Pest management by modifying insect development and behaviour

Insect growth regulators(IGR's)

- **Synthetic compounds possessing the activities of juvenile and moulting hormone of insects are called as IGR's/ JH mimics/ JH analogues/ Juvenoids.**
- **Retard the development of pest species particularly inducing effects from sterility to death.**
- **Effective only on immature insects.**

Invention of paper factor

- Discovered by Slama and Williams, 1967

- In *Pyrrhocoris apterous*
- Paper towel was developed from Balsam fir tree

- Mimic the JH- kills the insects without reaching to adult stage

Affects the insects in different ways

1. Antimetamorphic effect
2. Larvicidal effect
3. Ovicidal effect
4. Diapause disrupting effect
5. Embryogenesis inhibiting effect

Chitin synthesis inhibitors

- Chemicals which interferes with the biosynthesis and deposition of chitin.
- Acts on chitin synthase.
- Acts as stomach poisons and kills insects at the time of moulting and also suppress the fecundity and exhibit ovicidal and contact activity.
- Causes improper attachment of the new cuticle during moulting and produces a cuticle that lacks some of the layers.
- Larvae die from rupture of the new malformed cuticle, starvation desiccation and predation.
- Benzyl phenyl urea analogues - affects the larval stage.

Practical IGR's found in market

1. Methoprene (Altosid)- Homopterans and Dipterans
2. Kinoprene (Enstar-IGR)- mosquitoes, flies
3. Hydroprene (Altozar)- Lepidopterans, coleopterans, Homopterans and for few stored pests
4. Pyriproxifen (Admiral)- flies, beetles, midges and mosquitoes.
5. Diflubenzuron (Dimilin)- flies, midges and mosquitoes.

Other chitin synthesis inhibitors

- **Diflubenzuron (Dimilin)** - used in cotton, soybean, citrus, vegetables and also medical pests (mosquitoes).

- **Lufenuron (Match)** - lepidoptera and coleoptera on cotton, corn and vegetables.

- **Buprofezin (Applaud)** - produces weakened exoskeleton in moulting immatures both insecticides and acaricides. Used against hemipterans in rice.

- **Novaluron (Rimon)** - used for whiteflies on tomato and lepidopterans.

Anti-juvenile hormones

- Tested plant extracts for antagonistic activity of JH.
- Discovered anti JH activity from bedding plant, *Ageratum houstonianum.*
- Identified 2 compounds- Precocene I and Precocene-II.
- As they induce precocious form of metamorphosis and their chemical structure.
- Induce premature metamorphosis.
- Lethal activation within the corpora allata, thus destroying the glands.
- Azadirachtin- liquid and dust formulations from neem seeds- disrupts molting process.

Advantages

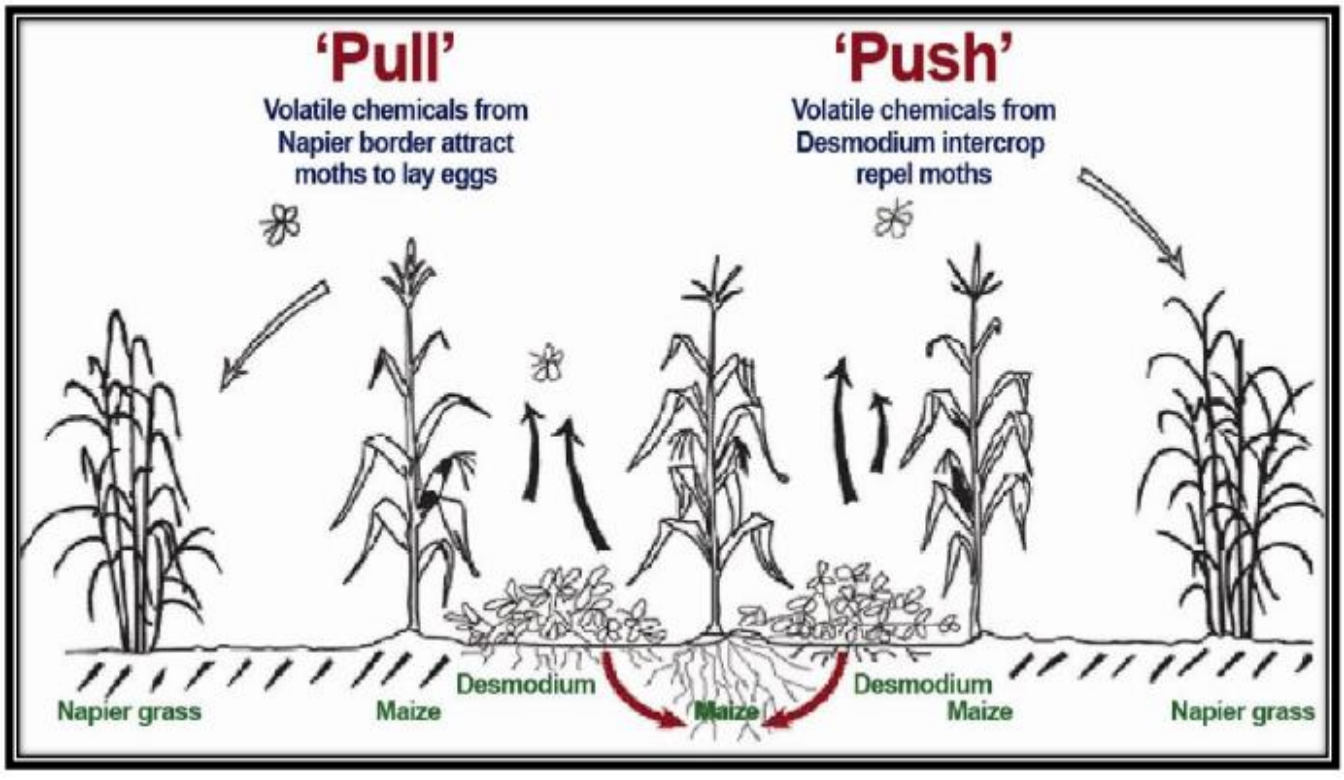
- Effective in minute quantities and hence are economical
- Highly species specific; so non-target organisms are spared
- Affects more than one aspect of insect development and hence effective against insects which are resistant to insecticides.
- Highly biodegradable- non polluting, eco-friendly.
- Non-toxic to plants and animals.
- Suitable for insects which are living in concealed environments.

Disadvantages

- They have a narrow physiological windows; hence cannot be applied at all times.
- Effective only for last larval instars and hence stages will continue to feed.
- Slow mode of action
- Chances of resistance development
- Few are unstable in environment
- High cost of chemicals

Push-Pull Strategy or Stimulo-deterrent diversion

- A strategy where a host-plant attractant(s) and a repellent(s) are used in combination.
- Tested using a repellent intercrop and an attractant "trap" plant.
- Insects are repelled by volatiles emitted from the intercrop (push) and simultaneously attracted by volatiles from the trap plant (pull).
- The most successful work on push-pull to date has been conducted in Africa to control stem borers in maize and sorghum (Cook *et al.*, 2007).
- Works not only by decreasing stem borer damage to maize, but also by enhancing the efficacy of natural enemies.



Attractants

- Chemicals which elicit oriented movements by insects towards their source.
- Also called as Food lures

Important food lures includes

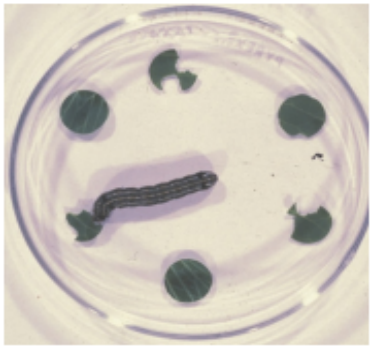
Sl. No.	Lure	Insect
1	Sugar + Molasses	House fly
2	Geraniol	Japanese beetle
3	Trimed lure	Mediterranean fruit fly
4	Melon fruit fly	Cue lure
5	Methyl eugenol	Oriental fruit fly
6	Sinigrin	Cabbage butterfly
7	Cinnamaldehyde	Spotted cucumber beetle

Antifeedants

- Chemicals which inhibit feeding when present in a place where insects in its absence would feed.

OR

- Chemical compound which prevent feeding of insect or animal on a treated material without necessarily killing or repelling.

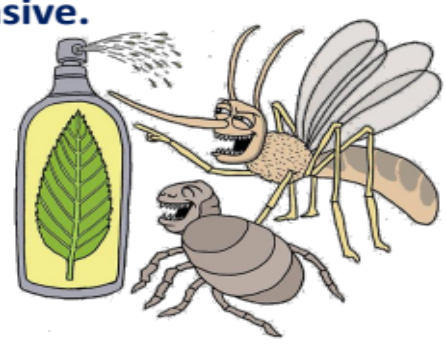


- 1st antifeedant – Zinc salt of Dimethyl dithiocarbonic acid against rodents and trees- to prevent feeding on bark of trees.

Sl. No.	Antifeedant	Target insects
1	Azadirachtin	Desert locust and other insects
2	Baygon	Cotton boll weevil
3	Brestan	Cut worms and potato tuber moth larvae
4	Chlorinated triphenyl methane and triphenyl sulfonium salts	Phytophagous insects
5	Organotins	Grasshoppers, Agrotis sp.
6	Phlorizin	Myzus persicae
7	Pyrethrum	Glossina sp.
8	Solanine	Potato leaf hopper
9	Thiocarbamates and phenyl carbamates	Beetles
10	Triazines	Cockroaches and beetles

Repellents

- Chemicals that cause insects to orient their movements away from a source.
- Allied materials that do not cause movement away but do prevent feeding or oviposition by insects- deterrents.
- Repellents- volatile chemicals- activity in the vapour phase.
- Plants- unattractive, unpalatable or offensive.



List of important synthetic repellents

Sl. No.	Repellents	Insect
1	Benzyl benzoate	Mites
2	Bordeaux mixture	Foliage feeders
3	Creosote	Chinch bugs
4	Diacetyl pthalate	Cattle fleas
5	Dimetyl pthalate	Mosquitoes
6	N, N, diethyl m-toulamide (DEET)	Mosquitoes, fleas, flies
7	Naphtalene balls	Cloth moths
8	N-butylacetanilide	Ticks, fleas
9	Pentachlorophenol	Termites
10	Pine tar oil	Screw worm flies

Advantages

- Low toxicity-safe to humans, plants and domestic animals.
- Protects the desired plants and insects are not killed.
- Resistance development- low.

Disadvantages

- The need to completely cover all susceptible surfaces with repeated applications
- Possibility of increasing infestations on near by untreated surfaces.

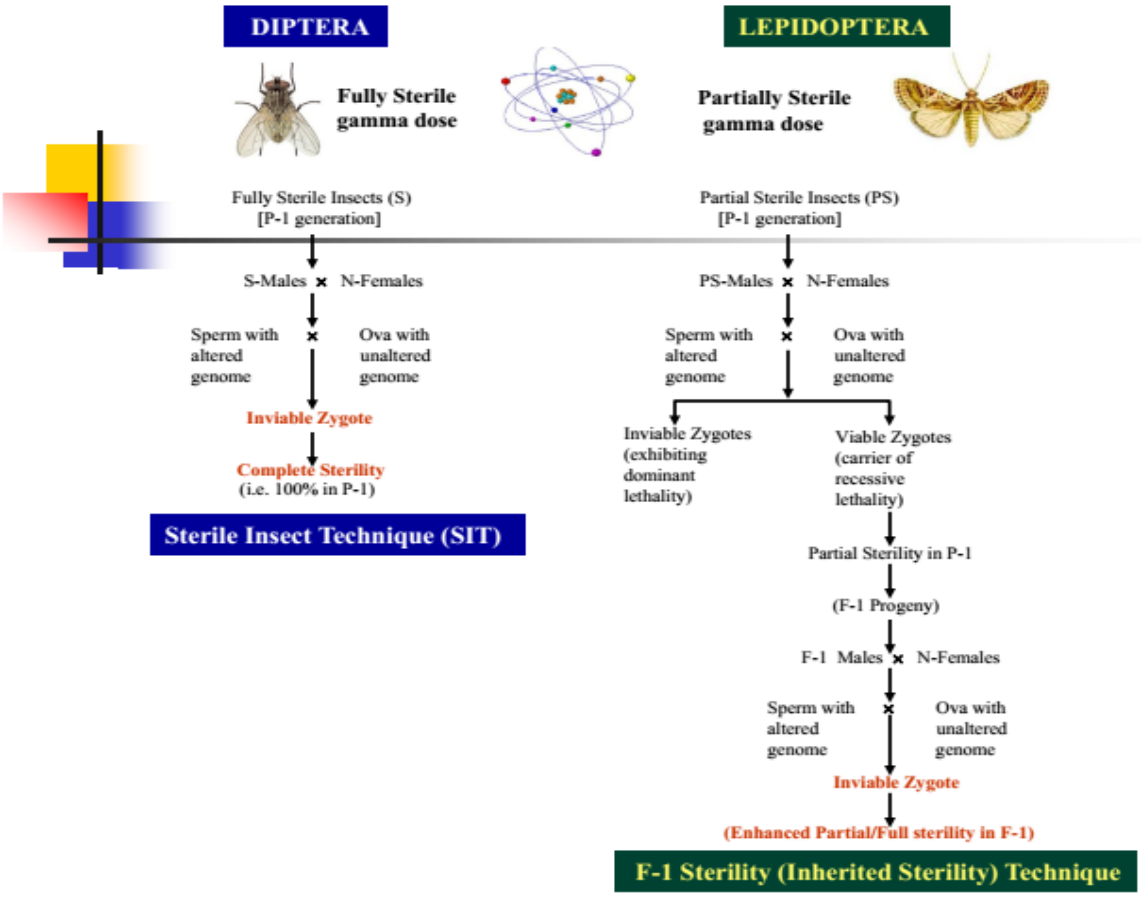
Feasibility of SIT for Lepidoptera


- Limited as Lepidoptera are highly radio-resistant
- Holokinetic chromosomes → High radio-resistance
- Require large doses for 100% sterility
- Associated with somatic damage and behavioural incompetence in P-1(parent generation) that lead to limited success by SIT

Modified SIT (F-1 Sterility or Inherited Sterility) for Lepidopteran control


A favoured alternative : Employ F-1 Sterility

- Use F-1 progeny of sub-sterile P-1(males)
- Use of less amount of radiation
- Induction of inherited sterility in F-1 insects
- Production of competitive moths.



- ***Codling moth***
- ***Cydia pomonella*** (Lepidoptera: Tortricidae)

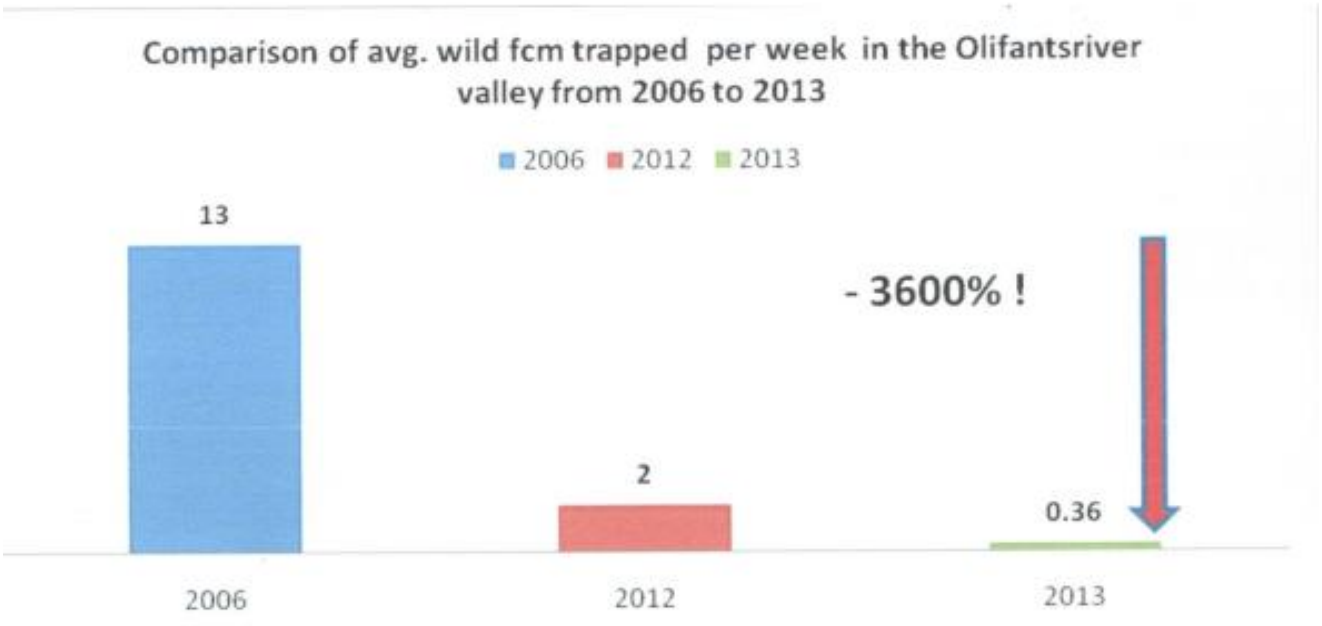
Pest of Citrus, apple & pear

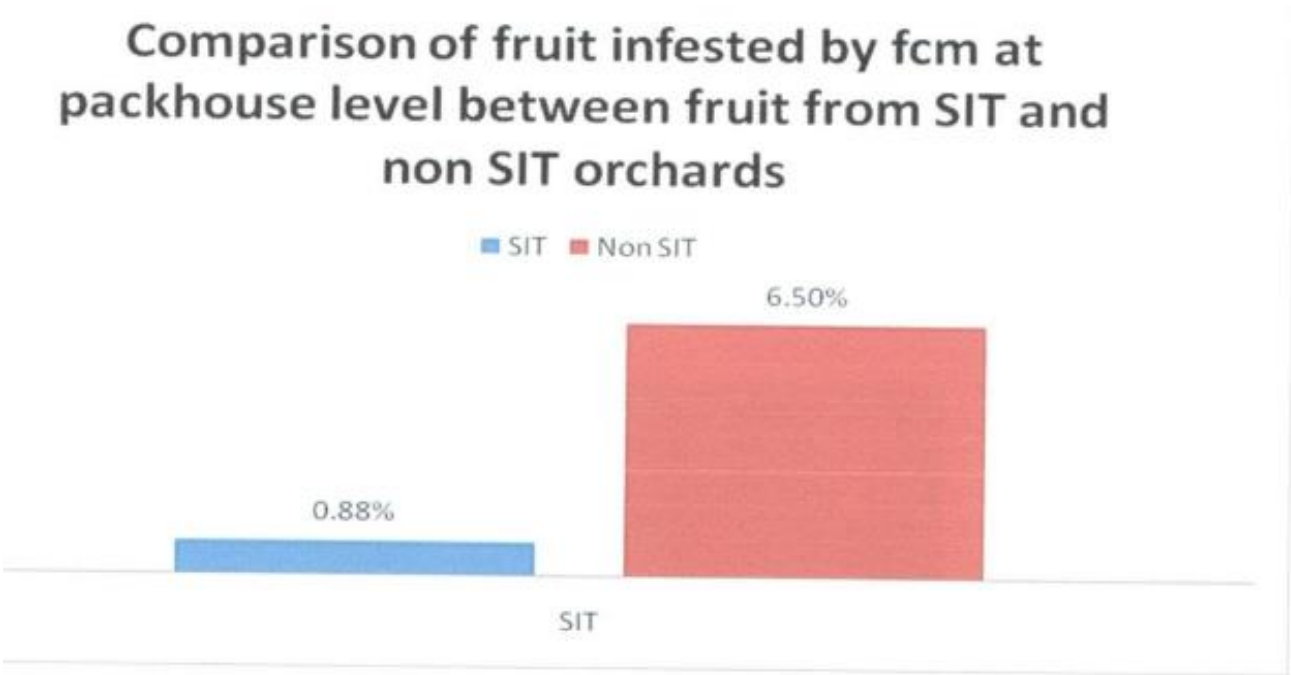

MACADAMS

Gamma Cell – 500 : Radiation Unit

- 2000 moths/ha/week during fruiting season (7-8)
- Mating disruption technique (Shinetsu)
- 7 staff & 2 tech
- Production capacity (60000/day)
- Number of sprays reduced: (12 to 2)
- 100% share from HORTGRO(farmer's owned group)
- 'Entomon' charges R-3000(Rs.18,000)/year/ha

Comparison of the average wild codling moth trapped per week in the ORV from 2006-2013





Comparison of fruit infested by fcm at pack house level between SIT and non-SIT orchards

Efficacy of Pink bollworm eradication programme by SIT

Parameter	Before the programme (up to 2005)	At the end of the programme (2006–2009)	Remarks
Extent of refugia planted	37.4%	~3%	More land for *Bt* cotton and increased yield
Infestation rate on non-*Bt* cotton	15.3%	0.012%	99.9% reduction in infestation
Number of wild male PBW caught per trap per week	26.7	0.0054	99.98% reduction
Mean number of insecticide sprays per hectare per year	2.7	0	Increased profits and associated benefits (cleaner health and environment)
Mean annual cost of yield losses and plant protection	US$ 18 million	US$ 0.17 million	Increased net profits




SIT / Inherited Sterility Work done in India

Sterile Insect Technique(SIT)

Phthorimaea operculella (Potato tuber moth) (BARC)
Spodoptera litura (Tobacco caterpillar) (Delhi Univ)
Culex pipiens fatigans (WHO, MRC, DRDO)
Rhyncophorus ferrugineus (Red palm weevil) (BARC)
Tribolium castaneum (Rust flour beetle) (NRL)

Inherited Sterility [F-1 Sterility]

[Specifically designed for Lepidopteran control]

OTHER POTENTIAL APPLICATIONS of *RADIATION* in Applied Entomology

- **Irradiation for dis-infestation of stored food commodities**
- **Radiation Hormesis**
- **Light Activated Pest Control**: *Allelochemicals as Phototoxins (Potent and Safe Insecticides)*
- **Radiation in Ecological and behavioural studies**
- **Radiation in Toxicological studies**

DISINFESTATION OF STORED AGRO-COMMODITIES

- **Radiation as a disinfestation measure of stored product insect pests, viz.,**
  Rhyzopertha dominica, Sitophilus oryzae, Tribolium confusium, T. castaneum, Lasioderma serricorne, Ephestia cautella, Anagasta kuhniella, Plodia interpunctella, etc.
- **0.5 KGy suggested as a safe dose for the treatment of a wide range of commodities to practically control the pests**
- **0.6 - 0.7 KGy as a recommended dose for control of noxious stored products mites**

QUARANTINE

Irradiation as a useful and unique quarantine tactic for Disinfestation against Acarina, Thysanoptera, Coleoptera, Lepidoptera and Diptera

Radiation as a quarantine treatment for tropical fruitfly (fam.Tephritidae) in fresh fruits or vegetables.

10 KGy dose approved by FAO/WHO, as safe for use on any food (Codex Alimentarius Commission 1984).

1 KGy approved for disinfestation of fresh fruits, vegetables.