

INSECT PEST MANAGEMENT

(in respect of current scenario)

Indiscriminate use of Chemical Pesticides

- **Insecticidal resistance**
- **Environmental residues**
- **Adverse health effects**

Need to develop strategies

- **Ecological Compatible**
- **Environmentally safe**
- **Reproductive suppression**
(in lieu of Instant Mortality)

Most suitable alternative is to opt for

- **Non-chemical control**
- **Biological/ Parabiological control**

Pest Management through Radiation Technology

- **Sterile Insect Technique (SIT)**
- **Other Radio-Genetic Tactics**
(F-1 sterility, Chromosomal aberrations)
- **Biological control**
- **Radiation hormesis**
- **Dis-infestation of stored products & agro-commodities for quarantine/ phytosanitation**

Advantages of Nuclear Techniques

- **Ecologically Compatible**
- **Parabiological approach**
- **No transgenic**
- **Environmentally safe**
- **No radio-activity**
- **No residue**



Characteristics of Electromagnetic Spectrum

Types of EM radiation	Frequency	Wavelength	Quantum	Nature of chemical effect
Gamma rays	$> 10^{20}$ Hz	$< 10^{-12}$ m	> 1 MeV	Ionising
X-rays	3×10^{16} Hz	100nm -10 nm	≥ 124 eV	Ionising
UV rays	7.5×10^{14} - 3×10^{16} Hz	400nm – 100nm	3.1-124 eV	Non-ionising
Visible rays	$4-7.5 \times 10^{14}$ Hz	750-400nm	1.65-3.1eV	Non-ionising
IR rays	$0.003-4 \times 10^{14}$ Hz	1mm – 750 nm	0.0012-1.65 eV	Non-ionising
Microwave	$3 \times 10^9-3 \times 10^{11}$ Hz	$10^{-3}-10^{-1}$ m	$2 \times 10^{-24}-2 \times 10^{-22}$ J	Non-ionising
Radiowave	$< 3 \times 10^9$ Hz	10^{-1} m	$< 2 \times 10^{-24}$ J	Non-ionising

Estimated sterilization doses for insects from different taxonomic orders

Order (Gy)	Sterilization Doses
Coleoptera 200	13 -
Dictyoptera 120	5 -
Diptera 200	10 -
Hemiptera 200	10-
Hymenoptera 200	80 -
Lepidoptera 400	40 -

An Environment Friendly Pest Management Approach



Area-Wide Pest Management



- Population suppression
- Large area augmentation
- Sterile insects
- Parasitoids
- Synergistic

Sterile Insect Technique(SIT)

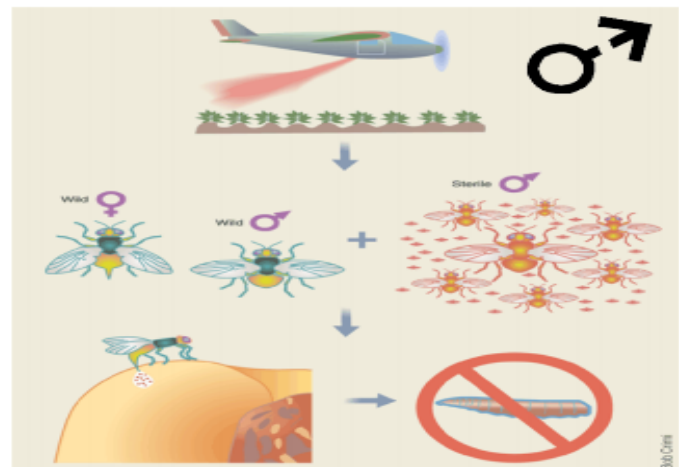
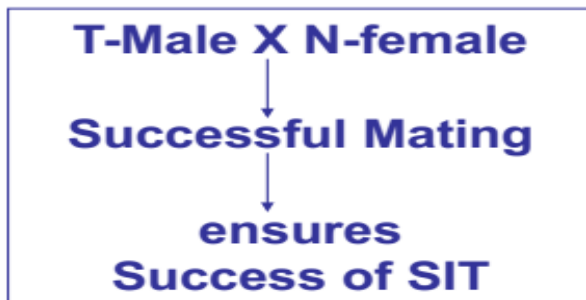
• **E. F. Knippling** conceived an approach to insect control by **SIT**



- **Screwworm fly** (*Cochliomyia hominivorax*) eradication : **Foremost successful example**
- **Sterile insects** are released into environment in large numbers (**10 to 100 x**)
- **Native female** mating with a **sterile male** produce **fertilized** but **sterile** eggs
- **Success of screwworm eradication** through **SIT** program led to investigations on this **radio-genetic technique** for control of many other pests.
- **IAEA** runs **Coordinated Research programmes & Technical projects** to promote **SIT**

Sterile Insect Technique(SIT)

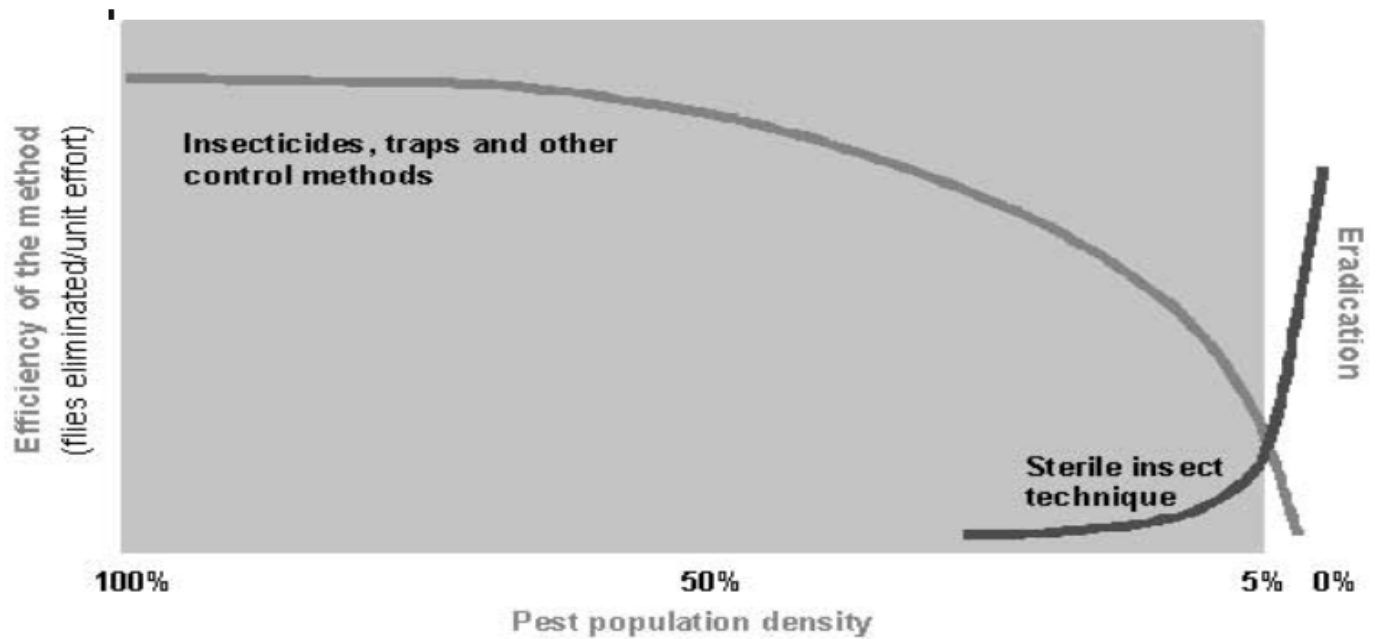
DEFINITION: A genetic method of pest suppression involving mass release of compatible but sterile insects into a wild fertile pest population to overwhelm & suppress its reproductive capacity, often eventually to the point of extinction.



Main components of employing of 'sterility principle' (i.e., SIT)

- | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> (i) Rearing (iii) <u>Competitiveness</u> (v) Evaluation | <ul style="list-style-type: none"> (ii) Treatment (iv) Release (vi) Re-infestation |
|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|

Optimizing the efficiency of SIT in IPM



Optimizing the efficiency of an insect pest intervention campaign by using conventional control and SIT in an integrated, phased approach

Some success stories...

- **Screwworm fly** (*Cochliomyia hominivorax*)- eradicated from the United States (1950s-90s), Netherland (Curaçao, 1954) and Libya (1990-92)
- **Mexican fruit fly** (*Anastrepha ludens*) eradicated from most of northern Mexico.
- **Tsetse fly** eradicated from Zanzibar (1970–1990s).
- **Medfly** (*Ceratitis capitata*)- eradicated from northern part of Chile and southern part of Peru and southern part of Mexico (1970s–80s)
- **Sweet potato weevil** (*Cylas formicarius*) eradicated from Kume Island, Okinawa, Japan (1994-99).

Etc....

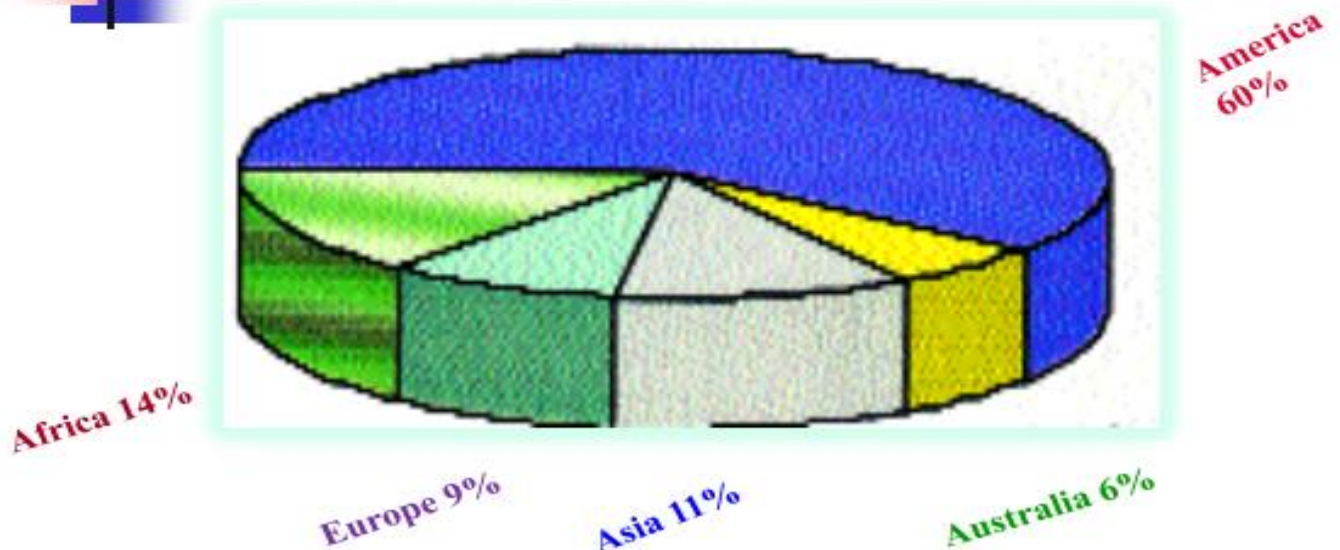




Various Insect Species subjected to SIT

- **Screwworm fly** / **USA, Mexico, South America, Libya**
- **Mediterranean Fruit Fly** (*Ceratitis capitata* Wiedemann) / **USA (Cal.), Mexico**
- **Melon Fly** (*Dacus cucurbitae* Coquillett) / **Japan, Taiwan**
- **Pink Bollworm** (*Pectinophora gossypiella* Saunders) / **USA (California)**
- **Tsetse Fly** (*Glossina* species) / **Tanzania, Zimbabwe, Upper Volta**
- **Mosquitoes** (various spp.) **USA (Florida), East Africa, Venezuela**
- **Boll Weevil** (*Anthonomus grandis* Boheman) / **Southeastern USA**
- **Mexican Fruit Fly**, (*Anastrepha ludens* Loew) / **USA (Texas), Mexico**
- **Gypsy Moth** (*Lymantria dispar* Linn.) / **Northeastern USA, Canada**
- **Stable Fly** (*Stomoxys calcitrans* Linn.) / **USA (St. Croix, Virgin Islands –exptl)**
- **Horn Fly** (*Haematobia irritans* Linnaeus) / **USA (Texas - experimental)**
- **Corn Earworm** (*Helicoverpa zea* Boddie) / **USA (St. Croix, VI)**
- **Tobacco Hornworm** (*Manduca sexta* Linnaeus) / **USA (St. Croix, VI)**

Continents adopting SIT



Pest management by modifying insect development and behaviour



Contents

- ✚ Communication in insects
- ✚ Behavioural alteration
- ✚ Semiochemicals
- ✚ Pheromones
- ✚ Allelochemicals
- ✚ Chitin synthesis inhibitors
- ✚ Attractants
- ✚ Repellents
- ✚ Antifeedants

METHODS OF COMMUNICATION IN INSECTS

AUDITORY



VISUAL



OLFACTION



TACTILE



- Control strategies against insect pests involve some sort of change to their behaviour through

- ✦ Chemical (*i.e.* volatiles and non-volatile compounds, feeding deterrents)
- ✦ Visual or
- ✦ Auditory signals.

- Manipulating pest behaviour for insect control -known for centuries through the practice of trap cropping.

- Ex: Food lures and baits with pesticides to control household pests.



Adoption of technologies to manipulate insect behaviour in agricultural systems – **Slow ????**



- Arrival of cheaper chemical controls with broad insecticidal activity.



Later

- ✚ Increasing public awareness of the negative effects of broad-spectrum insecticides on humans and non-target organisms.
- ✚ United States, the Environmental Protection Agency (EPA) implemented the Food Protection Act (FQPA) in 1996.
- ✚ Adoption of alternative pest management practices- manipulation of pest behaviour and
- ✚ To promote a transition from insecticide-based to more ecologically, integrated pest management (IPM)-based programs.

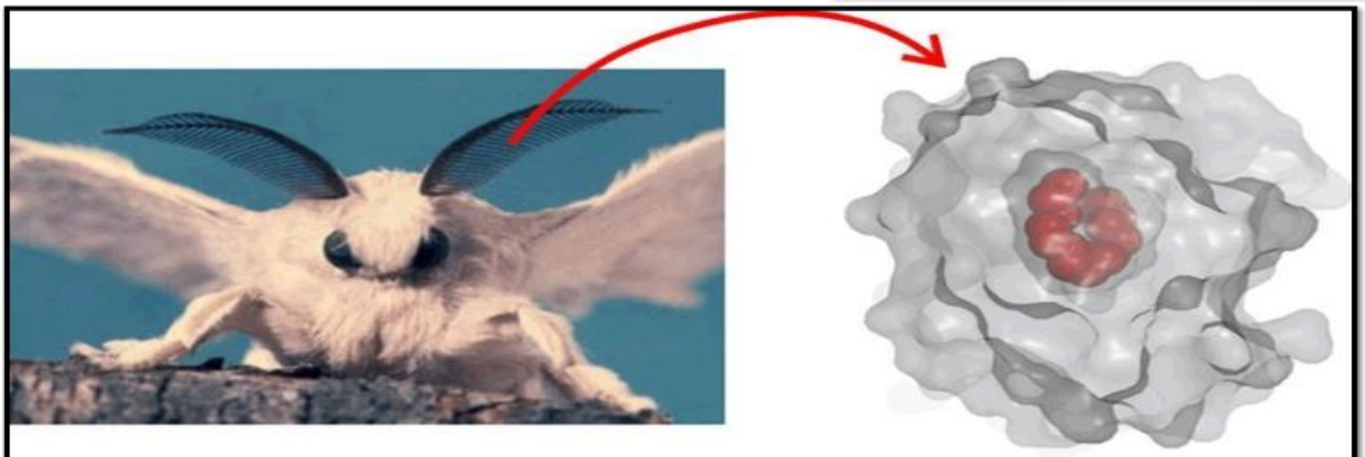




- Since then, many conventional pesticides have been replaced by low risk or bio-rational pesticides/ reduced risk pesticides.
- Chemicals that affect the growth, development, biology and ecology of pest species, differently from that of beneficial species.
- Low toxicity to non-target organisms.

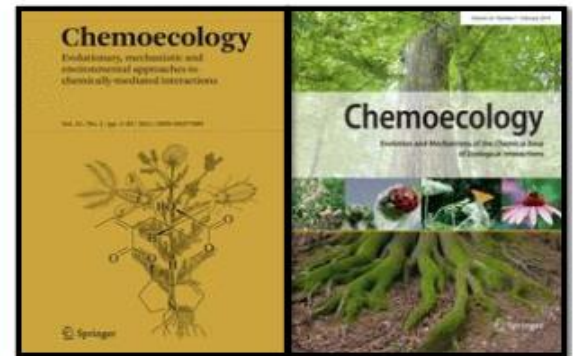


- Insects more dependent on chemical cues and chemicals.



Exploitation in pest management

- Advances in chemical technology in the last three decades have allowed the discovery, identification and synthesis of specific chemicals that regulate or mediate growth and development and species behaviour.
- That may cause
 - Premature death (abnormal moulting or metamorphosis)
 - Attracting or repelling towards the source.



Behaviour alteration

- Manipulation of pest behaviour is defined as “the use of stimuli that either stimulate or inhibit a behaviour and thereby change its expression” (Foster and Harris, 1997).
- **Semiochemicals:** Greek word- simeone – a mark or a signal. Chemicals that are able to modify the behaviour of a perceiving organism at sub micro or nano gram levels.



