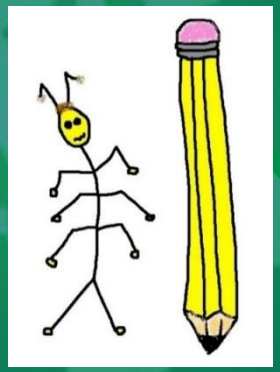
We should be ahead of it

Hanem F. Khater

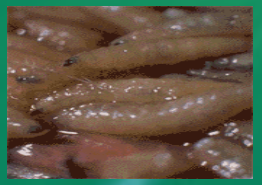
Professor of Parasitology, Benha University, Egypt
School of Biological Sciences, Bristol University, UK

Vector resistance to pesticides:

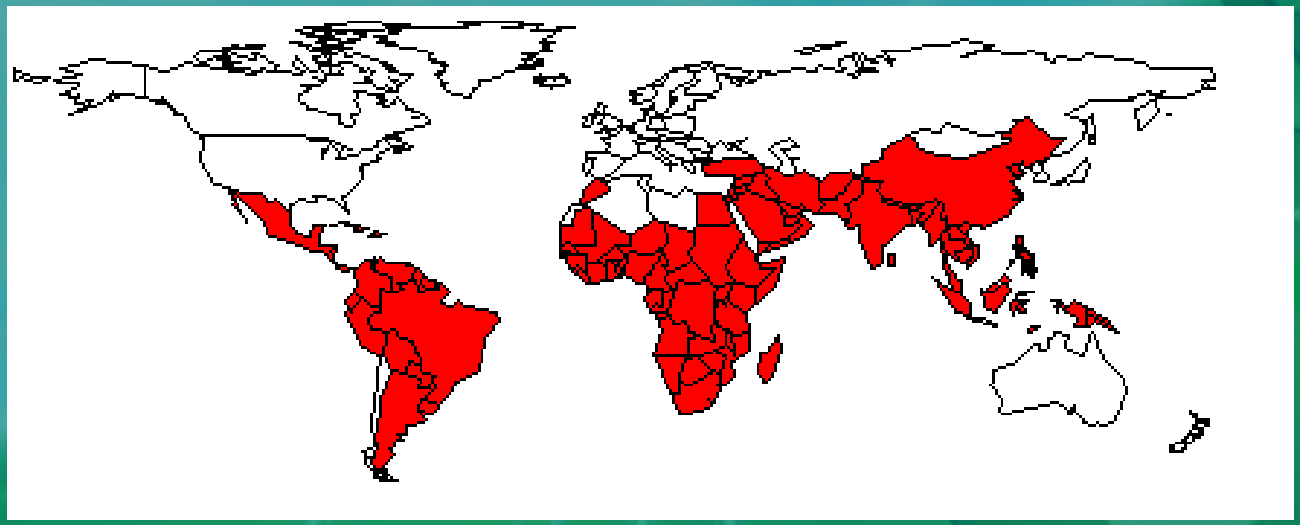


Arthropods

Transmit diseases to humans and animals
Damage agricultural crops and harvested food.



WHO map showing area affected by malaria



Malaria is a tropical disease today >> it's range once extended into Western Europe and as far north as the Ohio River Valley in North America.

The architect

Imhotep

One of the founders of “pharaonic” medicine

Given credit for using of oils, herbs
and aromatic plants for medicinal purposes.

Doctor, architect
The main chancellor of king Zoser
(2780 - 2720 BC).

Using botanical insecticides

dates back at least two millennia in ancient civilizations

ANCIENT CIVILIZATIONS

- Ancient Mesopotamia
- Ancient Egypt
- Ancient India
- Ancient China
- Ancient Greece
- Ancient Rome

World War II

Malaria was the most important health hazard encountered by U.S. troops in the South Pacific during World War II

About 500,000 men were infected.

According to Joseph Patrick Byrne, "Sixty thousand American soldiers died of malaria during the African and South Pacific campaigns.

Insecticides

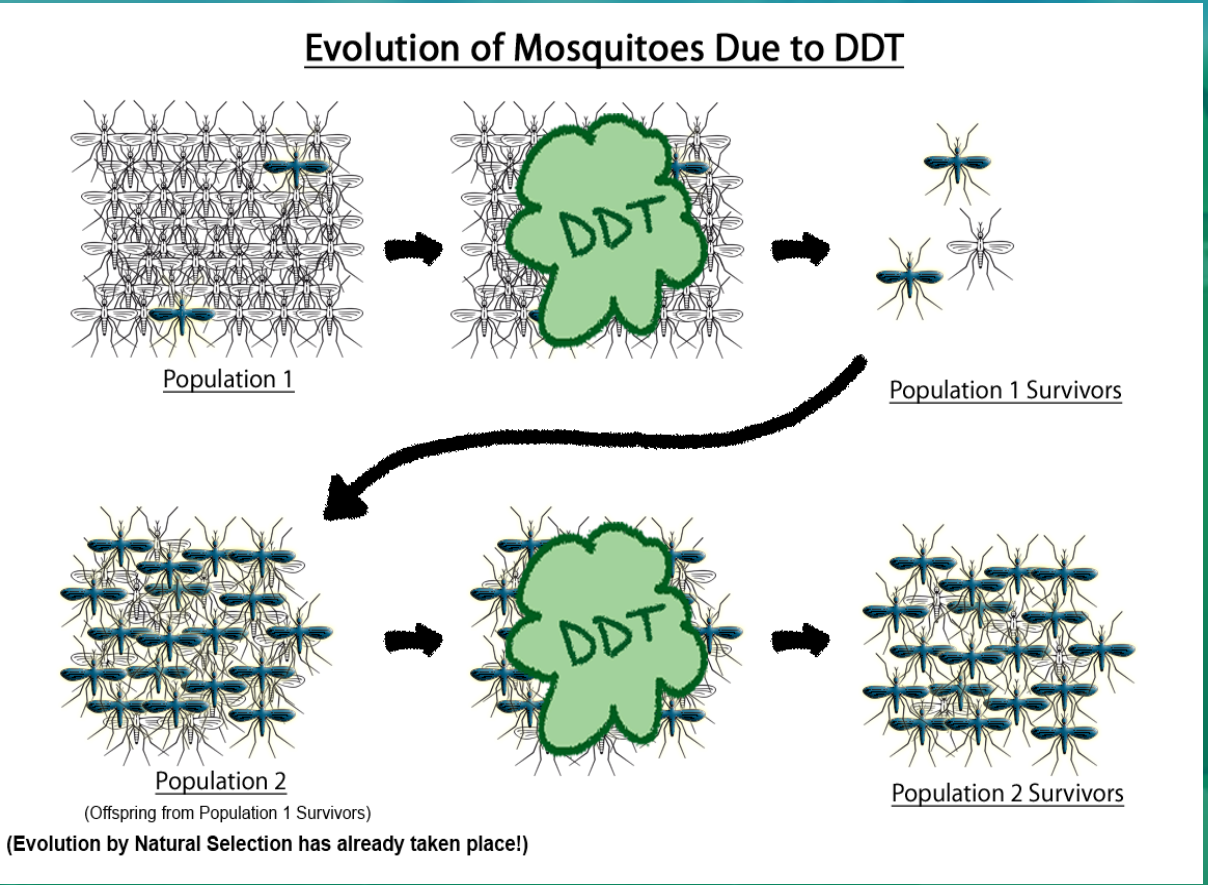
WWII open the modern era
of chemical control with DDt

Insecticides

World Health Organization Assembly

Proposed the global eradication malaria by the use of residual house- spraying of DDT in 1955

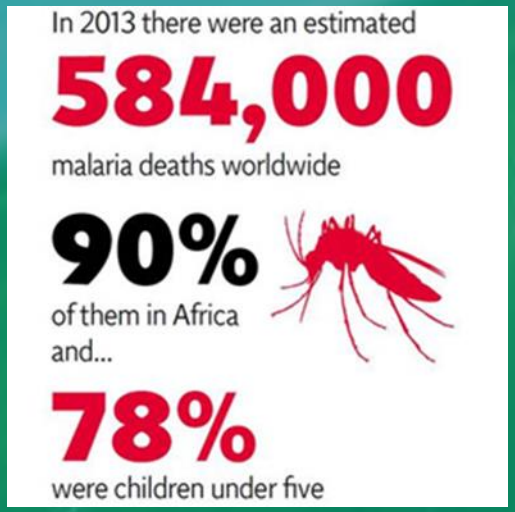
Resistance against DDT



Malaria control

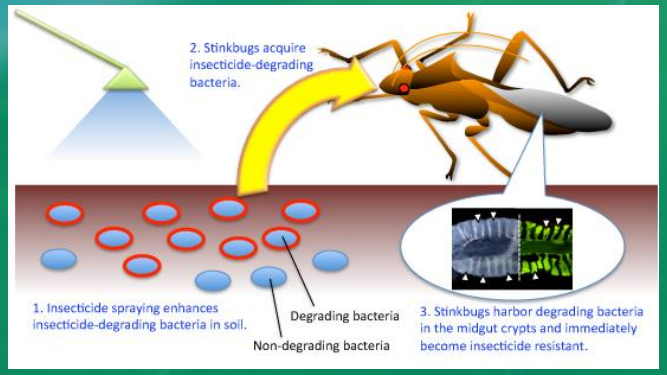
In 1967:

WHO reverted form malaria eradication to malaria control because of mosquito resistance against DDT



Insect resistance

The umbrella of insect resistance has covered newer insecticides ex. organophosphates, carbamates, and pyrethroids



Health & environmental hazards

Synthetic insecticides induce

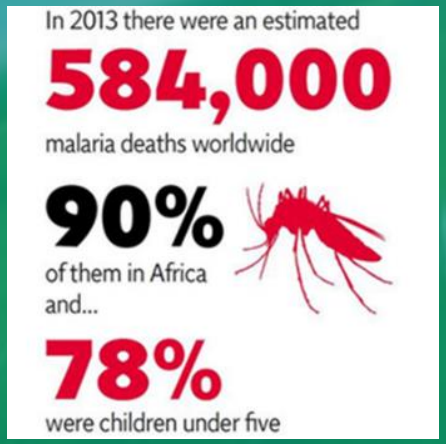
- **Environmental contamination**
- **Toxicity to non-target organisms**
- **Negative effects on animal and human health.**

ACUTE & CHRONIC TOXICITY

Re-emergence of diseases

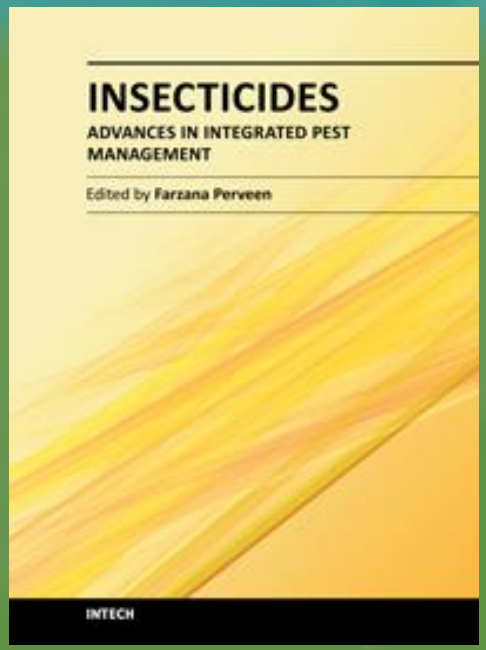
A dramatic re-emergence of epidemic vector-borne diseases has been reported in the past 30 years throughout much of the world.

Natural and Safe Alternative Strategies



Alternative Insect Control Strategies

Alternative Insect Control Strategies




2

Ecosmart Biorational Insecticides: Alternative Insect Control Strategies

Hanem Fathy Khater

1. Introduction

Hanem Fathy Khater (2011). Ecosmart Biorational Insecticides: Alternative Insect Control Strategies. In Farzana Preveen (Ed.) Insecticides - Advances in Integrated Pest Management. ISBN: 978-953-307-780-2, InTech, Croatia..

Biorational Insecticides

Derived from two words

"Biological" and "Rational"

Have limited or no adverse effects on the environment, non- target organisms and humans.

Include:

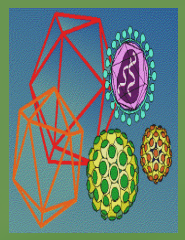
- Biochemicals
- Biological
- Transgenic insecticides

(Genetically modified plants or organis

Classification of Biorational Insecticides

***Alternatives emerge for regulated chemical products*.**

Biological



Microbials

Bacteria

Viruses

Fungi

Protozoa

Nematodes

Prdatators

Parasitiodes

Biochemicals

Botanicals

Pheromones

Photoinsecticides

Inorganics

IGRs

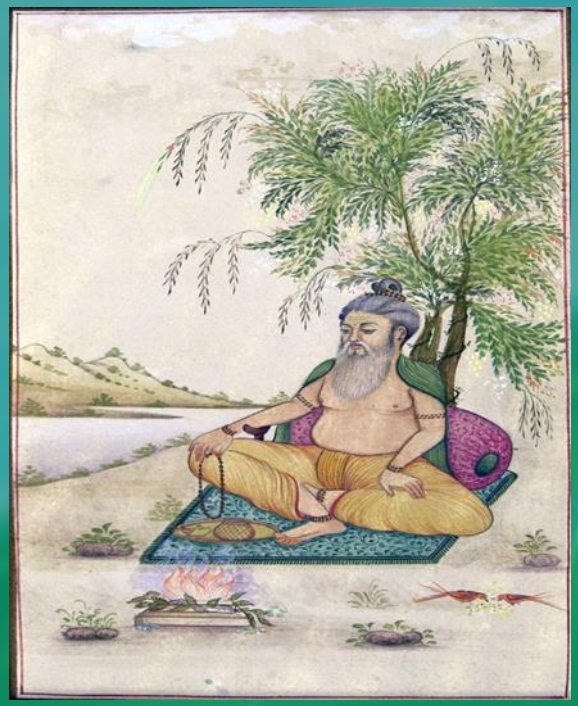
Botanicals

Old: Pyrethrum & Other traditional

New: Neem & Essential oils

BacktoNature

Neem



Great repellent

Active principle: azadirachtin

Neem

Azadirachta indica A. Juss

- acaricidal and insecticidal
- Anthelmintic
- Antiprotozoal
- antibacterial
- Antifungal
- Antiviral
- antipyretic
- Immunostimulant

Neem

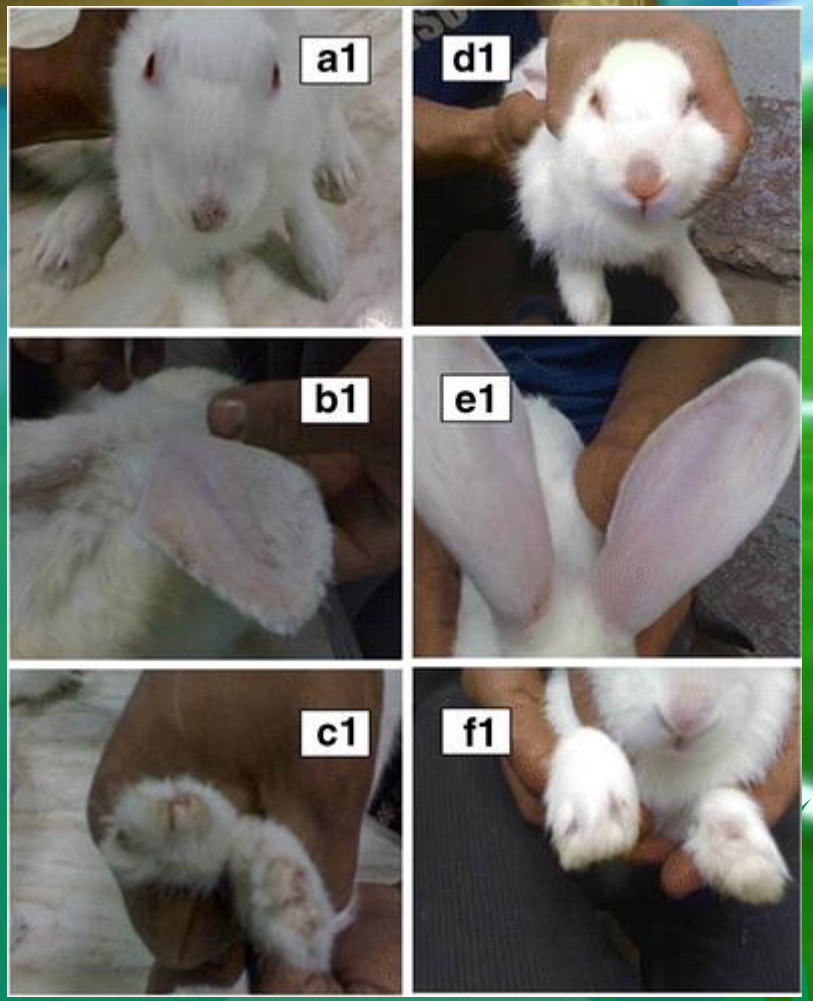
Actions:

1.Anti-feedant
2.IGR (ecdysone blocker)
3.Oviposion deterrence
4.Female sterility

Over 100 commercial neem formulations:
Margosan-O, Bio-neem, Azatin, , Neemies, Safer's ENI, Wellgro, RD-Repelin, Neemguard, Neemark, and Neemaza.

Neem + *S. scabiei*

- Crude aqueous extract of neem had *in vitro* and *in vivo* acaricidal efficiency similar to that of ivermectin against *S. scabiei var. cuniculi*. .
- It improved the growth performance (body weight and gain) of rabbits infested with *S. scabiei var. cuniculi.*



Seddiek, S.A., **Khater, H.F.**, El-Shorbagy, M.M., and Ali, M.M.A. (2013d). The acaricidal efficacy of aqueous neem extract and ivermectin against *Sarcoptes scabiei var. cuniculi* in experimentally infested rabbits. *Parasitology Research*. 112:2319–2330. DOI 10.1007/s00436-013-3395-2.
http://link.springer.com/article/10.1007%2Fs00436-013-3395-2
http://link.springer.com/article/10.1007%2Fs00436-013-3395-2

Essential oils

Generally Recognized As Safe BY THE EPA

Uses in embalmment, preservation of foods and as antimicrobial, analgesic, sedative, anti-inflammatory, spasmolytic, anticarcinogenic, and locally anesthetic remedies

Actions against insects:

*** Ovicidal, larvicides, adulticides, repellents, IGRs, chemosterilant.**

Alter insect feeding growth, development, molting, and behavior during mating and oviposition.

Contain manily monoterpenoids:

Ex. Cinnamaldehyde, Eugenol, limonine, cineole, graniol, and piperidine

Insect repellents

Lavander

coriander االكسبرة

marigold

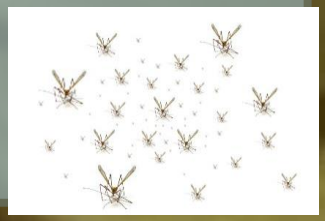
Geranium

الأقحوان

Chrysanthemum

Peppermint, Lemongrass,

Cedarwood, Patchouli بتشول, Ageratum



Planting repellent plants

tomato leaves

eucalyptus

basil الريحان

catnip النعناع البري

Bay leaves ورق الغار

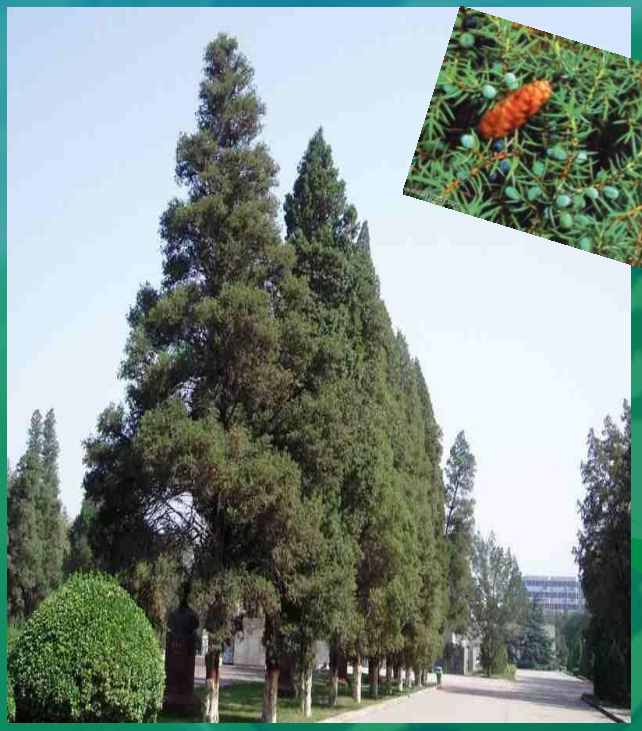
Lemon grass حشيشه الليمون

Planting repellent plants

:

Citronella

Artemisia



Juniper العرعر وثماره

Fumigants effect

Eos (Products)

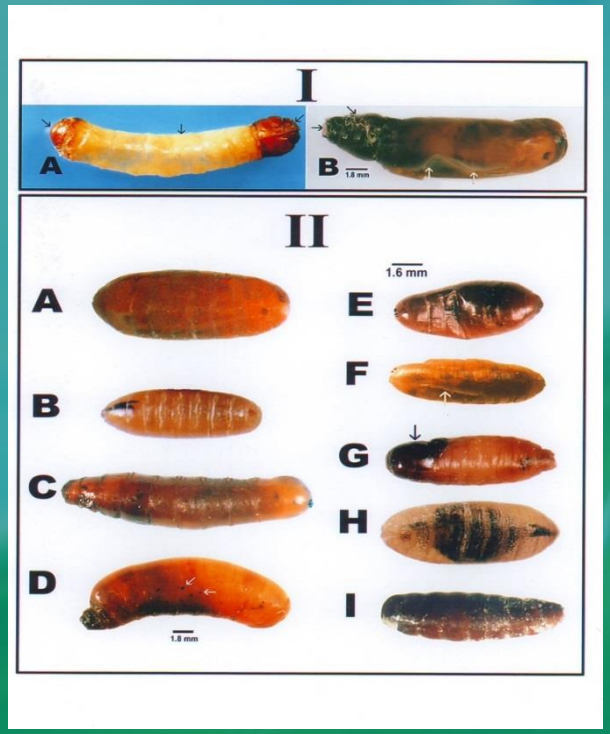
Green Ban® (containing oils of citronella, cajuput, lavender, safrole free sassafrass, peppermint, and bergaptene free bergamot oil)

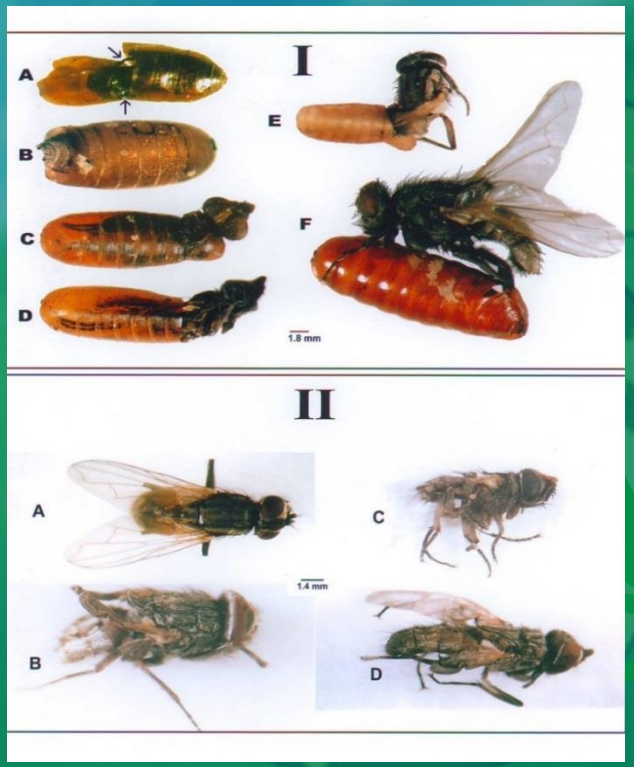
Buzz Away® (containing oils of citronella, cedarwood, eucalyptus, and lemongrass)

d-limonene is an active ingredient of commercially available flea shampoos pulegone and citronellal are used as mosquito repellents.

Generally recognized as safe, GRAS, by the US Food and Drug Administration. constituents or even a Complete essential oils are more effective than individual combination of constituents.

House flies, *Musca domestica* treated with IGRs and botanicals

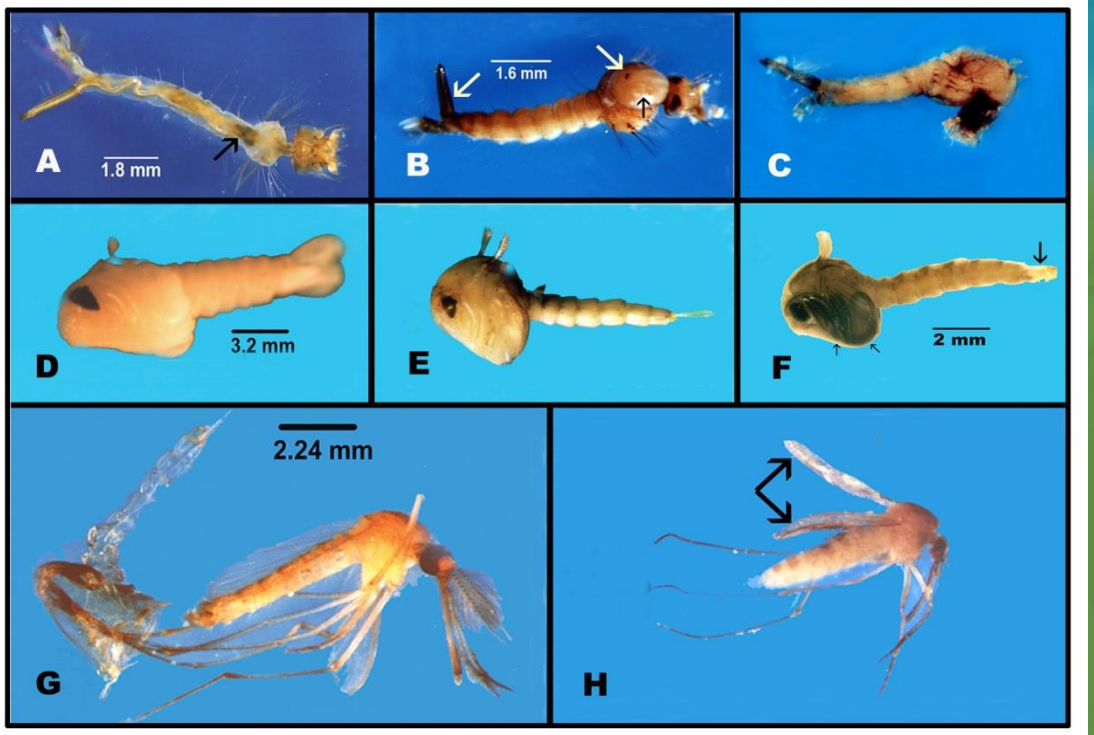




Adapted from

Khater H F. 2003. Biocontrol of some insects. Ph.D thesis, Zagazig University, Benha Branch, Benha, Egypt. 151p.

Mosquitoes, *Culex pipiens*,



Botanicals:

onion, nigella, and sesame oils.

Insect Growth Regulators (IGRs):

Diflubenzuron (Dimilin ®)

Pyriproxyfen (Sumilarve ®)

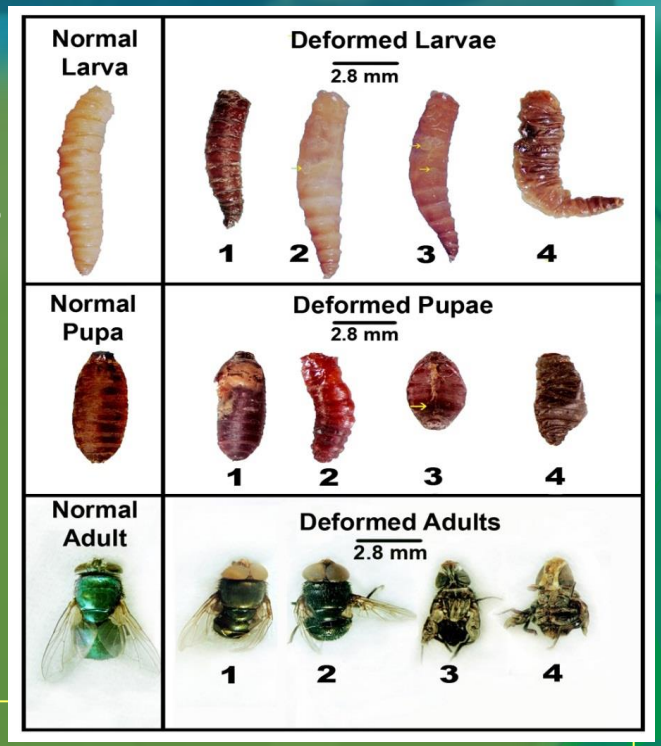
Adapted from

Khater H F. 2003. Biocontrol of some insects. Ph.D thesis, Zagazig University, Benha Branch, Benha, Egypt. 151p.

Khater, H.F. and Shalaby, A.A. (2008). Potential of biologically active plant oils for control mosquito larvae *Culex pipiens* (Diptera: Culicidae) from an Egyptian locality. *Revista do Instituto de Medicina Tropical de Sao Paulo*. 50 (2): 107-112.

Myiasis- producing fly,
Lucilia sericata

3rd larval instars of
Blowflies treated with essential oils



Lettuce, chamomile, anise, and rosemary

Fenugreek, celery, radish, and mustard

Adapted form:

1- Khater HF, Khater DF. 2009. The insecticidal activity of four medicinal plants against the blowfly *Lucilia sericata* (Diptera: Calliphoridae). *Int J Dermatol* 2009; 48: 492-497.

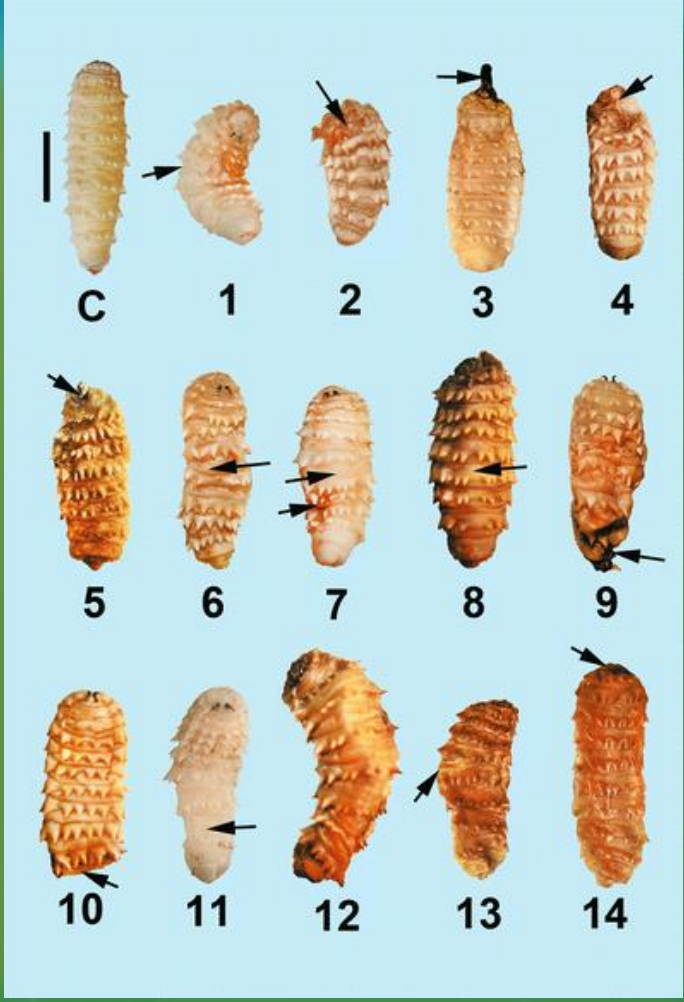
2- Khater, H.F., Hanafy, A.M., Abdel- Mageed, A.D., Ramadan, M.Y., and El- Madawy R.S. (2011). Control of the myiasis-producing fly, Lucilia sericata, with Egyptian essential oils. International Journal of Dermatology. 50: 187–194.

Myiasis- producing fly

Cephalopina titillator

Cephalopina titillator

Essential oils of pumpkin, lupines, garlic and peppermint against the third larval stage of *C. titillator* using larval immersion tests.



Source:
Khater (2014) Bioactivities of some essential oils against the camel nasal botfly, *Cephalopina titillator*. Parasitol Res (2014) 113:593–605.

Cephalopina titillator

Essential oils of **pumpkin, lupines, garlic and peppermint** against the third larval stage of *C. titillator* using larval immersion tests.

Source:
Khater (2014) Bioactivities of some essential oils against the camel nasal botfly, *Cephalopina titillator*. Parasitol Res (2014) 113:593–605.

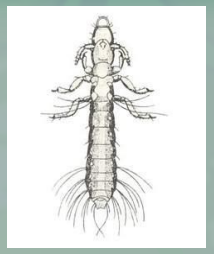
Camphor oil + pigeon lice *Columbicola columbae*

***In vitro* treatments**

All lice were died within an hour PT with camphor oil, 1%.

***In vivo* treatments**

infestations were completely eliminated 7 days post-treatment with camphor and *d*-phenothrin and 14 days PT with deltamethrin.



With breathless anticipation, the crowd awaits the unveiling of the Obama statue

Source:

Khater, H.F., El-Shorbagy, M.M., and Seddiek S.A. (2014) Lousicidal efficacy of camphor oil, d-phenothrin, and deltamethrin against the slender pigeon louse, *Columbicola columbae*. International Journal of Veterinary Science and Medicine. DOI: 10.1016/j.ijvsm.2013.12.003.

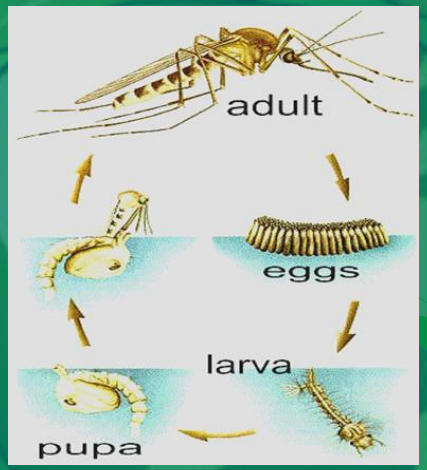
Insect Growth Regulators

Chemical compounds alter growth and development of insects

Affect insect hormones

1- Ecdysteroid agonist
2- JH analogues
3- Anti JH

Juvenile hormones (JH)
Prevent insects from maturing→
Force an insect to remain in its juvenile stage (immature, caterpillar or grub stage).



Insect Growth Regulators

Chemical compounds alter growth and development of insects

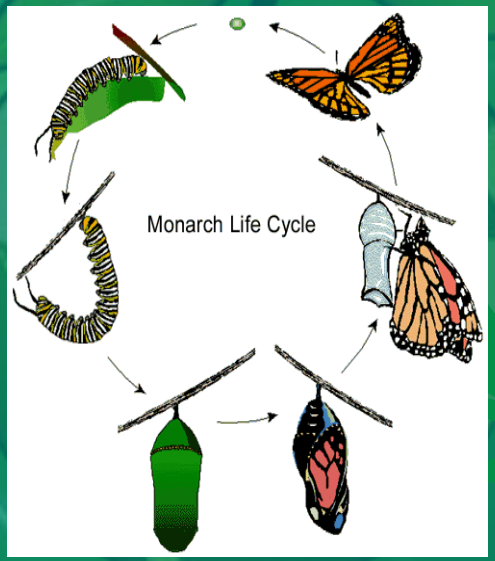
Chitin synthesis inhibitors

Inhibit the production of chitin >> an insect is unable to produce new exoskeletons (skin).

insects cannot survive.

Appropriate control product for the turfgrass insect pests

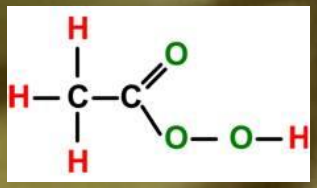
1- Benzoylphenylurea
2- Triazine/pyrimidine derivatives



Acids

Peracetic acid (PAA)

acaricide) >> 1st time



Khater et al. (2009; 2013)

Highly effective when used at lower doses and short exposure time against:

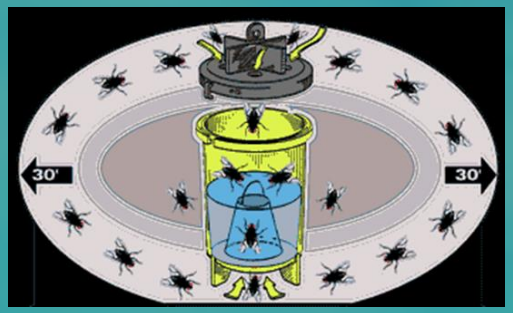
- ✓ ***Boophilus annulatus* (in vitro)**
- ✓ ***Argus persicus* (in vitro and in vivo) than DMT.**

The high speed of killing ticks is very important for avoidance of the hazard ensued by pathogen transmission in the course of delayed mortality caused by the currently used acaricides.

Sources:

1. **Khater, H.F.**, Seddiek, S.A., El-Shorbagy, M.M., and Ali, M.M. (2013e). The acaricidal efficacy of peracetic acid and deltamethrin against the fowl tick, *Argas persicus*, infesting laying hens *Parasitology Research*. 112 (1): 259-269.
2. **Khater, H.F.**, Ramadan, M.Y., and El- Madawy, R.S. (2009).The lousicidal, ovicidal, and repellent efficacy of some essential oils against lice and flies infesting water buffaloes in Egypt. *Veterinary Parasitology*. 164: 257-266.

Insect pheromones



A class of semiochemicals that insect release to communicate with other individuals of the same species

-Sexual attraction
-Dispersion
-Alarm or warning.
- Oviposition (egg laying)
-Aggregation

USES OF PHEROMONES:

- Male trapping
- Movement monitoring
- Detection and population monitoring
- Confusion.

Fly traps

sticky fly paper

Join the crowd

As soon as a few flies get trapped, others can't wait to join them.

Fly traps

- More effective than pesticides!
  - More economical and certainly far safer!
- Flies come in... but they can't get out!

Effective even against pesticide resistant flies!

- 18 Billion Flies Can’t Be Wrong!

Photoxicity of Rose Bengal against the Camel Tick, *Hyalomma dromedarii*

Hanem F. Khater

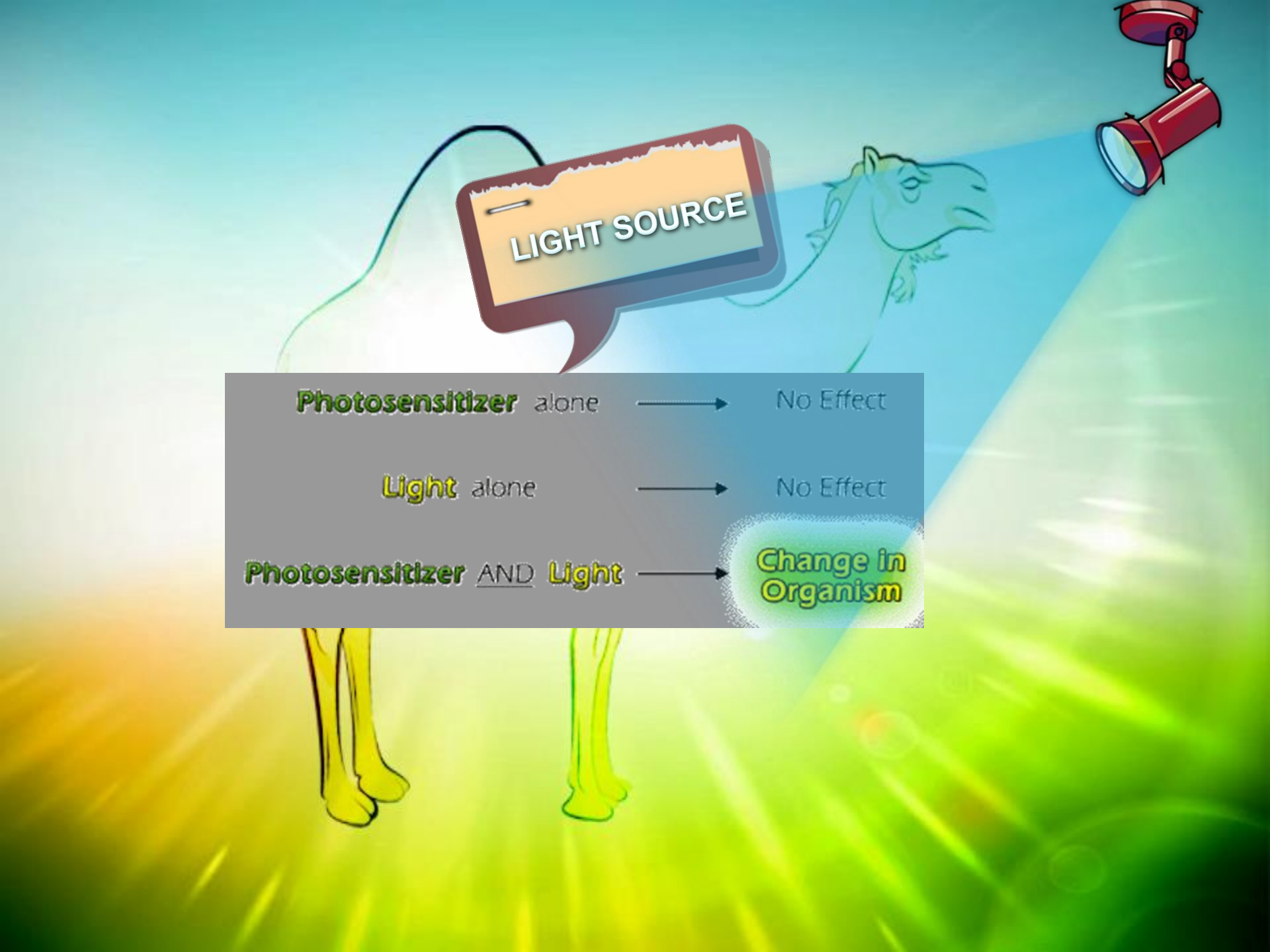
And Nabil I. Hendawy

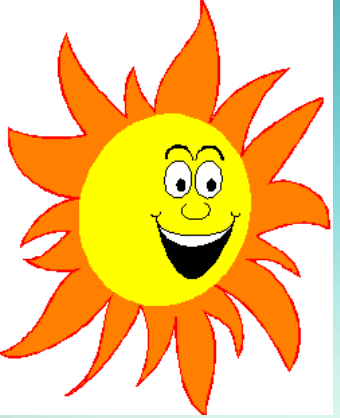
International Journal of Veterinary Science
3(2): 78: 86 (2014)

A photoactive compound
(photosensitizer)

Accumulates within the insect body and exposure to visible light >> lethal photochemical reactions >>>> death of the organism.

It is an organic chemical that uses light energy to "catalytically" generate toxicity.


LIGHT SOURCE
Photosensitizer alone
No Effect
Light alone
No Effect
Photosensitizer AND Light
Change in Organism

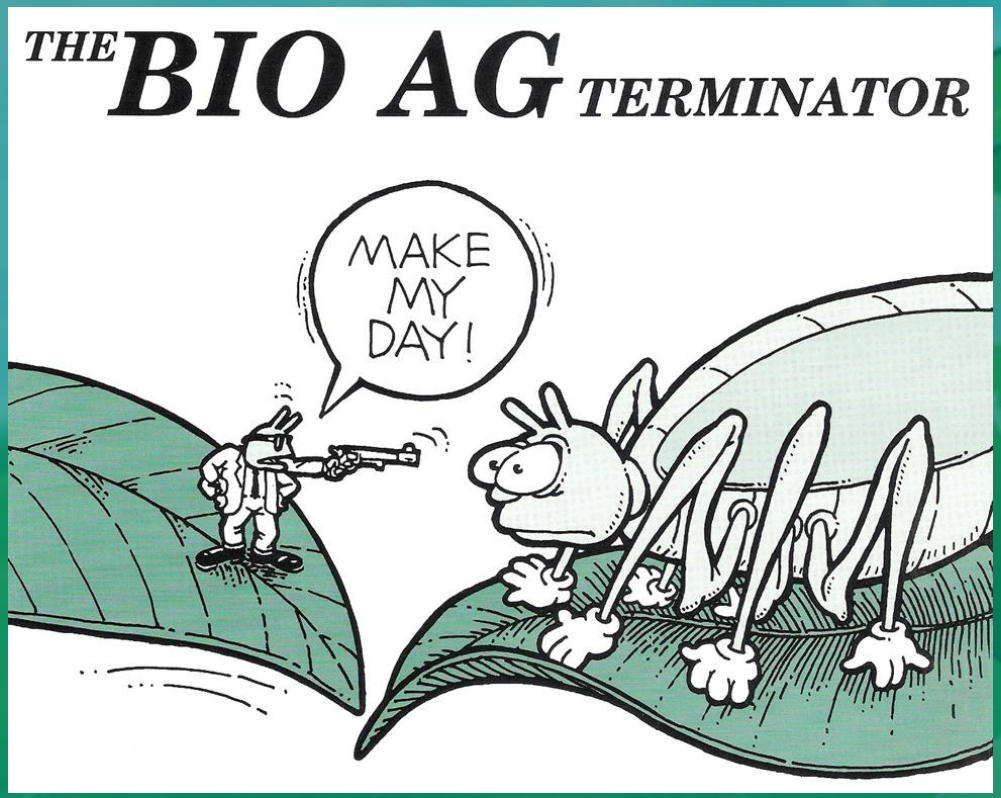


Rose bengal is highly effective than ivermectin when used at lower doses and
for short exposure time.

If we expose ticks to RB for 1400 second illuminated by the used light source >>> we would get the same effect after exposure to sun light for 1 second.

This is a very practical point as camels live in the desert where sun light is available all the year round.


LIGHT SOURCE



Biological

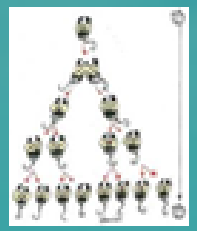
Microbials
Bacteria
Viruses
Fungi
Protozoa
Nematodes
Prdatators
Parasitiodes

Classical biological control

1. Conservation of existing natural enemies
2. Introducing new natural enemies
3. Establishing a permanent population

Massive rearing and release

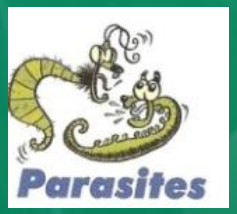
Microbial Insecticides



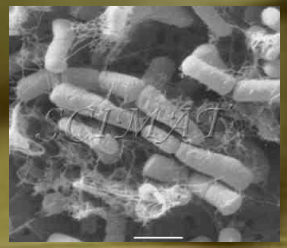
- **Insecticides that contain microorganisms or their by-products (toxins).**

Living organisms:

(viruses, bacteria, fungi, protozoa, or nematodes)



Bacteria



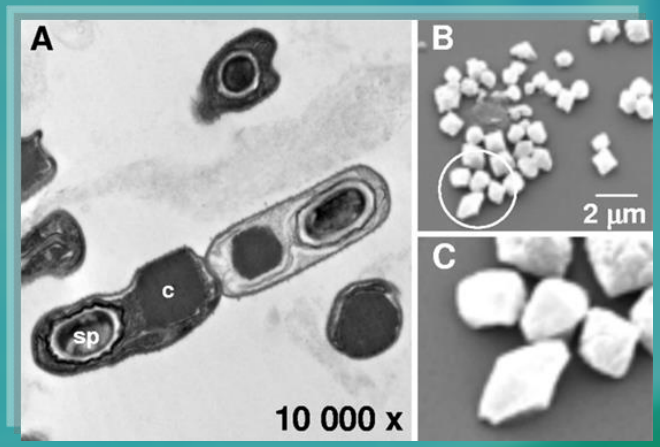
Bacillus thuringiensis (Bt)

- Spore-forming, rod-shaped
- occur commonly in soils
- Gram positive

Specificity

- an entire order of insects
- one or a few species

Endotoxin of *Bacillus spp*



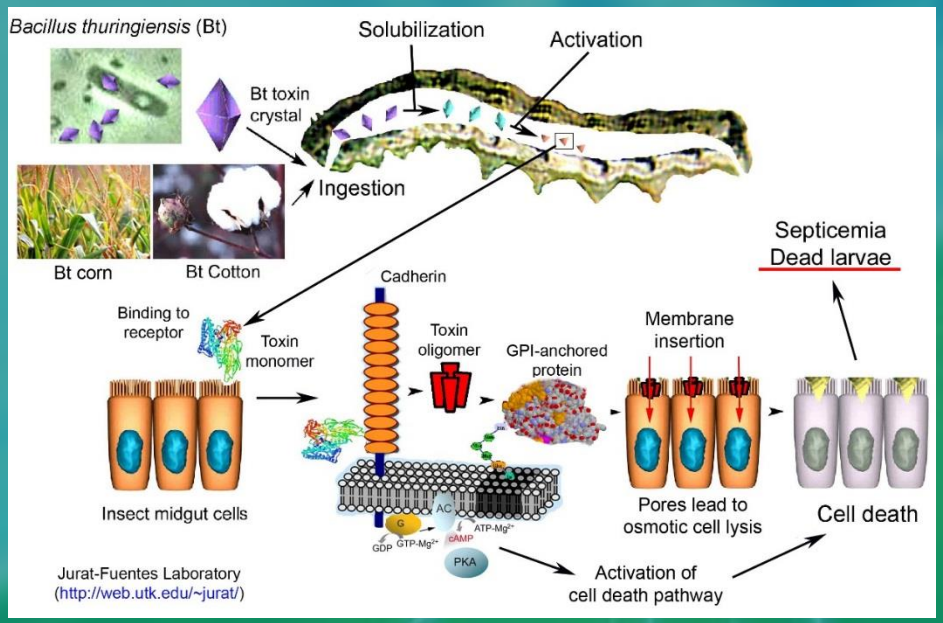
Forest tent caterpillar killed by *Bacillus thuringiensis*

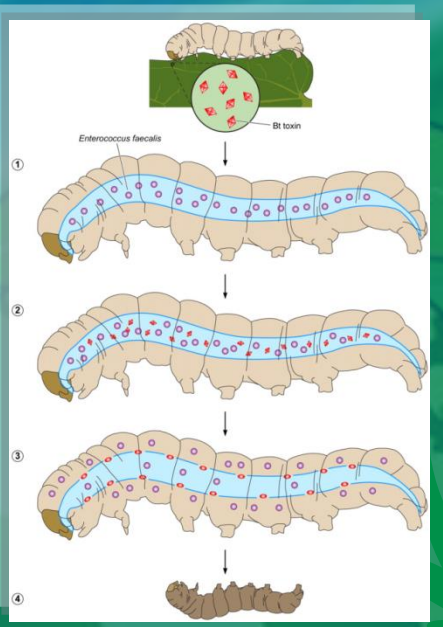
Morphology of insecticidal crystals produced by the IS5056 isolate of *B. thuringiensis* subsp. *thuringiensis*. (A) Transmission electron micrograph of sporulated cells. (B) Scanning electron micrograph of purified crystals. (C) Higher magnification (×3.6) of crystals in the area circled in panel B. sp, spore; c, crystal.

- **When the conditions for bacterial growth are not optimal**

→→ *B. thuringiensis*, like many bacteria, forms spores (dormant stage) >> spore endotoxin

Bacillus thuringiensis (Bt)





***B. thuringiensis* (Bt) toxins**

cry →→ crystal protein →→ I, II, III, IV

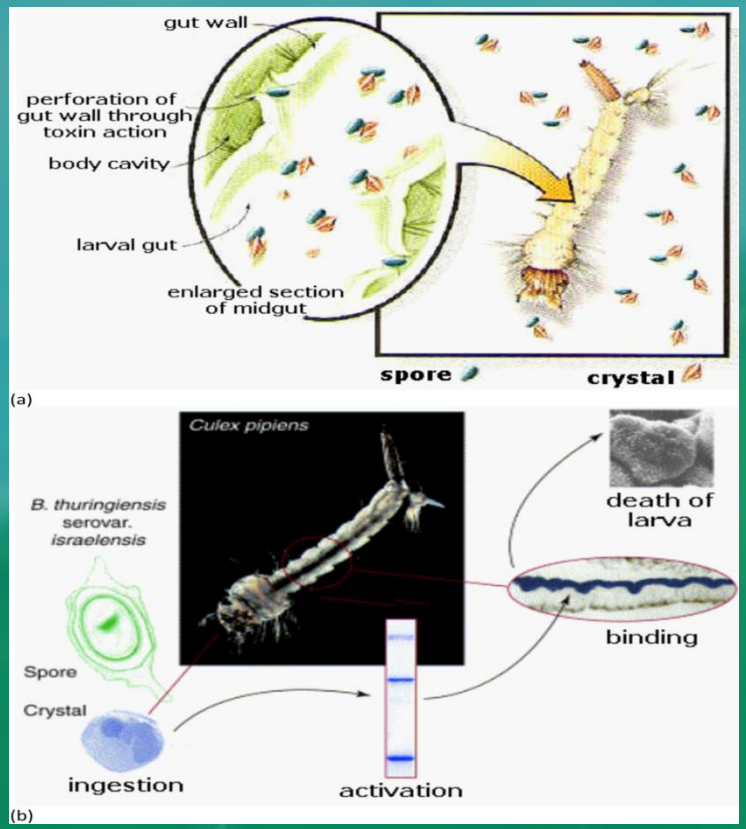
cyt →→ cytolysin protein

BS Bin (Binary toxins →→ A & B

Commercial products: protein toxin only
protein toxin and spores

Pathogen	Product Name	Host Range
***Bacillus thuringiensis* var. *kurstaki* (*Bt*)**	Bactur®, Bactospeine®, Bioworm®, Caterpillar Killer®, **Dipel®,** Futura®, Javelin®, SOK-Bt®, Thuricide®, Topside®, Tribactur®, Worthy Attack®	a wide array of caterpillars (larvae of moths and butterflies)
***Bacillus thuringiensis* var. *israelensis* (*Bt*)**	Aquabee®, Bactimos®, Gnatrol®, LarvX®, Mosquito Attack®, Skeetal®, Teknar®, **Vectobac®**	larvae of *Aedes* and *Psorophora* **mosquitoes,** black flies, and fungus gnats
Bacillus thuringiensis* var. *tenebrinos	Foil®, M-One® , M-Track®, Novardo®, Trident®	larvae of Colorado potato beetle, elm leaf beetle adults
Bacillus thuringiensis* var. *aizawai	Certan®	wax moth caterpillars
Bacillus popilliae* and *Bacillus lentimorbus	Doom, Japidemic,® Milky Spore Disease, Grub Attack®	larvae (grubs) of Japanese beetle
Bacillus sphaericus	Vectolex CG®, Vectolex WDG®	larvae of *Culex*, *Psorophora*, and *Culiseta* mosquitos, larvae of some Aedes spp.

Bacillus sphaericus



Bti:
for application to sensitive water bodies.

Bacillus sphaericus:
control mosquito larvae breeding in polluted water.

Transgenic pesticides

Genetically modified organisms (GMO) and crops (GMC)

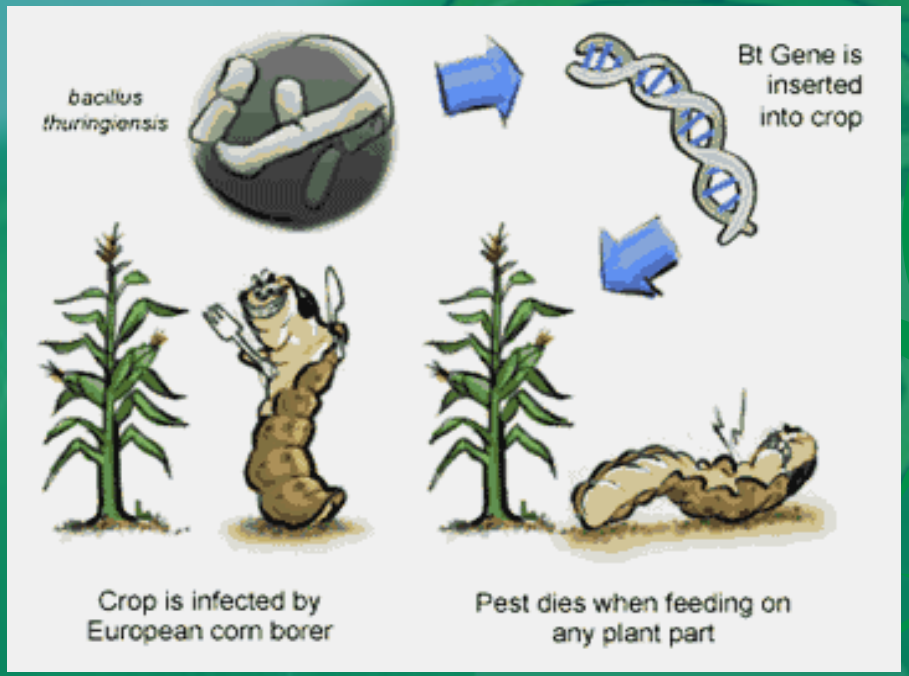
Genetically altered by artificial introduction of DNA form another organism

Genetic Engineering For Pest Control

GM crop: genetically modified (corn, rice, cotton)

Transgenic corp.: have a gene form an insect pathogen (Bt) which encodes protein toxin to European corn borer (Tunneling insect)

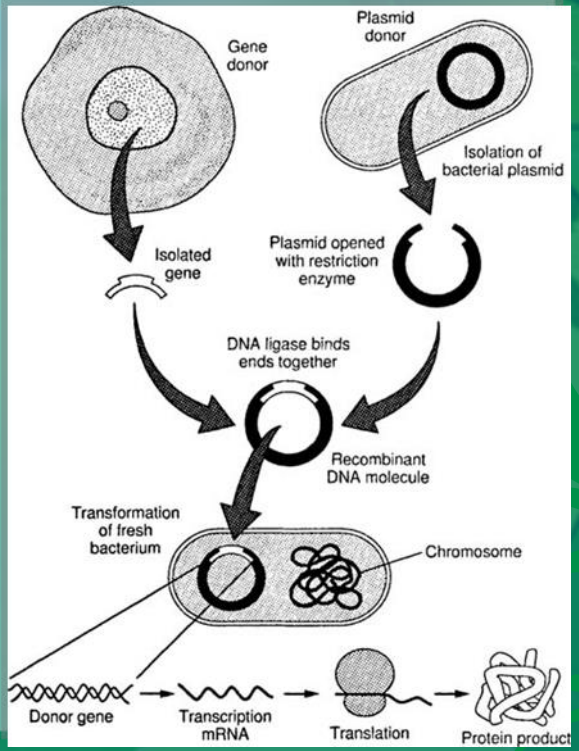
حفار ساق الذرة الأوروبي



Genetic Engineering For Pest Control

Cloning various toxin genes into host organism's increase the persistence or the insecticidal properties and delays resistance.

To overcome resistance:
Cry + Cyt
Cyt + BS Bin



Recombinant bacteria

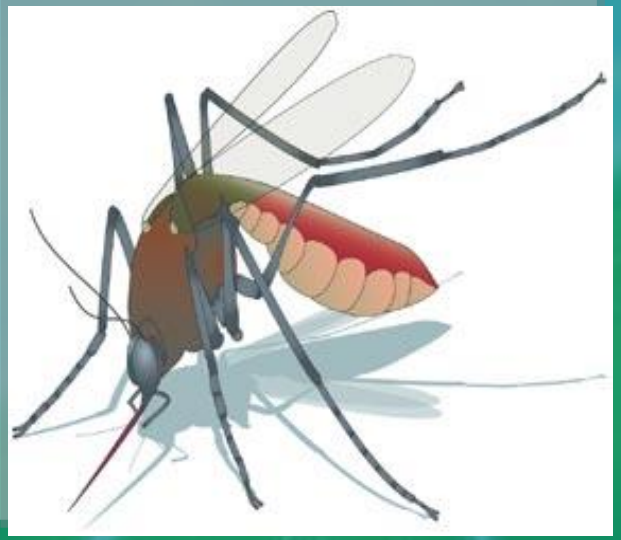
Improves the efficacy of Bti through combining the most potent insecticidal proteins from Bti, Btj, and Bs into new bacterial strains.

Ten-fold more toxic than wild type species of Bti and Bs used in current commercial formulations.

New bacterial larvicides offer environmentally compatible options for use as components in integrated vector control programs aimed at reducing malaria, filariasis, and many important viral diseases

Cost >> as new chemical insecticides

Transgenic insects
genetically modified organisms, GMOs



Genetic modification of mosquitoes >> for controlling malaria.
To replace or suppress wild vector populations
To reduce transmission and deliver public health gains.

Entomopathogic Fungi

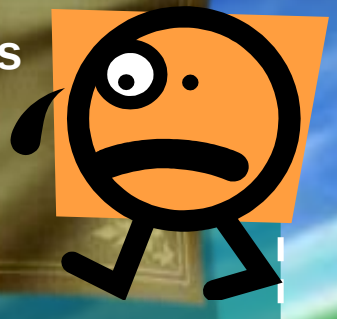
- *Spread by asexual spores (**conidia**)*

- **Mode of action**

- **Viable conidia reach a susceptible host→→ *germination on the insect cuticle* →→ penetrate the cuticle →→ enter the insect's body**

PEST SPECIFIC

Control only a portion of the pests present in a field, garden, or lawn



Limited market

not available
expensive

UV
Heat
Desiccation

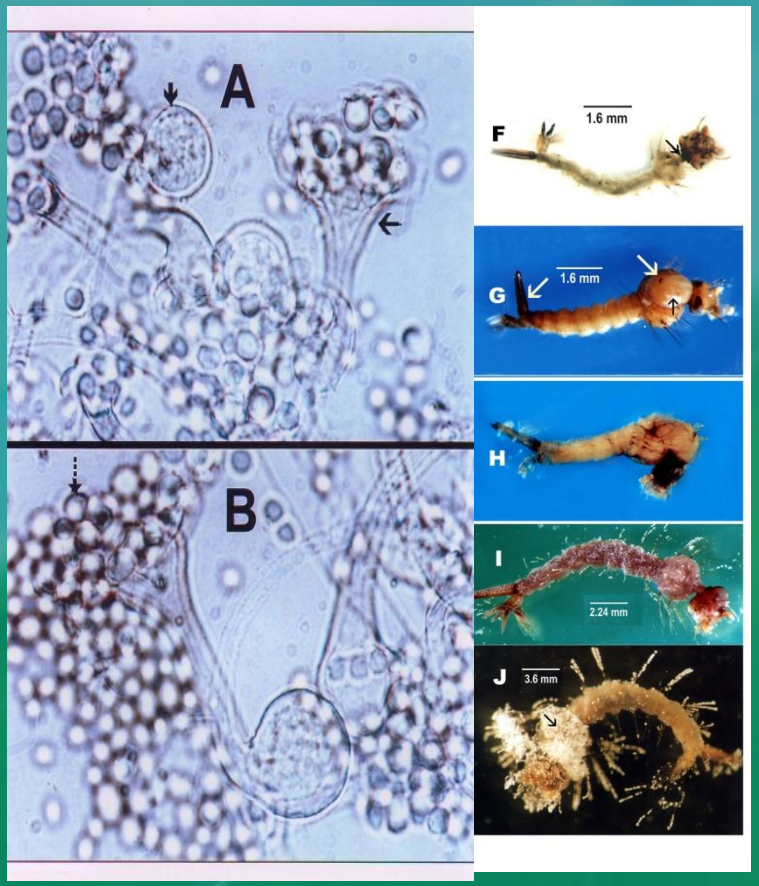
REDUCE EFFECTIVENESS

Disadvantages of Microbial Insecticides

Proper timing

Application procedures are important

Oomycetes (water molds)
Lagenidium giganteum



Adapted form Khater (2003)

Oospores (sexual stage):

resistant to desiccation
mechanical abrasion
stable for 7 years.
.

Infective stages

1- Motile biflagellate zoospores (asexual)
2- oospores (sexual)

Laginex®:

90% control of mosquito larvae in rice fields in California

Hyphomycetes
Beauveria bassiana & Metarhizium anisopliae


Beauveria bassiana

Cause natural outbreaks to a wide range of insect hosts,

B. bassiana >>

white muscadine disease

The fungi may survive in the soil through recycling in insects
Provide a long-term strategy for larvae, puparia, and adult control

Hyphomycetes

Beauveria bassiana

Products based on *B. bassiana* are Mycotrol O (Emerald BioAgriculture), Naturalis Home and Garden (H&G), Naturalis L (Troy BioSciences, Inc.), and Biosect® (Kafr El Zayat - KZ Chemicals, Egypt)

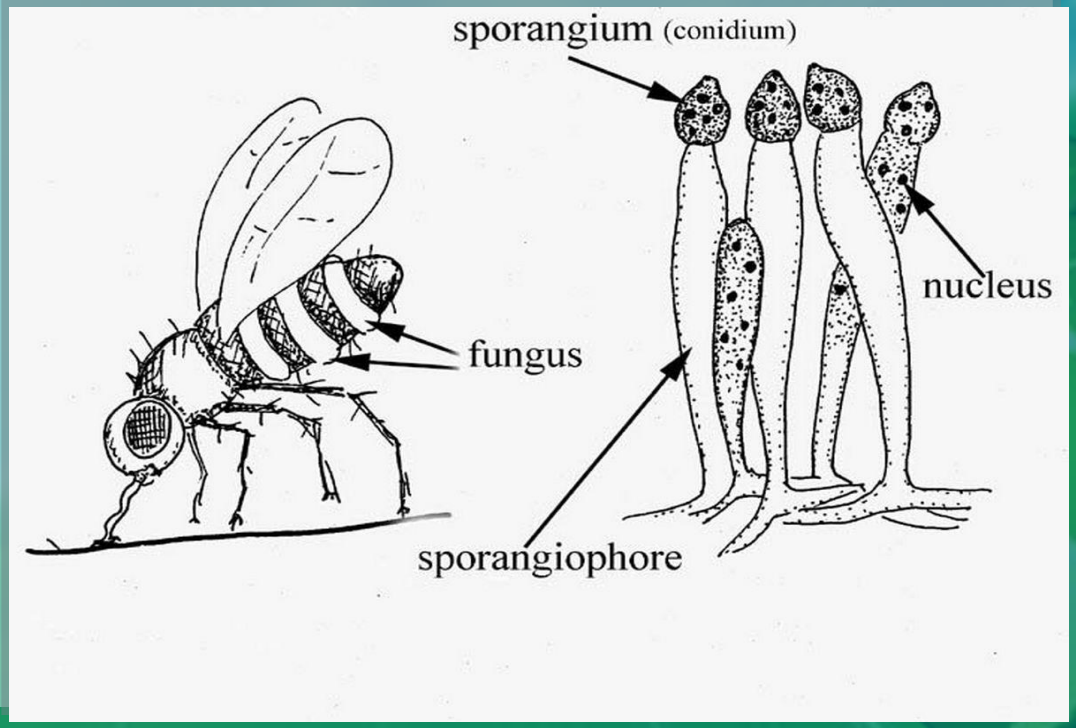
USING BEAUVERIA BASSIANA FOR INSECT MANAGEMENT

Environmental safety is good

- **Generally non-toxic to beneficial insects, however, applications to areas where bees are actively foraging should be avoided.**
- ***Beauveria* products should not be applied to water, as they are potentially toxic to fish.**

Entomophthorales

Entomophthora muscae sensu stricto genotypes



A very high degree of host specificity at or below the level of the subfamily

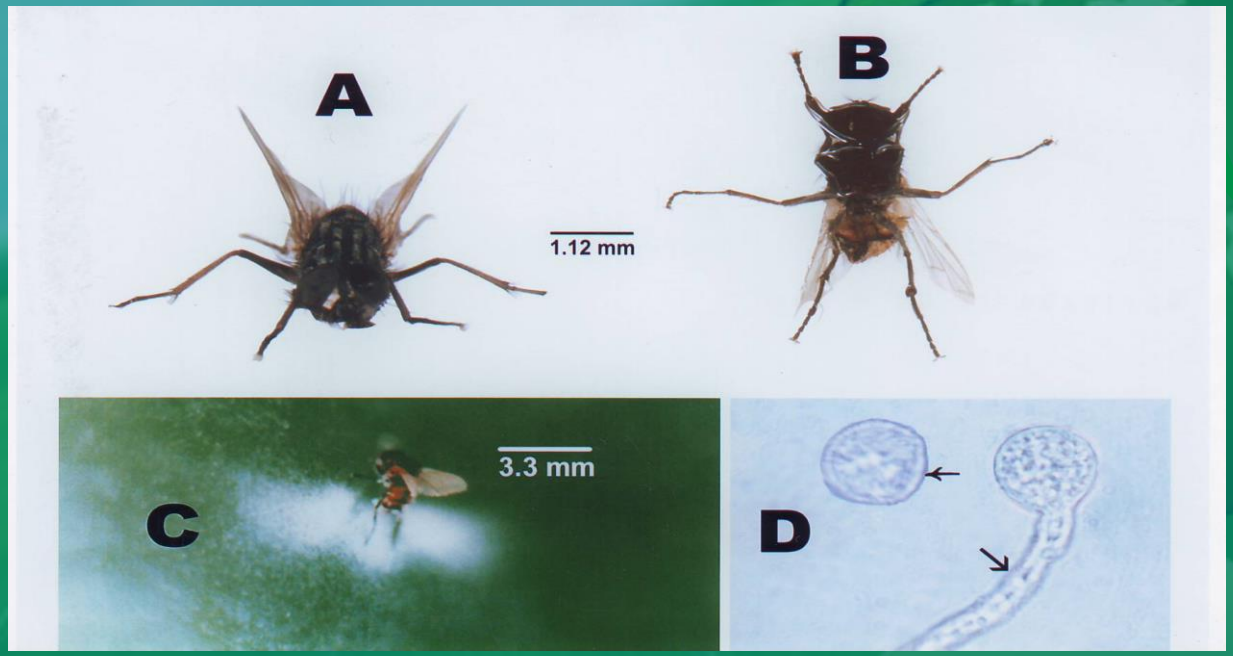
Cause natural outbreaks in insect populations.

Manipulation of host behavior for his own dissemination

Entomophthora spp.

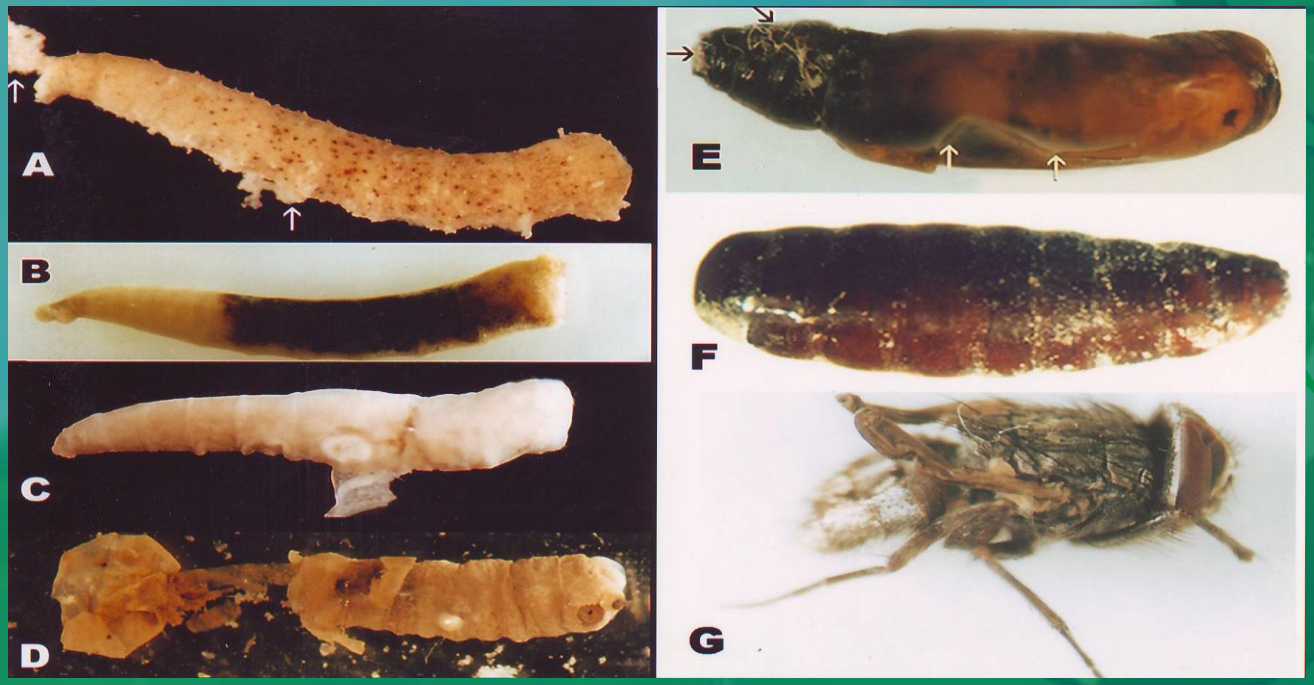
Infects house flies

Kills 99% of insects in a farm



(Adapted form Khater 2003)

Morphological abnormalities of house flies after treatment with fungi (*Entomophthora* spp. & *Beauveria bassiana*)



Adapted form Khater 2003

Protozoa

Infect a wide range of insects

↓

Chronic, debilitating effects

↓

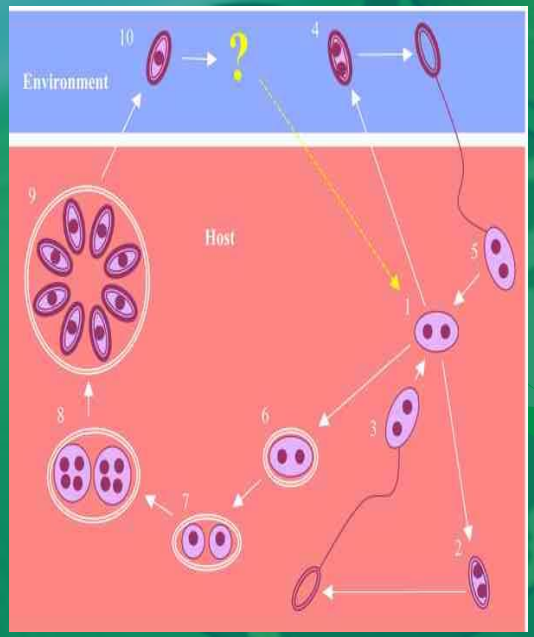
reduction in the number
of offspring

↓

kill their insect hosts (2-3 weeks)

↓

Natural limitation of insect population



Nosema/Vairimorpha life cycles

Nosema locustae

infects grasshoppers and crickets and is slow to kill its host

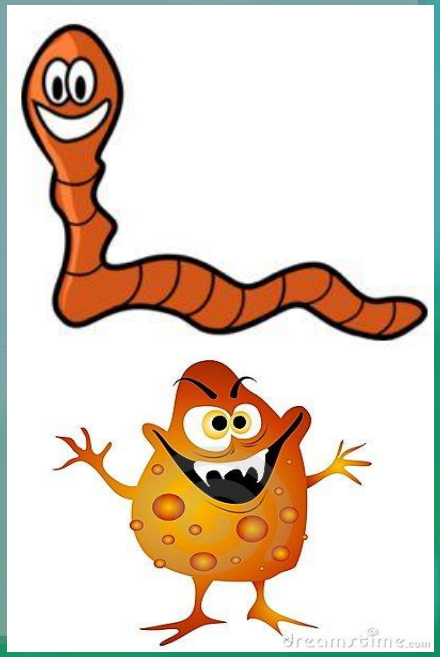
PROTOZOA			
PATHOGEN	**PRODUCT NAME**	**HOST RANGE**	**USES AND COMMENTS**
Nosema locustae	NOLO Bait®, Grasshopper Attack®	**European cornborer caterpillars** ***grasshoppers** *** mormon crickets**	Useful for rangeland grasshopper control, (**especially immature)** Active only if ingested. Also effective against caterpillars. **Not recommended for use on a small scale, such as backyard gardens, because the disease is slow acting and grasshoppers are very mobile.**

Nematodes

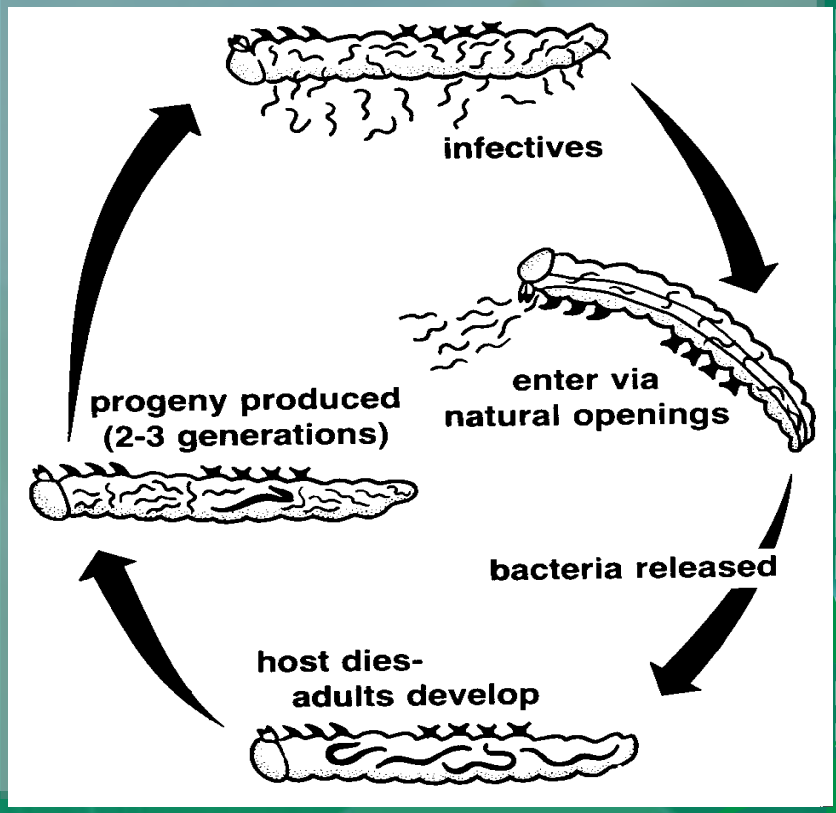
Families: Steinernematidae and Heterorhabditidae
30 spp. >> 7 products

Steinernematid
Heterorhabditid

House fly larvae infected with *Steinernema feltiae*



Bacteria + nematodes



from: Nematodes, Southern Cooperative Series Bulletin 331, AK Ag. Exp. Stn., Fayetteville, AK 72701

Outdoor control

Nematodes

These microscopic worms eat flea larvae and are therefore a natural way to control the flea population.

Place them in moist, shady spots near your house; neither fleas nor nematodes survive in the hot sun.

As nematodes multiply rapidly, you have only to introduce a small number to have the desired effect. Flea Away may also be used outdoors. Apply on dry walks, dry decks, dry patios, dry lawns.

Nematodes

PATHOGEN	PRODUCT NAME	HOST RANGE
Steinernema feltiae (=*Neoaplectana carpocapsae*) *S. riobravis*, *S. carpocapsae* and other *Steinernema* species	Biosafe®, Ecomask®, Scanmask®, also sold generically (wholesale and retail), Vector®	**larvae** of a wide variety of insects **soil-dwelling boring insects**
Heterorhabditis heliothidis	currently available on a wholesale basis for large scale operations	As before
Steinernema scapterisci	Nematac®S	late nymph and adult stages of **mole crickets**

Paraiotonchium muscadomesticae

Infect housefly larvae
Mortality was low except at high nematode concentrations

Nematode invade and damage the ovaries of adult flies
Flies lay nematode larvae instead of its own eggs

***Reduce* affect fly population indirectly.**

المتطفلات
Parasitoids

spends a significant portion of its life history attached to or within a single host organisms >>
it ultimately kills (and often consumes) in the process.

Parasitoids are also often closely coevolved with their hosts.

fly parasite wasp
actual size is approximately 1/10 inch

Parasitoids

Caterpillar parasites

Hyposoter → → parasitizes cabbage looper, fall webworm, tent caterpillars, and tomato fruitworm .
Cotesia → → parasitizes alfalfa caterpillar, imported cabbage worm, loopers, and tent caterpillars .

The parasitic emerald wasp *Ampulex compressa* and the cockroach *Periplaneta americana*

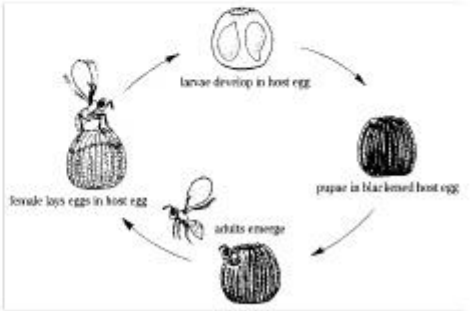
Parasitoids
المتطفلات

Egg parasite

Trichogramma Wasp (*Trichogramma spp.*)

- Tiny, < 1mm
- Eggs are deposited in moth eggs
  - Wasp larvae eats moth egg from inside
  - Parasitized moth eggs turn black
- 8-10 day life cycle
- Harmless to people and animals
- Adult wasps are nectar feeders

Wasp ovipositing on moth egg



http://www.entomology.wisc.edu/mbcn/kyf104.html

Parasitoids
المتطفلات

Pleolophus basizonus
ectoparasitoid of diprionids .

Egg of *P. basizonus* .The eonymph had been paralized by the female parasitoid prior to oviposition

Larvae in a cocoon of *Diprion pini*.

Attract of natural enemies

- Do not use insecticides
- Companion plants

Marigold ماريجولد

coriander
الكسبرة

sunflower دوار الشمس

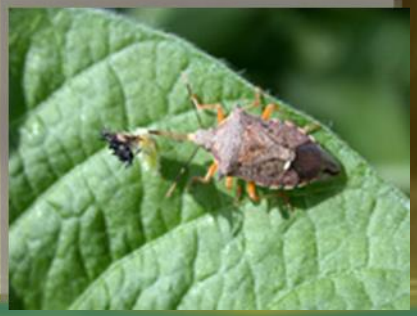
Planting early in the season>> attract parasitoids

cumin الكمون

Fennel الشمر

clove القرنفل

yarrow نبات ذات الألف ورقة



Chinese praying mantis

Insect predators

المفترسات

Green lacewing adult.

Predatory mite

الحلم المفترس

Dragon fly

Genetic control

Sterile insect technique

- **Millions of sterile insects are released.**

-The sterile males → compete with the wild males for female insects.

If a female mates with a sterile male → it will have no offspring → the next generation's population → reduced.

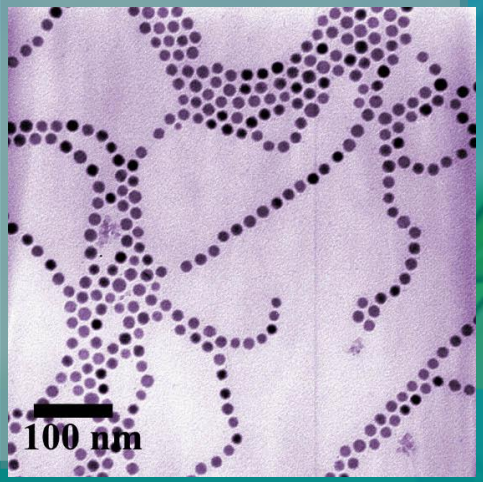
Sterile insect technique

Successful stories:

Screw worm fly
Cochliomyia hominivorax

Tse Tse fly
Mosquitoes
Fruit fly species

Future trends
Nanoparticles



Nanotechnology:

1- nanocapsules for vector and pest management

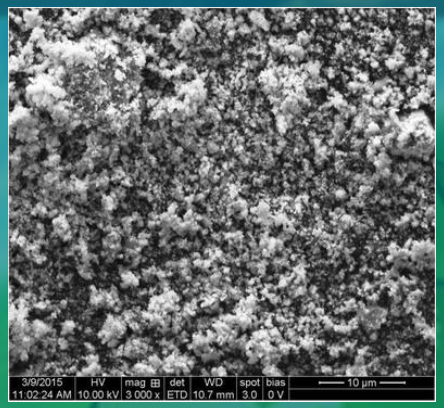
2- nanosensors for pest detection.

Nanoparticles are 1-100 nm in diameter.

The size of a virus is roughly 100 nm.

Such particles are agglomerated atom by atom.

Future trends
Nanoparticles

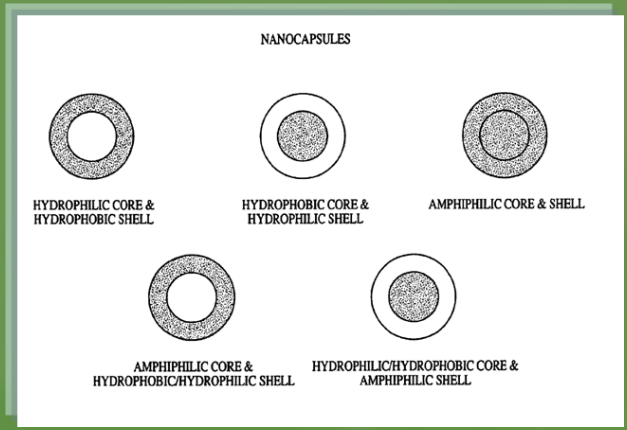


Scanning electron micrograph of *Artemisia vulgaris*-synthesized silver nanoparticles

Murugan et al. (2015) Characterization and biotoxicity of Hypnea musciformis-synthesized silver nanoparticles as potentialeco-friendly control tool against *Aedes aegypti* and *Plutella xylostella.* Ecotoxicology and Environmental Safety

Murugan et al. (2015) Predation by Asian bullfrog tadpoles,*Hoplobatrachus tigerinus*, against the dengue vector, *Aedes aegypti* , in an aquatic environment treated with mosquitocidal nanoparticles. Parasitolog Research.

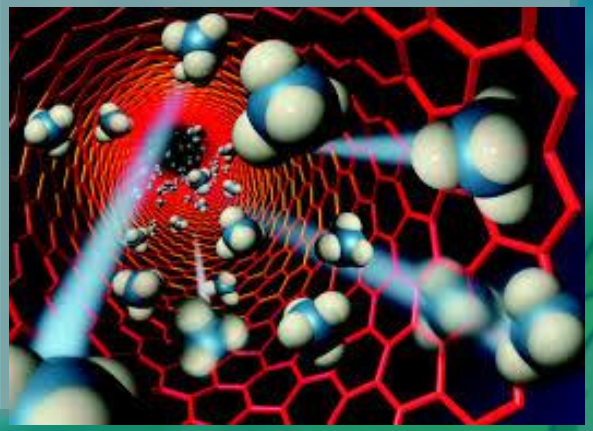
Nanoencapsulation



A process through which an insecticide is slowly but efficiently released to a particular host for insect pest control.

Aluminosilicate filled nanotube can stick to plant have the ability to stick to the surface hair of insect pests and ultimately enters the body and influences certain physiological functions

Nanoencapsulation

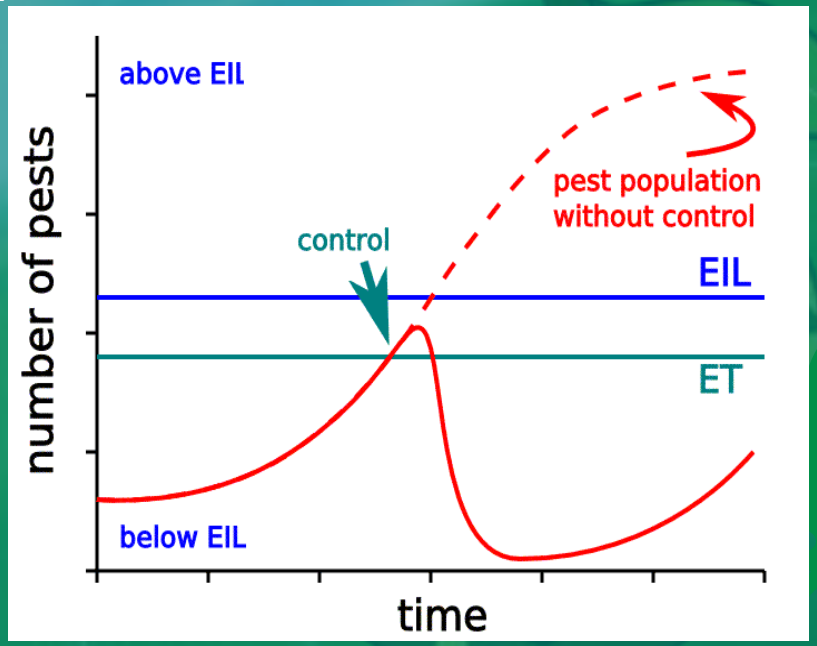


The encapsulated product "gutbuster" only breaks open to release its contents when it comes into contact with alkaline environments, such as the stomach of certain insects.

Improve pesticide and fertilizer delivery systems which can take action to environmental changes, ex. they will release their cargo in response to different a controlled manner (slowly or quickly) in signals e.g. heat, moisture, ultrasound, magnetic fields, etc.

Integrated pest management

The use of all available means to maintain pest populations below levels that would cause economic loss while minimally impacting the environment.

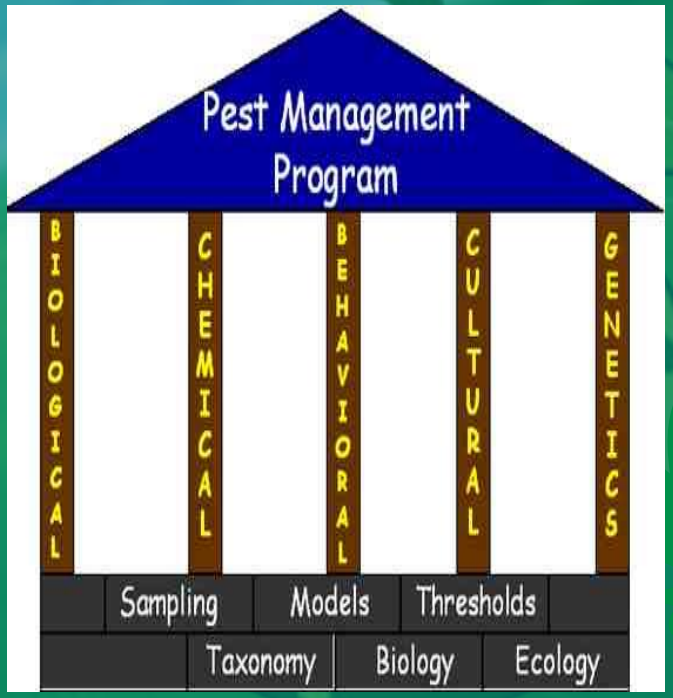


Economic Threshold (ET) or
Action Threshold (AT),
Economic injury level (EIL)

Integrated Pest Management

Use current, comprehensive information on the life cycles of pests and their interaction with the environment.

↓↓

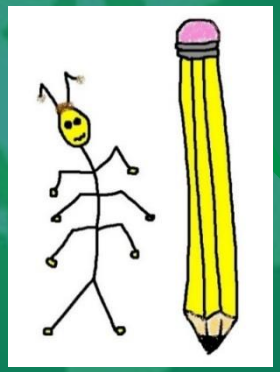


Conclusion

Conclusion

We should be ahead of it

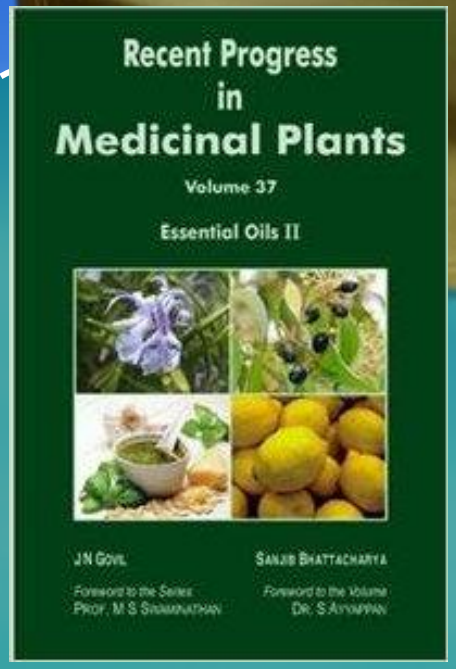
Vector resistance to pesticides:



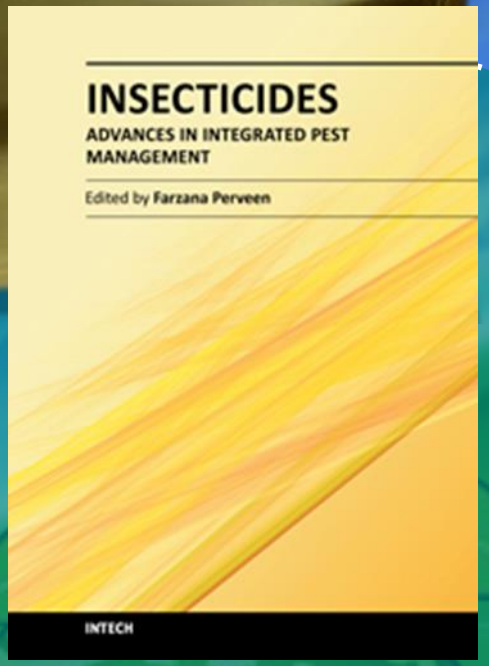
Thank You

Biorationals

Conventional Insecticides



More Information



Review article:

Khater, H.F. (2012). Prospects of botanical biopesticides in insect pest management. *Pharmacologia* 3 (12): 641-656.

Book chapters:

1- Hanem Fathy Khater (2013) **Bioactivity of Essential Oils as Green Biopesticides: Recent Global Scenario**. In: Recent Progress in Medicinal Plants. Vol. 37; Essentials Oils II, JN Govil & Sanjib Bhattacharya (Eds), Studium Press LLC, USA, pp. 153-220.

2- Hanem Fathy Khater (2011). **Ecosmart Biorational Insecticides: Alternative Insect Control Strategies**. In Farzana Preveen (Ed.) Insecticides - Advances in Integrated Pest Management. ISBN: 978-953-307-780-2, InTech, Croatia. DOI: 10.5772/27852.


Lets the nature protect your loved ones.


THANK YOU


hello
goodbye


THANK YOU
谢谢
GRACIAS
MERCI
DANKE
GRAZIE
DANKIE
KIITOS
OBRIGADO
DěKUJI
شكرا
ありがとう
спасибо
TAKK
GRÀCIES
GRATIAS AGIMUS TIBI
TAK
FALEMINDERIT
DZIĘKUJĘ
БЛАГОДАРЯ
ESKERRIK ASKO
Дзякуй
благодариме
PAKKA PÉR

تم بحمد الله

Hanem F. Khater

Thank You

Professor of Parasitology, Benha University, Egypt
School of Biological Sciences, Bristol University, UK

hafkhater@yahoo.com
hanem.khatersaleh@bristol.ac.uk
0044 747 0064087
0020 10 60728777