USE OF NUCLEAR TECHNOLOGY IN THE CONTROL OF INSECT PESTS

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Over one million insect species inhabit the world. Majority of these insects are fortunately beneficial or harmless. The species that are detrimental cause losses estimated at between 8-20% of the total production of crops and livestock throughout the world. Very significant losses are caused by insects during storage of agricultural products. Losses also occur from human diseases such as malaria and dengue that are transmitted by insects.

For more than fifty years man has relied mainly on insecticides to kill insects that ravange crops. The impact of modern pesticides on agricultural production is such that the total withdrawal of these chemicals would reduce the output of crops and livestock considerably and increase the price of farm products. Because of the harmful effects of these chemicals efforts have been made to develop safer alternatives to pesticides. All these alternative methods are of limited applicability and need specialized management. Therefore the use of pesticides is expected to continue. However, more environmentally conscious alternative methods of insect control are required. One such alternative method is the use of isoptes and radiation in the control of insect pests.

Nuclear techniques are commonly used in studying the environmental fate of pesticides in different environmental matrices and the metabolism of pesticides in animals and plants. Radioisotopes are used as tags or markers of insecticides, insects or plants. With such tags one can follow the fate of insecticides within insects and the environment, the movement of insects under field conditions and the incorporation of nutrients into the insects. They can be used to follow parasites and predators of insects, to monitor their numbers, movement and ability to help control insect pests. Radioisotopes are also used to identify the degradation products of pesticides and in preparation of pesticide formulations.

The use of radioisotopes such as tritium, C^{-14} and P^{-32} as tracers in pesticide research are well established. A pesticide molecule labelled with a radioactive atom can be easily traced among scores of non labelled chemicals found in the environmental matrices by using radiation detectors. The degradation products can be separated from the other chemicals by conventional methods and quantified by estimating the radioactivity associated with them. The radio tracer technique is very reliable and very sensitive to detect minute quantities of a substance. As such nuclear techniques have played an important role in developing safer and more effective pesticide delivery systems.

In another approach to control insect pests radiation is used to sexually sterilize insects. The technique is known as the Sterile Insect Technique-SIT. H.J. Muller who was awarded the Nobel Prize for his work on the genetic effects of irradiation in insects demonstrated that X-rays or gamma radiation could cause genetic damage to insect reproductive systems to induce sterility. The SIT is an approach to insect birth control. The technique is highly selective ecologically in that it affects only the targeted species.

It exploits the mate seeking behaviour of the insect. Insects are reared in mass numbers and sexually sterilized using gamma rays from a Co-60 source. The sterile insects are thereafter released in a controlled manner into the required environment. When matings occur between the released sterile insects and the wild insects, offspring will not be produced. If sufficient matings occur the insect pest population declines. With continued release the insect pest population can be controlled and in some cases eradicated.

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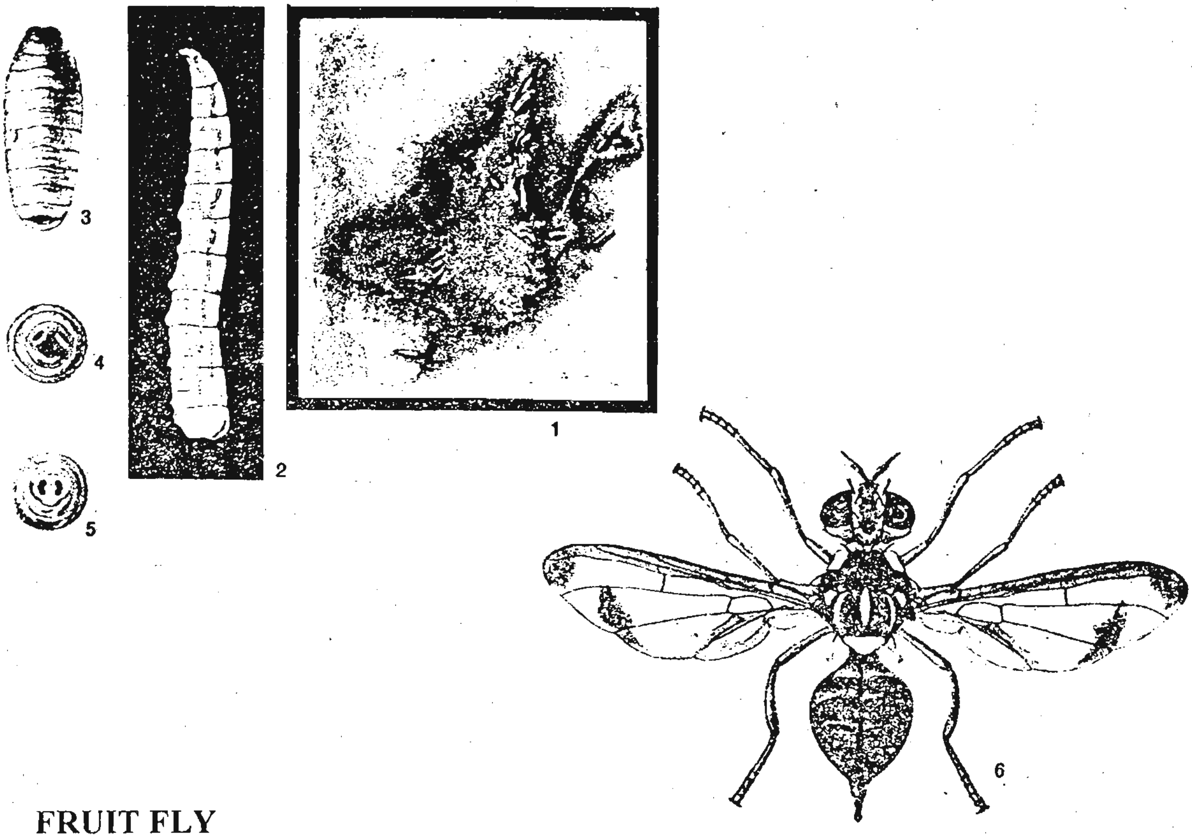
The first demonstration of this technology was the eradication of the screw worm from the islands of Curacao and Sanibel in the 1950s. This project was international. To a large extent operational SIT projects since then have remained international in scope. SIT has successfully been used against tsetse fly, Mediterranean fruit fly, pink boll worm and the melon fly.

Although the basic idea appears simple, the application of the SIT requires considerable biological sophistication. The basic idea of the technique theoretically suggests that it could be applied against any insect pest that reproduces by sexual means. However, in practice obstacles can be encountered. For some insects such as butterflies and moths the main difficulty is mass rearing. These insects belonging to the order Lepidoptera are amongst the major insect pests in the world. Another problem is that many moths are difficult to sterilize with radiation. They require a radiation dose 2-10 times greater than that for flies. These large doses have been observed to reduce the competitiveness of the released insects. During the recent past mass rearing of this insect group have been successful on artificial diets. Also a modification of the SIT called the F1 or inherited sterility method has been developed to suppress butterflies and moths. In the F1 method much lower doses of radiation are used so that the released males are only partially sterilized and the females are fully sterile. **Hence, when released females mate with native males no progenies are produced. When released males mate with native females a reduced number of progeny is produced but the offspring are completely sterile.**



FRUIT FLY

1. Maggots in fruit 2. A single larva 3-5. Pupa along with details of extremities 6.Adult

The SIT is effective for area wide insect eradication programmes. It is not applicable on an individual field or farm basis. SIT programmes tend to be large and are considered expensive. However, when applied against very damaging and widely dispersed insects the cost per unit area of land is less than the cost of each individual field being treated separately by other technologies. Other factors favouring the use of SIT includes the growing problem of insect population that become resistant to insecticides and concerns about the environmental damage caused by the continuous use of insecticides.

To conclude two special benefits should be stressed with regard to SIT. SIT can suppress and eradicate insect pests in an environmentally harmless manner. It combines nuclear techniques with genetic approaches and replaces intensive use of insecticides. In some SIT programmes insecticides are used sparingly at the outset to reduce the size of the insect pest population before sterilized insects are released. However, the amount of insecticides used in such programmes is a fraction of what would be used without SIT. SIT is suited for use in integrated pest management programmes to achieve control at the lowest possible price with a minimum contamination of the environment with chemicals.