CONTROL OF AGRICULTURAL PESTS

It has been estimated that in the United States the annual losses to agriculture caused by insect pests alone amount to $4 billion; the corresponding figure for the world as a whole is estimated at $27 billion. The consequences of such enormous damage are particularly menacing to those vast areas of the world where the economy is primarily agricultural.

All over the world a huge effort is being made to fight these pests and now new weapons have been added to man's armoury in this battle. These are radioactive isotopes and radiation sources. Their contribution to the control of agricultural pests is not yet precisely calculable, but several promising lines of attack have been opened up and some concrete results already achieved. The main value of radioisotopes lies in the fact that they are unique instruments for the study of insects, that is, their physiological composition and biochemical processes, their biological habits, and their behavior in relation to their surroundings.

The methods of using isotopes and radiation sources in agricultural entomology were discussed by experts from 11 countries at a scientific symposium held by the International Atomic Energy Agency in Bombay from 5 - 9 December 1960. The scientists reviewed the techniques which have already been introduced, exchanged information on the results obtained and discussed the possibilities of further research in new directions.

Limitations of Insecticides

Millions of tons of toxic chemicals or "insecticides" are sprayed on crops every year as the most important operation against insect pests. This is a continuous operation to prevent the insects from taking over before man finds more specific solutions to the problem through research. But the operation has its limitations and disadvantages. It is not 100 per cent efficient; insects develop resistance to every new insecticide. Besides, the chemicals may be hazardous to plants and animals and even to man when he consumes the agricultural produce.

More effective and selective, yet less toxic, insecticides are therefore necessary. To develop them, it is essential to know what happens to the toxic chemicals in plants and animals, how efficiently they can be applied to crops, how much is left days or weeks after spraying, and how possible residues on and in agricultural produce affect living organisms.

Together with other techniques, radioisotope tracers are indispensable tools in these investigations and the first session of the Bombay Symposium heard reports on studies on the behavior of insecticides labeled with radioactive isotopes through various stages of their metabolism and turnover in plant and animals. It was pointed out that these radiotracer studies had already increased the knowledge essential for the rapid development of more efficient, more selective and safer insecticides. The studies were throwing much light on the toxicity of insecticides, especially on the mechanism of their toxic action in living organisms and the countermeasures to be taken against this action, when necessary. The problem of residues left on and in plants and animals is in fact a potential public health problem; radioisotope techniques have now become a valuable aid in determining even the smallest quantities of residues left on or in agricultural produce long after the spraying of the insecticide.

Locating the Vulnerable Spots

The next subject discussed at the symposium was the use of isotopes in studying insect physiology and biochemistry. The scientists who took part in the discussions referred to the crucial problem posed by the ability of insects to develop strong resistance against the chemicals now used to destroy them. Although much is already known about this problem, it has not yet been solved, and the scientists stressed the need for intensified research to locate the vulnerable spots in the defensive armoury of various insect species. One group of investigators is trying to solve this problem by studying the behavior of labeled insecticides in insects. Another new technique is to label the life processes of insects with radioactive tracers and study the influence of the normal, non-labeled insecticides on these labeled processes.

Apart from these tracer uses, radiation is also being employed directly for the effects it can produce on the insects themselves. A relatively straightforward method is to try to destroy insects by subjecting them to large doses of radiation; for example, it was shown that grain and other agricultural products stored in warehouses could be disinfested with the aid of mobile radiation sources.

Sterile Male Release

Among other interesting techniques described at the symposium were those of using insects against themselves, as for instance, the release among insect populations of male insects made sterile by radiation. This, it was pointed out, had already been tried successfully in some cases. For example, screw-worm flies in the Island of Curaçao were completely eradicated in 1954 by four months of sterile male release. Male screw-worm flies, irradiated as pupae in the laboratory, were released in nature, and since the female insects of this species mate only once, there was no reproduction by those which mated with the sterile males. A similar program was launched early in 1958 in the south east of the United States, and towards the end of that year more than 25 million sterile males were being released each week from aircraft over 80 000 square miles in Florida, Georgia and Alabama. The operations were so successful that no native screw-worms were found after February 1959.

Possibilities of wider application of this technique were discussed at the Bombay symposium, especially to such pests as the Mexican and Mediterranean fruit fly and the Tsetse fly. It was, however, pointed out that while this technique appeared very promising, even better results could perhaps be expected from radiation-induced genetic changes which would eliminate an insect population in a few generations. It was also suggested that in some cases these techniques might be employed in combination with the use of insecticides.

The use of radioisotopes in the study of the biological and ecological characteristics of insects was considered at a separate session of the meeting. Thorough knowledge of the life history, migration habits, feeding behavior and other characteristics of insects is essential for all research on insect pest control and for the development of effective control measures. It was emphasized that large-scale ecological studies should first be carried out in detail; otherwise, the results of newly developed chemicals and radiation control might indeed be very poor.

At the closing session, the main points which had emerged from the discussions were reviewed by three of the participating scientists: Mr. F.P.W. Winteringham, of the Pest Investigation Laboratory, Buckinghamshire, United Kingdom; Mr. P.B. Cornwell, of the Isotope Research Division, Wantage Research Laboratory, United Kingdom; and Mr. D.W. Jenkins, of the Entomology Division, Army Chemical Corps, Biological Laboratories, Fort Detrick, United States.

"No Universal Panacea"

Giving a resumé of the discussions on insect physiology and biochemistry and resistance problems, Mr. Winteringham listed some of the more important results reported at the symposium. Among them were findings about the persistence and effective toxicity of some established insecticides from studies on their metabolism in both plants and animals and new information on mechanisms of insect resistance to insecticides. He, however, emphasized that radioisotopes must not be regarded as a universal panacea in the research laboratory; they were most effectively used in conjunction with other methods.

P.B. Cornwell (UK) addressing one of the sessions of the Bombay symposium, with S.W. Andreev of the USSR (left) in the chair. In the center is the Scientific Secretary, Johan Halberstadt of IAEA

Mr. Cornwell said the symposium had done much to indicate what could and what could not be done in the field of disinfestation by radiation. In his view, radiation disinfestation was a sophisticated technique which required the presence of various favorable factors for successful practical application. He thought that disinfestation could be combined with sterile male release with a view to preventing reinfestation. He also pointed out that if radiation disinfestation was applied commercially, the problem would arise of international clearance of irradiated foods for human consumption, and in this respect international organizations could be of help.

Dr. Jenkins pointed out that insects which had at one time been susceptible to certain insecticides had now developed a resistance or new species of insects were replacing those which had been effectively controlled. He believed that in the future a great deal more would be heard about the methods for the self-eradication of insects, for example by sterile male release or genetic changes, and thought that before these were actually applied on a large scale, ecological studies should be carried out extensively and in detail. He was of the view that the use of radiation in the field of insect genetics would be of great value. He, however, agreed with Mr. Winteringham and Mr. Cornwell on the usefulness of combining a number of techniques, such as the use of insecticides to reduce the insect population to a low level and the use of the sterile male technique or genetic factors to eliminate the residue.