RADIATION USES IN AGRICULTURAL GENETICS IN THE UNITED ARAB REPUBLIC

Under its programme of technical assistance, the International Atomic Energy Agency has provided the United Arab Republic with the services of an expert in the agricultural applications of radioisotopes, more specifically in agricultural genetics. The expert assigned to this project is Professor Alois Tavčar, of Zagreb University, Yugoslavia.

Professor Tavčar's services will be available for this work for a total of seven months. He has already spent four months in Cairo (January - May 1962), and he is due to return there soon for a further period of three months. A report on his work during the first part of his assignment, which he has submitted to the Agency, indicates the nature and scope of the activities initiated in the UAR under his guidance.

On the purely scientific side, the main purpose of Professor Tavčar's assignment was to assist the UAR authorities in developing a programme for a study of the genetic effects of different types of radiation on cell tissues and of the influence of irradiating either seeds or growing plants on the rate of growth of agricultural crops. In addition, it was also envisaged that he would participate in the general training programme of the National Radioisotope Training Centre in Cairo and organize a special training programme for the agricultural uses of radioisotopes.

A good part of this work was accomplished during the first part of Professor Tavčar's assignment. It is expected that during his forthcoming trip to Cairo it will be possible not only to assess some of the results of this work but also to strengthen and expand these activities in the light of the experience gained so far. Although most mutations are visible from the second or subsequent generations of plants, certain useful observations can be made also in the first generation of plants developed from irradiated seeds.

Irradiation Experiments

On Professor Tavčar's arrival in Cairo, a programme of work was drawn up in consultation with Dr. Ismail Hazza, Director of the National Radioisotope Centre. An important part of this work was irradiation of various field crops.

Under the IAEA expert's guidance, the seeds of some important field crops were irradiated with gamma rays in order to obtain beneficial mutations, especially with regard to improving the quality of the product and increasing the yield potential in addition to increasing the resistance against disease and lodging and shortening the vegetation period and plant height. Plant breeders of the Ministry of Agriculture were consulted to determine which seeds could be considered representative of the most important field crops in the country, and the best varieties of seeds of maize, sesame, peanut, sorghum, and horse beans were selected for gamma irradiation. Cotton seed was excluded from this study as research on irradiation for breeding purposes was already in progress at the Institute for Cotton Research of the Ministry of Agriculture.

The irradiation was done with a cobalt-60 unit. Once the seeds were irradiated, they were examined for the degree of germination attained. The germination test was carried out at the Laboratory of Seed Control of the Ministry of Agriculture. About 45 days after irradiation, the seeds were planted at an agricultural experimental field at Inshas.

For cytological investigations, i.e. for a study of the radiation effects on cell tissues, the root tips of the seedlings were cut off after the germination test and were examined by a special process.

Another type of experiment carried out under Professor Tavčar's guidance consisted in soaking small samples of certain seeds in a solution of radioactive phosphorus (phosphorus-32) before planting them. This was intended to obtain beneficial mutations in some of the morphological and physiological characteristics of the plants. Some of the seeds were soaked for 24 hours, others for 48 hours. Later they were washed in distilled water and planted at the Inshas experimental field.

Experimental Facilities

Apart from guiding the actual experiments, Professor Tavčar gave such advice as was needed on the technical requirements of the experimental facilities. This was mainly in connection with the selection and setting up of a gamma irradiation field at Inshas. Upon his arrival at the Atomic Energy Establishment at Inshas, a committee, including him and Dr. Ismail Hazza, was formed to determine the site for the irradiation field. A cobalt-60 unit had already arrived, and plans had been prepared for the concrete buildings where the gamma unit would be located and operations take place. The Committee, together

Material for the concrete foundation and walls to house the cobalt-60 unit being transported by camels to the radiation field at Inshas

Installation of the cobalt unit in the radiation field

with the Secretary General of the Atomic Energy Establishment and the engineers who had been engaged for the technical work, also discussed various other matters, such as the supply of water for irrigation purposes and the transportation of clay of 50 cm thickness for an area of about three acres. It was considered desirable that the irradiation field should have the same soil conditions as those in the main agricultural regions in Egypt and that it be located near the Establishment at Inshas. The field was therefore set up on pure sand at a prudent distance from the other buildings of the Establishment.

Professor Tavčar proposed that the irradiation angle of the cobalt unit be increased from 90° to about 130° to provide a larger irradiation area without reducing the safety of the installations, which are situated several hundred meters away from the irradiation field. This modification was agreed to by the experts who were to install the cobalt unit and was approved by the Director of the Radioisotope Centre.

By the time Professor Tavčar left Cairo in May last year,

(a) the water tubes had been installed in the field, and a stone road had been built at a distance of about 700 meters;

(b) two walls around the cobalt-60 unit, as well as the foundation for the container, had been completed and the container together with the cobalt unit had been placed in the pit;

(c) the operations building was nearly completed;

(d) in collaboration with Dr. Hazza, experts from the United Kingdom had connected the necessary metal parts to facilitate the early use of the cobalt unit; and

(e) clay from the Nile had been transported to the irradiation field, and a great part of the surface of the field had been covered.

Training

In the course of the irradiation experiments, Professor Tavčar explained the methods and gave detailed instructions to the research workers associated with this work. For example, instructions for cytological examination of root tips, observation of different characteristics in the plants of the first generation and further handling of the offspring were given to the agronomists engaged in the application of radiation genetics in plant breeding.

Apart from these instructions in the course of the actual experiments, Professor Tavčar gave eight lectures on radiation genetics. The lectures were attended by research workers in agriculture and biology from the Radioisotope Centre, the National Research Centre and Laboratories for Plant Breeding, Plant Production and Seed Control. In connection with these lectures, visits were arranged to the irradiation and experimental fields at Inshas.

Some preparatory work was done for the establishment of a laboratory for radiation cytology and radiation genetics, and Professor Tavčar was able to give cytogenetic demonstrations on plant tissues in connection with his lectures.

Genetics is taught at the University of Cairo, and the Ministry of Agriculture has a Plant Breeding Department; besides, there is a Plant Breeding Section at the experimental farm of the Egyptian Agricultural Organization at Bahtim. Professor Tavčar noted that these institutes have very good research workers and recommended that their work concerning isotope applications in the breeding programme be coordinated. He also recommended that a department

for the agricultural applications of radioisotopes be established at the Atomic Energy Establishment at Inshas and that in the meantime this work be carried out at, or through, the Radioisotope Centre at Cairo.

Professor Tavčar's report also contains an outline of the instruction to be given to the assistants assigned to work on the application of radiation genetics and radiation cytology in plant breeding.

PRACTICAL APPLICATIONS OF SHORT-LIVED RADIOISOTOPES

The use of radioisotopes as tracers is well established all over the world. Up to now the great majority of isotopes used in this work have been those with comparatively long half-lives, that is the time taken for the radioactivity of these isotopes to decay to half its initial value is several days, weeks or even years. For example, the half-life of iodine-131, one of the most commonly used isotopes, is eight days.

While a long half-life is in some respects an advantage, in other important ways it is a distinct disadvantage. Thus, if a radioisotope is used for investigating or checking a process in industry or agriculture, it is obviously undesirable that any residual radioactivity be left in the product, which may have to be handled, or eaten, by the consumer. This means that sufficient time must be allowed for the radioisotopes in the article to lose their activity by natural decay, and the shorter the half-life the more quickly will this stage be reached. Again, when radioisotopes are used in medicine for diagnostic tests, it is desirable to reduce to a minimum the radiation dose delivered to the patient during the test. It may also be required to repeat the test at intervals without having to worry about the activity remaining in the body from the previous test. On both accounts, a short-lived radioisotope is preferable to a long-lived one, although naturally other factors besides half-life have to be considered in choosing an isotope for a particular test.

A short-lived radioisotope is usually defined as one whose half-life is reckoned in seconds, minutes or hours. By their very nature, these isotopes must be used at or near the site of production, unless it is possible to produce and ship many times the activity actually required by the user. In the past, this limitation has restricted the use of these isotopes to institutes located reasonably close to a major producer; inevitably, these have been in advanced countries.

Isotopes from Small Research Reactors

A new factor has now entered the situation. Numerous small research reactors have been built and are now coming into operation in various parts of the world, many of them in developing countries. These reactors can serve several purposes, of which the production of isotopes is one of the most important. Furthermore, it has been shown that it is more economic to produce short-lived than long-lived radioisotopes in such small reactors.

In order that maximum advantage can be gained from the isotope production facilities provided by these research reactors, it is essential, first of all, to exchange and disseminate information on the production and separation of short-lived radioisotopes and on the varied uses to which they can be put. With this objective in view, the International Atomic Energy Agency held a seminar in Vienna last November on the practical applications of short-lived radioisotopes produced in small research reactors. Some 170 scientists from 29 countries attended the seminar.

The seminar opened with two review papers, presented by L. G. Stang Jr. and P. C. Aebersold (both from the USA), which covered the whole field of production and preparation. These were followed by about a dozen reports from institutes in a number of countries, dealing with the different techniques of radioisotope production.

A large part of the seminar's discussions was devoted to the use of short-lived radioisotopes as tracers, which, in fact, is their main application at present.

Industrial Uses

L. G. Erwall (Sweden) dealt extensively with their use in industry, with special reference to the industry in his own country. "When choosing a ra-