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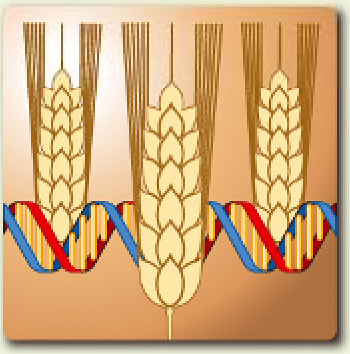

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Groundnut mutant varieties: Through the IAEA/RCA Project RAS/5/40, more than 20 new mutant varieties were developed and officially released and numerous mutants were generated (See TC Project Highlights). Among them are groundnut mutants of seed size, colour and plant height, produced by Bhabha Atomic Research Centre, India.

To Our Readers

An International Symposium on Induced Mutations in Plants (ISIM) is being planned to take place at the International Atomic Energy Agency (IAEA), Vienna, Austria, 12-15 August 2008, to celebrate 80 years of mutation induction enhanced breeding and the renaissance of mutation induction.

I would like to guide you through the development of mutation breeding in the Joint FAO/IAEA Programme. The mandate of the Plant Breeding and Genetics (PBG) Section of the Joint FAO/IAEA Programme is to transfer technology and enhance capacity for crop germplasm improvement, characterization and functional genomics. Its major objective is to improve national capacities for using mutation induction and efficiency enhancing biotechnologies such as *in vitro* and molecular techniques in crop improvement and in molecular genetics for germplasm characterization, leading to an increased availability of new crop genetic lines and to the release of new varieties.

The IAEA serves as the global focal point for nuclear cooperation, mobilizing peaceful applications of nuclear science and technology for critical needs in developing countries, including fighting hunger, disease, poverty and pollution of the environment and thereby contributing to the sustainable development goals of its Member States. Biotechnology, defined as "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use" (Convention on Biological Diversity, 1992), has been an important component of the IAEA's Programme in Food Agriculture since it was established as a joint programme with FAO more than 40 years ago.

With increasing recognition of the roles of radiation in altering genomes and phenotypes and of isotopes as detection systems in molecular biology, demands from countries and their institutions for support in various applications of modern biotechnology increased dramatically over the last 20 years. Hence, support for both R&D (through the IAEA Research Contract activities) and for training and capacity building through fellowships, expert services and provision of equipment (through the IAEA Technical Cooperation Programme) in molecular and genomic approaches to solving agricultural and human health constraints have increasingly become part of the technological packages fostered by the IAEA in recent years.

The Joint FAO/IAEA Programme's activities – particularly in crop improvement – are conducted in close collaboration with the relevant international agricultural research centres of the CGIAR, and it is developing research projects in collaboration with the International Food Policy Research Institute (IFPRI) through the Harvest-Plus programme (i.e. involving both its Human Health and Joint FAO/IAEA Divisions, aiming at using stable isotope techniques to assess the bioavailability of minerals and vitamins from biofortified crops such as beta-carotene rich sweet potatoes, high zinc wheat, and low phytate rice).

The use of induced mutations in crop improvement began over 70 years ago and continues to be massively used by plant breeders. Mutation induction has been proven to be very efficient and has been the tool of choice for enhancing breeding programmes, although it rarely made headlines from 1980s till 2000. But recently, the development and deployment of mutant crop varieties have begun to receive renewed attention and support.

At the same time, the applications of mutation techniques have quietly expanded beyond direct use in breeding new crop varieties to the more upstream novel applications in gene discovery and reverse genetics. Mutation grids (characterized and systematically ordered mutant populations) have proven their worth to fill the phenotype gap in reverse and forward genetics to discover genes and assay gene functions. Most recently a technology package, containing mutation induction and transcriptome markers (single nucleotide polymorphisms, SNPs), called targeting induced local lesions IN genomes (TILLING), has proven its utility in breeding (waxyness, hexaploid wheat). It comes, therefore, as no surprise that commercial companies have begun redirecting research efforts to the development of mutant crop varieties. More and more scientists and policy makers recognize that induced mutagenesis remains the cleanest and most inexpensive way to create novel varieties by changing single characters without affecting the overall phenotype. By altering the expression of only one or two traits, cultivars with proven consumer acceptance and known production requirements have been introduced to markets with minimum expense. This, in part, could possibly explain the renaissance of mutation induction techniques in fundamental science, bio-tech firms and breeding.

We cordially invite you to consider participating at this international event and would be glad to welcome you to Vienna.

On a completely different and more melancholic note, we regretfully bid farewell to one of our colleagues, Dr. Manoela Pessoa de Miranda, who has left the service of the IAEA to break new ground and take up a managerial position with a Canadian Seed Company.

Dr. Miranda's field of expertise is molecular biology applied to agriculture. Prior to joining the IAEA, she successfully implemented a functional genomics project to study pathogen defense response in hybrid poplar. Proficient in sequencing and high-throughput gene expression profiling (micro-arrays), she is also acquainted with tropical crop research (kumquat, citrus) which she extended here at the IAEA to include cactus and *Musa* (banana and plantain), among other crops.

Dr. Miranda developed excellent personal and working relationships at the Vienna International Centre (IAEA Headquarters), a multicultural and pluridisciplinary environment. As a technical officer (TO) for the Plant Breeding and Genetics Section, she was responsible for the conception, evaluation and scientific backstopping of Technical Cooperation Projects (TCPs) in developing Member States related to food and feed. She also served as scientific secretary of the Coordinated Research Project (CRP) on Physical Mapping Technologies for the Identification and Characterization of Mutated Genes Contributing to Crop Quality. Her dedication and intensive involvement in the organization and implementation of the section's subprogramme activities, including the fact that she willingly and proactively took up more than her share of responsibilities, is greatly appreciated and will be fondly remembered by her colleagues in the Section. Already possessing a good publishing record, her last implemented task was the edition of a book on *in vitro* screening techniques, which is expected to be available at the end of this year.

We all wish her a fond farewell and success in her new position.

Pierre J.L. Lagoda
Head,
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[3] Joined PBU in February 2007.

Forthcoming Events

Regional Training Course on GxE Testing, Seed Storage and Farmer Participation, Amman, Jordan, 15-19 July 2007

Technical Officer: P.J.L. Lagoda

Wheat, barley, lentils and chick-peas are among the most important food crops contributing to food security and sufficiency in the ARASIA region. However, despite advances made in increasing their yields, several biotic (disease and pest) and abiotic (drought) factors continue to limit their productivity. It is now a matter of urgency that new varieties be bred with higher and more stable yield potentials, superior quality, and multiple resistances to disease and insects. The ARASIA countries have recognized the prime importance of developing improved varieties of food crops through the application of mutation techniques: the use of induced mutation for creating useful new germplasm and developing new cultivars is a profitable approach to improvement. If desired traits are to be enhanced and mutant varieties with high yield, short duration, shatter-resistance, and stress tolerance are to be developed, it is important that various valuable mutant germplasm be generated, identified, and made the best use of. In order to maximize the usefulness of mutant germplasm and to achieve synergy amongst the participants of this ARASIA project, promising advanced mutant lines must be tested in multiple locations. This Research Coordination Meeting (RCM) aims to propose guidelines to the project counterparts on:

- how to test environmental effects on the crops (GxE), i.e.:
  - choosing test sites
  - multilocation trials
  - statistical analyses
- seed storage, i.e.:
  - short and medium term
  - germination assays
  - seed multiplication
  - phytosanitarian aspects
- farmer participation, i.e.:
  - participatory rural appraisal techniques; participatory planning and monitoring
  - on-farm participatory trials
  - community-based action and development activities for supporting the livelihoods
  - biostatistics in participatory approaches.

Under the guidance of the experts, the participants will draw a tentative roadmap for national GxE trials with farmer's participation and trans-national multilocation trials.

Third Research Coordination Meeting on Effects of Mutagenic Agents on the DNA Sequence in Plants, Stellenbosch, South Africa, 24–28 September 2007

Technical Officer: P.J.L. Lagoda

The CRP on Effects of Mutagenic Agents on the DNA Sequence in Plants aims to understand the mechanism of mutation induction in plants and to quantify the types (base pair changes or deletions), frequencies (rates of change relative to mutagens dose) and patterns (induction of changes in different parts of the genome) of changes in DNA induced by a range of physical and chemical mutagens in a range of key crop plant species. Knowledge obtained will assist Member States in enhancing crop breeding programmes through the application of targeted induced mutation, complementary genomic approaches and knowledge for the identification and selection of mutants of specific genes with the objective of increasing agricultural sustainability, food security and economic stability.

This Coordinated Research Project is moving into its mid-life phase, where some preliminary results will be consolidated and steering of the overall project becomes paramount to keep it focused on the target objectives. This project is producing original molecular data on crops and the individual yearly work plans will be fine-tuned to warrant maximum data yield. The overall strategy will be reappraised critically and it is expected that the scientific discussions will yield an optimized integrated roadmap for the final years of the CRP.

Third Research Coordination Meeting on Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality, South Perth, Australia, 15–19 October 2007

Technical Officer: Q.Y. Shu

This RCM aims to review the overall progress made during the past three years and to exchange research findings and new ideas among the participants. It will provide the participants with the opportunity to propose and agree on future work plans. Based on the results achieved, recommendations will be made for the continuation of individual contracts as well as the Coordinated Research Project (CRP) as a whole.

Second Coordinators Meeting on Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity in ARASIA Member States, RAS/5/048, Damascus and Aleppo (tentative), Syrian Arab Republic, 28 October–1 November 2007

Technical Officer: P.J.L. Lagoda

The second coordination meeting under RAS/5/048: (Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity in ARASIA Member States) will take place in the Syrian Arab Repulic, to review the status of implementation of strategic decisions taken during the first coordination meeting held in Vienna from 21 to 25 May 2007. The second coordination meeting will include a workshop in which a Memorandum of Understanding on germplasm exchange and phytosanitary measures will be drafted and may be signed among the ARASIA Member States participating in this project.

Past Events

Final IAEA/RCA Project Progress Review Meeting on Mutant Multi-location Trials and Mutation Enhancement of Genetic Diversity, RAS/5/040, Mumbai, India, 15–19 January 2007

Technical Officers: Q.Y. Shu and Y. Lokko

The meeting was hosted by the Bhabha Atomic Research Centre (B.A.R.C.). In the opening session, the Indian RCA National Representative and Head of the International Studies Division of the Department of Nuclear Energy, India, Dr. K. Raghuraman opened the meeting; the Director of B.A.R.C., Dr. S. Banerjee, delivered the inaugural speech; Dr. K.B. Sainis, director of Bio-Medical Group of B.A.R.C., welcomed the participants, and Dr. S.F. D'Souza, associate director of Bio-Medical Group and Director of Nuclear Agriculture Division of B.A.R.C. expressed a vote of thanks. The opening session was attended by about 25 scientists from the Division of Nuclear Agriculture of the B.A.R.C., in addition to the meeting participants.

Seventeen scientists from 10 countries (Bangladesh, China, India, Indonesia, the Republic of Korea, Mongolia, The Philippines, Sri Lanka, Thailand and Vietnam) and two invited experts from Japan and the International Crop Research Institute for the Semi-Arid Tropics (INCRISAT) attended the meeting. Each participant presented two final reports: one on the results of the Regional Mutant Multi-location Trials (RMMTs), and another on the progress made in enhancement of genetic diversity by using induced mutations. Crop-wise and overall group meeting sessions were organized for discussions on the overall achievements of the project and preparation of a draft project brochure. In addition, one session was organized for a scientific visit to various research sections in B.A.R.C., followed by open lectures by the Technical Officer, Dr. H. Nakagawa (an invited expert) and six scientists from B.A.R.C. The title of Mr. Shu's talk was "*Some thoughts on gene biology, mutagenesis, and molecular characterization of induced mutations in plants*".

This IAEA/RCA project was successfully concluded thanks to the high commitment and hard work of all participating institutes. For a brief summary of the achievement of this project, please refer to TC Project Highlights.

Second Research Coordination Meeting on Molecular Tools for Quality Improvement in Vegetatively Propagated Crops including Banana and Cassava, Thiruvananthapuram, Kerala, India, 5–9 February 2007

Technical Officer: C. Mba

This RCM, hosted by the Indian government, took place at the University of Kerala, Thiruvananthapuram (Trivandrum), Kerala State, India from 5 to 9 February 2007. The CRP aims at the development of molecular tools and harnessing the potentials of induced mutagenesis, genomics and other relevant tools for enhancing the improvement of two important asexually reproducing crops, banana and cassava. The participants in this CRP are drawn from 17 R&D institutions made up of 12 National Agricultural Research Systems (NARS) centers from Bangladesh, Brazil (2), China, Cuba, Ghana, India, Indonesia, Kenya, Mexico, Nigeria and the Philippines; and two centers of the Consultative Group for International Agricultural Research (CGIAR) - International Centre for Tropical Agriculture (CIAT); and the International Network for the Improvement of Banana and Plantain (INIBAP) of Bioversity, France. The remaining three participants were from advanced laboratories from developed Member States, the Czech Republic and the UK (2).

The RCM was attended by 18 participants (including the Scientific Secretary and two observers from India, and the UK). The highlights of the progress reports presented by participants include the following:

Musa

- Significant progress has been made in the development of expressed sequence tags (ESTs) and resistance gene analogs (RGAs) related to resistance to *Mycosphaerella. fijiensis*. It is envisaged that the simple sequence repeat (SSR), EST and RGA derived functional markers to be developed from these resources in addition to the ESTs to be incorporated in a gene expression array will lead to the identification of genes implicated in resistance to this fungal disease in *Musa*.
- Significant progress has been attained in understanding the mechanisms for somatic embryogenesis from embryogenic cell suspension cultures in *Musa*, a regeneration process that will lead to the production of regenerants with minimal chimeras. The genetic stability of plants obtained via embryogenesis through embryogenic cell suspensions showed the possibility to use the new ex-plants for developing somatic embryos.
- Significant progress has been made towards the development of a cytogenetic *Musa* map using the BAC FISH strategy. Three repetitive units were mapped to a chromosome. Additionally, almost 600 repetitive DNA clones that represented various types of DNA repeats were selected for the assembly of a boutique DNA microarray which would lead to a better understanding of the genome organization in *Musa*.
- Friable brown and white calli and globular somatic embryos were obtained from anther cultures of different diploid genomes. The aim is the development of di-haploid plants and the successful completion of this will arm *Musa* scientists with a tool that will facilitate the generation of homozygous starting materials for induced mutagenesis.
- The development of conserved orthologous (COS) markers for drought stress tolerance-related and starch biosynthesis and catabolism genes and their allelic diversity is at the core of the activities of a counterpart. Significant progress has been made in this through the amplification of the desired genomic regions. The sequencing of these amplified regions is ongoing.
- A report highlighted significant progress in the development of doubled haploid plants through banana anther culture. These plants have been potted and their ploidy levels will be determined using flow cytometry in due course. This development opens the way for exposing the anthers to mutagens and later generating di-haploid (equivalent to diploid) plants that would be homozygous for the different loci. The other option of generating di-haploid plants from the anthers of putative mutants would also enhance efficiency for induced mutagenesis in this crop.

Cassava

- Preliminary evaluation of induced cassava mutants arising from the activities of a counterpart indicated the development of variants with significantly elevated levels of dry matter and carotenoid contents.
- The activities of a counterpart relating to cDNA microarray analyses have highlighted the central role of reactive oxygen species (ROS) together with the enzymes and compounds that modulated them in the post harvest physiological deterioration (PPD) response in cassava. In addition, the significant changes in expression of pro- and anti-apoptotic genes during PPD suggested that PPD is also a senescence or apoptotic event. The tentative conclusion was that PPD is a ROS-mediated senescence phenomenon. The next stages will involve the test of this conclusion through the use of these genes in transforming cassava. Once established, molecular markers will be developed from these genes and used in routine assays of germplasm characterization or marker-aided selection.
- A protocol for the induction of somatic embryos from axiliary buds of a Chinese cassava genotype grown in the Hainan island of China was established. Somatic embryogenesis in cassava has proven to be recalcitrant as there have been strong genotypic responses. It would be very worthwhile therefore to establish these protocols for a wide

spectrum of cassava genotypes spread over the different agro-ecologies where the crop is cultivated.

- The activities of a counterpart that involve the biochemical characterization of carotenoid and starch profiles of spontaneous mutant cassava landraces and their inclusion in gene expression assays is contributing to the elucidation of the functions of genes. Additionally, the development of ESTs relating to these traits by this counterpart contributes to the identification of genes and eventual development of molecular genetic markers for assaying for these traits.

Third Research Coordination Meeting on Physical Mapping Technologies for the Identification and Characterization of Mutated Genes Contributing to Crop Quality, Cordoba, Argentina, 19–23 March 2007

Technical Officer: M. Miranda

The RCM was attended by nine participants from Argentina, Bulgaria, China, Czech Republic, Germany, Iceland, Pakistan and Poland. The objectives of the meeting were to evaluate the progress of each project since the beginning of the CRP in March 2003, strengthen collaboration between the research teams, discuss individual work plans, and assess the need for an extension of the CRP.

The projects in this CRP have produced excellent results related to the application of markers for the identification of traits related to quality. Advanced mutants of tomato, pepper, rice, cotton and rapeseed with value-added quality traits have been produced and characterized, among which several have already been introduced into breeding programmes. Markers closely linked to quality traits were identified that enable marker assisted selection (MAS), thereby increasing the efficiency of crop breeding programmes. Physical mapping using fluorescent *in situ* hybridization (FISH) with cytogenetic markers has been accomplished in banana, sugar beet, rice, chili pepper, lymegrass, quinoa, brassica and wheat. Genome specific probes were identified which will be used for tracing alien introgression lines containing chromosome segments from wild germplasm. Considerable progress has been made in the development and utilization of molecular markers associated with the value added traits and for genotyping mutant germplasm. These activities are nearing completion. Complementary marker systems have been established and gene-specific markers have been applied in sweet pepper, tomato and rice. Mutations in genes involved in carotene biosynthesis, phytic acid and gelatinization temperature have been detected by these markers and correlated to the phenotypic traits. These markers are being used for MAS. Additional advanced mutant lines are being characterized at the molecular level. Tailored recommendations were made to the work plans of each Research Contract Holder. These work plans will be detailed in the Working Material of the RCM.

The CRP on Physical Mapping is very close to reaching important outputs that will increase the impact and visibility of the IAEA's Programme on food security and enhancement of life quality. The IAEA's input and support is being recognized through publications and networks established in the CRP. During the fourth RCM, which will take place for three days (16-18 August 2008) in conjunction with the International Symposium on Induced Mutations in Plants, a book summarizing the achievements of the CRP will be drafted for publication.

Activities completed include production of mutant lines with improved quality traits, development and utilization of molecular and cytogenetic markers for the identification of chromosomes, and analysis of evolutionary relatedness between wild and cultivated germplasm. By this physical mapping approach, the group gained detailed insights into the long-range organization of crop genomes and higher-order structure of chromosomes which are essential for the characterization and selection of induced mutants.

The CRP is not only meeting its main objectives, but it has surpassed the expected outputs by recognizing the importance of the preservation of genetic resources. Characterization of biodiversity and genetic variability in wild and cultivated species accomplished in this CRP is of fundamental importance for the utilization of genetic resources for improving quality traits in crops. For instance, an international scientific network on chili pepper research has been established as a result of this CRP and will provide the platform for the exchange of information, material and genetic resources on a multidisciplinary approach. These resources are very useful as tools to accelerate crop improvement programmes worldwide.

Seventh FAO/IAEA Interregional Training Course on Mutant Germplasm Characterization Using Molecular Markers, Seibersdorf, Austria, 21 May–22 June 2007

Technical Officer: C. Mba

The Interregional Training Course on Mutant Germplasm Characterization Using Molecular Markers is an annual event of the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture that is designed for supporting capacity in developing Member States through the use of induced mutagenesis and relevant biotechnologies to develop superior crop varieties. During the course, 20 budding scientists from developing Member States of both the IAEA and the Food and Agriculture Organization (FAO) work with renowned experts and Joint Programme staff members to acquire additional skills through a series of seminars, structured theoretical lectures, practical exercises in the laboratory, green houses, experimental fields and computer based analyses. The external lecturers were from Universities in Finland, France, UK and USA.

This five-week Training Course is divided into six modules, each consisting of a set of structured lectures and practical exercises:

- Inducing and detecting mutants;
- *In vitro* techniques in crop improvement;
- Molecular genetic markers;
- Molecular cytogenetics;
- Reverse genetics for high throughput detection of mutation events; and
- Population genetics and data management.

The training programme also included field trips to the Cereals Breeding Station, Saatzucht Donau. A visit to the Wintersteiger firm in Ried, an agricultural equipment manufacturing company, highlighted mechanization in different agricultural processes. There was also a study visit by the participants to the Institute for Agrobiotechnology Research (IFA), Tulln.

First Coordination Meeting on Development and Dissemination of Improved Crop Varieties Using Mutation Induction and Biotechnology Techniques, AFRA Project II-5, RAF/5/056, Quatre Bornes, Mauritius, 21–25 May 2007

Technical Officer: M. Spencer

Twenty countries were represented at the meeting – Benin, Burkina Faso, Democratic Republic of Congo, Cameroon, Central African Republic, Egypt, Ghana, Kenya, Madagascar, Mauritius (Host country), Morocco, Niger, Sierra Leone, Senegal, South Africa, Sudan, United Republic of Tanzania, Tunisia, Zambia and Zimbabwe.

The meeting voiced the great appreciation for the exceptional organization ensured by Dr. Dumur, Director of the Agricultural Research and Extension Unit (Areu), Dr. Mala Gungadurdoss, the Project Coordinator for RAF/5/056 in Mauritius and all the staff involved. The meeting was an excellent opportunity for the participants to assess the progress made since the last meeting in Nairobi, Kenya in 2005. The conclusions highlighted two main achievements: an increased number of mutant lines released or in the pipeline for release, and also an enhanced access to biotechnologies in most of the countries.

Mutation derived varieties released under RAF/5/050 and RAF/5/056

Sesame varieties: Taka 1, 2, 3 released in Egypt in 2006 and cultivated now on 8,000 ha in the country and disseminated to Libya, Yemen and Iraq.

The banana mutant variety Albeeli released in Sudan in 2003 and widely cultivated throughout the country.

Kenya, where the wheat mutant variety Njoro BW1 was released in 2001 and is now grown in 10,000 ha, has released a new variety (DH1) obtained by doubled haploid methods using irradiated plant material.

The mutant derived lines of Finger Millet released in Zambia in 2003 (FMM165, FMM175) are now cultivated on approx. 5,000 ha

Zambia reported the pre-release of two mutant lines of Bean (CA15-40-4-B and CA38-38-9-B) in 2006.

Finally, the United Republic of Tanzania also reported the pre-release of two Rice mutant lines in 2005 (Mwangaza and Kalalu), which are now under multilocation trials.

Biotechnologies

Most countries are now proudly and very efficiently using plant tissue culture and/or molecular characterization techniques together with mutation induction. Various molecular techniques have been successfully applied for fingerprinting the germplasm pool of genotypes tolerant to drought, for the identification of genomic regions associated with tolerance to disease resistance and /or quality traits such as oil content. In biotechnology the progress is invaluable:

In 2005, two countries did not possess a plant tissue culture laboratory to complement the work on crop improvement using micropropagation and other regeneration techniques. All of the participating countries present in Nairobi have now a fully functional plant tissue culture laboratory.

In 2005, only four countries reported on a molecular biology laboratory fully operational and during this meeting nine countries reported on molecular characterization work with their putative mutant lines.

Anturium

Colocasia

The green house in the Agricultural Research and Extension Unit in Quatre Bornes, Mauritius (AREU) presents a flourishing collection of plant material from various breeding/research programmes on horticultural and ornamental crop improvement using mutation induction and other supportive biotechnologies (banana, colocasia, anthurium, tomatoes, etc.) being hardened after in vitro culture.

First Coordinators Meeting Under RAS/5/048, Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity in ARASIA Member States, Vienna, Austria, 21–25 May 2007

Technical Officer: P.J.L. Lagoda

The Cooperative Agreement for Arab States in Asia for Research, Development and Training related to Nuclear Science and Technology (ARASIA), entered into force on 29 July 2002. The countries under the ARASIA agreement are Iraq, Jordan, Lebanon, Saudi Arabia, Syrian Arab Republic, United Arab Emirates and Yemen.

From 21 to 25 May, the National Coordinators from the six ARASIA Member States participating in RAS/5/048 (Iraq, Jordan, Lebanon, Saudi Arabia, Syrian Arab Republic, Yemen), with the participation of Mr. Shakeel Bhatti, FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) Secretariat, met to:

1. Lay out a strategy and networking among participating ARASIA Member States;
2. Discuss core issues concerning the mobility of germplasm resources among Members of ARASIA (material transfer agreement and phytosanitary regulations). The participants shared their national legislation in order to enable the coordination meeting to lay out a basis for enabling legal documents to ensure smooth cooperation among participating ARASIA Member States and;
3. Identify national elements that can be incorporated into the project work plan in order to building synergies between the participants.

All participants presented an updated quantitative report on the existing activities in relation to mutation induction and breeding.

The participating Member States have nominated their counterpart personnel and have established national working groups. They will also provide premises and other physical facilities, lecturers (free of cost), and vehicles for field work. The participating countries will officially release the improved crop varieties and ensure their proper dissemination to farmers, including seed multiplication. They will accept the transboundary movement of improved seed materials in accordance with procedures developed under the project. The project will continue by improving other valuable crop varieties. Improved varieties of crops with desirable attributes, such as earliness and wide adaptability, will be officially released in their countries of origin. A sustained informal seed production system for these improved varieties will be established. Improved germplasm of various cereal and grain legume crops with appropriate drought-tolerance traits will be obtained, with the technique for dealing with drought-tolerant crops being used on a routine basis and national gene banks of traditional and neglected crops and their inventories will be established and used in breeding programmes.

Farmers, National Agricultural Research and Extension System (NARES) as well as companies will be the end-users and beneficiaries of this project. The project will raise levels of collaboration on training, exchange of germplasm and harmonization of screening methods for harsh environments, especially for drought-tolerance. Policy makers and end users will benefit from increased awareness of the effectiveness of nuclear techniques in overcoming crop production constraints; and functioning laboratories will be established, managed by locally trained scientists employing these new techniques.

First Regional Coordination Meeting of Project Implementation for 2007–2008 on Evaluation and Utilization of Natural and Mutant Cereals Germplasm, RER/5/013, Vienna, Austria, 29 May–1 June 2007

Technical Officers: Y. Lokko and Q.Y. Shu

The objective of the Regional TC Project RER/5/013 is to assess the extent and further enhance genetic diversity in major cereals, using induced mutations, nuclear, biotechnology and molecular techniques.

The objectives of the meeting were to:

1. Review the status of application of mutation and molecular techniques, particularly molecular markers for cereal improvement in Eastern and Central Europe;
2. Identify crops and traits of interest for the region;
3. Develop detailed individual and group work plans for the implementation of the project.

Cereals are an important food staple in the world and a number of improved varieties of wheat, barley cultivars and maize developed from induced mutant contribute to the available popular cereal varieties and genetic resources. However, production levels in many parts of the world, including Europe are adversely affected by susceptibility to biotic and abiotic stresses in particular. Thus, improved levels of tolerance to these stresses are essential.

The available germplasm of different cereal crops is the primary source of material for this task. However, studies have shown that extensive use of closely related genotypes in breeding could result in vulnerability to pests and diseases. Furthermore, diverse parental combinations also provide an ample supply of allelic variation that can be used to create new favorable gene combinations, and an increase in the levels of genetic variation, heterosis, and transgressive segregants in a population.

Mutation induction is a valuable technique in enhancing genetic diversity of a crop, thereby increasing the possibility of selecting new variants with traits of economic importance. With multi-location evaluation and introgression into existing genotypes, new improved varieties of the cereal crops would be developed to meet regional and global needs. Information on the extent of genetic diversity within the existing cereal genetic resources in the region is also important for plant breeders, to decide on target genotypes for induced mutation and parental combinations for cross breeding.

Project Formulation Meeting of IAEA/RCA Project on Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology, RAS/5/045, Kuala Lumpur, Malaysia, 25–29 June 2007

Technical Officer: Q.Y. Shu

The meeting will be organized by the International Atomic Energy Agency in cooperation with the Government of Malaysia through the Malaysian Institute for Nuclear Technology Research (MINT). Twenty participants from Australia, Bangladesh, China, India, Indonesia, Republic of Korea, Malaysia, Mongolia, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam will be attending.

Background of the new project

In RCA (Regional Cooperative Agreement) countries, the improvement of quality characters and tolerance to various stresses are currently the primary objectives in major breeding programs. In fact, these traits are critical for achieving high and stable yield under harsh environments and fetching a reasonable price for agricultural produce, thus sustaining agriculture production. Therefore, there is a need to accelerate breeding programmes in RCA countries to improve quality traits and stress tolerance in crops that contribute to food security, health, and agricultural sustainability. The previous RCA project RAS/5/040 focused on enhancing genetic diversity in crops and establishing a mutant germplasm network on a broad basis. The results provided a very good foundation for further improvement of some major agricultural traits in selected crops.

This new project is designed to help participating countries address the problems associated with the improvement of quality traits and stress tolerance in selected crops by mutation techniques and biotechnologies. The objectives of this project are to develop and transfer methodologies and technologies for the induction and identification of mutated genes contributing to important crop quality characters and stress tolerance to RCA Member States, and to develop improved breeding materials using molecular marker-assisted selection. It will focus on the following topics:

1. Development and establishment of efficient methodologies for the induction of mutants and the screening of crop germplasm with various and desirable quality characters, including nutrition and process characters, and tolerance to stress;
2. Development of molecular markers for tagging genes for quality characters and enhanced tolerance to stress in induced mutants;
3. Use of molecular markers with the aim of developing improved crop varieties; and
4. Development of improved germplasm with enhanced quality traits and improved resistance to stress.

Regional training and information will be provided on the use of proper methodologies and technologies for achieving the above objectives. This will be further distributed at the national level by the national team, who will devise their own strategies with regard to the institutes, policy makers, extension agencies, and farmers. The materials produced for training and information at the regional and national levels will create a resource that can be used by regional and national bodies, such as academic institutions and other training organizations, thus promoting the sustainability of the project. Outreach to such organizations is part of the project design. **It is also envisaged that the Asian Association of Plant Mutation Researchers will be established for sustaining the network and facilitating information exchange in this field.**

In this meeting, participants will review and discuss the issues pertinent to each participating RCA country in the context of the overall objectives of this project. They will also develop and reach a consensus on both overall project work plan (group activities) and the country-wise work plan.

More information will be provided in the next issue of the Plant Breeding & Genetics Newsletter!

Status of Coordinated Research Projects

Physical Mapping Technologies for the Identification and Characterization of Mutated Genes Contributing to Crop Quality

Technical Officer: M. Miranda

This CRP was initiated in 2002. The second RCM was held in Reykjavik, Iceland, 22–26 August 2005. The third RCM took place in Cordoba, Argentina, 19–23 March 2007.

Mutation induction technology is able to address the need for improving quality traits in crops – especially those grown by smallholder farmers adapted to local environmental conditions that contribute to food security, health, and agricultural sustainability. However, for an efficient utilization of induced mutations in breeding programs, an understanding of the physical organization of genes and chromosomes is essential. This CRP addresses the problems associated with the physical placement of a gene or gene complex in a chromosome. An understanding of the physical organization of genomes and chromosomes is important to the utilization of induced mutations for plant improvement. The work plan applies the technology involved in accessing the genetic and physical position of quality genes in various crop genomes, builds towards using physical map information and develops suitable cytological and molecular markers to screen for specific traits in crop improvement breeding programs.

In fact, the rapid development of genomic resources has generated a serious gap and shallowness in mutant collections. At the moment there are too many candidate genes that could be responsible for a repertoire of traits as opposed to few characterized mutations (the 'phenotype gap'). This lack of mutations may inhibit our ability to assign biological function to quality trait genes. In return, the improvement of yield and quality traits, as well as the reduction of post-harvest losses in agricultural crops is hampered by the lack of information on the genes underlying these characters. Genetic linkage maps of various densities are being constructed in most of the crops, providing markers that may be used for marker-assisted breeding. Less attention has been paid to physical mapping and the physical location of genes of interest remains unknown. Yet, it is recognized that the expression of a gene depends on its physical location in a genome, which defines its interaction with other genes and DNA sequences. Gene location may be changed due to spontaneous or induced mutations as well as recombination in intra- and interspecific hybrids. Physical mapping is needed for efficient transfer of genes between varieties and species and may provide an effective approach to manipulate various plant characters. This CRP addresses the urgent need for physical mapping in selected crops by developing appropriate technologies and materials for physical mapping and applying them to solve specific problems. Although good results have been achieved, they need to be consolidated, and much remains still to be done in this rather neglected field of physical mapping applied to enhance breeding.

So far, the achievement highlights of this CRP are:

- Development and molecular characterization of mutants for male-sterility in tomato, high beta-carotene content in sweet pepper, high oleic acid in rapeseed, elongated fibers in cotton, low gelatinization temperature in rice;
- Development of chromosome markers for brassica, quinoa, banana, triticeae, wild rice and sugar beet;
- Detailed cytogenetic characterization of chili pepper species and mutants;
- Development of mapping populations for several crops and mapping of important quality trait genes;
- Modeling the effect of mutagens at the DNA and chromosomal levels.

Effects of Mutagenic Agents on the DNA Sequence in Plants

Technical Officer: P.J.L. Lagoda

This CRP was initiated in 2003. The first RCM was held in Vienna, Austria, 1–5 March 2004. The second RCM was held in Seoul, Republic of Korea, 14–18 November 2005.

The third RCM is planned to take place in Stellenbosch, South Africa, 24–28 September 2007.

Given the materials and methods used, this CRP was initially planned for five years: different polymorphism screening methods are being assayed (whole genome/transcriptome scans vs. mutation trap assays) using diverse monocotyledonous, dicotyledonous, diploid, polyploid, seed and vegetatively propagated crops (Banana, Barley, Cassava, Cowpea, Rice, Soybean, Tomato, Wheat) at the M_0, M_1, M_2 and M_3 level.

Physical, chemical and biological mutagenic agents cause genes to mutate at rates above the spontaneous baseline, thus producing a range of novel traits and broadening the genetic diversity of plants. The use of induced mutants in breeding has had a profound impact on world agriculture and more than 2500 new crop varieties, all carrying novel induced variation, have now been officially registered (IAEA Mutant Variety Database). This has all been achieved largely in the absence of knowledge of the precise changes induced at the DNA level. Indeed, there still is very little understanding of the nature of the mutations induced by different mutagens. With the advent of molecular genetics and genomics, induced mutations are finding new applications in modern plant breeding. Reverse genetics and deletion library methodologies capable of discovering new genes and their modes of action are often underpinned by variation induced by both physical and chemical mutagens. However the efficiency of these new methods will be enhanced only when the type, frequency and distribution of mutations in a range of crop species can be predicted, and ideally directed.

Measurements of three parameters within mutation - rate, nature and pattern - are on track as per the timeframe of the original CRP proposal. With current technologies it is unlikely that a single scanning tool will answer all the questions. Therefore, it is accepted that a combination of different DNA scanning approaches will be required, as planned in this CRP. The measurements of frequencies and rates accommodate a minimum effort approach able to provide statistically significant levels (number of individual per number of polymorphisms). In order to assay types and patterns of mutations, the approach is to maximize the screening effort. The ultimate number of individuals times polymorphisms assayed will depend on resources and the timeframe allocated.

According to the progress reports, this CRP is proceeding as scheduled at this mid-term point. Intermediate data and preliminary results have already been produced and are worth being consolidated.

For example: preliminary data confirm that mutation rates vary considerably across genomes. Explanations for the observed intra-genomic heterogeneities are needed, if these preliminary results can be confirmed. The preliminary results hint at links between the sequence & structure of nucleic acid sequences and the mutation effect. We are currently testing if the rise of mutations is constrained by the structure of nucleic acids.

The majority of changes in the sequence of closely related DNA from higher organisms are due to insertion and deletion (INDEL) events and these occur during induced mutagenesis. In plants, genomic rearrangements and transposable element activity are also fundamental processes that drive genomic evolution. Interestingly, both of these processes leave INDEL footprints in genomes. In this respect, the phenomenon of microsyntenic patterns as evolutionary footprints of the genomic rearrangement process is being explored. The role of gene-interleaving patterns in the evolution of chromosomal rearrangement is being studied. The preliminary results suggest patterns in the evolution of genomic architecture.

Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality

Technical Officer: Q.Y. Shu

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 13–17 September 2004. The second RCM was held in Nanjing, China, 10–14 April 2006.

The third RCM is planned to take place in South Perth, Australia, 15–19 October 2007.

This project has been in its third year of implementation. Most research contracts have been renewed and have been carried out according to the work plan. A large number of mutant lines have been produced through chemical and physical mutagenesis in barley, wheat, rice, cotton and other crops. Suitable molecular markers have been adopted, or are already being used in various crops, and mutant genes are being tagged through mapping populations. Here is a brief summary of the progress made in different crops:

In barley, research has been focusing on the identification of genes controlling high lysine content, resistance to virus (barley yellow mosaic virus -BaYMV and barley mild mosaic virus-BaMMV), and root characteristics. Several dozen mutants have been identified and mutated genes are being tagged and mapped using various genetic populations (F_2, F_3, double haploid [DH], recombinant inbred lines) and molecular markers (AFLP and SSR). The locus for the short root hair (*rhs*) mutation was mapped on the 5H chromosome, closely linked with AFLP and SSR markers within a region of 21 cM. Meanwhile, two chromosome regions were found to be correlated with the BaYMV resistance. A high throughput system has been developed for marker assisted selection, i.e. for tolerance to preharvesting sprouting, which is routinely used in breeding group's laboratory.

In wheat, the development and characterization of mutants with changed protein composition (glutenins and gliadins) has been the main objective of several research groups. Induced mutants were produced from seven varieties and appeared in a range of variation of these traits. Development of optimized allele combinations of the two genes are being carried out. In addition, the development of low phytate wheat mutants is also being carried out.

In rice, numerous starch mutants were developed. Some of them have been characterized at molecular genetic and biochemical levels. Besides SSR markers, gene specific markers (STS and SNP) have been developed for key genes involved in starch biosynthesis, i.e. SSI, SBE1, SBE3 and SSIIa. These markers are being used for identifying different alleles of these genes in rice mutants as well as in hundreds of rice varieties and landacres. Molecular markers are also being developed for resistance to rice blast disease and are used to pyramid these genes into elite breeding lines.

In cotton, the molecular markers have been used for identifying mutations and QTLs of fibre quality characters and for pyramiding desired alleles, together with the insect resistance gene, into new cotton varieties. Two major QTLs, QTLfs-1 and QTLfs-2, for fiber strength were identified and fine mapped on chromosome 10 and 16 respectively. QTLfs-1 and QTLfs-2 could provide an explanation for more than 30% and 12.5% of the phenotypic variation in the 7235 ×TM-1 F_2 population. It was also proven that the genetic effect of both QTLfs-1 and QTLfs-2 was stable over different environmental conditions. The selection efficiency of fibre strength can be significantly increased when QTLfs-1 and QTLfs-2 are simultaneously selected using linked markers. Two M_2 populations of *G. arboretum*, through EMS mutagenic treatment at concentrations of 0.25% and 0.33% for 10 h, were developed for selection of desirable mutants.

In okra, significant progress was reported, including: confirmation of the semi-dominant nature of the induced mutation for YVMD resistance; identification of a putative marker band (MF43 microsatellite anchored primer and Mse I-CAG selective primer) co-segregating with resistance in 104 BC_1F_1 plants; and development of a PCR marker for detection of YVMV infection, which could be used to confirm YVMD resistance. Field evaluation showed B-21 derived mutant lines resistant to at least two local isolates of YVMV.

In groundnut, the project aims to develop high yielding groundnut varieties through generating and consequently combining desirable characteristics, i.e. large seed, tolerance to salinity and resistance to late leaf spot (LLS) and rust diseases. A number of mutants, i.e. large seed (53-63 g/100 seeds as compared to 49 g/100 seed of the parent), LLF resistant (score 1 in a 1-9 scoring system) and salinity tolerant (up to 100mM NaCl) mutants, were developed from chemical (NaN_3) and physical (gamma rays) and combined mutagenesis. Breeding populations are being developed by crossing these mutants and other germplasm with other varieties of complementary desirable traits. Molecular tagging for these mutant characteristics were initiated and a couple of markers were identified as polymorphic between the selected parental varieties. Therefore, this project should be further supported to achieve the ultimate objective.

Identification and Pyramiding of Mutated Genes: Novel Approaches for Improving Crop Tolerance to Salinity and Drought

Technical Officer: M. Spencer

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 14–18 March 2005. The second RCM was held in Accra, Ghana, 6–10 November 2006.

The third and last RCM is tentatively planned for the end of 2008.

The second RCM, which was held in Accra, Ghana, 6–10 November 2006 was already cited in the last issue of the Plant Breeding & Genetics Newsletter, No. 18. I would like to come back to this important event in order to shed more light on the tremendous progress made and the excellent "melting-pot" of scientists created within this CRP. As scientists, we all know that working on drought and salinity is very challenging, time consuming and can even be frustrating. The participants, however, managed to reach some interesting developments in terms of advanced mutant lines and the characterization of specific genomic regions associated with those multigenic traits:

Advanced mutant lines

- One spontaneous mutation in Barley (recessive) and four induced mutants with early heading, wax mutant, wide adaptation, large Kernel, and WUE;
- Salt tolerance confirmed in 100 families M_7 of peanut mutant lines, which are now being tested under different conditions;
- 250 families M_3 of rice mutant being tested, also for high yield;
- One mutant line derived from a local cultivar of soybean being confirmed in M_4 generation in large areas.

QTL/genomic regions identified

- Candidate genes: TNHX1 & TVP1 characterised and being overexpressed in Arabidopsis for confirmation of role in salinity tolerance;
- Nine QTL identified for the partial gene Gmsk1 in soybean and being tested for role in Na transport;
- Five SSR and five AFLP markers linked to already known markers for salinity identified in local rice germplasm;
- One gene: Two oxoglutarate-dependent dioxigenase involved in oxidative stress response, Negative regulator/oxidative stress identified in Arabidopsis;

- *osBADH* gene from indica rice identified in local variety is being prepared for registration in the gene bank;
- Expression of OSHk-1 in IR-64-Sensitive and Pokali-tolerant correlation with tolerance established.

Several outstanding publications were derived from these results and this trend will certainly continue, due to the high commitment level of the participants.

The main objective of this CRP is to be able to select one or two outstanding genotypes and/or molecular markers to be disseminated as material for pyramiding genes associated with tolerance to biotic stresses. The tremendous power of TILLING was recognised and objectives were designed to allow at least some participants to begin building TILLING platforms in Arabidopsis, barley and rice.

The second aspect which I would like to mention is the excellent team work observed during the RCM between Agreement Holders and Contract Holders. The exchanges were very fruitful and generated great enthusiasm, particularly in TILLING. This technology can be an excellent basis for net-working among scientists. For example, in order to create a good TILLING platform there are some prerequisites, which are very demanding, mainly in terms of space and personnel. A close collaboration, therefore, between research institutes working on the same traits and/or genes is invaluable.

Figure 1. Different deletion mutants at IRRI

This teamwork led to the initiation of several working proposals. Below are two:

- The use of the expertise and facilities in IRRI (The Philippines) to test the plant material or use of IRRI material as a standard check for the identification of the genes (Figure 1);
- A close collaboration with research group "TILL-more", a TILLING resource in barley, led by Prof. R. Tuberosa in Italy, in order assist in the development of TILLING platforms on specific traits and/or plant material (Figure 2).

Figure 2. Field testing of root-ABA1 testcrosses - Photograph courtesy of Prof. R. Tuberosa, TILLMore, Italy

Molecular Tools for Quality Improvement in Vegetatively Propagated Crops Including Banana and Cassava

Technical Officer: C. Mba

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 18–22 July 2005.

The second RCM took place in Thiruvananthapuram, Kerala, India, 5–9 February 2007.

Vegetatively propagated crops are critical for food security in the tropical and subtropical regions of Africa, Asia and Latin America. Increased and stable yields in these crops are a must to meet the calorie needs of the rapidly growing populations in these regions. The challenges are particularly urgent in sub-Saharan Africa, where rapid population growth and an alarming rate of climate change are making vegetatively propagated crops even more vital for achieving food security. The production of improved varieties that are nutritionally acceptable, minimize post-harvest losses, show tolerance to abiotic and biotic stresses, and satisfy the diverse preferences and agro-ecologies across the tropics and sub-tropics is a daunting task, given the biological constraints of high heterozygosity of vegetatively propagated crops. However, improvement of these crops can be greatly facilitated by new tools of genomics-assisted breeding, induced mutants, and cell culture techniques. This Coordinated Research Project (CRP) works to ensure that the existing tools of genomics for banana and cassava are brought to bear on efforts to produce new varieties of both crops. It will achieve this goal by the development of gene discovery grids, building upon the experience of the International Atomic Energy Agency (IAEA) in the use of induced mutations for the genetic improvement in both crops, facilitating access to genomics resources held by advanced labs, and the development of doubled haploids and gene mapping populations. The above tools will be aggressively applied to improve the efficiency of improving quality traits, and related abiotic stress constraints in banana and cassava in active cassava and banana breeding programs in Member States. The results of these activities will also be documented to provide a proof of concept on the use of genomics and induced mutation to dissect complex genetic traits and their application in crop improvement.

The counterparts so far had the opportunity to share experiences and build a cohesive network of collaborating institutes developing and using molecular tools for the genetic improvement of quality-related traits in banana and cassava. This led to the fine-tuning of individual work plans, identification of collective strengths, weaknesses (missing links) and opportunities for collaborating.

Intermediate results on the development, optimization and application of the aforementioned strategic technologies, including the production of promising mutants in both crops, demand to be consolidated as this CRP is nearing its midterm.

Assessment of Nutrient Uptake from Biofortified Crops in Populations from Developing Countries

Technical Officers: T.P. Trinidad and P.J.L. Lagoda

This CRP was initiated in 2005. The first RCM was held in Vienna, Austria, 17–19 May 2006.

The second and last RCM is tentatively planned for the end of 2008.

This CRP proposal was developed together with the Human Nutrition Section (at NAHU) and HarvestPlus, a global alliance of research institutions and implementing agencies that have come together to breed and disseminate crops for better nutrition. HarvestPlus is coordinated by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI). The main objective of this project is to determine the bioavailability and bioefficacy of micronutrients from nutritionally improved crop varieties or biofortified crops provided by HarvestPlus and the CRP counterparts in humans using stable isotope techniques. Bioavailability has been defined as the proportion of the ingested nutrient that is absorbed and available for physiological processes in human body. Iron and zinc, once absorbed in the human body, are bound in blood to proteins for transport to sites where they can directly fulfill their functions. However, provitamin A carotenoids must be converted in the intestine or other sites in the body to retinol to exert vitamin A activity. Bioefficacy refers to the proportion of the ingested nutrient that is absorbed and converted to its active form.

Biofortification is the process of breeding staple food crops that are rich in micronutrients. The ultimate goal of the biofortification strategy is to reduce mortality and morbidity rates related to micronutrient malnutrition and to increase food security, productivity, and quality of life for poor populations of developing countries by breeding staple crops that provide, at low cost, improved levels of bioavailable micronutrients in a sustainable manner. Indeed, the effective supply of micronutrients in the human body not only depends on micronutrient concentrations in the ingested food, but also on the amount of food consumed and many factors that influence bioavailability and bioefficacy of these nutrients.

Quantitative estimates of bioavailability of iron and zinc and bioefficacy of provitamin A carotenoids are lacking for many crops. Thus, a crucial step in the development of improved crop varieties is to conduct studies to determine the bioavailability and bioefficacy. This should also guide plant breeders on the target concentrations of micronutrients to be eventually achieved in edible parts of the crops, so consumption of nominal amounts of these foods results in the supply of a substantial proportion of the daily recommended intake.

So far this CRP has developed and optimized efficient methodologies and techniques to assay and quantify bioavailability and bioefficacity of micronutrients.

One salient fact worth mentioning is the development of a ferritin assay for cereals. Using this preliminary method, we could begin to characterize various cereals and legumes for ferritin content as well as the distribution of ferritin between outer layers and endosperm.

IAEA Coordinated Research Activities Web Site:

http://www-crp.iaea.org/html/forms.html

Technical Cooperation Projects

Currently Active Projects

Project Number	Title and Objective(s)	Technical Officer
AFG/5/003	Sustainable Increase in Crop Production in Afghanistan ***Objectives:*** To increase the productivity and production of crops through the development of improved nitrogen fertilizer and water management practices using nuclear and supportive biotechnologies. Phase I (2007-2008) will aim at refurbishing the national soil fertility laboratory and developing national capacities to provide fertilizer recommendations. In phase II (2009-2010), the laboratory will be upgraded and staff will be trained to conduct experimental work using nuclear techniques for improving water and nitrogen fertilizer management for wheat in target areas; recommendations on these will be formulated and disseminated to the farmers. In phase III (2011-2012), plant breeding programmes initiated in phases I-II will be developed on the basis of integrated soil-water-plant approaches using nuclear and supportive biotechnologies.	P.J.L. Lagoda in collaboration with Soil and Water Management Section
ALG/5/023	Protection of Date Palm Trees Against Bayoud Disease ***Objectives:*** Rehabilitation and development of date palm oasis using mutation induction in Algeria.	P.J.L. Lagoda
ALG/5/024	Improvement of Cereals for Tolerance to Drought and Resistance to Disease ***Objectives:*** To increase the cereal production (wheat and barley) by introducing at the farmer's level new high yield varieties tolerant to biotic and abiotic stresses.	P.J.L. Lagoda
ANG/5/006	Improvement of Food Crops Through Mutation Breeding and Biotechnology ***Objectives:*** To establish a national capacity to develop crop varieties with increased vitamin and mineral content and improved yield, quality, disease resistance and stress tolerance.	M. Spencer
BGD/5/026	Increasing Agricultural Production in the Coastal Area through Improved Crop, Water and Soil Management ***Objectives:*** To increase agricultural production in coastal areas through integrated and efficient management of crop, water, soil and land resources.	Q.Y. Shu
BOT/5/003	Mutational Improvement of Groundnut Varieties ***Objectives:*** Development of high yielding groundnut mutant varieties with high tolerance to abiotic stress.	Q.Y. Shu
CAF/5/003	Development of New Varieties of Cassava Through Mutation Breeding and Biotechnology Techniques ***Objectives:*** To develop manioc varieties with resistance to the African Cassava Mosaic Virus (ACMV) through mutation breeding and biotechnology techniques.	M. Spencer

Project Number	Title and Objective(s)	Technical Officer
CPR/5/017	Construction of Radiation-Induced Mutant Libraries and Function Analysis of Mutated Genes in Crop Plants ***Objectives:*** To establish large-scale screening of induced mutations using molecular high-throughput techniques for mutant germplasm characterization and construct-induced mutant libraries for new variety development, genomics, proteomics and mutational analysis of gene networks in order to increase the efficiency of nuclear irradiation-induced mutation breeding of major crops (especially rice and wheat) in China.	P.J.L. Lagoda
COS/5/025	Development of Induced Mutations and Biotechnology for Improved Productivity and Competitiveness ***Objectives:*** To contribute to improved quality of life of the small-scale bean farmers and strengthening of the food security in Costa Rica through increased productivity and competitiveness of the national bean production system by means of the control of the bean web blight disease (*Mustia hilachosa*).	M. Spencer
COS/5/027	Generation of Promising Strains of Beans Through Induced Mutations in Calluses and Seeds to Increase Competitiveness ***Objectives:*** To contribute to an increase in the competitiveness and productivity of beans by strengthening the National Programmes for Bean Improvement.	M. Spencer
ECU/5/023	Inducing Mutations in Agriculture with the Aid of Radiation ***Objectives:*** To improve varieties of maize, potato and barley using mutagenic techniques leading to an increase in the productivity of these subsistence crops.	M. Spencer / P.J.L. Lagoda
ERI/5/004	Improving Crop Productivity and Combating Desertification ***Objectives:*** To improve and sustain crop productivity through the development of efficient breeding, water and fertilizer management practices in arid and semi- arid areas in the eastern and western lowlands of the country.	P.J.L. Lagoda in collaboration with Soil and Water Management Section
GHA/5/032	Enhancing Production and Use of Cassava ***Objectives:*** To develop cassava varieties with high-quality starch, tolerance to African Cassava Mosaic Virus (ACMV), and excellent cooking quality; and to develop soil and nutrient management strategies in the sustainable production of cassava.	M. Spencer / Y. Lokko
INS/5/030	Sustainable Agriculture Development in Yogyakarta ***Objectives:*** To increase overall crop production by integrating newly developed drought-tolerant crops into existing cropping systems; to identify drought- and salt-tolerant crop varieties by radiation-induced mutation techniques; to identify promising fertilizer management practices for improved crop rotations by using nuclear techniques such as nitrogen-15 labeled fertilizers; and to develop sustainable agricultural practices for increased crop production in Gunung Kidul area in Yogyakarta.	M. Spencer
INS/5/031	Mutation Breeding of Horticultural Crops ***Objectives:*** To develop commercially viable induced mutant varieties of horticultural crops such as cut flowers, garlic, and citrus by gamma irradiation; to increase farmers' income by growing better quality mutant varieties; and to create more employment opportunities.	M. Spencer

Project Number	Title and Objective(s)	Technical Officer
INS/5/035	Application of Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands ***Objectives:*** To improve crop productivity for sustainable agricultural development in coastal areas through crop genetic improvement and development of soil, water and nutrient management practices.	Q.Y. Shu
INT/5/147	Developing Salt-Tolerant Crops for Sustainable Food and Feed Production in Saline Lands ***Objectives:*** To assist Agency Member States in the improvement and sustainability of food and forage crop production in salt-affected environments through the development of salt-tolerant crops using nuclear and related biotechnological techniques.	M. Spencer
IRQ/5/015	Induction of Mutations in Crops Through *In Vitro* Culture ***Objectives:*** To develop mutants of crops with high yield and tolerance to salinity, drought and heat, using in-vitro techniques.	P.J.L. Lagoda
IRQ/5/017	Optimization of Land Productivity Through the Application of Nuclear Techniques and Combined Technologies ***Objectives:*** To improve use and efficiency of water and fertilizer and to establish criteria for optimum fertilizer dose and water salinity for sustainable crop production followed by an effective plant breeding programme for new cultivars and improved plant resistance techniques.	P.J.L. Lagoda
JAM/5/010	Plant Breeding and Diagnostics Technologies ***Objectives:*** To enhance capacities in crop improvement in Jamaica so as to increase food production using induced mutations and related biotechnologies.	Y. Lokko
KEN/5/024	Crop Improvement and Management Through Application of Nuclear and Biotechnology Techniques ***Objectives:*** To use radiation-induced mutation technology in combination with modern biotechnology to increase yield potential and adaptability of major and under-exploited crops to drought, soil acidity, pests, and diseases for smallholder farmers.	Y. Lokko / Q.Y. Shu
MAR/5/018	Improvement of Banana and Tomato Varieties Through the Use of Nuclear Techniques for Mutation Induction and Biotechnology ***Objectives:*** Enhanced national capacity to develop varieties of bananas and tomatoes through mutation induction and biotechnology.	M. Spencer
MYA/0/007	Nuclear Science and Technology Training Centre (Currently a Human Development Project) ***Objectives:*** To establish a nuclear science and technology training centre for scientists, engineers, technicians, and graduate students in the field of nuclear science and technology; and to develop local human resources for application of nuclear techniques in various fields.	P.J.L. Lagoda
MYA/5/010	Development of Improved Rice with Tolerance to Drought ***Objectives:*** To develop drought-tolerant rice mutants for rain-fed uplands and hilly areas, and to develop salt-tolerant rice mutants for coastal areas.	Q.Y. Shu
MYA/5/016	Development of Rice Varieties with Improved Iron Content / Bioavailability Through Nuclear Techniques ***Objectives:*** To combat iron deficiency through food based strategies.	P.J.L. Lagoda

Project Number	Title and Objective(s)	Technical Officer
NER/5/012	Improvement of the Productivity and Sustainability of Cowpea with Finger Millet ***Objectives:*** To develop improved drought-resistant lines and amelioration of soil and water management practices using nuclear, isotopic and mutation breeding techniques for cowpea.	M. Spencer
NIR/5/031	Radiation-Induced Mutations for the Development of Cowpea Varieties ***Objectives:*** To develop pest tolerant/resistant cowpea varieties using radiation-induced mutation and advanced screening techniques for insect pests to improve the cowpea yield, quality, and diversity.	P.J.L. Lagoda
NIR/5/035	Adding Value to Root and Tuber Crops Through the Use of Mutation Induction and Biotechnologies ***Objectives:*** To improve crop productivity for sustainable agricultural development in coastal areas through crop genetic improvement and development of soil, water and nutrient management practices.	Y. Lokko
PAK/5/040	Improvement of Heat-Tolerant Semi-Dwarf Bread Wheat Through Radiation Induced Mutations ***Objectives:*** To develop heat-tolerant semi-dwarf genotypes of bread wheat with high yield and better quality characteristics through radiation-induced mutation techniques.	P.J.L. Lagoda
PAK/5/042	Induced Mutation to Improve Salt-Tolerance in Non-Aromatic Rice Varieties ***Objectives:*** To induce mutations in existing semi-dwarf non-aromatic rice varieties in order to achieve salt tolerance, high grain yield, good grain quality, early maturity, and resistance to insect pests and diseases.	Q.Y. Shu
PAK/5/044	Improvement of Drought Tolerance in Chickpea Through Induced Mutations ***Objectives:*** To develop drought-tolerant and high-yielding desi chickpea mutants for the low-moisture chickpea growing areas in Pakistan through induced mutation.	M. Spencer
PER/5/028	Use of Nuclear Techniques to Improve Cotton Production ***Objectives:*** To improve cotton production, particularly that of short vegetative period, using nuclear and related techniques.	Y. Lokko
PER/5/030	Genetic Improvement of Quinoa and Kiwicha Using Mutation Induction and Biotechnology ***Objectives:*** To improve the national capacity to increase the yields and market competitiveness of quinoa and kiwicha.	Y. Lokko
PHI/5/029	Enhancing Agricultural Productivity Through Radiation Technology in Mindana ***Objectives:*** To develop new mutant varieties of fruit crops such as mangosteen and cashew with high yield, improved quality, short stature, early maturing, and non-seasonal; and to develop new rice mutant varieties with resistance to pests and tolerance to abiotic and biotic stresses through radiation-induced mutations and molecular techniques.	M. Spencer / Y. Lokko

Project Number	Title and Objective(s)	Technical Officer
QAT/5/002	Developing Biosaline Agriculture in Salt-Affected Areas in Qatar ***Objectives:*** To develop biosaline agriculture in salt-affected areas in Qatar through: 1) sustainable utilization of saline groundwater and land resources, 2) introduction of salt-tolerant plant species, selected for their comparative advantages over others (as to water-using efficiency, greening of desert, forage and fodder use, etc.), 3) creating national capacities to utilize isotopic, nuclear and other modern techniques, and 4) transfer of the technologies to beneficiaries and end users.	P.J.L. Lagoda in collaboration with Soil and Water Management Section
RAF/5/049	Field Evaluation of Bayoud-Resistant Date Palm Mutants ***Objectives:*** To assist Algeria, Morocco, and Tunisia in producing date palm trees with improved fruit yield, short height, and resistance to Bayoud disease.	M. Spencer
RAF/5/050	Increasing Production of Nutritious Food Through Mutation Breeding and Biotechnology ***Objectives:*** To assist AFRA Member States in the development and field evaluation of improved crops for higher agricultural productivity, better nutrition, and greater tolerance to stress.	Q.Y. Shu / M. Spencer
RAF/5/056	Field Evaluation and Dissemination of Improved Crop Varieties Using Mutation Breeding and Biotechnology Techniques ***Objectives:*** To assist AFRA member states in the development and dissemination of improved mutation induced staple and market oriented crops.	M. Spencer
RAS/5/040	Enhancement of Genetic Diversity in Food, Pulses and Oil Crops and Establishment of Mutant Germplasm Network (RCA) ***Objectives:*** The specific objectives are 1) to use radiation-induced mutation breeding technology combined with biotechnology to develop improved germplasm of food crops, pulses and oil crops; and 2) to establish a Mutant Germplasm Network (MGN) of promising genotypes of selected crops. The mutations will be induced using ion and electron beams, in addition to gamma irradiation and neutrons, in combination with chemical methods and *in vitro* biotechnology. Biochemical and molecular technologies will be used for improving mutation efficiency.	Q.Y. Shu / Y. Lokko
RAS/5/045	Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology (RCA) ***Objectives:*** The objectives of this project are to develop and transfer methodologies and technologies for the induction and identification of mutated genes contributing to important crop quality characters and stress tolerance to RCA Member States, and to develop improved breeding material using molecular marker-assisted selection, through: 1) Development and establishment of efficient methodologies for the induction of mutants and the screening of crop germplasm with various and desirable quality characters, including nutrition and process characters, and tolerance to stress; 2) Development of molecular markers for tagging genes for quality characters and enhanced tolerance to stress in induced mutants; 3) Use of molecular markers with the aim of developing improved crop varieties; and 4) Development of improved germplasm with enhanced quality traits and improved resistance to stress.	Q.Y. Shu

Project Number	Title and Objective(s)	Technical Officer
RAS/5/048	Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA) ***Objectives:*** An improved regional partnership in the field of mutation induction to enhance breeding for food security and socioeconomic development.	P.J.L. Lagoda
RAS/7/014	Monitoring of Food Fortification Programmes Using Nuclear Techniques ***Objectives:*** The objectives of the project are twofold: 1) to evaluate and monitor the food fortification intervention programmes in five participating Member States, and 2) to develop rice mutants with low phytic acid from the country's high-yield rice varieties.	P.J.L. Lagoda
RER/5/013	Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques ***Objectives:*** 1) Genetic improvement of barley (*Hordeum vulgare*), pea (*Pisum sativum*), beans (*Phaseolus vulgaris* L.) and cotton through induced-mutations. 2) Animal nutrition and reproduction. 3) Vegetal physiology, soils and fertilizers applied to potatoes, barley and other crops.	Y. Lokko / Q.Y. Shu
SAF/5/008	Mutant Amaranth, Bambara Groundnut and Cowpea with Enhanced Abiotic Stress Tolerance ***Objectives:*** To screen, evaluate, and identify mutant amaranth, bambara groundnut and cowpea with enhanced abiotic stress tolerance, in collaboration with resource poor farmers.	Y. Lokko
SAF/5/010	Development of New Maize and Sorghum Germplasm with Enhanced Nutritional Content ***Objectives:*** To develop and characterize new maize and sorghum germplasm with enhanced nutritional value that are suitable for subsistence farming systems. To develop human capacity in the region to use mutation breeding to improve the nutrition of cereals.	Y. Lokko
SEN/5/030	Integrated Approach to Develop Sustainable Agriculture in Senegal ***Objectives:*** To screen, select and develop improved cowpea and sesame cultivars for nitrogen fixation and natural phosphorus uptake under drought conditions using mutation induction and biotechnologies.	M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
SIL/5/007	Development of High-Yielding Rice Varieties for Low-Input Agriculture Systems Using Mutation Techniques ***Objectives:*** To develop high-yielding rice varieties adapted to low-input agriculture systems using mutation techniques in order to enhance the capacity for crop improvement, rice in particular, and increase food (rice) self-sufficiency in Sierra Leone.	Q.Y. Shu
SIL/5/009	Improving Sorghum Productivity Through Nuclear and Biotechnology ***Objectives:*** To assist in the development of new mutant lines of sorghum with increased yield and disease resistance.	Q.Y. Shu
SUD/5/030	Increasing productivity of Selected Crops Using Nuclear Related Techniques ***Objectives:*** To use nuclear techniques to expand production of established varieties in banana and wheat lines and to increase the productivity of new varieties in sugarcane and tomatoes in Sudan through introduction of new production packages (new variety, new cultivation technology and crop management system).	Q.Y. Shu

Project Number	Title and Objective(s)	Technical Officer
TUN/5/023	Radiation-Induced Mutations for Improvement of Cactus ***Objectives:*** To develop improved varieties of cactus by induced mutations, which are relatively high in nitrogen for use as feed for sheep and goats.	P.J.L. Lagoda
TUN/5/024	Development of Improved Strains of Olive Tree Through Mutation Breeding and Biotechnology ***Objectives:*** To develop a routine protocol for mass micropropagation of high yielding olive varieties.	P.J.L. Lagoda
TUR/5/023	Application of Nuclear and Gene-Based Biotechnology in Agriculture ***Objectives:*** To establish a biotechnology laboratory for molecular characterization of induced mutants and thus enhance the efficiency and widen the application of induced mutations in crop improvement, i.e. quality, yield, biotic stress and disease tolerance in Turkey.	Q.Y. Shu
URT/5/023	Enhancing Crop Productivity Through Radiation Technology ***Objectives:*** To develop improved varieties of basic crops such as rice, banana and barley through tissue culture, radiation-induced mutations and molecular techniques, and enhance the crop breeding capacity in Tanzania.	Q.Y. Shu
UZB/5/004	Development of Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity ***Objectives:*** To develop new mutant prebreeding cotton lines and enhance breeding capacities for resistance to the major fungal diseases, drought and salinity in Uzbekistan.	Y. Lokko / P.J.L. Lagoda
VIE/5/015	Enhancement of Quality and Yield of Rice Mutants Using Nuclear and Related Techniques ***Objectives:*** To further develop and extend improved mutant varieties and advanced mutant lines of rice for export and high-grade domestic consumption.	Q.Y. Shu
YEM/5/007	Use of Induced Mutations and *In Vitro* Culture for Improving Crops ***Objectives:*** To use radiation-induced mutation technology, in combination with modern biotechnology, to produce improved mutants of major crops that have higher yields and that can adapt to the changing climate and water resources.	P.J.L. Lagoda
YEM/5/008	Introduction of Gamma Ray Irradiation Techniques for Agriculture Purposes ***Objectives:*** To support the use of gamma ray irradiation techniques, such as mutation induction enhanced breeding, for service and applied research purposes.	P.J.L. Lagoda
ZAI/5/016	Mutation Techniques for Improving Nutritional and Medicinal Plants with a Curative Effect on Human Diseases and Alimentary Plants ***Objectives:*** To build the basis for a long-term national strategy to fight malaria and improve food security.	M. Spencer
ZIM/5/013	Development of Drought Tolerant and Disease Resistant Grain Legumes, Phase I ***Objectives:*** To develop drought and/or disease tolerant mutant grain legume varieties suitable for resource poor smallholder farmers in Zimbabwe.	Y. Lokko

Recently Closed Project

Project Number	Title and Objective(s)	Technical Officer
ZAI/6/009	Mutation Techniques for Improving Medicinal Plants with a Curative Effect on Human Diseases ***Objectives:*** To identify, isolate, and characterize by chemical analyses new secondary metabolites with medicinal values.	M. Spencer

IAEA Technical Cooperation Programme's Web Site:

http://www-tc.iaea.org/tcweb/default.asp

Technical Cooperation Project Highlights

Improvement of Drought Tolerance in Chickpea through Induced Mutations, PAK/5/044

This project is under the umbrella of the Pakistan Atomic Energy Commission (PAEC) and hosted by the Nuclear Institute for Food and Agriculture (NIFA) in Peshawar (NWFP and FATA Provinces). Excellent work is being accomplished there in terms of crop breeding, particularly in mutation breeding. The multidisciplinary research groups integrate excellent researchers and the results are outstanding. The Chickpea breeding programme at NIFA is receiving a great deal of attention due to nation-wide success and accessibility to farmers in drought prone regions of Karak and Lakki Marwat, and in most of the south-eastern part of the NWFP Province. The IAEA's appreciation for the high level of research and the commitment of all scientists involved in the TC projects, together with the support provided by the administration and the new Director, Dr. Farooq-e-Azam is hereby expressed.

Madeleine Spencer
Technical Officer

Putative mutant lines of Chickpea Desi, at NIFA, Pakistan

Enhancement of Genetic Diversity in Food, Pulses, and Oil Corps and Establishment of Mutant Germplasm Network (RCA), RAS/5/040

1. Increased mutant germplasm exchange and utilization

One major task of this project is to exploit direct or indirect use of mutant varieties/lines in other countries than its origin, through germplasm exchange and evaluation among participating countries. This has been carried out through RMMTs for soybean, mungbean, sesame, groundnut, wheat and sorghum. Mutant lines were further demonstrated in farmers' fields and national yield trials when they had the potential to be released as a new variety in testing countries, or were used in breeding programs as a donor variety if they had useful characteristics.

In soybean RMMTs, 14 soybean varieties/lines were tested in 20 locations/seasons in China, India, Indonesia, Republic of Korea, Thailand and Vietnam. Through the systematic trials in Thailand, one mutant variety from Vietnam (DT84) and one from the Republic of Korea (Bangsakong) consistently outperformed (higher yield or early maturity) local check varieties. The counterparts have thus proposed to officially release these two lines as a new variety for farmers in rice based cropping systems in the upper northern part and lower northern part of Thailand, respectively. Ten groundnut varieties plus local controls were tested in Indonesia, Philippines, Sri Lanka and Vietnam. All five countries with the exception of Vietnam have identified promising lines which have been recommended for either variety release or inclusion in national new variety tests. In Sri Lanka, for example, after demonstration trials on farmers' land, four varieties, i.e. B/30/12/10, Kidang, Binschinabadam 2 and Karisma Serene appeared to be very promising and will be recommended for official release after another trial in 2007. Several promising lines were also identified as having shown the potential of becoming a new variety in mungbean, sesame and sorghum RMMT, but they will be subject to further trials before firm recommendations could be made.

All countries reported that some of the exchanged mutant germplasm has already been used as parents in their respective breeding programs, which potentially can lead to the development of even more new varieties in the coming years.

2. New mutant varieties released during the project

Development of a new crop variety always takes many years, hence it is almost impossible to develop and release a new variety within four years, if the work was initiated only after this project started. However, most participating institutes have on-going breeding programs, and they succeeded in developing and releasing mutant varieties within the project timeframe (Table 1).

Apart from the varieties already released, there are more breeding lines whose performance is very promising and which might be released as new varieties in the coming two years (Table 1).

Table 1. New mutant crop varieties released by the participating institutes of RAS/5/040

Crops	Release – variety name (year)	Pending for release
Soybean	Thailand - Chinang Mai 5 (2006); Vietnam – DT22 (2005); India - TAMS98-21 (2006); Indonesia – Rajabasa (2006)	Republic of Korea – Josaengseori; Bangsakong" (CB27-15-52); Vietnam --SM-50 (TL2211); SM115 (TL2212); India -TS-3
Groundnut	India: TG 37A (2004), TG 38 (2006) and TPG 41 (2004); Bangladesh - Binachina Badam 1, 2, 3 (2006)	India - TLG 45, TG 51, TG 39; Indonesia: B 30 12/10; Sri Lanka: - Karisma Serene, B 30/12/10
Mungbean	China - Jinludou (2006) Pakistan – NM2006 (2006)	India - TJM 2, TM 96; Sri Lanka - Nm 51 X VC 1973V, Nm 92
Wheat	China – H6756 (2004) total, 15; Mongolia - Darkhan-141 (2005)	Indonesia – CPN-01, CPN – 02
Sorghum	-	Indonesia – E20/477
Sesame	Republic of Korea – Pyoungankakae (2006); Miheuckkae (2006); Kungbackkae (2005); Kangheuckkae (2005). Sunbackkae (2004)	

3. New germplasm developed

Mutation techniques have also been used to produce novel mutations for enhancing crop quality and resistance to biotic and abiotic stresses. Here are a few examples of significance in future soybean improvement: (a) Mutants resistant to soybean crinkle leaf disease (Thailand). The soybean crinkle leaf disease, caused by the soybean crinkle leaf virus (SCLV) is the major disease in major soybean production areas; however, no released soybean variety is resistant to this disease in Thailand. Through gamma beam irradiation, the research group led by Drs. S. Srisombun and P. Srinives has developed four resistant and two moderately resistant mutant lines. Yield trials showed they also had a significantly higher yield than commercial varieties. One of the mutant lines will be released as a new variety in 2007 or 2008.(b) Mutants with enhanced tolerance to salinity (India). Soybean is an important legume crop in India but is highly susceptible to salinity. Through a series of screening, four plant lines consistently showed high salt tolerance in M_2 and M_3 generation, and will be field tested in 2007. (c) Mutant lines with reduced phytic acid content (China). Phytic acid is the main anti-nutritional component in soybean and other cereals and legumes. It can chelate important mineral micronutrients, i.e. Fe and Zn into compounds that are not digestible by humans and non-ruminant animals. Two mutant lines with reduced phytic acid content were developed by Zhejiang University and had been tested in yield trials. The two genes contributing to the reduction of phytic acid content have either been tagged by microsatellite markers or cloned/sequenced. The mutant germplasm together with the molecular markers will greatly advance the quality of nutritional improvement in soybean. In other crops, various mutants have also been developed, i.e. a large collection of mungbean and groundnut mutants have been developed in Thailand and India, respectively. Individual mutant lines are developed in all participating institutes, i.e. drought tolerant mutant lines have been developed in China and Indonesia, respectively, for wheat and sorghum; no-shattering sesame lines and easy-cooking soybean lines in the Republic of Korea; early maturing groundnut in Sri Lanka; and virus resistant mungbean lines in Pakistan.

4. Capacity and network development

Technical capacity and network development on mutation breeding is one major objective of this project. This has been achieved through regional meetings, regional training courses, and expert service and out-reaches activities. (a) Training Courses: Five regional training courses were supported by this project and carried out in different countries. These courses covered topics on: Application of induced mutations and biotechnology for crop improvement [2003, Sri Lanka]; Methodology for multi-location trials and selection of mutants tolerant to abiotic stresses [2003, INCRISAT]; Induced mutation in crop quality improvement [2004, China]; Marker techniques for mutant characterization [2005, Republic of Korea]; Targeted-select mutagenesis and its application in plant improvement [2006, China]. The courses have been highly praised by the trainees and have provided them with important and necessary knowledge, skill and know-how for the implementation of the project. (b) Project meetings and group technical visits: Five project meetings and one follow-up meeting of the previous IAEA/RCA Project (RAS/5/037) were organized from 2002-2007. The Project Formulation and Coordination Meeting was held in China (2002); Three project review and progress reporting meetings were organized in the Philippines (2003), Republic of Korea (2004) and Indonesia (2005); and the Final Project Review Meeting was held in India (2007). The RAS/5/037 project follow-up meeting "FAO/IAEA/RCA Workshop on Nuclear Techniques for Rice Improvement in Asia" was organized as a special workshop in conjunction with the World Rice Research Conference in Tsukuba, Japan, 3-7 November 2004. Most of the meeting was comprised of technical visits and open lecture sessions; hence the participants had extensive interactions with researchers in various international and national research institutes, i.e. International Rice Research Institute; Institute of Plant Breeding, University of Philippines; National Institute of Crop Science, Rural Development Administration of Republic of Korea; Agriculture and Life Science College, Seoul National University (Republic of Korea); Bogor Agricultural University (Indonesia); Indonesian Centre for Agricultural Biotechnology and Genetic Resources Research and Development; Bhabha Atomic Research Centre (India); Institute for Radiation Breeding and Genebank, National Institute of Agrobiological Sciences, in Japan. (c) Expert missions: More than 10 international experts either:

1. Lectured in training courses,
2. Provided consultancy in project review and progress report meetings; or
3. Gave advice on research project in counterpart institutes.

Through the above activities and follow-up interactions, a network was built among and outside of the project teams.

5. Publications

The project teams had more than 20 publications, either published in a journal as research articles, or presented in various scientific meetings. A brochure will be prepared to compile the output and outcome of this project; research findings will also be published in a special issue of Plant Mutation Reports.

Qingyao Shu
Technical Officer

Field Evaluation and Dissemination of Improved Crop Varieties Using Mutation Breeding and Biotechnology Techniques, RAF/5/056

Improvement of Colocasia (*Colocasia esculenta* var. *esculenta*), Through *In Vitro* Mutagenesis in Mauritius

Colocasia is a crop which is well appreciated by the Mauritian population. The most appreciated species actually provide leaves, used as vegetable, whilst others are grown for their corms. In 1995, an outbreak of the leaf blight disease caused by *Phytophthora colocasiae* caused a drastic drop in production from 500 tons in 1993 to about 40 tons in 1997 as most of the local germplasm were susceptible.

Due to strict biodiversity preservation laws in Mauritius, no import of new resistant germplasm is allowed in the country. On the other hand, conventional breeding of this species is quite difficult due to the scarcity of flowers of local species; therefore the Agricultural Research and Extension Unit (AREU) initiated a programme on "The Improvement of Colocasia Through *In Vitro* Mutagenesis" under the project RAF/5/050 – Increasing production of nutritious food through mutation breeding and biotechnology.

The project consists of four distinct components, namely, the micropropagation methodology, the mutation induction, the screening methodology for disease resistance and molecular characterization of colocasia germplasm and the pathogen.

As regards the micropropagation methodology, the protocol for *in vitro* culture of colocasia has been determined, whereby the best concentration of sodium hypochlorite for aseptic cultures was found to be 2%. The optimal media for *in vitro* initiation and *in vitro* multiplication were found to be MS media supplemented with IAA 10 mg/L and MS media supplemented with BA 2 mg/L or TDZ 0.9 mg/L, respectively.

Radiosensitivity tests carried out showed that the LD 30 was of 7.65 grays. 300 colocasia apices were irradiated with this dose and multiplied fro M_1V_1 to M_1V_4 generation. To date, about 30,000 colocasia tissue cultured plantlets at M_1V_4 generation are available in the laboratory. Out of these, 6000 have been hardened on a substrate consisting of 60% scum and 40% flyash which are by-products of the sugarcane industry.

The pathogen of *Phythophthora colocasiae* has been successfully isolated and is being maintained on PDA medium. Sporangial suspension at a concentration of 2x 10^6 spores per ml is being used for screening the plantlets for disease resistance. 200 plantlets have already been screened out of which 1800 were found susceptible.

RAPD, IRAP and SSR molecular characterization of colocasia germplasm as well as RAPD and ITS fingerprinting are ongoing.

Mala Gungadurdoss
Project Coordinator RAF/5/056
Agricultural Research and Extension Unit
Ministry of Agro-industry & Fisheries
Mauritius

a) *Healthy Colocasia plant*

b) *Susceptible germplasm displaying water soaked lesion which could cover the entire leaf*

c) *Tolerant germplasm displaying water soaked lesion which is limited by a yellow halo*

Ongoing Activities at the Plant Breeding Unit, Seibersdorf

Introduction

The Plant Breeding Unit (PBU) of the Agriculture and Biotechnology Laboratory of the Agency's Laboratories, Seibersdorf, in conjunction with the Plant Breeding and Genetics Section of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture implement activities, which aim to enhance the capacity in Member States to develop superior crop varieties using induced mutagenesis. These activities are implemented under the auspices of the Sustainable Intensification of Crop Production Systems Subprogramme of the Joint FAO/IAEA Programme on Nuclear Techniques for Food and Agriculture. The Unit is responsible for the laboratory components of this mandate, which include carrying out research and development (R&D) activities, the provision of services, and human capacity-building. The scope of these activities – covering R&D, training and services – specifically target innovations with a continuous striving to achieve maximum efficiency in the use of induced mutants, both as breeding materials and functional genomics resource.

Research and development

The R&D activities aim at the development and adaptation of technologies that enhance efficiency in the induction, detection and deployment of induced mutants in crop improvement and functional genomics. As has been highlighted in previous editions of this Newsletter, an innovative strategy of the Unit has been the use of crops with differing biological systems, production constraints and breeding objectives (banana, rice and cassava) as platforms for induced mutagenesis.

For the 2006–2007 biennium, the majority of the Unit's efforts are geared towards the establishment of a routine high throughput reverse genetics platform, Targeting Induced Local Lesions IN Genomes (TILLING), for the detection of mutation events. In 2006, significant progress was made in the development of appropriate populations, using *in silico* strategies for identifying the genes involved in critical steps for some breeding objectives for banana, rice and cassava and optimizing protocols for validating the TILLING methodology for these three crops. The appropriate polymerase chain reaction (PCR) primers were designed and synthesized, while the PCR conditions – cycling parameters and reaction mixtures – were optimized. The first half of 2007 has been invested in building upon the progress that has been made through the validation and fine-tuning of the protocols. For Eco-TILLING and TILLING analyses, 8 genes related to abiotic stresses resistance in rice; two genes implicated in cassava starch biosynthesis; and 14 genes located in the *Musa* genome are being used in pilot assays. The next stages will involve scaling up for validating the high throughput aspects and the inclusion of other genes.

Services

The services provided by the Unit in support of activities in MSs for the period January to May 2007 are summarized below:

Irradiation

A total of 70 radiation treatments were carried out and are broken down thus:

Number of requests	9
Number of species	7
Number of varieties	33
Number of treatments	70
Number of requesting Member States	4

Research collaboration with International Ograrizations and National Agriculture Research Institutes

As part of the ongoing collaborative activities with two NARS in the genetic improvement of banana and cassava, the following were implemented:

- Over 2000 putative induced banana mutants from three accessions were shipped to National Plant Breeding Research Centre (NPBRC), Kenya Agricultural Research Institute (KARI); and
- Over 1600 cassava mutants were sent to Crop Research Institute, Accra, Kumasi, Ghana.

Cassava seeds, from 65 accessions, that were irradiated with different doses of gamma rays and fast neutrons were sent to IITA, Nigeria. This is a part of the on-going collaborative activities between the IAEA and IITA on induced mutations for cassava genetic improvement.

Mutant Germplasm Repository (MGR)

A total of 5400 putative mutant rice lines were received from China for inclusion in the MGR.

Visiting Scientists

Name	Subject Area	Period
Olalekan AYINDE Institute of Tropical Agriculture (IITA), Ibadan, Nigeria	Pathology/Mycotoxins. Consultant worked with Subprogramme staff members in setting up the platform for the use of isolates from *Mycosphaerella. fijiensis* cultures in challenging *Musa* plants in order to ascertain tolerance to the black sigatoka disease	7–18 May 2007

Fellows/Cost-Free Interns

Name	Country	Area of Training	Period
Atallah ALWAN	Iraq	• Induced mutation in crop improvement, • *In vitro* techniques in combination with mutation induction for crop improvement with special emphasis on banana and cassava, • Application of molecular genetic markers for germplasm characterization.	January–June 2007
Zaria A. AMINU	Nigeria	• Induced mutations in seed propagated crop, i.e. cowpea improvement, • Molecular markers for germplasm characterization, • Hands on experience with measuring the ploidy levels of plant species using the Flow Cytometer.	13 November–13 March 2007

Reports

Visit to the National Institute of Fruit Tree Science at the National Agriculture and Food Research Organization, Tsukuba, Japan, 31 January–2 February 2007

Technical Officer: M. Miranda

Upon an invitation by Dr. Takaya Moriguchi, National Institute of Fruit Tree Science (NIFTS), National Agriculture and Food Research Organization (NARO), Tsukuba, Japan, the Technical Officer undertook this travel to disseminate information on the Joint FAO/IAEA Programme and established contact with scientists at the National Institute of Fruit Tree Science (NIFTS), National Agriculture and Food Research Organization (NARO) and at the University of Tsukuba, both in Tsukuba, Japan.

At the University of Tsukuba, the Technical Officer met Prof. Hiroshi Gemma, who is one of the coordinators of the Special Master's Programme in Sustainable Agricultural and Rural Development within the Master's Programme in Agro-Bioresources Science and Technology at the University of Tsukuba.

Aiming at alleviating poverty, this special Master's programme offers practical and technical training at the graduate level on sustainable food production and supply. Students from developing countries, who have at least 5 years of experience working for their national government, NGOs or international organizations are eligible to apply. During the first year of the Master's programme, the students take part in preparatory courses on Methodology for Community Development and Livelihoods Improvement Approach through e-learning in their home countries. In the second year, students must undergo a residential period of 10 months at the University of Tsukuba, where they can take part in core and elective courses on agricultural sciences. This programme was designed in collaboration with the Japan International Cooperation Agency (JICA), United Nations University, FAO and UNESCO among others. JICA is the major funding agency providing student stipends for participation in the programme. Due to the innovative nature of this Master's programme and overlapping interests with the Joint Programme, the Technical Officer inquired about possibilities of collaboration. This idea was warmly welcome by Prof. Gemma, who emphasized that, in case any UN Agency would sponsor students, the tuition fees of the University of Tsukuba could possibly be waived. The special programme is very new and still does not have a website in English, but additional information can be found at the Master's Programme in Agro-Bioresources Science and Technology, University of Tsukuba, 1-1-1 Tennodai, Tsukuba-shi, Ibaraki, 305-8572, Japan, Tel/Fax +81-29-853-7298, http://www.life.tsukuba.ac.jp.

Another potentially important contact made was with Dr. Walter Reyes-Borja from the Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Los Ríos, Ecuador. Dr. Reyes-Borja works on mutation induction in banana focusing on the improvement of disease resistance, particularly of Black Sigatoka. Because his research focus is closely related to some of our activities in the Sub-Programme, such collaboration between our Sub-Programme and INIAP-Los Rios would be of mutual benefit.

In 2006 the Agricultural and Forestry Research Center, University of Tsukuba launched the Journal of Development in Sustainable Agriculture (Online ISSN: 1880-3024; Hardcopy ISSN: 1880-3016; http://www.jstage.jst.go.jp/browse/jdsa). This is a peer-reviewed international journal that publishes research articles on agricultural sciences (in English). The dissemination of this journal is done primarily online through free access.

Announcements

International Symposium on Induced Mutations in Plants (ISIM) International Atomic Energy Agency, Vienna, Austria, 12-15 August 2008

Announcement and Call for Papers

1. Background

The year 2008 will mark the 80th anniversary of mutation induction in crop plants. The application of mutation techniques, i.e. gamma rays and other physical and chemical mutagens, has generated a vast amount of genetic variability and has played a significant role in plant breeding and genetic studies. The widespread use of induced mutants in plant breeding programmes throughout the world has led to the official release of more than 2600 mutant crop varieties. A large number of these varieties (including cereals, pulses, oil, root and tuber crops, and ornamentals) have been released in developing countries, resulting in enormous positive economic impacts.

The International Symposium on Induced Mutations in Plants (ISIM) will be the eighth in the Joint FAO/IAEA Programme's Symposium series dedicated exclusively to harnessing and disseminating information on current trends in induced mutagenesis in plants, the first of which was held in 1969 and the last in 1995. These previous symposia dealt with themes relating to the development of efficient protocols for induced mutagenesis and their role in the enhancement of quality traits, as well as resistance to biotic and abiotic stresses in crops and the integration of *in vitro* and molecular genetic techniques in mutation induction.

Since 1995, there has been an increased interest within the scientific community, not only in the use of induced mutations for developing improved crop varieties and for the discovery of genes controlling important traits and understanding their functions and mechanisms of actions, but also in deciphering the biological nature of DNA damage, repair and mutagenesis. A symposium that brings together the key players in basic research, as well as in the development and application of technologies relating to the efficient use of induced mutations for crop improvement and empirical genetic studies, is therefore justified and necessary.

2. Main Topics

Topics to be addressed at the symposium:

- Molecular genetics and biology of physical, chemical and transposon-induced mutagenesis
- New mutation techniques, i.e. ion beam implantation, and their integration with other molecular and biotechnological techniques
- Induced mutations in crop breeding programmes
- Mutation induction for gene discovery and functional genomics, including targeting induced local lesions in genomes (TILLING) and other reverse genetic strategies
- Mutational analysis of important crop characters (tolerance to abiotic stresses, resistance to diseases and insects, quality and nutritional characters, etc.)
- Socio-economic impact of widespread mutant varieties.

3. Target Audience

It is envisaged that this symposium will not only attract eminent basic research scientists but also active plant breeders from all over the world. Therefore, the symposium will at once provide the platform for the exposition and rigorous discourse on current research and technology development in this field and establish linkages among scientists in order to develop knowledge-based breeding strategies and mechanisms for sharing information and resources. It will also be a venue for project managers of international and national organizations, as well as multinational and private companies engaged in plant breeding activities, to gain insights into the applications of, and current trends in, mutation techniques.

4. Exhibits

Limited space will be available for commercial vendors' displays/exhibits during the symposium. Interested parties should contact Mr. Qingyao Shu, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture IAEA, at e-mail: q.shu@ iaea.org.

5. Contributed Papers and Posters

Concise papers on issues falling within the topics outlined in Section 2 above may be submitted as contributions to the symposium.

(a) Submission of synopses

Persons who wish to present a paper or poster at the symposium must submit an extended synopsis (in English) of 800 words maximum (i.e. two A4 format pages of single spaced typing or the equivalent, including any tables or diagrams and a few pertinent references) on one of the topics listed under Section 2. The extended synopsis should be submitted together with the completed Form for Submission of a Paper/Poster (Form B), and the Participation Form (Form A) to the competent national authority for official transmission to the IAEA in time for them to be received by the IAEA by **14 December 2007**. In addition, the synopsis must be sent electronically to the IAEA scientific secretariat, e-mail:

plant.mutation@iaea.org.

Authors are urged to make use of the Synopsis Template in Word on the symposium web page (see Section 15). The specifications and instructions for preparing the synopsis and how to use the synopsis template are given in the attached instructions. Also attached is a sample extended synopsis.

The synopsis should give enough information on the contents of the proposed paper to enable the selection committee to evaluate it. Introductory and general matters should not be included. The synopsis - if accepted - will be reproduced in unedited form in the Book of Extended Synopses; the original must therefore be submitted as a camera-ready copy in a form in which the author will wish to have the work presented. The general style and presentation should be as in the attached sample.

(b) Acceptance of Papers for Oral Presentation and Poster Presentation

Given the number of papers anticipated and the need to provide ample time for discussion, the number of papers that can be accepted for oral presentation is limited. Authors who would prefer to present their papers in a poster session are requested to indicate this preference on Form A with which they send the extended synopses.

Authors will be informed whether their papers/posters have been accepted for presentation on the basis of the extended synopsis. Guidelines for the preparation of the papers and the deadlines for their submission will be provided at that time.

The IAEA reserves the right to decline to present or publish any paper that does not meet expectations based on the information in the extended synopsis.

Further details about the preparation of papers and oral presentation at the symposium will be sent to the authors of the papers accepted together with notification of acceptance.

6. Expenditures

No registration fee is charged to participants.

As a general rule, the IAEA does not pay the cost of attendance, i.e. travel and living expenses, of participants. However, limited funds are available to help meet the cost of attendance of selected specialists mainly from **developing countries with low economic resources**. The grants awarded will be in the form of lump sums usually covering only part of the cost of attendance. Generally, not more than one grant will be awarded to any one country.

If governments wish to apply for a grant on behalf of one of their specialists, they should address specific requests to the IAEA to this effect. Governments should ensure that applications for grants are submitted by **14 December 2007** and are accompanied by a duly completed and signed Grant Application Form (as attached). Applications that do not comply with these conditions cannot be considered.

7. Symposium Proceedings

The proceedings of the meeting will be published by the IAEA as soon as possible after the symposium.

8. Distribution of Documents

A preliminary programme of the symposium will be sent to participants in advance. The final programme and the book of extended synopses will be distributed at registration.

9. Working Language

The working language of the symposium will be English.

10. Participation

All persons wishing to participate in the symposium are requested to **register in advance online**. In addition they must send a completed Participation Form (Form A) and if relevant, the Form for the Submission of a Paper (Form B) and the Grant Application Form (Form C) through the competent official authority (Ministry of Foreign Affairs, Ministry of Agriculture, national FAO committee, or national atomic energy authority) to the IAEA. A participant will be accepted only if the Participation Form is transmitted through the government of a Member State of the Sponsoring Organizations or by an organization invited to participate.

- Participants whose official submissions have been received by the IAEA will receive further information on the symposium approximately three months before the meeting. This information will also be posted on the symposium web page.

11. Accommodation

Detailed information on accommodation and other symposium related information will be sent to all designated participants well in advance of the symposium. This information will also be available on the symposium website.

12. Visa

Designated participants who require a visa to enter Austria (Schengen State) should submit the necessary applications to the nearest diplomatic or consular representative of Austria or any other consular authority of a Schengen partner State representing Austria as early as possible (please note that it could take up to three weeks to obtain a visa).

13. Channels of Communication

The Participation Form and as applicable, the Form for Submission of a Paper/Poster, and the Grant Application Form, should be sent to the competent national authority (Ministry of Foreign Affairs, Ministry of Agriculture, national FAO committee, or national atomic energy authority) for official transmission to the IAEA.

Subsequent correspondence on scientific matters should be sent to the Scientific Secretary and correspondence on administrative matters to the IAEA Conference Services Section.

14. Symposium Secretariat

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15. Symposium Web Page

Please visit the IAEA symposium web page regularly for new information regarding this symposium: http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=167

Publications

Recent Staff Articles Published in Scientific Journals

Karyotype of *Araucaria angustifolia* and the Decondensation/Activation Mode of its Nucleolus Organiser Region

Miranda, M., Almeida, C.C.S. and Guerra, M.

Australian Journal of Botany, 55

Abstract

The chromosomes of the gymnosperm *Araucaria angustifolia* (Bertol.) Kuntze were analysed with the fluorochromes chromomycin A3 (CMA) and 4',6-diamidino-2-phenylindole (DAPI) and with C-banding. This species contains a diploid complement made of 26 chromosomes, with 18 larger metacentric, four smaller metacentric and four submetacentric chromosomes. The only $CMA^+/DAPI^-$ region observed corresponded to the nucleolus organiser region (NOR) localised at the proximal portion of a large metacentric chromosome pair. C-banding marked the NOR as well as a terminal region of another chromosome pair. In addition, small C-bands were occasionally seen interspersed in many chromosomes. The NOR appeared to condense at approximately the same rate as the rest of the chromosome from prophase throughout metaphase. In interphase nuclei, NOR decondensation and activation was characterised by the formation of CMA^+ blocks that resembled a string of beads inside the nucleolus. The number and size of beads was inversely proportional to the size of the nucleolus, suggesting that transcriptional activation of the nucleolar cistrons starts simultaneously at several points of the NOR. The mode of NOR activation in *A. angustifolia* differs from that observed in most species, providing a unique opportunity to study activation and transcriptional control of rRNA genes.

(2007)

The Transcriptional Response of Hybrid Poplar (*Populus trichocarpa* x *P. deltoides*) to Infection by *Melampsora medusae* Leaf Rust Involves Induction of Flavonoid Pathway Genes Leading to the Accumulation of Proanthocyanidins (in press)

Miranda, M., Ralph, S.G., Mellway, R., White, R., Heath, M.C., Bohlmann, J. and Constabel, C.P.

Molecular Plant-Microbe Interactions, 20

Abstract

The transcriptional response of hybrid poplar (*Populus trichocarpa* x *P. deltoides*) to poplar leaf rust (*Melampsora medusae*) infection was studied using the Populus 15.5K cDNA microarray. Pronounced changes in the transcriptome were observed, with approximately 20% of genes on the array showing either induction or repression of transcription within the nine-day infection time course. A small number of pathogen defense genes encoding PR-1, chitinases, and other pathogenesis-related proteins were consistently up-regulated throughout the experimental period, but most genes were affected only at individual time points. The largest number of changes in gene expression was observed late in the infection at 6 to 9 days post–inoculation (dpi). At these time points, genes encoding enzymes required for proanthocyanidin (condensed tannin) synthesis were dramatically up-regulated. Phytochemical analysis confirmed that late in the infection proanthocyanidin levels increased in infected leaves. Strongly *M. medusae*-repressed genes at 9 dpi included previously characterized wound- and herbivore-induced defense genes, which suggests antagonism between the tree responses to insect feeding and *M. medusae* infection. In this highly compatible plant-pathogen interaction, we postulate that the biotrophic pathogen evades detection and suppresses early host responses.

(2007)

Mutation Techniques for Gene Discovery and Crop Improvement

Shu, Q.Y. and Lagoda, P.J.L.

Molecular Plant Breeding, Vol. 5, pp. 193-195

Abstract

One of the most important breakthroughs in the history of genetics was the discovery that mutations can be artificially induced in organisms (van Harten, 1998). Artificially induced mutations, by physical and chemical mutagens, have greatly advanced the understanding of genetics of higher organisms. Starting in the late 1960's, the International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization (FAO) of the United Nations sponsored extensive research on mutation induction and their application to breeding of food and industrial crops that resulted in the introduction of new varieties of rice, wheat, barley, apples, citrus, sugar cane, banana, and others (more than 2500 officially released new varieties can be found in the FAO/IAEA Mutant Varieties Database http://www-mvd.iaea.org/MVD). However, the usefulness of mutation techniques has been underappreciated in research communities, particularly during the last decade, when more and more researchers and breeders were rushing into molecular marker techniques and transgenic plants. In this paper, after a brief review of the past accomplishments of mutation induction and its application, we discuss the uniqueness of induced mutations in gene discovery and how to integrate induced mutants into functional genomics programs; we also explore the

possibilities of increasing the efficiency and efficacy of mutation techniques in crop breeding and research, by integrating up-to-date knowledge and state-of-the-art technologies.

(2007)

Cassava

Lokko, Y., Okogbenin, E., Mba, C., Dixon, A., Rajil, A. and Fregene, M., pp. 249-266 in: Genome Mapping and Molecular Breeding in Plants, vol. 3: Pulses, Sugar and Tuber Crops, C. Cole (Editor), Springer-Verlag Berlin Heidelberg,

Abstract

Genetic linkage maps provide a direct method for selecting genes via their easily detectable markers, a guide for sequencing experiments by showing the positions of genes and other sequence features. The first genetic linkage map of heterozygous species cassava (*Manihot esculenta* (Crantz)) was developed at the Centro Internacional de Agricultura Tropical (CIAT), from a segregating F_1 population of two geographic divergent parents, the African accession TMS 30572, and the South American male parent was CM 2177-2 (ICA-Cebucan). The map currently consists of 830 RFLP, RAPD, and SSR markers. Following the development of cassava SSR primers, efforts were made to develop linkage maps of cassava from diverse genetic backgrounds and for specific traits based on simple, PCR based techniques. Three genetic linkage maps were developed at the International institute for tropical Agriculture (IITA) specifically to map the genes conferring resistance to cassava mosaic disease (CMD), develop molecular markers for CMD resistance in African cassava germplasm and to assist the incorporation and enhancement of resistance to this disease in African, Latin American and Asian cassava gene pools. The mapping populations were generated from crosses between a CMD resistant breeders line and susceptible landrace, a moderately susceptible breeders line and CMD resistant landraces. The TMS 30572 X CM 2177-2 F_1 mapping population was used for QTL analysis of many traits and SSR marker linked to CMD resistance was identified in two of the CMD maps. Molecular marker-assisted selection (MAS) for breeding resistance to CMD has been successfully implemented for introducing resistance into elite gene pools at CIAT. A number of genomic tools including expressed sequence tags (EST) and bacterial artificial chromosomes (BAC) have been developed to further saturate the maps and for high resolution mapping around the cassava genome region bearing a dominant CMD resistance gene, *CMD2.*

(2007)

List of IAEA Newsletters and Publications

Plant Mutation Reports

Year	Edition	Contents (a sampling of the papers are listed below):	Reference No.
2006	Vol. 1, No. 2	• 30 year's rice mutation breeding and genetics • Mutant groundnut varieties in Bangladesh • Shortening durum wheat plants • Seedless mutant sweet orange • Colorful chrysanthemum mutations • Radiosensitivity of cassava *in vitro* culture	ISSN 1011-4289
2006	Vol. 1, No. 1	• Rice mutation breeding in China • Long grain aromatic rices and induced mutations • Significant contribution of mutation techniques to rice breeding in Indonesia • Use of induced mutants in rice breeding in Japan • Katy deletion mutant populations • Rice mutation breeding in Viet Nam	ISSN 1011-260X

Mutation Breeding Newsletter and Reviews

Year	Edition	Contents (a sampling of the papers are listed below):	Reference No.
2005	No. 1	• High yielding mutants in cotton • Drought resistant tomato • Groundnut resistant to foliar diseases • Lodging resistant glutinous rice • First ever oilseed mustard mutant	ISSN 1011-260X

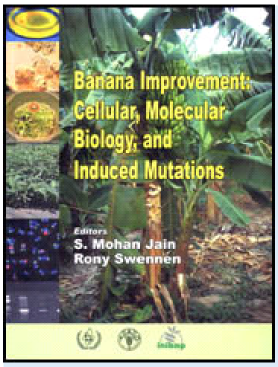
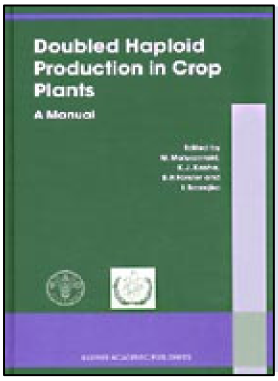
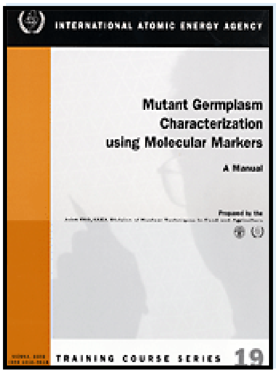
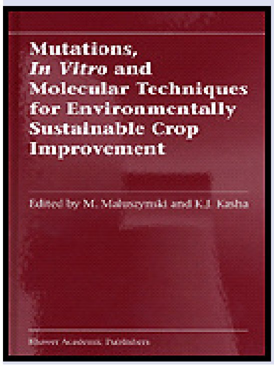
Mutation Breeding Review (published until 2004)

Year	Edition	Title	Reference No.
2004	No. 14	Officially released mutant varieties in China	ISSN 1011-2618
2001	No. 13	Grain legume cultivars derived from induced mutations, and mutations altering fatty acid composition	ISSN 1011-2618
2000	No. 12	Officially released mutant varieties – The FAO/IAEA database	ISSN 1011-2618
1999	No. 11	Oilseed cultivars developed from induced mutations and mutations altering fatty acid composition	ISSN 1011-2618

Mutation Breeding Newsletter (published until 2003)

Year	Edition	Title	Reference No.
2003	No. 46	Index Issue No. 21-44	ISSN 1011-260X
2001	No. 45	Issue No. 45	ISSN 1011-260X
1999	No. 44	Issue No. 44	ISSN 1011-260X

Books

Year	Edition	Title	Book Cover	Reference No.
2004		Banana Improvement: Cellular, Molecular Biology, and Induced Mutations		ISBN 1-57808-340-0
2003		Doubled Haploid Production in Crop Plants – A Manual		ISBN 1-4020-1544-5
2002	Training Course Series No. 19	Mutant Germplasm Characterization using Molecular Markers – A Manual		ISSN 1018-5518
2002		Mutations, *In Vitro* and Molecular Techniques for Environmentally Sustainable Crop Improvement		ISBN 1-4020-0602-0

Year	Series	Title
2006	IAEA-TECDOC-1493	Mutational analysis of root characters in food plants
2004	IAEA-TECDOC-1384	Low cost options for tissue culture technology in developing countries
2004	IAEA-TECDOC-1426	Genetic improvement of under-utilized and neglected crops in low income food deficit countries through irradiation and related techniques
2003	IAEA-TECDOC-1369	Improvement of new and traditional industrial crops by induced mutations and related biotechnology
2001	IAEA-TECDOC-1195	Sesame improvement by induced mutations
2001	IAEA-TECDOC-1216	Induced mutations in connection with biotechnology for crop improvement in Latin America
2001	IAEA-TECDOC-1227	*In vitro* techniques for selection of radiation induced mutations adapted to adverse environmental conditions
2001	IAEA-TECDOC-1253	Radioactively labeled DNA probes for crop improvement
1998	IAEA-TECDOC-1010	Application of DNA based marker mutations for improvement of cereals and other sexually reproduced crop plants
1998	IAEA-TECDOC-1047	Use of novel DNA fingerprinting techniques for the detection and characterization of genetic variation in vegetatively propagated crops
1997	IAEA-TECDOC-951	Improvement of basic food crops in Africa through plant breeding, including the use of induced mutations
1996	IAEA-TECDOC-859	Use of mutation techniques for improvement of cereals in Latin America
1995	IAEA-TECDOC-800	*In vitro* mutation breeding of banana and plantains
1995	IAEA-TECDOC-809	Improvement of root and tuber crops in tropical countries of Asia by induced mutations
1994	IAEA-TECDOC-781	Mutation breeding of oil seed crops

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New

Whole-Genome Analyses of *Oryza sativa* Reveals Similar Architecture of Two-Componenet Signaling Machinery with Arabidopsis

Pareek, A., Singh A., Kumar, M., Kushwaha, H.R., Lynn, A.M. and Singla-Pareek, S.L.

Plant Physiology, Vol. 142, pp. 380-397

Abstract

The two-component system (TCS), which works on the principle of histidine-aspartate phosphorelay signaling, is known to play an important role in diverse physiological processes in lower organisms and has recently emerged as an important signaling system in plants. Employing the tools of bioinformatics, we have characterized TCS signaling candidate genes in the genome of *Oryza sativa* L. subsp. Japonica. We present a complete overview of TCS gene families in *O. sativa*, including gene structures, conserved motifs, chromosome locations, and phylogeny. Our analysis indicates a total of 51 genes encoding 73 putative TCS proteins. Fourteen genes encode 22 putative histidine kinases with a conserved histidine and other typical histidine kinase signature sequences, finve phospotransfer genes encoding seven phosphotransfer protein, and 32 response regulator genes encoding 44 proteins. The variations seen between gene and protein numbers are assumed to result from alternative splicing. These putative proteins have high homology with TCS members that have been shown experimentally to participate in several important physiological phenomena in plants, such as ethylene and cytokinin signaling and phytochrome-mediated responses to light. We conclude that the overall architecture of the TCS machinery in *O. sativa* and *Arabidopsis thaliana* is similar, and our analysis provides insights into the conservation and divergence of this important signaling machinery in higher plants.

(2006)

As of 2004

Physical Mapping Technologies for the Identification and Characterization of Mutated Genes Contributing to Crop Quality

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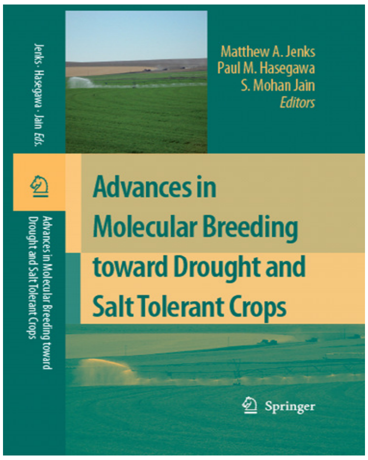
Recent Non-IAEA Publications in the Field of Plant Breeding and Genetics

Advances in Molecular Breeding toward Drought and Salt Tolerant Crops

Edited by Matthew A. Jenks, Paul M. Hasegawa and S. Mohan Jain. Springer, The Netherlands.



Abstract

Plant stress caused by drought and salinity are among the major constraints on crop production and food security worldwide. Breeding programs to improve crop yield in dry and saline environments have progressed slowly due to our limited understanding of the underlying physiological, biochemical, developmental, and genetic mechanisms that determine plant responses to these forms of stress, as well as to technical difficulties in combining favorable alleles to create the improved high yielding genotypes needed for these environments.

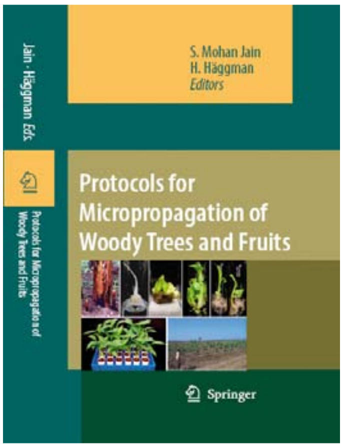
Advances in Molecular Breeding toward Drought and Salt Tolerant Crops seeks to integrate the most recent findings about key biological determinants of plant stress tolerance with modern crop improvement strategies. This volume is unique because it provides exceptionally wide coverage of current knowledge and expertise being applied in drought and salt tolerance research, spanning the scientific hierarchy from physiology, biochemistry, development, and genetics, to the newest technologies being used to manipulate drought and salinity associated traits for germplasm improvement. This book will be an invaluable reference for educators and researchers in agronomy and horticulture, crop breeding, molecular genetics, and biotechnology.

(2007) ISBN 978-1-4020-5577-5

Hardcover

Protocols for Micropropagation of Woody Trees and Fruits

Edited by S. Mohan Jain and H. Häggman. Springer, The Netherlands.



Abstract

Micropropagation has become a reliable and routine approach for large-scale rapid plant multiplication, which is based on plant cell, tissue and organ culture on well defined tissue culture media under aseptic conditions. A lot of research efforts are being made to develop and refine micropropagation methods and culture media for large-scale plant multiplication of several number of plant species.

However, many forest and fruit tree species still remain recalcitrant to *in vitro* culture and require highly specific conditions for plant growth and development. The recent challenges on plant cell cycle regulation and the presented potential molecular mechanisms of recalcitrance are providing excellent background for understanding on totipotency and what is more development of micropropagation protocols. For large-scale *in vitro* plant production the important attributes are the quality, cost effectiveness, maintenance of genetic fidelity, and long-term storage. The need for appropriate *in vitro* plant regeneration methods for woody plants, including both forest and fruit trees, is still overwhelming in order to overcome problems facing micropropagation such as somaclonal variation, recalcitrant rooting, hyperhydricity, polyphenols, loss of material during hardening and quality of plant material.

Moreover, micropropagation may be utilized, in basic research, in production of virus-free planting material, cryopreservation of endangered and elite woody species, applications in tree breeding and reforestation.

(2007) ISBN 978-1-4020-6351-0

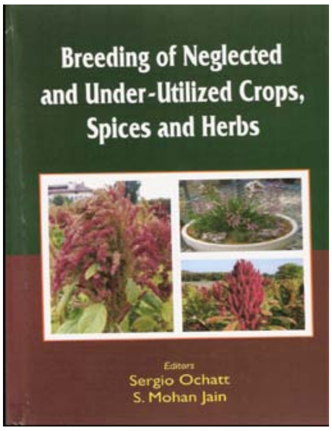
Hardcover

Breeding of Neglected and Under-Utilized Crops, Spices and Herbs

Edited by Sergio Ochatt and S. Mohan Jain. Science Publisher, USA.

Abstract

Food availability in the developing world is declining due to constant demographic increase, environmental factors, lack of improvement of local crops, erosion of genetic diversity and dependence on few crops. Only 30 species meet 95% of the world's food requirement. Neglected and underutilized crops are often considered as "minor crops" due to their lesser importance in terms of global production and consumption systems. They are, however, traditionally grown in their centres of origin or diversity, and are instrumental in the subsistence of local communities. They are well adapted to marginal lands, and they constitute and important part of local diets, providing valuable nutritional elements and spices, often lacking in staple crops; also they have a special role in traditional medicine. As reservoirs of resistance genes for biotic/abiotic stress breeding, they contribute significantly to sustainable agricultural production. Researchers have recognized their enormous potential for food security, sustainable agriculture and improving the socio-economic conditions in the poor rural sector. Despite that since they are poorly characterized and lack government funding to foster research and interest, their potential is underutilized. This book comprises of 20 chapters, and provides researchers the information available on the cultivation, taxonomy, socio-economic importance and breeding of a number of underutilized and neglected crops.



(2007) ISBN 978-1-57808-509-5

Hardcover

In Memoriam

Prof. Stefan Daskalov (1937–2007)

Prof. Stefan Daskalov was born on 26 September 1937 in Plovdiv, Bulgaria. He graduated from Sofia Agricultural University, where he also earned his Ph.D. He worked at the Sofia Institute of Genetics and Breeding, now known as the Institute of Genetics "Prof. D. Kostov", where he began his research on pepper genetics and breeding. He also worked at Purdue University, USA and at the Institute of Molecular Genetics, Lund, Sweden as a long-term fellow in experimental mutagenesis. His experiences in that institute, which was a "Mecca" for visiting foreign geneticists, must have been inspiring to the young researchers who then became aware of the significance of mutation breeding programs. Prof. Daskalov often served as an expert in Bulgaria as well as in many other countries. From 1980-1986 he worked as an expert for FAO/IAEA in Vienna. In 1989 he served as a corresponding member of the Bulgarian Academy of Sciences. In 1996 he became a Scientific Secretary at the Bulgarian Academy of Sciences.

For the last four decades and until he sadly passed away, Prof. Daskalov played a vital role in the development of pepper genetics and breeding in Bulgaria. As a researcher at the Department of Heterosis and Mutagenesis he significantly contributed not only to the conservation of this scientific legacy, but also to its successful development, transfer and wide application.

Prof. Daskalov's scientific interests extended to a wide range of issues, however, experimental mutagenesis and its exploitation in pepper breeding remained his main research subject. The long years of research resulted in the development of three original technologies for hybrid seed production and the development of varieties widely used in Bulgaria. Prof. Daskalov inspired and put significant efforts into organizing a number of national and international symposiums on experimental mutagenesis and the benefits of its application in plant breeding.

Prof. Daskalov's findings and conclusions have proven to be equally important to theory and practice. One of the most intriguing problems that he approached in his studies was finding ways to facilitate pepper hybrid seed production. To this purpose, he and his group concentrated on detailed studies of different types of genetic male sterility. Step by step, Prof. Daskalov revealed several outstanding discoveries in pepper genetics and breeding for high nutritive quality and tolerance to biotic and abiotic stresses. On the basis of mutant genes and hybridization of mutant genes, he and his collaborators succeeded in developing lines and cultivars possessing a high content of ß-carotene which are resistant to various diseases and setting fruits under unfavorable conditions.

Prof. Daskalov's involvement in the progressive development of pepper genetics and breeding is evidenced by a significant number of publications and pepper cultivars developed over the last 30 years. He is author, or co-author, of more than 115 scientific publications on plant genetics and breeding, some of them published in international journals, 13 monographs, books and school publications. He was a member of several editorial boards of specialized genetic reviews and he had a significant role in teaching. He is the author of Albena cv., which, for a period of more than 10 years was the most widely used mutant cultivar resource for early and mid early field production, of Orangeva kapija the first Bulgarian cultivar possessing high beta-carotene content and of nine male sterile mutant pepper lines. This list of his achievements would not be complete without mentioning a number of successful cultivars widely spread showing resistance to various pepper pathogens.

Significant numbers of agronomists, among them researchers from different countries earned their Ph.D.s with Prof. Daskalov. Several scientists were trained at the Department of Experimental Mutagenesis, working on projects set by him and attending his lectures, profiting not only from his scientific knowledge, but also his strong personality and energy.

Prof. Daskalov was a preferred partner in the development of international projects. For many years he was involved in projects supported by the International

Atomic Energy Agency. He continued actively working in the field of pepper genetics and breeding up until his passing away on 24 January 2007. International recognition was expressed for Prof. Daskalov's talent as a scientist and breeder.

Nasya Tomlekova
Maritsa Vegetable Crops Research Institute
Bulgaria

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

PLEASE COMPLETE THIS REGISTRATION FORM AND SEND IT TO THE PLANT BREEDING AND GENETICS SECTION

E-mail: Plant.Mutation@iaea.org

New Crop Variety Developed through Mutation Induction or by Crossing with Induced Mutants

A. Latin name of species:

English name:

B. Name of new variety (cultivar):

C. Year of release from breeder:

D. Place and Date of official approval:

E. Parent variety(ies) - if new variety results from a cross with mutant, indicate which is the mutant:

		mutant
1.		yes / no
2.		yes / no
3.		yes / no

F. Main improved characters of variety (indicate if character is derived from mutation or not):

		mutation derived
1.		yes / no
2.		yes / no
3.		yes / no

G. Kind(s) of mutagenic treatment:

H. Doses(s) and/or concentration(s):

I. Year of mutagenic treatment:

How was the variety bred:

K. Name(s) of breeder(s) and institute(s):

Address:

L. Extent of acceptance by growers:

- Commercial value:

- Hectares of cultivation:

- Other:

M. References (published articles, official documents, etc.):

Name of person contributing this information: ______________________

THANK YOU FOR YOUR COLLABORATION!

IMPORTANT!

AUTHOR'S GUIDELINES FOR MANUSCRIPT SUBMISSION TO PLANT MUTATION REPORTS

Articles will be indexed and abstracted in CABI!

Scope

Plant Mutation Reports (PMRs) publishes (mini) reviews, short communications and complete research papers in all areas of plant mutation research which focuses on mutagenesis, mutation induction, mutant characterization, and mutant applications. It also publishes description papers on mutant germplasm and mutant varieties. Papers on social-economic impact analysis of induced mutations and mutant varieties are also accepted.

Style

The manuscript should be concisely written with the following sections:

Title page

- Title: the title should be as short as possible, but should contain adequate information regarding the contents.
- Authors: Initials of given name followed by full family name.
- Affiliation(s)/Address(es):
- Email address: the corresponding author's email address should be given.

Abstract and Keywords

A brief and informative summary of the paper not exceeding 150 words. Optional for short communications. Each paper should have 3-5 keywords.

Main text

- Review articles may be organized according to their specific requirements.
- Research articles should include: Introduction, Materials and Methods, Results (and) Discussion (this could be combined for Short communications).
- New mutant germplasm should include a short description of initial material used and the mutagen and doses applied; selection process; mutated characteristics and its genetic and agronomic analysis. Description of mutant variety should, in addition, include its performance in yield trials for varietal release and the releasing committee, when applicable.

Acknowledgements

- Acknowledgements of grants, support etc, should follow the text and precede the references.

References

The literature references should be cited either as John (1990) for single author paper, John and Johnson (2000) for papers with two authors, or John *et al.* (2000) for papers with more than two authors throughout the text, and alphabetically listed in the Reference following the style shown below:

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- Books (identical author and editor) van Harten A.M. (1998) Mutation Breeding, Theory and Practice. Cambridge University Press, Cambridge, U.K. pp. 237-240.

Figures and Tables

- All tables and figures, i.e. photographs, graphs and diagrams should be referred to as either "Table" or "Fig." and be numbered consecutively (1, 2, etc.) in the text.
- In tables, footnotes are preferred over long explanatory material in the heading or table body. Such explanatory footnotes, identified by superscript letters, should be placed immediately below the table.
- Do not use boxes; use horizontal lines only. Figures and tables should be placed on separate pages.

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The standard SI units and symbols should be used throughout (www.scenta.co.uk/tcaep/science/siunit/index.htm).

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