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Role of Radiation in Pest Management

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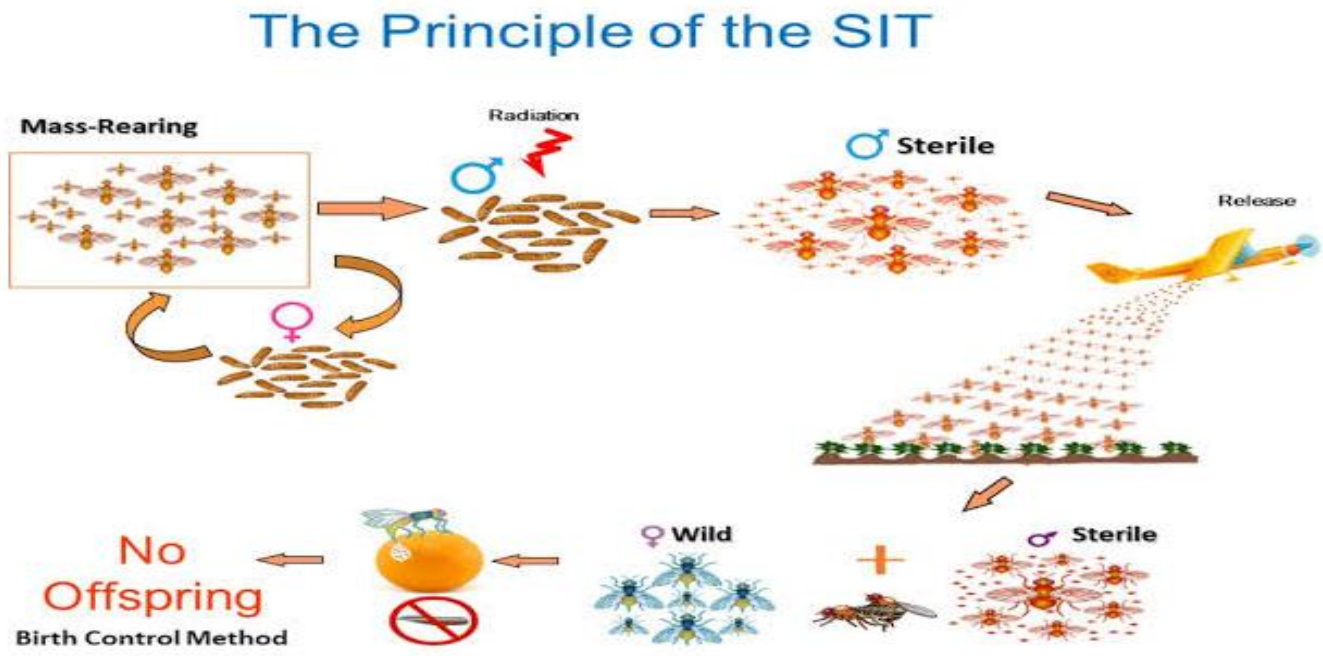
SUMMARY

Interest in the use of irradiation as a phytosanitary treatment for agricultural commodities and other techniques such as sterile insect technique for the control of dipteran pests ,treatment of stored commodities against various stored grain pests is growing worldwide, particularly since publication of the International Plant Protection Convention (IPPC) standard that endorses and facilitates trade based on this disinfestation method. Irradiation is broadly effective against insects and mites at doses that do not compromise quality of most commodities. Unlike other disinfestation techniques, irradiation does not need to kill the pest immediately to provide quarantine security, and therefore live but sterile or not viable insects may occur with the exported commodity making inspection for the target pests redundant. Generic irradiation treatments have been approved in the USA to control broad groups of insects in all commodities. The approved generic doses are 150 Gy for tephritid fruit flies and 400 Gy for all insects except Lepidoptera pupae and adults (which may require higher doses). Generic irradiation treatments will accelerate the approval of irradiation quarantine treatments for specific crops and expedite new trade in agricultural products because research will no longer be needed for each quarantine pest and commodity. The availability of generic treatments makes irradiation an attractive option compared with other quarantine treatments.

INTRODUCTION

The radiations such as ,alpha rays,beta rays,gamma rays and the X-rays are known as ionising radiations whereas UV-rays & IR-rays are known as nonionizing radiations.Both Ionising radiations and nonionizing radiations are used for the sterile insect technique,to control the stored grain pests ,to control the growth and reproduction of the regulated pests by phytosanitary measure and to arrest the development of the preys & hosts of the predators and the parasitoids. The SIT is an environmentally-friendly pest management method by which a population of insects is controlled by releasing mass-reared sterile males in a target area. When these sterile males mate with females in the wild, there are no offspring. The systematic and repeated release of sterile males reduces the target wild insect population over time.The SIT was developed in the late 1950's and has been successfully used in many countries in the management of agricultural pests, such as the Mediterranean fruit fly, the false codling moth, the New World screwworm and tsetse flies, among others. The stored grain pests are irradiated making them sterile & thus the damage is reduced.



Use of radiation in sterile insect technique

Sterile insect technique, or SIT, is the release of a large number of sterile males into a wild population of the target species to over-flood the area with sterile males. Females of the wild population that mate with the sterile males fail to produce viable offspring and in the next generation the population size is reduced. Successive releases of sterile males over a sustained period will lead to a reduction in the pest population size with eradication possible (Knipling 1955). SIT is also inversely-density dependent. As the pest population reduces in size, successive releases of the same number of sterile males have a greater effect on the pest because the ratio of sterile to fertile males increases. This makes SIT an effective control method, even at low population densities (Knipling 1955). Pupal stages are the most appropriate stages for sterilisation in holometabolous insects.

Advantages of SIT

- The most target specific.
- Nondisruptive method
- Species specific
- Does not release exotic agents into environment.
- It uses no chemicals,leaves no residues.
- Does not introduce new genetic materials into the hosts
- Improve the quality and quantity of fruit production & reducing the pesticide use & promotes IPM.

Limitations of SIT

- Costs of production high.
- Must provide reliable sterilisation.
- Must have reliable supply of sterile insects.
- Regional cooperation.
- Sterilisation quality control issues.
- Re-invasion of sterility zone.
- Sterile insects should not inflict direct damage.
- Lab rearing quality control issues.
- Released insects must be competitive with sterile insects for mating.

Use of radiation in the control of stored grain pests

Gamma radiation can eliminate insect pests of stored grains as well as field crops more efficiently. It is applied to targeted insect pests, hence it is eco-friendly technology for insect pest management, without causing any induced radioactivity and residual effect. Gamma radiation @ 251200 Gy can effectively suppress pests viz., grain weevil, Mediterranean flour moth, Indian meal moth, cigarette beetle, medfly, onion fly, fall armyworm, tobacco budworm, African cotton leafworm.The most commonly used radiation for the insect sterilization is gamma radiation from the radioisotopes 60Co and 137Cs. Control of insect pest through radiation is carried out by two methods ,(a) by release of sterile adults, e.g. fruit fly, flour mill moth etc. and (b) by exposing infested products, e.g. stored grain pests (Cornwell and Bull, 1960).

Advantages

- Improves the quality and quantity of crop production as it reduces pesticide use .
- Absence of undesirable residues in treated foods.
- Insects having resistance to insecticides can be managed.
- No resurgence of insect pests.
- Safer to natural enemies

Disadvantages

- Radiation, transport and release can reduce male mating fitness.

- Mass rearing and irradiation require precision Processes.
- It may affect human health

Use of radiation as a phytosanitary measure

The NPPO is responsible for the phytosanitary aspects of evaluation, adoption and use of irradiation as a phytosanitary measure. The objective of using irradiation as a phytosanitary measure is to prevent the introduction or spread of regulated pests. This may be realized by achieving certain responses in the targeted pest(s) such as:

- Mortality
- Preventing successful development (e.g. Non-emergence of adults)
- Inability to reproduce (e.g. Sterility), or - inactivation.

Phytosanitary uses of irradiation also include the devitalization of plants (e.g. seeds may germinate but seedlings do not grow; or tubers, bulbs or cuttings do not sprout).

Application

Irradiation can be applied:

- As an integral part of packing operations
- To bulk unpackaged commodities (such as grain moving over a belt)
- At centralized locations such as the port of embarkation.

When safeguards are adequate and transit movement of the untreated commodity is operationally feasible, treatment may also be performed at:

- The point of entry
- A designated location in a third country
- A designated location within the country of final destination

CONCLUSION

The determination of a radiation dose (160 Gy) to produce high quality insects that exhibit a high proportion of sterility and comparable fitness to wild insects that show some level of population suppression are important, promising steps in the development of SIT as a viable option for insects suppression. To develop a financially viable SIT programme the current limitations must be addressed. Further work must be undertaken to increase the ease and cost efficiency of the mass-rearing process. Knowledge is also required to understand the triggers that cause pupae to enter and leave extended pupation for overwintering. The release of sterile insects needs to be examined on a larger scale, than the cage study, to determine the sterile to wild release ratio and the release frequency required to suppress an insect's infestation. Ideally this would be carried out during the early growing season when the greenhouse conditions are optimal for insect's development and oviposition. To develop insects SIT to this stage a cost-benefit analysis is required to determine the financial feasibility of this method. More detailed knowledge of the market will allow for an accurate cost-benefit analysis. Financial investment is required to develop insects SIT into a fully functioning SIT programme; but this is only possible if the SIT programme can be developed as a financially viable business.

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