IAEA Technical Cooperation Programme

Improving crops and optimizing fertilizer use in the Asia and the Pacific region

The challenge

Food security and human nutrition are topics of major concern in the Asia and the Pacific region. The population is growing rapidly, and large areas of crop land are disappearing due to urban and industrial development. To meet the growing market demand and ensure food security, agricultural production had to be intensified.

The challenge is exacerbated by the impact of climate change and climatic variability, including widespread water scarcity. Seventy percent of the freshwater used for agricultural production is applied using traditional irrigation methods. Improved irrigation management is essential.

The project

A regional technical cooperation project was established to improve the genetic traits of selected crops in participating countries. The project also aimed to optimize the use of fertilizers and irrigation water to ensure high yields and stable food production. Induced mutation techniques, using both gamma rays and heavy ion beam irradiation, were used to produce mutant lines in key crops in countries in the region. These crops included rice, wheat, barley, soybean, mung bean and sorghum. The project aimed to develop and improve key traits such as resistance to disease, saline soil tolerance, and a high degree of adaptability to changing climate conditions such as drought and varying availability of water.

The project also supported studies on the efficiency of organic fertilizer and nitrogen fertilizer in increasing yield, as well as on crop quality and fertilizer use efficiency, of advanced mutant lines in selected crops, using the nitrogen 15 technique.

The IAEA provided support to 15 participating countries from the Asia and the Pacific region in building or enhancing their national capacities in mutation breeding, fertilizer and water use efficiency, and fertigation.

Newly developed mutant varieties were identified and tested for productivity, resource use efficiency and tolerance to stress.

Participants at a training course on applying molecular markers in mutation breeding programmes, Australia, November 2012.

17-44011

PROJECT INFORMATION

Project No: RAS5056

Project title: Supporting Mutation Breeding Approaches to Develop New Crop Varieties Adaptable to Climate Change

Duration: 2012–2015 (4 years)

Budget: €409 925

Regional Agreement: RCA

Contributing to:

Partnerships and counterparts

The project was planned and implemented by the IAEA in partnership with the Food and Agriculture Organization of the United Nations and the Forum for Nuclear Cooperation in Asia.

Facts and figures

- 15 participating countries, 4 regional training courses, 10 national training courses, 4 sets of interregional training materials and 29 national training protocols developed and distributed
- 96 researchers trained in international workshops and 340 researchers trained in national training courses through on-site training in Malaysia, Korea and Pakistan
- 28 mutant varieties were developed and released (9 wheat, 6 sorghum, 4 rice, 3 kenaf, 1 barley, 1 blackgram, 1 pigeonpea, 1 cotton, 1 sugarcane, 1 mungbean).
- 351 advanced mutant lines were developed.
- 4360 mutant lines in an advanced stage were identified.
- Web page established (www.plantmutagenesis.net), including content from the Asian and Oceania Association of Plant Mutagenesis (AOAPM).

The impact

Twenty eight new mutant varieties were officially released as a result of the project. These varieties were developed using induced mutation techniques and were disseminated to farmers in the region. In addition, a total of 351 advanced mutant lines were developed, several of which are under multi-location evaluation and in breeding programmes. National core teams were established, which will devise national strategies for relevant institutes, policy makers, extension agencies and farmers.

Thanks to the newly developed mutant varieties or advanced lines, together with improved information on the appropriate amounts of organic and nitrogen fertilizers and water, farmers are now able to grow stronger crops under varying climatic conditions, and to be confident that they will achieve stable and even higher yields. In Malaysia, for instance, two rice mutant varieties have been developed and released that are adaptable to varying water regimes, as well as being resistant to rice blast disease.

Enhanced, stable crop production makes an important contribution to food security for growing populations with diminishing agricultural land. This contributes to economic growth and increases the prosperity of the people in the region.

Thanks to the enhanced human and technical capacities of the participating institutes, the 15 participating countries will be able to continue developing mutant lines with different improved characteristics as needed for the specific circumstances and climatic conditions of their countries and localities, and will be able to share their experience and know how in the field. In addition, the participating institutes have significantly enhanced collaboration at the national, regional and interregional levels as a result of the project.

The science

Plant mutation breeding is the process of exposing plant seeds, cuttings or a shredded plant leaf to radiation, such as gamma rays and ion beams, in order to generate mutants with desirable traits to be bred with other varieties. By using nuclear radiation, scientists can develop new plant varieties with higher yields, finer quality and good resistance to biotic and abiotic stresses.

Fertigation is the use of soluble fertilizer through drip irrigation. It is an effective way to promote efficient and sustainable use of both water and nutrients to improve crop productivity while reducing environmental damage.

Nitrogen is a major nutrient required for plant growth. Many agricultural crops use nitrogen inefficiently, leaving over 50% of it in the ground. Scientists use fertilizer labelled with the stable nitrogen isotope nitrogen 15 in a small plot on an experimental station or in a farmer's field. The nitrogen 15 isotopes have a different molecular weight to the rest of the fertilizer mixture. This allows scientists to trace them as they move through the soil and are taken up in the plant. Based on this data, it is possible to determine the optimal amount of fertilizer to use and the best method for applying it. This ideal combination is then transferred to the farmers.