Sudan University of Science and Technology

College of Graduate Studies

Evaluation of some plant extracts against adults of the Saw-toothed grain beetle, *Oryzaephilus surinamensis* (Linn.) (Coleoptera: Silvanidae)

تقييم بعض المستخلصات النباتيه ضد خنفساء الحبوب المنشاريه {Saw-toothed grain beetle, *Oryzaephilus surinamensis* (Linn.) } (Coleoptera: Silvanidae)

A thesis submitted in partial fulfillment of the requirements for the M.Sc. Degree in Plant Protection

By:

Rogeia Elmahe Haj Elawad Yousif

B.Sc. (Agric) (Hons) . , Sudan university of Science and Technology

(2000)

Supervisor:

Prof. Awad Khalafalla Taha

Department of Plant Protection

College of Agricultural Studies -(Shambat)

Sudan University of Science and Technology

March2017

Dedication

TO THE SOUL OF MY PARENTS

ROGEIA

ACKNOWLEDGMENST

First of all, I render my gratitude and praise to the Almighty; ALLAH who offered me the health, determination and the ability to undertake this work.

I would like to express my sincere thanks and deep gratitude to my supervisor Prof Awad khalaf Allah Taha for his guidance, encouragement and suitable help to solve all problems in this work .

Iªm deeply greatfull to(Ministry of Agricultural and animal wealth& Irrigation, General Administration of Human &Financial Resources) especially“Karary Locality Administration Agriculture” who gave help in many ways, also deep thanks to staff of the Lab of Plan Protection, College ofAgricultural Studies, Sudan University.

I wish to express my deep gratitude to all the persons who stand by me for their encouragement and continuous support,especially my family.

Finally This work also contains information gathered from numerous published resources, and thus we would like to extend our appreciation to all authors of the references used in this research .

Table of Contents

List of Tables

Title **Page No**

List of Figures

Title **Page No.**

List of Plates

Abstract

A survey was appliedin grain stores in Omdurman Locality (Hi Alarab- Libya market – Omdurman Estate - Dura market-Date market).The survey recorded infestation in dry Dates by two important pests, the Saw -toothed grain beetle (*Oryzaephilussurinamensis*), and Date Moth (*Ephestiacautella*) and other economic pestsof different crops.Concerning pest control methods at the stores, the survey indicated that, 70 % of the stores use chemical methods for the protection.

Laboratory studies were carried out to determine the effects of three plant extracts on the adult of the saw toothed grain beetle *Oryzaephilussurinamensis* . The three plants were (Usher (*Calotropisprocera,* Argel (*Solenostemmaargel*), Datura (*Datura stramonium*) , used at three conditions (Powder , water extract , ethanol extract) .

The Results revealed that , at the three doses applied (5%, 10% and 15%), all plants tested have shown some potential insecticidal effect.Usher , *C . procera* (Ethanol extract) was the most effective, and causedhigh lethal effect on the adults, with a percentage mortality of (30%) after 48 hrs. Also, the ethanol extract of Argel recorded similar results as Usher, with a percentage mortality of (26 – 30%) of adults at all concentrations.

In the experiment of (Treated sack penetration), the *D.stramonium*water extract was the best, compared with Usher and Argel extracts, as it showed high effect at concentration (15%), with an average penetration effect of (1,3) in the second week, compared with a penetration effect of (10) with the control.

Concerning the chaise of (WPI), for evaluationof botanical extracts as grain protectants (as : Strong, Weak, or Negative) , an evaluation was made for the extracts of the 3 plants, at 3 concentrations (10, 20, and 3o (W/W), to study

their effects on the larvae of Khapra beetle. The results showed that, of the 3 plants screened, *D.stramonium* showed the best grain protectant effect,(Chick pea)with a WPI value of (24) at dose of 30% (w/w) , while the less grain protectant effect was recorded by Argel at dose 10% (w/w) with a WPI value of 40.63.

ملخص الدراسة

تم عمل مسح للمخازن في محلية أمدرمان (حي العرب- سوق ليبيا– الإستاد - سوق العيش- سوق البلح- سوق البقوليات).أظهرت نتائج المسح خلال 2012-2013م إصابات عالية لمحصول البلح بحشرتي خنفساْ ء الحبوب المنشاريةOryzaephilussurinamensis وفراشة البلح *Ephestiacautella*, وبخصوص طرق مكافحة الآفات فى المخازن , أوضحت نتائج البحث أن 70% من المخازن تستخدم المكافحة الكيميائية .

تم إجراء التجارب لدراسة الأثر القاتل- الطارد للآفة باستخدام نباتات (ألعشر-الحرجل- السكران).تم إجراء التجارب المعملية لتقييم فاعلية النباتات على خنفساء الحبوب المنشارية تحت ظروف المعمل باستخدامها فى 3 صور (بودرة- محاليل مائية- محاليل كحولية) , بثلاث تركيزات لكل منها .

أظهرت النتائج أن الجرعات الثلاث المستعملة (5%، 10%، 15%) من كل من النباتات المختبرة قد أحدثت بعض الخصائص السمية على الحشرة المستهدفة.

أظهر نبات العشر فاعلية أكثر في تجربة الأثر القاتل بالمحلول الكحولي، أعلى متوسط موت في الحشرة(30%) بكل التركيزات في اليوم الثاني , كما أعطى المستخلص الكحولى للحرجل أيضآ نتيجة متشابه مع العشر , بنسبة موت (26-30%) بالتركيزات الثلاث .

فى تجربة (إختراق الجوالات المعاملة) : كان مستخلص نبات السكران هو الأفضل مقارنة بمستخلصى العشر والحرجل , حيث أظهر فعالية اكثربتركيز (15%) بمتوسط اختراق داخل الجوالات المعاملة (1.3)في الأسبوع الثاني , مقارنة بنسبة إختراق للشاهد (10) لنفس الفترة .

بالنسبة لاختبار "معدل ثقب الحبوب بواسطةالسوس" (WPI) الذي يستخدم لتقييم المستخلصات النباتية من حيث فاعليتها في حماية الحبوب المخزونة (قوية– ضعيفة- سلبية)، تم تقييم فاعلية مستخلصات العشر، السكران، الحرجل بنسب (10%، 20%، 30%) (وزن/وزن), ودراسة تأثيرها على يرقات خنفساء الخابرا، أوضحت النتائج أنه من النباتات الثلاثة أظهر مستخلص السكيران أفضل النتائج في حماية الحبوب المخزونة (كبكبي) (بمعدل 24) عند التركيز 30% (وزن/وزن) , بينما كان مستخلص الحرجل بتركيز 10% , هو الأقل فاعلية بمعدل (WPI)يساوى 40.63.

CHAPTER ONE

INTERDUDCTION

INTERDUDCTION

Sudan is one of the largest agricultural countries in Africa, with an area of 200 million feddans that can be cultivated. This area, coupled with huge amounts of water resources and the diversified agricultural environments enabled the production of different agricultural commodities. Cereal crops, oil crops and all types of horticultural produce are grown successfully.

Concerning stored grain crops synthetic pesticides have traditionally been used as grain protectants across the globe, They have great potential in pest control, especially in terms of efficacy during emergency situations.

However, chemicals used for controlling store pests have resulted in many problems, such as toxicity of the treated food grains ultimately creating some sanitary and phytosanitary problems, lethal effects on non –target organisms (Ajayi and Lale,2001) ozone layer depletion, high costs of chemicals, resistance of pests to pesticides and harmful effects on human beings (Gao,*et,al.*, 2008).Other problems include poor knowledge of application cost, non-availability, genetic resistance and hazard to health have necessitated the search for humanly safe, ecologically tolerable and relatively cheap control measures(Adedire , Ajaji, 1996 and Akinkurolere, *etal*, 2006).In the developed countries, conventional fumigation technology is currently being scrutinized for many reasons such as ozone depletion potential of methyl Bromide and carcinogenic concerns with phosphine (Adedire, 2002).

These problems caused by synthetic pesticides and their residues have increased the need for residue- free grain, effective biodegradable pesticides with greater selectivity.

At present, alternative strategies have included the search for new types of pesticides which are often effective against a limited number of specific target species, are biodegradable into nontoxic products and are suitable for use in

integrated pest management programs and ecologically safer means of controlling insect pest infestation of stored cereal grains and dry fruits, especially in the tropics.

Botanical insecticides are of great interest in many parts of the world, because they are "natural insecticides and toxicants derived from plants. Historically, the plant materials have been in use longer than any other group, with the possible exception of Sulphur. Tobacco ,Pyrethrum, Derris , Quassia ,Camphor, and Turpentine were some of the more important plant products in use before the organized search for insecticides began .In the Northeast of Brazil, the use of leaves and seeds of herbs in the control of stored bean and corn pests is a common practice among small farmers . Bioactive compounds kill, repel, inhibit oviposition , and reduce larval development, fecundity and adults' fertility (Sousa *etal*,.2005).

The use of botanical pesticides is now emerging as one of the prime means of protection of crops and their products and protection of the environment from pesticide pollution.

Botanicals have been used for centuries and were widely used in the United States of America until the 1940s and 50s when synthetic pesticides were introduced. Botanicals have many advantages, e.g., they degrade more rapidly from sunlight, air, and proper moisture than most chemical pesticides, and are, therefore, considered relatively environment friendly and less likely to kill beneficial species than synthetic pesticides with longer environmental retention, Botanicals act quickly to stop feeding of insect pests and often cause immediate paralysis or cessation of feeding, and most botanicals are not toxic to plants, except insecticidal soaps.

Poison which act as contact when sprayed on the insect, or as a stomach poison when applied to the plant and eaten by the insect. More than 1000 species of plants have been reported to have chemicals in leaves, stems, flowers seeds and roots which have insecticidal properties however, only a few of them have been used for practical insect control on a commercial scale in the past (Shahid, 2003).The use of plants as repellents is very old but has not received the necessary attention for proper development (Isman, 1997). Botanicals are processed into various forms: dusts and powders made from ground and dried plant parts, pure chemicals isolated from plants, and plant extracts or resins. These extracts and resins are formulated as liquid concentrates, dusts or wettable powders.

The specific objectives of the present study:

1.Developing insecticides of plant material that are economically cheap, safe and locally available in Sudan.

1. Application of a survey of grain stores in Omdurman Locality to define : the storage conditions, the important crops stored, the economic store pests availableand type of the control measures applied.

2.To assess the toxic potential, repellent activity and penetration effect of the extracts from three plants (usher,*Calotropisprocera* Ait) ,(Argel,*Solenostemmaargel* Del) and (Datura,*Daturastramonium* L.) against the saw-toothed grain beetle *Oryzaephilus surinamensis* (Linnaeus) .

CHAPTER TWO

LITERATURE REVIEW

LITERATURE REVIEW

2-1 The storage

The need for storage of food grains has been there since the time when the agricultural practice was discovered as a source of food grains (sorghum – wheat … etc) which are cultivated over a period of 3 or 4 months and have to be stored until the harvest of new crops. However, the problem of the storage is that, they maybe subjected to invasion the pests.

The production of grains and pulses in Sudan was faced by problems of insects and diseases and significant crop losses could occur during field and storage. The majority of these losses are due to insect infestation (Ibrahim, 2003).

The major store pests include:

1- *Trogodermagranarium* (Khapra)
2- *Bruchidius incarnatus*(faba bean beetle)
3- *Triboliumcastaneum*(flour beetle)
4- *Oryzaephilussurinamensis*(saw- toothed grain beetle*)*

The incurred losses can be direct, such as loss in weight, or indirect such as reduction in quality of the stored product by changing the appearance, color, contamination by dead or alive insects, cast skin, feces, loss in germination ability, incidence by pathogens and subsequently severe reduction in economic value. Other losses include damage to grain structure and cost of control operation.

Damage caused by stored product pestsdifferes from those caused by field pests in that, stored products can't compensate for loss as the case in live plants, and there are severe restriction for chemical treatments as in many cases stored products represent a ready form of human or animal food.

2-2Date palm

2-2-1classification

***Phoenix dactylifera*.**

Kingdom: Plantae

Order: Arecales

Family: Arecaceae

Genus: *Phoenix*

Species: *P*. *dactylifera*.

2-2-2Date palm varieties: -

In any country where date culture has been long established, varieties most widely grown are usually those that are best adapted to local conditions. Some varieties grown in other countries might do equally if offshoots could be obtained. However, it takes many years to determine their adaptability and much longer period before a new variety could be established. In evaluating date varieties, careful consideration must be given to those well established within the country. (Nixon 1969),In Sudan there are many datepalm varieties which resulted from seed propagation carried out in traditional areas of date palm cultures in Sudan. The fruits of seedling cultivars are almost of inferior qualities compared with known varieties but there is a chance for seedling trees of superior or excellent qualities.

The varieties of date palm grown in Sudan were uncountable (Osman ,1979; Bashab;1997) However; there are some leading cultivars such as Barakawi; Gondeila; Tamoda; Kulma and Mushrigi Wad laggai; Mushrigi Wad khateeb and Madina. Osman and Boules (1977) Barakawi is one of the most important dry date cultivars grown in northern Sudan. Barakawi of sukkot and dongola areas is known in Egypt as (Sukkoti) or as (Ibrimi). It is

estimated that Barakawi comprised about 70% of the date population in the Northern State (Dirar;2003) .

Betamoda is probably one of the best Sudanese date varieties in quality. It represents about 2% of date population, most of which is present in the region between Dongola and WadiHalfa (Nixon, 1967).

Gondila is the second most important variety.According to (Dirar, 2003), it represents 5% of palm population in the Northern State. Gondeila is commonly treated as dry date but it does not have the hard texture of Barakawi . If it is harvested just when it reaches maturity and before drying, it can be handled as a firm semi-dry dates.

According to Nixon, (1967).Kulma variety is the most superior and scarce date variety in Sudan. There are only a few hundred palms of this variety, most of them in Al Mahas tribe area north of Dongola. The fruit caneither be dried or eaten soft.

Zaghloul (Arabic: زغلول) -The variety is essentially exclusive to Egypt, where it is subject to an element of nationalist sentiment on account of sharing a name with national hero SaadZaghloul.Dark red skin, long, and very crunchy when fresh (when they are typically served); extremely sweet, with sugar content creating a sense of desiccation in the mouth when eaten.

2-2-3Major pests and diseases

Serious problems facing date palm in northern Sudan result from infestation by numerous pests, among which are:

2-2-3-1Green pit scale insect (*Asterolecaniumphoenicis*Rao)

This insect was introduced about 20 years ago in Golid area through illegal importation of an infested off-shoot from Saudi Arabia. Because of lack of natural biological control agents in Sudan, it has become a serious pest. The insect attacks the leaflets, leaf rachis and fruits before maturity leading to

sever losses in palms productivity. Death of trees occur at the end. An eradication program was attempted based on pruning, local quarantine, and both aerial and ground insecticide applications (Ahmed, 2003)

2-2-3-2 Termites

Termites' damage to date palms in the Northern Sudan has been recorded since the 1920, and has been recognized as serious problem by several authorities (Schmutteres, 1969; Sacks,2011).

The United states Department of Agriculture (1962-1963) reported that 60% of date palms in northern Sudan were attacked by termites and that 35% were seriously affected. Idris *etal* (2006) reported severe infestation of date palm in most plantations in the Northern Sudan.

2-2-3-3Rats

Nile rat, white bellied house mouse and roof rats occasionally reach importance as crop pests and cause considerable damages in the stores . These species, together with Nile rats, are found in the field and sometimes are encountered in orchards climbing date palm trees.

Control of these rats is by crushed sorghum as a carrier to which a rat poison is added with adhesive. The common rodenticide used is zinc phosphide. The estimated annual loss due to rats about is 1.5% However, the latest survey of date palms highlighted the hazard of this pesticide and the need for serious control measures (Idris *etal*, 2006)

2-2-3-4 White scale insect (*Parlatoriablanchardi*(Tarqioni)

The white scale insect is found wherever date palm is grown in Sudan but it causes severe damage in the southern part of the Northern and Nile States.

It mainly infests the leaves, and the damage occurs from the nymphs sucking action .The leaves may be fully covered with white scales and finally dry out

.In heavy outbreaks, fruits may be attacked and fall –off before maturity. According to Mohamed (1991), varietal susceptibility experiments showed that Mushrig and Gondaila were the most susceptible varieties.

The infestation on the varieties of Brakawi and seedling dates were moderate, and Tomoda was the least affected variety.

2-2-3-5 Date palm mites

The spread of date mites extends all over the country .Occasionally, serious damages are found in palm under close spacing especially upon mixed planting with citruses or mangoes . The mite usually feeds on the fruit at the khalal and rutab stages resulting in rough silvery surfaces. Severely infested fruits stop expanding and do not mature properly.

Palms dusting with sulfur at the end of May or the first week in June is best recommended for control. However according to Idris *etal* (2006), this pest is of wide spread in the Northern State and poses serious economic losses in the area north of Dongola

2-2-4 Uses of date palm

The food and medicinal values of dates were repeatedly mentioned in holy Quran. Prophet Mohammed (Peace Be Upon Him) has said that, the best property of date palm it cures many diseases and causes no harm. Therefore, he urged Muslims to eat its fruit and encouraged date palm cultivation.

The date fruits are considered a complete diet for their high nutritive value. It is presumably the most nutritive and energy producing food. It is the main diet of those living in desert and arid regions .The nutritional value of date fruit is due to its high carbohydrates content (about 65-75 %) which is a major source of energy. These carbohydrates are easily digestible and quickly absorbed into the blood stream and body cells. The fruits are also good source of proteins, fats, minerals and vitamins.

Besides, alcohol, vinegar, animal feed, organic acid and pharmaceuticals are secondary products that can be obtained from the fruits. Also the tree is used for various construction requirements such as the use of the trunk for beams and water channels. Leaflets are used in preparation of fans, matting brooms and baskets. The whole leaves are used for making ropes. The main rib is used for making chairs, cages and fences. (Ibrahim, 2007)

2-2-5 Date variety groups :

On the basis of the texture and consistency of the fruits under normal conditions of ripening ,datesvarieties are divided into three groups

1. Soft varieties: The moisture content of the fruit exceeds 30% the fruits generally pass through Rutab stage and remain soft to Tamar stage - The sugars are mostly of reducing types, with no or little sucrose, e.g; medina cultivar.

2.Semi – dry varieties: the moisture Content in the range of 20 -30% The fruit passes through Rutab stage to dryish to tamar. Sugars are of reducing type and low sucrose, e.g;mishrig wad lagiCultivar.

3. Dryvarieties:-The moisture content is less than 20% .the fruits do not pass through rutab stage .The sugars are mostly of sucrose type e .g.Barakawi cultivar (Rashid and Nizia , 1972and Ahmed ,(2003) .

Both the climate and the cultural condition affect the consistency of the flesh .

2-2-6 Storage of date fruits

Dates storage differs according to the locality and the stage of date fruits.

1. Field storage: A temporary field store built in the garden in which dates are stored for several months is very common in North Sudan. According to the cultivar, dates are heaped on straw mat to a reasonable high leap and covered with plant material such as straw (Babikir, 2005)

2. Madabis Storage: In Southern Iraq , dates are stored in open or covered madabis.

3. Date storage in sand : In North Africa, beside some other places, dry dates are stored in pits made in sandly soils .

4. Shona(Mastaba): It is a cement terrace built above the ground level on which date sacks are piled up

5. Gossypa storage: Gossypa is build by the blend of mud and cattle dung .It is small in size and used as store for small quantities of dates.

6 Jars: Clay jars are used as local and domestic stores for dates.

7. Old fashion stores: These are made of mud or bricks and the roof is corrugated or made of plant materials

8. Modern stores: These are made of bricks and cement**.** The walls are finished in smooth texture and painted .The roof is also made of cement or gypsum .This type of store usually has two doors facing each other, fewer number of windows and designed in a way that does not let the toxic gasses to scape when store pests are controlled by chemicals (Babbikir,2005)

2-2-7 Dry dates pests

According to Abdul Wahab and Eissa (1986) there are fifteen species of Insects which attack the dry dates. These species belong to nine genera , under seven families belonging to the two orders Coleoptera and Lepidoptera; of these the most important pests are *Ephestiacautellas*and *Oryzaephilussurinamensis,*

2-3 Saw Toothed Grain beetle

2-3-1Classification

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Coleoptera

Family: Silvaniidae–Cucuajidae

Genus: *Oryzaephilus*

Species: *surinamensis*

The beetles in this family are so closely related to Cucujidae that most authors include them in that family. In so far as the stored products species are concerned, the Silvanidae can be distinguished by the antennae which end in a compact club. The family includes two genera represented by the two species *Ahasverusadvena* and *Oryzaephilussurinamensis* which is are common in our warehouses and granaries . *Ahasverusadvena* differ from *O.surinamensis* in its square prothorax which has one prominent tooth at each apex (Munro,1966).

2-3-2 Distribution and hosts: -

Oryzaephilus surinamensis is cosmopolitan while *O .mercator* is mostly found in warmer temperate and tropical regions (Annon.,1985). Howe., (1956)suggested that *O . surinamensis* is cold hardy. The adult and the larva attack the dates, cereal products , dried fruits and many types of stored food

2-3-3 Economic Importance:-

Both adult and larva feed on the dates and leave residues inside the fruit (dead insects, larva exuviate, cocoons and faces),this contamination reduces the quality and quantity of the dates. In high infestation all the date contents becomes a yellow powder.

2-3-4 Morphology

The adult is 1.8 - 3.5 mm in length, dark brown in color. The body is dorso ventrally flattened, the antenna is a filament. Pronatum has three ridges and six toothed lateral margins. The temple margin is more than half the vertical diameter of eye (Compared to *OryzaephilusMercator)*which has a narrower temple behind the eye(Howe., 1956) . Brees., (1961) gave an average of 2.2mm. for males and 2.26mm for females .

Average size of larva is 3mm. Yellowish – white color, deeply segmented larva. Antennal segment elongate clubbed shaped. Well developed thoracic legs (CFIA, 2002) the larvae of *O.surinamensis* has tergites on abdominal segments 2-7,bearing two long setae anterolaterally, Inner pair shorter while *O . Mercator* has four long setae . (Cutler,1971) .

2.3.5 Ecology

The optimum temperature for *O. surinamensis* is between 30^0 and 34^0 C Development ceases below 18^0C but the insect can tolerate the cold and can live for up to three years . It can also withstand drought ,but its optimum humidity is 90 %(Skinner, 1987).

2.3.6 Biology:

The female lays 50-300 white slender eggssingles . The egg incubation period is 4-6 days , the larval period range is 14-21 days, with an average of 15.9 days . the pupal period ranged between 6 and 7 days, with an average of 6.6 days. The duration of all the developmental stages from egg hatching to adult emergence average 22.5 days, in summer (Cotton, 1963, Abdul Wahab and Eissa, 1986, and Skinner, 1987)

2.3.7 Field control measures

The newly harvested dates should not be mixed with the fallen one, because the latter are usually infested by pests. There should be animmediate conveyance of the harvested dates from the farm to its place of delivery. Dates should be packed in special and clean containers before it is transported outside the farm.

2-3-8Consideration of date storage in stores:

1- The date store should be well maintained, cleaned after the previous season harvest, sprayed with malathion or any other appropriate chemical and should be insect proof .

2- Date sacks or boxes inside the store should be arranged in rows to facilitate insect inspection and control

3- Periodical store pest survey is important for timely pest control.

4- Low temperature near to zero c^0 kills all the larvae of the saw. toothed grain beetle after a period of 2 weeks and is also fatal to the adults after about 4 weeks .

5- Date heating as physical control measure, can be used successfully against store pests, since 100% control could be achieved when dates were subjected to $50c^0$ for 4 hours .

6. if *Oryzaephilus –s* beetle is exposed to cobalt Gama ray at a dose rate of 0.20 kilo rad all stages of the beetle will be killed (Ahmed , 1990).

7- Fumigation by means of hydrogen (H_3.p) (phostoxin) for 3days at arate of 1.5 tablets /$2CM^3$ is effective against date insects inthe store (Babikir, 2005).

2-4Application of Botanical extracts in Pest control :

The use of botanical pesticides to protect plants from pests is very promising because of several distinct advantages; Pesticidal plants are generally much safer than conventionally used synthetic pesticides; Pesticidal plants have been in nature as one of its component for millions of years without any ill or adverse effect on the ecosystem . In addition, plant-based pesticides are renewable in nature and cheaper. Also, some plants have more than one chemical; the chances of developing quick resistance to these different chemicals are highly unlikely (Saxena, 1989). Plant-derived pesticides can be transferred into practical application in natural crop protection, which can help the small-scale farmers (Binggeli, 1999).

Sudan is one of a large country covering all geographical zones from desert to ever –green forests, and for that it is one of the richest countries in natural flora. Plants of this country, both cultivated and wild are undoubtfully an unlimited reservoir for medicinal, pharmaceutical, agricultural and aromatic chemicals. In Sudan, a number of studies have been made for the control of stored grain pests through application of plant extracts e.g., (Ali, 1988; Ahmed, 1993; Fageer,1999; Ibrahim,2003; and Eldoush,2009).

Dwivedi and Garg (2003) reported that, plant products widely used as traditional stored grain protectants in powder form, crude mixtures or extracts due to their easy accessibility and biodegradable nature. Hasan *etal*., (2006) stated that, the toxicity of plant extracts had been checked against a number of stored product insects.

Siddig, (1980) found in Sudan that, treating wheat with powdered neem seeds reduced the damage of *Trogodermagranarium* and the effect increased as dosage increased. Giannini (1997) stated that, the infective ingredients are the Tropane alkaloids atropine hyoscyamine and scopolamine which are classified as deliriants, or anticholinergics. Due to the elevated risk of

overdose inuninformed users, many hospitalization, and some deaths, are reported from recreational use.

Neem extracts are very effective against Khapra beetle as well as many other insects. There is an indication that burning neem leaves will fumigate stored goods. However, these may be used as supplemental treatment .The use of deoiled Neem (*Azadirachta indica*) seed powder mixed into wheat seemed to be effective and cheap method to control the pest in stored wheat in India (Singh, *et. al*., 1978; Dabire, 1993; Arivudainambi and Singh 2003).

2-4Usher

2-4-1-Classification

Order: Gentiales

Family: Asclepidaceae

Genus: *Calotropis*

Species: procera

Common Name Sadom apple

2-4-2 Distribution

In Sudan Sadom apple widely grows throughout the greatest parts of Sudan especially along Nile Banks and Rahad (Broun, 1906 Brann *etal*, 1991).

2-4-3Description

Andrew (1952) described the usher plant as spot woody shrub or small tree up to 18 ft high, Bark is yellow – brown, thick and corky. Young parts are covered by a white tomentum.

Leaves are pale-green fleshly, sessile or shortly petioloted. Flowers are in 3-10 flowered sabs umbellate up to 3inches long. Fruit is green 3-6 inches long with a thick spongy inflated pericarp.

2-4-4 Chemistry

Hess *etal*. (1936) reported that, the chemical constituents of usher present in the aerial parts of the plant include alkaloids. Cardiac, glycosides, flavonoids, tannins, saponins sterols and triterpens (Osman, 2003).

Hesse and Lubwing (1960) reported that some sulphur containing heart poisons have been in the latex, and Sharma (1934) reported many active principles from different plant parts of usher. According to Malik *et, al* (1979), dried leaves, flower and root –bark of *C . procera* contained high amounts of ash and protein of 10.9-11.7 and 18.9-25.2 % respectively, with varying quantities of alkaloids. The leaves contain calotropin and calotropanin

2-4-5 Usage of Usher plant:

Many authors reported on the use of usher plant parts in the industry. It has been suggested to be used for different commercial purposes since the beginning of this century like rubber extraction (Dubose, 1927), and textile and paper manufacturing (Budd ,1913). The plant was reported to be beneficial in a number of human ailment and is used by flolk media practioners of Africa and Saudi – Arabia as purgative anti rheumatic, diaphoretic, expectorant antidysentric and for the treatment of bronchial – asthma (Al-Yahaya, *etal*, 1986).

The floss from the fruit is used for stuffing pillows and the leaves are used for fermenting Dura in the preparation of Merissa (Broun, 1906).

Extracts of the plant had given strongly positive antibiotic test of illness including leprosy ,fever, menorrhagia, malaria, and Snake bite (Parrotta;2001)

2-4-6 Medicinal uses:

The plant is reported to be beneficial in a number of human aliments. *Calotropis procera* is used as a traditional medical plant (lindley, 1985) traditionally usher is used alone or with other medicinals (Caius, 1986), to treat common diseases such as fevers, rheumatism, indigestion, cough, aneamia, fits, fungal infection, gastric disorder, headache, infertility, atorrboea, pain, leprosy, snakebite, stays, tonsillitis, tuberculosis, cholera, strangely, ulcer, piles, rounds, hepatic and splenic enlargement (Al-Yahya *etal* 1986 , Sharma, 1934, Watt *etal*, 1982).

The Hindu Physician uses the root bark to promote the secretion and to be useful in skin disease, enlargement of abdominal viscera, infanticide, sometimes taken by women to procure abortion, usher is also a reputed homeopathic drug (Ghosh, 1988, Ferringoton, 1990).

2-4-7 Insecticidal properties of Usher

Latex from *C. Procera,* applied in water at 10,000 ppm was found to be toxic to the larvae of *A. stephensi*, *C. fatigans* and *Ae. Egypti* giving 100% mortality.

Adult femalesspecially those of the first two species avoided oviposition in water containing the latex, but they were killed when in contact with the same treated water.

The effect of the latex was found to be comparable with those of the pyrethrins, but latex of *C. procera* appears to have no adverse effects on non-target organisms except (temporarily) on fish (Girdhar, *etal* ., 1984).

Aqueous extract of *C. Procera* leaves and stem was found toxic to the larvae of *Plecopteriareflexa* (*a* lepidopterandefaliator) and gave significant mortalities (66.7%) (Chaudbry, 1972) .leaves extracts of four natural plants including *C. Procera* were tested against citrus nematodes larva

Tylenchulussemipenetrans Cobb and the results were promising. Larval mortality increased with increase in the exposure time and the concentration of the extracts

Osman (2003) found that, temephos was the most potent agent followed by usher fruits (with seed) water extract and leaves water extract, respectively for the two mosquito species *Anophelesarabiensis* and *Culexquinquefaciatus*.

However, Usher fruits and usher leaves water extracts had almost the same efficiency for each tested species. The average LE50 of leaves water extracts and fruit against these mosquitoes larvae, were 0.929 g/l, 1.367 g/l and 0.823 g/l 1.95 g/l respectively .

Ali, (2004) reported that, application of Usher leaves powder on the larvae of the mosquitoes *Anopheles* and *Culex*. showed that ,usher leaves powder has alarvicidal activity against these mosquito larvae , the average LD_{50} were 166.71 mg/L, and 122.29mg/L,respectively.

Ayoub and Kingston (1981); and Ayoub and Svendsen, (1981) stated that, *C. procera*(Usher), has been widely used in Sudanese medicinal system. The bioactivity of *C. procera* tested as insecticidal by (Jacob and Sheila, 1993;Khan and siddigui;1994 and Moursy,1997). Wat *et. al*., (1962) reported that, Usher plant contain insecticidal ingredients and the leaf is used for destroying fowl lice in Senegal . In the Moshi district of Tanganyika, the plant is placed in the bed by Africans as an insecticide. Ahmed *et. al.*, (2006) stated that, shaker aqueous extract of leaf, flower and roots of *C .procera* proved most effective in the control of *Henosepilachnaelaterii* and showed strong repellent activity and thus deterred the insects from feeding . Five percent shaker extract of different plant parts gave 100% protection of cucurbit leaves and no larvae survived after exposure to 5% extract and 2.5% concentration of shaker extracts which highly reduced the fecundity and

longevity of the insect. The results showed the potential of the aqueous shaker extract in the control of vegetable pests .

2-4-1 Argel

2-4-1-2 Classification

Arabic name: Hargal, argel,

Order: Gentiales

Family: Asclepidaceae

Scientific Name :*Solenostemmaargel*

2-4-2-2 Distribution

Solenostemma argel (Del.) Hayne is a desert plant which is widely spread in Egypt, Libya, Chad, Algeria, Saudi Arabia, Palestine and Central and Northern part of the Sudan, however, Sudan is regarded as the richest source of this plant (Organgi, 1982).

2-4-2-3 Description

Solenostemma argel is an erect perennial shrubby plant, reaching up to 1.5 – 2m in height, with smaller branches carrying opposite decussate leaves.

The leaves are pal. Grey – green, also are lancelet to oblong – ovate, with a cute or sub-acute apex and cuneastebasg (El-kamali, 2001)

2-4-2-4 Locality:

S. argel is suspected to grow wild in Northern Sudan extended from Barbar to Abu Hamad especially" Rubatab " area , (El-kamali, 1991) .

2-5-2-5Medicinal and pharmacological activity of *solenostemma argel*:

The popular medicinal plant in the Sudan is used traditionally for treatment of Coli and gases or treatment of diabetes (Elagib, 2001) . The pharmacological

activities of different extracts of *S-argel* have been shown in a number of reports. Ross, *etal*, (1980) showed the presence of antibiotic substances in the ethanol extracts of Argell plant and they also realized the antifungal properties of the plant. Tharib, *etal*, (1986) showed the presence of a substance or a compound isolated from Argel stem, and was realized to have antibacterial properties against both gram -positive and gram-negative organisms. Argel infusion, used to treat oliabetes and jaundice, is also used to treat measles and cough (El kamali and Khalid, 1996).

2-4-2-6 Insecticidal activity of Solenostemma – argal (Del.) Hayne:

El kamali, (2001) reported that the crude aqueous extracts of dried leaves, flower, root and stem of *S. argel*, were tested in the laboratory for activity against the thirdinstar larvae of the mosquito*Culexquinquefasciatus*, and the results revealed that, extract of the leaves was most effective with Lc50 of 0-5 mg/ml at 24 hr. and the Lc50 of crud aqueous extracts for flowers, root, and stem for mosquito larvae were 1.74, 3.02 and 3.98 mg/ml, respectively

2-4-3*Datura stramonium*

2-4-3-1Classification

Order:Solanales

Family:Solanaceae

Subfamily:Solanoideae

Tribe: Datureae

Genus: *Datura*

species:*Datura stramonium*

The genus ,,Datura " (Solanaceae) comprises all the night –shades and agricultural plants, including Potato ,tomato, coffee and pepper . Classification of different species within Datura genus relies heavily on

genetic markers which suggests that this genus has huge variation due to mutation .*Daturastramonium*, the most common species within this family .is native to Asia, but is also found in the United states, Canada and the west Indies . It is widespread with higher abundance in temperate tropical and sup tropical regions .

2-4-3-2Photochemistry

Phytochemical studies of *Datura .stramonium*have been conducted since the early 1930s. The major photochemical Isolated from *Daturastramonium* are tropane alkaloids atropine and scopolamine (Gaires. 2013)

2-4-3-3 Insecticidal properties of Datura

Karzan*et.al*.,(2011) tested the effects of ethanol extracts of *Daturastramonium,solanumnigrum, Quercusinfectoria, Xanthium strumarium*andcypermethrinonthemortality,egghatching reduction in F1 progeny and repellents on *Trogdermagranrium.* Theresultsshowedthatcypermethrinhadthebest effect onthemortalityofadults *(*100*%)* onallconcentrations,whereasthefruits of *D.stramonium* and *X. strumarium* had a mortality rate of 100% in 2% and 4% concentration . Egg hatching was also delayed, and began after four days of treatment, in *Q.infectoria* and *X. strumarium*. Ethanol plant extracts of *D. stramonium* caused 100% mortality of larvae at a concentration of 1% after eight days of treatment, followed by the alcohol extract of *S. nigrum* with 97.43% mortality in 1% concentration.

Preissel, *et .al*., (2002) reported that, all parts of Datura plants contain dangerous level of poison and may be fatal if ingested by humans or other animals, including livestock and pest .

Giannini (1997) stated that, the infective ingredients are the Tropane ,alkaloids, atropine hyoscyamine and scopolamine which are classified as deliriants , or anticholinergics. Due to the elevated risk of overdose

uninformed users, many hospitalizations, and some death, are reported from recreational use.

CHAPTER THREE

MATERIALS AND METHODS

MATERIALS AND METHODS

3-1 Survey of grain stores in Omdurman locality

The survey was carried out to identify main points of storage conditions : i.e., the environment of the places inside and around the store, the important crops and materials stored, the economic pests anddisease infection available, the methods of pest control applied (by chemical or natural methods), storage of dry dates, and percentage of damage of stored materials.

3-2 The preparation of experiments

The experiments were conducted at the College of Agricultural Studies-Shambat under laboratory conditions, to study the efficacy of extracts of some indigenous plants(Usher,*Calotropisprocera*.Ait), (Argel, *Solenostemma argel* Del) and Datura(*Datura stramonium* L) for controlling the main store pest found in the study area, the Saw- toothed grain beetle-(*Oryzaephilussurinamensis* (Linnaeus) .

3-2-1 Mass culturing of the insects

The Saw toothed grain beetle adults were collected from infested dates (plate 1) brought from difference out stores and reared in the laboratory in the Department of Plant Protection¸ during (2012 – 2013).

The collected adults were distributed in a large number of glass jars containing clean, undamaged dates.And each is tightly covered with a muslin cloth (plate 2).

3-2-2 Preparation of the plant materials

The plant species used in the study were:

1\ Usher,*Calotropisprocera* Ait . (plate 3).

2\ Datura,*Daturastramonium*L (plate 4).

3\ Argel, *Solenostemmaargel* (Del) (plate 5).

Samples..Usher leaves and Datura leaves were collected from the field around the College Agricullral studies in Shambat . Samples of Argel leaves was bought fresh from Omdurman market.

3-2-3 Preparation of plant powders:-

The plant samples were kept in a dark room for almost 3-5 days. until completely dry. Then the samples were crushed firstly by hand and then blended by an electric blender to powder. All plant powder Samples were kept in tightly closed glass jars.

3-2-4 Preparation of the Concentrations:-

The aqueous solution of each plant sample was prepared by adding 10 gram of the leaves powder to 90 ml of distilled water in a conical flask.

The mixture of each sample was left to stand for 24 hrs at room temperature according to National Research Center (NRC) recommendation, and it was then thoroughly shaken by hand every 8 hours for ten minutes, within a period of 24 hrs, the mixture was then strained using a light cloth and then filtered by a filter paper. The preparation method applied was based on the method by Ascher (1981).

3-2-5 Preparation of plant aqueous extracts:

The aqueous extracts of Usher, Argel and Datura leaves were prepared by adding 5,10 and 15gms of the powder to 95, 90 and 85 ml of distilled water in conical flasks, respectively. The mixtures were thoroughly shaken by hand for ten minutes and kept in the laboratory for 24 hrs at room temperature, then the mixtures were filtered using filter papers.The extracts were kept in cleaned flasks and used for the mortality experiments.

3-2-6Soxhlet Extraction:

TheSoxhlet extraction was made for the three plant extracts. A sample of 20 grams of the fine powder of each plant (Usher, Argel and Datura) were weighed and placed in the extraction tube, and the tube was placed in a flask containing ethanol (200ml) in soxhlet apparatus . The soxhlet was powered for 6 hours to extract the active ingredients , and then the flask was left under room temperature for evaporation of the ethanol. The extract was used after 7days in the experiments . The ethanol extracts of Usher, Argel and Datura were prepared by adding 5,10 and 15ml of the active ingredients to 95, 90 and 85 ml of Ethyl Alcohol to give 5,10 and 15% concentrations, respectively.

3-3 Experiments: on

3-3-1 Experiment 1: The effect of powder extracts on the adult insect

Three glass jars each contained 20g of dates and 20 adult insects were treated with three different Weights of powder (5, 10 and 15g) of each of the three botanical plant extracts (Datura, usher and Argel). A fourth glass was used as control, the percentage mortality was taken twice after 24 and 48 hours. (plate 6).

3-3-2 Experiment 2: The effect of water extractson the adult insect

Three glass jars, each contained 20g of dates and 20 adult insects were treated with three different concentrations of the water extracts (5%, 10% and 15%) of the three botanical plants (Datura, Usher and Argel) A fourth glass was used as control, the mortality was measured at two times after 24 and 48 hours.

3-3-3 Experiment 3: The effect of ethanol extracts on the adult insect

Three glass jars each, contained 20g of dates and 20 adult insects were treated with three different ethanol extract concentrations (5%, 10% and 15%) of each of the three botanical plants (Datura, Usher and Argell). A fourth glass was used as control, the mortality was also recorded at two times after 24 and 48 hours.

3-3-4 Experiment 4:

WeevilperforationIndex (WPI) with plant materials:

In this experiment, the method described by Fatope, *et al*, (1995) was followed .

Four glass jars were filled with 50g each of imperforated chick pea(*Cicer arietinum*)seeds. Portions (5g, 10g and 15g) of dry pulverized plant materials corresponding to 10%, 20% and 30% (w/w) respectively, were added to three of the fours glass jars.The untreated seeds in the fourth glass jars served as control.

Each glass jar was infested by adding five seeds infested with *T. granarium* The glass jars were then closed with muslin cloth and left at room temperature. Tests at each dosage and the control were repeated 4 times for the three plants, Usher, Datura and Argel, after 4 months.

After 4 months , the seed in each glass jars were examined for perforations . The number of seeds perforated in the treated and control jars were counted for the determination of the (weevil perforation index) (WPI), and calculated for each dosage for comparison of the grain protectant effect of each plant material . The following formula was applied for calculating the WPI

$$WPI = \frac{\%\text{of treated perforated seeds}}{\%\text{of control perforated seeds} + \%\text{of treated perforated seeds}} \% 100$$

a WPI value > 50 indicates negative grain protectant effect, or enhancement of infestation by the weevil.

3-3-5 Experiment 5:Testing the residual effect of the plant extracts

The experiment was conducted in a completely Randomized Design which contained ten treatment (3 species * 3rates + Control) in three replications in store conditions of 27-35^0 C and 58-65% RH.The dates were washed then subjected to sun light for 12 hours . Nine Jute sacks were treated with the botanical extracts of each of the three plant species, at 3 concentrations 5, 10 and 15%. In the Tenth treatment with each plant extract, the jute sacks were treated with distilled water as a control treatment. Each impregnated jute sack was filled with 50grams of date fruits. All the jute sacks (Plate7) were kept for 14 days in cages, in which 100 adult insects of *Oryzaephilussurinamensis* were manually introduced into the cages.

3-4 Statistical analysis

The experiments were assigned in a Completely Randomized Design (CRD). The data were subjected to Analysis of Variance (ANOVA).The treatment means were separated using the Least Significant Difference (LSD) at 5% level of probability.

Plate (1). Mass culture of insects

Plate (2). Clean undamaged dates

Plate (3). Usher *Calotropisprocera*

Plate (4) Datura (*Daturastramonium*)

Plate (5). Argel (*Solenostemmaargel*)

Plate(6). Test of the mortality of the *O . surinamensis*

Plate(7). Testing the residual effect of the plant extracts

CHAPTER FOUR

RESULTS

RESULTS

4 .1 Results of the survey of stores in Omdurman Locality

Results of the survey carried out in Omdurman Locality are summarized in (Table 1), which showed: stores conditions , stored materials , period of storage , store pests found, percentage of infestation and type of control measure applied .

Table(1) showed that;important pests stores recorded were : *Trogoderma granarium* (Khapra), with high infestation in the grains stores, also *Tribolium castaneum*(flour beetle) recorded high infestation in the grains. Dry dates, the more important crop storedwas affected by two pests, *Oryzaephilus surimamensis*(saw- toothed grain beetle)and *Ephestia cautella*(Date mouth)(plates 8, 9). Stored wheat was also found heavely infested with *Oryzaephilus surimamensis*)(plate10).

Plate (8). Datesinfestation by(*O . surinamensis*)

Plate (9). Dates infestation byDate mouth(*Ephestiacautella*)

Plate (10). Wheat(*Triticum aestivum*) infestation by Saw- toothed grain beetle (*Oryzaephilus surinamensis*)

4.2.1 The effect of Usher leaves powder extracts (ULPE) on infestation of Saw- toothed grain beetles

The three tested concentrations (5%,10% and15%) of ULPE resulted in high mean numbers of dead insects (4.0), (4.6) (4.8) for same the period , with no significant differences between adult mortality at all concentration. Also, in the 2nd day no significant differences were recorded between adult mortality at all concentrations. However, There were significant differences between all concentrations and the control during the test periods,24hrs and 48 hrs(Table 2and Table 3) and(Figures 1and 2).

4.2.2 The effect of Argel leaves powder extracts (ALPE) on infestation of Saw- toothed grain beetles

Generally, there were no significant differences between adult mortality percentages between all concentrations of each period 24hrs and 48hrs (Tables2 and 3) and(figures 1and 2).Thehighest mean numbers of dead beetles were recorded at concentration 15%, while the lowest number of adult mortality were recorded at concentration 10%.Also, there were clear significant differences between treatments and control.

4.2.3 The effect of Datura leaves powder extracts (DLPE) on infestation of Saw- toothed grain beetle on dates.

Also, in these treatments , no significant differences were recorded in the meannumbers of mortality during the test periods, 24hrs and 48hrs.However, there were significant differences found between all concentrations and the control(Table2 and Fig 1).

Table (2). The effect of Usher,Argel and Datura leaves powder extracts on mortality rate of the adult of Saw- toothed grain beetles After 24 hrs

Treatments		Replications			Means
		R1	R2	R3	
Usher	5%	10 (3.2)	15 (3.9)	25 (5)	16.6 (4)abc
	10%	20 (4.5)	20 (4.5)	25 (5)	21.6 (4.6)ab
	15%	20 (4.5)	25 (5)	25 (5)	23.3 (4.8)a
Argel	5%	20 (4.5)	10 (3.2)	15 (3.9)	15 (3.8)abc
	10%	10 (3.2)	10 (3.2)	10 (3.2)	10 (3.2)bc
	15%	20 (4.5)	20 (4.5)	15 (3.9)	18.3 (4.2)ab
Datura	5%	5 (2.3)	5 (2.3)	15(3.9)	8.3 (2.8)c
	10%	5 (2.3)	10 (3.2)	20 (4.5)	11.6 (3.3)bc
	15%	10 (3.2)	15 (3.9)	10 (3.2)	11.6(3.3)bc
Control		0 (0.7)	0 (0.7)	0 (0.7)	0 (0.7) d
SE ±		0.4535			
CV %		22.97			
LSD		1.339			

*Means followed by the same letter(s) in the same Colum are not significantly different at (p=0.05) according to Duncan's Multiple Range Test (DMRT).

.

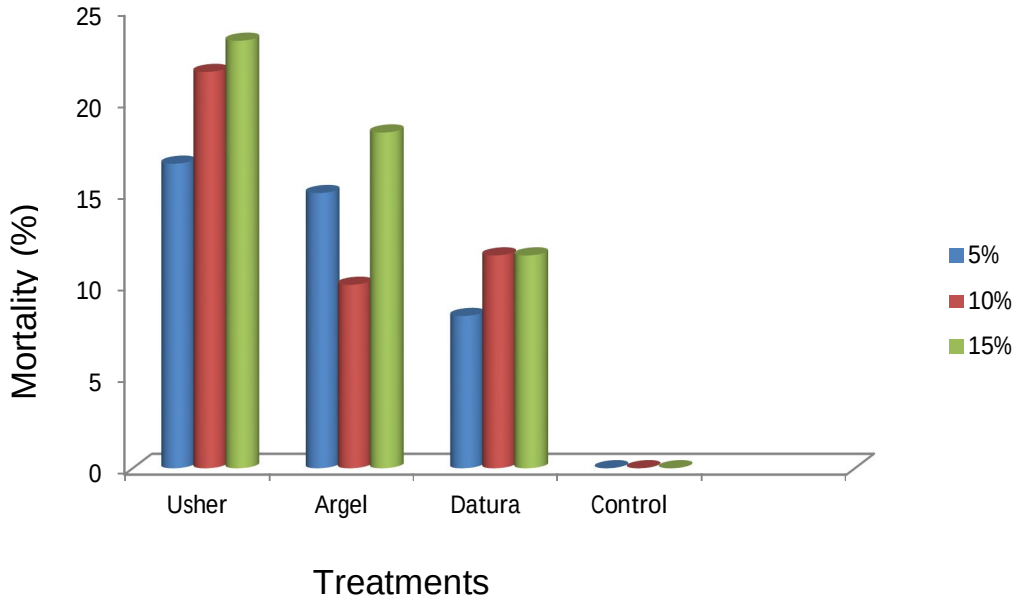

Fig 1. The effect of Usher , Argel and Datura leaves powder extracts on mortality rate of the adult of Saw- toothed grain beetle After 24 hrs.

Table(3). The effect of Usher, Argel and Datura leaves powder extracts on mortality rate of the adult of Saw- toothedgrain beetlesAfter 48 hrs

Treatments		Replications			Means
		R1	R2	R3	
Usher	5%	20 (4.5)	25 (5)	30 (5.5)	25 (5)a
	10%	25 (5)	20 (4.5)	30 (5.5)	25 (5) a
	15%	25 (5)	25 (5)	30 (5.5)	26.6 (5.1)a
Agel	5%	30 (5.5)	20 (4.5)	20 (4.5)	23.3 (4.8)a
	10%	20 (4.5)	15 (3.9)	25 (5)	20 (4.4) a
	15%	30 (5.5)	20 (4.5)	30 (5.5)	26.6 (5.1)a
Datura	5%	10 (3.2)	15 (3.9)	20 (4.5)	15(3.8)a
	10%	10 (3.2)	15 (3.9)	25 (5)	16.6 (4)a
	15%	5 (2.3)	30 (5.5)	30 (5.5)	21.6 (4.4)a
Control		0 (0.7)	0 (0.7)	0 ((0.7)	0 (0.7) b
SE ±		0.4550			
CV %		18.47			
LSD		1.342			

*Means followed by the same letter(s) in the same Colum are not significantly different at (p=0.05) according to Duncan's Multiple Range Test (DMRT).

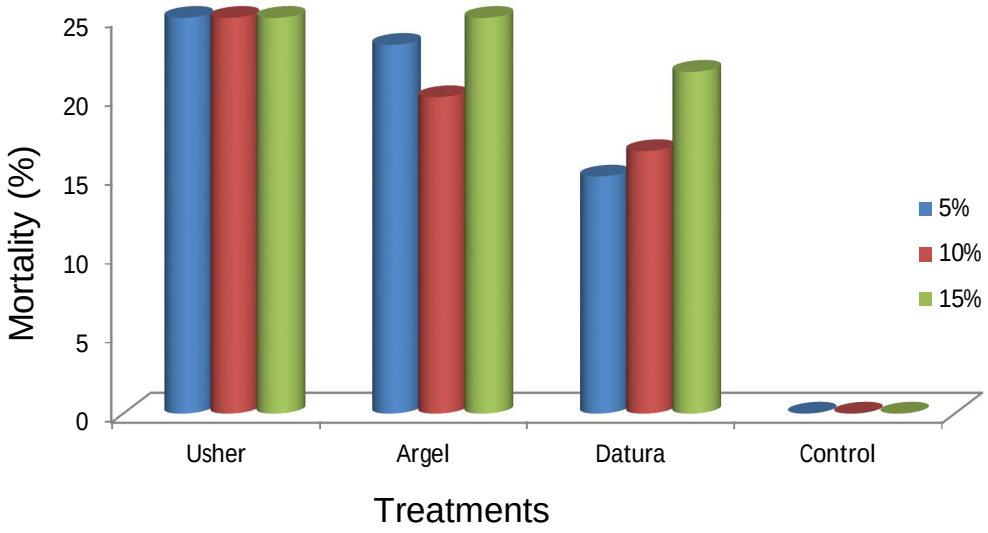

Fig 2.The effect of Usher Argel and Datura leaves powder extracts on mortality rate of the adult of Saw- toothed grain beetles After 48 hrs

4.3.1 The effect of Usher water extracts (USWE) on infestation of saw - Toothed grain beetle

In (Table 4and 5) and (figures 3and4) the three test concentrations (5% ,10%,15%) resulted in high mean number of dead adult insects (3.9), (4.5), (5.07),for the same period,but with nosignificant differences between them.Also in the 2ndday no significant differences were found between the three concentrations. However , clear significant differences were recorded between percentage of adult mortality at all concentrations and the control.

4.3.2 The effect of Argelwater extracts (AWE) on infestation of saw-toothed grain beetles.

The highest mean number of dead adult insects recorded at concentration 15% of (AWE) was (4.6) in the second day (Table 5and Figure 4).Also, in the 2nd day no significant differences were recorded between adult mortality at all concentrations. However, the highest mean number of dead adult insects recordedat concentration 15%was (4.1) in the first day (Table 4 and Figures3).However, there were significant differences between all concentrations and the control during the test periods of 24hrs and 48 hrs (Table 4 and Table 5).

4.3.3 The effect of Datura water extracts (DWE) on infestation of Saw-toothed grain beetleson Dates.

The three tested concentrations (5%,10% and 15%)of there wereresulted in high mean number of dead adult insects (3.1), (3.8), (3.5), for the same period , with no significant differences between concentrations, but significant differences were found between concentrations and control. The highest mean number of dead adult insects was recordedat concentration15% in the second day (Table 5 and Figure 4).

Table(4). Effect of Usher, Argel, and Datura water extracts on mortality rate of Saw- toothed grain beetle on dates after 24 hrs

Treatments		Replications			Means
		R1	R2	R3	
Usher	5%	10 (3.2)	20 (4.5)	15 (3.9)	15 (3.9)a
	10%	10 (3.2)	10(3.2)	20 (4.5)	13.3 (3.6)a
	15%	15 (3.9)	20 (4.5)	15 (3.9)	16.6 (4.1)a
Argel	5%	5 (2.3)	15 (3.9)	10 (3.2)	10. (3.2)a
	10%	10 (3.2)	10(3.2)	10 (3.2)	10 (3.2) a
	15%	10 (3.2)	20 (4.5)	20 (4.5)	16.6 (4)a
Datura	5%	5 (2.3)	10(3.2)	15(3.9)	10 (3.1)a
	10%	10 (3.2)	15 (3.9)	20 (4.5)	15 (3.8)a
	15%	5 (2.3)	20 (4.5)	15 (3.9)	13.3 (3.5)a
Control		0 (0.7)	0 (0.7)	0 (0.7)	0 (0.7)b
SE ±		.3945			
CV %		20.55			
LSD		1.164			

*Means followed by the same letter(s) in the same Colum are not significantly different at (p=0.05) according to Duncan,s Multiple Range Test (DMRT) .

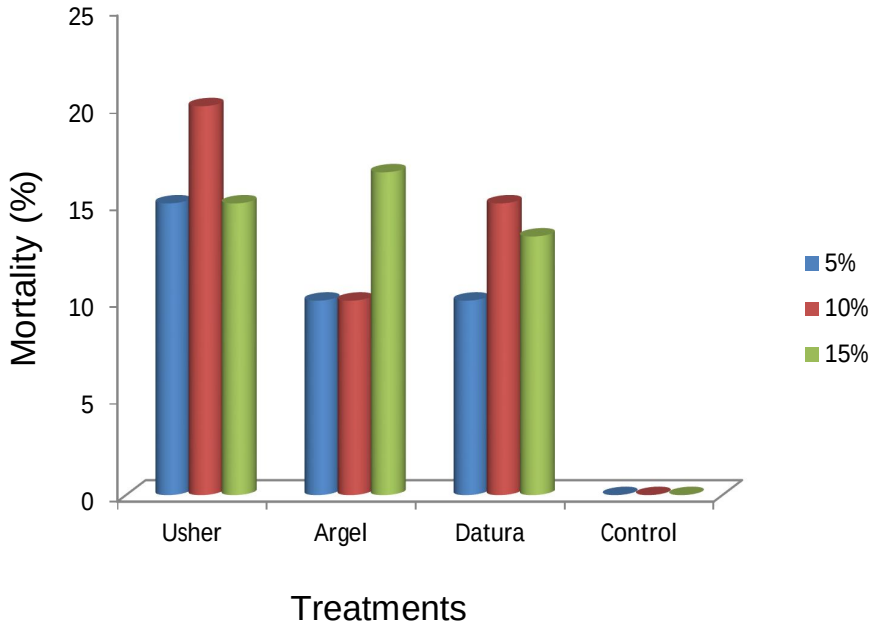

Fig 3. Effect of Usher, Argel , and Datura water extracts on mortality rate of Saw - toothed grain beetle on dates after 24 hrs

Table (5) . Effect of Usher, Argel, and Datura water extracts on mortality rate of Saw- toothed grain beetle on dates after 48 hrs

Treatments		**Replications**			**Means**
		R1	R2	R3	
Usher	5%	10 (2.3)	15 (3.9)	20 (4.5)	15 (3 .9)a
	10%	20 (4.5)	20 (4.5)	20 (4.5)	20 (4.5)a
	15%	25 (5)	25 (5)	25 (5)	25 (5)a
Argel	5%	10 (3.2)	10 (3.2)	15 (3.9)	11.6 (3.4)a
	10%	10 (3.2)	20 (4.5)	15 (3.9)	15 (3.9) a
	15%	15 (3.9)	25 (5)	25 (5)	21.6 (4.6)a
Datura	5%	15 (3.9)	15 (3.9)	20 (4.5)	16.6 (4.1)a
	10%	15 (3.9)	15 (3.9)	20 (4.5)	16.6 (4.1)a
	15%	20 (4.5)	20 (4.5)	20 (4.5)	20 (4.5)a
Control		0 (0.7)	0 (0.7)	0 (0.7)	0 (0.7) b
SE ±		0.7188			
CV %		26.54			
LSD		2.120			

*Means followed by the same letter(s) in the same Colum are not significantly different at (p=0.05) according to Duncan's Multiple Range Test (DMRT) .

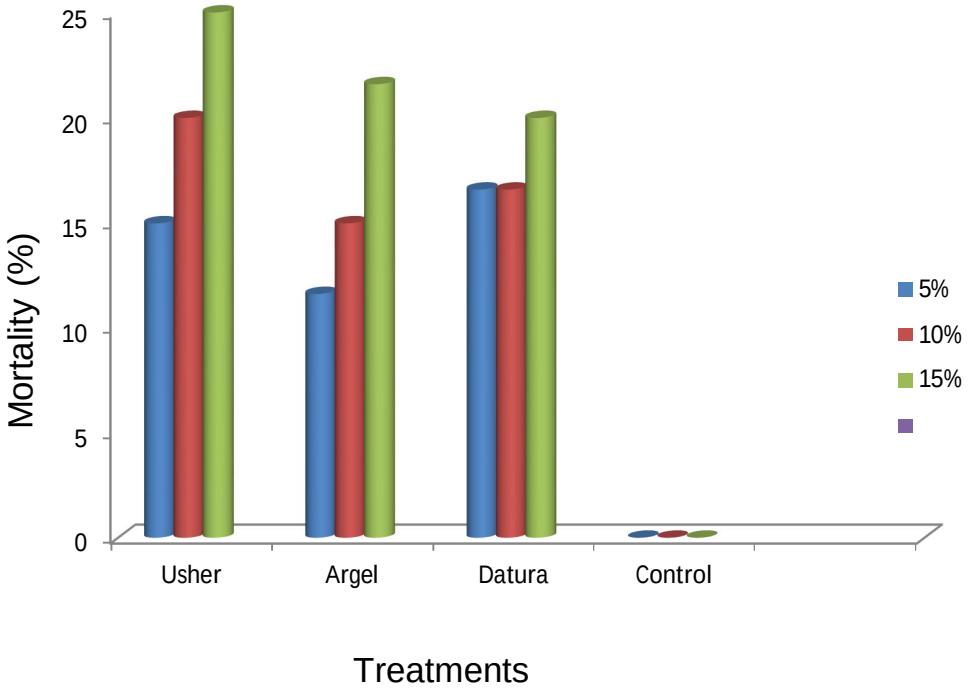

Fig 4. Effect of Usher, Argel , and Datura water extracts on mortality rate of Saw toothed grain beetle on dates after 48 hrs

4.4.1 The effect of Usher Ethanolextracts(UEE) on infestation of Saw-tooth beetle on Dates

(Table 7 andFigure 6)showed highest number of dead insects at three concentrations (5%,10% and 15%) in the second day.No significant differences were recorded between the three concentrations, but there were significant differences between concentrations and the control.

4.4.2 The effect of Argel Ethanolextracts (AEE) on infestation of Saw- t

Significant differenceswere found between all concentrations and the control.Argel was observed recording high number of dead insects (5.5)with concentration 15%in the second day. Also,it was observed that Argel at three concentrations in the first day recorded similar results of mortality number of adult insects(4.1)(Table 6 and Figures 5).

4.4.3 The effect of Datura Ethanol Extracts (DEE) on infestation of Saw-toothed grain beetle on dates

In(Tables6 and 7) and (Figures 5 and 6),no significant differences were found in the mortality numbers of beetles between all concentrations.However, There were significant differencesin the mortality numbers of beetles between concentrations and control.(Table 6).

Table(6). Effect of Usher , Argel and DaturaEthanol extracts on mortality rate of the adult of Saw- toothed grain beetle After 24hrs

Treatments		Replications			Means
		R1	R2	R3	
Usher	5%	15 (3.9)	20 (4.5)	25 (5)	20 (4.4) abc
	10%	15 (3.9)	25 (5)	25 (5)	21.6 (4.6)ab
	15%	25 (5)	25 (5)	30 (5.5)	26.6(5.1)a
Argel	5%	10 (3.2)	20 (4.5)	20 (4.5)	16.6 (4.1) bc
	10%	10 (3.2)	20 (4.5)	20 (4.5)	16.6 (4.1) bc
	15%	15 (3.9)	15 (3.9)	20 (4.5)	16.6 (4.1) bc
Datura	5%	10 (3.2)	15 (3.9)	15 (3.9)	13.3 (3.6)c
	10%	20 (4.5)	20 (4.5)	15 (3.9)	18.3(4.3)abc
	15%	20 (4.5)	20 (4.5)	20 (4.5)	20 (4.5)abc
Control		0 (0.7)	0 (0.7)	0 (0.7)	0 (0.7)d
SE ±		0.2781			
CV %		12.14			
LSD		0.8204			

*Means followed by the same letter(s) in the same Colum are not significantly different at (p=0.05) according to Duncan's Multiple Range Test (DMRT) .

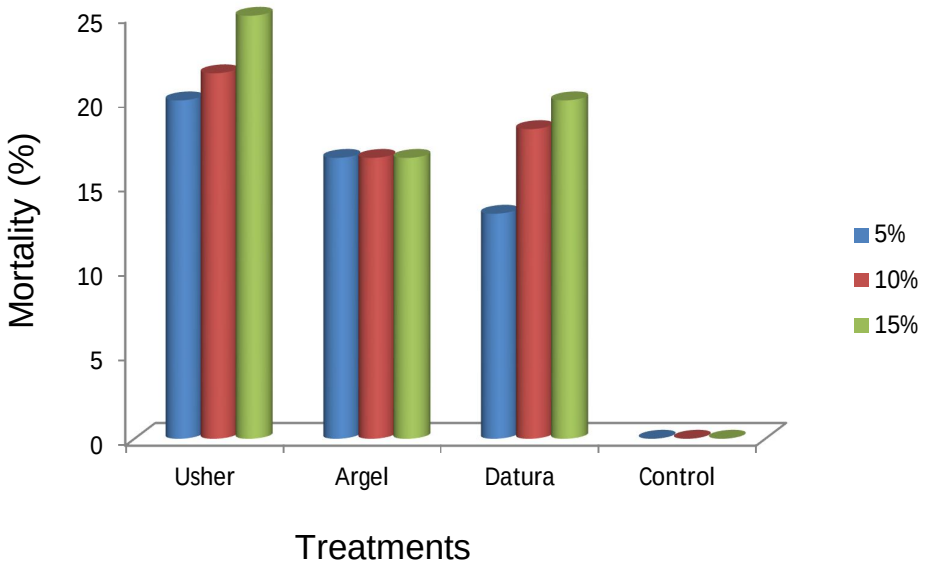

Fig 5. Effect of Usher ,Argel and Datura Ethanol extracts on mortality rate of the adult of Saw toothed grain beetle After 24hrs

Table (7). Effect of Usher , Argel and Datura Ethanol extracts on mortality rate of the adult of Saw- toothedgrain beetle After 48hrs

Treatments		Replications			Means
		R1	R2	R3	
Usher	5%	30 (5.5)	30 (5.5)	30 (5.5)	30 (5.5) a
	10%	25 (5)	30 (5.5)	30 (5.5)	28.3 (5.3)ab
	15%	30 (5.5)	30 (5.5)	30 (5.5)	30 (5.5) a
Argel	5%	25 (5)	25 (5)	30 (5.5)	26.6 (5.1)ab
	10%	30 (5.5)	30 (5.5)	30 (5.5)	30 (5.5)a
	15%	25 (5)	30 (5.5)	30 (5.5)	28.3 (5.3)ab
Datura	5%	15 (3.9)	20 (4.5)	25 (5)	20 (4.4)c
	10%	25 (5)	30 (5.5)	25 (5)	26.6 (5.1)b
	15%	25 (5)	30 (5.5)	25 (5)	26.6 (5.1)b
Control	2.5 (0.5)	0 (0.7)	0 (0.7)	0 (0.7)	0 (0.7) d
SE ±		0.1354			
CV %		4.95			
LSD		0.3994			

*Means followed by the same letter(s) in the same Colum are not significantly different at (p=0.05) according to Duncan's Multiple Range Test (DMRT) .

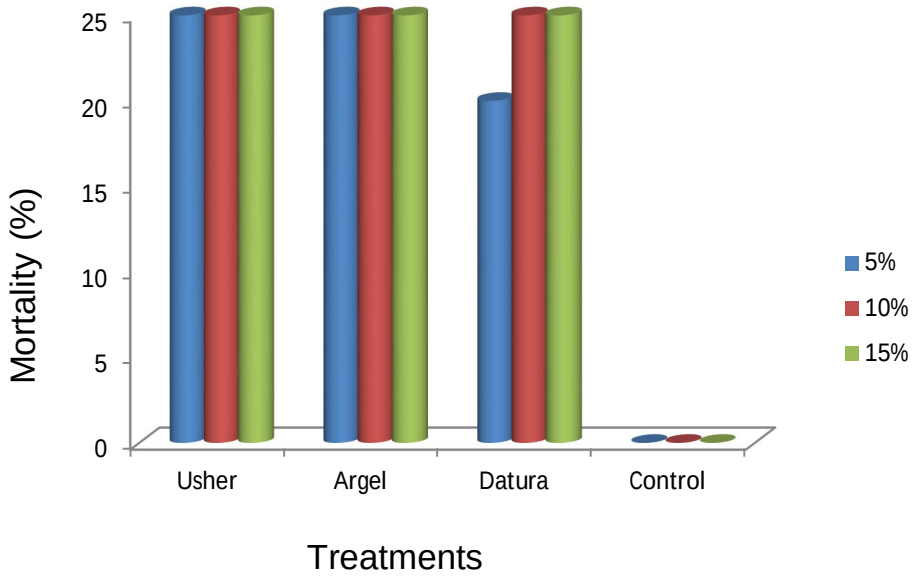

Fig 6. Effect of Usher ,Argel and DaturaEthanol extracts on mortality rate of the adult of Saw- toothedgrain beetle After 48h

4.6 1 Test the percentage of penetration of the insects

(Table 8 and Figure7), in the 1st week. At 1st week highest penetration effect of the insects was found in the control (12.7).At the end of the 2nd week, the insects penetration effect were(9.6) at control jute sacks at the same period , the high effect againstinsect penetration were recorded by Datura extracts at concentration 15%(Table 9).

Table(8). Test on thepenetration percentage of the insecst in the first week

Usher	treatment	R1	R2	R3	Mean
	C5%	8	4	6	(6.0)bc
	C10%	4	6	4	(4.6)cde
	C15%	3	2	3	(2.6)e
Argel	C5%	4	2	5	(3.2)de
	C10%	3	3	2	(2.6)e
	C15%	7	8	8	(7.6)b
Datura	C5%	5	2	4	(3.6)de
	C10%	6	4	7	(5.6)bcd
	C15%	5	3	3	(3.6)de
Control		13	13	12	(12.6)a
SE±		0.7071			
CV%		23.11			
LSD		2.086			

*Means followed by the same letter(s) in the same Colum are not significantly different at (p=0.05) according to Duncan's Multiple Range Test (DMRT).

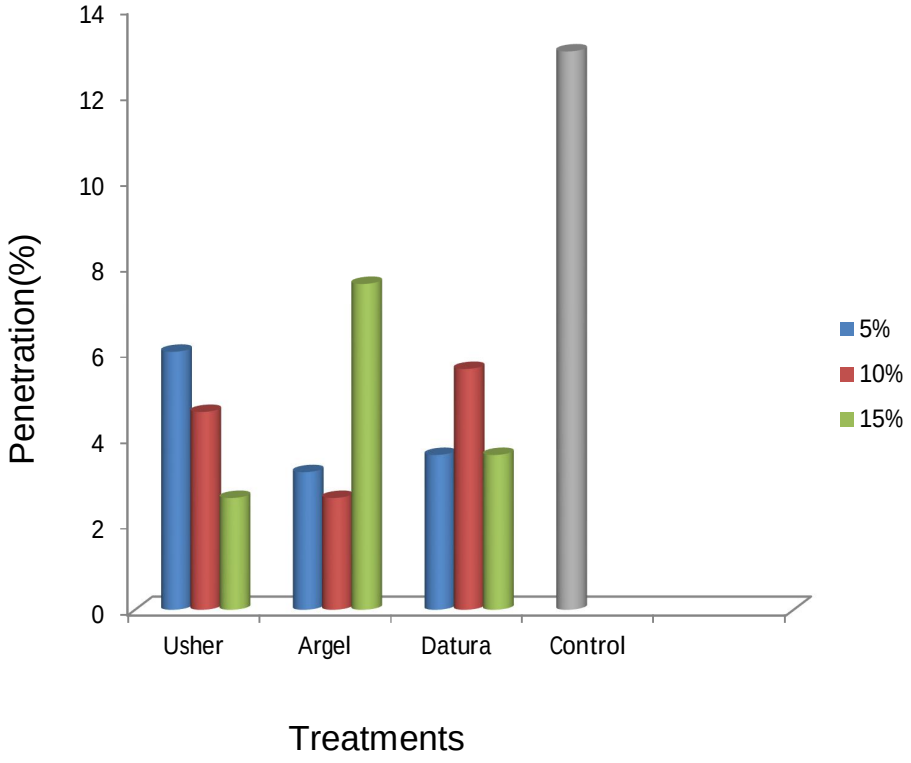

Fig 7. Test the penetration percentage of the insect in the first week

Table (9). Test the penetration percentage of the insect in the secondweek

	treatment	R1	R2	R3	Means
Usher	C5%	8	8	6	(7.3)b
	C10%	3	4	2	(3)de
	C15%	3	3	1	(2.3)e
Argel	C5%	2	4	2	(2.6)e
	C10%	7	6	8	(7)bc
	C15%	3	4	4	(3.6)de
Datura	C5%	3	1	1	(1.6)e
	C10%	8	3	4	(5)cd
	C15%	2	1	1	(1.3)e
Control		10.	10.	9	(9.6)a
SE±		.07148			
CV%		28.36			
LSD		2.109			

*Means followed by the same letter(s) in the same Colum are not significantly different at (p=0.05) according to Duncan's Multiple Range Test (DMRT).

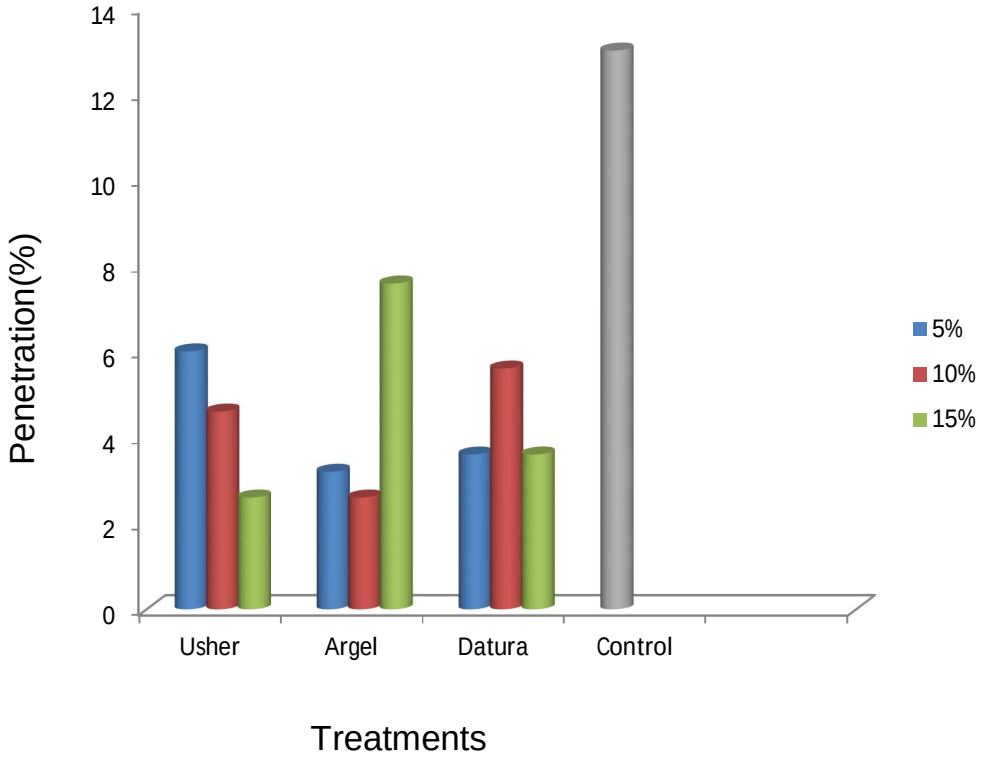

Fig 8. Test the penetration percentage of the insect in the 2 week

4.7 Weevil perforatedIndex (WPI) with plant materials

This bioassay procedure thus allows plant materials with strong ,weak or negative " grain protectant effects" to be detected, irrespective of their mode of action.The weevil perforation index (WPI) compares the activities of different species of plant extracts used. From the results of this study, shown in Table 10 and Figure 9, it was evident that, of the three plants screened, Daturashowed the best grain protectant effects, a WPI value recorded was (24%) at a dose of 30% (w/w) and it is considered to be a strong effect.At the same period, Usher andArgelextracts showed lowest effects, with a WPI valuesof (31.6 and 37.1) at a dose of 30%(w/w), respectively.However, the powder extracts ofthe 3 plants, in general, prevented infestation and damage of treated grains, at different levels.

Table (10) . Weevil perforationIndex (WPI) of the plant materials

	Dose	Mean No. of perforated(damage)seeds	Mean No of unperforted seeds	Total	%of PercementPerforted seeds	WPI
Control		41.7	342.3	384	10.8	50
Usher	10%	20	355.3	375.3	5.33	32.98
	20%	18	346.3	364.3	4.94	31.27
	30%	17.7	342.3	360	4.91	31.63
Argel	10%	29.3	366.7	396	7.41	40.63
	20%	25	370.7	385.4	6.32	36.85
	30%	24.7	352.3	377	6.41	37.18
Datura	10%	15	362.3	377.33	3.97	26.83
	20%	15	351.6	366.6	3.9	26.46
	30%	13	347.3	360.3	3.42	24

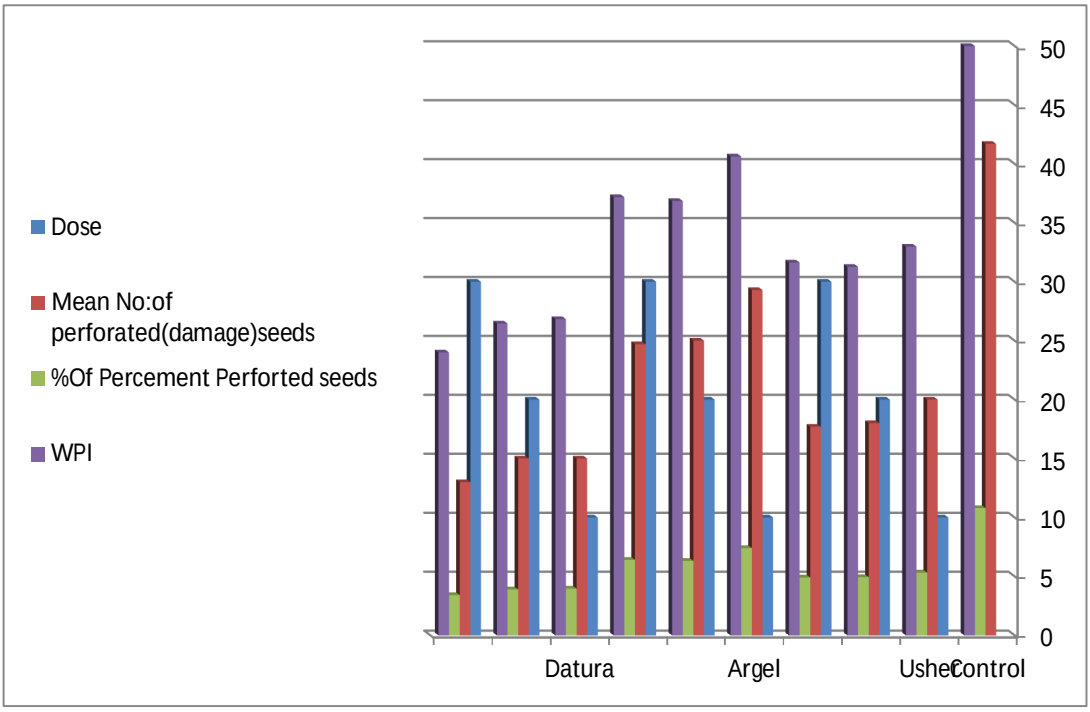

Fig 9. Weevil perforation index (WPI) of the plant materials

CHAPTER FIVE

DISCUSSION

DISCUSSION

The conventional use of synthetic pesticides and their success during the past three decades led to their wide acceptance for use against different groups of agricultural pests. However, the extensive use of these synthetic insecticides was associated with certain drawbacks and hazards , including high persistence , toxicity to mammals and non _target organisms, and genetic resistance .

In a reaction to these problems, researchers all over the world have resorted to using more available and environmentally friendly botanicals; they focused on the use of plant products , such as plant powders , water extracts and oils, which are cheaper, safe, of low mammalian toxicity, with relatively short environmental persistence and enhancement of selectivity to target pests. Many plant products show abroad spectrum of activity against pest insects from insecticidal, antifeedant ,repellent, oviposition deterrent, growth regulatory effect and anti –vector effects. Especially remarkable, are tropical plants from which hundreds of secondary metabolites, with insecticidal properties, have been extracted(Hiiesaar *et. al.,* (2001).

The good example of botanical insecticides used so far were those that has been derived from the Neem tree (*Azadirachtaindica* A., juss), which were tried against more than 400 species of insect pests(e. g .,Schmutterer *et.al* ., 1995). Also, Stoll (2000) mentioned more than 65 plant speciesthat showed insecticidal activity against a number of insect pests. Examples of those plant are, Derris(*Derriselliptica*), Garlic (*Aliumsativum*), Ginger (*Zingiberofficinale*), Malabar tree (*Adathodavasica*),… ect .

Also , in Sudan, the same trend towards application of botanical extracts was tried by many workers. Fore example, Sidahmed *et.al.,* (2009) Applied aqueous extracts of Argel (*Solenostemma,argel*) against Cotton soil termites,*Microtermes thoracales*in laboratory experiments.Their results

showed that , all concentrations of the Argel aqueous extracts caused high mortality of the termites . Also, no significant differences were found between the highest concentration of Argel extract and that of the standard insecticide Dorisban4.

In Pakistan,Badshah*et.al.*,(2004) applied plant extracts of Usher (*Calotropisprocera*) against two species of termites (*HeterotermesIndicola*)and(*Coptotermesheimi*). Their results indicated that, the toxic effects of flowers extracts caused more mortality of the termite species than the leaves extracts .

In the present study,theSurvey carried in grain stores in Omdurman defined serious points about the stores conditions and the considerable infestation pest infestationwas recorded stores in the stores (plates 8,9 and 10). Also the survey indicated that, the methods of chemical control applied by the stores owners was the main problem.

The present study was also carried out to investigate the insecticidal effects of three plants naturally grown in Sudan, namely Usher(*Calotropisprocera),* Datura, (*Daturastramonium*) and Argel (*Solenostemmaargel*) against main pest in those stores, the saw – toothed grain beetle, *O. surinamensis.*

The results showed that, all the plant materials tested had varying degree of insecticidal activities. The ability of the three plants conditions (i.e., powder, water extract, ,andethanol extract) to cause effect on the Saw- toothed grain beetle on Dates can be attributed mainly to their contact toxicity.

In the present study,the mortality effect of usher becomes a well documented fact with two conditions, ethanol extracts in(table 6 and figure 5) and (table 7 and figure 6) and powder extract in table(2) and fig(1), and table(3) and fig (2).The three concentrations of Usher leaves powder extract with three conditions revealed that, the Saw- toothed grain beetles mortality was affected by the potential of usher and the mortality was increased by increased

the time .The present study agreed with Shah *et al*., (2006), and Shah *et. al*., (2008), who mentioned that, the extracts of six plants had toxicity and repellency effects against the saw-toothed grain beetle, *Oryzaephilussurinamensis* (L.). The rate of repellency increased with increase in the 4 concentrations applied. Similarly, these finding agreed withSaghee*et.al.*, (2011) who stated that, the mortality of *T. castaneum* increased with both an increase of concentration of 4 plant extracts as well as exposure time of treatment. Also, Das *et.al.*, (2008) and Ahmed *et.al*., (2006) pointed to the potential of Sodom apple (Usher) plant extracts in the control of bean aphid *Aphiscraccivora* Koch and *Henosepilachnaelaterii* (Rossi).

The results of treatments with Argel extracts shown in tables (2-7) also indicated that, the high mean numbers of adult mortality were caused by the leaves' powder and ethanol extracts. Generally, there was no significant difference between percentage mortality caused by the three extracts. However, there were a significant differences between treatments and control mortality. The results of a study by Neetu*et.al.*, (2015), showed that, the extracts of 4 plants and their combinations controlled *O. surinamensis* by showing repellent behavior. Al Qahtani*et. al.*, (2012) mentioned that, the extracts of 3 tested plants, (ginger, *Zingiberafficinale;* hail, *Elettariacardamomum;* and shammar, *Foeniculumvulgare*,)showed insecticidal activity against *O. surinamenss,* andindicated that, Ginger was the most potent plant, recording the lowest LC_{50} value (0.14 mg /g) followed by hail and shammar (LC_{50}=0.4 and 0.7 mg/g), respectively. Similar results were obtained by Yousif and Satti (2014) who showed inferior insecticidal effect from *S.argel* against *T. granarium* larvae, as compared with other six plants. Also, similar findings were reported by Mahmoud *et.al.*, (2015) who investigated the effects of four plants, neem*A.indica* (seeds) , Usher *C.procera* (leaves), Argel*S.argel* (leaves) and scorpion root, *Aristolochiabracteolate* (shoots). The results of the bioassay showed that, all

the plants have insecticidal effects on the *T. granarium* with variable levels. The current results also agrees to some extent with Bakhiet and Taha (2009) regarding the effect of *S. argel* on the adults of faba bean beetle, *Bruchidiusincarnatus*.

The argel effectson the Saw toothed grain beetles shown in table (6) and table (7) also indicated that,Argel was recorded good results by ethanol extracts .This insecticidal effect of Argel ,was similar to that proposed by Abdalla (2006) when testing the effectsof Argel treatment on the white scale insect on date palm. .

Elkamali (2001) and Hag – Eltayeb (2005) reported larvicidal effects of Argel cruds and aqueous extracts against mosquito larvae . Moreover , an Argel insecticidal effect on adult beetles of faba bean was reported by Mohamed (2004), and also Ibrahim (2007) reported beneficial effects were obtained from Argel additive to the soil, where the Barakawi date palm cultivar was planted . Babikir (2005) studies on infestation of dates by *O. surinamensis* showed that, Barakawi cultivar is the least susceptible cultivar to the store pests followed by Gaw and then Bentamoda. Gondeila was the most susceptible cultivar to the Saw- Toothed grain beetles .Also Eldoush (2009) Reorted that, Argel and Usher proved to be effective in the control of the green pit insect on date palms when compared to the untreated controland Actara the recommended chemical pesticide.

Analysis of data of the mortality caused by treatments with *D.stramonium* extracts shown in tables (2-7) indicated that, generally no variation in percentage mortality was noticed between the different concentrations of the 3 extracts. However, there was a significant difference in adult mortality between treatments and control. The three concentrations of the plants revealed that, the mortality of the insect was affected by increase in time. Similar results were reported by Farkhanda*et.al.*, (2011) who investigated the

effects of ethanol extracts of five plants' leaves, Bakain (*Meliaazedarach*), Mint (*Menthalongifolia*), Habulas (*Myrtuscommunis*), Lemongrass (*Cymbopogoncitrates*) and Datura (*D.stramonium*). The extracts were mixed with 10 mg/g of grains, and comparison of the plant extracts on *O.surinamensis*showed that, Habulas extracts were the most effective, causing 50.71% mortality, while Datura showed Minimum mortality of (21.43%). Also, Malgorzata and Anna (2015) mentioned that, the powdered plants of different species namely: peppermint, *Menthapiperita*(L.); wormwood *Artemisia absinthium*(L.); common sage, *Salvia officinalis*(L.), allspice *Pimentadioica* and common garlic *Allium sativum*(L.), added to semolina using 3 concentrations, influenced the mortality rate in the saw-toothed grain beetleby different degrees, with allspice seeds caused the highest mortality. These results are also in agreement with Abid*et.al.*, (2012), who assessed the contact toxicity and the trans-generational effect of *D. alba* leaf extract against two important stored insect pests of Rice, *T. granarium* and *S. oryzae*, under laboratory conditions. The highest concentration (2.5%) induced significantly high mortality of 33.5 and 45% in *T. granarium* and *S. oryzae* after 7 days of exposure, respectively.

Test the percentage of penetration of the insectsshowed the percentage of penetration of the adult beetles Saw- toothed grain beetles for the treated jute sacks of the three botanicals.At the end of the 2nd week, , the high effect against insect penetration was recorded by Datura extracts at concentration 15% (Table 9).Also Chakravarty (1976) in chemical analysis, Stated that, *D.stramonium*contains alkaloid compounds such as atropine , scopolamine in the leaves, stems and fruits in addition to essential oils, which may be the direct reason of killing the insects. The present result is also in agreement with Khan & Marwat (2004) who evaluated the leaves bark and seeds of bakain (*Melia azadarach*) and Usher (*Calotropis procera*) powder against lesser grain borer (*R. dominica*). They stated that**,** insect (*R .dominica*) was

repelled from bakains bark powder with 98-25 % repellency followed by powder of usher (*C. procera*).

The Weevil perforation index (WPI)compared the activities of the extracts of three plants used. WPI values of 50 shows that, equal amounts of treated and untreated chick pea seeds were perforated. From the results of Table 10, it was evident that, Of the three plants screened,*D. stramonium*showed the best grain protectant effects. The results indicated the possibility of using leaves powder extract in pest management. Protectant ability of Datura powder shown in this test are agreement with the observation of *Kuganathan etal*, (2007) who showed that, extract of*D. alba* leaves at higher concentration was more toxic and can be used as insecticide against aphid and black ants.The results also agreed with Kuganathan (2011) who investigated,the acute toxicity of *D . metel* at varying concentrations on grasshoppers and red ants. The results indicated that extract of *D. metel* leaves at higher concentration was more toxic, and it can be used as an insecticide against grasshoppers and red ants.

These results also agreed with Ragab (2014) who stated that,*D. lba* showed the best grain protectant effects , compared to other plants,*Calotrpisprocera* and*Jatrophacurcas* L. against *Trogodermmagranarium.*

CONCOLUTIONAND RECOMMENDATION

It was evident from this study that, all the plants, tested at different conditions, have the potential of being used as Biopesticides.

The results therefore, strongly suggest the possibility of using the extracts of three plants (Usher ,Argel, Datura) effectively against the Saw- toothed grain beetles on stored Dates.

Datura extracts recorded the highest repellency effect in the penetrationexperiment, compared with the control, which allow its application for pest control in stores, through its repellency effect.

Also, Datura with high concentration in this study, can be used agood grain protecant In Dates stores.

However, there is a need for more investigationsin the future , to identify other local plant materials that would be used in stores of dry dates against the disturbing infestation of *Oryzeaphilussurinamensis.*

REFERENCES

REFERENCES

Abdalla, O.A. (2006).Field control of the white scale insect *Parlatoria blanchardi*(Targ) (Homoptera : Diaspididae) with aqueous extract of Argel (*Solenostemmaargel*) (Del). Hayne .M .Sc .Thesis , Sudan University. Of Science –and Technology. p61.

Abdul Wahab, D. H. and Eissa,I .S. (1986). Biological studies on some dry Date pests in Egypt .2nd symposium on date palm . AL- Hassa, Saudi Arabia,pp: 284-288 .

Abid, A. Farooq, A. Antonio, B. Yash, W . and Nicolas D. (2012). Potential for using *Daturaalba* leaf extracts against two major stored grain pests, the Khapra beetle *Trogodermagranarium* and the rice weevil *Sitophillusoryzae*. J Pest Sci (2012)85;359-366 .

Adedire , C. O. (2002). Use of nutmeg , *Myrristicafragrans* (Houtt) powder and oil for the control of cowpea storage bruchid, *Callosobruchusmaculatus* (F). J. Plant Dis .Protect .,109: 193 -199 .

Adedire, C.O & Ajaji, T. S .(1996). Assessment of the insecticidal properties of some plant extracts as grain protectants against the maize weevl , *Sitophilus* . *zeamais* . Nigerian Journal of Entomlogy, 13:93-101.

Ahmed, M.A .(2003). Effect of the insecticide confidor on the date palm green pit scale insect *Asterolecaniumphoenicis* (Rao) (Asterolecanidae : Homoptera . Proceedings of the International Conference on Date Palm . King Saud university, Qaseem Branch . 16 – 19 Dec 2003

Ahmed, A.M, Umsalama, Shi Zuhu, Nabil. H. H.Bashir, Muafi K. Hao Zhongping.Yuling, G.(2006) . Evaluation of insecticidal potentialities of aqueous extracts from *Calotropisprocera* Ait . against

Henosepilachnaelatrii Rossi .Journal of applied Sciences ,6 (11) :2466-2470 ,2006. ISSN 1812-5654-2006 Asian Network for Scientific Information .

Ahmed, G .A. (1993). Preliminary investigation in the insecticidal potentialities of Usher plant . *Calotropisprocera* Ait, M. Sc. Thesis,Fac . Agric . Univ. of Khartoum, Sudan .

Ahmed,M. (1990). Irradiation of dried dates for Insect control. The workshop on date palm . Post – harvest processing technology .FAO Tehran, Iran –6 .

Al Qahtani, A. M.;AI- Dhafar, Rady. M. H. (2012)). Insecticidal and biochemical effect of some dried plants against *Oryzaephilus surinamensis* (Coleoptera: Silvanidae) Journal of Bazic & Applied Zoology, Volume 56: 88-93.

Ajayi,F. A., &Lale , N. E .S .(2001).Susceptibility of unprotected seeds and seeds of local bambara groundnut cultivars protected with insecticidal essential oils to infestation by *Callosobruchusmaculatus* (F) . Journal of Stored Products Research , 37: 47-62 .

Akinkurolere, R . O, Adedire, C. O & Odeyemi, O.O. (2006). Laboratory evaluation of the toxic properties of forest Anchomanes, *Anchomanesdifformis* against pulse beetles *Callosobruchusmaculatus* Coleoptera: (Bruchidae) . Insect Sci., 13:25-29

AL –yahya ,M . A. A, Al meshal, I .A; Moss J . S .and Jangi, M. (1986). phytochemical and pharmacological studies on the toxic plants of Saudi Arabia . 3r . Am Symp . Animal . Plants and microbial toxins , Arizona .

Ali, M. A (2004). larvicidal potentialities of 20 plant species from wad Medani –Gezira State on *AnophelesArabiensis* Patton and

Culexguinguefasciatus say (Culicidae : Diptera) . Ph .D . Thesis University of Gezira .

Ali, S. M.H. (1988). Screening of the potentially active chemical control agent from the ornamental plant *Ocimumbasilicum* (L) " Rehan" on Selected crop pests M. Sc .Thesis ,Fac. Agric., Univ. Khartoum, Sudan.

Andrew , F . W. (1952). Description of usher plant character . The flowering plants in Sudan . Vol .H : 404

Annonymous, (1985). Identification and biology of storage insects and mites . A training manual . Tropical Stored Product Institute Storage Department (TSPC), Slough, U. K . pp.259 .

Arivudainambi, B.N.M Singh B.R.P; (2003). Fumigant toxicity of Neem (*Azadirachtaindica* A. Juss .) seed oil volatiles against Khapra beetle , *Trogodermagranarium* . Annals of Plant Protection Sciences 2003; 11:207-11 .

Ascher, K . R .S. (1981).Some physical (Solubility) properties and biological (Sterilized for Epilachna varieties females) Effect of dried methanolic neem (A- Indica) seed kernel extract. Proc .1st . Neem conf . Rottach Egern (1980) . 63-74

Ayoub ,S . M . H and A .B Svendsen. (1981).Medicinal and aromatic plants in Sudan : Usage and exploration . Fitoterapia ,LII, 66:243-246 .

Ayoub, S.M.H and D.G .I Kingeston, (1981) .Screening of plants used in Sudan folk medicine for anticancer activity (1) Fitoterapia, 52:281-284 .

Babikir, E. E.B. (2005). The Susceptibility of some Date Cultivars to the Infestation by the Saw –Toothed grain beetle

Oryzaephilussurinamensis ,L .(Coleoptera -Silvanidae) . M . Sc .Thesis. Sudan University of Sc . & Tech p41.

Bakhiet ,E.H, Taha, A.K. (2009).Effect of leaves powder and aqueous of periwinkle (*Vincarosea* L) and Hargel (*Solenstemmaargel*) (Del .), Hayne on the adults of the faba bean beetle *Bruchidiusincarnatus* (Boh .) (Coleoptera; Bruchidae) . Journal of Science and Technology, 10 (3) , 135-154.

Bashab, F. A .(1997). An investigaton in pollination and fruit thinning of mishrig wad khateeb date palm cultivar in Sudan .M . Sc (Agric) . Thesis, University of Khartoum

Binggeli .P (1999). *Lantanacamara* L . (Verbenaceae). Retrieved October12, 2005 from http//www. Memberslycos.co.uk/ woodyPlant Ecology/docs/web-spdhtm.

Brann, M. Taller, H.B; Hamdoun, A. M. and Walter, H. (1991). Common weeds of central Sudan. Deutch Gesellschaft fur Technishe Zasammen arbeit (GTZ) GmbH, Eschborn, Fed. Ref. of Germany .

Brees, M.H. (1961). The development and oviposition of *Oryzaephilus*. Spp. On unrefined sugar . Bull. Ent. Res.,52: 7-16.

Broun, A . F (1906). Catalogue of Sudan flowering plant giving short description a number of vernacular names and some economics and other uses , El .Sudan Printing Press .

Budd , Th. (1913) . The milky juice of the, *Calotropisprocera* A poth ztg. 28:586 .

CFIA, (2002). Canadian Food Inspection Agency . Plant Products Directorate . Plant Health Division . Grains and Field crops Section

(http/www .Inspection . gc . ca / English / plaveg / grains /pesorg /coleopter /prim/ory –sur esl…2p .

Chakravarty , H . L . (1976). Plant wealth of Iraq . Ministry of Agriculture and Agrarian reform , Iraq : 190-194 pp.

Chaudhry. M (1972). Efficacy of botanical pesticides against *Plecopterarareflexa* Guen(Noctidae : Lepidoptera) .*Schisham defoliater* –Pakistan , Journal of Forestry 42 :4, 199-2 02

Cotton, R . T . (1963). Pests of stored grain and grain products .3rd edition . USA . Bergess Publishing company .243 pp

Cutler, J . R . (1971). A key for distinguishing the larvae of *Ahasverusadvena* (waltl), *Cathartusquadricollis* (Gver), *Oryzaephilussurinamensis* (L) and *OryzaephilusMercator* (Fauv). Coleoptera: Silvanidae, Store prod, Res, J. Vol . 7,125-127 .

Dabire V, C. (1993). Method traditionelle de conservation due niebe (*Vignaunjuiculata*) au Burkinafaso . In Thiam A., Ducommun, G (Eds), protection naturelle des vegetauxen Afrique . Edition Enda Dakar, Senegal .pp 45-55) .

Das. B .C, Sarker PK, Rahman M.M . Aphidicidal activity of some indigenous plant extracts against bean aphid *Aphiscraccivora* Koch (Homoptera Aphididae) .Journal of Pest Science ,81 (3) . 2008 ,153-159 .

Dirar , A . M .(2003). Date Palm economics , an analytic study about the Northern State . Regional Symposium on Date Palm Problems in Sudan . Sudan University . of Sc & Tech . Dec . 2003 . pp 165 -171.

Dubose,A. (1927). Calotropis or silk tree .Bull .Soc. Ind . Rouen, 54: 128-138 .

Dwived, S.C. and S. Garg, (2003). Toxicity evaluation of flower extracts of *Lantanacamara*.on the life-cycle of *Corcyracephalonica* . I. J Entomol., 65:330-334 .

Elagib, H . M . (2001). Pharmacology of Sudanese plants with putative Anti –inflammatory activities, M .SC .Thesis , faculty of . Pharmacology , university , of Khartoum pp . 119

Eldoush, K.O; (2009). Effect of argel *Solenostemmaargel* and usher *Calotrpisprocera* on date palm green pit scale insect *Asterolicaniumphoenicis* M. Sc Thesis, Sudan University . p85.

ELkamali, H. H. and Khalid, S. A . (1996). The most Common herbal remidies in Dongola province. Northern Sudan . Fitoterapia, 69: 118-121 .

El-kamali, H.H (1991). Botanical and chemical studies on *Solenostemmaargel* (Del., Hayne) grown in Khartoum . M .Sc. Thesis, Faculty of Science, University of Khartoum .

Elkamali, H. (2001). larvicidal activity of crude aqueous extracts of *Solenostemmaargel* (Del .Hayne) against mosquito larvae . J.of Herbs, Spices and Medicinal plants . 8 (4);83-86.

El Nadi, A . H, E. A .Elhag, A,A Zaitoon and M . A . Al-Doghairi, (2001). Toxicity of three plants extracts to *Trogodermagranairum* Everts (Coleoptera : Dermestidae) . Pak. J . Biol . Sci., 4(12):1503-1505 .

Fageer, T. M. O. (1999). Evaluation of usage of various plant products on broad bean beetle *Bruchidiusincarnates* (Boh) (Coleoptera: Bruchidae) . M. Sc .Thesis ,Fac.,. Agric. Univ. Khartoum, Sudan.

Fatope , M. O., Mann, A., & Takeda, Y. (1995). Cowpea weevil bioassay: A simple prescreen for plants with grain protectant effects . International Journal of Pest Management, 41,44-46.

Farkhanda, M. Ghazala ,N. S, Saadiya, A. M. (2011). Effect of ethanlic Plant on three storage grain pests of economic importance .

Pak . J. Bot ., 43(6-) : 2946, 2011

Ferringoton ,E . A. (1990). Chinical material Medical (reprinted) . B .Jain Publ . Pvt. Ltd New Delhi Ganapathm . Kalyani Publishers Ludhiana , India . P. 47 .355 .

Gaius, I. F (1986). The medicinal and poisonous plants of India scientific publ . Jodhpur. India .P . 35 -38 .

Gao, B., W. u .J ., Huang S., Mu. L, Han , Z.,(2008).Insecticide resistance in field population of *Laodelphax striatellus* Fallen(Homoptera: Delphacidae) in China and it's possible mechanisms .Int .J . Pest Management .54 (1): 13-19

Gaire . B .P and Subedi . L (2013). Areview on the pharmacological and toxicological aspects of *Daturastramonium* L, Journal of Integrative medicine VOL 11. No2

Ghos, N .C . (1988). Comparative Malaria Media Hannemman Publ . Co . Pvt .Ltd . Calacutta , India .

Giannini, A. J (1997). Drugs of Abuse—Second Edition. Los Angeles, Practice Mangement Information Corporation, pp.48-51 ISBN 1-57066-053-0 .

Giridhar, G. Deval R. Mittal , P . and Vasuderrhan , R . (1984). Mosguito control by *Calotropis* latex . Pesticides, 18:26-29

Hag- Eltayeb, F .M .(2005). Evaluation of larvicidal activity of Hargel *Solenostemmaargel* Del Hayne and Ushe *Callotropisprocera* Ait water extracts against larvae of *Anophelesarabiensis* Patton and *Culexquinuesfasciatus* Say (Diptera;Culicidae) .M. Sc.Thesis.Sudan University of Sc .& Tech .p52.

Hasan, M., M. Sagheer, A. Ullah, Wakil and A. Javed . (2006). Response of *Trogodermagranarium* (Everts) to different doses of *Haloxylonrecurvum* extract and deltamethrin .Pack. Entomol .28 (2): 25-30 .

Hess, G; Reichender, F. and Eysenbach, H.(1936). African Arrow Poisons . H. Heart Poisons in *Calotropislatex* . Leibigs Ann. Chem. 537:67 .

Hesses, G. and Ludwing W.(1960). African Arrow Poisons XIV Voruscharine. A scend Sulfur . containing health poison from *Calotropisprocera* Ann. 632. 158 -171 .

Hiiesaar. K L, Metspalu A and Kuusik S (2001). An estimation of influences evoked by some natural insecticides on greenhouse pest insects and mites In;Metspalu L and Mitt S (Ed) .Practice oriented results on the use of plant extracts and pheromones in pest control .Proceedings of the international workshop, Estonia, Tartu , 24-25, January 2001 .pp. 17-27 .

Howe, R . W .(1955). The Biology of two common species of *Oryzaephilussurinamensis* (coleoptera- Silvanidae)(Cucujidae) In : Munro , J . W (1966) Pests of stored products .

Ibrahim, A .M . (2007). Effects of Argel Addition to Soil on Flowering and yield of Dry Date Palm *Phoenixdactylliferal* Cultivar Barakawi M , Sc. Thesis, in Horticulture, Sudan University of Science & Technology .p41

Ibrahim, I. A (2003).The effect of Rehan leaves (*Ocimumbacilium*) on *Bruchidiusincarnatus* . (Coleoptera: Bruchidae) . Graduation Project. Dept. plant Protection, College of Agric. Studies- Shambat, SUST.

Idris, T .I . M ., Ibrahim , A . H .and Taha , A . K . (2006). Asurvey Study of the current status of date palm in the Northern state. Sudan University of Sc & Tech . in collaboration with the Ministry of Agric . (Northern State) ,ARC and Dongola Univ . Sept – Nov .2006 , 85 pp.

Islam, K. Islam MS, Ferdousi Z (2011). Control of *Epilachnavigintioctopuntata* Fab .using some indigenous plant extracts .Life Earth Sci, 6, 2011, 75-80.

Isman , M .B . (1997). Leads and prospects for the development of new botanical insecticides . Rev . Pesticide Toxicol ., 3: 1 -20

Jacob, S. and M .K Sheila.(1993). A note on the protection of stored rice from the lesser grain borer , *Rhizoperthadominica* Faber. By indigenous plant products . India J. entomol.,55:337-779.

Karzan Omar, Nask Muhammad Faraj, Sahar A . A Malik and Iman M . AI-Farhani. (2011). Effect of some medicinal plants extracts and cypermthrin against Khapra Beetle (*Trogodermagranarium* Evert). Emir . J. Food Agric.24 (2):120 -127 .

Khan ,S . M and A . A Marwat, (2004). Effects of Bakain (*Meliaazadarach*) and Ak (*Calotropisprocera*) against Lesser grain borer (*Rhyzoperthadominica* F).Journal of Research (Scinence) Bahauddin Zakariya Univ Multan , 15: 319-324 .

Khan, S . M and M. N Siddiqui. (1994). Potential of some indigenous plants as pesticides against the larvae of cabbage butterfly *Pierisbrassica* L . Sarhad J . Agric., 10:291-301 .

Kuganathan, S Saminathan, S Muttukrishna. (2007). Toxicity of *Daturaalba* leaf extract to aphids and ants .The Internet Journal of Toxicology , Vol . 5 (No. 2)

Kuganathan, (2010). Chemical Analysis of *Daturametel* Leaves and Investigation of the Acute Toxicity on Grasshopper and Red Antes .E-Journal of Chemistry . ISSN; 0973-4945; http:// www.e-journals .net 2011, 8 (1), 107-112 .

Lindley , J .(1985). Flora medica .Ajai Book services , New Delhi

Malik, C. P; Nadeem, A. and Parazish, A. (1979). Chemical composition and active principles of *Calotropisprocera* ,Pakistan Soc. Biochem, latione, park.

Mohamed, E .H .B . (2004). Effect of vinca *Vincarosea* L .and Hargel *Solenostemmargel* Del.Hayne powder and aqueous extracts on faba bean beetle adults *Bruchidiusincarnates* Boh (Coleoptera : Bruchidae) . M. Sc.Thesis; Sudan. University . of Sc & Tech .

Mohammed G. S .. (1991). Studies on the date palm scale insect *Parlatoriabalanchardii* Targ . (Homoptera) (Diaspididae) . M .Sc . Thesis ; university .of Khartoum .

Moursy, L. E (1997). Insecticidal activity of *C. procera* extracts on the flesh fly, *Sarcophagahaemorrhoidalis* Fallen. J .Egyptian Soc .Parasitol., and 27:505-514 .t

Munro, J .W . (1966). Pests of Stored products . Imperial College of Science and Technology, University of London . 234pp .

Neetu, K. Geeta D. M and Shashi, M. (2015). Plant extracts controls *Oryzaephilus surinamensis* by showing repellency behavior. European Journal of Experimental Biology, 5(5): 98-101.

Nixon , R .W.(1967) . Possibilities for improving date culture in the Sudan, information production Center, Dept. of Agric. Khartoum. Sudan .

Nixon R .w .(1969). Date culture in Sudan . Date Growers Institute Report 44:4-19

Organgi, R. A.(1982). Ecological and phytochemical studies on *Solenostemmaargel* growing in Suadi Arabia, J . Coll .Sci king saud Uiversity 13 (1) pp, 17 -24.

Osman M . E .(2003). Evaluation of the larvicidal activity of Usher plant *Calotropisprocera* (*Ai*) against the larvae of *Anophelesarabiensis* (Patton) and *Culexguinyuefacitus* . M .Sc . Thesis, University of Khartoum .

Osman, A . M .A (1979).Date production in Sudan . Ministry Agriculture , Extension Department.

Osman,A .M . A . and Boules , N . N .(1977).Evaluation of some Sudanese date cultivars. Acta Hort -84 : 185 – 190 .

Ragab, A .M. EL . (2014). Evaluation of the effect of some plant extracts against Khapra beetle *Trogodermagranarium* Everts . (Coleoptera: Dermestida) M. Sc .Thesis, Sudan.University. p84.

Rashid , A . and Nizia, A.(1972) . The date in west Pakistan . Punj . Fruit .J . (Date palm) 33 -34 (114-119) : 68-8

Rees, D. (2004). Insects of Stored Products. CSIRO, Collingwood VIC, Australia.

Ross, S . A ; Medgalla , S. E ., Dishay. D . (1980). Studies for determining antibiotic substances in some Egyptian plants , part . Screening for antimicrobial activity . Fitoterapia 5, 303 .

Sacks, E. (2011). Termites eat through $222,000 worth of rupee notes in Indian bank . Daily News (Newyork) .

Saghee M., Mansoor-ul-Hasanl, Muhammad Asif Latif and Jamshaid Iqbal . (2011). Evaluation of some indigenous medicinal plants as a source of toxicant, repellent and growth inhibitors against *Triboliumcastaneum* (Coleoptera: Tenebrionidae). Pakistan Entomologist Journal homebage: www . pakentomol. com .

Saxena, R.C., (1989). Insecticides from Neem in: Insecticides of plant origin, By : (J.T Arnason. B.J.R. Philogene and P. Morand eds .), Ser . 387. American Chemical Society, ACS Symp. Washington DC. Pp. 110-135.

Schmutterer, H .(1969). Pest of crops in North East and central Africa Gustau Fisher Verlag, Stuttgart.pp.297 .

Schumutterer, H.;Asccher, K. R. S.; Isman, M.B.;Jacoboson, M. ; Ketkar C. M,; Kraus, W.; Rembold, H.; and Saxena, R. C .(1995). The neem tree (*Azadirachtaindica* Juss) and other meliaceous plant .

Shah, M. M. R & Shahjahan, M. (2006). Toxicity Effect of Some Indigenous Plant Extracts against Saw – Toothed Grain Beetle, *Oryzaephilus surinamensis*(L) (Coleoptera: Silvanidae). Bangladesh J. Entomol.16 (1) : 57-66 .

Shah, M. M. R, Prodhan, M. D. H, Siddguie, M. N. A, Mamun, M. A. A and Shahjahan, M. (2008). Repellent Effect of Some Indigenous plant Extracts against Saw – Toothed Grain Beetle, *Oryzaephilus surinamensis* (L) InternationalJournal of Sustainable Crop Prod., 3 (5): 51-54

Shahid , M .(2003). Principles of insect pest management . New Delhi: CBS Publishers and Distributors .

Sharma G. K. (1934). *Calotropisprocera* and *Calotropisgiganatia* . Indian J. Vet .Sci . Husb., 4:63-74 .

Sidahmed, O . A . A ., Eldoush , K . O . A . M and Taha , A . K ., , (2009). A Note on the effect of aqueous filtrates of Argel plant parts (*Solenostemmaargel* ,Del Hyne) on the mortality of Cotton Soil termite (*Microtermesthoracalis* jost .)(Isoptera : Termitidae).

Siddig, S.A. (1980). Efficacy and persistence of neem seeds powder for Treatment of stored wheat against *Trogodermagranarium* (natural Pesticides from the neem tree *AzadrachctaindicaA. Juss* . Proceeding of the first international neem conference . Rotlch-Egrn, Federal Republic of Germany, 16-18.

Siddig, S .A .(1990). Recommendation of neem (*Azadirachtaindica* A,juss) for the control of vegetable pests infestation .Paper prepared for the approval of the national pests and Diseases committee, ARC.Wad madani .

Singh, S.R; Lusechner, K; Nangjlii, D (1978). Groundnut oil treatment for the control of *callosobruchusmaculatus* .During cowpea storage . Journal of stored products research, 14.77-80 .

Skinner . P (1987). The storage of food grains and seeds . The tropical Agriculturalist. Hand book 17-18 .

Sousa, A . H; Maracaja, P ; Silva , R . M . A ; Moura , M . N . and Andrade W. G. (2005). Bioactivity of vegetable powder against *Callosobruchus maculatus* (Coleoptera :Bruchidae) .*RevistaDeBiologiaECiencias Da Terra ISSN* 1519 -5228

Stoll, G., (2000). Natural crop protection in the tropics . Margraf Verlag, germany, 376 pp .

Tharib, S.M; Migirab , S and Veiteh G . B . A. (1986). A preliminary investigation of the potential Antimicrobial activity of *Solenostemmaargel* In.t.J . Grude Drug Res-24 (2) P . 101 .

United states department of agriculture .(1962-1963). The important disease and pests of date.

Parrotta, J . A . (2001). Healing plants of perinsular India CAB. International, walling ford , lik and New York . P . 944Pressel, Ulrike; Hans- Georg

Pressel, Ulrike; Hans- Georg Preissel (2002) .Brugmansia and Datura : Angel' s Trumpets and Thorn Apples. Buffalo, New York :Firefly Books. pp. 124 -125. ISBN 1-55209-598-3 .

VanRyckeghem, A. (2004). Chapter 13: Stored product pests, pp. 747-823. In S. A. Hedges and D. Moreland (eds.), Mallis Handbook of Pest Control: The Behavior, Life History, and Control of Household Pests, 9th Ed. GIE Media, Richfield, OH.

Wat, J .M,Breyer. and Wijk, M .G . (1982). Active Principles of *calotropisprocera* in the medicinal and poisonous plants of southern and eastern Africa – Second Edition- Edinburgh , E and S living stone (TD) p.125-127

Yousif, E.A.A, Satti A.A (2014). Evaluation of water extracts from seven Sudanese plants as natural insecticides. International journal of Science and Research, 3 (12) , (2014),1305 -1310.

APPENDICES

APPENDICES

Appendix (1)

ANOVA (1) The effect of Usher Argel and Datura leaves powder extracts on mortality rate of the adult of Saw tooth beetle After 24 hrs

	Sum of squares	Df	Mean Square	F	Sig
Between Groups	45.436	9	5.048	**7.**652	000
Within Groups	13.194	20	.660		
Total	58.631	29			

ANOVA (2) Effect of Usher ,Argel and Datura leaves powder extracts on mortality rate of the adult of Saw toothed grain beetle After 48 hrs

	Sum of squares	Df	Mean Square	F	Sig
Between Groups	51.939	9	5.771	9.096	000
Within Groups	12.689	20	.634		
Total	64.628	29			

ANOVA (3) Effect of Usher, Argel , and Datura water extracts on mortality rate of Saw tooth beetle on dates after 24 hrswater24hr

	Sum of squares	Df	Mean Square	F	Sig
Between Groups	30.210	9	3.357	3.053	000
Within Groups		20	1.099		
Total	21.986	29			
	52.196				

ANOVA (4) Effect of Usher , Argele and Datura water extracts on mortality rate of Saw toothed grain beetle on date after 48 hrs water48hr

	Sum of squares	Df	Mean Square	F	Sig
Between Groups	44.113	9	4.901	20.262	000
Within Groups	4.838	20	.242		
Total	48.951	29			

ANOVA (5) Usher , Argel and Datura Ethanol extracts on mortality rate of the adult of Saw- toothed beetle After 24hrs ethanol 24hrs

	Sum of squares	Df	Mean Square	F	Sig
Between Groups	42.436	9	4.715	18.508	000
Within Groups	5.095	20	.255		
Total	47.532	29			

ANOVA (6) Effect of Usher ,Argel and Datura Ethanol extracts on mortality rate of the adult of Saw- toothed beetle After 48hrs

	Sum of squares	Df	Mean Square	F	Sig
Between Groups	7o.443	9	7.827	56.087	000
Within Groups	2.791	20	.140		
Total	73.234	29			

Appendix (2)

ANOVA (1) effect of penetration of Saw- Toothed grain beetle after one weeks

Source	DF	SS	Mean Square	F
Between Group	9	248.3	27.589	18.39
Error	20			
Total	29	30	1.5	

ANOVA (2) effect of penetration of Saw- Toothed grain beetle after two weeks

Source	DF	SS	Mean Square	F
Between Group	9	232	25.79	14.79 z
Error	20	34.88		
Total	29	266.95	1.74	

Appendix (3)

Table (1)

Control			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	55	345	400
R2	30	362	392
R3	40	320	360
Means	41.7	342.2	384
Percent	10.83		

Table (2)

Usher 10%			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	23	337	560
R2	20	377	397
R3	17	352	369
Mean	20	355.3	375.3
Percent	5.33		

Table (3)

Usher20%			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	22	348	370
R2	14	344	358
R3	18	347	365
Means	18	346.33	364.33
Percent	4.94		

Table (4)

Usher 30%			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	23	338	361
R2	13	346	359
R3	17	346	360
Mean	17.7	343	360
percent	4.91	342.3	

Table (5)

Argel10%			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	26	375	400
R2	31	358	389
R3	32	367	399
Mean	29.33	366	369
Percent	7.41		

Table (6)

Argel 20%			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	30	370	400
R2	25	370	395
R3	20	372	392
Mean	25	370.7	395.7
Percent	6.32		

Table (7)

Argel 30%			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	5	395	400
R2	30	330	360
R3	10	362	372
Mean	15	362.3	377.3
Percent	3.97		

Table (8)

Datura 10 %			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	5	395	400
R2	30	330	360
R3	10	362	372
Mean	15	362.3	377.3
Percent	3.97		

Table (9)

Datura 20%			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	10	382	392
R2	20	340	360
R3	15	385	400
Mean	15	369	384
Percent	3.9		

Table (10)

Datura 30%			
Treatment	No : of Perforated seeds	No : of Perforated seeds	Total
R1	8	381	389
R2	17	343	360
R3	14	375	399
Mean	13		379.3
Percent	3.42		

Appendix (4)

Onion storage Oumcatty thouth of Omdurman

Appendix (5)

Onion storage Alsrorab thouth of Omdurman

Appendix (6)

Saw- toothed grain beetle

Appendix (7)

Bad storage

Appendix (8)

Good storage

Appendix(9)

Sorghum storage

Appendix(10)

The adult of Saw- toothed grain beetle