Chapter one

Introduction

Guava is an important tropical fruit and claims superity over other fruits by virtue of its commercial and nutritional values. It is particularly rich in vitamin (Menzel, 1985). Guava is considered a common mans fruit and is rightly called the apple of tropics. Lt is consumed mostly as fresh. It is also processed into a variety of products such as jam jelly cheese toffee juice sguash wine dried fruiy and canned dices (Menzel, 1985). Sudan offers special opportunity for horticultural development vegetable and fruits. production comprises more than 12 percent of total agricultural output. The main fruit citrus paradisis , lemon mango (mangiferaindica) guava (psidiumguajava) and date (phoenix dactilefera (Gadoura 1997). Guava pisiduimguajava is memder of diocolyledon family myrtaceae the genus pisiduiminludes five species pisiduimguinenspcattleeianum p friedrichsthaliuamchinense p guava the rapid human population growth of sub Saharan Africa and the progressive urbanization has resulted in increasing rates of malnutrition and vitamin deficiencr (world bank 1996)

This along with the increasing awarenss about the the improved purchasing power of of the some of the segments of

the local population translates into increseddemamd of fresh fruits.

Horticultural production in most African countries is limited by many biotic and abiotic constrains. Biotic factors infestation which constitute enormous threat to fruit and vegetable production throthout the world (Mommed and Alwakkad, 2003).

The fruit flies were added to the list of national pests of Sudan. But there isnostanding recommendation for theicontro

(Fruit national workshop, 2008).

The commercially cultivated guava belongs to guaiara sub species several varieties of guava are under cultivation in these are named mostly after the location in which they cultivated. The trees native in tropical and subtropical America but now present in evary tropical and subtropical country. Guava tolerate wide range of climates.

In a survey of insect pests of fruit crops carried out several times at different parts of the country indicated that scale insect mites fruit flies leaf miner and mealy bugs are the pests inflicting considerable

damage to fruit crops in the country (Siddig, 1984)

The genus Ceratitis (drew1989).

The med fly is cosmopolitan and prolific pest whose exclusion from areas of fruit and vegetable production reguires constant vigilance (Mc Donald and lenis, 1985)

The pests is difficult to control because of it world geographical distribution and wide range of its host plant .

This research was designed to fuifillthe following objectives

To test effeicacy of botanical such as kafur on mortality of fruit fly

Chapter two

Literature review

Guava (*Psidium Guava*).

Guava is cultivated or grown wild throughout the tropical and subtropical regions of the world. It is considered to be native of tropical America (Chopra and Singh 1971)

The distribution of guava to other parts of the world is reported to be due to the Spaniards. India lead the world in guava production with an estimated annual production of 165,000 metric tons (MT) of fresh fruit (Action et al,1998)

The other major producer of guava are Mexico (27,000mt) Pakistan (105,000mt) Colombia(20,000mt) Egypt (28,000mt)brazil (27,000mt) Puerto recon Jamaica ,Kenya Australia and Hawaii also produce significant quantities of guava

World production of guava was estimated at about (500,000mt)(Jactioni et al 1998)

Classification

Guava (psidiumguajava l) is member of the dicotyledon family myrtaceae the genus psidium includes of the five species psidiumguinense the comer

P. cattleinam p. chinense p. friedrichsthalianam and p. guava the commercially cultivated guava belongs to the guajava species several varieties of guava are under cultivation these are named mostly after the location in which they are cultivated (Singh 1988)

History

The trees aer native to tropical America but now present in envery tropical and subtropical country guava tolerates wide range of climate and can be grown on many different soil types (Chopra and Singh 1971)

Botany

Guava is asmall tree or shrub 2-3m in height with wide spreading branches.the trunk is often mottled in appearance with reddish-brown outer scale bark the leaves of the guava plant are oval or oblong 7-15cm in length prominently veined and commonly hairy underneath the flower are perfect white an irregularly split bell-shaped green calyx-the flowers contain six white petals and numerous stamens with yellow anthers the ovary is inferior (Wilson 1980)

Guava fruit consists of a fleshy pulp and numerous small seeds the seeds are hard and kidney shaped the seedless varieties it is pink numerous stone cells (Scleroids) occur in the fleshy part of the fruit .these stone cell impart agrilty texture guava to the flesh.

The flavor of mature guava fruit has been described as sweet musky.and highly aromatic(wilson1980)guava fruit takes about 110-150 days from the date of flowering to reach maturity more time is required during the rainy season than in winter season .Several physic chemical changes take place during development of guava fruit(Yosif 1987)

The fruit weight and volume increases moderately up to the first 50 days rapidly up to 100 days and very slowly thereafter (Gangwer.1972)

The color of the fruit remains green up to maturity it starts becoming yellow due to loss loopy chlorophyll just before reaches

maturity the softening of guava fruit progresses after about 115 days from anthesis the fruit detachment force and decline during maturation(Paul and Goo 1983).

Sugar content of guava fruit increases during development

The sugar fructose increases rapidly while glucose content inereasesslowly.pectin content increases during ripening and

declines rapidly in overripe fruit (Angihorti et al.1962) acidity decreases while ascorbic acid content increases during development of guava fruit (luhi 1997) .

Disease and pests

Guava is a hardy plant and is not much affected by insect or pests birds such as parrots mynahs and crows and fruit eating bats eat semi ripe fruits on the trees and cause serious damage to guava

The diseases of guava include fruit rots fruit sports anthracnose and fruit canker fusarium wilt affects the entire tree it causes yellowing dying and abscission of the leaves and ultimately the whole tree dies mucor rot (mucorhiemalis) appears in mature fruit and develop rapidly to cover the entire fruit rhizopus rot (Rhizopusstolonifer)is similar in appearance to mucor rot this rot may be caused by bruising fruit spots appear as gray black circular masses on the ripening fruit anrhracnose (coletricumpsidii)is a serious disease in lndia particularly in the rainy season.

It is characterized by the appearance of brown round decayed spots the fruits then turn brown and shrivel in canker (physalosporapsidii)the green fruit are affected superficially showing brown elevated necrotic areas (Butni and Dalhi 1979)

The insects and mites infesting guava include guava scale (Pulvinariapsidii) palm scale (Hemiberlesialataniae)green (Coccusviridis)oriental fruit fly (Dacusdorsalis)spiraling white fly (Selenothripsrubrocincrus)coconut mealy bug(Pseudococuslongispinnus)coconut bug (Pseudo theraptuswayi(false codling moth(Cryptophlebialeueotetra)guava moth (Anuaindiscriminata)fullers rose beetle(Pantomonuseervinus)Chinese rose beetle (Adoretussinicus)and red and black flat mite (Brevipapusphoenicis)(Butni-1979-Menzel 1985)fruit fly mediterrean fruit fly(ceratitscapitata)(Weid)

Taxonomy:

Fruit fly (Ceratits capitates)(Weird)is a member of

Family Tephritidae.OrderDiptera

Medfly (English)Mediterrean fruit fly (English)this name become widely used than other common names used inliterture such as fruit fly orange fly try pet(Back and Pembberton 1918). *Ceratitiscitriperda*maclegyCertitishispanicasdeberm*Parodalaspi sasparagi*Bezzi- *Tephritiscapitata* (wiedmann)the identification of fruit is very difficult even for the Prodalaspistaxonomis(Dallwitz 1993.1995 2000ab)for this reason fruit fly identication system was developed by many

authors as part of along project in order sflies name(Norrbom et al 1999ab)

The fruit flies belong to the order Diptera family Tephritidae and sub family dacinae.most of the tephritidae species which attack fruit belong to the genera ceratitisbactroceradacus-anastrapha and rhagletis (white and Elisonharrs 1992)

Economic importance and damage:

Economic inportance

Fruit fly most important insect pest throughout the world it causes economic damage to their host fruits of the subtropical tropical and warm temperate.

Hill(1993)put c.capitata as amain pest of guava in Khartoum are and was found only on guava (Deng 1990)while Siddig(1984)reported it as minor pest of guava many authors indicated the dominance of C.cosyra in mango and guava (Elheweires2003)Ahmed(2001)found guava pisidium to be an alternative host of C.cosyra and observed its migration to guava trees when mango fruit were not available in the orchaards in the sudan very few works have been done on ecology and damage assessment of fruit fly on guava (Ali.2007)

The pest and many other species of family tephritidae are major pest because of its wide distribution over the world its ability to tolerate cooler climate then other species of fruit fly and wide

range of hosts it is ranked first among economically important fruit fly species each infestation procedures that the pest did not become established(Abbas2008)

Damage:

Schmutterer (1969) reported that the symptom vary from host fruit to another e.g. the infestation appears dark spots in citrus and as black sunken areas in the lower half of the guava fruit

Attack fruit usually shows sight of ovipositor punctures the larvae bore into the fruit often accompanied by fungi and bacteria which rotten the fruit severely attacked fruit fall prematurely (Hill.1993).

Schmuttertterer (1969)recorded symptoms of C.capitata in citrus as small dark spot on the fruit surrounded by bright zones attacked guava have obvious black shaken area in the lower half of the fruit the larvae tannel into the fruit and gradually destroy it usually in association with bacteria and fungi dried fruit beetle *Cerpophilushemipterus* and the small fly dorsophila melanogaster also attack rotten fruit (Schmutettrer1969).

Distribution

The med fly is is one of the world destructive fruit pest because of wide distribution over the world and its ability to tolerate cooler climate better than most other species of fruit flies

It occurs in mediteranean countries central and south America east west and south Africa the species originated in Mediterranean region of Europe and north Africa and it is not known to be established in the main land U.S it occurs in western Australia countries in Europe and north Africa and in Asiatic area such as lsrealGordan Lebanon and Turkey. Mediterranean fruit flies were accidentally introduced into Hawaii from Australia around 1907.they are usually found at upper elevation although breeding has occurred in lower(Vagast1983) in the Sudan this pest has been recorded in Khartoum state

The eastern region (kassala) northerregion(shandihudieba) blue nile (Venkatraman and Eikhidir 1965)Ali and Schumtterer1969)now it is wide spread in Sudan occurring in all regions of fruit and vegetable Deng(1990)stated that *Ceratitiscapitata* has been recorded in Khartoum while beji(1996)recorded it from kassalarecentty it has been recorded in eastern wester and and central sudan(Ahmed2001 Elheweris 2003 and Bashir2007)

Host plant

In Sudan fruit flies were first repoted by Venkatraman and Elkhidirin(1965)on egg-plant(*Solanammelongena* and guava(pisidiussp)

The species has been recoded as pest for the first time in different part of the world in early 2oth century or late 19thcentury(Back and Pembberton1918)this pest attack more than 260different fruits flowers vegetables and nuts thin shrinked ripe succulent fruits are preferred the med fly is known to attack over than 300 different hosts primarily temperate and subtropical fruits(liguido et al 1994)

Fruit fly have so many host plant such peach eggplant guava-apple-banana-date-palm-okra-okra-orange-papaya-peach plam apple and tropical citrus(Schmutterer 1969).

Peaches and citrus constitute the main host of the pest in other part of the world while the guava is the main host in the Sudan but coffee beries cacao ficas mango *prunnusspp*

Solanumspp are some of its alternative hosts recorded in other part of the world (Hill)

Most of fruit.

Infesting tephritide are polyhagous. liguido et al(1994)reported 253plant species as hosts potential hosts for this pest its colose relative C.cosyra is primarily considered to be apest of mango the host range of B.cucurbitae is primarily cucurbits

Amango the fruit flies found in Sudan *Ceratitiscapitata* and *Ceratitiscosyra* are considered as devastating pest to fruit **trees**

Mango guava and citrus all over the country especially at shendisingasennar beside anew species of the genus bactrocerinvadens(Drew et al2005).

Preference for ovipostion

Mc Donald and lnnis(1985)stated that host properties affected Willard(1932)fount the fruit varieties within the same species very widely in resistance to infestation

By fruit flies in mangifera in their indica .infestation percentage varies from zero in the variety biorbach to 58.8 in the variety French Back and Pemberton(1918)attributed high mortality rate of the immature stage of the flies on citrus to the oil glands on the rind also they added some substances such as tenninladin juice in the peel of green banana milk-like visicid juice of the pineapple which sticks the females to the fruit surface while ovipositing and the oil released by oil glands in citrus fruit reduce the infestation by flies and explain why these particular hosts are rarely attacked by the pest Willard(1927).

Suggested that in mango the high rate of latex secretion may create some sort of repellency Back and Pemberton (1986)found that juicy fruit were not suitable for fruit fly development because the larvae would be drowned and acidity of fruit (Severin1913).

Movement and dispersal of fruit flies :

Transport of infested fruit from other area as well as to previously uninfested area is also an important means of fruit fly

Movement and dispersal (Gurshiet al1975).

Behavior:

Females pierce the ripening fruit and insert the eggs into punctures. The maggots feed on the pulp making the fruit unacceptable. Pupation occurs either inside the fruit or in the ground(Gurshi et al 1975).

Ovipositionbehavicur:

Females often discharge a marking pheromone on the fruit or other part of the plant in which eggs are deposited this pheromone deters oviposition by other females. The female lays several eggs singly or in cluster beneath the skin of mature hours (wong and Random 1992).

Feeding behavior

Feeding behavior of tephritids in nature is poorly understood(Ehite and Sloson-Haris1992).The larvae feed on the internal issues of infested fruits causing rot and the fruit drop(F.A.O.2004).

Adult nutritional requriments vary largely . The quality of larval food usually include at least carbohydrates and

water(White and Eloson –Haris1992).Adults may feed on plant exudates including those from the oviposition punctures or rotting fruit bird feces nectar honey dew pollen grain and rain drops(White and Eloson-Haris1992).

Morphology and life cycle:

The biology of Ceratitiscapitata(Mediterranean) fruit fly similar to that of Ceratitiscosyra (the mango fruit fly)(Hill1983)

Stated that the biology of C.capitata especially in behavior biology and life cycle they also reported that the life cycle of both ranged between 22-30days the length of time required for capitata to develop from egg to adult is about 21-23days.

Under tropical condition according to Thomas et al (2001) Adults die within days if they can not obtain food.

Usually about 50-100 of the flies die during the first two months after emergence some adults survive up to six months or more under favorable condition of food (fruit honey dew or plant sap) water and cool temperature continuously lack of fruit for three to four months.

Reduces the fruit fly population to minimum(Thomas reduces the fruit fly population to minimum)(Thomas et al2001).

The egg stage

The eggs are laid in groups under the fruit skin into the pulp ltanna(1947)reported that mostly 6-10eggs were deposited in afruit each time and a female may deposit 300-400egg during its life –time incubation period takes 2-4days (Hill 1983 deng1990 ahmed2001)however Singh(1988)reported 1-2days for incubation period.

Larval stage:

The newly hatched larvae bore through the pulpa of the fruit usually 10-12 maggots are found per fruit but more than 100have.

Been recorded(Hill1983)there are larval instars that take 10-14days for development(Hill1983)while Hanna(1947)in Egypt reported 9days for the larval development Ahmed(2001) found that the larval duration of C.cosyra ranged between8-10days.

The larval moult twice the second instars measures 7-5-10mm in length and1,5-2mm in width (White and Elson-Harris1992).

The maggots are white broader at the posterior and pointed at the anterior and the feed on the internal tissues of infested fruited causing rot and the fruits fall from(F.A.O.2004)larvae pass throuth three instars within 9-25days.

After which they drop into the soil for pupation to a depth of about 5cem depending on soil type the development of maggots

depends on temperature moisture ripeness hardness decay dryness and acidity of fruit (Severin1913).

The pupal stage

The third larval instars leave the infested fruit and bury them selves in the soil kranz et al(1972)f0und that med fly larvae pupated at depth of 5-10cm Deng(1990) reported that the pupation depth of the same species ranged between 1-2-5cm the pupation period for capitata varies between 5days in sammer and 35days during winter atter which the flies emerge from the soil (kranz et al 1977).Hill(1983)recorded 14days and Hanna (1947)in Egypt found it ranged between 9-11days.

Back and Penberton(1918)recorded 17days Singh.(1988)stated that the pupal period lasts for 7-11days (Ahmed2001).

The adult stage

C.capitata is multivoltine the optimum temperature for its development is around 12c while that of matins is 6c a preoviposition period of 2-4days during which adult emerged. Adult must feed on a proteinaceaus source so that their internal genitalia develop(kranz et al 1972).Back and Pemberton (1918)reported that the preoviposition period ranged between 4-8days while 8days were reported by Hill(1983)2-9days by Vargas et al (1984).Ahmed(2001)found the preoviposition period for C.cosyra ranged between 2-6days.

The med fly females become sexually mature 4-5days after emergence-the first ovipositionoccurs after8days the adult requires sugary food at this time they live for 5-6months there may.

Be 8-10generations per year (Hill1983)in Hawaii. back and Penbertion(1918)found that the average med fly longevity was 32days while some might last for 96days Shoukry and Hafiz(1979)found that adult male fly longevity was 31 and 25-5days at the same temperature respectively.

But females reared without males lived longer(67days)adult longevity can become longer when vitamins and hydrolyzed protein are addad to the food in Egypt Hanna(1947)found that the longevity of the med fly ranged from 32-96days.

While that of the males ranged between 30-45-days(F.A.O.2004)

or combination of all(Bateman1982)

Sterile insect technique(S.I.T) is used to contain and exclude population of med fly. The goal of (S.I.T)is to release sterile males to mate with any introduced wild females resulting in the production of infertile eggs in California the(S.I.T) program in changing from the release of both male and female sterile flies (sexual strain)to the use of sterile insect technique(S.I.T)is

amore ecologically acceptable contro measure but this approaches complicated and very expensive(Bateman1972).

Sit may not work as asole control strategy

Particularly when the population density of the fruit flies is high(knipling1992)and perhaps more importantly when several species co-exist grower requirements because sterile females will continue to oviposit and damage fruit even if the eggs were not viable(Vargas 2004)

Further more (S.I.T)for control of C.cosyraC.rosa ,c.fasciventris and C.anonae is currently not possible because no appropriate methods for mass production of these species have been developed.

The sterile insect technique has been successful used to the eradicate fruit flies in several parts of the world early exapuples were the eradication of the melon fly from the marina island(Stainer et al 1965)and kume island in japan(Wahasi1977)as well as the oriental fruit fly from guava(stein et al 1970)as aresult of which japen was declared free of the oriental and flies(kawasaki1991)-

Sit has been extensively investigated in 13 species of Tephritidae (Hopper1989)the use of sit is not simple procedure and involves high degree for technical experts time and funds there are several direct components of sit that must be

investigated to ensure success of project and these were reviewed by Hopper(1991)the important component include appropriate diets and mass rearing techniques to sterilize flies transport and release methods to evaluate the progress of the control or eradication program.

Sit technique were used successfully to eradicate B.dorsails from Okinawa and neighboring lsland in the rukya archipelago and japan(ffepo.1987).

IPM: The use of some or all the previously mentioned control measures were adopted to minimize the pest population of fruit flies

Malathion 57%

Malathion is a non-systemic wide spectrum insecticide it was one of the earliest organophosphate insecticides developed and introduced in 1950%

Malathion is suited for the control of sucking and chewing insects on fruits and vegetables malathion 57%is also used to control mosquitoes flies household insects animal parasites.

(Ectoparasites)and head and body lice malathion is as organophosphate(O.P)insecticide that has been registered in the united state since 1956 it known under the chemical name diethyl (odimethoxyphosphinothioyl) thiobutanedioate the well-

known trade names are ArbofosMaldison and Mecarptothion it has melting point of 2.9c and boiling point of 156c-157c.

However

malathion breaks down Into malaoxon which is 60time more toxic than malathion. It has characterized by low persistence that greatest in sand soils with few microorganisms the reported half life in river water is one week. It is more stable under acidic aquatic condition and solubility in water is 130mg when malathion used as sprayed insecticide it gives unpleasant odor which some time inhibits its use as adulticide (Anonymous 2005).

Uses

Malathion is used in agriculture as it is used in usa in many control mograms like the eradication effects of bollworms control of Mediterranean fruit fly and grass hoppers. It is used also in gardens and public recreation areas and originally.

In public heath pest control programs as its is widely used as mosquito adulticide beside it is used in the treatment of head lice and scabies it is effectively kills both eggs and adult (Anonymous2005).

Toxicity

Malathion is only slightly toxic to mammals using epa standard of determining acute toxicity it could be highly toxic to fish and

other aguatic organism however it is highly toxic to larval sages of

amphibians and aguaticinverbrates the products is slightly to moderately to birds with an acute oral ld50 ranging from loomg/kg(Anonymous,2005).

Cafur:

The genus Eucalyptus belongs to the family myratacae and order myratiflorae sub class archichlanydae and class angiosperm.

Description

Large evergreen tree24-40m high with stout trunk often short and crooked 2m in diameter crown open and widely spreading irregular bark is smooth and white gray twigs are long slender and with angled reddish coloured leaves are alternate narrowly lancceolate about8-22cm long and 1-2cm wide often curved or sickle shaped tapering to long point short pointed at base with dull pale green on both surfaces or occasionally grayish umbels single at leaf base 25cm long on slender stall(auxiliary)greenish white in color capsules are several clustered hemiglobose7-8mm long and 5-6mm wide light brown in color.

Seed are many tiny i5mm long with light brown color(little1983).

Distribution:

Eucalyptus camaldulensisDehn.said to be the most widely distributed eucalyptus it is indigenous to eastern Australia in most of arid and semi aridragions but not the humid westerm coasts plantation occurs in argentine Arizona Egypt California Kenya morocco Nigeria Pakistan Senegal sierra leonespain Tanzania upper voltauraguay and Zimbabwe in sudan the species was planted along the bank of the Blue Nile river however Microtheca is another species planted in the irrigated area of the Gezira scheme (Duk and Win1981).

Ecology:

Eucalyptus is planted in a wide range of tropical to sub-tropical and warm temperate and in arid to semi-arid areas the tree tolerates temperature from3in winter. Suitable annual rainfall ranges from minimum of about 250-625mm to as high as 101250mm(little1983)the tree tolerates many different soil conditions high calcium high salt periodic water logging occasionally pare stands may develop naturally along flood plains and stream banks the mean maximum.

Temperature of the warmest where it grows well at 298(Marianiet al1981).

Economic importance

The tree is an importance source of timber fire-wood shelter belt and honey in Sudan it is planted to protect crops from blowing sands Australia to termites.

So it is widely used for strong construction interior finish flooring cabinetry furniture fence post and cross ties also people in Sudan know how to obtain water from it superficial roots(Duke and Win1983).

In Argentina the trees wood is a good source of charcoal and the steel making.

In world Wartwoaustralins used the charcoal for gas plants.

In traditional medicine red gum eucalyptus is a folk remedy for colic cough diarrhea dysentery hemorrhage laryngalgialaryngitis sore throat and wounds(Duke and Wain1981).

Chemical constituents

Various species of eucalyptus were examined for volatile oil production leaves contain 0;1-0,4%esential oil 77%of which is cineol beside some cuminalphellandrene.

Aromadendrenvaleryklehydegeranoil cymene and phelladral(Wallis 1960)-fresh leaves contain about 3-4%volatile oils which contains the bitter constituents.

Leaves contain5-11%kinotanic acid as well as kino red glycoside catechol and pyrochatechol leaves and fruit test positive for flavonoids and sterols the bark contains2-5-16%tannin the wood 2-14% and the kino46-7-76-7%(Watt and Breyer1960).

Cafure as biocide

The potential usage of eucalyptus plant as pest control material was tested under laboratory conditions against some important pests of stored agains in the northern Sudan viz the faba been beetle Bruchidius incarnates the red flour beetle Triboliumcastaneum and khapra beetle Trogodermagranarium results indicated that eucalyptus organic leaves extract has typical insecticidal effect causing high mortality on the tested insects.

The efficiency of the other parts is arranged in as asending order as follows bark flower seed and stem(Elsidig2007).

Leyneol and limonene of essential oils of e.camaldulensis and e camerniharesighificant insecticides action lethal Rhyzoperthadominica and Triboliumcastaneum the later was more effective(Santos etal1997).

Observation recorded after few monthe indicated that

Ecamaldulensis was very effective against oil vapours distilled from eucalyptus camaldulensis was tested against eggs of the

confused flour beetle Triboliumconfusum and Mediterranean flour moth Ephestiakuehniella the exposure to this vapours caused 45%and 65%martalities respectively at the concentration 98.5al essential oil/liter air(Hanif et al1988).

Control

Cultural control

the principals cultural control method used for controlling this pest is field sanitation directed toward the destruction of all unmarketable and infested fruits should be buried 3feet under soil surface with an addition of sufficient lime to kill larvae.

Harvesting fruit weekly also reduces food sources from which large populations may develop by keeping the quantity of ripe fruit on the trees to minimum other procedures that reduce the amount of in field breeding of med flies should be used several methods suggested for disposal are soaking fruit in water topped by layer of kerosene to cut oxygen supply freezing fruit for few days cooking or pureeing fruit burial not recommended at depth of less than 18inch and med fly can survive a burial.

Bagging of fruits with muslin which is time consuming but it can be effective in small plots (Shumutterer1969and Agarawal et al 1989)

Mechanical control:

One of the more effective mechanical control methods is bagging the fruit to exclude egg laying bagging of fruit with muslin which is time consuming but it can be effective in small plots.

(Schumutterer1969and Agarawal et al 1989).

Biological control:

Biological control is potentially use approach in suppressing fruit fly densities(Wharton1989 knipling1992 and Sivinski et al 1996)-

Recently natural enemies were used to reduce the population of med fly c.capitata(wong et al 1992and Headricks and Godden 1996)

Biological control has been tried against some fruit fly species.

Namely AnastrepheiadensBactroceradorsalisB.cucurbitaeB.tryoni and C.capitata but introduced parasitoid have little impact(Wharthon 1986)

Predators:

Three parasite species were introduced to Hawaii between 1947 and 1952to control the fruit flies these parasites lay their egg or maggot fruit flies and emerge in the pupal stage many parasitoid species especially in the family Braconidae are used for biological control of fruit flies(Wharton1989)tetratichusgiffardiisilvestri(Hymenoptera eulophidae)is a gragarious larva-pupalendoparasitoid of many fruit fly species(lasalle and Wharton2002Mouhmmed and Wharton2006).

Microbial agents

Fungi

The genera penicillium serrate and mucorae were reported to cause considerable mortality to the larvae and pupae of b dasalis (newel and haramoto1968)studies carried out by Ekesi.et al(2002)proved the Metarhiziumanisopliae had very high potential in suppressing fruit fly population.

Bacteria:

Bacillus thuringienses(beliner)sub species darmadiensis when mixed aprotein diet and suger introduced as bait was found to kill Anastrephaladens(loewin)and (Martinez et al 1997)

Nematodes

the med fly C.capitata was found susceptible to the entomopathogenic nematode Steinernemefelitiae(filipjevi)field

exposure of final instars of C.capitata larvae to a dose of 500 nematodes/cm caused high mortality(lindegren et 1990).

Legislative control

Transferring infested fruits from highly infested area to slightly infested area also planting different types of hosts at one place in order to break the food cycle of the fly throughout the year(F.A.O2004).

Chemical control:

The chemical or the insecticide method of the control of fruit flies fall under three main categories.

These are spraying the adult flies with suitable insecticides trapping of the adult flies fly means of chemical attractants and bait spray that in essence consists of an insecticide mixed with bait(Narayanan and Batra1960)-chemical sprays have not been completely effective in protection fruit from med flies.

Egg lying requires only a few minutes and chemical residues do not kill adult within this time frame proteinceous liquid attractants in insecticide sprays is recommended method of controlling adults med stream fruit fly population in the minacity of crops the bait insecticide sprays are applied to broad

leaf plants that serve as refuge for Mediterranean fruit fly adults bait serves to encourage adult(especially females)

To feed on spray residue bait good sanitation practice these practices residue immediately after economic unmarketable fruit harvest date and destruction of crop residue immediately after economic harvest has been completed nu-lure is commercial liguid bait that is available for use against fruit flies.

The main control method recommended are foliage baiting and cover sprying the female med fly requires sources of protein for the maturation of her eggs which she obtain from nature the foliage bait combines a sources of protein with an insecticide and attractive for both the male as the female med fly the bait is usually applied in the morning hours and applied as spot application aim at the middle of the trees.

Cover spraing carried out when fruit are half or two thirds in size although spraying of the entire trees is sometimes used the use of bait sprays is both more economical and more environmentally system using auto typed protein in Malaysia thas been developed into a very effective commercial product derived from brewery waste.

Trapping and of are highly species specific while the food bait attrat both females and males and males and are not species specific(Billah 2006)the first attractant for Bactrocera 20nata followed by kerosene for the Mediterranean fruit fly

c.capitata(Severin1913)discovered Trimedlue(tml)to be effective against CeratitiscapitataTerpinylacertata attracts c.cosyra(lae2003F.A.O2008).

Baited food traps based on protein sugar fruit juice and vinegar had been used since since 1918to capture temales of several fruit fly species the mephail trap was the first device to be used with protein bait(mcphail1939)Jackson trap in 1971 for tml(harris and white1971)these traps are currently being used in various countries.

It is well known that bait-spray offers one of the most effective methods of control especially in the pre-oviposition stage when the flies reguire protein for egg maturation this habit of the flies has been utilized to poison and kill them the insecticides employed included lead arsenate paris green potassium arsenate sodium arsenate and carbonate the insecticides are dissolved in syrup of cane suger(narayanan and batra 1960).

Chapter three

Field experimenta

Study area

The area under investigation included what is known as garf along river Nile namely lkadrewElezergab north of khartoum(fig..1)during January2015.December2016.The area were selected for experimental work because they were heavily infested with fruit flies.

Generally the climate in the experimental site was described as relatively cool dry in winter and warm to hot humid in summer with annual temperature ranging from 13-47c The average relative humidity was ranging from 22 to 40% .The soil in the experimental area was classified as clay loam or saline sodic (kabashi2010).

Collection of adult flies:

Random samples of ripe fruits of guava were collected from various fruit trees orchard at the selected areas. Each of the

collected fruits was weighed and kept in separate plastic container (25+18+18cm).

The plastic cover was punctured to facilitate

respiration plate (1).wheat bran was placed on the bottom of the container as pupation medium.U

Identification of fruit flies:

Random samples of emerged adult flies were collected stocked packed and examined using I.c.ip.e.pictorial key (Billah1980) in August2007.

Traps

A cylindrical crystal plastic bottle measured (5cm high. 13cm diamerter)was modified from Lynnfield trap plate (z)fig(2).Four equidistant opening each (2cm)were made round the top. One hundred ml of already made juice of guava pulp 20%source citric acid(e300)sodium benzoate(ezii)sodium citrate(e331gum Arabic(e414)guava flavor manufactured by crystal industrial co. Arrack Group was used with 50% solution + juice of mango. The traps were hanged by mean of short rope 10 centimeter long from a middle branch of guava trees. Traps were placed at each area at random with at least 200m apart .

Trap servicing:

The content of traps was sieved using plastic mesh. The caught insects removed of trap by camel hair brush and preserved in glass bottle with 70% alcohol plate (1-2)and transported to laboratory after each experiment. The traps were washed by soap and water and kept dry for next experiment. A comparison of med fruit flies population between the three selected areas during July, August and September was made during 2006:

Catches were carried out every seven days for the period July-August and September2006 to investigate abundance of med fruit fly at selected area elkadrew using locally made traps described above.

Seasonal abundance of med fruit fly during May 2015-Aprill2016 . Guava trees were selected to monitor the population of Ceratitiscapitata from May 2007 to April2008.

Catches were carried out during May2008 April2008-3times a month at the l,15and 28day at Elezrgab using 10 traps as mentioned above.

Comparison of med fruit fly population between Khartoum state(elezergab).

Catches were carried out during august 2008 using the same traps and the sam methods mentioned above to monitor the abundance of fruit flies comparing elezergab with sing sennar state caunts were made three times at 25^{th}

Statistical analysis

Fruit fly counts were expressed as a number of insect trapped per 2hours or a week or a month. Statistical analysis data were subjected t to separate means (Cochran and Cochran 1987)

Chapter four

results

field experiments

identification of fruit fly species the collected species indentified in the laboratory from guava fruit at shambat in auguat 2007 using l.c.i.p.e pictorial key(billah 1980)thes species` identifited as follows

ceratitiscapitata(miedmann)

Concentration	R1	R2	R3	mean	L S D
10%	10(18.43)	20(26.57)	40(39.23)	28	A
20%	20(26.57)	20(26.57)	20(26.57)	26	A
30%	20(26.57)	20(26.57)	10(18.43)	31	A
40%	30(33.21)	30(33.21)	20(26.57)	30	A
Control	0(0)	0(0)	0(0)	0.0	B

Table (1)

The effect of cafur leaf extract on adult fruit fly of (24 hours).

C V	22.54
L S D	7.24

Table (2)

Adult fruit fly controlled with kafur leave in whing of 48 hours

Concentration	R1	R2	R3	Mean	L S D
10%	10(26.57)	40(39.23)	30(33.21)	36	A
20%	90(71.57)	50(45.0)	60(50.77)	55	A
30%	80(63.43)	100(90.0)	50(45.0)	66	AB
40%	100(90.0)	70(56.79)	90(71.57)	72	B
Control	0(0)	0(0)	0(o)	0.0	C
C V					35.70
L S D					22.67

Table (3)

The adult fruit fly controlled with cafur leave in within of 72 hours

Concentration	R1	R2	R3	mean	L S D
10%	20(26.57)	50(45.0)	100(90.0)	54	A
20%	90(71.57)	50(45.0)	90(71.57)	62	A
30%	80(63.43)	90(71.57)	80(63.43)	66	A
40%	100(90.0)	80(63.43)	100(90.0)	81	A
Control	0(0)	0(0)	0(0)	0.0	B
C V					33.00
L S D					27

Results

1-The effect of cafur leaf extract on adult fruit fly (24 hours).

All treaments wert not significantly different from each other .But significantly different from control (Table 1).

2-the effect of cafur leaf extract on adult fruit fly (48 hours)

The best result was obtained with 40% concentraction as 72% mortality followed by 30% concentration which was 66% mortality .The least effect of 36% mortality obtained by 10% concentration (Table 2).

3-the effect of cafur leaf extract on adult fruit fly (72 hours).

The best result was obtained by 40% concentration which was 81% mortality followed by 30% concentraction as 66% mortality .

The least effect was 54% mortality given by 10% concentraction (Table3).

Chapter five

DISCUSSION

Horticultural production in most African countries is limited by many biotic constrains. Biotic factors include among other heavy fruit fly infections which constitute enormous threat to fruit and vegetable production throughout the world (Mohamed,2004) . In the tropics ,the problem is further aggravated by the prevailing warm weather condition, which

interfere with the fruiting patterns, resulting in overlapping fruit infestation all the year around (Mohamed, and Alwaked,2003).

In the Sudan fruit flies are the serious insect pests of Guava causing great losses and seriously affecting export. In the year2007,the fruit flies were added to the list of national pests of Sudan(Abdemajia,(2008).The identification of fruit fly is very difficult even for the professional taxonomist (Dallwitz , 1980:Dallwitz et al 1993,1995,1999,and 2000).For this reason a fruit fly identification system was developed by many authors as part of long project in order to make taxonomic information on tephritidae available.

Family Tepheritidae the true fruit flies has about 4000 species assigned to 500 genera. Thus it is probably the largest of Diptera families (true flies),and economically, one of the most important pestiferous groups (white and Elson –Harris ,1992).

In the present study about species identification *Ceratitiscapitata* was found to be the most abundant in Elezergab.

n the present study cafur 40% water extract gave the best result in controlling *Ceratitiscapitata.*

This result is in agreement with previous works.

Conclusion

Cafur water extract is promising in controlling *Ceratitiscapitata*

Recommendation

1-it is recommended to use cafur solution higher doses

2-Early harvest is recommended before fruit reach yellow mature susceptible stage

References

- Abbas ,A.M.(1998). Assessment of some cultural practices for the control of the fruit fly certitiscapitata .M.Sc.Thesis faculty of Agriculture University of Khartoum ,Sudan .
- Agnihorti ,b, N,K,.L. Kapoor and R. Goel(1962). Ascorbic acide content of guava fruit during growth and maturity, Sc.Cult.

- Anonymous (2005).Malathion for mosguitocontrol.U.S Environmental protection agency.
- Ahmed ,E.E.(2001).studeis on mango fruit fly ceratitescosyra in central Sudan .M.Sc. thesis fculaty of agricultural sciences university of gaziera,Sudan , 105PP.
- Ahmed,F.(2011).Pest management Approach to the fruit flies in ShendiArea.M.Sc. thesis university of Khartoum.
- Ali,EE.(1967).Studies on some trypetidae of Economic importance in the Sudan, M.Sc.Thesis faculty of Agriculture, university of Khartoum .
- A,S.A.I.(2007).Detection and monitoring of some tephritidae of fruit trees and their host range in Abugubeiha, south kordofan .MSc. thesis faculty of Agriculture university of Khartoum , Sudan
- Abdelmajia F.M.(2008).Fruit fly review Sudan froml.1960-2008 fruit flies national project for control of fruit flies in Sudan workshop 26-26-2008.
- Back E.A.AND pembbetro (1918)life cycle history of the midetraean fruit fly of agricR.E.S.3:363-369-374.O.S.A Back .E.A.andpembberton C.E(1918).The miditraen fruit fly in Hawaii U.S.D .A. Ball:1-118.
- Bashir Y.G (2007).Stadies on mango fruit flies inkordfan Area Sudan ph.D thesis facuty of Agricultural Science university of Gerira Sudan.

- Bateman M.A(1982)chemical method for Suppression on eradication of fruit fly population In Economic important of South pacific region ceds Drew R.A.L Hooper G.H.S and baterman M.A 11-128 OueenslandDepartman of primary Industries Brishane.
- Beige.C.M(1996).Reports on field trip to kassala and Gash Delta F.A.O I.P.M. project GCP/025/NET ARC. Wad Medan. Sudan.
- Bess H. and F.H Harrmomto(1969). Contribuition to the Biology and ecology of the Oriental fruit fly Dacusdorsalis in Hawaii AgriExpsta tech Ball 31:251-285- Billahm.(2006).Survay trapping protocols first mobile nfruit fly school Activity and Awareness creation on Economically Important fruit flies in Sudan I M P research and training center wafMadeniOrganiZed by L C I PE Nirobi Kenya and ARC Sudan Cinpress
- Butni D.K Delhi(1979) . Insect and fruits periodical Expert Book Agency.
- Carroll L.E(1999).fruit fly Larvechavacterdatar matrix 76 characters for 97 taxa in D. E. Lt A format In F.C Thompson (ed).Fruit fly expert identicationsysem and biosystematics information data base. Dipterpissemination Disk(CD-Rem).(1998).L:Data
- Carroll, L.E,.A.L. Norrbom, F.C. Thompson & N.L. Evenhuis (1999).Bibliograph, pp. 303-513.In Fruit fly

expert identification system and biosystem information database ,(Ed.F.C. Thompson.) myia (1998) 9:524pp. Also Dipter Data Dissemination Disk(CD-Rom)(1998)1:/names/fruit fly /ffessib.pdf

- Carroll,L.E., I.M. White, A. Freidberg& A.L. Norrbom.(1999).Fruit fly adult character data matrices. 213 characters for 60(small) or 193 (large) taxa in DELTA format. In Fruit fly expert identification system and biosysteminformation database. (Ed.F.C.Thompson.) Dipter data Dissemination Disk(CD-ROM) (1998) 1:/fruit fly /fruit fly dat&/ fruit fly 2.Dat.
- Carroll, L.E., I.M. White, A.freidberg,A.L. Norrbom,M.j.Dallwitz,and F.C. Thompson.(2004).Pest fruit flies of the world :

  Identification,descriptions,illustrations, and information retrival. Dipter Data Dissemination Disk (CD-ROM)2.

- Chopra, S,K And R.S Singh,(1971)Studies on Floral biology of gauava (pisiduim guava L.).A review Punjab Hort. J.11.204.
- Clausen ,C.P., Clancy, D.W. and Chock, Q.C. (1978).Biology control of the oriental fruit fly (DacusdorsalisHendel) and other fruit flies in Hawaii. United statesDepartmant of Agriculture, Technical Bulletin 1322:1-102.

❖ Clark,L.R (1957).The ecology of insect population in theory and practice. London.Methuen,232p.

Cochran and Chorchan (1987)

❖ Correia, A.R., Rego, J.M., Olmi, M.(2008).A pest of significant economic importance detected for the first time in Mozambigue:Bactrocerainvadens Drew, Tsuruta&White (Diptera:Tephritidae: Dacinae). Bolletino di ZoologiaAgreriae diBachicolturaSerie 40(1),9-13.

❖ Dallwitz, M.J.(1980). A. paine and E.j. Zurcher.(1993). Onwards.User,s guide to the DELTA System: ageneral system for processing taxonomic descriptions 4th edition .http://delta- intkkey.com.

❖ Dallwitz, M.J., (2000)onwards . comparison of the main screans of Intkey and lucid.http://delta- intkey.com

Deng, A.L.(1990).Studies on the behavior, host range , srasonal abundance and chemical control of the med fly ceratitiscapitata(Wieddmann) in Sudan . M.Sc. Thesis, university of Khartoum.

❖ Drew, R.A.I.(1989)the tropical fruit fly (Dipter:tephritdae: Dacinee)of the Australasian and Oceanian regions. Memoirs of the Queensland Museum,26,1-521.

❖ Drew, R.A.I.,Romig, M.C.&Dorji, C.(2007)Records of Dacine fruit flies and new species of Dacus (Dipter

:Tephritidae) in Bhutan.TheRafles Bulletin of Zoology,55,1-21.

- Drew,R.A.L., Tsuruta,k.&White, I.M.(2005)Anew species of pest fruit fly (DipterTephritidae :Dacinae) from Sri Lanka and Africa.African Entomology,13,149-154.
- Duke,J.A.AndK.k.Wain (2007) Medicinal plant of the world computer index with more than 85.000 entries.3volumes .
- EKesi,S., Nderitu, P.W.&RWomushana, I.(2006)Field infestion, life history and demographic parameters of the fruit fly Bactrocerainvadens (Dipter:Tephritidae) in Africa Bullentin of Entomological Research,96,379-386.
- EKesi, S.,Nderitu, P.W. & Chang, C.L.(2007).Adaptation to and small-scale rearing of invasive fruit fly Bactrocerainvadens (Ditera: Tephritidae) on artificial diet. Annals of the Entomological Society of America ,100,562-567.
- Ekesi,S., Billah,M.K., Nderitu, P.W., LuX, S.A &Rwomushana L. (2009). Evidence for competitive displacera of Ceratitiscosyraby the invasive fruit fly Bactrocerainvadens (Diptera: Tephritidae)on mango and mechanisms contributing to the displscement. Journal of Economic Entomology,102,981-991.
- Elhewieris, O.M.(2003).Studies on the biology of ceratitiscosyra (Dipter:tephritidae).On mango fruits in

Sinnar state Sudan M.Sc thesis ,Faculty of Agriculture university of Sinnar,Sudan.

- Elshafie,H.I.(2007).The effect of the cafur ,and rehan organic extract compared to other chemical and biological stander insecticidae on Anopheles arabeins, patonMusguto.Ph.Dtheis . faculty of Agricultral studies, Sudan university of Science and Technology.