The Effect of Some Plant Extracts on Mortality, Fecundity and longevity of the Tomato Leaf miner *Tuta absoluta*

أثر بعض المستخلصات النباتية على موت وخصوبة و فترة حياة حشرة حافرات أوراق الطماطم *Tuta absoluta*

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بسم الله الرحمن الرحيم

الآيـــة

قال تعالي :

(وَقُل رَّبِّ زِدْنِي عِلْماً) سورة طه الاية (114)

DEDICATION

TO my dear father and mother,

To my

Brothers

And

Sisters,

To relatives and friends.

With love

Elham

ACKNOWLEDGEMENTS

All praise and thanks be to Allah the Almighty who blessed me with the health and knowledge for preparation and completion of this work.

I would like to express my deep appreciation and sincere gratitude to Dr. Abdelgadir Ahmed Osman for his supervision and close following of this work with guidance, keen interest and sound advice during the course of the investigation.

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Abstract

This study was conducted at the laboratory of the entomology, Department of Plant Protection, College of Agricultural Studies, Sudan University of Science and Technology (SUST) Shambat to evaluate the effect of hexane and ethanol organic extracts of jatropha *Jatrophacurcas*seeds,leaves, neem *Azadirachta indicaA*. Juss, seeds, argel *Solenostemma argel* Del stems and malathion 57% EC on mortality, fecundity and longevity of the tomato leaf miner *Tuta absoluta.* Four concentrations of each extract were prepared and tested against two-day old adults. The results showed that all tested concentrations gave significantly higher mortality percentages than the control. The LC_{50} of the ethanolic extract of jatropha leaves after 24, 48 and 72 hrs of exposure were 15.649, 6.684 and 4.435 respectively whereas those of the hexane extract of jatropha leaves were 6.266, 1.881 and 1.583 respectively. The results clearly showed that the LC_{50} obtained by jatropha leaves hexane extracts after 24, 48 and 72hrs of exposure were consistently lower than their counterparts of jatropha leaves ethanolic extract. This may indicate that the active ingredient in jatropha leaves is easily extracted in hexane rather than in ethanol. The LC_{50} of the ethanolic extract of jatropha seeds after 24, 48 and 72 hrs of exposure were 6.406, 2.278 and 2.493 respectively whereas those of hexane extracts of jatropha seeds were 6.219, 5.629 and 3.139 respectively. On the other hand the hexane and ethanol extracts of neem seeds generated the same LC_{50} values after 24, 48 and 72 hrs of exposure and the LC_{50} values obtained were 7.143, 3.592 and 3.333 respectively. The mortality results generated by the 15% hexane and ethanol extract of both jatropha leaves and seeds as well as neem seeds were not significantly different from the standard, malathion, after 48 and 72 hrs of exposure which is an indicative of the potency of these extracts. The LC_{50} values of the ethanol extract of argel stem after 24, 48 and 72 hrs of exposure

were 17.716, 8.336 and 6.860 respectively whereas those of hexane extract were 26.191, 26.191 and 13.571 respectively.

The fecundity study results showed that all tested concentrations of hexane and ethanol extracts of jatropha seeds, leaves, neem seeds and argel stems generated a significantly lower fecundity of the treated insects than that of the control. All tested concentrations greatly reduced the fecundity of the treated insects, but there was no significant difference in fecundity obtained by insects treated with different concentrations.

The longevity studies showed that all insects treated with the different concentrations of organic extracts gave significantly lower longevity percentage than the control throughout the experimental period.

الخلاصة

أجريت هذه الدراسة في معمل الحشرات بقسم وقاية النبات بجامعة السودان للعلوم والتكنولوجيا شمبات لتقييم أثر المستخلص الهكسينيوالأيثانولي لكل من بذور وأوراق الجاتروفا*Jatrophacurcas*Jatropha, بذور النيم,neem*AzadirachtaindicaA*. Jussوسيقان الحرجل *Solenostemmaargel* argel*Del*على موت وخصوبة وطول فترة حياة حشرة حافرات أوراق الطماطم. تم تحضير أربعة تراكيز مختلفة ثم تم أختبار ها على الحشرات البالغه في اليوم الثاني من عمرها.

أظهرت النتائج أن كل التراكيز المختبرة أعطت نسبة موت أعلى من الشاهد وبفروقات معنوية, ونجد أن التركيز النصفي القاتل لمستخلص أوراق الجاتروفا بمذيبالأيثانول بعد 24, 48 و 72 ساعة من التعرض 15.649, 6.684و 4.435 على التوالي أما بالنسبة لمستخلص أوراق الجاتروفابمذيب الهكسين كانت 6.266, 1.881 و 1.583 على التوالي.

وأظهرت النتائج بصورة واضحة أن التركيز النصفي القاتل لمستخلص أوراق الجاتروفا بمذيب الهكسين بعد 24, 48 و 72 ساعة أقل من نظائره لمستخلص أوراق الجاتروفا بمذيب الإيثانول وهذا قد يشير إلى أن المادة الفعالة لأوراق الجاتروفا يتم أستخلاصها بسهولة في الهكسين من الإيثانول.

وجد أن التركيز النصفي القاتل لمستخلص بذور الجاتروفا بمذيب الإيثانول بعد 24, 48 و 72 ساعة 6.493, 2.278 و 2.493 على التوالي بينما أعطى مذيب الهكسين لبذور الجاتروفا 6.219, 5.629 و 3.139 على التوالي.

ومن ناحية أخرى فقد أعطى مستخلص بذور النيم بمذيبي الهكسين والإيثانول نفس القيمة للتراكيز المختلفة بعد 24, 48 و 72 ساعة من التعرض وكانت 7.143, 3.592 و 3.333 على التوالي.

وأظهرت النتائج أن للتركيز 15% لمستخلصات بذور وأوراق الجاتروفا وبذور النيم بمذيبي الإيثانول والهكسين أعطى نسبة موت لا تختلف معنوياً عن مبيد الملأثيون بعد 48 و 72 ساعة وهذا مؤشر على فعالية هذه المستخلصات.

لقد كان التركيز النصفي القاتل لمستخلص سيقان الحرجل بمذيب الإيثانول بعد 24, 48 و 72 ساعة من التعرض 8.336 , 17.716 و 6.860 على التوالي وبالهكسين 26.191 , 26.191 و13.571 على التوالي.

وأظهرت النتائج أن الحشرات المعاملة لكل التراكيز في كل المستخلصات قد أعطت خصوبة أقل معنويا بالمقارنة بالشاهد ولكن لم يكن هناك فروقات معنوية في خصوبة الحشرات المعاملة بتراكيز مختلفة.

وأوضحت الدراسة أن الحشرات التي تمت معاملتها بتراكيز مختلفة من كل المستخلصات قد عاشت لفترة أقل بالمقارنة بالشاهد وبفروقات معنوية.

CHAPTER ONE

1. INTRODUCTION

The tomato leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the most important lepidopterous pests associated with tomato crops(Lycopersicon esculentum L.) in South America (Torres *et.al.*, 2001; EPPO 2005; Desneux *et. al.,* 2010).

This pest entered Europe through the Mediterranean coast, being firstsighted late 2006 in the Iberian Peninsula (Urbaneja *et. al.,* 2007).

In August 2007, the first affected tomato plantation was detected in the south of Catalonia (NE Spain) (SSV, 2008).

Recently the pest has been detected in France, Italy, United Kingdom and the Netherlands and it may become a significant problem in greenhouses or in open crops in other European countries(EPPO 2009).

It has recently been detected in various parts of the Sudan and immediately considered a serious threat to tomato production in the Sudan. Females have a high reproductive potential and each female can lay about 260 to 300 eggs during its life span. Depending on environmental conditions the pest can produce 10 to 12 generations per year. After hatching, young larvae penetrate into tomato fruits, leaves or stems on which they feed and develop, thus creating conspicuous mines and galleries. Fruits can be attacked as soon as they are formed, and the galleries bored inside them can be invaded by secondary pathogens leading to fruit rot. On leaves, larvae feed only on mesophyll tissues, leaving the epidermis intact (Fernandez and Montagne, 1990).

The control of insect pests both agricultural and medical in Sudan and worldwide depends mainly on the use of synthetic insecticides. But their problems in agriculture, house-hold and disease vector control are continuously increasing. These problems include exposure of Man and animal to serious hazards, destruction of beneficial organisms in addition to their high cost. This situation has led in Sudan and worldwide to the search for other alternatives particularly those of plant origin to replace chemical insecticides and alleviate their hazards(Fernandez and Montagne, 1990).

Among the different plant species evaluated in Sudan, is the neem tree (Azadirachta indica A. Juss) which is widely grown as shade and avenue tree proved to be a potential source of botanical insecticides (Siddig, 1991).

More than 100 compounds have been isolated from various parts of the neem tree according to investigations made by Siddiqui (1942).

Most of the active ingredients belong to the group of tetanotriterpenoids and a small number of non-terpenoidal ingredients have also been isolated (Schmutterer, 1995).

Azadirachtin is the most potent ingredient which is found only in the neem seed and completely lacking in other parts of the neem tree. Neem seeds in Sudan are only available in summer (June-Augest) and lacking in winter Accordingly, neem seeds are usually stored for the control of pests in the winter season. *Solenostemma argel*, belongs to the Asclepiadaceae family.This family includes many wild growing medicinal plants (e.g. *Calotropis procera, S. argel*, Leptadinea spp.).

These plants are known to contain secondary metabolites such as alkaloids, cardinolides flavonoids etc., which are needed in manufacturing important pharmaceuticals.

Herbal medicine sometimes referred to as herbalism or botanical medicine, is the use of herbs for their therapeutic or medicinal value. Aherb is a plant or a plant part valued for its medicinal, aromatic or savory qualities Herb plants produce and contain a variety of chemical substances that act upon the body(Shelef, 1983).It has been estimated that approximately 80% of the world's inhabitants rely mainly on traditional medicines for their primary health care; where plant based systems still play a vital role in health care. In developed countries, plant drugs are also extremely important, currently at least 119 chemicals derived from plant species can be considered as important drugs in use (Mullholland, 2000).

Spices and herbs have been used for thousands of centuries by many cultures to enhance the flavor and aroma of food. Early cultures also recognized the value of using spices and herbs in preserving food and for their medicinal value (Shelef, 1983).

Scientific experiments since the late 19th century have documented the antimicrobial properties of some spices, herbs, and their components (Zakia, 1988).

Hayne, S oleifolium Bullock et Bruce, S. triste (Nees) K. Muelli. S. argel is known in the Sudan as Hargel. It is widely spread in the Sudan commonly found in the northern region between Bar Bar and Abuhamed in Northern State (El-kamaliand Khalid, 1996). Sudan is regarded now as the richest source of this plant (Organgi, 1982).

Hargal grows naturally in the northern parts of the Sudan and extends from Berber to Abu-Hamad, especially the Rubatab area It is also widely distributed throughout North Africa (Egypt, Libya and Algeria) and the Saudi Arabia (Ahmed, 2004).

The specific objectives of the study are:

1- To evaluate the lethal effect of two organic extracts of seeds and leaves of Jatropha, neem seeds, and argal stem against the adults of the tomato leaf miner, *Tuta absoluta*.

2- To investigate the toxic effect of the organic extracts on mortality, fecundity and longevity of the pest in question.

CHAPTER TWO

2. LITERATURE REVIEW

2-1-**Tomato leaf miner *Tuta absoluta*:**

2-1-1-Classification

Phylum: Arthropoda

Class: Insecta

Order: Lepidoptera

Sub order: Glossata

Super family: Gelechioidea

Family: Gelechiidae

Sub family: Gelechiinae

Tribe: Gnorimoschemini

Genus: Tuta

Full Name: *Tuta absoluta*(Meyrick, 1917)

Common Name: Tomato leaf miner

2.1.2 Taxonomic history and synonyms

The generic assignment of *Tuta absoluta* has been questioned Povolny(1964) split the species among many genera, several of which he described himself and many of which he later synonymized .other gelechiid taxonomists have questioned the validity of many of these genera. Three of Povolnygenera that included North American species, including *Tuta,* were recentiy synonymized in the checklist of North American gelechiids by Lee, *et.al.,*(2009). However, the publication did not list *T.absoluta* as a new combination because *T.absoluta* does not occur in North America (Brown 2010).

Meyrick described *phthorimaea absoluta* in 1917 from a single adult male collected in Huancayo, Peru (at 10,650 ft (3,246m)) (Meyrick,1917).Clarke (1965) transferred. *T.absoluta* to *Gnorimoschema* as a new combination and reported in form the Juan Fernandez Islands off the coast of Chile (apparently introduced). Clarke also mentioned specimens reared from potato and tomato from Chile,Peru, and Venezuela.Povolny (1964) described *Scrobipapula* in 1964, and transferred *T. absoluta* to this genus .Becker (1984) included *absoluta* in *Scrobipalpula* in Heppner's atlast of Neotropical Lepidoptera, but did not list it as a new combination. Povolny (1987) described *Scrobipalpuloides* as a new genus and transferred*T.absoluta* to this genus as a new combination. Later transferred *absoluta* from *Scrobipalpula* to *Tuta* as a new combinationPovolny (1994).

The genus *Tuta* and its type species, *atriplicella,* were made available by kieffer and Jorgensen in 1910. Meyrick (1925) subsequently placed the genus *Tuta* in synonymy with *Gnorimoschema.* Hodges considered *T.atriplicella* to be congeneric with the type species of *Phthorimaea, P.operculella,* and thus these two genera were synonymized in Hodges and Beckerand khled (1990).however,did not mention *T.absoluta* as a new combination in this workHodges and Backer (1990).

Povolny (1993) reinstated *Tuta* as a valid genus without giving any morphological basis for doing so. The two genera were again synonymized by Lee *et.al,.*(2009) based on similarity of male genitalia of *Tuta atriplicella,* the

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type species, and *Phthorimaea operculella.*However, a recent study of gnorimoschemini of Europe (Huemer and Karsholt,2010) has adopted a conservative approach to recognizing *Tuta* as a valid genus. Thus, *Tuta* is here recognized as the valid genus for the species *absoluta.*A synonymy that only includes the various named combinations of *absoluta* would be as follows:

Phthorimaea absoluta (Meyrick, 1917)

Scrobipalpula absoluta (Clarke, 1965)

Scrobipalpuloides absoluta (Povolny, 1987)

Tuta absoluta (Povolny, 1994)

2.1.3 Ecological Range

The tomato leaf miner is not known to occur in the United States. However, Garcia and Espul (1982) erroneously reported that this pest had spread from the United States (California) in to Central and South America. A closely related Gelechiid species, the tomato pinworm, *keiferia lycopersicella*(Walshingham) occupies the ecological niche of the tomato leaf miner on tomatoes in the United States (CABI, 2011).

The Tomato leaf miner is aneotropical oligophagous pest of solanaceous crop (Lietti *et. al.,*2005). It is native to South America (Urbaneja *et. al.,* 2007). A recent reference suggested that the tomato leaf miner is distributed throughout the South American continent with the exception of the Andean Region at altitudes higher than 1,000m (Viggiani *et. al .,*2009). However, it is worth noting that the type specimen for *Tuta absoluta* was collected from the Andean region of Peru at an altitude of 10,650 ft (Meyrick,1917).

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South America- Argentina (Giganti *et. al.,*1993; Pastrana,2004); Brazil (Pastrana,2004);Colombia (Colomo and Berta, 2006);Ecuador (Povolny,1994); Panama (Russell IPM,2009a); Uruguay (Pastrana,2004); Venezuela (Fernandez and Montagne,1990a).; Spin (Potting *et. al.,* Torres-Gregorio *et. al.,* 2009;Urbaneja *et. al.,* 2007).

Africa- Algeria (EPPO, 2008b); Egypt (Russell IPM, 2009a); Libya (Russell IPM, 2009); Morocco (EPPO,2008c); Sudan (Russell IPM, 2009a).

2-1-4-Hosts:

The main host of *T. absoluta* is tomato, but potato is also reported as a host (CIP, 1996; Galarza, 1984; Notz, 1992), together with *Lycopersicon hirsutum, Solanum lyratum* and various wild solanaceous species such as *Solanum nigrum, Solanum elaeagnifolium , Solanum puberulum* , *Datura stramonium , Datura ferox* and *Nicotiana glauca*. In laboratory studies(Galarza, 1984), aubergine was reported as a potential host (with other solanaceous species), but there are no references to its importance in the field. There is an old record of tobacco being attacked in Argentina (Mallea *et. al*., 1972).

2-1-5-Morphology (Pest Description):

Egg: Small (0.36 mm long and 0.22 mm large), cylindrical, creamy white to yellow. Eggs are mainly deposited on the underside of leaves. Hatching takes place after 4–5 days (EPPO, 2005).

Larva: Cream in color with dark head, becoming greenish to light pink in the second to fourth instars. First instar is 0.9 mm long and fourth is 7.5 mm long. Duration: 13–15 days (EPPO, 2005).

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Pupa: Brown. Duration: 9–11 days(EPPO, 2005).

Adult: About 10 mm long, filiform antennae, silverish-grey scales, black spots on anterior wings (Korycinska and Moran, 2009).

2-1-6-Life Cycle:

Tuta absoluta is a holometabolous insect with a high rate of reproduction. Itmay be able to complete 12 generation per year depending on environmental condition each female can lay 250-300 eggs in her life time, (EPPO,2005). In the laboratory (at a constant temperature of 25^{o}C and 75 percent R.H.) , *Tuta absoluta* completes a generation 28.7 days (Vargas, 1970) .Given the field conditions in the Africa Valley in Chile, *Tuta absoluta* could complete seven to eight generation per year that location per year at that location (Vargas, 1970).

Since this pest can infest hosts grown in protected situations (such as greenhouses) its rapid reproductive rate should be kept in mind. The species can overwinter in the egg, pupal, or adult stage. No information is available on whether this species is capable of diapauses(EPPO, 2005).

2.1.6.1 Adults

The sex ratio in field-collected population in Venezuela was 1 male to 1.33 females (Fernandez and Montagne, 1990). Adult males live longer than females. In the laboratory, mated males lived 26.47±7.89 days while virgin males lived 36.17±6.55days. Mated females lived 23.24±5.89 days while virgin females lived 27.81±10.78days (Fernandez and Montagne,1990).

Both genders mate multiple times. The first mating usually occurs the day after adults emerge. Mating occurs at dawn (Vargas, 1970). Studies in Chile revealed that the greatest number of males were captured in pheromone traps during the period 7 to 11 a.m., suggesting that this is the time when males are searching for calling females (Miranda-Ibarra,1999).

The average preoviposition period for females was 2.4±0.61 days (Fernandez and Montagne, 1990). female fecundity can range between 60 to 120 eggs (Torres *et. al.,* 2001) but each Oviposition studies in laboratories showed that females can lay egg for more than 20 days ; however, 72.3 percent of the eggs were deposited during the first 5 days and 90 percent in the first 10 days (Fernandez and Montagne, 1990a).

2.1.6.2 Eggs

Eggs are laid singly (rarely in batches) on all above-ground parts of the host plant (Fernandez and Montagne, 1990a).

2.1.6.3 Larvae

Larvae complete four instars that are well-defined and are of different size and color,but variation in the number of instars is well-documented within any species of Lepidoptera. After hatching, larvae enter the plant tissue and begin feeding, thus creating mines(Estay, 2000).

In tomato, young larvae can mine leaves, stems, shoots, flowers, and developing fruit; later instars can attack mature fruit (Vargas,1970).larval mines increase in length and width as the larva develops and feeds. In cases of severe attack, all leaf tissue is consumed leaving behind a skeletonized leaf and large amounts of frass larvae spin silken shelters in leaves or tie leaves together (Vargas, 1970).

2.1.6.4 Pupae

Mature larvae purge themselves of food and build a silken cocoon larva transforms into a pupa(Fernandez and Montagne, 1990).

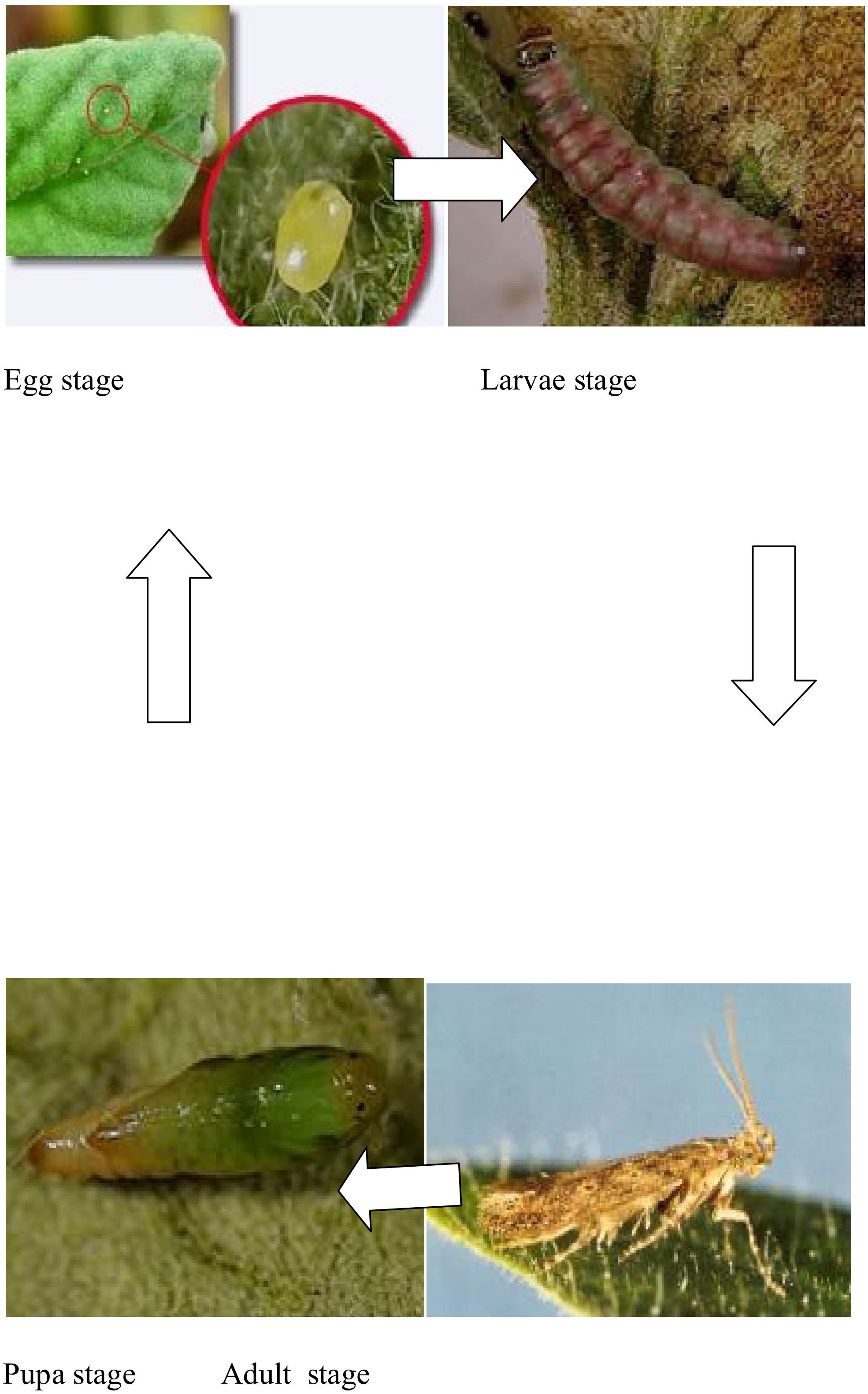

Plate 1: Tomato leaf miner ***T. absoluta***(Vargas, 1970)

2.1.7 Developmental Rates and Day Degrees

The lower developmental (or baseline) temperature for *Tuta absoluta* is 8.14^{o}C.for egg development this temperature is 6.9^{o}C; for larvae it is 7.6^{o}C; and for pupae it is 9.2^{o}. Using the mean baseline temperature of 8.14^{o}C, *Tuta absoluta* requires 459.6 degree days to complete its development.A degree day is a measurement of heat units over time, calculated from daily maximum and minimum temperatures. Degree days are based on the rate of an insect's development at temperatures between upper and lower limits for development. The minimum temperature at which insect first start to develop is called the lower developmental threshold, or baseline temperature (Murray, 2008).degree day requirements to complete egg, larval and pupal development are 103.8,238.5 and 117.3, respectively (Barrientos *et. al.,* 1998).

Laboratory studies in Chile showed that the development of *Tuta absoluta* from egg to adult requires 76.3 days at 14^{o}C (57^{o}F), 39.8 days at 19.7^{o}C (67^{o}F), and 23.8 days at 27.1^{o}C (81^{o}F).Barrientos *et.al.,*(1998). reported that the egg stage of *Tuta absoluta* lasted 4.4 to 5.8 days at a temperature of 24.6^{o}C and a relative humidity of 76.17 percent; larval development was completed in 11 to 15 days at 24.09^{o}C and 70.64 percent R .H.; and males emerged in 7 to 8 days and females in 6 to 8 days at 26.3^{o}C and 72.3 percent R.H. the sex ratio was 3 males to 4 females, or 1:1.33(Barrientos *et. al.,* 1998).

2-1-8-Behavior:

Adult*T. absoluta* are most active at dusk and dawn, and rest among leaves of the host plant during the day (Fernandez and Montagne, 1990; Viggiani *et. al.,* 2009). Mating usually occurs the day after adults emerge, usually at dawn.

Studies in Chile revealed that the greatest numbers of males were captured in pheromone traps during the period 7 to 11 am, suggesting that this is the time when males are searching for calling females (Miranda-Ibarra, 1999).

Hickel *et.al.,.* (1991) studied the mating behavior of *T.absoluta* in the laboratory and determined the sequence of male mating behaviors can be divided into two phases: long-range female location and short-range courtship. Long-range female location includes behaviors that eventually lead to the arrival of males in the vicinity of females. Short-range courtship behaviors focus on interactions between the genders that eventually lead to mating. Of the short-range behaviors, male walking while fanning the wings was an essential component of courtship. Duration of copula is variable, sometimes taking 2 to 3 hours or extending to as much as 6 hours. Both genders mate multiple times. Santos-Silva (2008) reported that males mate more times (up to 12 times in their lifetime) than females. In laboratory studies conducted in Venezuela, adults mated up to 16 times during their lifetime (Fernandez and Montagne, 1990). However, data from laboratory mating studies may not reflect the true number of mating taking place in the field We found no information on the number of mating for *Tuta absoluta* under field conditions. Adults, both males and gravid females, exhibit a strong phototactic response (Vargas, 1970).

Adult females lay their eggs singly (rarely in batches). Egg lying takes place throughout the day, but peak oviposition occurs at night (Vargas, 1970).

Laboratory studies showed that females can lay eggs for 20+ days; however 72.3 percent of the eggs were deposited during the first 5 days and 90 percent in the first 10 days (Fernandez and Montagne, 1990). Other references suggest that up to 92 percent of the eggs are laid in the first few days after mating.

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The tomato leaf miner prefers to lay eggs on the leaves (both sides); however they will oviposit on other aerial parts of the plant such as shoots, stems, flowers and green fruit underneath the sepals that form the calyx. Riquelme (2009) observed no significant differences in the vertical distribution of Tuta absoluta eggs on tomato plants, however, females tended to concentrate their egg laying activity on the upper third of the tomato plants after the third week of planting (Riquelme, 2009).

Larvae normally hatch from the eggs in the morning. In laboratory studies conducted in Venezuela, 96.8 percent of a cohort of 94 eggs eclosed between 6 and 9 a.m. (Fernandez and Montagne, 1990). After hatching, larvae penetrate plant tissue (leaves, shoots or flowers) and begin to feed, forming irregular mines that get longer and wider as the larvae continue to feed The larvae consume the mesophyll leaving the epidermis intact (Vargas, 1970). Later instars can attack maturing fruit (Vargas, 1970).

Although larvae spend most of their life inside mines, second instars can leave the mines, thus exposing them to predation, well-timed application of pesticides and possibly parasitism. In the laboratory, larvae have been observed leaving their mine and starting a new mine on a different part of the plant (Fernandez and Montagne, 1990).

When outside of the mines, larvae move quickly and use silken threads to locate to other parts of the plant (Fernandez and Montagne, 1990).Leaf mines have an irregular shape and may later become necrotic. The galleries in the stems may alter the general development of the plant (EPPO, 2005).

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The fruits can be attacked as soon as they are formed, and the galleries bored inside them can be invaded by secondary pathogens leading to fruit rot (EPPO, 2005). Affected fruit lose their commercial value. Larval damage to terminal buds in greenhouse-grown tomatoes in Argentina negatively effects plant architecture and can result in a significant of fruit yield (Botto, 2011b).

2-1-9-Dispersal:

T. absoluta caterpillars have been observed walking on leaves outside of their mines. This behavior might be related to the temperature inside the mine, the depletion of food, and/or the accumulation of fecal material (Torres *et. al.,* 2001).When outside of the mines; larvae move quickly and spin silken threads to move around safely (Fernandez and Montagne, 1990).Mature larvae will sometimes exit the plant and move to the soil before pupating (Torres *et. al.,* 2001). Adults have well-developed wings that allow them to disperse, but we found no information concerning their ability to fly.

2-1-10-Damage:

Larvae of *T absoluta.* Mine the leaves, flowers, shoots, and fruit of tomato as well as the leaves and tubers of potato (Pastrana, 2004). After hatching, larvae penetrate apical buds, flowers, new fruit, leaves, or stems. Conspicuous irregular mines and galleries as well as dark frass make infestations relatively easy to spot. Fruits can be attacked soon after they have formed, and the galleries made by the larvae can be colonized by pathogens that cause fruit rot. The damage caused by this pest is severe, especially in young plants. When potato plants have completed the vegetative cycle, larvae of *T. absoluta* mine the tubers underneath the epidermis. Larval feeding can cause the tubers to rot (Pastrana, 1967).

2-1-10-1-Leaves:

After hatching, larvae mine the leaf tissue. The serpentine-shaped mines increase in length and width as the larva develops and feeds. In some cases, especially at the beginning of the infestation, the mines can be mistaken for those caused by leaf miners in the family Agromyzidae. In cases of severe attack, the larva consumes all the leaf tissue and leaves behind a skeletonized leaf and copious amounts of frass. It is common for larvae of the second to fourth instar to spin silken shelters in leaves or tie leaves together (Vargas, 1970).

2-1-10-2-Shoots:

Larvae are capable of penetrating and mining tender shoots, usually gaining entry through the apical end or at the angle formed between the petioles and the leaves. Larvae can also pull together new shoots using silk produced by specialized salivary glands(Vargas, 1970).

2-1-10-3-Flowers and Fruit:

Larvae of *T.absoluta* can destroy the developing fruit by mining its flesh. Infested fruit will usually fall to the ground. Larvae can attack the flowers, but the most severe damage is found in developing (early instars) or maturing fruit (later instars).The larva usually enters the fruit under the calyx and tunnels the flesh, leaving galleries clogged with frass that cause the fruit to drop or to rot on the vine.Larvae can also enter the fruit through the terminal end or through other fruit parts that are in contact with leaves, other fruits, or stems(Vargas, 1970).

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2-1-11-Economic impact:

Since its introduction into Europe in 2006, *Tuta absoluta* has continued to rapidly spread through the European and Mediterranean regions where it is a serious pest of field and greenhouse grown tomatoes. *Tuta absoluta* is the major limiting factor for tomato production in South America (Ferrara *et. al.,* 2001).It is a key pest of most greenhouse-grown tomatoes in Argentina (Botto, 2011b), and the key pest of tomato production in Chile (Estay, 2000). Without adequate controls, information of *T.absoluta* can result in 90 to 100 percent loss of field-produced tomatoes in Chile (Vargas, 1970; Estay, 2000). *Tuta absoluta* is considered one of the most important lepidopterous pests associated with processing tomatoes in Brazil (Torres *et. al.,* 2001).

Larvae of *Tuta absoluta* attack leaves, buds, stems, flowers, calyces, and tomato fruit. In Brazil, Benvenga *et. al.,* (2007) found a good correlation between increases in pheromone trap captures and positively infested plants, and decreases in open field tomato production by the end of the season (expressed as marketable boxes of fruit per 1,000 plant). However, in greenhouse-grown tomatoes in Argentina, pheromone traps were useful only for early detection of the pest. Adult males were trapped almost 10 days before the first eggs were found on the plants, and trap captures were not useful in predicting damage levels (Riquelme, 2009).

Tuta absoluta is multivoltine. Robredo-Junco *et. al.,*(2008) determined that based on mean temperatures in Ibiza, Spain, *Tuta absoluta* can complete 9 to 10 generation per year in field tomatoes and 12 generations per year in greenhouse tomatoes.

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Both yield and fruit quality can be significantly reduced by direct feeding by the larvae, and subsequently by secondary pathogens entering the mines and causing fruit rot. Severely attacked tomato fruits lose their commercial value. The tomato leafminer caused up to 100 percent losses in tomato crops planted during the winter in the Province of Valencia (EPPO, 2008a).damage to terminal buds in greenhouse-grown hybrid tomato plants in Argentina negatively affects plant architecture and results in reduced plant growth and decreased fruit yield (Botto, 2011b).

Tuta absoluta feeds on potato leaves (EPPO, 2005), including those from *Bacillus thuringiensis*-transgenic plants (DelaVas *et. al.,* 1992), but recent (Russell IPM, 2009b; Maiche, 2009) and historical references report that larvae also attack potato tubers (Pastrana, 1967) In Italy, eggplant was reported to be the second-preferred host of *T.absoluta* after tomato; however, it is unclear if the species attacks only the leaves or if it attacks eggplant fruit. It has been reported on protected tomato and eggplant crops in a number of regions in Italy (MinisterDelle*et. al.*, 2009). *Tuta absoluta* was also reported on greenhouse peppers and beans in Sicily, Italy (EPPO, 2009 i; MinisterDelle*et. al.*, 2009) however, there was no mention of the plant parts affected Also in Italy, Cape gooseberry (*Physalis peruviana),* is reportedas a host of *T.absoluta,* however, it is not clear from the report which plant part is affected (Garzia, 2009b).

2-1-12-Symptoms/Signs:

All parts of the tomato plant can be attacked by *T. absoluta* (Potting *et. al.,* 2009).Larvae can feed and develop on tomato fruit, leaves, or stems, creating feeding mines which can affect the plant's photosynthetic capabilities (Potting *et. al.,* 2009)

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Even a small amount of damage will make fruit unmarketable if intended for the fresh market (Potting *et. al.,* 2009).Because larvae prefer leaves, stems, buds, or the calyx over tomato fruit, examining these areas of the fruit. Tomato fruit showing entrance holes created by *T. absoluta* larvae. Image taken in a fruit packing house inEngland on fruit imported from an unknown European country (Image courtesy of The Food and Environment Research Agency [FERA], Crown Copyright). (FERA, 2009).

Fruit rot can occur when secondary pathogens invade the galleries bored by *T. absoluta* (EPPO, 2005). Fruits can be attacked at any stage (EPPO, 2005), although they are not usually attacked unless infestations are heavy (Korycinska and Moran, 2009).When attacking fruit, larvae may tunnel into the fruit, leaving a hole visible on the surface. Larvae may also mine below the surface, turning the mine of the pest yellow. Besides tomato, there are no records of other species of fruit being attacked (Korycinska and Moran, 2009).

Larvae feed on mesophyll tissue and leave the epidermis intact Mines are irregular and sometimes become necrotic (EPPO, 2005). Several mines can be found on a single leaf (Korycinska and Moran, 2009). The development of plants can be affected by stem galleries produced by *T. absoluta* larvae. *T. absoluta* prefers apical buds, flowers, and new fruits and can be found in these areas along with black frass. Tomatoes can be attacked at any stage of development (EPPO, 2005); however, larvae only attack the above ground portions of the tomato plant (Van Deventer, 2009).

T. absoluta only attacks aerial parts of potato and cannot develop on tubers (EPPO, 2005). "Unacceptable levels of cosmetic fruit damage may occur in fresh market tomato production due to the mining habit of the organism. Without any control measure the potential damage may be 100%, especially at high population densities at the end of the growing season" (Potting *et. al.,* 2009).

2.1.13 Control procedures

Because of its biology and behavior, *Tuta absoluta* is a challenging pest to control. *Tuta absoluta* produces several broods each year. After emergence, larvae can either tie together leaves or young shoots to create a shelter from which to feed (Pastrana, 1967), or immediately penetrate the young fruit, leaves, buds, or stems where they feed and develop.

Pupation occurs inside galleries, in dried material, or in soil. Effective chemical control is difficult because *Tuta absoluta* feeds internally. Its ability to produce many offspring the development of pesticide resistance. For these reasons, a combination of control methods has been used in South America and Europe for containment or eradiation of the tomato leaf miner.Control methods include mass-trapping of adults, well-timed pesticide applications, and a variety of cultural controls such as removal and destruction of infested plants, scheduled host-free periods, and removal of wild hosts in the vicinity of places of production. Integrated pest management (IPM) is being developed in several South American countries where *Tuta absoluta* is a serious pest of tomato. Biological control methodare being investigated in most countries where *Tuta absoluta* is present.A successful IPM program will consider chemical, biological and cultural techniques to reduce pest populations(Pastrana, 1967).

2.1.14 Overview of Emergency Programs

A PHIS-PPQ develops and makes control measures available to involved states Environmental Protection Agency-approved treatments will be recommended

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when available. If the selected treatments are not labeled for use against the pest or in a particular environment, PPQs FIFRA Coordinator is available to explore the appropriateness in developing an Emergency exemption under Section 18, or a state Special local Need under section 24© of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act), as amended. The PPQFIFRA Coordinator is also available upon request to work with EPA to hurry approval of a product that may not be registered in United States or to obtain labeling for a new use-site. The PPQFIFRA Coordinator is available for guidance pertaining to pesticide used and registration (USDA, 2011).

2.1.15 Treatment options

All treatments listed in the guidelines should only be used as a reference to assist in the regulatory decision making process. It is the National Program Manager,s responsibility to verify that treatments are appropriate and legal for use. Upon detection and when a chemical treatment is selected. The National Program Manager should consult with PPQ,s FIFRA Coordinator to ensure that the chemical is approved by EPA for use in the United States prior to application(USDA, 2011).

Treatments can include any combination of the following options:

- Sanitation and other cultural control methods
- Application of insecticides

2.1.16 Eradication

Eradication is the first action to consider with the introduction of a new pest. Eradication may be feasible in some conditions, but if it fails then other strategies will be considered. Eradication may be feasible when the following conditions exist pest population is confined to a small area, detection occurs soon after the introduction, or pest population density is low. If an infestation and destruction of all infested plant material, removal of host material within 2 miles (3.2km) of the find, and treatment of the soil and surrounding vegetation with an approved pesticide after removal of the infested plants (USDA, 2011).

2.1.17 Cultural control

2.1.17.1Sanitation

Population of *Tuta absoluta* can carry over on infested plant left in greenhouses or fields after harvest or can arrive at these sites via the movement of infested plants. Production nurseries, tomato production sites, and tomato packing sites should follow strict sanitation guidelines to prevent the arrival and spread of *Tuta absoluta*(InfoAgro Systems, 2009).

2.1.17.2 Nurseries and Greenhouse Tomato Production

Installing double self-closing doors and covering windows and other opening with 1, 6 mm (or smaller) insect mesh can prevent entry or exit of adult *Tuta absoluta* in greenhouse. Pots, carts and greenhouse tools should be inspected and thoroughly cleaned before moving them to other areas(InfoAgro Systems, 2009).

Inside the greenhouse, plants should be routinely examined: leaves and stems should be checked for evidence of egg, mines, frass, and other damage. The underside of fruit calyces and the fruit itself should be checked for the presence of small heaps of frass that indicate larval entry holes (Mallia, 2009) Infested plants or plant parts should be removed, especially at the beginning of cultivation, and residues should disposed of carefully, ensuring that they are stored in sealed containers until they are sent to a wastes management facility (InfoAgro Systems,2009).

Solanaceous weeds in the vicinity of infested greenhouses should be removed and destroyed, to prevent the build-up of a potential population reservoir.

Greenhouse workers should check their clothing before moving to other greenhouses for the presence of eggs, larvae, and resting adults of *Tuta absoluta*(Koppert,2009).

2.1.17.3 Field Grown Tomatoes

Destruction and incorporation of crop residues after harvest effectively interrupts the life cycle of *Tuta absoluta* by killing the immature stages present in the plant material. Mechanical harvesting and tilling equipment should be cleaned using high pressure washing or steam after use in infested fields. Clean and inspect all harvesting containers, field boxes, carts, etc., before moving them to other areas.Solanaceous weeds in the vicinity of infested areas should be removed and destroyed to prevent build-up of a potential population reservoir (Koppert,2009).If at any time during the growing cycle *Tuta absoluta* is detected, remove and securely destroy (by plowing, burning, etc.) the whole plot to interrupt the pest life cycle and spread (Russell IPM, 2009b).

2.1.17.4 Vegetable packing stations

The United Kingdom has published best practices guidelines for managing *Tuta absoluta* at tomato packing sites since these could provide a pathway for movement of the pest to the open environment (FERA, 2009a) Strict waste management procedures are employed so that no plant waste is left uncovered and exposed. Larvae, pupae and adults might hide in plastic or cardboard packing materials in tomato grading areas.To mitigate the risk, packing sites are encouraged to regularly examine and clean grading containers and/or use plastic bags in grading containers and replace the bags daily Tomato crates that are returned to suppliers should be cleaned to prevent introduction of *Tuta absoluta* to growing sites. Alternatively, non-returnable tomato packing boxes can be used and should be assembled and stored in an area of the packing station away from infested crates (Sixsmith, 2010) Inspection measures at packing stations call for examination of fruit with calyces for evidence of larval mining. In particular, vine (or truss) tomatoes should have stems and calyxes examined, and this should be a priority over the examination of fruit. At all times, windows and other openings should be kept covered with 1.6 mm (or smaller) mesh to prevent the entry or exit of moths. Tomatoes awaiting packaging should also be protected with insect-proof mesh or plastic tarpaulin. As before, solanaceous weeds should be removed and destroyed, to prevent the build-up of a potential population reservoir(InfoAgro Systems, 2009).

2.1.17.5 Other cultural controls

Cultural control methods for *Tuta absoluta* include crop rotation with non-solanaceous crops, plowing, adequate fertilization and irrigation, destruction of infested plants and post harvest plant debris, and disposing of infested residues. Additional cultural methods to decrease populations of *Tuta absoluta* have been reported.In greenhouse crop production; soil solarization during at least 4 to 5 weeks eliminates pupae that remain on the ground (InfoAgro Systems, 2009).

In open fields, (MARM, 2008).recommended a 6-week host-free period between cultivation of susceptible crops in the same area. The period should be increased to 8 weeks during the winter to account for slower *Tuta absoluta* rates of development. The host-free period can be reduced if additional strategies to destroy pupae in the soil are used together with this method (MARM,2008).

In the United States, a crop rotation with a host-free period is essential for reducing *keiferia lycopersicella* (tomato pinworm) population in tomato crop (Zalom *et. al.,* 2008), and the following guide lines may also help to suppress *Tuta absoluta* populations.

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The host-free period for *K.lycoptersicella* should be scheduled at least once per year, and its duration should be as long as possible. Host-free periods are most effective when practiced area-wide, so cooperation among growers is important (Stansly, 2009).

Growers should also avoid both early and late-season tomato crops if pinworm is present in their fields. If high pinworm populations are present during the first planting and a second crop has been planted in an adjacent field, consideration should be given to shredding and disking the first crop.

If two crops are grown in the same field, refuse from the first crop must be destroyed as soon as harvest is complete (Zalom *et. al.,* 2008).

Also in field situations, conventional and center-pivot irrigation is favored over soil irrigation since these methods disturb eggs, larvae and pupae, and can increase mortality in field populations (Embrapa, 2006).

2.1.18 Managing Insecticide Resistance

The non-judicious application of insecticides can lead to the development of resistance. In Bolivia and Chile, *Tuta absoluta* was reported to be resistance to organophosphates in the early-to mid-1980s. More recently, laboratory studies of resistance in field strains of *Tuta absoluta* in Argentina revealed reduced efficacy of deltamethrin and abamectin (Lietti *et. al.,* 2005). Resistance to cartap, abamectin, permethrin and methamidophos (Siqueira *et. al.,* 2000a, 2000b), and acephete and deltamethrin (Branco *et. al.,* 2001), has been reported in Brazil.

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The newer insecticide classes have provided good activity against the tomato leaf miner (IRAC, 2009a). However, the modes of action, usually provides a sustainable and effective approach to managing insecticide resistance (IRAC, 2009c).

2.1.19 Procedure

One of the key steps in resistance management is to minimize the continuous use of pesticides with the same MOA classification system makes it easy for farmers and farm advisors to understand which pesticides share the same MOA without having to know the biochemical basis. The MOA classification thus provides growers, advisors, extension staff, consultants and crop protection professionals with a simple guide to the selection of insecticides for use in an effective and sustainable insecticide resistance management strategy(USDA, 2011).

2.1.20 Insecticides

Historically, *Tuta absoluta* has been controlled with chemicals.

Organophosphates and pyrethroids were used during the 1970s and 1980s until new products introduced in the 1990s (such as abamectin, spinosad, tebufonzide, and chlorfenpyr) became available (Lietti *et. al.,* 2005). At least 12 classes of insecticides control *Tuta absoluta (*IRAC, 2009b).

Control failures with organophosphates and pyrethroids in South America (Salazar and Araya, 2001) prompted research on the resistance status of *Tuta absoluta* (Siqueire*et. al.,* 2000a,2000b; Lietti *et. al.,*2005); however, newer classes of insecticides are providing good control of this pest (IRAC, 2009a).

This section describes pesticides used in current outbreaks and also mentions insecticide used to control *keiferia lycopersicella* (tomato pinworm), a gelechiid moth that occupies the ecological niche of *Tuta absoluta* in the United States.

Indoxacarb, spinosad, imidacloprid, deltamethrin, and *Bacillus thuringinsis* var. *kurstaki,* were applied for the control of larvae infestations in Spain (FERA, 2009; Russell IPM, 2009b). Chlorpyrifos and pyrethrins were used in Italy (Garzia *et. al.,* 2009a). Abamectin, indoxacarb, spinosad,imidacloprid, thiacloprid, lufenuron, and *bacillus thuringiensis (*Bt), were recommended for outbreaks in Malta (Mallia, 2009). Indoxacarb and BT were recommended for use in France (FREDON-Corse, 2009a). in Brazil, abamectin, cartap, chlorfenapyr, phenthoate, methamidophos, spinosad, and indoxacarb, were recommended for use in the south, southeastern, and savannah tomato-growing regions, while chlorfenapyr, phenthoate, and spinosad were recommended for use in the northeastern region (IRAC, 2007). In Argentina, Bt and triflumuron were recommended for control of *Tuta absoluta* larvae as part of an IPM program that also included parasitoids (Riquelme, 2006).

2.1.21 Bacillus thuringiensis

Bacillus thurnigiensis var. kurstaki (Btk) is a Lepidoptera- specific microbial that, when ingested, disrupts the midgut membranes. For larval control, neutral solutions of Btk should be applied to crops once per week at the end of the end of the day (FREDON-Corse, 2009a). The leaf epidermis presents a significant barrier to control with chemical or microbial insecticides (Salvo and Valladares, 2007). As such, Btk may not be effective once *Tuta absoluta* larvae enter plant parts (. Btk is registered for use on tomatoes in United States(Sixsmith, 2009).

2.1.22 Azadirachtin

Azadirachtin is the key insecticidal ingredient found in neem tree (*Azadirachta indica* A.Juss.) oil. It is structurally similar to ecdysones, insect hormones that control metamorphosis.

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It is thought to as ecdysone blocker interfering with the insect's ability to molt. Azadiractin is effective on larvae (all insects) and pupae. After ingestion, insects stop feeding; however, death may not occur for several days(EXTOXNET, 1995).

Azadirachtin has been recommended for use as a preventive spray and for light infestations (<30 adult catches per week) of *Tuta absoluta* in Spain. In the United States, azadirachtin is registered for use on tomatoes to control tomato pinworm. This product has low toxicity to pollinating been, butterflies, and parasitic wasps(Van Deventer, 2009).

2.1.23 Population Monitoring

2.1.23.1 Population-baited Traps

Use traps baited with synthetic sex pheromone for monitoring of *Tuta absoluta* in open fields, greenhouses, and packing sites. Sex pheromone-baited traps will capture only adult males. The sex pheromone of *Tuta absoluta* has been isolated and identified. The main compounds are (3E, 8Z,11Z)-3,8,11-tetradecatipon-1-yl acetate and (3E,8Z)-3,8-tetradecadien-1-yl acetate in the proportions of 90:10, respectively (Svatos *et. al.,*1996).

2.1.23.2 Mass-Trapping

Mass-trapping involves placing a number of pheromone baited traps in strategic positions within a crop. Large numbers of adult males are trapped resulting in an imbalance to the sex ratio which impacts the mating pattern of *Tuta absoluta.* Mass trapping can be used to reduce *T.absoluta* populations and is particularly useful in production of greenhouse tomatoes (Russell IPM, 2009b). For mass trapping, pheromone trap density should be 20 to 25 traps/ha inside greenhouses (30 traps/hafor greenhouses destined for plant propagation) and 40 to 50 traps/ha in open fields (Bolkmans, 2009; FREDON-Corse, 2009a).

2.1.23.3 Pan traps

Pan traps are easier to maintain, and are less sensitive to dust, compared to delta, McPhail, and light traps also have a larger trapping capacity than Delta traps. Rectangular plastic trays that hold 6 to 8 liters of water baited with pheromone lures are recommended for mass trapping (InfoAgro, 2009).

2.1.23.4 Light traps

Light traps can also be used to capture adult males and females of *Tuta absoluta* *(*Bolkmans, 2009). Light traps have been used to control *T.absoluta in* greenhouse tomato production in Italy as follows: Install traps at a heigh of 1 meter or less from the ground, at a rate of 1trap per 500 to 1000 m^2(Laore Sardegna, 2010). Light traps should be placed near entry doors and used only during sunset and sundown (Bolkmans, 2009). Light traps should not be used in vented greenhouses that lack proper screening in the openings (koppert, 2009).

Russell IPM (2009a) recently developed a light trap for *Tuta absoluta* that is capable of capturing of male insects in addition to a substantial number of females per night. The light trap, named ferolite-TUA, uses a combination of sex pheromone and a specific light frequency that is highly attractive to *T.absoluta.* The trap has a reported improved effectiveness (over the standard pheromone trap) of 200 to 300 percent.

2.1.24 Biological control

Biological control is being investigated in most countries where *Tuta absoluta* is present(Faria *et. al.,* 2008).

2.1.24.1 Egg parasitoids

Trichogramma pretiosum, Trichogramma achaeae, and*Trichogrammatoidea bactrae,* parasitizes the eggs of *Tuta absoluta.* In one study, adults of *T.absoluta* were released onto fully developed tomato plants, followed by the release of *Trichogramma pretiosum* 12 hours later. After 24 hours, the level of egg parasitism varied between 1.5 to 28 percent (Faria *et. al.,* 2008).

In another study, the optimal number of *Trichogramma pretiosum* needed to control *Tuta absoluta* in commercial tomato plantations was determined to be 16 parasitoids per host egg (Pratissoli *et. al.,* 2005). In Argentina, inundative releases of *Trichogrammatoidea bactrae* to control *T.absoluta* in greenhouse grown tomatoes gave good results (Botto et al., 2009; Riquelme *et. al.,* 2006).

Trichogramma achaeae has been shown to control *Tuta absoluta* in greenhouses in southeastern Spain (Cabello *et. al.,* 2009a). under laboratory conditions, 100 percent parasitism by *T.achaeae* was reported and of those, 83 percent developed to the blackhead stage. In greenhouse tomatoes there was a 91 percent reduction in damage when 30 *T.achaeae* per plant (75adults/m^2) were released every 3 to 4 days (Cabello et. al., 2009a).

2.1.24.2 Larval Parasitoids

Larvae of *Tuta absoluta* spend most of their lifetime inside mines, however, second instars leave their mines during the cooler times of the day making them vulnerable to parasitoids and predation (Torres *et. al.,* 2001). Of the larval parasitoids, the braconid *pseudapanteles dingus* is frequently found parasitizing larvae in South America (Sanchez *et. al.,*2009). Studies have shown that female parasitoids attack hosts daily and do not have a preference among larval instars. Parasitism of *T.absoluta* by *p.dignus* can reach up to 46 percent in late tomato crops (Sanchez et al., 2009). In Argentina, researchers have tested inoculative releases of *p.dignus* in greenhouses before *T.absoluta* reaches high population levels (Botto, 2011).

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2.1.24.3 Predators

The damsel bug *Nabis pseudoferus* is an effective egg and larval predator of *Tuta absoluta* in Spanish greenhouses (Cabello *et. al.,* 2009b). In two semi-field studies, first stage nymphs of *N.pseudoferus* released onto tomato plants (8 to 12 per plant) killed *Tuta absoluta* eggs, reducing the number of egg by 92 percent and 96 percent. In addition, adults and last instar nymphs of *N.pseudoferus* were also observed preying on larvae of *T.absoluta* , even when these were inside the mines (Cabello *et. al.,* 2009b). *Nabis pseudoferus* is widely distributed in Europe and is commercially available. The recommended dose for outbreaks is 10 to 15 individuals/m^2.

The mirids *Macrolophus pygmaeus* and *Nesidiocoris tenuis* are endemic to Spain and feed on egg and larvae of *Tuta absoluta.* In one study, adult *M. pygmaesus and N.tenuis* are available commercially. However, according to a report from the United Kingdom, *Nesidiocoris tenuis* is problematic because it can attack host plants when prey are in short supply. Plant feeding causes brown ring in the vascular tissue and destruction of the plants growing points (Sanchez *et.al.,* 2008; Sixsmith, 2009).

2.1.25 Microorganisms

Bacillus thuringensis has been recommended forcontrol of *Tuta absoluta.*more recently, the muscadine fungus *Metarhizium anisopliae (*Metschn) Sorokin has been studied for control of *T.absoluta* (Pires*et. al.,* 2009). Adult females infected with the fungus with the fungus did not reduce their oviposition or fecundity; however, infection with *M.anisopliae* resulted in 37 percent female mortality. Eggs exposed to *M.anisopliae* were all infected after 72 hours.

Beauveria bassiana was tested alone or in combination with *Bacillus thurenginsis* for control of *Tuta absoluta* in open tomato fields in Ibiza, Spain

(Torres Gregorio *et. al.,* 2009). Both treatments reduced the number and severity of fruit damage when compared to the control.

2.1.26 Mating disruption

Michereff-Filho et al.(2000) examined the use of mating disruption for *Tuta absoluta* in small plots of fresh market tomatoes in Brazil. The effectiveness of the technique was assessed through trap captures of mails in disrupted plots, mating frequency in mating tables, as well as plant damage. The highest levels of disruption (60 to 90 percent) were recorded in plots treated with 35 to 50 g/ha of sex pheromone. However, no treatment was capable of significantly reducing the percentage of mined leaflets or bored fruits or the frequency of mating as compared to the control plots. The results may be attributed to the composition of the synthetic pheromone; doses used, high pest population density, and mated female migration to the area treated.

More recently, Navarro-Llopis *et. al.,* (2010) used mating disruption against *Tuta absoluta* in tomato greenhouses in Spain. Their results showed that *T.* absoluta can be controlled with mating disruption if the treatments are carried out in greenhouses with good isolation which prevents the moth from entering from the outside. Although the method appears effective, final adoption will depend on the price of the pheromone dispenser. Marti-Marti *et. al.,*(2010) also suggested that more economical and long –lasting pheromone dispensers need to be available before mating disruption can be considered as a suppression technique for this pest.

2.1.27 Integrated Pest Management

Integrated pest management (IPM) programs are being developed in several countries to manage infestation of *Tuta absoluta.* Most IPM programs include the monitoring of pest population, effective methods of prevention and control, and the use of pesticides when needed. Biological control is also implemented if available.

In Spain, IPM for *Tuta absoluta* includes the following management tools (Robredo- Junco and Cardenoso-Herrero, 2008):

- Mass-trapping of adults prior to planting.
- Clearing of crop residues from planting soil.
- Application of imidacloprid in irrigation water 8 to 10 days after planting.
- Application of spinosad or indoxacarb when *T.absoluta* is detected.
- Elimination of crop residues immediately after the last fruits have been harvested (Robredo-Junco and Cardenoso-Herrero, 2008)

  In Argentina, IPM for *Tuta absoluta* in greenhouse tomatoes has been tested at INTA (Instituto Nacional de Tecnologia Agropecuaria) over the last 10 years with positive results (Botto, 1999; 2011a). With positive results (Botto, 1999; 2011a). The strategy includes the following:

  - Monitoring for early detection of adults using pheromone traps and visual inspection of plants, primarily for eggs
  - Inundative releases of *Trichogrammatoidea bactrae,* initiated when the first adults are trapped and/or the first eggs are observed
  - Use of *Bacillus thuringiensis* is in conjunction with (or after) release of egg parasitoids to control larvae
  - Compatible pesticides based on safe pesticide usage if necessary
  - Crop rotation with non-host plants

Cultural control practices in the greenhouse and surrounding environment (Botto,1999; 2011a).

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2-1-28-Botanical insecticides:

Neem seed extract, Azadiractin acts as contact and systemic insecticide against *Tuta absoluta*. A soil application 48.9-100% larval mortality was recorded. Application of Neem oil in adaxial surface of the foliage causes 57-100% larval mortality. However, it reported that application directly on larvae caused 52.4-95% mortality (Conclaves - Gervasio and Vendramin, 2008).

The sex pheromone for *Tuta absoluta* has been identified by researchers at Cornell University and has been found to be highly attractive to male moths. Pheromone lures are used extensively throughout Europe, South America, North Africa and the Middle East for the monitoring and mass-trapping of *Tuta absoluta*. The making, using, selling, offering to sell, or importing of products based on the sex pheromone of the *Tuta absoluta* is protected by a United States which is exclusively licensed to Technologies and its distributors(ISCA, 2010).

2-1-29-**Phytosanitary risk:**

T. absoluta is potentially a serious pest of tomato in the warmer parts of the EPPO region, both in the field and in protected conditions. On potato, the risk appears more limited as *T. absoluta* does not attack tubers in the field or in storage (unlike Tecia solanivora).*T. absoluta* has spread from Central America to most of South America, where significant damage is reported. In addition, control may be complicated by the appearance of pest resistance to insecticides(USDA, 2011).

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2-1-30-Phytosanitary measures:

T. absoluta was added in 2004 to the EPPO A1 action list of pests recommended for regulation as quarantine pests. Plants for planting and fruits of tomato originating from countries where *T.absoluta* occurs should

be free from the pest(USDA, 2011).

2- 2-**Tomato plant:**

2-2-1Classification:

Kingdom:plantae

Subkingdum:tracheobionia.

Division: magnoliopsida.

Sub class: Asteridae.

Order: Solanales.

Family: Solaneceae.

Genus: Lycopersicon.

Species: lycopersium(mill)

Esculantum var cerasiform.

2-2-2 Description:

Tomato *(Lycopersion esculentum*) is a tender warm season perennial cultivated as an annual (GZT, 1987); Decteau,(2000). It is an annual shrubby member of the solanaceae. In a protected environment, tomato is a short-live herbaceous perennial. Determinate tomato hight,3-4 ft, and indeterminate,7-15ft,spread in 24-36 in and most of the roots are found in 8 in. But some fibrous spreading roots extend 4-8ft dee(Decteau.2000).Tomato leaves are compound, alternate, from 10-30cm in long, and 10-15 in diameter (Tindall,1986). Tomato is characterized by glandular hairs (trichomes) that emit a strong aroma when broken.

Tomato flower are relatively small and consist of a five lobed corolla and calyx. The staminal cone represents a fusion of five ansther around the ovary. Style and stigma, ensures a high level of self-pollination and homozygosis. Pollination is not a function of insect’s activity but occurs as flowers vibrate from wind currents .The fruit botanically a berry has two or more cavities(locules) containing seeds imbedded in a gelatinous matrix that softens as fruit reach mature size and seeds are fully developed. Small fruited cultivars generally have only two locules; those with large fruit have many(Peirce,1987). Ripe fruit colors may be red , pink, yellow or orange, a function of several independent genes controlling either flesh or skin color (peirce,1987,and Decteau,2000) .in addition to these basic fruit colors other genetic factors modify flesh color intensity (crimson or high pigment) or chlorophyll expression in unripe fruit , ripe color is a function of two carotenoid pigments, lycopne(Peirce 1987).Shapes may vary from globe or round to slightly flattened, or spear like (Decteau,2000).tomato seeds can conserve vitality for four years (Ahmed,1998).

2-2-3 Distribution:

The written literature of tomato began in the 1500s when Spanish and Portuguese explorers found these plants first in Mexico and then along the west coast of South America, mainly Peru, and then along on the Galapagos Islands. Tomato is native to peru-Equador region of South America, evolving from the cherry from (lycopersicon esculentum var cerasiform).The first historical mention of tomato by Malthiolusin 1544, placed in Italy. However, it was first introduced to Spain by explorers returning from south and Central America. The plant received little notice in Spain (Peirce,1987). Based on the world Food and AgriculturalOrganization(FAO)in1994,tomato fruit-for fresh market and processing worldwide was approximately 2.8 million hectares (Benton,1999).Tomato is one of the most important vegetable crops in the Sudan(GTZ,1987).the production area of tomato in the Sudan is unknown ,it is estimated at more than 100.000 feddans. Whereas more than 20.000 feddans are grown in Al Gezira region and also growing in a great area in Al Rahad Scheme , Rivers Banks, and valleys in small separate area.

2-2-4 Importance of tomato:

Tomato is grown for its, commercially important fruits. Its grown for fresh market in the field or greenhouse and for processing as whole pack, juice, or puree.(Decteau, 2000).tomatoes and pepper, although not among the most valuable crops in nutrients per pound, are important contributors to dietary needs because of substantial per capita consumption of each. Tomato contain significant amounts of vitamins A and C , although levels of both in fruit from shaded plants as in those in strong sunlight , the carotenoides are effected by temperature(light intensity), but vitamin A(β-Carotene) is relatively stable (Peirce,1987). Besides being eaten fresh, tomatoes can be boiled, stewed, fried, juiced, or pickled and use in soups, salads, and sauces. (Tomatoes are an important in salsa along with onions, garlic, peppers, cilantro, cumin and lime juice). Cherry tomato tyoe (cultivar for fresh market) producing many small fruits , cherry tomatoes are often served as appetizer , are generally considered the best suited for cooking in it sauces and ketchup due to their lower water contained (Decteau,2000).

2-2-5 Nutrient value content of tomato:

Tomato is considered as an important source for some vitamins and mineral salts, such as; vitamin C, vitamin B, and Riboflavin, which are consider necessary for growing,and safety skin. The external part of fruit contains high level of vitamin C (Ahmed in Arabic, 2006).

2-2-6 Medical uses of tomato:

Tomato is known for its medical value, it is important in protection from cancer, it use in difficult digestion such as constipation, disorder in liver and kidney function. However , these important in protection and cure due to containing anti-oxygenate substance such like , vitamin C , glutathione , or β-carotene, as well as it rich in lycopine which result in activation in body and mind when take it (Ahmed in Arabic 2006).

2-2-7 Type of tomato in the Sudan:

Tomato is a major vegetable crop in the Sudan. The major varieties of tomato growing in the Sudan are strain B, and peto 86, since they rejected by farmers for many reasons, these include, Early pack, money maker, Pearson, and Ace. There are other resistance type breeding in the Sudan against tomato yellow leaf curl virus include , Sennar(1), Sennar(2) , Omdurman, and Aljazeera (96). Variety Abed Allah and Samarset (98) are breeding to resist high temperature in the Sudan (Ahmed in Arabic, 2006).

Khartoum State ranks top among other states in Sudan regarding to production and consumption of vegetables that relates to the higher increase in population growth, income level and nutritional awareness (Mohammed, 2005).

Tomato product is considered as most important vegetables crops in Sudan and that due to its economics and nutritional value. It occupies about 28% of the total area under vegetables production (Ahmed, 2009).

2-2-8 Tomato Diseases:

Several bacterial diseases (caused by fungi and viruses) affect tomato these in clued: Fusarium wilt, verticillum wilt, bacterial wilt, bacterial spots, early blights, Anthracnose, Powdery mildew, Nematodes (Decteau,2000).

2-2-9 Tomato insects:

Several insects infest tomatoes. Some of those are white fly (*Bemisia tabaci*), Flea Beetle (*Epitricx cucumeries)*, Colordo potato beetle (*Leptinotarsadecimlineata)* the green peach aphids (*Myzus persicae*)and potato aphid (*macrosiphum solanifolliare*), leaf hoppers (*Circulifor tenellus*) , tomato horn worm , tomato fruit worm, life miner, corn borer, spider mite, common stem borer , fruit fly, stink bugs (Ahmed in Arabic,2006,Snyder *et. al.,*2005; Decteau, 2000; Peirce, 1987 and Cantelo *et. al.,*1974) .

2-3- Jatropha (*Jatropha curcas*):

Jatropha is a genus of approximately 175 succulent plants, shrubs and trees (some are deciduous, like *Jatropha curcas* L.).The name is derived from Greek words, iatros= physician and trophe =nutrition,andhence the common name physic nut. Jatropha is native to Mexico and Central America (Heller and Joachim, 1996, Morton, 1997, Little *et. al.,* 1974).

2-3-1- Classification:

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Malpighiales

Family: Euphorbiaceae

Subfamily: Crotonoideae

Tribe: Jatropheae

Genus: Jatropha

Species: curcas

2-3-2-Description:

Jatropha or physic nut can grow to a height of about 3 to 5 meters. If the conditions are favorable they can grow to height of about 8 to 10 meters,with spreading branches and stubby twigs with smooth grey bark and they emit white water latex when they are chopped (James, Ducke. 1983).

Normally five roots are formed from seeds, one tap root and 4 lateral roots. Leaves are deciduous broad and usually simple alternate but apically crowded, ovate, acute to acuminate, basally cordate, deeply palmate 3 to 5 lobed, green or pale green in color. Flower: several to many in greenish cymes, yellowish, bell shaped are formed terminally on branches. Fruits: small capsule-like round fruit about 2.5-4cm in diameter there green and fleshy when immature. Seed: 2 or 3 black seeds and each one is about 2cm long (Morton, 1977,Little *et. al.,* 1974).

2-3-3varieties:

2-3-3-1-Cape Verde variety:

These are small seeds (weight of 1.000 grains is about 682 g. Length of seed is about 16.8 mm). This variety is found almost in all countries of the world, except Central America (Aregheor *et. al.,* 2003).

2-3-3-2-Nicaragua variety:

This variety is different from the Cape Verde variety by having larger leaves, which have a more rounded form and by having larger seeds (weigh of 1.000 grains is about 878 g) and the length of the seed is about 20.3 mm).The yield of the trees seems to be the same because there are less fruits on a tree than with the Cape Verde variety ((Aregheor *et. al.,* 2003).

2-3-3-3-Nontoxic Mexican variety:

Weight of 1000 grains is between 524 g and 901 g. This Non –toxic variety of jatropha could be a potential source of oil for human consumption, and the seed cake can be a good protein for human as well as for live stocks (Becker & Makkar, 1998).

2-3-4-Distribution:

Though native to Americathe species is almost tropical now and it is widely planted as a medicinal plant. It is listed as a weed in Brazil, Fiji, Honduras, India, Jamaica, Panama, PuertoRico, and Salvador. The plant was spread as a valuable hedge plant to Africa and Asia by Portuguese traders. (Holm *et. al.,* 1979).

In Sudan Jatropha is found in many areas such as Khartoum state, in Central Sudan, Kassala state, in the East and Kordofan state, in the West. It is also dominant in the Southern states especially in Bahr eljebel and Bahr elgazal state where the farmers use it as hedges to protect houses and gardens. Jatropha project was in Kutum, North Darfur, with participation of the German Development service (List and Horhammer, 1969-1979, Henning. ,2001).

2-3-5-Ecological requirements:

Jatropha will have its best result when it is planted in the rainy season. So it would be easy to prepare the seedlings during the dry season and make them ready before the rainy season. Jatropha plant grows on a wide range of climates and soils and can be established marginal /poor soil. In fact, Jatropha curcus grows almost anywhere, even on gravelly, sandy and saline soils. It can also thrive on the poorest stony soil and grow in the crevices of rocks (James, 1983).

Jatropha are found in tropical and subtropical zones and also in regions that have lower temperature and it has the capacity to withstand little frost. The jatropha trees can live with the minimum water content and can live for several months without water by shedding its leaves to reduce the transpiration losses.(Duke, and Wain, 1981).

2-3-6-cultivation:

Growth can occur readily, from cuttings or seeds. Cuttings roots is so easy and the plant can be used as energy–producing material as wellliving fences post.(Morton, 1977and Little *et al.,* 1974).

2-3-7-Yield and Economics:

Seed yields approach 6-7 MT/ha with 37% oil. They calculated that such yields could produce the equivalent of 2,100-2,800 liters fuel oil /ha in Madagascar where, they have 10,000 ha of purging nut, each producing 2,400 oil/ha for a potential production of 24,000,000 liters. The plant yields more than four times as much fuel per hectare as soybean, as and more than ten times that of maize (Michael, 2006).

2-3-8-chemistry:

Per 100g, the seed is reported to contain 6.6g H2O, 18,9g protein 38,0g fat, 33.5g total carbohydrate, 15,5g fiber and 4.5g ash (Duke and Atchley, 1984).Leaves, which show anti-leukemic activity, contain a-amyrin, b-sitosterol, stigmastterol, and compesterol, 7-Keto-6 sitosterol, stigmast-5-ene-3-6,7-a-diol (Morton,1981).

Leaves contain isovitexin and vitexin, Saccharose, raffinose, stachyose, glucose, fructose, galactose, protein and oil. Oleic and linoleic-acid (List & Horhammer, 1969-1979). Curcasin, arachidic, linoleic-, myristic-, oleic-, palmitic-, and steric-acids are also reported (perry, 1980).

2-3-9-seeds and its toxicity:

The seed of physic nut are a good source of oil, which can be used as a diesel substitute. However, the seed of J.curcas are in general toxic to humans and animal. Curcin, a toxic protein isolated from the seeds ,was found to inhibit protein synthesis in vitro studies .The high concentration of phorbol esters present in Jatropha seed has been identified as the main toxic agent responsible for Jatropha toxicity.(Adolf *et.al.,* 1984. ,Makkar *et. al.,*. 1997).

Several cases of J.curcus nut poisoning in humans after accidental consumption of seeds have been reported with symptoms of giddiness, vomiting and diarrhea and condition even death have been recorded (Becker and Makkar, 1998).

Ionizing radiation treatment could serve as a possible additional processing method for in activation or removal of certain anti nutritional factors such as phorbol esters, phytates, saponins and lectins (Siddhuraju *et. al.*, 2002).It is not possible to destroy phorbol ester by heat treatment because they are heat stable and can withstand roasting temperature as high as 160c for 30 min. However, it is possible to reduce its concentration in the meal by chemical treatments .This treatment is promising, but in economic term it is expensive to produce jatropha meal from it(Areqheor*et.al.,* 2003).

(Martinez- Herrera *et. al.,* 2006)studied the nutritional quality and the effect of various treatments to inactivate the anti-nutritional factors indefatted jatropha kernel meal of both toxic and nontoxic varieties from different regions of Mexico.Complete removal of the toxins is therefore necessary before jatropha oil can be used in industrial application or in human medicineThe oil must be completely innocuous before it is used commercially.

2-3-10-Uses of jatropha:

2-3-10-1-As hedge:

Jatropha Is an excellent hedging plant for protection of agricultural fields against damaged by livestock as unpalatable to cattle and goat(Sherchan *et. al.,*1989s).

2-3-10-2-As green manure and fertilizer:

The seed cake is an excellent source of plant nutrient,in a green manure trial with rice in Nepal, the application of 10 tons of fresh physic nut biomass resulted in increased yield of many crops (Sherchan *et. al.,*1989).

2-3-10-3-AS food:

The physic nut seed is eaten in certain regions of Mexico once it has been boiled and roasted (Delgado and par ado, 1989)

2-3-10-4-**soap:**

The glycerin that is a by –product of biodiesel can be used to make soap ,and soap can be produced from Jatropha oil itself .In either case the process produces a soft,durable soap and is a simple one,well adapted to house hold or small-scale industrial activity(Delgado and par ado, 1989).

2-3-10-5-pesticide:

The oil and aqueous extract from oil has potential use as an insecticide, for instance, it has been used in the control of pests of pulses, potato & corn.Methanol extracts of Jatropha seeds which contain biodegradable toxins are being tested in Germany for control of bilharzia-carrying water snails(Kaushik and Kumar, 2004).

2-3-10-6-As an energy source:

The oil from Jatropha is regarded as a potential fuel substitute.Air New Zealand Houston based continental Airlines have run tests in January2009 for demonstrating the viability of Jatropha oil as jet fuel .Japan Airlines also conducted test flights in Jan .2009 as well. Researchers at Daimler Chrysler Research explored the use of Jatropha oil for automotive use, concluding that although Jatropha oil as fuel has not yet reached optimal quality, it already fulfills the European norm for biodiesel quality".(Daimler Chrysler,2004).

2-3-10-7-Medicinal uses:

All parts of Jatropha (seeds,leaves &bark) have been used in traditional medicine and for veterinary purposes for a long time (Dalziel,1995؛Duke,1988).The oil has a strong purgative action is also widely used for skin diseases and to soothe pain such as that caused by rheumatism.The oil is used as cathartic purgative and for the treatment of skin ailments (Duke,1988).The leaves & latex are used in healing of wounds, refractory ulcers , and septic gums and as a styptic in cuts.Roots is used in decoction as a mouth wash for bleeding gums and toothache.otherwise used for eczema ,ring worm and,scabies (Perry ,1980؛Duke and Ayensu,1984).Latex used to dress sores and ulcer and inflamed tongues and also effective against Plasmodiumfalciparum, P.vivax ,P.ovale, and P.malariae. (Perry 1980).The seeds used to treat arthritis, gout and jaundice. Leaves are regarded as anti-parasitic, applied to scabies rubefacient for paralysis, rheumatism, also applied to hard tumors (Hartwell, 1967-1971).

2-3-10-8-Biotic factors:

Agricultural Hand book lists the following as affecting Jatropha curcas:

-*Clitocybe tabescens.*(root rot).

-*Colletotrichum gloeosporioides*.(Leaf spot).

-*Phakospora jatrophicola* (rust).

Spodoptera liture (fab) Boursin (Lepidoptera: Noctuidae) is reported as a pest of *Jatropha curcas* L. in India

2-3-10-9-**Botanical insecticides:**

Higher plants and extremely abundant with biologically active secondary metabolites over 80%of all known alkaloids, phenols another secondary metabolite were produced by higher plants (Elsiddig, 2007).

Many plant extracts or products have proven to be as potent as many conventional synthetic pesticides and are effective at very low concentrations On the other hand botanical insecticides possess great advantage over synthetic pesticides in being more environmentally friendly, to be accepted by the majority of farmers, governmental organization and decision makers (Kelany, 2001).

2-3-10-10-Use of botanical insecticides:

Stoll (2000) demonstrated that the use of plant extracts to control destructive insect in not new .Rotenone, nicotine and pyrethrin have been used for a considerable time in small scale subsistence and also commercial agriculture.

(a) (b)

Plate.2: *Jatropha curcas* tree (a) and *Jatropha curcas* seeds

(Morton, 1977,Little *et. al.,* 1974)

2-4-Neem (*Azadirachta indica* A. Juss):

2-4-1-Taxonomy:

Neem (Azadirachta indica, Syn. *Melia azadirachta* L., *Antelaea azadirachta* (L) Adelb.) is a tree in the Mahogany family Meliaceae. It is one of two species in the genus Azadirachta (Schmutterer, 1995).

Kingdom: Plantae

Division: Magnoliophyta

Order: Rutales

Suborder: Rutinease

Family: Meliaceae

Genus: Azadirachta

Species: Azadirachta indica

S.N: *Azadirachta indica* A.juss

E.N: Neem

A.N: نيم

(Vietmeyer, 1992, and Schmutterer, 2002)

2.4.2 Origin

The Neem is versatile tree of Indian and Burma origin where the ancient healers of that region knew it very well in health (ICIPE, 2002).

2.4.3 Morphology

Neem is a fast growing tree that can reach a height of 15-20m, rarely to 35-40m. Its ever green but under severe drought it shed mostly or nearly all of it leaves.

The branches are wide spread, the fairly dens crown is roundish or oval may reach diameter of 15-20m. In old tree standing specimen the trunk is relatively short straight and many reach a diameter of 1.2m. The bark is hard fissured or reddish-brown. The sap wood is grayish white and heart wood reddish when first exposed to the air becoming reddish after exposure. The root system consists of a strong tap root and well developed tateral roots. The alternate, pinnate leaves are medium (Ganguli, 2002).

2.4.4 Distribution

Neem is widely distributed throughout South East Asia and West Africa and part of Central America (Stoll, 2000). Neem is introduced to Sudan in the 20 century. The first one were planted at shambat in 1916, today trees are spread in town and villages along the Blue and White Nile, irrigated areas of Central Sudan, Kordofan and Darfur (Schmutterer, 1969).

2.4.5 Ecology

The neem trees is famous for its drought resistance, normally it thrives in areas with sub-arid to sub humid conditions with an annual rainfall between 400 and 1200 mm. it can also grow in regions with an annual rainfall 400MM. but in such cases it depends largely on the ground water levels. Neem can grow in many different types of soil, but it seems to develop best on well drained, deep sandy soils. It is a tropical and subtropical tree, and exists at annual means temperatures and does not tolerate (Ganguli, 2002).

2.4.6 Active Ingredients

The neem tree produce a compounds of many active ingredients called Azadirachtin and it is tetramer titer penoid compound which influences the hormonal system, feeding activity reproduction and fling ability of insect. Azadirachtin has low mammalian toxicity. It degrades rapidly in the environment and has low side effects on non-target species and beneficial insects. Seeds of the Neem tree contain the highest concentration of Azadirachin. Salanin inhabits the feeding of wider any of insect pests, Nimbin and Nimbidin showed antiviral effects (Ganguli, 2002).

2.4.7 Chemical Compounds of Neem tree

Extract of various parts of the tree studied by many chemicals that isolated many different compounds. Most of the known active compounds belong to the group of titer penoids (Schmutterer, 1990). Azadirachtin and Solanin are the most important constituents of Neem seed kernel composition, other active compounds in the seed kernel are Salanin, Salanol, Acetate, Nimbin and Deactly nimbidin (Jacobson, 1989).

2.4.8 Mode of action

Neem acts as insects feeding deterrent and growth regulator, the treated insects usually cannot molt to its next life stage and dies, Azadirachtin is chemically similar to ecdysone responsible for triggering molts. It also acts as repellent when applied to plant and does not produce a quick knock down and kill (Schmutterer, 1990).). Also Neem has some systemic activity in plants, its most effectively growing immature stages and adults are not killed by the growth regulator properties of Azadirachtin, but mating and sexual communication may be disrupted which results in reduced fecundity (Schmutterer, 1990 and Pedigo, 1999).

2.4.9 Uses of Neem in pest and disease control

Neem is deemed very effective in the treatment of scabies although only preliminary scientific proof exists which still has to be corroborated and is recommended for those who are sensitive to Permethrin. A known insecticide which might be irritants and also the scabies mite has yet to become resistant to Neem, so in persistent cases Neem has been shown to be very effective, there is also anecdotal evidence of its effectiveness In treating infestations of head lice in humans, it is also very good for treating worms (soak the branches and leaves in lukewarm water and drink it) In the traditional medicine Neem trees originated on the Indian subcontinent. The Neem twig is nature's tooth brush to over 500 million people daily in India alone. Herbal medicine is the oldest form of therapy practiced to be mankind and much of the oldest medicinal use of plants seems to have been based on highly developed 'dowsing instinct' (Schmutterer, 2002).Siddig (1993) reported from Sudan that Neem seed water extracts at1Kg/1Liter of water repelled foliage pest of potato including *B. tabaci*, *Aphis gossypii* and *J. lybica* and yield increased to 5 ton/ ha. Mohammed (2002) reported that Neem seed showed good performance against *A. gossypii*,*B. tabaci*, and *J. lybica* on Okra Dawood (2001) reported that Neem water extracs at 1Kg/liter water reduced the number of onion thrips at 63.5% under the field condition.

2-4-10-Neem research in the Sudan:

Research work in the Sudan dates back to the year 1967 when Siddigstarted some observation trials at Hudeiba Research Station. These trialsevaluated different parts of the neem tree as protectants to wheat against thestone pest (Trogoderma granarium Everts). Preliminary results wereencouraging to resume this type of research later at Shambat Research Station(Siddig, 1991)Accordingly the Environment and Natural Resources Research Institute has started intensive research programmes onneem biocidal property since the 1980s. Many successes have been realizedabout the effectiveness of neem crude extracts, neem oil and different organicextracts on vegetables and stored pests (Cited in Mohammed, 2003).

Some of these achievements include: a. Neem seed water extract was recommended as component of an integrated pest management package suggested for the control of potatopests such as leaf hoppers and cutworms

(Siddig, 1987)Confirmation of ARC findings related to the efficacy of neem seed waterextract in controlling vegetable pests on Okra (Ahmed, 1998), tomato andeggplants. C. Neem seed water extract was found comparable to the standard insecticideMalathion in controlling cucumber pests, e.g. white flies, aphid, leafminers and without harming their nature enemies (Satti, 1997).

2-5-Argel:

Solenostemma argel (Del.) Hayne

Cynanchum argel Delile,

Cynanchum oleaefolium Nect.

Solenostemma oleaefolium (Nectoux) Bullock &Bruce.

Arabic: arghel, hargal

Targui: aghallachem

English: arghel

2-5-1-Characteristicand Distribution:

Argel *Solenostemma argel* (Del) Haynes is aromatic and medicinal pantcontains a variety of chemical substances that act upon the body (Shayoub, 2003).It is a desert plant belongs to the family Asclepiadaceae, which widely distributed in Egypt, Libya, Chad, Algeria, Saudi Arabia, Palestine, and Central and Northern part of the Sudan (Ahmed, 2004).However, among these above mentioned countries, Sudan isregarded as the richest source of the Argel plant which grows naturally in the northern of the Sudan and extends from Berber to Abu- Hamad, especially the Rubatab area. In other Arabic countries and Sudan, the tradition name of this plant is Hargel. The part used of the plant is dried leaves and stems (El- Kamali, 1996).

Sudan is regarded as the richest source of this plant (Orange, 1982). Phyto-chemicals of medicinal properties from argel shoots had been reported by many workers (Roos *et. al.,* 1980; Hamed, 2001). Sulieman *et. al.*,(2009) reported that the aqueous extracts of argel have antifungal and antibacterial properties.

The farmers in Kassala State put argel shoots in porous jute sacks in the irrigation canals to be leached by waterThe water was effective in controlling aphids and white flies in summer tomatoes and Egyptian bull worm in okra respectively Elkamali and Khalid, 1996).

(Unpublished observation) In a pilot field experiment on *Brassica nigra*, some peripheral plots were severely infested by aphids. The infestation caused stunting of shoots and delayed flowering compared to non-infected plots. However, upon treatment with argel as a soil additive, or a spray of shoot water extract or a combination of soil additive and spray, the vegetative growth was restored in all plots after pest disappearance and the plants flowered within 10-15 days after treatments. The inflorescence was abnormally thick and profusely branched in plants that received the combined treatment suggesting a growth-regulator-like effect and indicating the efficiency of argel as a pesticide (Abdelwahab, 2002).

S. argel (Del.) Hayne is a desert plant which is widely spread in Egypt , Libya , Chad , Algeria , Saudi Arabian , Palestine and Northern parts of Sudan . Howerever Sudan is regarded as the richest source of this plant (Organgi, 1982) .S. argel is a popular medicinal plant in the Sudan and it is used traditionally for treatment of colic and gases as well as for treatment of diabetes (Elagib, 2001)

The pharmacological actives of different extracts of *S. argel* have been investigated by Roots, *et. al.,* (1980) and Tharib, *et. al*., (1986) and confirmed the presence of antibiotic substances in the ethanolic extracts of the argel plant as well some antifungal properties of the plant Additionally some substance or a compound was isolated from the argel stem, and was realized to have antibacterial properties against both gram positive and gram negative organisms.

2-5-2-Chemical Composition:

Aerial parts of *S. argel* plant were successively extracted with methanolic/ water in different proporation which produced 4 fractions the phytochemical screening revealed the presence of the flavonoids (aglycones and glycosides), unsaturated sterols and / or triterpenoids, saaponins and tannins The chemical composition of leaf is 4.4% .protein content (15%) whereas, crude fiber of the leaf studied is 1.6% and the ash content is 7.7%. The crude oil of leaf studied is 6.5% while total carbohydrates of sample investigated is 64%. In another study by Sabsh El-Kheir *et al*, (2003)the findings indicated that moisture of leaf is 4.4%, Protein (15%) whereas, crude oil of leaf considered is 1.6% and the ash is7.7%. the crude organize of the leaf considered is 6.5% while total carbohydeates is 64.8%.

2-5-3-Pest control Ability 0f Hargel:

The crude extracts of Hargel plant can be effective against many pests. It has been shown toxic activity against a variety of insects species .It is act as antifeedant against Larvae of Cotton Leafworn *Spodoptera littor alis* (Abdel-Rahman and Mozini, 2007). A crude aqueous extract of dried fruit pericarp, flower, root and stem of the plant were tested for larvicidal activity on the third instar larvae of the mosquito *culex quinquefasiatus* (say). Extract of the fruit pericarp was found most effective with Lc50 of 0.49g/ml at 24nh. (El- Kamali, 2001).

CHAPTER THEREE

3. MATERIALS AND METHODS

This study was conducted at the laboratory of the Entomology, Department of Plant Protection, College of Agricultural Studies, Sudan University of Science and Technology (SUST). "Shambat" in (sept 2011- sept 2012) to evaluate the toxic effect of jatropha (Jatropha curcas) seeds and leaves, Neem seeds and Argel stems ethanolic and hexane extracts against the Leaf miner *Tuta.absoluta*.

3-1-Rearing method:

Adults of tomato leaf miner were collected from unsprayed tomato fields in Shambat area and brought to the laboratory and reared in plastic cages 31×20×19 cm covered with muslin clothes. Each plastic cage was supplied with tomato plants and a beaker filled with sugar solution and a piece of cotton soaked into it for adults feeding. The insects were left to multiply until a sufficient number was collected for conducting the bioassay.

3-2-Extraction method:

Extraction processes were conducted at the Department of Pesticides Alternatives at the Environment and Natural Resource Research Institute (ENRRI), National Research Center (NRC). 600 grams of each of previously prepared powder of jatropha leaves and seeds, neem seeds and argel stem were divided into three parts each of which consists of 200 grams .Each part was placed separately in a thimble and then placed in the extraction chamber of the soxhlet extractor apparatus, and then extracted with 500 ml of ethanol (99.7%) The extraction continued until the extract was completely colorless, and then ethanol was removed by a rotary evaporator in order to obtain the crude materials of jatropha leaves and seeds, neem seeds and argel stem. The same process was followed for the hexane extract.

3-3-Preparation, collection and extraction of test products

3-3-1-Neem seeds:

Ripened mature fruits of the neem tree ***Azadirachta indica*** A. Juss were collected at Shambat area, Sudan. Fruits were then washed with tap water and left to dry under shade for 5 days. The seeds were then crushed and ground into fine powder using a common domestic grinder

3-3-2-Jatropha Seeds:

Fresh ***Jatropha Curcas*** seeds were obtained from Department of Plant Protection, College of Agricultural Studies, Sudan University of Science and Technology (SUST).The seeds were then carefully selected according to their condition where damaged seeds were discarded Seeds in good condition were cleaned, shelled and subsequently the seed kernels and hulls were separated manually and dried. The seeds were then crushed and ground into fine powder using a common domestic grinder.

3-3-3-Jatropha leaves:

Fresh ***Jatropha Curcas*** leaves were obtained from a field at the College of Agricultural Studies, Sudan University of Science and Technology (SUST).The leaves were thoroughly cleaned, left to dry under shade for 5 days, crushed into fine powder and then used for extraction.

3-3-4-Argel stems (Hargel):

Samples of argel ***Solenostemma argel*** stems were obtained from a retail store in Baharey Marketing Center The stems were freed from foreign materials such as stones; sand and dust, before being brought to the laboratory for further investigation.The leaves were thoroughly cleaned, left to dry under shade for 5 days, crushed into fine powder and then used for extraction.

According to volumetric law, 5%, 10%, 15% and 20% concentrations were prepared from each extract. The recommended dose of malathion 57% was also used as standard.

3-4-Bioassay procedure:

Twelve Petri dishes were lined with sterile filter papers.Then 2 mls of each concentration were added to each petri dish and rotated in such a way that an even distribution was achieved The insects were placed in a refrigerator for 3-5 minutes to reduce their activity so that they can be easily handled and sexed using a magnifying glass.Ten insects (5 males and 5 females) were placed in each of the treated dishes for 4 hrs Each treatment was replicated three times in a completely randomized block designthe treated insects were then moved into cages containing dampened soil and covered with fresh tomato leaves for eggs oviposition The cage also contained a small beaker filled with 10% sugar solution and covered with a piece of dampened cotton for adult feeding Mortality counts were taken and recorded after 24, 48 and 72 hours of exposure. Egg counts were taken as of the fourth day and the subsequent days.

3-5-Statistical analysis:

The data obtained was statistically analyzed according to analysis of variance (ANOVA) whereas Duncan's multiple range tests was used for means separation EPA probit analysis program for calculating LC/EC values, version 1.5 software, was adopted to compute LC50 values for each plant extract used in this study.

Plate.3: Equipments used in this study

Plate.4: Rearing cages

Plate.5: Eperiment Design

CHAPTER FOUR

.RESULTS4

4-1-Motality:

As seen in Table (1) Figure (1) all concentrations of ethanolic extracts of jatropha seeds gave significantly higher mortality percentages than the control after 24, 48 and 72 hrs of exposure. Moreover the two highest concentrations (15% and20%) gave higher mortality percentages than malathion after 48 and 72hrs of exposure. Generally as the concentration increases the mortality percentage increases. Even the second highest concentration (15%) gave an equal mortality percentage to that of malathion after 24 hrs of exposure.

The mortality percentage results exhibited in Table (2) Figure(2) showed that all concentrations of ethanolic extracts of jatropha leaves gave significantly higher mortality percentages than that of the control after 24, 48 and72hrs of exposure .The data also showed that there was no significant difference in the mortality generated by the 57% malathion and the highest concentration of jatropha leaves ethanol extract (20%) after 48 and 72hrs of exposure which is a good indication of the effectiveness of jatropha leaves ethanol extract.

As seen in Table (3) and Figure (3) all concentrations of ethanolic extracts of neem seeds gave significantly higher mortality percentages than that of the control after 24, 48, and 72hrs of exposure. Additionally both the 15% and 20% concentrations gave higher mortality percentages than the 57%

Table 1: Effect of ethanolic extract of jatropha seeds on mortality of adults of tomato leaf miner ***Tuta absoluta.***

Concs. (%)	Mortality (%)		
	Exposure time (hrs.)		
	24	48	72
5	43.3 (6.6)c	66.7 (8.2)c	66.7 (8.2)b
10	60 (7.8)b	73.3 (8.6)bc	76.7 (8.8)ab
15	80 (9.0)a	83.3 (9.2)ab	83.3 (9.2)a
20	83.3 (9.2)a	86.7(9.3)a	90.0 (9.5)a
Malathion	80 (9.0)a	80 (9.0)ab	80.0 (9.0)a
Control	0 (0.7)d	0 (0.7) a	0 (0.7)c
SE±	0.7	0.8	0.8
C. V.(%)	5.7	4.6	5.1

Means followed by the same letter (s) are notsignificantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$.

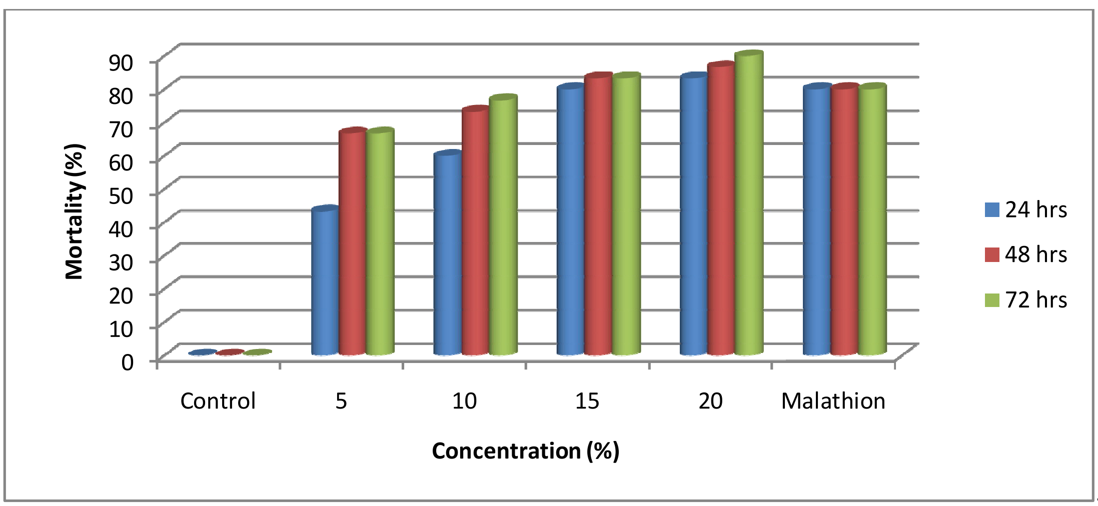

Fig. 1: The effect of ethanolic extract of jatropha seeds on mortality of adults of tomato leaf miner ***T. absoluta.***

Table 2: Effect of ethanolic extract of jatropha leaves on mortality of adults of tomato leaf miner ***Tuta absoluta***.

Concs. (%)	Mortality (%)		
	Exposure time (hrs.)		
	24	48	72
5	23.3(4.8)d	46.7(6.9)b	56.7(7.6)b
10	40.0(6.3)c	53.3(7.3)b	60(7.8)b
15	43.3(6.6)bc	66.7(8.2)a	80(9.0)a
20	60.0(7.8)ab	80(9.0)a	83.3(9.2)a
Malathion	80.0(9.0)a	80(9.0)a	80(9.0)a
Control	0(0.7)e	0(0.7)c	0(0.7)c
SE±	0.7	0.7	0.7
C. V.(%)	12.2	6.3	6.4

Means followed by the same letter (s) are notsignificantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

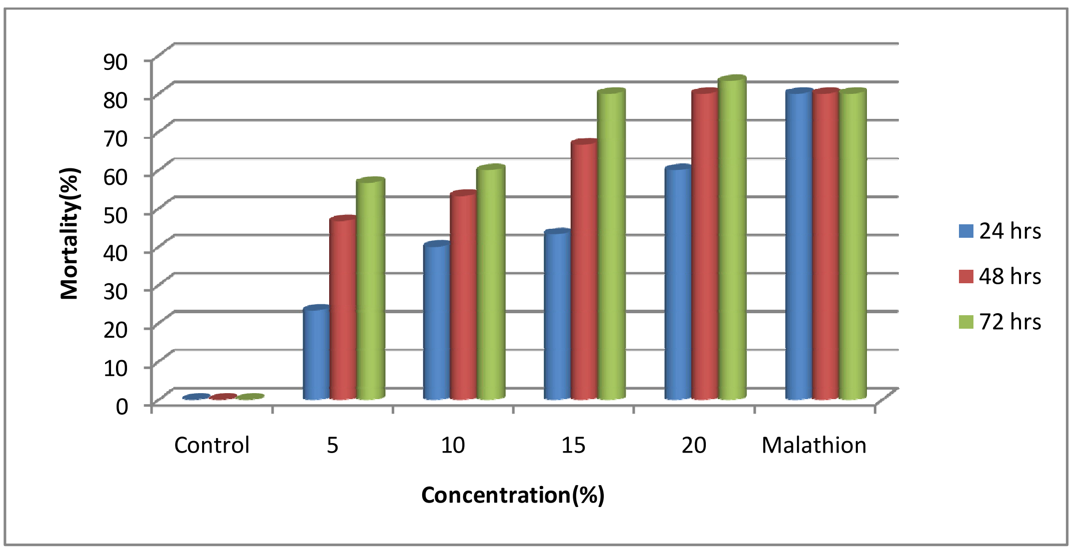

Fig. 2: The effect of ethanolic extract of jatropha leaves on mortality of adults of tomato Leaf miner ***T. absoluta***.

Table 3: Effect of ethanolic extract of neem seeds on mortality of adults of tomato leaf miner ***Tuta absoluta*** after 24 hours.

Concs. (%)	Mortality (%)		
	Exposure time (hrs.)		
	24	48	72
5	36.7(6.3)c	63.3(8.0)b	66.7(8.2)b
10	56.7(8.0)b	83.3(8.0)b	83.3(8.8)a
15	86.7(8.4)ab	90(8.6)ab	93.3(9.0)a
20	90(8.6)ab	96.7(8.8)a	96.7(9.2)a
Malathion	80(9.0)a	80(9.0)a	80 (9.0)a
Control	0(0.7)d	0(0.7)c	0(0.7)c
SE±	0.8	0.8	0.8
C. V.(%)	7.8	6.0	4.3

Means followed by the same letter (s) are notsignificantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

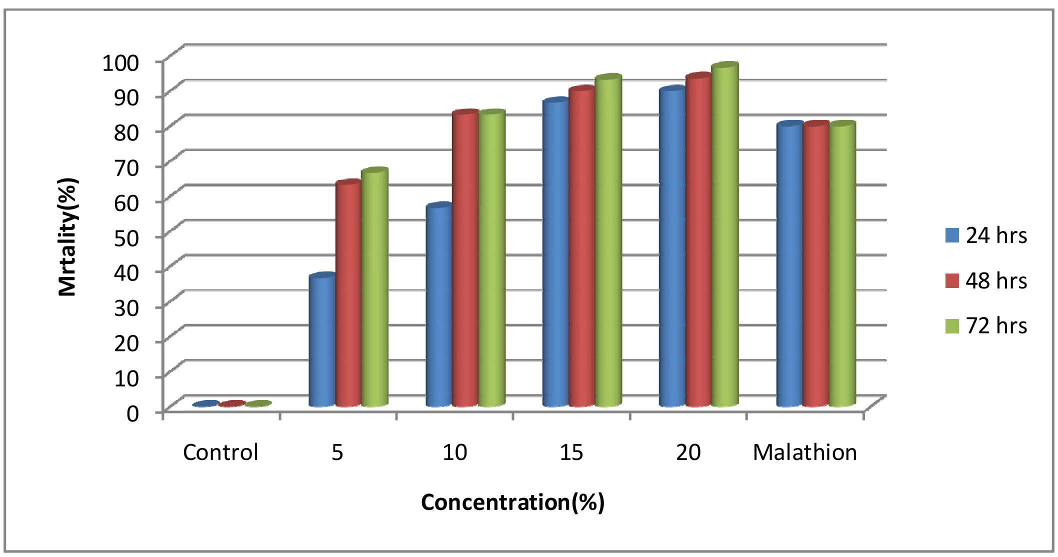

Fig. 3: The effect of ethanolic extract of neem seeds on mortality of adults of tomato Leaf miner ***T. absoluta***.

malathion suggesting the effectiveness of neem seeds ethanolic extract as a potential insecticide.

Table (4) and Figure (4) show that all concentrations of ethanolic extracts of argel stem gave significantly higher mortality percentages than that of the control after 24, 48 and 72hrs of application. The results also show that there was no significant difference in mortality percentages among the different concentrations after 24hrs of application .The malathion 57% gave significantly higher mortality percentage than all tested concentrations after 24, 48 and 72 hrs of exposure.

The mortality results exhibited in Table (5) and figure (5) show that all tested concentrations of hexane extract of jatropha seeds gave significantly higher mortality percentages than the control after 24, 48 and 72 hrs of exposure. The results also show that the 20% concentration significantly higher mortality percentage than the 15% concentration after 24 and 48 hrs of exposure. However there was no significant difference in mortalityPercentage between highest concentrations (20%) and malathion 57% after 24, 48 and 72hrs of exposure.

As seen in Table (6) and figure (6) all concentrations of hexane extract of jatropha leaves gave significantly higher mortality percentages than that obtained by the control after 24, 48 and 72hrs of exposure; moreover, the mortality percentages generated by the two highest concentrations (15% and 20%) after 24 and 48hrs of exposure were not significantly different from the standard, malathion suggesting the efficiency of the extract as a chemical control agent.

Table 4: Effect of ethanolic extract of argel Stem on mortality of adults of tomato leaf miner ***Tuta absoluta***.

Concs. (%)	Mortality (%)		
	Exposure time (hrs.)		
	24	48	72
5	40(6.4)b	46.7(6.9)c	46.7(6.8)d
10	43.3(6.6)b	50(7.1)c	53.3(7.3)cd
15	46.7(6.9)b	53.3(7.3)bc	60(7.8)bc
20	53.3(7.3)b	60(7.8)b	63.3(8.0)b
Malathion	80(9.0)a	80(9.0)a	80(9.0)a
Control	0(0.7)c	0(0.7)d	0(0.7)e
SE±	0.6	0.7	0.7
C. V.(%)	8.6	5.0	5.4

Means followed by the same letter (s) are not significantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

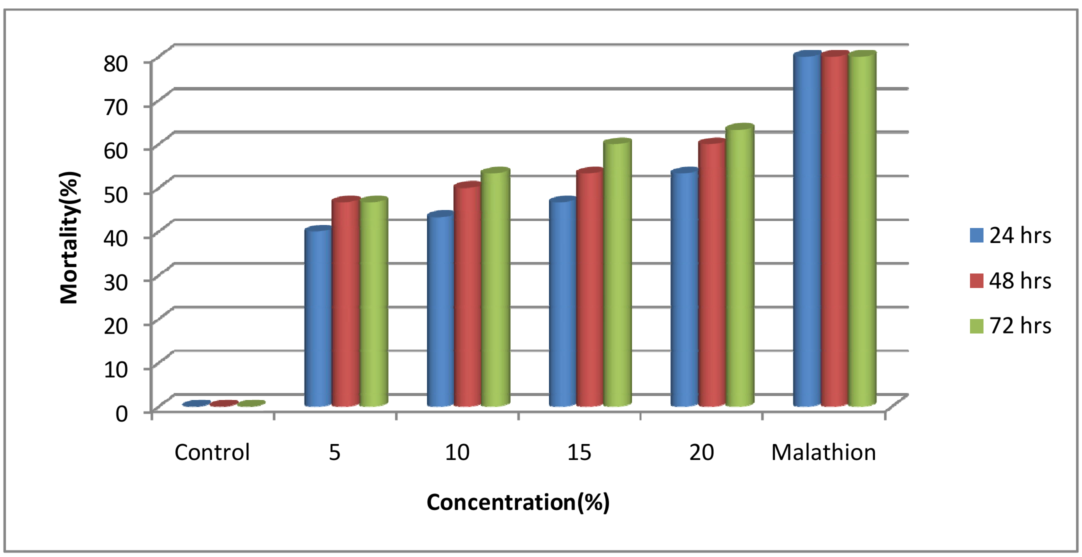

Fig. 4: Theeffect of ethanolic extract of argel Stem on mortality of adults of tomato Leaf miner ***T. absoluta***

.

Table 5: Effect of hexane extract of jatropha seeds on mortality of adults of tomato leaf miner ***Tuta absoluta***.

Concs. (%)	Mortality (%)		
	Exposure time (hrs.)		
	24	48	72
5	50 (7.1)c	50(7.1)d	63.3(8.0)c
10	53.3 (7.3)c	63.38.0)c	70(8.4)bc
15	66.7(8.2)b	66.7(8.2)bc	76.7(8.8)abc
20	86.7(9.3)a	90(9.5)a	90 (9.5)a
Malathion	80(9.0)ab	80(9.0)ab	80(9.0)ab
Control	0(0.7)d	0 (0.7)e	0(0.7)d
SE±	0.7	0.7	0.7
C. V.(%)	7.0	6.5	5.7

Means followed by the same letter (s) are notsignificantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

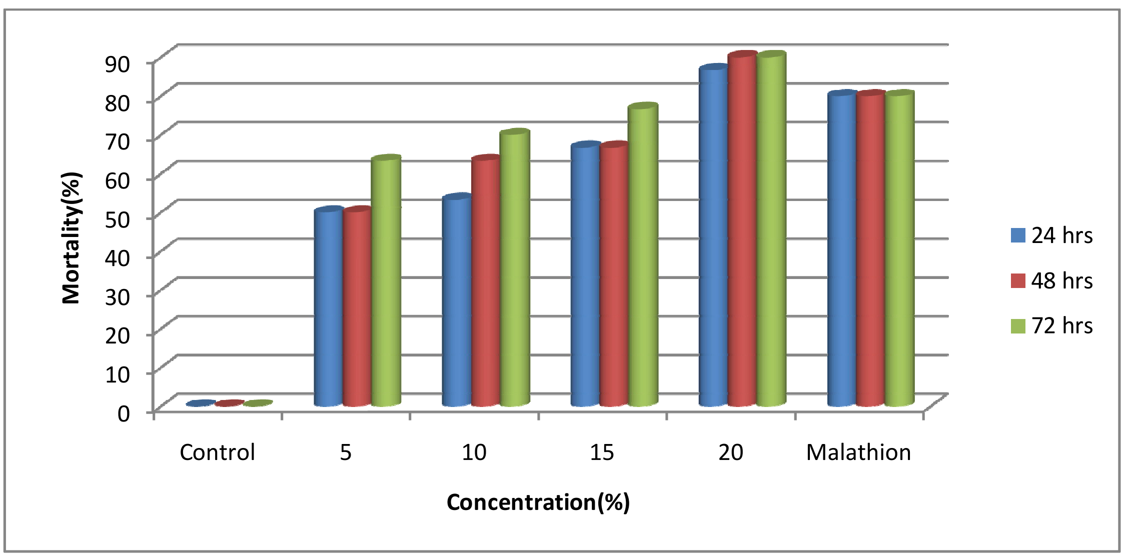

Fig. 5: The effect of hexane extract of jatropha seeds on mortality of adults of tomato Leaf miner ***T. absoluta***.

Table 6: Effect of hexane extract of jatropha leaves on mortality of tomato leaf miner adult ***Tuta absaluta*** .

Concs. (%)	Mortality (%)		
	Exposure time (hrs.)		
	24	48	72
5	43.3(6.3)c	63.3(8.0)b	66.7(8.2)b
10	63.3(8.0)b	63.3(8.0)b	76.7(8.8)a
15	70(8.4)ab	73.3(8.6)ab	80(9.0)a
20	73.3(8.6)ab	76.7(8.8)a	83.3(9.2)a
Malathion	80(9.0)a	80(9.0)a	80(9.0)a
Control	0(0.7)d	0(0.7)c	0(0.7)c
SE+	0.7	0.7	0.7
C. V.(%)	7.6	5.0	4.3

Means followed by the same letter (s) are not significantly different at (P< 0.05).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

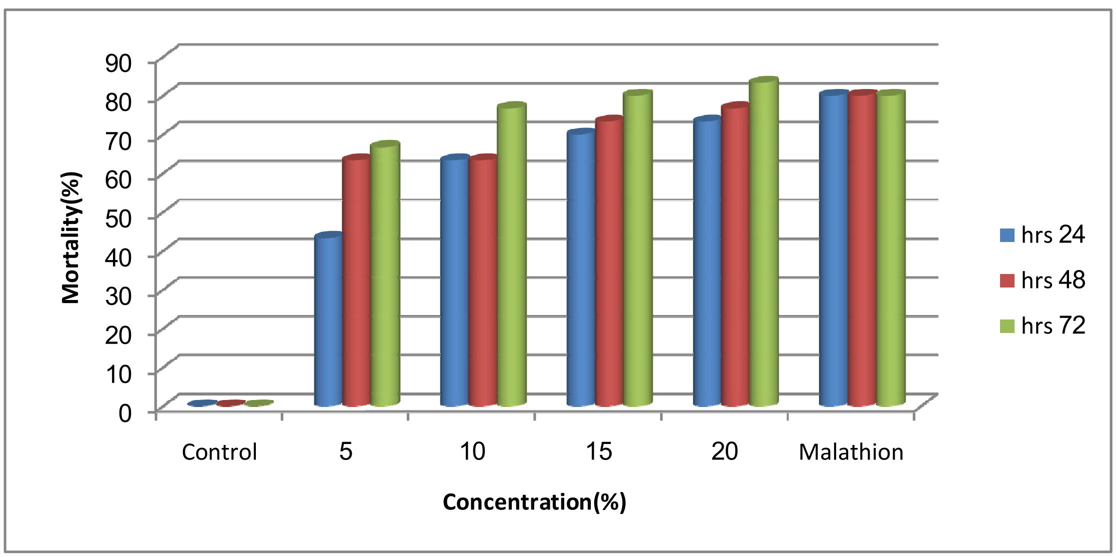

Fig6: The effect of hexane extract of jatropha leaves on mortality of adult stage of tomato Leaf miner ***T. absoluta***.

The mortality percentage results exhibited in Table (7) and figure (7) showed that all concentrations of hexane extract of neem seeds gave higher mortality percentage than that of the control after 24, 48 and 72 hrs of exposure. Additionally, the mortality percentages generated by the two highest concentrations (15% and 20%) were higher than those obtained by malathion after 24, 48 and 72 hrs of exposure which suggest the efficacy of this extract and the possibility that it contains some active ingredients.

As seen in Table (8) and figure (8) all concentrations of the hexane extract of argel stem gave significantly higher mortality percentages than that of the Control after 24, 48 and72hrs of exposure. It is interesting to note that even the highest concentration (20%) generated less than 50% mortality after 24, 48 and 72hrs of exposure.

As seen in Table (9), (10) and (11) the LC50 obtained by the hexane extract of jatropha leaves after 24, 48 and 72 hrs of exposure were consistently lower than their counterparts of the ethanolic extract. The results may suggest that the active ingredient is extracted more easily in hexane than in ethanolic and hence jatropha leaves hexane extract stands a good chance as a source of a potential insecticide. The LC50 of the ethanolic extract of jatropha seeds after 24, 48 and 72 hrs of exposure were 6.406, 2.278 and 2.493 respectively whereas those of hexane extracts of jatropha seeds were 6.219, 5.629 and 3.139 respectively. On the other hand, both hexane and ethanol extracts of neem seeds generated the same LC50 values after 24, 48 and 72 hrs of exposure.

Table 7: Effect of hexane extract of neem seeds on mortality of adults of tomato leaf miner ***Tuta absoluta***.

Concs. (%)	Mortality (%)		
	Exposure time (hrs.)		
	24	48	72
5	36.7(6.0)c	63.3(8.1)b	66.7(8.2)d
10	56.7(7.5)b	83.3(9.2)a	83.3(9.2)bc
15	86.7(9.3)a	90(9.5)a	93.3(9.7)ab
20	90(9.5)a	96.7(9.8)a	96.7(9.8)a
Malathion	80(9.0)a	80(9.0)a	80(9.0)c
Control	0(0.7) d	0(0.7)c	0(0.7)e
SE±	0.8	0.8	0.8
C. V.(%)	7.8	6.0	4.3

Means followed by the same letter (s) are not significantly different at (P< 0.05).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

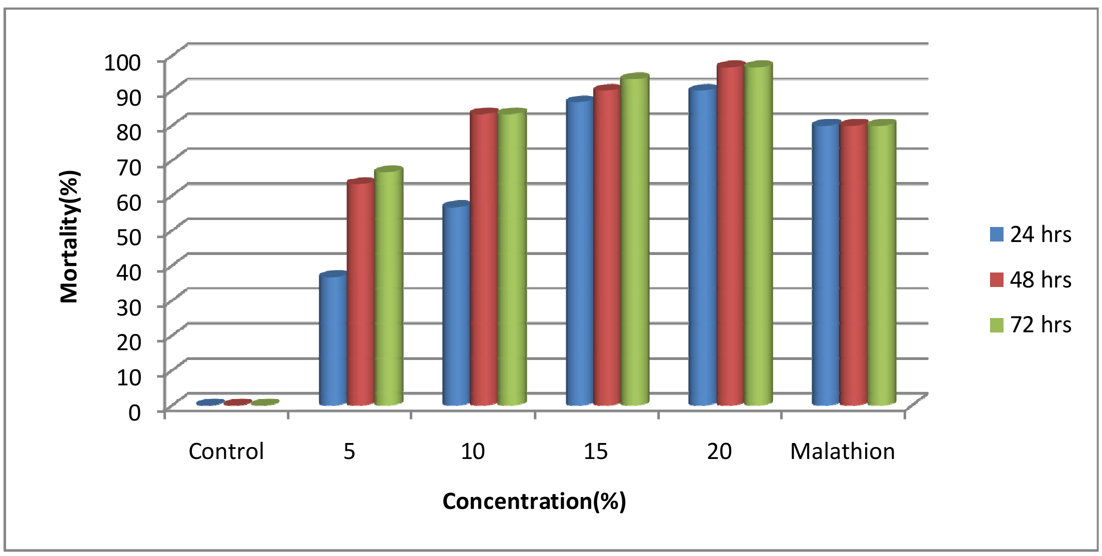

Fig. 7: The effect of hexane extract of neem seed on mortality of adults of tomato Leaf miner ***T. absoluta***.

Table 8: Effect of hexane extract of argel stem on mortality of adults of tomato leaf miner ***Tuta absoluta***.

Concs. (%)	Mortality (%)		
	Exposure time (hrs.)		
	24	48	72
5	30(5.5)c	30(5.5)c	33.3(5.8)d
10	36.7(6.1)bc	36.7(6.1)bc	36.7(6.1)d
15	43.3(6.6)b	43.3b(6.6)b	50(7.1)c
20	46.7(6.9)b	46.7(6.9)b	63.3(8.0)b
Malathion	80(9.0) a	80(9.0) a	80(9.0)a
Control	0(0.7)d	0(0.7) d	0(0.7)e
SE±	0.6	0.6	0.7
C. V.(%)	8.9	8.9	7.9

Means followed by the same letter (s) are not significantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

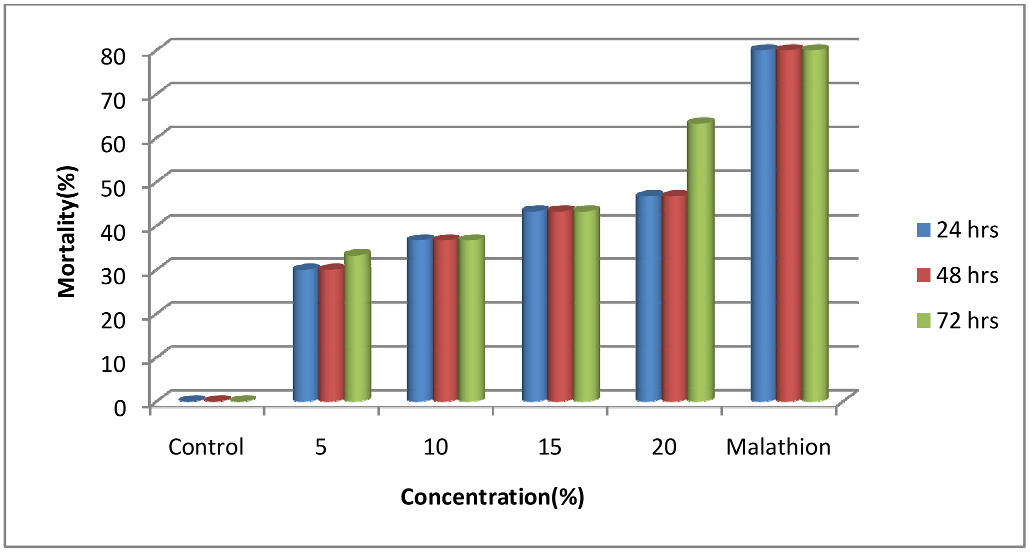

Fig. 8: Theeffect of hexane extract of argel stem on mortality of adults of tomato Leaf miner ***T.absoluta***

Table 9: LC_{50} values of tested botanical extracts used in this study adults of tomato leaf miner ***Tuta absoluta*** after 24 hours.

Botanical extract	Slope	Intercept	Chi-square	LC_{50} (%)
Ethanolic extract				
Jatropha seeds	1.976	3.405	0.532	6.406
Jatropha leaves	1.495	3.213	0.566	15.649
Neem seeds	2.817	2.594	1.808	7.143
Argel stems	0.515	4.356	0.148	17.716
Hexane extract				
Jatropha seeds	1.535	3.780	3.175	6.219
Jatropha leaves	1.339	3.932	0.162	6.266
Neem seeds	2.817	2.594	1.808	7.143
Argel stems	0.746	3.941	0.021	26.191

Table 10: LC_{50} values of tested botanical extracts used in this study adults of tomato leaf miner ***Tuta absoluta*** after 48 hours.

Botanical extract	Slope	Intercept	Chi-square	LC_{50} (%)
Ethanolic extract				
Jatropha seeds	1.136	4.593	0.263	2.278
Jatropha leaves	1.420	3.828	1.174	6.684
Neem seeds	2.230	3.761	0.272	3.592
Argel stems	0.512	4.528	0.155	8.336
Hexane extract				
Jatropha seeds	1.648	3.762	2.969	5.629
Jatropha leaves	0.657	4.819	0.474	1.881
Neem seeds	2.230	3.761	0.633	3.592
Argel stems	0.746	3.941	0.021	26.191

Table 11: LC_{50} values of tested botanical extracts used in this study adult of tomato leaf miner ***Tuta absoluta*** after 72 hours.

Botanical extract	Slope	Intercept	Chi-square	LC_{50} (%)
Ethanolic extract				
Jatropha seeds	1.309	4.480	0.216	2.493
Jatropha leaves	1.383	4.105	1.465	4.435
Neem seeds	2.245	3.825	0.219	3.333
Argel stems	0.714	4.402	0.029	6.860
Hexane extract				
Jatropha seeds	1.284	4.361	1.326	3.139
Jatropha leaves	0.878	4.824	0.015	1.583
Neem seeds	2.245	3.825	0.219	3.333
Argel stems	1.235	3.600	1.144	13.571

The LC 50 values of the ethanolic extract of argel stem after 24, 48 and 72 hrs of exposure were 17.716, 8.336 and 6.860 respectively whereas those of hexane extract were 62.191, 26.191 and 13.571 respectively.

4-2- Fecundity:

As seen in Table (12) and Figure (12) all concentrations of ethanolic extracts of jatropha seeds gave significantly lower fecundity than the of the control on the 4th, 5th, 6th and 7th after exposure. Generally as the concentrations increases the fecundity decreases, but there was no significant differace amog treatments.

The fecundity results exhibited in Table (13) and Figure (13) showed that all tested concentrations of ethanolic extract of jatropha leaves gave significantly lower fecundity than the of the control on the 4th, 5th, 6th and 7th after exposure. Females treated with the two lowest concentrations (5% and 10%) continued to lay eggs till the 6th day whereas those treated with the two highest concentrations (15% and 20%) continued to lay eggs till the 5th day.

Table (14) and Figure (14) shows that on the 4th, 5th, 6th and 7th after exposure all concentrations of ethanolic extracts of neem seeds gave significantly lower fecundity than that of the control. The insects treated with the two lowest concentrations (5% and 10%) continued to lay eggs till the 6th day whereas those treated with the two highest concentrations (15% and 20%) continued to lay eggs till the 5th day.

As seen in Table (15) and Figure (15) all concentrations of ethanolic extracts of argel stem gave significantly lower fecundity than that of the control on the 5th, 6th and 7th after exposure. It is also noticeble as the concentrations increases the fecundity decreases.

Table 12: Effect of ethanolic extract of jatropha seeds on fecundity of adults of tomato leaf miner ***Tuta absoluta***.

Concs. (%)	Fecundity (No. of eggs)			
	Exposure time (days.)			
	4th	5th	6th	7th
5	1.7b	0.7b	0.3b	0.0b
10	0.7b	0.3b	0.0b	0.0b
15	0.3b	0.3b	0.0b	0.0b
20	0.0b	0.0b	0.0b	0.0b
Malathion	0.0b	0.0b	0.0b	0.0b
Control	25.0a	22.0a	22.0a	21.7a
ES±	0.6	0.4	0.4	0.3
C. V. (%)	23.4	20.0	20.0	17.3

Means followed by the same letter (s) are notsignificantlydifferent at ($P < 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

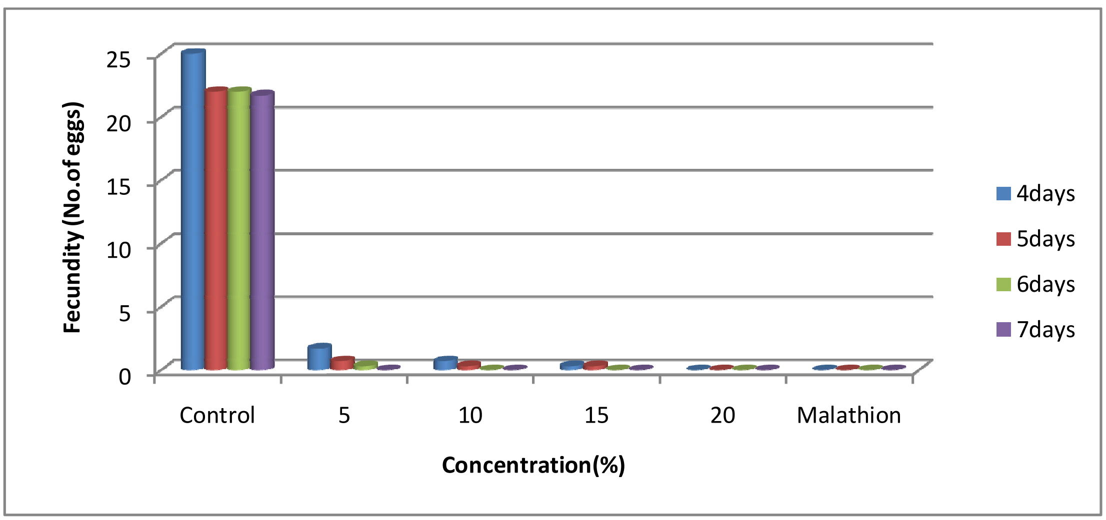

Fig. 12: The effect of ethanolic extract of jatropha seeds on fecundity of adults of tomato leaf miner ***T. absoluta*.**

Table 13: Effect ofethanolic extract of jatropha leaves on fecundityof adults of tomato leaf miner ***Tuta.absoluta*.**

Concs. (%)	Fecundity (No. of eggs)			
	Exposure time (days)			
	4^{th}	5^{th}	6^{th}	7^{th}
5	1.7b	1.0b	0.7b	0.0b
10	1.0b	0.7b	0.3b	0.0b
15	0.3b	0.3b	0.0b	0.0b
20	0.3b	0.3b	0.0b	0.0b
Malathion	0.0b	0.0b	0.0b	0.0b
Control	25.0a	22.0a	22.0a	21.7a
ES±	0.5	0.5	0.5	0.4
C. V. (%)	21.2	22.5	23.0	17.3

Means followed by the same letter (s) are notsignificantly different at (P< 0.05).

Means between brackets are transformed according to$\sqrt{X + 0.5}$.

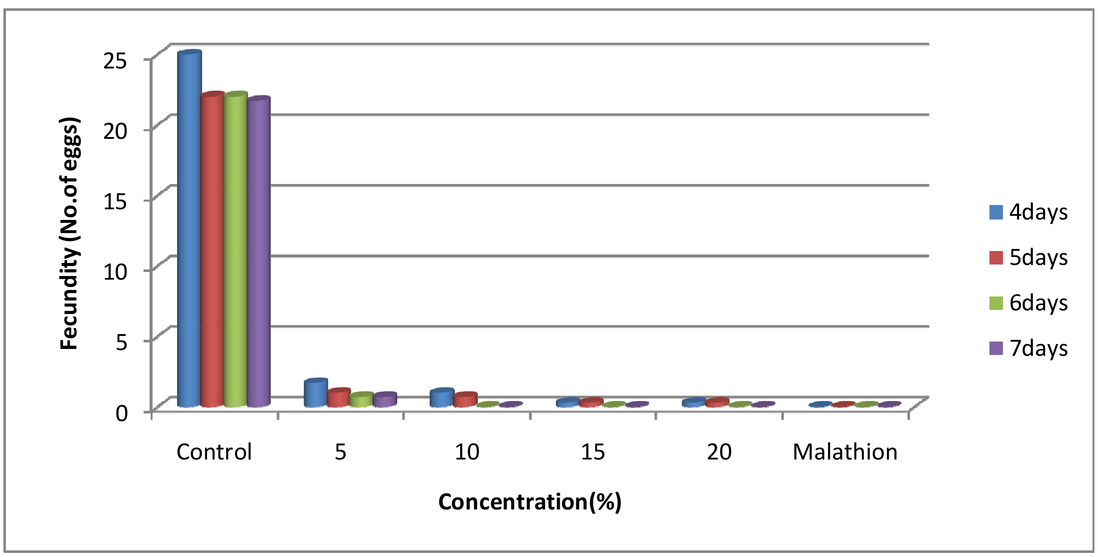

Fig. 13: The effect of ethanolic extract of jatropha leaves on fecundity of adults of tomato leaf miner ***T. absoluta*.**

Table 14: Effect of ethanolic extract of neem seeds on fecundity of adults of tomato leaf miner ***Tuta absoluta* .**

Concs. (%)	Fecundity (No. of eggs)			
	Exposure time (days)			
	4^{th}	5^{th}	6^{th}	7^{th}
5	1.3b	1.0b	0.7b	0.0b
10	0.3b	0.7b	0.3b	0.0b
15	0.0b	0.3b	0.0b	0.0b
20	0.0b	0.3b	0.0b	0.0b
Malathion	0.0b	0.0b	0.0b	0.0b
Control	25.0a	22.0a	22.0a	21.7a
SE±	0.5	0.5	0.5	0.4
C. V. (%)	22.5	22.0	20.4	17.3

Means followed by the same letter (s) are notsignificantly different at (P< 0.05).

Means between brackets are transformed according to$\sqrt{X + 0.5}$.

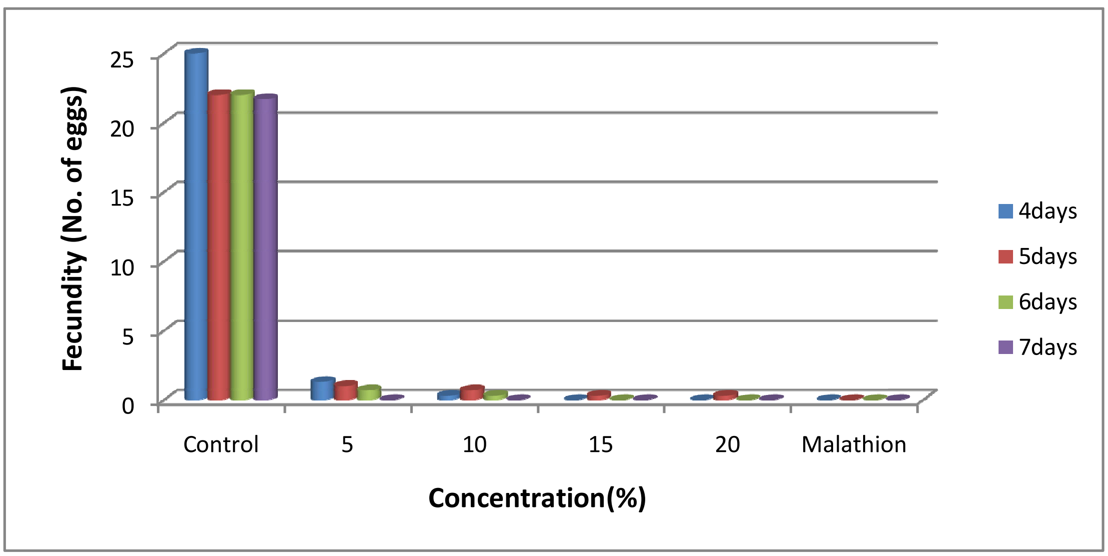

Fig. 14: The effect of ethanolic extract of neem seeds on fecundity of adults of tomato Leaf miner ***T. absoluta***.

Table 15: Effect of ethanolic extract of argel stems on fecundityof adults of tomato leaf miner ***Tuta absoluta.***

Concs. (%)	Fecundity (No. of eggs)				
	Exposure time (days.)				
	4^{th}	5^{th}	6^{th}	7^{th}	8^{th}
5	2.0b	1.0b	0.7b	0.7b	0.0b
10	1.3bc	1.0b	0.7b	0.3b	0.0b
15	1.0bc	0.7b	0.3b	0.3b	0.0b
20	1.0bc	0.3b	0.3b	0.3b	0.0b
Malathion	0.0c	0.0b	0.0b	0.0b	0.0b
Control	25.0a	22.0a	22.0a	21.7a	20.0a
ES±	0.6	0.6	0.5	0.5	0.2
C. V. (%)	20.3	23.3	21.3	20.0	12.3

Means followed by the same letter (s) are notsignificantly different at (P< 0.05).

Means between brackets are transformed according to $\sqrt{X + 0.5}$.

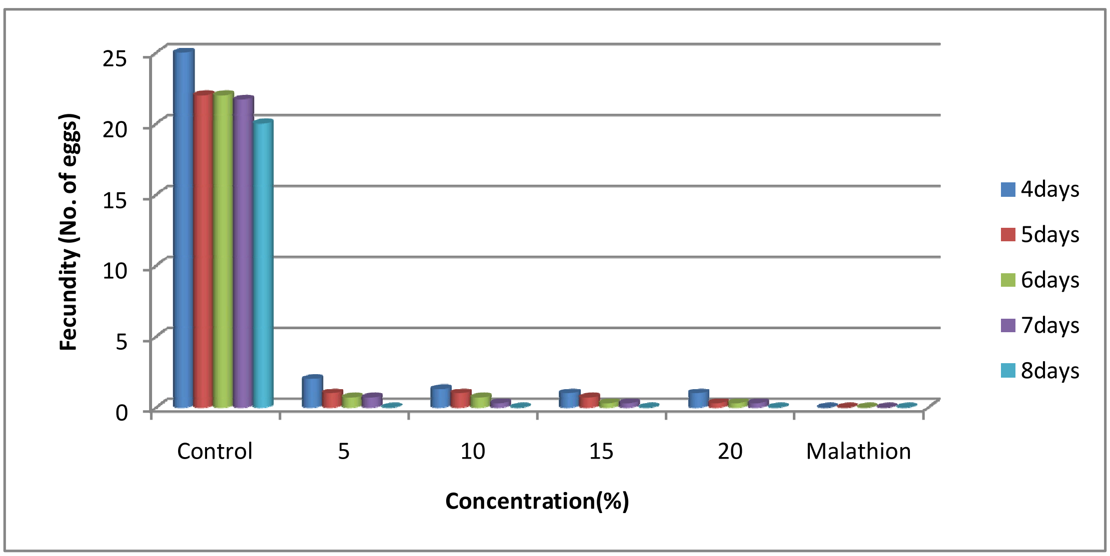

Fig. 15: Theeffect of ethanolic extract of argel Stem on fecundity of adults of tomato Leaf miner ***T. absoluta.***

As seen in Table (16) and Figure (16) all concentrations of hexane extracts of jatropha seeds gave significantly lower fecundity than that of the control on the 4th , 5th days, 6th ,7th and 8th after exposure and there was no significant difference among all treatments. Generally the fecundity decreases as the concentration increases.

The fecundity results exhibited in Table (17) and Figure (17) showed that all tested concentrations of hexane extract of jatropha leaves gave significantly lower fecundity than the of the control on the 4th, 5th, 6th and 7th after exposure. Females treated with 15% and 20% concentration did not lay eggs at all.

As seen in Table (18) and Figure (18) all concentrations of hexane extracts of neem seeds gave significantly lower fecundity than the of the control on the 4th, 5th, 6th and 7th after exposure indicating the great impact of the tested extracts on fecundity. In fact insects exposed to the two highest concentrations laid no eggs at all.

As seen in Table (19), and Figure (19) all concentrations of hexane extracts of neem seeds gave significantly lower fecundity than that of the control on the 6th, 7th and 8th day after a.Also as the concentrations decreases the fecundity increases.

Table 16: Effect of hexane extract of jatropha seeds on fecundity of adults of tomato leaf Mainer ***Tuta.absoluta***.

Concs. (%)	Fecundity (No. of eggs)				
	Exposure time (days.)				
	4th	5th	6th	7th	8th
5	1.3b	0.7b	0.7b	0.3b	0.0b
10	0.3b	0.7b	0.7b	0.3b	0.0b
15	0.7b	0.3b	0.0b	0.0b	0.0b
20	0.3b	0.0b	0.0b	0.0b	0.0b
Malathion	0.0b	0.0b	0.0b	0.0	0.0b
Control	25.0a	22.0a	22.0a	21.7a	20.0a
ES±	0.6	0.6	0.6	0.4	0.2
C. V.(%)	21.5	25.4	25.0	19.0	12.3

Means followed by the same letter (s) are notsignificantly different at ($P< 0.05$).

Means between brackets are transformed according to$\sqrt{X + 0.5}$.

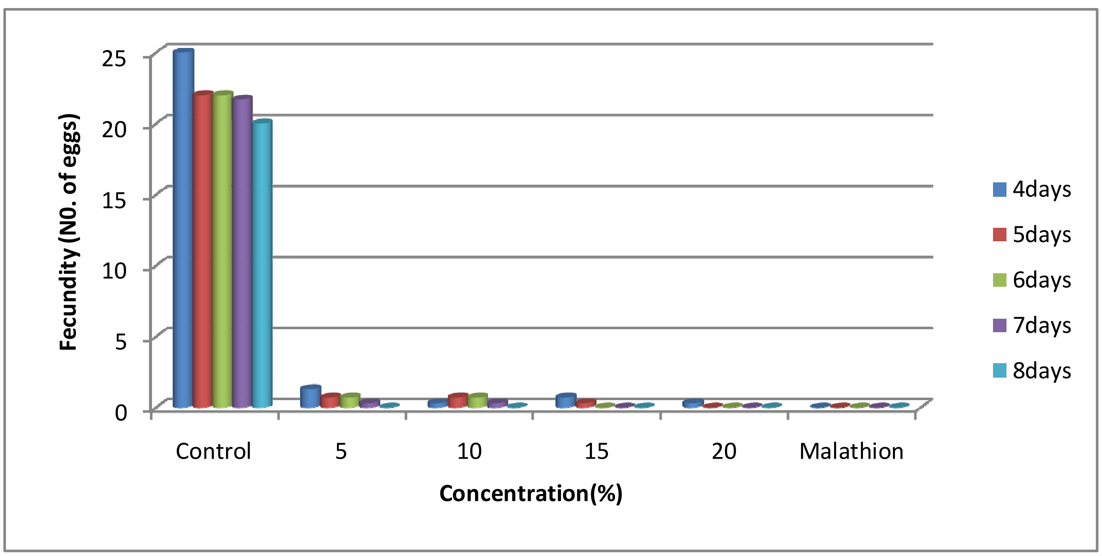

Fig. 16: The effect of hexane extract of jatropha seeds on fecundity of adult of tomato Leaf miner ***T. absoluta***.

Table 17: Effect of hexane extract of jatropha leaves on fecundity of adults of tomato leaf Mainer ***Tuta absoluta***.

Concs. (%)	Fecundity (No. of eggs)				
	Exposure time (days.)				
	4th	5th	6th	7th	8th
5	0.3b	0.3b	0.3b	0.3b	0.0b
10	0.3b	0.3b	0.0b	0.0b	0.0b
15	0.0b	0.0b	0.0b	0.0b	0.0b
20	0.0b	0.0b	0.0b	0.0b	0.0b
Malathion	0.0b	0.0b	0.0b	0.0	0.0b
Control	25.0a	22.0a	22.0a	21.7a	20.0
ES±	0.5	0.5	0.4	0.4	0.2
C. V. (%)	20.4	22.0	20.0	18.2	12.3

Means followed by the same letter (s) are notsignificantly different at (P< 0.05).

Means between brackets are transformed according to$\sqrt{X+0.5}$.

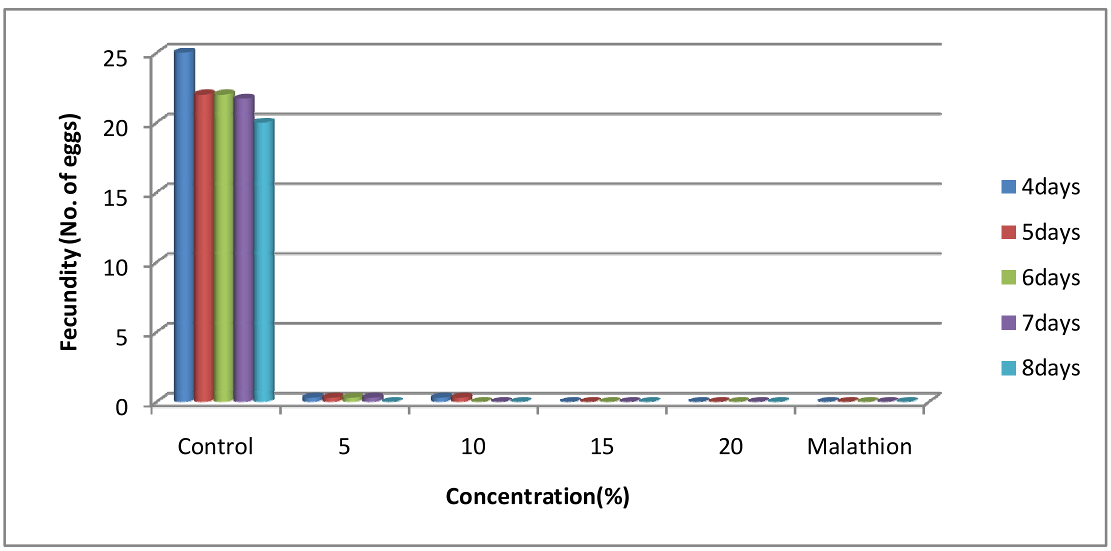

Fig17: The effect of hexane extract of jatropha leaves on mortality of adults of tomato Leaf miner ***T. absoluta***.

Table 18: Effect of hexane extract of neem seeds on fecundityof adults of tomato leaf miner ***Tuta absoluta*.**

Concs. (%)	Fecundity (No. of eggs)			
	Exposure time (days.)			
	4th	5th	6th	7th
5	1.3b	0.7b	0.3b	0.0b
10	0.7b	0.0b	0.0b	0.0b
15	0.0b	0.0b	0.0b	0.0b
20	0.0b	0.0b	0.0b	0.0b
Malathion	0.0b	0.0b	0.0b	0.0b
Control	25.0a	22.0a	22.0a	21.7a
ES±	0.5	0.4	0.4	0.4
C. V. (%)	19.6	19.7	20.0	21.7

Means followed by the same letter (s) are not significantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$.

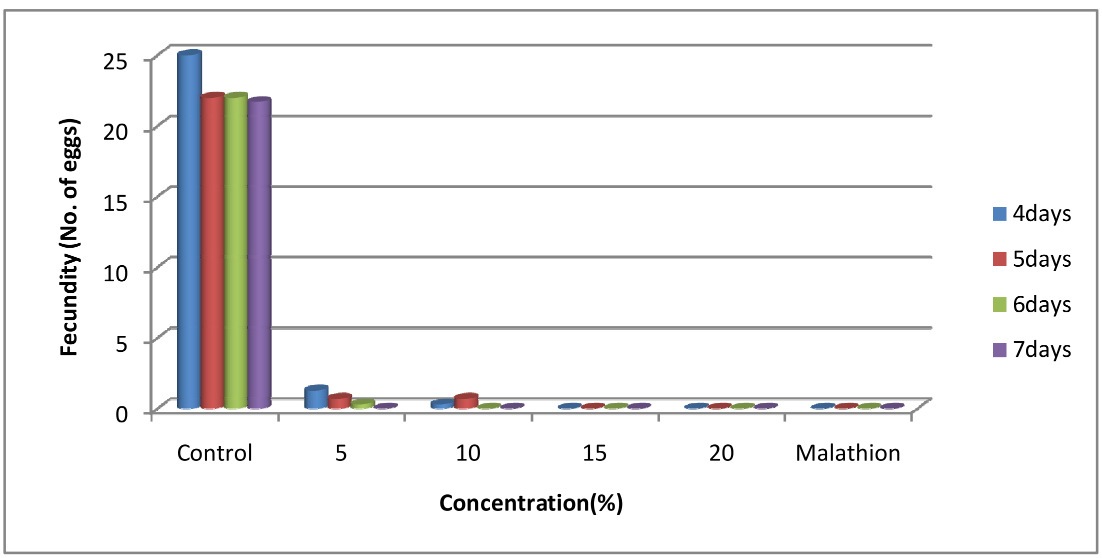

Fig. 18: The effect of hexane extract of neem seed on mortality of adults of tomato Leaf miner ***T. absoluta***.

Table 19: Effect of hexane extract of argel stems on fecundityof adults of tomato leaf miner ***Tuta absoluta*.**

Concs. (%)	Fecundity (No. of eggs)				
	Exposure time (days.)				
	4^{th}	5^{th}	6^{th}	7^{th}	8^{th}
5	1.7b	1.7b	1.0b	0.7b	0.0b
10	1.3bc	1.3bc	0.7b	0.7b	0.0b
15	1.0bc	0.7bc	0.7b	0.3b	0.0b
20	0.7bc	0.3bc	0.3b	0.0b	0.0b
Malathion	0.0c	0.0c	0.0b	0.0b	0.0b
Control	25.0a	22.0a	22.0a	21.7a	20.0a
ES±	0.5	0.5	0.5	0.4	0.2
C. V. (%)	18.5	19.6	22.0	19.2	12.3

Means followed by the same letter (s) are notsignificantly different at (P< 0.05).

Means between brackets are transformed according to$\sqrt{X + 0.5}$.

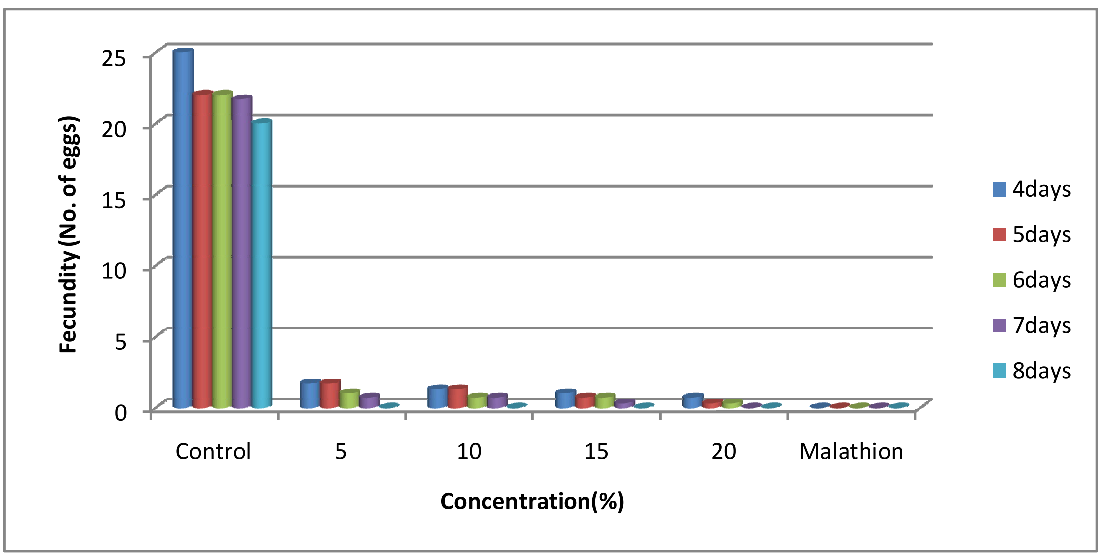

Fig. 19: Theeffect of hexane extract of argel stem on mortality of adults of tomato Leaf miner ***T. absoluta***.

4-3- Longevity:

As see in Table (20) and Figure (20) all concentrations of ethanolic extract of jatropha seeds gave significantly lower longevity percentage than that of the control on the 4th , 5th , 6th ,7th and 8th day after exposure. Moreover the highest concentration (20%) gave significantly lower longevity percentage than that of malathion on the 4th and 5th day after exposure and all treated insects of both treatments were dead by the 6th day .Generally as the concentration increases the longevity percentage decreases.

The longevity results exhibited in Table (21) and Figure (21) showed that all tested concentrations of ethanolic extract of jatropha leaves gave significantly lower longevity percentage than that of the control throughout the days of experiment. All treated insect were dead by the 5th day for malathain, by the 6th day for the 20% concentration, by the 7th day for the 15% concentration and by the 8th day for both the 10% and 5% concentration.

As seen in Table (22), and Figure (22) all concentrations of the neem seeds ethanolic extract gave significantly lower longevity percentage than that of the control throughout the experimental period. Addionally, all the increments in the concentration of extracts resulted in a lower longevityPercentage on the 4th day whereas all insects treated with the 20% concentration died by the 6th day. all insects treated with 5% and10% died by the 7th day. All insect treates with 20% concentration died by the 8th day whereas all other treated insects died by .The longevity caused by the two highest concentrations used in this study (15% and 20%) were not significantly different than the longevity caused by recommended dose of –

Table 20: Effect of ethanoicl extract of jatropha seeds on longevity of adults of tomato leaf miner *Tuta absoluta.*

Cocs.	Longevity (%) (Averge No of insect alive) (days.)				
	4^{th}	5^{th}	6^{th}	7^{th}	8^{th}
5	33.3(5.8)b	26.7(5.2)b	20.0(4.5)b	10.0(2.8)b	0(0.7)b
10	23.3(4.8)bc	20.0(4.5)b	13.3(3.6)c	3.3(1.5)bc	0(0.7)b
15	20.0(4.5)c	20.0(4.5)b	10.0(3.2)c	0(0.7)c	0(0.7)b
20	10.0(3.2)d	6.7(2.4)c	0(0.7)d	0(0.7)c	0(0.7)b
Malathion	20.0(4.4)c	0.7(0.7)d	0(0.7)d	0(0.7)c	0(0.7)b
Control	100(10.0)a	100(10.0)a	100(10)a	93.3(9.7)a	93.3(7.9)a
SE±	10.4	14.0	8.1	36.9	5.4
C. V.(%)	0.3	0.3	0.2	0.6	0.1

Means followed by the same letter (s) are not significantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

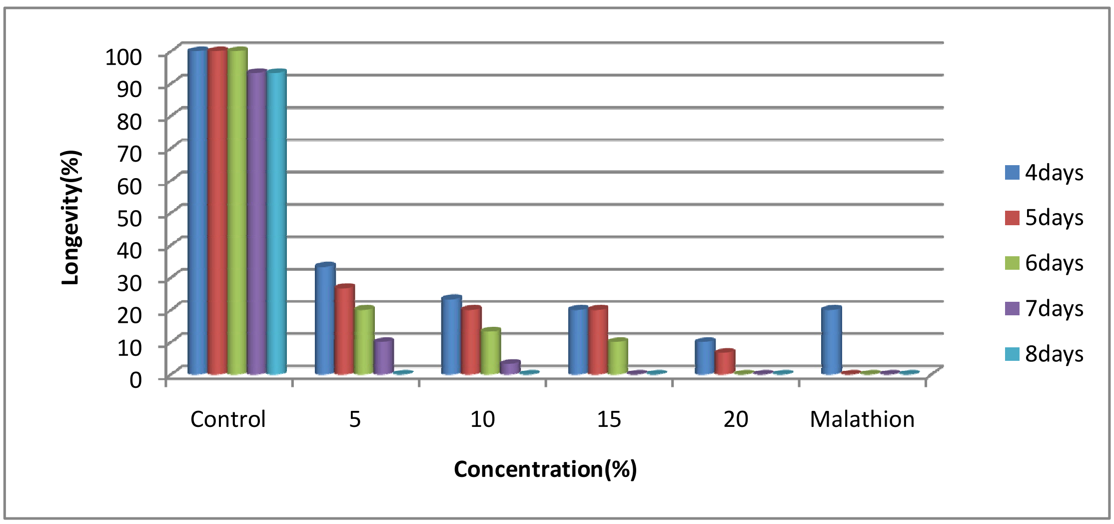

Fig20: The effect of ethanolic extract of jatropha seeds on longevity of adults of tomato leaf miner ***T. absoluta.***

Table 21: Effect of ethanoicl extract of jatropha leaves on longevity of adults of tomato leaf miner ***Tuta absoluta.***

Cocs.(%)	Longevity (%)(Averge No of insect alive) (days.)				
	4th	5th	6th	7th	8th
5	43.3(6.6)b	33.3(5.8)b	26.7(5.2)b	26.7(4.8)b	0(0.7)b
10	40.0(6.4)b	33.3(5.8)b	23.3(4.8)b	16.7(4.0)b	0(0.7)b
15	20.0(4.5)c	13.3(3.6)c	6.7(2.4)c	6.7(2.4)c	0(0.7)b
20	16.7(4.4)c	13.3(2.3)c	3.3(1.5)cd	0(0.7)d	0(0.7)b
Malathion	20(4.4)c	0(0.7)d	0(0.7)d	0(0.7)d	0(0.7)b
Control	100(10.0)a	100(10)a	100(10)a	93.3(9.7)a	93.3(9.7)a
SE±	9.8	16.6	21.9	19.2	5.4
C. V.(%)	0.3	0.5	0.5	0.4	0.1

Means followed by the same letter (s) are notsignificantly different at ($P < 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

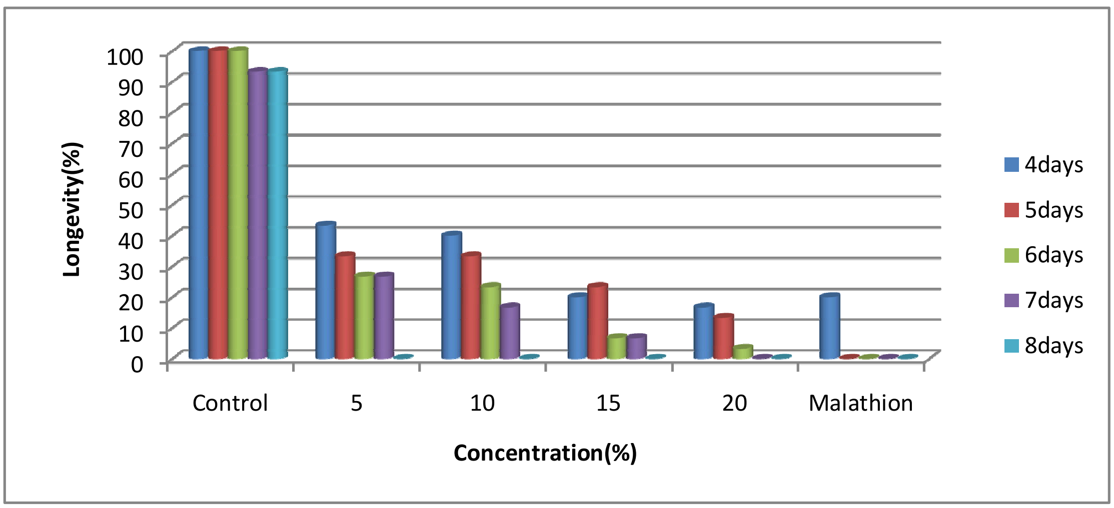

Fig. 21: The effect of jatropha leaves ethanolic extract on longevity in adults of tomato Leaf miner ***T. absoluta.***

Table 22: Effect of ethanolic extract of neem seeds on longevity of adults of tomato leaf miner ***Tuta absoluta.***

Concs.(%)	Longevity (%)(Averge No of insect alive) (days.)			
	4th	5th	6th	7th
5	33.3(5.8)b	30.0(5.5)b	23.3(4.8)b	0(0.7)b
10	16.7(4.0)bc	16.7(4.1)b	6.7(2.4)c	0(0.7)b
15	6.7(2.3)cd	3.3(1.5)c	0(0.7)d	0(0.7)b
20	3.3(1.5)d	3.3(1.5)c	0(0.7)d	0(0.7)b
Malathion	20.0(4.4)b	0(0.7)c	0(0.7)d	0(0.7)b
Control	100(10)a	100(10)a	100(10)a	93.3(9.7)a
SE±	22.0	22.8	19.7	5.4
C. V. (%)	0.6	0.5	0.4	0.1

Means followed by the same letter (s) are not significantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

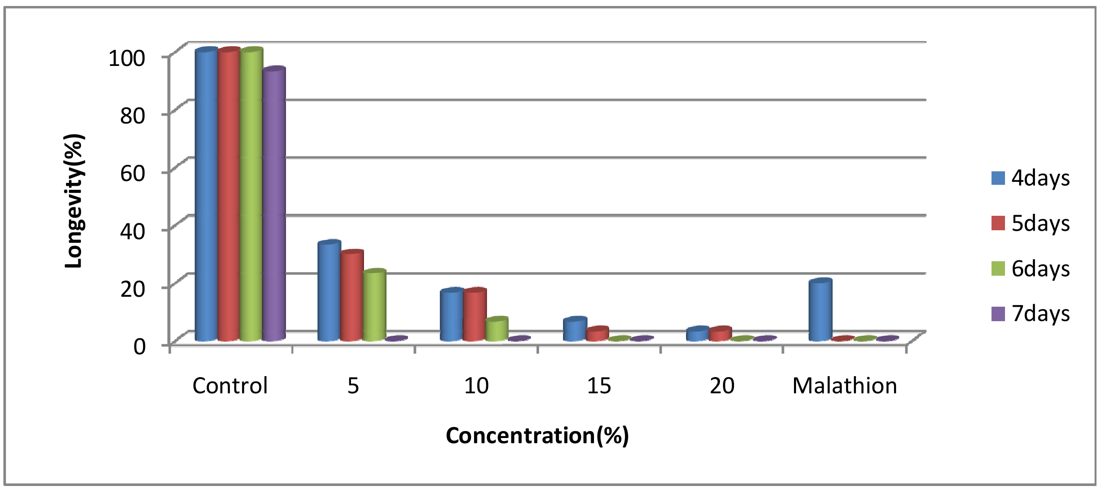

Fig. 22: The effect of ethanolic extract of neem seeds on longevity of adults of tomato Leaf miner ***T. absoluta***.

Malathion after 5, 6, and 7days of exposure. It shoud be noted that 93.7% of insectswere still alive in the control by the 7th day.

As seen in Table (23) and Figure (23), all concentrations of ethanolic extracts of argel stem gave significantly higher longevity percentage than the control throughout the experimental period. The results also show that there was no significant difference in longevity among the different concentrations after 4 days of exposure. All insects treated with 20% died by the 8th day whereas all other treated insects died by the 10th day.

As see in Table (24) and Figure (24) all concentrations of hexane extracts of jatropha seeds gave significantly lower longevity percentage than the control throughout the experimental period. Moreover, on the 4th day, the highest concentration (20%) gave lower longevity percentage than malathion. All insects treated with 20% concentration died by the 7th day whereas thoseTreated with malathion died by the 5th day.Generally as the concentrations increases the longevity percentage decreases.

The longevity results exhibited in Table (25) and Figure (25) showed that all tested concentrations of hexane extract of jatropha leaves gave significantly lower longevity percentage than the control throughout the experiment .The results also show that there was no significant difference in longevity percentage between the 20% concentration and malathion throughout the experimental period. Similarly and as of the 4th day there was no significant difference in longevity percentage among the 5%, 10% and 15% concentrations throughout the experimental period.

Table 23: Effect of ethanolic extract of argel stems longevity of adults of tomato leaf miner ***Tuta absoluta.***

Concs(%)	Longevity (%)(Averge No of insect alive) (days.)						
	4th	5th	6th	7th	8th	9th	10th
5	53.3(7.3)b	40.0(6.4)b	36.7(6.2)b	30.0(5.5)b	20.0(4.5)b	10.0(2.8)b	0(0.7)b
10	46.7(6.9)b	36.7(6.2)b	33.3(5.8)bc	26.7(5.2)b	20.0(4.5)b	6.7(2.0)b	0(0.7)b
15	46.7(6.9)b	33.3(5.8)bc	26.7(5.2)cd	23.3(4.8)bc	13.3(3.2)b	6.7(2.0)bb	0(0.7)b
20	43.3(6.7)b	26.7(5.2)c	23.3(4.8)d	16.7(4.1)c	0(0.7)c	0(0.7)b	0(0.7)b
Malathion	20.0(4.4)c	0(0.7)d	0(0.7)e	0(0.7)d	0(0.7)c	0(0.7)b	0(0.7)b
Control	100(10)a	100(10)a	100(10)a	93.3(9.7)a	93.3(9.7)a	86.7(9.3)a	76.7(8.8)a
SE±	7.9	9.2	8.6	9.3	51.4	51.4	6.9
C. V. (%)	0.3	0.3	0.3	0.3	0.5	0.9	0.1

Means followed by the same letter (s) are notsignificantly different at (P< 0.05).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

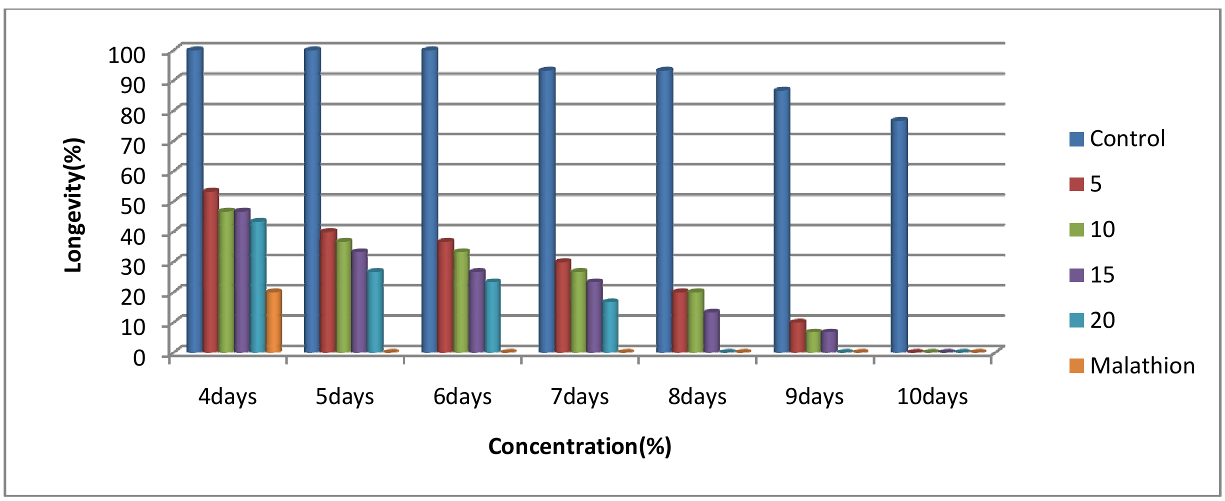

Fig. 23: Theeffect of ethanolic extract of argel Stem on longevity of adults of tomato Leaf miner ***T. absoluta.***

Table 24: Effect of hexane extract of jatropha seeds on longevity of adults of tomato leaf miner ***Tuta absoluta.***

Cocs.	Longevity (%)(Averge No of insect alive) (days.)				
	4th	5th	6th	7th	8th
5	43.3(6.6)b	23.3(4.8)b	16.7(4.1)b	6.7(2.3)b	0(0.7)b
10	23.3(4.8)c	16.7(4.1)b	13.3(3.6)bc	3.3(1.5)b	0(0.7)b
15	20.0(4.5)c	13.3(3.6)b	10(3.2)bc	3.3(1.5)b	0(0.7)b
20	16.7(4.4)c	10.0(2.4)c	6.7(2.4)c	0(0.7b	0(0.7)b
Malathion	20.0(4.1)c	0(0.7)d	0(0.7)(0.7)d	0(0.7)b	0(0.7)b
Control	100(10)a	100(10)a	100(10)a	93.3(9.7)a	93.3(9.7)a
SE±	11.0	18.0	18.3	37.4	5.4
C. V.(%)	0.4	0.4	0.4	0.5	0.1

Means followed by the same letter (s) are notsignificantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

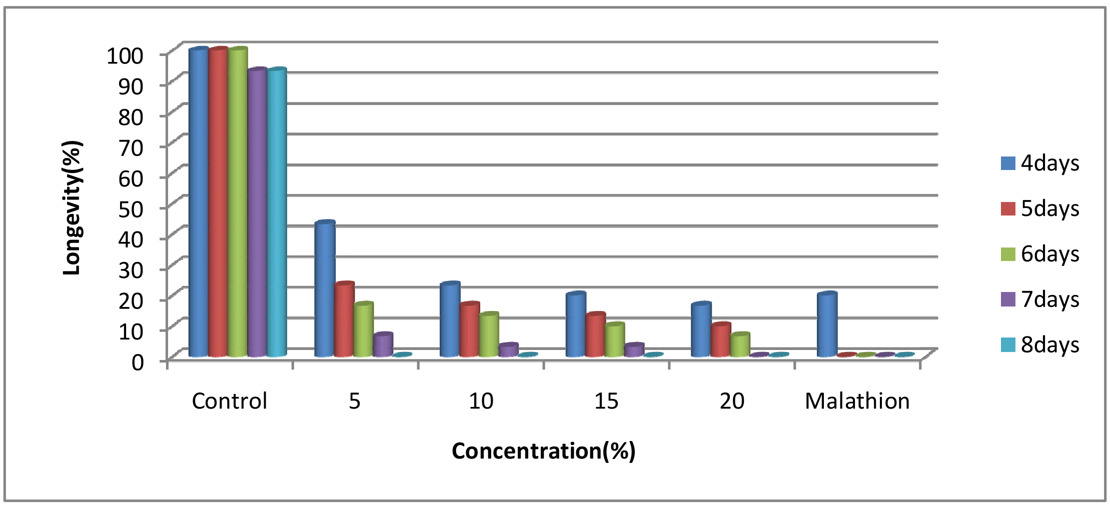

Fig. 24: The effect of hexane extract of jatropha seeds on longevity of adults of tomato Leaf miner ***T. absoluta***.

Table 25: Effect of hexane extract of jatropha leaves on longevity of adults of tomato leaf miner ***Tuta absoluta.***

Cocs.(%)	Longevity (%)(Averge No of insect alive) (days.)				
	4th	5th	6th	7th	8th
5	33.3(5.8)b	23.3(4.8)b	16.7(4.0)b	6.7(2.4)b	0(0.7)b
10	23.3(4.8)bc	16.7(4.1)b	13.3(3.6)b	3.3(1.5)b	0(0.7)b
15	20.0(4.5)c	13.3(3.2)b	10.0(3.2)b	3.3(1.5)b	0(0.7)b
20	16.7(4.4)c	10.0(2.8)bc	3.3(1.5)c	0(0.7)b	0(0.7)b
Malathion	20.0(4.1)c	0(0.7)c	0(0.7)c	0(0.7)b	0(0.7)b
Control	100(10)a	100(10)a	100(10)a	93.3(9.7)a	93.3(9.7)a
SE±	11.6	29.4	22.3	37.4	5.4
C. V.(%)	0.4	0.7	0.5	0.6	0.1

Means followed by the same letter (s) are notsignificantly different at ($P< 0.05$).

Means between brackets are transformed according to $\sqrt{X + 0.5}$

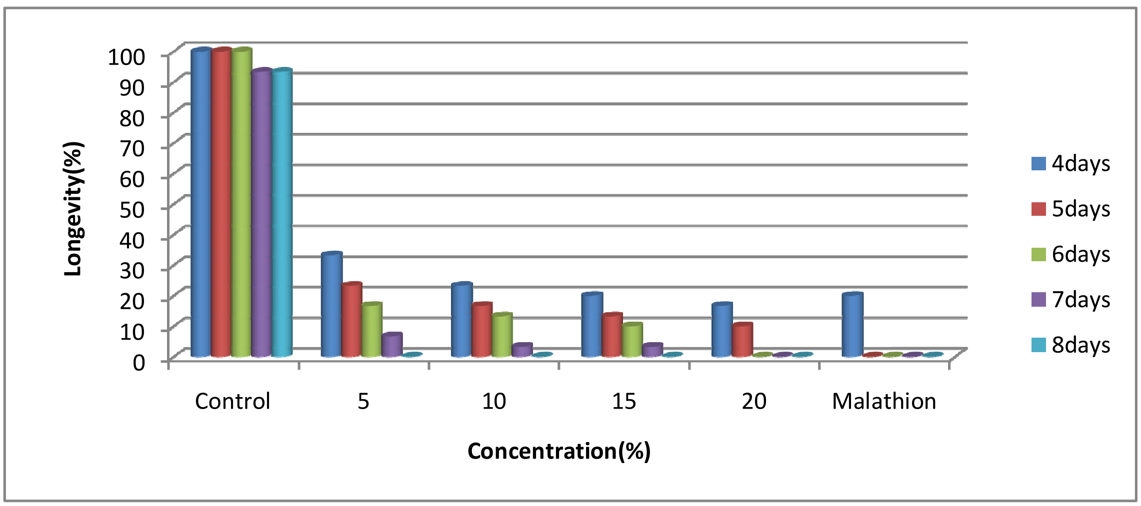

Fig25: The effect of hexane extract of jatropha leaves on longevity of adults of tomato Leaf miner ***T. absoluta***.

As seen in Table (26) and Figure (26) all concentrations of the neem seeds hexane extract gave significantly lower longevity percentage than the control throughout the experimental period. Addionally, all the increments in the concentration of extracts resulted in a lower longevity percentage. All insects treated with 15%, 20% and malathion died on the 5th dayof e.xposure.

As seen in Table (27) and Figure (27), all concentrations of hexane extracts of argel stem gave significantly lower longevity percentage than the control throughout the experimental period. The results show that there was noDifference in longevity among insects treated with 15% and 20% concentrations throughout the experiment except on the 5th day.

Table 26: Effect of hexane extract of neem seeds on longevity of adults of tomato leaf miner ***Tuta absoluta.***

Concs.(%)	Longevity (%)(Averge No of insect alive) (days.)			
	4th	5th	6th	7th
5	33.3(5.8)b	23.3(4.8)b	16.7(4.1)b	0(0.7)b
10	16.7(4.2)bc	6.7(2.4)c	3.3(1.5)c	0(0.7)b
15	6.7(2.0)cd	0(0.7)d	0(0.7)c	0(0.7)b
20	3.3(1.5)d	0(0.7)d	0(0.7)c	0(0.7)b
Malathion	20.0(4.4)b	0(0.7)d	0(0.7)c	0(0.7)b
Control	100(10)a	100(10)a	100(10)a	93.3(9.7)a
SE±	26.6	19.7	22.5	5.4
C. V.(%)	0.7	0.4	0.4	0.1

Means followed by the same letter (s) are notsignificantly different at ($P< 0.05$).

Means between brackets are transformed according to$\sqrt{X + 0.5}$.

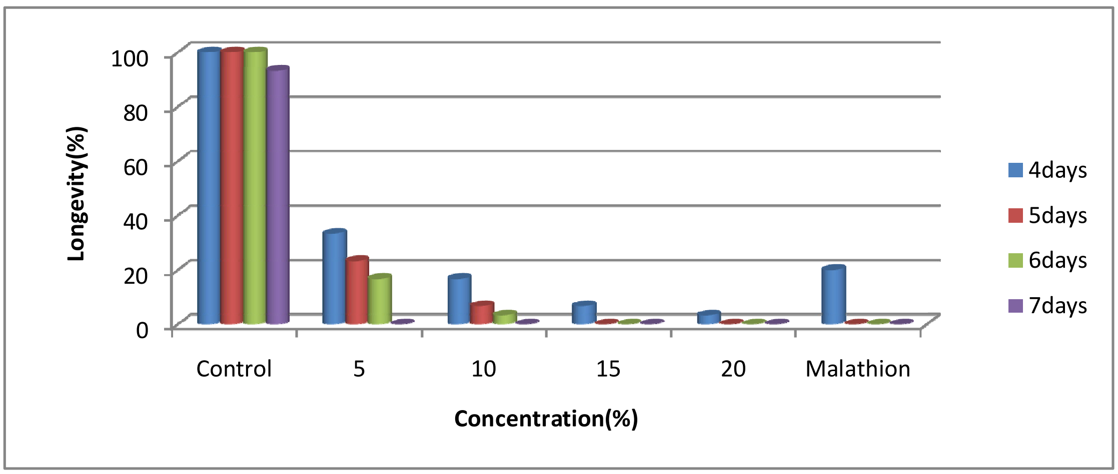

Fig. 26: The effect of hexane extract of neem seed on longevityof adults of tomato Leaf miner ***T. absoluta***.

Table 27: Effect of hexane extract of argel stems on longevity of adults of tomato leaf miner ***Tuta absoluta.***

Concs(%)	Longevity(%)(Averge No of insect alive) (days.)						
	4th	5th	6th	7th	8th	9th	10th
5	66.7(8.2)b	66.7(8.0)b	43.3(6.6)b	43.3(6.7)b	36.7(6.2)b	20.0(4.5)b	0(0.7)b
10	63.3(8.0)bc	66.7(8.0)b	43.3(6.6)b	36.7(6.2)b	26.7(5.2)b	13.3(3.2)b	0(0.7)b
15	50.0(7.1)cd	36.7(6.2)c	26.7(5.2)c	16.7(4.1)c	10.0(2.8)c	0(0.7)c	0(0.7)b
20	36.7(6.2)d	23.3(5.2)d	23.3(4.8)c	16.7(4.1)c	10.0(2.8)c	0(0.7)c	0(0.7)b
Malathion	20.0(4.4)e	0(0.7)e	0(0.7)d	0(0.7)d	0(0.7)d	0(0.7)c	0(0.7)b
Control	100(10)a	100(10)a	100(10)a	93.3(9.7)a	93.3(9.7)a	86.7(9.3)a	76.7(8.8a
SE±	7.7	6.1	11.2	10.1	25.7	28.3	6.9
C. V.(%)	0.3	0.2	0.4	0.3	0.7	0.5	0.1

Means followed by the same letter (s) are not significantly different at ($P< 0.05$).Means between brackets are transformed according to $\sqrt{X + 0.5}$

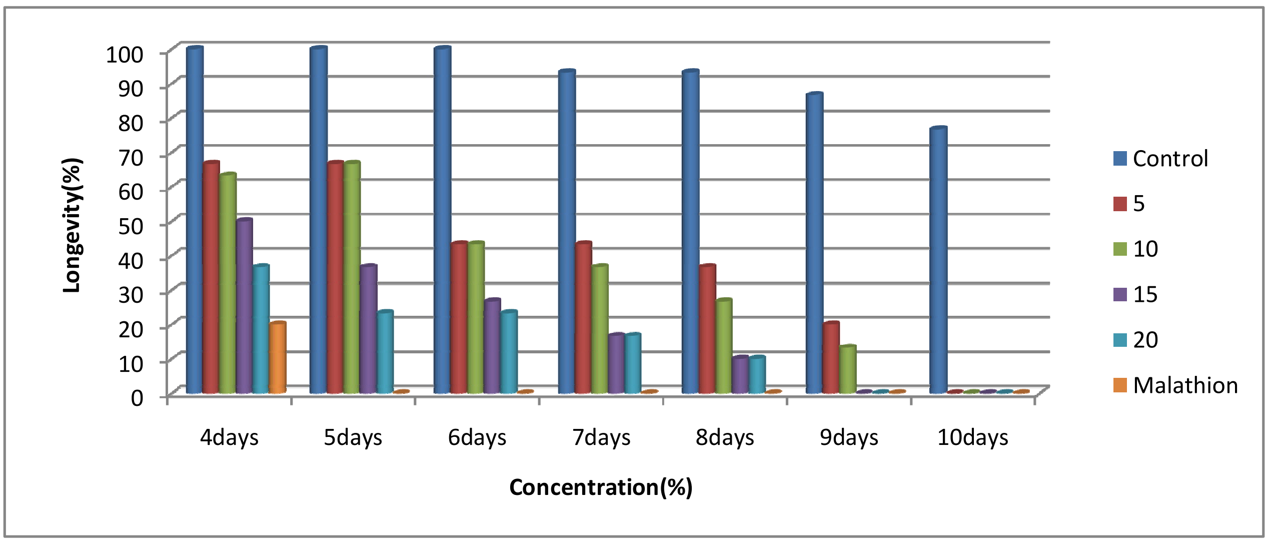

Fig. 27: Theeffect of hexane extract of argel stem on longevity of adults of tomato Leaf miner ***T. absoluta***.

CHAPTER FIVE

5. DISCUSSION

In the last four decades many botanical formulations have proven to be as potent as many conventional synthetic pesticides, even at low concentrations. Moreover, botanical insecticides have gained great attention over synthetic pesticides as a major control agent in organic farming.

This study was aimed to evaluate the lethal effect of organic extract of jatropha Jatropha `curcas seeds and leaves, neem Azadirachta indica A. Juss seeds, argel Solenostemma argel Del. stems, and malathaion on mortality, fecundity and longevity of the tomato leaf miner Tuta absoluta.

The two highest concentrations of jatropha seeds ethanolic used in this study (15% and 20%) induced high mortality percentages which were not significantly different from that of malathion throughout the experiment. Abrahim (2013) reported that jatropha and neem seeds and leaves contain active compounds which can be used as alternative insecticides for controlling insect pests. Ahmed (2012) found that the hexane extracts of Jatropha seeds gave significantly higher mortality percentage than that of the ethanol extracts.

The mortality generated by the highest concentrations of jatropha leaves ethanolic extract (20%) was not significantly different from that generated by malathion throughout the experiment. Similarly the mortality percentages generated by the 15% concentration of ethanolic extract of both Jatropha seeds and jatropha leaves after 48 and 72 hrs of exposure were not significantly different from that of malathion.

After 72 hrs of exposure, the two highest concentrations of neem Azadirachta indica seeds ethanol c and hexane extract (15% and 20%) induced a high mortality percentage of 93.3% and 96.7% after 72 hours of exposure respectively, and both results were not significantly different from that obtained by malathion. This clearly demonstrates that the neem Azadirachta indica seeds ethanolic and hexane extracts are very effective against the tomato leaf miner Tuta absoluta. Conclaves - Gervasio and Vendramin (2008) reported that, neem seeds extract, azadiractin, acts as contact and systemic insecticide against Tuta absoluta. According to Siddig (1987) neem seeds and leaves water extracts at 1 kg/40 litre of water repelled foliage pests of potato, including the algrodid Bemisi tabaci, Jacobiax lubica and Aphis gossypii. Rao (1987) reported that neem organic extracts do not have a universal knock down capacity; however, its insecticidal effect has been reported on some insect species such as Culex fatigans and C. quinquefasciatus.

The LC50 of argel stem ethanolic extract and hexane extracts used in this study were 6.860 and 13.571 respectively. The results suugest that the active ingredient in argel stem is better extracted in ethanol than in hexane. Phyto-chemicals of medicinal properties extracted from argel shoots had been reported by many workers (Roos et al., 1980; Kamel et al., 2000; Hamed, 2001). Sulieman et al. (2009) reported that the aqueous extracts of argel have antifungal and antibacterial properties.

As for the fecundity study, all concentrations of jatropha Jatropha curcas leaves, seeds, neem Azadirachta indica A. Juss seeds and argel Solenostemma argel Del. stems ethanolic and hexane extracts induced significantly lower fecundity than the control after 24, 48, and 72 hours of exposure.

The obtained results showed that all tested plant extracts generated lower longevity compared to that of the control during this experiment.

CONCLUSION AND RECOMMENDATIONS:

All concentrations of the Jatropha seeds and leaves Neem and argel stems ethanol and hexane extracts gaves significantly higher mortality percentage than the control after 24, 48, and 72hrs of exposure. It can also be noted that all the increments in the concentrations of the extracts resulted in a significantly higher increase of mortality percentage. Insect's treted with diffrant concentrations gave significantly lower fecundity and longevity shoter than the control of exposure.

The jatropha (*Jatropha curcas* L.) seeds,leaves and neem (*Azadirachta indica* A. juss.) seeds *seem* to contain lethal or active compounds that could be extracted and used for controlling tomato leaf miner ***T. absoluta***. However the results obtained in the research suggests the flowing recommendations:

- The Jatropha seeds and leaves can be used as a good source of elective extracts for combating tomato leaf miner ***T. absoluta***.
- The Neem seeds contain active ingredients capable of controlling tomato leaf miner ***T. absoluta*** .
- More studies on the biology and ecology of tomato leaf miner ***T. absoluta*** needed to know more about the weak points of its life cycle which can help in its control.
- Applications of quarantine measures are important in preventing entry of infested tomato leaf miner ***T. absoluta*** to the pest free areas.
- The establishment of separate orchards for each type of tomato was highly recommended for avoiding the continuous occurrences of tomato leaf miner ***T. absoluta*** .
- More studies will be needed to confirm the present results under field conditions.

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*Seen as abstract

APPENDICES

Table 1: Effect of ethanolic extract of jatropha seeds on mortality of adults of tomato leaf miner *Tuta.Absoluta*after 24hrs.

Concentration	Mortality %			
%	R1	R2	R3	Means
5	40 (6.4)	50 (7.1)	40 (6.4)	43.3 c
10	50 (7.1)	60 (7.8)	70(8.4)	60 b
15	80 (9.0)	80(9.0)	80 (90)	80 a
20	80 (9.0)	90 (9.5)	80(9.0)	83.3 a
Standert57%	90 (9.5)	70(8.4)	80 (9.0)	80 a
Control	10 (3.2)	0 (0.7)	10 (3.2)	6.7 d

Table 2: Effect of ethanolic extract of jatropha seeds on mortality of adults of tomato leaf miner *Tuta.Absoluta*after 48 hrs.

Concentration	Mortality %			
%	R1	R2	R3	Means
5	70(8.4)	70(8.4)	60(7.8)	66.7 c
10	80(9.0)	70(8.4)	70(8.4)	73.3 bc
15	80(9.0)	80(9)	90(9.5)	83.3 ab
20	80(9.0)	90(9.5)	90(9.5)	86.7 a
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 ab
Control	10(3.2)	0(0.7)	10(3.2)	6.7 d

Table 3: Effect of ethanolic extract of jatropha seeds on mortality of adults of tomato leaf miner *Tuta.Absoluta*after 72hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	70(8.4)	70(8.4)	60(7.8)	66.7 c
10	80(9.0)	80(9)	70(8.4)	76.7 bc
15	80(9.0)	80(9)	90(9.5)	83.3 ab
20	80(9.0)	100(10)	90(9.5)	90 a
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 ab
Control	10(3.2)	0(0.7)	10(3.2)	6.6 d

Table 4: Effect of ethanolic extract of jatropha leaves on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 24 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	30(5.5)	20(4.5)	20(4.5)	23.3 d
10	40(6.4)	50(7.1)	30(5.5)	40 cd
15	30(5.5)	40(6.4)	60(7.8)	43.3 bc
20	60(7.8)	70(8.4)	50(7.1)	60 b
Malathion57EC%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	0(0.7)	0(0.7)	0(0.7)	0 e

Table 5: Effect of ethanolic extract of jatropha leaves on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 48 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	50(7.1)	50(7.1)	40(6.4)	46.7 c
10	50(7.1)	50(7.1)	60(7.8)	53.3 c
15	60(7.8)	60(7.8)	80(9.0)	66.7 b
20	80(9.0)	80(9)	80(9.0)	80 a
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 d

Table 6: Effect of ethanolic extract of jatropha leaves on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 72 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	60(7.8)	60(7.8)	50(7.1)	56.7b
10	50(7.1)	70(8.4)	60(7.8)	60 b
15	90(9.5)	70(8.4)	80(9.0)	80 a
20	80(9.0)	80(9)	90(9.5)	83.3a
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 c

Table 7: Effect of ethanolic extract of neem seeds on mortality of adults of tomato leaf miner ***Tuta absaluta***after 24 hours .

Concentration %	Mortality %			
	R1	R2	R3	Means
5	50(7.1)	30(5.5)	30(5.5)	36.7 c
10	50(7.1)	70(8.4)	50(7.1)	56.7 b
15	90(9.5)	90(9.5)	80(9.0)	86.7 a
20	90(9.5)	90(9.5)	90(9.5)	90 a
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 d

Table 8: Effect of ethanolic extract of neem seeds on mortality of adults of tomato leaf miner ***Tuta absaluta***after 48 hrs .

Concentration %	Mortality %			
	R1	R2	R3	Means
5	70(8.4)	50(7.1)	70(8.4)	63.3c
10	90(9.5)	80(9.0)	80(9.0)	83.3 b
15	90(9.5)	100(10)	80(9.0)	90 ab
20	90(9.5)	100(10)	100(10)	96.7 ab
Standert57%	90(9.5)	70((8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 d

Table 9: Effect of ethanolic extract of neem seeds on mortality of adults of tomato leaf miner ***Tuta absaluta***after 72 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	70(8.4)	60(7.8)	70(8.4)	66.7 d
10	90(9.5)	80(9.0)	80(9)	83.3 c
15	90(9.5)	100(10)	90(9.5)	93.3 bc
20	90(9.5)	100(10)	100(10)	96.7 ab
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 e

Table 10: Effect of ethanolic extract of argel Stems on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 24 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	40(6.4)	40(6.4)	40(6.4)	40 b
10	40(6.4)	50(7.1)	40(6.4)	43.3b
15	50(7.1)	50(7.1)	40(6.4)	46.7 b
20	40(6.4)	50(7.1)	70(8.4)	53.3 b
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	0(0.7)	0(0.7)	0(0.7)	0

Table 11: Effect of ethanolic extract of argel Stems on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 48 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	40(6.4)	50(7.1)	50(7.1)	46.7 c
10	50(7.1)	50(7.1)	50(7.1)	50 c
15	50(7.1)	60(7.8)	50(7.1)	53.3b
20	60(7.8)	60(7.8)	60(7.8)	60 b
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	0(0.7)	0(0.7)	0(0.7)	0 d

Table 12: Effect of ethanolic extract of argel Stems on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 72 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	40(6.4)	50(7.1)	50(7.1)	46.7 c
10	50(7.1)	60(7.8)	50(7.1)	53.3 c
15	60(7.8)	60(7.8)	60(7.8)	60 b
20	60(7.8)	60(7.8)	70(8.4)	63.3b
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	0(0.7)	0(0.7)	0(0.7)	0 d

Table 13: Effect of hexane extract of jatropha seeds on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 24 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	50(7.1)	60(7.8)	40(6.4)	50 d
10	60(7.8)	50(7.1)	50(7.1)	53.3cd
15	70(8.4)	60(7.8)	70(8.4)	66.7 bc
20	80(9.0)	100(10)	80(9.0)	86.7 ab
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 e

Table 14: Effect of hexane extract of jatropha seeds on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 48 hrs .

Concentration %	Mortality %			
	R1	R2	R3	Means
5	50(7.1)	60(7.8)	40(6.4)	50 d
10	60(7.8)	70(8.4)	60(7.8)	63.3cd
15	70(8.4)	60(7.8)	70(8.4)	66.7 bc
20	80(9.0)	100(10)	90(9.5)	90 ab
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 e

Table 15: Effect of hexane extract of jatropha seeds on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 72 hrs .

Concentration %	Mortality %			
	R1	R2	R3	Means
5	60(7.8)	60(7.8)	70(8.4)	63.3c
10	70(8.4)	70(8.4)	70(8.4)	70 bc
15	70(8.4)	70(8.4)	90(9.5)	76.7 abc
20	80(9.0)	100(10)	90(9.5)	90 ab
Standert57%	90(9.5)	70(8.4)	80(9.0)	80a
Control	10(3.2)	0(0.7)	0(0.7)	3.3d

Table 16: Effect of hexane extract of jatropha leaves on mortality of adulta of tomato leaf miner ***Tuta absaluta*** after 24 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	60(7.8)	40(6.4)	30(5.5)	43.3 c
10	70(8.4)	50(7.1)	70(8.4)	63.3 b
15	70(8.4)	70(8.4)	70(8.4)	70 ab
20	80(9.0)	70(7.8)	70(8.4)	73.3 ab
Standert57%	90(9.5)	70(7.8)	80(9.0)	80 a
Control	0(0.7)	0(0.7)	0(0.7)	0d

Table 17: Effect of hexane extract of jatropha leaves on mortality of adulta of tomato leaf miner ***Tuta absaluta*** after 48 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	70(8.4)	60(7.8)	60(7.8)	63.3b
10	60(7.8)	60(7.8)	70(8.4)	63.3 b
15	70(8.4)	70(8.4)	80(9.0)	73.3 ab
20	80(9.0)	70(8.4)	80(9.0)	76.7 a
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3c

Table 18: Effect of hexane extract of jatropha leaves on mortality of adulta of tomato leaf miner ***Tuta absaluta*** after 72 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	70(8.4)	70(8.4)	60(7.8)	66.7 b
10	70(8.4)	80(9.0)	80(9.0)	76.7 ab
15	80(9.0)	80(9.0)	80(9.0)	80 a
20	80(9.0)	80(9.0)	90(9.5)	83.3a
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 c

Table 19: Effect of hexane extract of neem seeds on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 24 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	50(7.1)	30(5.5)	30(5.5)	36.7 c
10	50(7.1)	70(8.4)	50(7.1)	56.7 b
15	90(9.5)	90(9.5)	80(9)	86.7a
20	90(9.5)	90(9.5)	90(9.5)	90 a
Standert57%	90(9.5)	70(8.4)	80(9)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 d

Table 20: Effect of hexane extract of neem seeds on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 48 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	70(8.4)	50(7.1)	70(8.4)	63.3 c
10	90(9.5)	80(9.0)	80(9.0)	83.3 b
15	90(9.5)	100(10)	80(9.0)	90 ab
20	90(9.5)	100(10)	100(10)	96.7 ab
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 d

Table 21: Effect of hexane extract of neem seeds on mortality of adults of tomato leaf miner ***Tuta absaluta*** after 72 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	70(8.4)	60(7.8)	70(8.4)	66.7 d
10	90(9.5)	80(9.0)	80(9.0)	83.3 c
15	90(9.5)	100(10)	90(9.5)	93.3 ab
20	90(9.5)	100(10)	100(10)	96.7 ab
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	10(3.2)	0(0.7)	0(0.7)	3.3 e

Table (22) **:** Effect of hexane extract of argel stems on mortality of adulta of tomato leaf miner *Tuta absaluta* after 24 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	30(5.5)	30(5.5)	30(5.5)	30 c
10	30(5.5)	40(6.4)	40(6.4)	36.7bc
15	30(5.5)	50(7.1)	50(7.1)	43.3 b
20	50(7.1)	50(7.1)	40(6.4)	46.7 b
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	0(0.7)	0(0.7)	0(0.7)	0 d

Table (23) Effect of hexane extract of argel stems on mortality of adulta of tomato leaf miner *Tuta absaluta* after 48 hrs

Concentration %	Mortality %			
	R1	R2	R3	Means
5	30(5.5)	30(5.5)	30(5.5)	30 d
10	30(5.5)	40(6.4)	40(6.4)	36.7cd
15	30(5.5)	50(7.1)	50(7.1)	43.3 bc
20	50(7.1)	50(7.1)	40(6.4)	46.7 b
Standert57%	90((.5)	70(8.7)	80(9.0)	80 a
Control	0(0.7)	0(0.7)	0(0.7)	0 e

Table (24) Effect of hexane extract of argel stems on mortality of adulta of tomato leaf miner *Tuta absaluta* after 72 hrs.

Concentration %	Mortality %			
	R1	R2	R3	Means
5	40(6.4)	30(5.5)	30(5.5)	33.3d
10	30(5.5)	40(6.4)	40(6.4)	36.7 d
15	50(7.1)	50(7.1)	50(7.1)	50 c
20	50(7.1)	70(8.4)	70(8.40	63.3b
Standert57%	90(9.5)	70(8.4)	80(9.0)	80 a
Control	0(0.7)	0(0.7)	0(0.7)	0 e