleander is an evergreen shrub reaching four meters in height. Leaves are 10 to 22 cm long, narrow, untoothed and short-stalked, dark or grey-green in colour. Some cultivars have leaves variegated with white or yellow. All leaves have a prominent mid rib, they are "leathery" in texture and usually arise in groups of three from the stem.

The plant produces terminal flower heads, usually pink or white, however, 400 cultivars have been bred and these display a wide variety of different flower colour deep to pale pink, lilac, carmine, purple, salmon apricot, copper, orange and white (Huxley, 1992). Each flower is about 5 cm in diameter and five-petalled. The throat of each flower is fringed with long petal-like projections. Occasionally double flowers are encountered amongst cultivars. The fruit consists of a long narrow capsule 10 to 12 cm long and 6 to 8 mm in diameter; they open to disperse fluffy seeds. Fruiting is uncommon in cultivated plants.

The plant exudes a thick white sap when a twig or branch is broken or cut (Font-Quer, 1979; Schvartsman,1979; Lampe and McCann, 1985; Pearn, 1987).

2.5.4 Distribution and Habitat

N. oleander is cultivated worldwide as an ornamental plant; it is native only in the Mediterranean region (Kingsbury, 1964; Hardin and Arena,1974).

It is widely cultivated particularly in warm temperate and subtropical regions where it grows outdoors in parks, gardens and along road sides.

2.5.5 Poisonous parts

All parts of this plant are toxic, including the sap, either fresh, dried or boiled. A single leaf intensively chewed has been reported to be lethal.

2.5.5 Main toxins

The main poisonous principles are cardiac glycosides. *N. oleander* contains at least 2% cardiac glycosides. The one most studied is oleandrin, but there are more than ten other glycosides whose chemical structure is well known.

Toxicity studies of animals administered oleander extract, concluded that rodents and birds were observed to be relatively insensitive to oleander

Plate (4): *Nerium oleander L.*plant

cardiac glycosides. (Szabuniewicz , *et. al*.,1972).Other mammals, however, such as dogs and humans, are relatively sensitive to the effects of cardiac glycosides and the clinical manifestations of "glycoside intoxication".

2.5.7 Other chemical contents of the plant

Rosagenin may be extracted from the bark and has a strychnine-like action. Several flavones (0.5%) and volatile oils (unimportant amount), as well as rubber, fats, sugars and hydrocyanic acid, can be isolated from its leaves (Schvartsman, 1979; Shaw and Pearn, 1979; Pearn, 1987).

2.5.8 Uses

Oleander grows well in warm subtropical regions, where it is extensively used as an ornamental plant in landscapes, in parks, and along roadsides. It is drought-tolerant and will tolerate occasional light frost down to −10 °C (14 °F). (Huxley, 1992).

Preparations containing the active principles were used formerly as rodenticides and insecticides. Therapeutic use of oleander glycosides as cardiac drugs were assessed and documented in the 1930s (Shaw and Pearn, 1979; Osterloh *et. al*., 1982).

CHAPTER THREE

MATERIALS AND METHODS

These experiments were carried out at the College of Agricultural Studies- Shambat Sudan University of Science and Technology (SUST) under laboratory conditions. The study evaluated the effects of different leaves extracts of damas *Conocarpus lancifolius*, castor bean *Ricinus communis* L. and korobi *Nerium oleander* for controlling the lesser grain borer *Rhyzopertha dominica*.

3.1 Mass culturing of insects

Rhyzopertha dominica (F) was obtained from a culture established in the laboratory, insects were reared in plastic cages on sorghum grains under laboratory conditions. The culture was kept in the laboratory at normal room temperature (32 – 37°C) and 70% R.H).

3.2 Preparation of leaves powder of plants

Leaves of all plants were collected from Shambat area. The three plants leaves were washed and left under shade to dry in the laboratory for about 3-10 days .The dried plant leaves were crushed lightly by hand and then ground by an electric blender. The leaves powder of each plant was kept in glass jars until used.

3.3 The aqueous extracts of plant powder

The aqueous solutions of three plant were prepared by adding (10 ,20 and 30 gram) of leaves powder with 200 ml distilled water of each plant powder in a conical flask , and the solution was shaken for ten minutes, and after a period of 24 hours, the mixture was then filtered by using a filter paper to give aqueous solutions of 5,10 and 15% concentration . The filtrate solutions were kept in normal refrigerator until used.

3.4 Preparation of ethanol extracts

Extraction processes were conducted at the Environment and Natural Resources Research Institute (ENRRI), National Research Center (NRC). Fifty grams of each of the previously prepared powder of each plant were placed in a template and it was placed in a Soxhlet extractor apparatus, and the extraction was made with 300 ml of ethanol for each sample. The extraction continued for six hours, and the ethanol solvent was removed off the crude extract by Rotary evaporator. The obtained extracts were stored in a refrigerator until used for the experiments.

3.5 Treatment with plant powders

Twenty grams of sorghum grains were weighted and placed in plastic pots. The leaves powder of each plant was tested at 1, 2 and 3 grams to obtain (5%, 10%, and 15%) (W/W) concentration and were added to the plastic pots containing sorghum grain. Untreated twenty grams of sorghum were placed in plastic pots as control. Twenty newly emerged adult of *R. dominica* were then introduced in each plastic pots. Three replicates were made with each concentration. All plastic pots were closed with covers by muslin. The number of dead insects in each plastic pot was counted after 24, 48 and 72 hours.

Plate (5): Soxhelt Extractor Apparatus

Plate (6): Rotary Evaporator

3.6 Treatment **with aqueous extracts**

Treatments with aqueous extract of three plants of all concentrations (5%, 10% and 15% W/V) were made with three replicates. The control was treated with distilled water. Twenty grams of sorghum were treated with each concentration, the treated sorghum seeds were placed in Petri dishes (9cm diameter) and allowed to dry for one hour and placed in plastic pots. Twenty newly emerged adults of *R. dominica* were placed in each plastic pots for the experiment. The number of dead insects was counted every 24hours for three days.

3.7 Treatment with ethanol extracts

Concentrations of 5%, 10% and 15% of leaves ethanol extract were added on 95%, 90% and 85% distillated water. The treated seeds were allowed to dry for one hour. After that the treated seeds were taken in plastic pots and then twenty newly emerged adult of *R. dominica* (F.) .were introduced in each plastic pots. The treatments were replicated three times. Untreated twenty grams of sorghum were placed in plastic pots as control. The number of dead insects in each plastic pot was counted after 24, 48 and 72 hours.

3.8 The standard insecticide (Cypermethrin)

A standard insecticide Cypermethrin 25% E.C. (Emulsifiers and solvents) was used as standard for comparison with effects of botanical extracts.

3.9 Statistical analysis and Experimental Desgin

The data recorded for percent mortality of different treatments were subjected to statistical analysis using statistical software (Statistix 10). Means were compared using LSD test (Steels and Torrie, 1960).All treatments were replicated three times in Completely Randomized Design (CRD).

Plate (7) Experimental Desgin

CHAPTER FOUR

RESULTS

4.1 Effect of damas against lesser grain borer

The data presented in Table (1), Fig. (1, 2 and 3) and appendices (Tables1, 2,3 and 4) revealed that all tested concentrations gave significantly higher mortality percentage than the control after 24 hrs of exposure. It is interesting to note that there is no significant different between the lowest concentration (5%) of powder and aqueous extract of damas that revealed 15% and 18.3% mortality respectively after 24 hrs of application. Similarly there is no significant different between the highest concentration (15%) of powder and 10% concentration of aqueous and 10% concentration of ethanolic extract of damas used in this study , the results obtained were 31.7%,30%and 35% mortality respectively. There is no significant difference in mortality percentage caused by 10%, 15% concentration of each of aqueous and ethanolic extract of damas which generate 46.7% and50% mortality respectively after 48 hrs of exposure. The highest concentration (15%) of damas aqueous extract revealed 53.3% and there is no significant difference noticed compared with the same concentration of damas leaves ethanolic extract after 72 hrs of exposure which score 56.7% mortality. However, the standard insecticide Cypermethrin generated higher mortality percentage of 100% throughout the experimental period.

All formulations showed that lesser grain borer, *R. dominica* mortality increased with increase in the concentration and exposure time.

Table 1. Effect of different *Conocarpus lancifolius* formulations and concentrations on mortality percentage of *R. dominica*

	Formulation		
	Powder		
	Times (hours)		
Concentration	**24h**	**48h**	**72h**
5	15.0 k	23.3 ij	35.0 fg
10	21.7 ij	30.0 gh	41.7 de
15	31.7 gh	43.3 de	43.3 de
	Aqueous		
5	18.3 jk	30.0 gh	38.3 ef
10	30.0 gh	46.7 cd	46.7 cd
15	38.3 ef	50.0 bc	53.3 ab
	Ethanolic		
5	26.7 hi	33.3 fg	43.3 de
10	35.0 fg	46.7 cd	55.0 ab
15	43.3 de	50.0 bc	56.7 a
	Control		
	0.0 l	**0.0 l**	**0.0** l
	Standard		
Standard	**100.0**	**100.0**	**100.0**
SE±		**2.8**	
C.V.(%)		**12.05**	

Means followed by the same letters with in the same columns are not significantly different at (P<0.05).

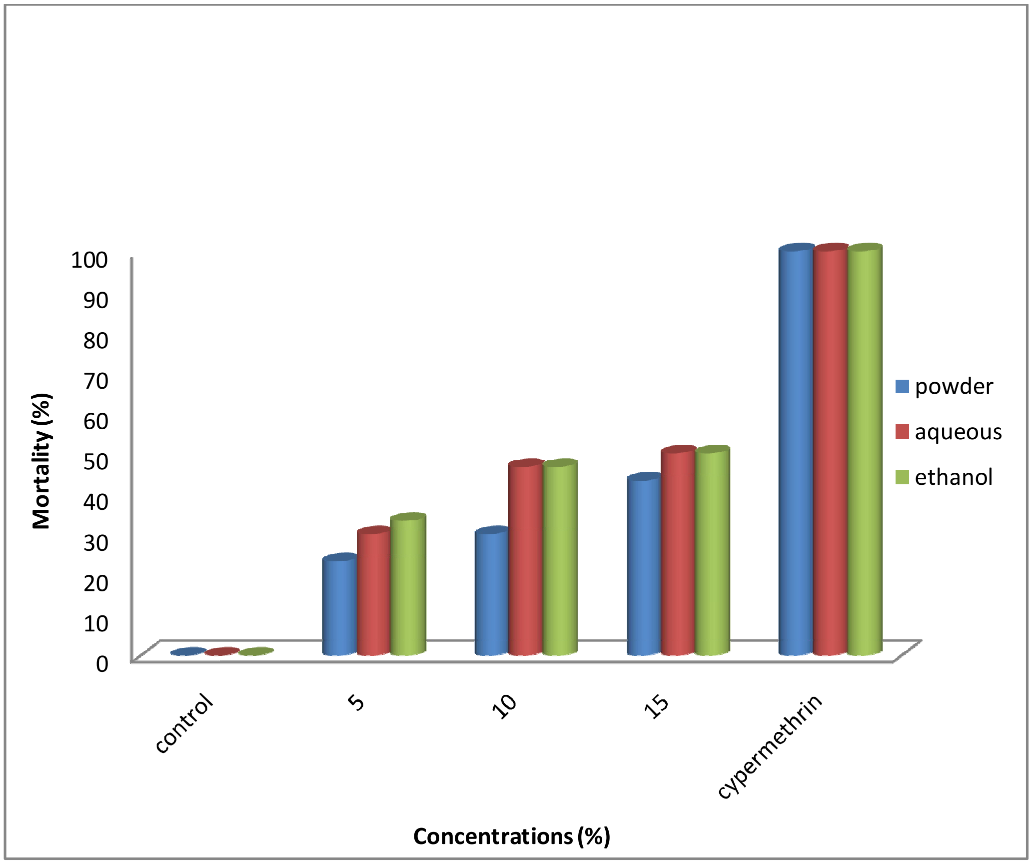

Fig. (1) Effect of damas against lesser grain borer *Rhyzopertha dominica* after 24 hrs.

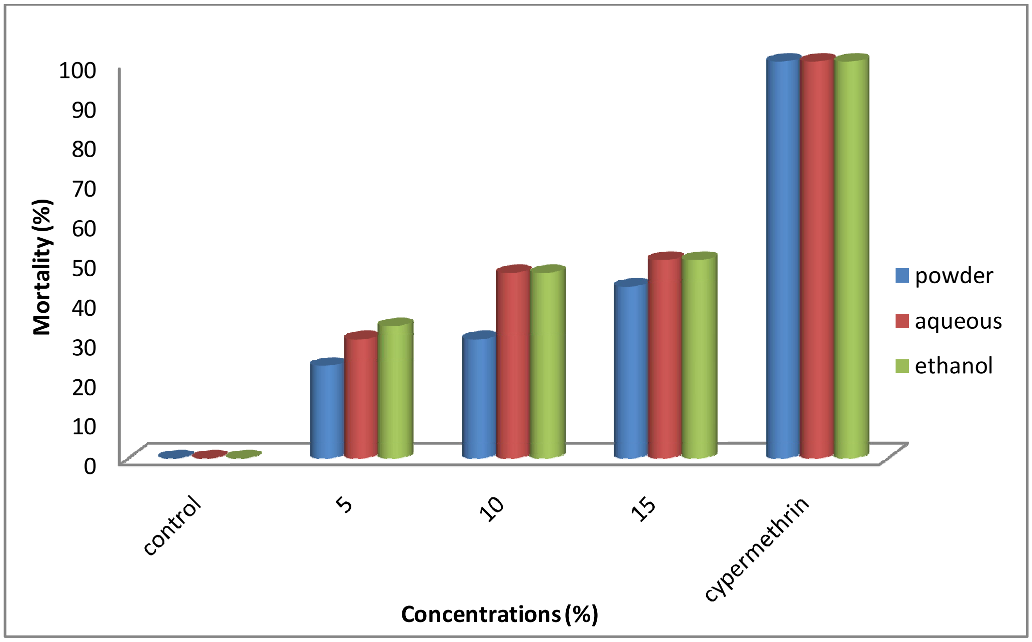

Fig. (2) Effect of damas against lesser grain borer *Rhyzopertha dominica* after 48 hrs.

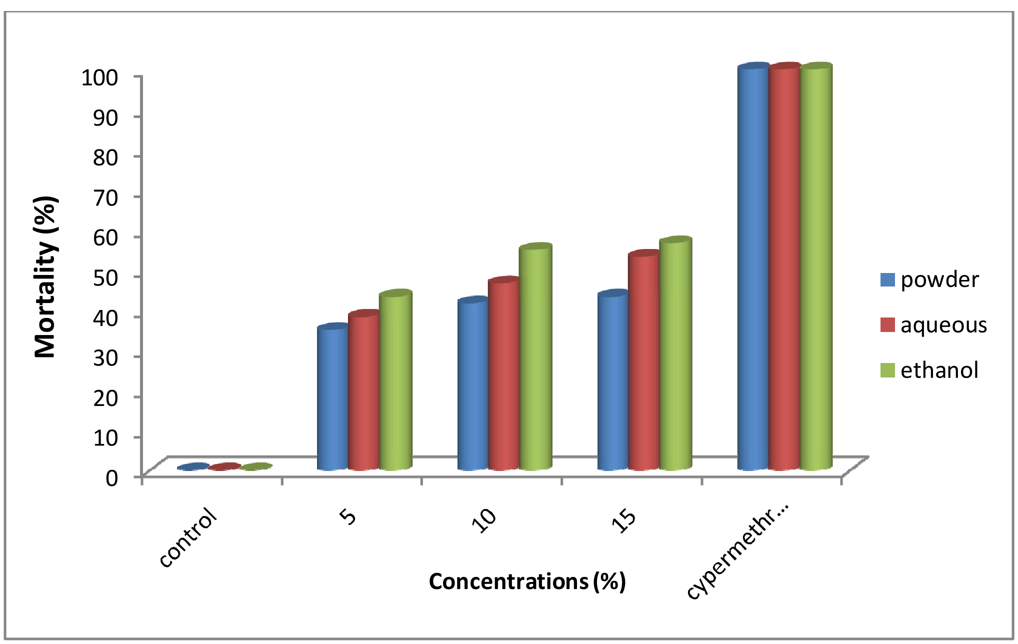

Fig. (3) Effect of damas against lesser grain borer *Rhyzopertha dominica* after 72 hrs.

4. 2 Effect of castor bean against lesser grain borer

The results exhibited in Table (2), Fig. (4, 5 and 6) and appendices (tables 5, 6,7 and 8) Showed that the lowest concentration of caster bean ethanolic extract generate 40% mortality after 24 hrs of exposure with no significant difference compared with the highest concentration of aqueous extract which scored 41.7% mortality. The results also revealed that 5% concentration of caster bean ethanolic extract scored 48.3% mortality after 48 hrs of application which significantly not different from the highest concentration (15%) of powder and aqueous extract of castor bean. The same trend continued after 72 hrs of exposure. Whereas, the standard insecticide Cypermethrin revealed higher mortality percentage of 99.4% throughout the experimental period.

Table 2. Effect of different castor bean formulations and concentrations on mortality percentage of *R. dominica*

Formulation			
Powder			
	Times (hours)		
Concentration	**24h**	**48h**	**72h**
5	18.3 p	26.7 o	35.0 lm
10	25.0 o	35.0 lm	48.3 fgh
15	33.3 mn	45.0 hij	55.0 cde
Aqueous			
5	28.3 no	38.3 klm	51.7 efg
10	35.0 lm	48.3 fgh	56.7 cde
15	41.7 ijk	53.3 def	60.0 bc
Ethanolic			
5	40.0 jkl	48.3 fgh	58.3 bcd
10	43.3 hijk	56.7 cde	63.3 ab
15	46.7 ghi	63.3 ab	66.7 a
Control			
	0.0 q	**0.0 q**	**0.0 q**
Standard			
Standard	**100.0**	**100.0**	**98.3**
SE±		**2.57**	
C.V.(%)		**9.3**	

Means followed by the same letters with in the same columns are not significantly different at (P<0.05).

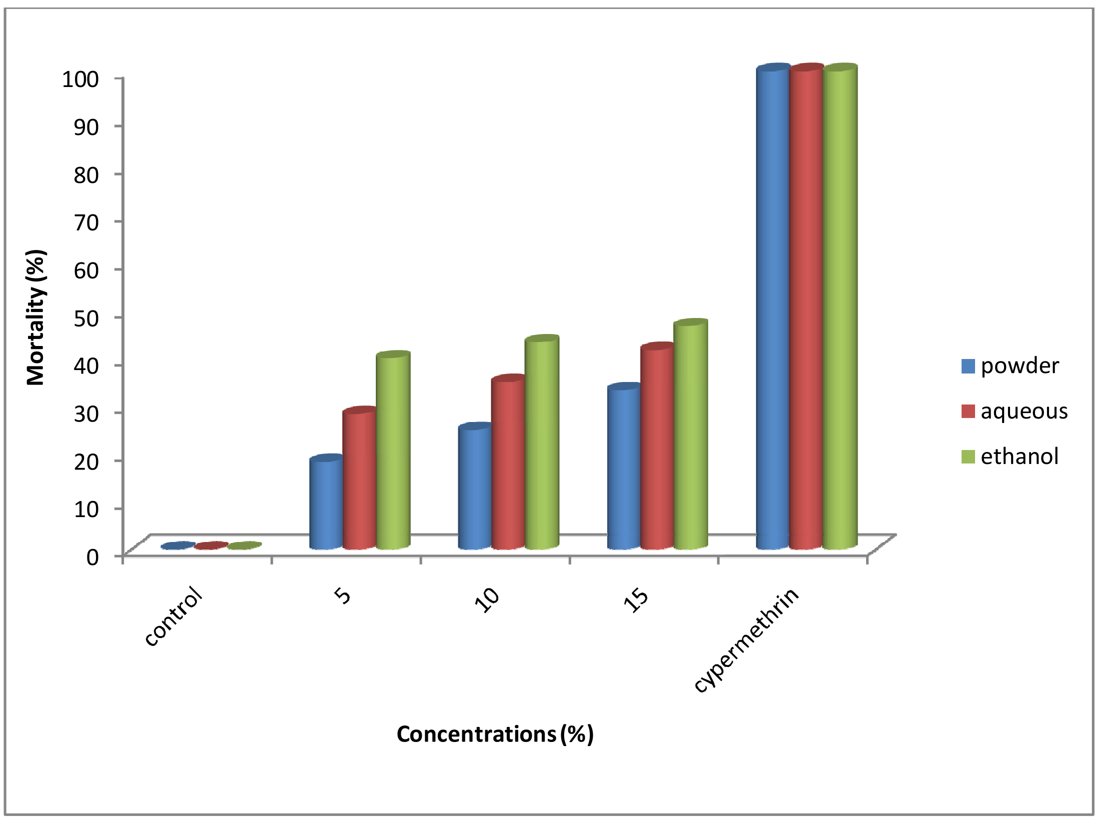

Fig. (4) Effect of castor bean against lesser grain borer *Rhyzopertha dominica* after 24 hrs.

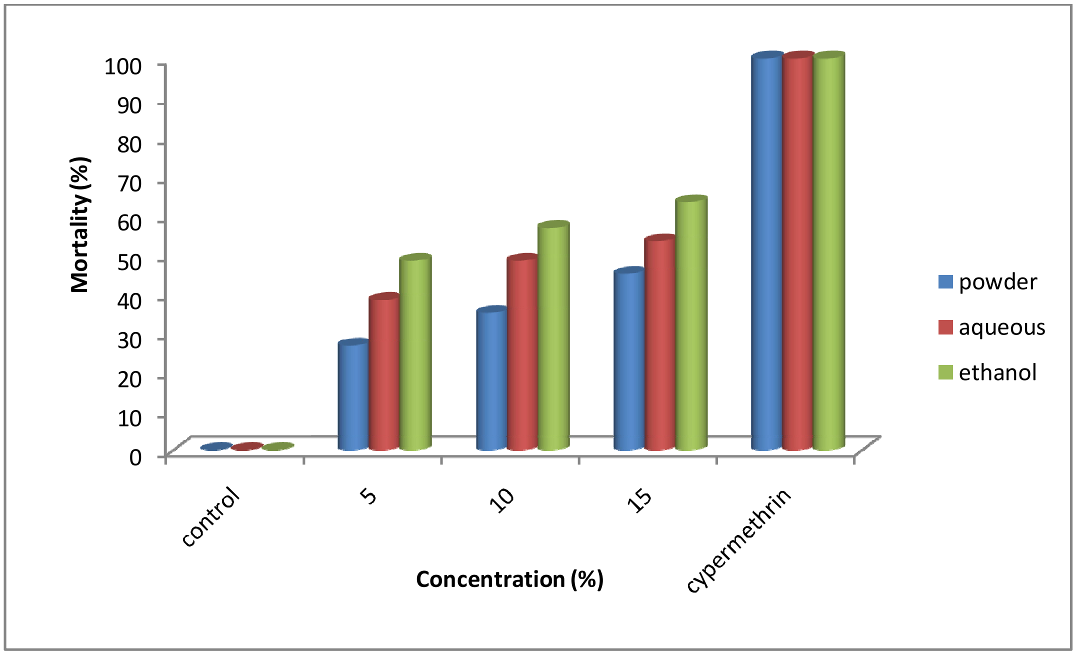

Fig. (5) Effect of castor bean against lesser grain borer *Rhyzopertha dominica* after 48 hrs.

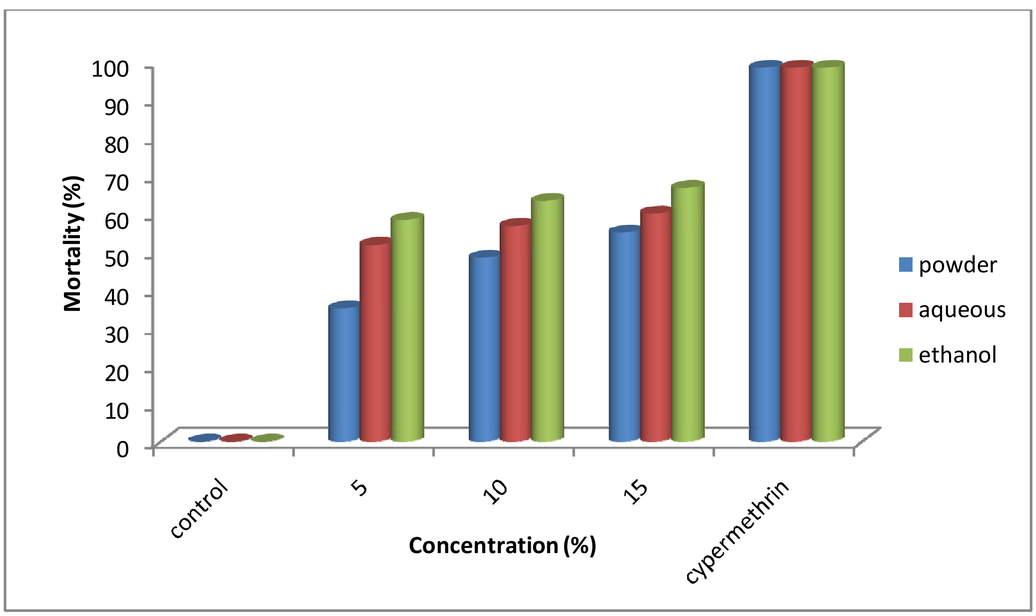

Fig. (6) Effect of castor bean against lesser grain borer *Rhyzopertha dominica* after 72 hrs.

4.3 Effect of nerium against lesser grain borer

As seen in table (3), Fig. (7, 8 and 9) and appendices (tables 9, 10,11 and 12) that the lowest concentration of nerium ethanolic extract generate 36.7% mortality after 24 hrs of exposure which significantly not different from the highest concentration of nerium leaves powders which score 31.7% mortality. Similarly there is no significant difference between the highest concentration (15%) of aqueous extract and ethanolic extract of nerium which generate 45% and48.3% mortality after 24 hrs of exposure.

The lowest concentration (5%) of each of nerium aqueous extract and ethanolic extract, generate 43.3% and 46.7% mortality respectively after 48 hrs of exposure with no significant difference compared with the highest concentration of nerium leaves powders which score 40% mortality.

It can also be noted that, there is no significant difference between the lowest concentration (5%) of nerium aqueous extract which generate 48.3%mortality after 72 hrs of exposure and the highest concentration (15%) of nerium leaves powders which score 46.7% mortality at the same period of exposure. However, the standard insecticide Cypermethrin generated higher mortality percentage of 99.4% throughout the experimental period.

Table 3: Effect of different *Nerium olender* formulations and concentrations on mortality percentage of *R. dominica*

Formulation			
Powder			
	Times (hours)		
Concentration	**24h**	**48h**	**72h**
5	18.3 m	26.7 kl	38.3 ghi
10	23.3 lm	33.3 ij	43.3 efg
15	31.7 jk	40.0 fgh	46.7 de
Aqueous			
5	31.7 jk	43.3 efg	48.3 cde
10	36.7 hij	48.3 cde	51.7 bcd
15	45.0 ef	51.7 bcd	55.0 ab
Ethanolic			
5	36.7 hij	46.7 de	53.3 abc
10	38.3 ghi	53.3 abc	55.0 ab
15	48.3 cde	56.7 ab	58.3 a
control			
	0.0 n	**0.0** n	**0.0** n
Standard			
Standard	**100.0**	**98.3**	**100.0**
SE±		**2.6**	
C.V.(%)		**9.9**	

Means followed by the same letters with in the same columns are not significantly different at (P<0.05).

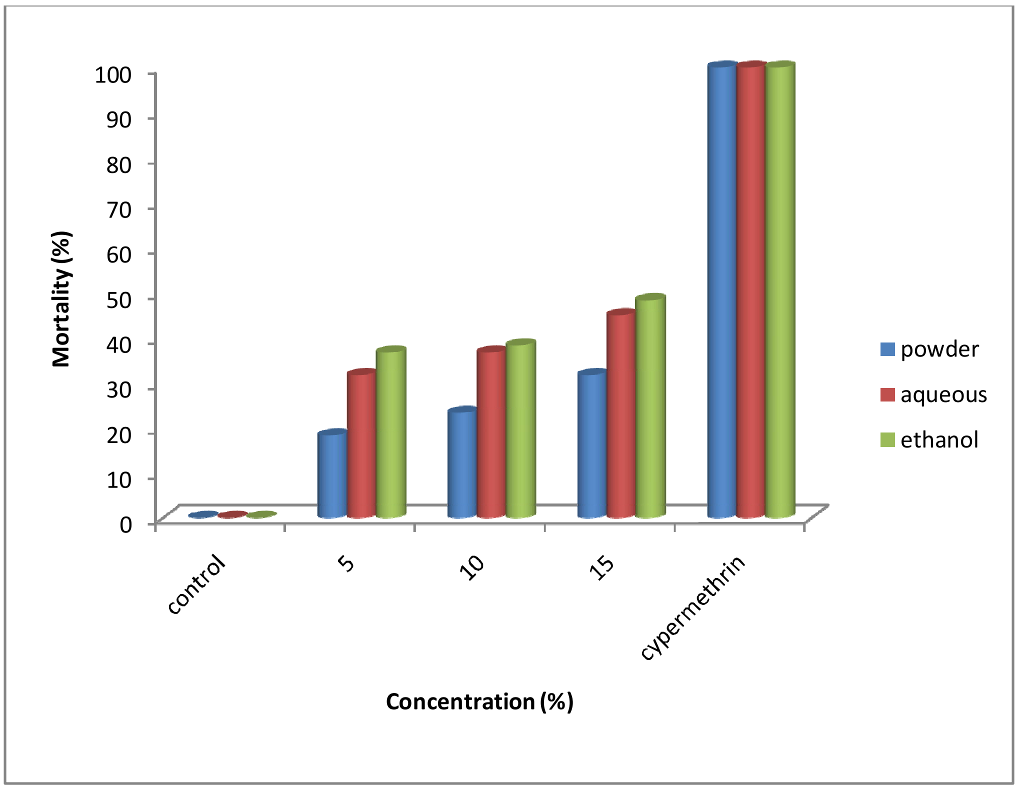

Fig. (7) Effect of nerium against lesser grain borer *Rhyzopertha dominica* after 24 hrs.

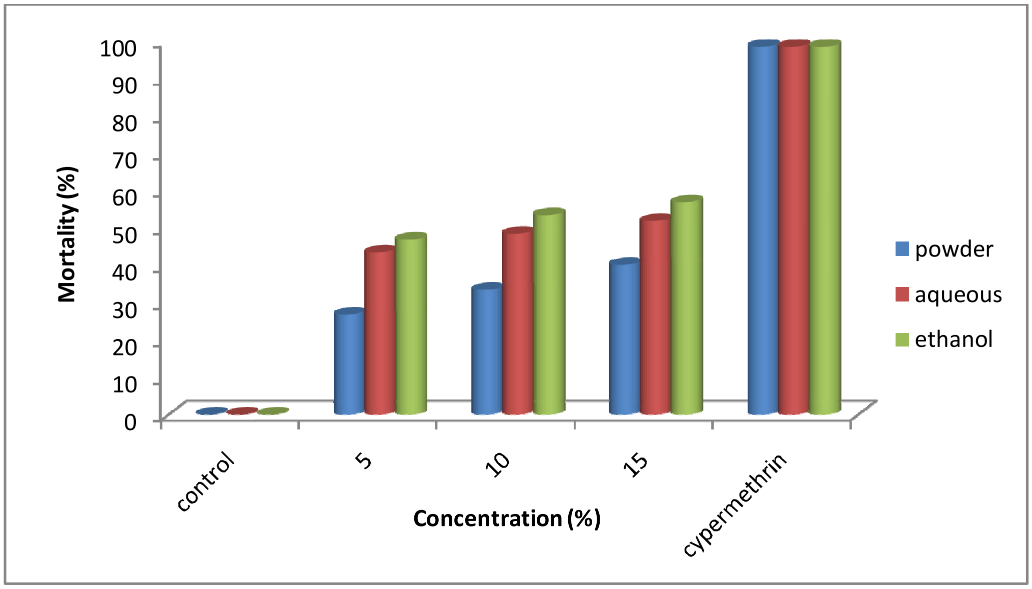

Fig. (8) Effect of nerium against lesser grain borer *Rhyzopertha dominica* after 48 hrs.

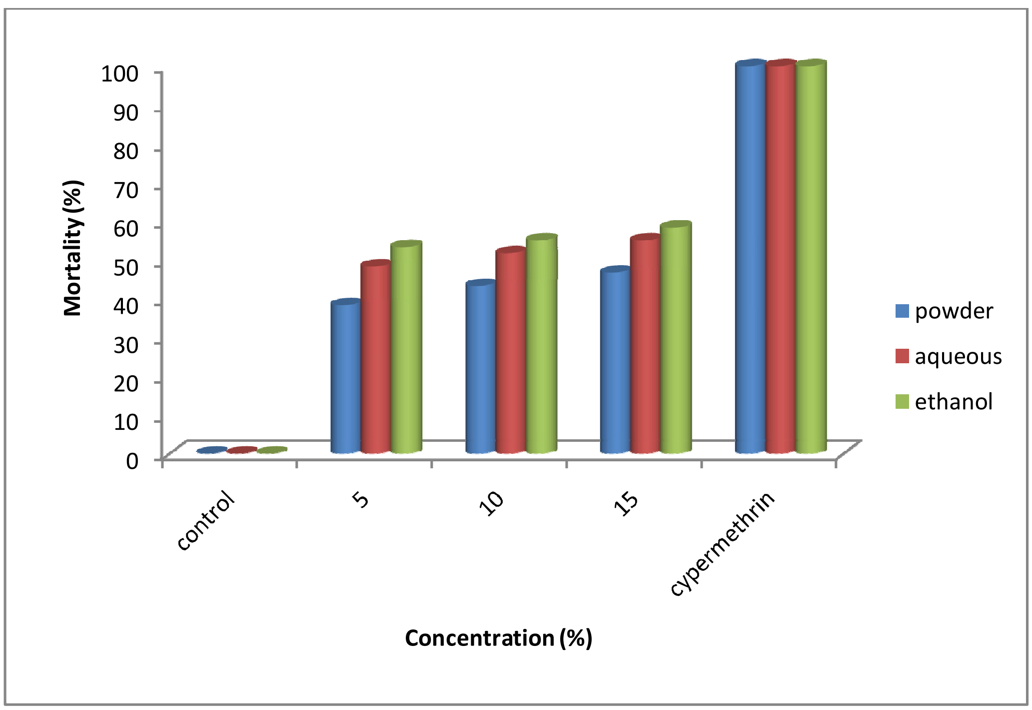

Fig. (9) Effect of nerium against lesser grain borer *Rhyzopertha dominica* after 72 hrs.

CHAPTER FIVE

DISCUSSION

There is a renewed interest amongst scientists to study the bioactivity of plant extracts against stored-grain insect pests (Stoll, 2000).This study was aimed to evaluate the lethal effect of powder, aqueous and ethanolic extracts of damas,castor bean and nerium against lesser grain borer *Rhyzopertha dominica*. The results obtained showed that all tested concentrations of damas in various formulations gave significantly higher mortality percentage than the control after 72 hrs.

The highest concentration (15%) of each of powder, aqueous and ethanolic extracts of damas generated 43.3%, 53.3% and 56.7% respectively after 72 hours of exposure. Feeny (1970) reported that tannin content in Oak leaves inhibits the growth of winter moth (*Operophtera brumata)* caterpillars and causes death. The result obtained in this study may also be attributed to the tannin content in *C. lancifolius* leaves.

All concentrations of castor bean ethanolic extract and aqueous extract gave significantly higher mortality percentage than the powder of castor bean after 72 hrs of application. In fact, 5%, 10% and 15% concentrations of castor bean leaves after 72 hours scored 58.3%, 63.3% and 66.7% mortality respectively for ethanolic extract and 51.7%,56.7% and 60% mortality for aqueous extract. This agree with Elimam, *et al*. (2009) who found that Using aqueous extracts from leave of *R. communis* have reported high larvicidal activity against larvae of *Anopheles arabiensis* and *Culex quinquefasciatus*. Similar results have been observed by Upasani, *et al*. (2003) who reported that castor bean leaf aqueous extract has insecticidal, ovicidal and ovipostion deterrent effects on the Chinese bean weevil *Callosobruchus chinensis* L.

The highest concentration (15%) of each of powder, aqueous and ethanolic extracts of nerium scored 46.7%, 55% and 58.3% respectively after 72 hrs of exposure. Similar results were obtained by Shah *et al*. (2008) who evaluate the repellent properties of nerium leaves against *Oryzaephilus surinamensis* and revealed excellent results.

CONCLUSION AND RECOMMENDATIONS

This study clearly demonstrates that all tested plants in various formulations have a lethal effect on the lesser grain borer. However, all formulations of castor bean seems to be much more toxic than the different formulations of damas and nerium.

Based on the above mentioned results, powder, aqueous and ethanolic extract of castor bean, nerium and damas can be recommended to be used as a control agent for *R. dominica*. Concentration that recommended for each plant extract are 5% concentration of powder and aqueous extract of damas , 5% concentration of ethanolic extract of castor bean and 5% concentration of aqueous extract of nerium. However, further experiments should be conducted with somewhat higher concentrations to evaluate the effects of these plants with other organic solvents and also against other insect pests. Finally, a comprehensive study should be conducted to determine the active ingredients of each plant extract.

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APENDICES

Table 1: Effect of damas against *R. dominica* adults after 24hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	10	20	15
	10%	25	20	20
	15%	35	30	30
Aqueous extract	5%	20	20	15
	10%	25	30	35
	15%	40	35	40
Ethanol extract	5%	25	25	30
	10%	30	35	40
	15%	40	40	50
Stander		100	100	100
Control		0	0	0

Table 2: Effect of damas against *R. dominica* adults after 48hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	25	25	20
	10%	30	25	35
	15%	45	45	40
Aqueous extract	5%	25	35	30
	10%	45	45	50
	15%	45	55	50
Ethanol extract	5%	30	30	40
	10%	45	45	50
	15%	45	55	50
Stander		100	100	100
Control		0	0	0

Table 3: Effect of damas against *R. dominica* adults after 72hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	35	30	40
	10%	45	40	40
	15%	45	45	40
Aqueous extract	5%	40	35	40
	10%	45	45	50
	15%	55	55	50
Ethanol extract	5%	45	45	40
	10%	50	55	60
	15%	55	30	55
Stander		100	100	100
Control		0	0	0

Table 4: Statistical analysis table of damas plant

Source of variation	Degrees of Freedom	Mean Squares	F- Value
Times* Treatments	4	27.7	2.3
Times* conc	6	198.5	11.8
Treatments* conc	6	94.1	7.9
Times*Treatments*Conc	12	9.9	0.8

Table 5: Effect of castor bean against *R. dominica* adults after 24hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	20	20	15
	10%	25	30	20
	15%	35	35	30
Aqueous extract	5%	25	30	30
	10%	35	30	40
	15%	45	40	40
Ethanol extract	5%	40	35	45
	10%	40	45	45
	15%	45	45	50
Stander		100	100	100
Control		0	0	0

Table 6: Effect of castor bean against *R. dominica* adults after 48hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	25	25	30
	10%	30	35	40
	15%	45	40	50
Aqueous extract	5%	35	40	40
	10%	45	50	50
	15%	55	55	50
Ethanol extract	5%	45	50	50
	10%	55	45	45
	15%	60	45	50
Stander		100	100	100
Control		0	0	0

Table 7: Effect of castor bean against *R. dominica* adults after 72hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	30	35	40
	10%	45	50	50
	15%	50	55	60
Aqueous extract	5%	50	55	50
	10%	55	55	60
	15%	55	65	60
Ethanol extract	5%	60	55	60
	10%	60	65	65
	15%	65	65	70
Stander		95	100	100
Control		0	0	0

Table 8: Statistical analysis table of damas plant

Source of variation	Degrees of Freedom	Mean Squares	F- Value
Times* Treatments	4	7.5	.8
Times* conc	6	245.4	24.7
Treatments* conc	6	214.1	21.5
Times*Treatments*Conc	12	7.5	0.8

Table 9: Effect of nerium against *R. dominica* adults after 24hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	20	20	15
	10%	25	25	20
	15%	30	30	35
Aqueous extract	5%	25	35	35
	10%	35	35	40
	15%	40	45	50
Ethanol extract	5%	35	35	40
	10%	35	40	40
	15%	45	50	50
Stander		100	100	100
Control		0	0	0

Table 10: Effect of nerium against *R. dominica* adults after 48hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	25	25	30
	10%	35	35	30
	15%	40	35	45
Aqueous extract	5%	40	45	45
	10%	45	50	50
	15%	55	50	50
Ethanol extract	5%	45	45	50
	10%	50	50	60
	15%	55	55	60
Stander		95	100	100
Control		0	0	0

Table 11: Effect of nerium against *R. dominica* adults after 72hrs

Formulation	Concs. %	Mortality %		
		R1	R2	R3
Powder	5%	35	40	40
	10%	40	45	45
	15%	45	50	45
Aqueous extract	5%	45	50	50
	10%	55	50	50
	15%	50	55	60
Ethanol extract	5%	50	50	60
	10%	50	55	60
	15%	60	55	60
Stander		100	100	100
Control		0	0	0

Table 12: Statistical analysis table of nerium plant

Source of variation	Degrees of Freedom	Mean Squares	F- Value
Times* Treatments	4	20.8	2.0
Times* conc	6	160.2	15.7
Treatments* conc	6	162.7	15.9
Times*Treatments*Conc	12	4.2	0.4