IAEA Technical Cooperation Programme

Developing new varieties of crops of economic importance through induced mutations in Latin America and the Caribbean

The challenge

Food production deficits in many countries in Latin America and the Caribbean have led to serious problems of poverty and malnutrition, mainly in rural areas. The situation is aggravated by the effects of climate change and population growth in the region. The main impacts of climate change on agriculture are experienced as higher temperatures, changes in rainfall patterns (in amount, spatial and temporal distributions), salinization of soils, and the increased occurrence of transboundary diseases and pests. The development of higher-yielding, more resilient crops using induced mutation techniques offers an effective way to respond to these challenges.

The project

The IAEA, through its technical cooperation programme, together with the Food and Agriculture Organization of the United Nations (FAO) has been working with countries in Latin America and the Caribbean for many years to introduce and strengthen induced crop mutation and breeding. In 2014, a new project was launched, with the participation of national agricultural research institutes and universities from 18 countries in the region. The project used mutation techniques to develop improved crops with tolerance or resistance to abiotic (drought and high temperatures) and biotic (disease and pests) stresses, as well as with boosted production potential. The project targeted crops of economic interest to the region, as well as native crops of more local importance. The improved plants are being developed into new varieties that can be distributed to farmers, where they will have an impact on food security and the agricultural economy in the region.

The impact

As a result of the project, participating countries have successfully developed a range of new mutant varieties. All of these new varieties are in the pipeline for official registration.

In Cuba, for example, tomatoes are a very important crop, but temperatures and water stress have seriously affected their production. A mutation breeding programme using nuclear techniques was developed to obtain new tomato varieties, tolerant to high temperatures and drought. The technique has

Tomato mutant varieties in Cuba. (Photo: Maria Caridad Gonzalez/INCA)

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been in use since 1990 in breeding programmes at the National Institute of Agricultural Science (INCA). Based on research carried out at INCA, the tomato mutant variety Girón 50 was developed under the new project. Seeds of selected mutant lines were provided to farmers and producers, who evaluated the plants for agronomic performance under biotic and abiotic stress conditions. The advanced mutant line Girón 50 was selected by the producers and farmers after the evaluation, and is now in the process of being officially registered for distribution.

Quinoa has important nutritional and agronomic value, and is increasing demand both locally and internationally. Its cultivation in Peru is limited by the crop's high susceptibility to the disease downy mildew. This is controlled by chemicals, which reduces options for its organic commercialization by small farmers of the Andean region, thus decreasing its profitability. The quinoa variety Marangani was irradiated with gamma rays and the genetic material in the third and fourth generations of mutants were subjected to a natural infection of downy mildew in hot spot zones on the Peruvian coast and in its central Andean region. More than 420 000 plants were evaluated and six mutant lines with disease resistance in coastal conditions and 29 resistant mutant lines in conditions of the Andean region with good potential were identified. Some disease tolerant mutant lines selected also had a high yield potential, making them candidates for official registration as new varieties.

In Brazil, two new lines of rice resistant to a specific group of herbicides called aryloxyphenoxypropionates (APPs) were developed at the Agricultural Research and Rural Extension Corporation of Santa Catarina (EPAGRI), Brazil, in collaboration with the University of São Paulo, Brazil, using mutation induction with gamma irradiation of rice seeds. Weeds, in particular weedy rice, or 'red rice', pose a major constraint to obtaining high yields in paddy rice productions systems. Molecular analysis revealed that the new rice lines were resistant to the herbicide due to a single base pair mutation in a specific gene. Thus, the herbicide eliminates the weedy rice only and does not affect the cultivated new rice. This approach, especially if applied in an integrated weed management approach, has the potential to provide a major increase in rice production in areas where weedy-rice is a problem. Opposite to similar approaches that use transgenic rice resistant to herbicides, the developed mutant lines do not contain foreign genetic material and can be cultivated under the same regulations as conventionally bred crops.

PROJECT INFORMATION

Project No: RLA5068

Project title: Improving Yield and Commercial Potential of Crops of Economic Importance (ARCAL CL)

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Contributing to:

Partnerships and counterparts

The project was carried out in partnership with the Food and Agriculture Organization of the United Nations (FAO), and through the Regional Co-operation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL)

The science

Mutation breeding is based on the induction of heritable genetic changes (mutations) in plant material, using gamma- or X-rays or other mutagens. The mutations are expressed in the mutant plants, which are selected for new and useful traits, such as disease resistance or tolerance to abiotic stresses. Plant mutation breeding does not involve gene modification, but rather uses the plant's own genetic make-up and enhances the natural process of spontaneous mutation, the motor of evolution. By using radiation, scientists can significantly shorten the time it takes to breed new and improved plant varieties.