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GENETICALLY MODIFIED INSECTS

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Insects transmit human, animal and plant diseases and also directly attack both plants and animals; this causes damage and losses and also impacts trade (Benedict *et al*., 2003; Deguine *et al*., 2009). Efforts to control insect pests have predominantly relied on the use of chemical insecticides. New active ingredients are rather difficult to identify, take more time for development and have high cost of registration. All together stimulates to search for new forms of pest control becoming viable to manage insects on the ground of genetics. Implementation of novel genetically modified insect (GMI) strategies removes some of the uncertainty, increases the familiarity and also confidence.

GMI: The insects in which foreign DNA are introduced to expresses the desirable traits are called as a Genetically Modified Insects

Different strategies for considering GM insects:

1) Propensity of genetic trait to establish or spread:

a) Self-limiting strategies: The use of genetically "sterile" insects is a self-limiting approach and least controversial and has the lowest risk among of new genetic control methods (Anon., 2004). The Sterile Insect Technique (SIT) is a species-specific and environmentally nonpolluting method of insect control that relies on the mass rearing, sterilization and release of large numbers of insects (Knipling, 1955). Released sterile males' mate with wild females, reducing their reproductive potential ultimately. If enough males are released for a sufficient time, totally eradicate the pest population. Successful area-wide SIT programs were conducted against the screwworm fly, *Cochliomyia hominivorax* (Krafsur, 1998); the Mediterranean fruit fly (Medfly), *Ceratitis capitata* (Hendrichs *et al.,* 1995) and the tsetse fly (*Glossina spp*.) (Anon.,1995). ***Release of Insects Carrying a Dominant Lethal (RIDL)*** is an alternative method and an ingenious approach was demonstrated in *Drosophila melanogaster* by Thomas *et al.* (2000). A transcriptional control element was used to derive the expression of the antibiotic, tetracycline repressible transactivator fusion protein (tTa). The transgenic males will mate to non-transgenic females and no female progeny will be produce which will satisfy the requirement of RIDL.

b) Self-sustaining strategies: They are primarily aimed to insect vectors for human diseases and convert or replace all insects in a population with a less harmful form. The modification is expected to persist indefinitely in the environment and perhaps to increase in frequency and geographic range. e.g., protects a mosquito from infection by *Plasmodium* Spp. (Wimmer, 2003).

2) Heritable modification (Paratransgenesis): The aim of paratransgenesis is to reduce vector competence by the genetic modification of symbionts living within the insect. Among various symbiotic associations, endosymbiosis is unique, where a prokaryote is enslaved within a eukaryotic cell. The symbionts are passed into generations by transovariole. Among various endosymbionts, two genera *viz*., *Wolbachia* (gram negative bacteria) and *Rhodococcus* (actinomycete) are important for pest management point of view. *Wolbachia* is predominant and is found in insects, nematodes, mites and spiders. *Wolbachia* infection results in diverse phenotypes of the host, ranging from induction of parthenogenesis, selective killing of males, altered sperm competition and cytoplasmic incompatibility (Asokan, 2007).

Technological Approaches: Insect Transformation *(Transposon mediated germ-line transformation)*

According to Asokan (2007), four transposable elements, *Minos, Hermes, PiggyBac* and *Mos1* have been used for genetically transform agriculturally important insect species. Transposons (mobile segments of DNA are sometimes called **"jumping genes"**) are characterized by the presence of left and right terminal inverted repeats (TIR) and the gene of interest is placed between the TIR. For stable integration, two separate transposons, one carrying the gene of interest a visible detectable marker within the functional TIR and another encoding a transpose with defective TIR are used. The most employed transposon is *piggyBac* which discovered from lepidopteron insects and encoded by transposase enzyme.

Selection of genetic transformed insects: The green fluorescent protein (GFP) from the jellyfish is a universal marker that could be used to follow gene transfer in any species (Tsien, 1998). They can show up in the live insect (Berghammer *et al.,* 1999).

Practical Utility of genetically modified insect

Insect pest Management:

Weekly releases of OX3864A Mediterranean fruit fly males into stable populations of wild-type medfly caused a successive decline in numbers and leading to eradication (Leftwich *et al.,* 2014). Transformed strains could be generated using different DNA constructs showed moderate-to-100% engineered mortality of pink bollworm. In permissive conditions, this effect was largely suppressed while under field conditions, increases the lethal effect (Morrison *et al.,* 2012).

As bioreactors: Genetically engineered silkworms are employed as bioreactors for the production of human skin protein, type III procollagen (Tomita *et al.,* 2003) which is used for covering the wounds and in making artificial skin. According to Wen *et al.* (2010), Germline-transgenic silkworm spun cocoon containing recombinant spider silk when compared with wild-type silk. The recombinant silk displayed a higher tensile strength and elasticity. Silkworm biotechnology is an innovative and easy approach to achieve high protein expression levels and is a very promising technology in the field of life science (Kato *et al.,* 2010).

Genetically Improved Biocontrol Agents: The conventional breeding and artificial selection for natural enemies resistant to pesticides takes many generations. With the efforts on genetically engineered parasitoids and predators, they can be made more hardiness to general environmental, increases fecundity, improves the host-seeking ability etc. Monocrotophos resistant strain of *C. scelestes* was developed and it could resist the dimethoate, acephate, phosphamidon and methyl-o-demeton (Patel and Yadav, 1997). An endosulfan tolerant strain of

T. chilonis (Endogram) has been developed by Project Directorate of Biological Control (PDBC), Bangaluru for the first time in the world. A High-Quality Strain (HQS) of *T. chilonis* with better host searching ability and females with higher fecundity was evaluated in the laboratory (Anon., 2006).

Possible risks: 1) Disturbance of ecological balance 2) total elimination of a pest species that give rise to another species to fill the vacuum 3) Viral vectors combining with other wild type viruses and also with the genome of the host 4) Exchange of transposons between organisms 5) Limited knowledge on molecular genomics of different species 6) low frequency of transformation 7) high cost etc.

Conclusion: Genetically engineered insects offer a great scope for crop pest management which would eventually results in reduction of pesticides. In addition, there is a possibility to modify behaviour of insects, improvement of efficiency of parasitoids and predators, disease and vector control in public health. However, despite rapid advances in the subject area, there are no widely accepted regulatory or bio-safety framework that provides guidance on all aspects, although some of these are currently in development. It is proposed that such a document could facilitate the standardisation of procedures and the comparability of results and conclusions, allowing robust assessments by decision-makers. However, even if such a framework document was in place, there is still a requirement for countries to develop their national guidelines, policies, safety and the risks by the use of GM insects.

Future thrust:

- Analyses of the potential risks of different drive mechanisms (transposable elements or symbionts such as *Wolbchia*) should studied
- Effect of gene transfer to non-target bacteria or to non-target arthropods should be find out
- Studies should be conducted to evaluate transgene stability and how horizontal transmission could be minimized.
- Assessment of the potential risk issues and bio-safety research of releases of transgenic insects is highly required

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