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Nuclear Techniques in Food and Agriculture

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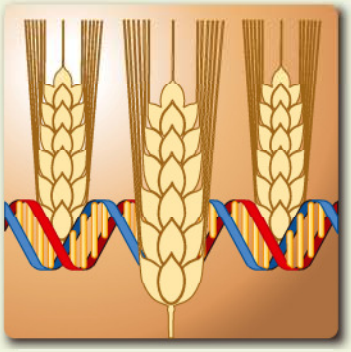

## Contents



*In Vietnam three-quarters of the population are living in rural areas. Nuclear techniques have been applied in food and agriculture for improving national food security since the 1970's with support from IAEA: See TCP Highlights (Photo courtesy of Q. Liang, NAFA)*

## To Our Readers

Climate variability and change will have increasing adverse effects on food security, precipitating transboundary threats to crop productivity from diseases and pests, including Black Sigatoka (Black Leaf Streak Disease) in banana, or Black Stem Rust (Ug99) in wheat. Stem rust has plagued wheat farmers for thousands of years, but for the last 50 years it has been largely forgotten thanks to resistant varieties, including mutant varieties, developed by a group of scientists lead by Dr. Norman E. Borlaug. Their work is credited with launching a Green Revolution that saved billions from starvation and earned Dr. Borlaug a Nobel Peace Prize.

In 1999, the stem rust variant discovered in Uganda showed itself able to overcome the resistance that had been established by Dr. Borlaug's team and wheat breeders at national and international research centers. These experts watched with growing alarm as Ug99 quickly moved to Kenya, where it has undergone mutations and proven capable of cutting wheat yields by 20 to 80%, with isolated incidents of 100% destruction. You may read more about this burning issue in the "Past Events" and "Technical Cooperation Project Highlights" sections.

IAEA International Atomic Energy Agency

Currently, we are scientifically and technically backstopping seven Coordinated Research Projects (CRPs) and 74 Technical Cooperation Projects (TCPs) (67 national, seven regional and one interregional). The covered subjects survey food security, quality and nutrition, mitigating the effects of harsh environments, climate variability and change and, increasingly, non-classical breeding targets such as breeding for pharmaceutically active components and for biofuels.

I will finish the introduction to this issue of our Newsletter by wishing a belated, but heartfelt, "Happy Birthday" to Prof. Dr. agr. Alexander Micke, who turned 80 in the beginning of this year. Prof. Micke was the Head of the Plant Breeding and Genetics Section, Joint FAO/IAEA Division, from 1969 to 1991. A true scientist, he actually never retired, but keeps his fertile mind fit and on top of the scientific developments focusing on mutation induction and breeding. And whoever wants proof for this should visit his webpage at http://www.plantmutations.com/.

***Pierre J.L. Lagoda***
***Head,***
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# Forthcoming Events

## Training Course on Methodology of Participatory Plant Breeding, RAF/5/056, Arusha, United Republic of Tanzania, 31 August–4 September 2009

Technical Officer: M. Spencer

The scientific background of this training course, planned during the first coordination meeting in Quatre Bornes, Mauritius (2007), recognizes the fact that participatory breeding is currently regarded as a powerful tool in developing crop varieties suitable for particular locations, especially marginal areas. It involves decentralized selection, defined as selection in the target environment, by farmers in local conditions and using their knowledge. The participation of farmers in the very initial stages of breeding, when the large genetic variability created by the breeders is virtually untapped, is expected to exploit fully the potential gains from breeding for specific adaptation through decentralized selection by adding the farmers' perception of their own needs and the farmers' knowledge of the crop.

The purpose of this training course is to provide participants with:

1. The opportunity to learn the methodologies of participatory plant breeding from invited experts (including stakeholder analysis, mother baby trials, data analysis, etc.);
2. A platform to exchange their experience and expertise on participatory plant breeding;
3. The chance to consult with experts for developing and improving the workplan of participatory plant breeding at their home institute.

The outputs to be expected are as follows:

- Increased understanding of participatory plant breeding and their applications under various situations including mutation induction.
- Improved participatory plant breeding workplan for each participating institute in the advancement and dissemination of putative mutant lines.

As always for these events sponsored by the IAEA and its network partners, namely African Regional Agreement for Research (AFRA), we are sure that this training will generate outstanding results in terms of preparing African scientists and breeders to engage in a more science, people and environment based agronomy approach in order to warrant food security for an increasing world population in the actual context of global warming, climate variability and change.

## Group Fellowship and Training Course on Inducción de Mutaciones en Cultivos de Importancia Económica, RLA/5/056, Lima, Peru, 23 September–6 November 2009

Technical Officer: M. Spencer

The first coordination meeting greatly contributed towards carefully assessing the problems agriculture in Latin America is facing and proposing to undertake the improvement programme in a very innovative way. In fact, even though ensuring food security for all based on sustainable yield increase of major crops, remains the main goal of scientists, breeders and officials of countries participating in the TC project, a look back at what ensured an environmental friendly and sustainable agriculture for the ancestors inspired several countries to initiate crop improvement programmes for the native crops.

The major crops: maize, wheat and rice, account for 87% of all cereal production, worldwide, and 43% of all food calories in 2007 (FAO 2008, ProdSTAT Crops http://faostat.fao.org/site/567/default.aspx#ancor). Other grains, among the so-called "neglected" or "orphan" crops are very important in those regions of the world to which they are native, but have little production globally, amongst them:

- Amaranth (*Amaranthus* spp), has been cultivated as a grain from the sixth millennium BC, dates back to the Maya culture of South America and Central America. It is an ancient pseudocereal, formerly beside maize, a staple crop of the Aztec Empire. Although an appreciable commercial cultivation of amaranth for human nutrition does take place beside Latin American countries in the United States of America (USA), China and Europe, Amaranth is not listed in the FAO statistics on production data.
- Quinoa or quinua (*Chenopodium quinoa* Willd.) is native to the Andes Mountains of Bolivia, Chile, and Peru, and has been cultivated and eaten continuously for over 5 000 years by people who live on the mountain plateaus and in the valleys of Peru, Bolivia, Ecuador, and Chile. Quinua means "mother grain" in the Inca language. This crop, which was a staple food of the Inca people remains an important food crop for their descendants, the people who live in rural regions and is increasingly appreciated by people in the cities promoting a "healthy life style".

The objective of this meeting is to bring all participants to a good understanding of all methods and techniques of handling irradiated plant populations. Following a group fellowship, a training course will also be planned to ensure that all Principal Investigators (PIs) involved in the TC projects acquire basic knowledge in the initial steps to be implemented in terms of: irradiation of plant material, careful handling of $M_1$ population, and then throughout screening of the sub-sequent generations $M_2$, $M_3$, $M_4$ based on rigorous, reliable and easy to apply screening protocols. The course will be organized in one of the most advanced institutes using mutation induction in Latin America, the National Agricultural University La Molina, Lima, Peru.

## IAEA/RCA Regional Training Course on Mutation Breeding for Crop Disease Resistance, RAS/5/045, Mumbai, India, 5–9 October 2009

Technical Officer: Q.Y. Shu

The training course is open to RCA Member States participating in the project on Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology (RAS/5/045). The objective of this training course is to provide young scientists, involved in the project, with advanced knowledge and skills related to mutation breeding for improving disease resistance of crop plants. The following crops and diseases will be covered at the training course: rice (Bacterial leaf blight; blast, grassy stunt virus), wheat (Rust), sorghum (Rust, mildew) and legumes (Rust, yellow mosaic virus).

## First Research Coordination Meeting on Isolation and Characterization of Genes Involved in Mutagenesis of Crop Plants, D2.40.13, St. Louis, USA, 26–31 October 2009

Technical Officer: Q.Y. Shu

The above-mentioned CRP has recently been approved for implementation (for detailed information see 'Status of Coordinated Research Projects'). The first Research Coordination Meeting (RCM) is planned to take place in conjunction with the ninth International Plant Molecular Biology Congress in St. Louis, Missouri, USA.

## IAEA/RER Regional Training Course on Cytogenetics and *In Vitro* Techniques in Mutagenesis and Radiation-induced Gene Transfer, RER/5/013, Sofia, Bulgaria, 2–12 November 2009

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

Mutation techniques and biotechnologies such as *in vitro* culture and cytogenetics have proven to be valuable techniques in enhancing genetic diversity of a crop, resulting in more than 2 500 mutant varieties released worldwide. Efficient methods of germplasm characterization, identification of gene(s) of interest and monitoring introgressed genes are keys to the successful utilization of natural and mutated germplasm in breeding. Conventional cytogenetics and recently, molecular cytogenetic methods (e.g. FISH, GISH, TUNEL test, COMET assay), and chromosomal DNA libraries (e.g. BAC libraries with deep genome coverage) add powerful new dimensions to chromosomal analysis, including assessing mutation induced changes. Once individual chromosomes are recognized based on the identified molecular tags on the chromosomes, genetic linkage and cytogenetic or physical maps can be integrated, thus allowing individual chromosomes and chromosome segments carrying useful genes or gene complexes, to be monitored in breeding. This provides opportunities for the rapid utilization of marker-assisted breeding through introgression of mutant and alien genes for crop improvement.

Under the regional TC project on Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques (RER/5/013), a training course on Cytological and *In Vitro* Techniques in Experimental Mutagenesis and Radiation-Mediated Gene Transfer will be organized by the IAEA in cooperation with the Government of Bulgaria through the Bulgarian Academy of Sciences. The objective of the course is to provide participants with theoretical and practical aspects of techniques used in cytogentics and their application to breeding and genetics of cereals.

The course is open to scientists from participating countries actively involved in the project and requiring skills in the use of cytogentics in utilization of mutant and natural cereal germplasm in breeding. Candidates should have at least a BSc degree in Plant Breeding, Plant Sciences, Biological Science with adequate credits in genetics.

## Fourth Regional Coordination Meeting on Supporting Strategic Planning to Meet Future Energy Needs in ARASIA Member States, RAS/5/048, Vienna, Austria, 9–13 November 2009

Technical Officer: P.J.L. Lagoda
Programme Management Officer: M.S. Abdullah

### Participants' qualifications

The meeting is open to ARASIA Member States.

The officially designated project coordinators from each of the participating Member States.

In addition, a representative of each of the National Agricultural Research and Extension Systems (e.g. Ministry of Agriculture) is invited and/or representatives of farmers' associations.

### Background

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 the advances 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 should be bred with higher and more stable yield potentials, superior quality, and multiple resistances to disease and insects. 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 should be generated, identified, and made best use of. The ARASIA countries have recognized the prime importance of developing improved varieties of food crops through the application of mutation techniques.

The purpose of this coordination meeting is to:

1. Report on the progress made since the third coordination meeting.
2. Review the work plan of the project and agree to a plan for the activities to be implemented in the year 2010.
3. Discuss farmer participation in research/breeding programmes.

### Nature of the course

The meeting will discuss the progress made and the achievements reached at each participating Member State during the last growing season. Each national coordinator will present a report on the activities carried out, difficulties and needs. The meeting will discuss the previously agreed upon national work plans and review the overall regional workplan and introduce changes and modifications if deemed necessary. The meeting will review the project work plan and identify regional activities that need to be held during the year 2010. Further, the meeting will prime a discussion on farmer participation. The idea behind tropical farmer participation schemes is that a central breeding station does the technical work, and then hands out promising seeds or clones to farmers for evaluation and selection. This concept started in the tropics, with subsistence farmers, but there is no apparent reason why it could not also be attempted with commercial farmers in emerging or rich industrial countries.

Detailed information can be obtained from Mr. Mahfoudh S. Abdullah (e-mail: m.abdullah@iaea.org).

## Fourth and Final Research Coordination Meeting on Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality, D2.30.25, Plovdiv, Bulgaria, 16–20 November 2009

Technical Officer: Q.Y. Shu

This CRP was initiated in 2004 and will be completed in December 2009. The fourth and final RCM is planned to review the progress made under this CRP, summarize the output, assess the outcome, identify areas to be further investigated, and recommend further actions to be taken by both the IAEA and participating countries.

For detailed information regarding this CRP, see ‘Status of Coordinated Research Projects’.

## Joint FAO/IAEA International Training Course on Novel Biotechnologies and Molecular Technologies for Enhancing Mutation Induction Efficiency, Seibersdorf, Austria, 2 November – 4 December 2009

Training Course Director: C. Mba

This training course is open to 20 participants from developing Member States of FAO and IAEA.

### Participants’ qualifications

Plant breeders/geneticists with basic experience in molecular techniques, particularly in DNA extraction, restriction digestion, polymerase chain reaction (PCR), and actively involved in crop breeding programmes, research and training.

### Background

The induction of mutation events has played a key role in the development of superior crop varieties and genetic stocks for the identification and elucidation of gene functions. The outcome of induced mutagenesis, being heavily dependent on chance, is aided by the generation of large populations of putative mutants for assaying. Novel molecular and cell biology techniques hold immense potential for significantly enhancing the efficiency levels for the generation, detection and deployment of the induced mutants either for crop improvement activities or for functional genomics studies. Molecular biology strategies such as marker-aided selection can be used to trace the inheritance of mutated segments of the genome in populations. Reverse genetics approaches, especially ones that are amenable to high throughput platforms, on the other hand can lead to the rapid detection of targeted mutations in known gene regions thereby opening up the

possibility for 'designer mutants'. Additionally, cell biology techniques can greatly increase the seed versus seedling multiplication ratio leading to the rapid generation of large mutant populations while making use of a comparatively negligible footprint. When properly harnessed, cell and tissue culture approaches mitigate the bottlenecks posed by chimeras and heterozygosity of mutant alleles in vegetatively and seed propagated plants, respectively. The use of both cell and molecular biology in concert to facilitate induced mutagenesis is therefore called for.

The purpose of the course is to contribute to the development of a critical mass of trained counterparts in the national agricultural research systems of developing Member States of both FAO and the IAEA with skills for the use of biotechnologies to enhance the efficiency of induced crop mutagenesis.

As the course will be conducted in English, participants should be proficient in understanding and expressing themselves in this language.

### Nature of the course

The 5-week course, delivered in cooperation by the staff of the Plant Breeding and Genetics Section and the Plant Breeding Unit, assisted by three internationally renowned experts and one colleague from FAO AGP Division, and consisting of theoretical lectures, laboratory, field and glasshouse experiments and computer-based analyses, will be made up of the following modules:

- Induced mutations
  - Mutagens and strategies for inducing mutations - seed and vegetatively propagated plants
  - Types of populations and generations
  - Large scale screening (phenotypes and genotypes)
- Cell biology
  - doubled haploidy;
  - somatic embryogenesis - cell suspension; friable embryogenic callus; etc.
- Marker systems for detecting polymorphisms
  - Molecular marker systems
  - Chromosome-based assays
- Reverse genetics for the directed identification of mutations
  - High throughput platform - target induced local lesions in genomes (TILLING)
  - EcoTILLING
- Data management
  - Analyses of molecular marker data
- Seminars
  - Invited lectures
  - Participants' presentations

Detailed information can be obtained from Mr. Chikelu Mba (e-mail: c.mba@iaea.org).

## IAEA/RER Regional Training Workshop on Standardizing Methods for Antioxidants Analysis in Solanceous Food Crops, RER/5/013, Budapest, Hungary, tentatively planned for December 2009

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

Under the regional TC project on Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques (RER/5/013), a training workshop on Standardizing Methods for Antioxidants Analysis in Solanceous Food Crops will be organized by the IAEA in cooperation with the Government of Hungary through the Central Food Research Institute.

The objective of the training workshop is to provide participants with theoretical and practical knowledge of antioxidant analysis and hands-on techniques in optimizing methods. The workshop is open to scientists from participating countries actively involved in the project, requiring skills analysis of antioxidants for screening germplasm. Candidates should have at least a BSc degree in Plant Breeding, Plant Sciences, or Biological Science.

# Past Events

## Mid-term Progress Review Meeting of the RCA project on Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology, RAS/5/045, Ho Chi Minh City, Vietnam, 16–20 February 2009

Technical Officer: Q.Y. Shu

Twenty-seven participants from Australia, Bangladesh, China, India, Indonesia, Malaysia, Myanmar, Pakistan, the Philippines, Republic of Korea, Sri Lanka, Thailand, and Vietnam, as well as the technical officer attended the meeting. Dr. Quang Luan Le of Centre of Nuclear Techniques hosted the meeting.

All participants presented a technical paper on recent developments in their respective institutes and the national coordinator reported on the progress and workplan of each country. The workplan for 2009-2011 was updated during the meeting, addressing new issues arising in crop production and new available technologies.

During the past two years, significant progress has been made in the establishment and adoption of new techniques, development of mutant populations, mutant selection and advancement. More than 100 new mutant lines have entered into regional and national yield trials for potential release as new varieties. Based on previous work, some are also results of previous IAEA/RCA projects RAS/5/037 and RAS/5/040 the participating institutes also released 18 mutant varieties, covering crops such as rice, wheat, soybean, groundnut, mustard, mungbean, sunflower, cowpea and pigeon pea.

*Participants visiting mutant rice variety field trials in the Experimental Farm of Institute of Agricultural Science for Southern Vietnam*

## First Coordination Meeting of the Regional Technical Project RLA/5/056 on Improving Food Crops in Latin America through Induced Mutation, ARCAL CV, Havana, Cuba, 16–20 February 2009

Technical Officer: M. Spencer

In the actual context of global warming and climate change, the improvement of drought tolerance traits is more than ever the most important goal in plant breeding. It is also paramount to realize that these climatic alterations will more acutely affect regions with already challenged agriculture, such as marginal dry lands and coastal saline prone reclaimed lands. There is, therefore, an urgent need to address drought tolerance, while increasing productivity for the major food crops. Additionally, an essential aspect to consider in the region targeted by this TC project is the history of the local populations, rich of ancient agricultural traditions, e.g. using native crops now known as pseudocereals as staple food crops.

As a result, the different partners decided to establish as the objective of this project the increase of food production in drought affected areas through the development and dissemination of drought tolerant advanced mutant lines of major food crops, such as rice, beans, tomatoes, selected fruit trees, and pseudocereals including amaranthus and quinoa.

*Advanced mutant lines ($M_6$) of tomatoes tolerant to drought – the fields are watered only during germination stage and the plants survive the onset and development through the dry season.*

*Detail of advanced mutant lines currently under testing in farmers fields. Some farmers reported plants bearing up to 100 fruits and expressed their satisfaction.*

The meeting was hosted by the Instituto Nacional de Ciencias Agrícolas, Havana, Cuba, and was attended by Project Coordinators (PCs) from Argentina, Bolivia, Brazil, Colombia, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Mexico, Paraguay, Peru and Venezuela.

The event was really appreciated by all participants as being an excellent opportunity for assessing the current status of the application of induced mutations in crop improvement in the region and firmly stating their ambitions of maintaining and even developing the use of this technology together with plant tissue culture and molecu-

lar characterization in crop improvement in their respective countries.

A meeting report was drafted (in Spanish) including two flagship decisions:

- The creation of a new network on the application of radiation induced mutation in crop improvement. The objectives are to promote, coordinate and widely disseminate the research activities on this technology.
- The commitment to include all the results on advancement of mutant lines tolerant to drought and the screening protocols developed into a book in Spanish language for the use of all scientists and breeders in the region.

## Second Borlaug Global Rust Initiative Workshop, Ciudad Obregón, Mexico, 17–20 March 2009

Technical Officer: P.J.L. Lagoda

The world's leading wheat experts from 40 countries (278 delegates, including 57 from five international organizations), invited to Mexico by Peace Nobel Prize Winner Dr. Norman Borlaug, gathered in Ciudad Obregón to report on progress in developing new varieties of wheat capable of resisting a virulent form of an old plant disease that threatens wheat production worldwide: wheat black stem rust.

Wheat (black) stem rust (caused by the fungal pathogen *Puccinia graminis* f. sp. *tritici* race Ug99), which was first identified in Uganda in 1999, is a new race of an old crop disease. It is particularly alarming because it is more virulent than previous races, mutates more quickly and withstands a larger range of temperatures and humidity.

Since 1999, Ug99 has spread alarmingly into the wheat producing countries of North Africa and the Middle East, mutating quickly to break down the defenses of each new wheat variety it encounters. In 2001 Ug99 was identified in Kenya, 2003 in Ethiopia, 2007 in Yemen, and in 2008 it had spread to Iran. Experts project that the "bread basket" of Europe (Kazakhstan and Ukraine) and later India and China will be next on its hit-list. Cooperative global efforts have intensified following the wake-up call of Nobel Laureate Dr. Norman Borlaug, who has warned that "Ug99 is the most serious threat to wheat and barley in 50 years".

Wheat provides 20% of the world's calories, and Ug99 is capable of cutting wheat yields by 20 to 80%, with isolated incidents of 100% destruction, as about 90% of commercial high-yielding wheat varieties are vulnerable to Ug99. So scientists are working to select new wheat varieties that are impervious to the fungus.

Every region of the world was represented at the meeting in Ciudad Obregón, which was organized by the Borlaug Global Rust Initiative [*], a group led by, among others, the Mexico-based International Maize and Wheat Improvement Center (in Spanish: Centro Internacional de Mejoramiento de Maíz y Trigo, or CIMMYT) [**], the Syria-based International Center for Agricultural Research in the Dry Areas (ICARDA), Cornell University, the Food and Agriculture Organization of the United Nations (FAO), and the Indian Council of Agricultural Research (ICAR). Both CIMMYT and ICARDA are supported by the Consultative Group on International Agricultural Research (CGIAR) [***].


Research results released at the Borlaug Global Rust Initiative 2009 Technical Workshop confirmed that the dangerous and newly-emerged stem rust race known as Ug99 is now in Kenya, Uganda, Ethiopia, Sudan, Yemen and

Iran, and is on the march toward South Asia. According to scientists at the four-day conference in Ciudad Obregón, longer distance movement to other regions cannot be excluded. The short-term solution for this disease is to apply fungicides to the wheat, but this comes with an economic and environmental cost. Named for its discovery in Uganda ten years ago, Ug99 is well established already in Kenya. In addition, any movements into southern Africa must be monitored, because there is historical evidence that high altitude winds and even hurricanes can transport plant pathogens from that region into the Americas and Australia, although these would be rare events. An update from the Global Cereal Rust Monitoring System shows that the mutated fungus could be headed for South Asia, where farmers, many of them poor subsistence growers, produce 19% of the world's wheat for a population of 1.4 billion people. The monitoring system also has implemented wind models showing that Ug99, which has moved out of eastern Africa to the Middle East, could soon travel to the Caucasus, Central Asia, or Afghanistan. Dr. Borlaug, whose call to action inspired the creation of the stem rust initiative, said that new findings regarding the expected trajectory of Ug99 - and its wily ability to mutate quickly - reinforces the need for ongoing research and for supporting a massive effort to scale up production and distribution of resistant varieties in vulnerable nations. "Our scientists are making incredibly rapid progress, but we should have no illusions: a global food crisis is still a distinct possibility if governments and international institutions fail to support this rescue mission", said Dr. Borlaug, who warned that, even in today's environment of dwindling resources, governments cannot afford to jeopardize a crop that provides 20% of the world's food calories. Scientists at the conference also considered new evidence that global warming could send stem rust into parts of the world where it has never been seen before. For example, Ug99 already has been found in a part of Iran where no wheat stem rust of any type had ever been documented. However, it is not clear whether its spread to that particular region is connected to climate change, higher adaptability of Ug99 to environmental conditions or other reasons.

Thus, there is a need for the early and rapid diagnosis of transboundary plant diseases, disease vectors and agents (including emerging diseases) to ensure advanced and appropriate control actions. Nuclear (e.g. mutation induction, isotopes) and related bio-technological methods (RIA, ELISA, PCR a.o.), when appropriately integrated, provide substantial added value to national and international efforts to engage appropriate countermeasures in order to warrant crop productivity, and ultimately protect the environment and human health.

In a new study released at the event, researchers from CIMMYT, ICARDA, the Kenya Agricultural Research Institute (KARI), and the Ethiopian Institute for Agricultural Research (EIAR) described a breakthrough in their efforts to develop new varieties of wheat that are not only resistant to Ug99, but also produce more grain than today's most popular varieties. High-yielding, Ug99-resistant spring wheat varieties are rapidly emerging through an intensive international "shuttle breeding program". Breeding materials under development in CIMMYT's test fields in Ciudad Obregón and Toluca - and at ICARDA fields in Aleppo, Syria - are sent to Kenya and Ethiopia, where they are exposed to Ug99 in real world conditions. They are then sent back to Mexico or Syria for further refinement and then back to Kenya and Ethiopia for more exposure. Through this approach, scientists - also shuttling between continents - have produced new types of high-yield wheat that contain "multiple minor genes" that have resistance to Ug99. Though this strategy may not provide the same level of protection as that provided by one or two major genes, it is high enough to be effective, and the researchers believe that by forcing the fungus to overcome a larger array of genetic barriers, these new wheat varieties could provide long-term protection against future stem rust mutations through a systemic response to the fungus, which in the long run might prove to be more sustainable than the gene-to-gene resistance that is overcome by a new fungal strain. There are numerous examples in the last century of stem rust mutating and "defeating" wheat plants that have contained single major resistance genes. One of the alarming hallmarks of Ug99 is that in Kenya it has mutated and overcome two additional major stem rust resistance genes called Sr24 and Sr36 that had been effective against the original form of Ug99, thus accelerating the "boom and bust" cycles of gene to gene resistance. A significant achievement with the varieties produced in the project is that they provide superior yields. This is of major importance, as the battle against Ug99 appears to be shifting from a scientific challenge to a logistical one. Averting a crisis will require farmers to replace their existing varieties with resistant ones, even though they may not face an immediate threat from Ug99. But convincing the farmers to switch requires offering resistant varieties that also produce higher yields.

A team of researchers from the Southern Cone region of South America, where there are approximately nine million hectares of wheat under cultivation, said there is intense interest in both the spread of Ug99 and the effort to develop resistant varieties. They noted that studies completed last year show that most of the wheat in the region is susceptible to Ug99. Many colleagues involved in the conference said that the unprecedented effort to combat Ug99 has resulted in a new level of international scientific collaboration that could provide a range of benefits for global food production. "What you see in Obregón is that we have put together a very powerful team for fighting Ug99, but its value extends well beyond this threat", said Ronnie Coffman, Director of the Durable Rust Resistance in Wheat project at Cornell. "Farmers also need

more productive varieties to feed a growing population and they will need varieties that can survive any new stresses induced by climate change". Thomas Lumpkin, Director General of CIMMYT, noted that the lack of investment over the last decades in wheat breeding programs and facilities has put the world in a weak position to combat newly emerging dangers such as Ug99. "It's a classic case in which few are aware of these deficiencies until the capabilities and innovations are needed", Lumpkin said. "The BGRI, through its coordinated efforts so evident in this meeting, is pulling us back from the brink of a Ug99 disaster. But the funding base for R&D is still too small to tackle problems such as emerging new disease strains and the increasing temperatures and water scarcity that are resulting from climate change in major wheat-producing areas".

In this context, the IAEA was very welcomed to add a new tool to the toolbox of the wheat breeders: mutation induction and the additional resources of mutant genetic stock, human capacity and wheat mutation assisted breeding programs fit snugly as a piece of the puzzle into the global picture.

[*] The Borlaug Global Rust Initiative, chaired by Dr. N.E. Borlaug, replaces the Global Rust Initiative (GRI) established as an outcome of the May 2005 Expert Panel report of race Ug99 in Kenya and Ethiopia and the potential for impact in neighboring regions and beyond. The BGRI has the overarching objective of systematically reducing the world's vulnerability to stem, yellow, and leaf rusts of wheat and advocating/facilitating the evolution of a sustainable international system to contain the threat of wheat rusts and continue the enhancements in productivity required to withstand future global threats to wheat (http://www.globalrust.org/).

[**] CIMMYT is an internationally funded, non-profit organization that conducts research and training related to maize and wheat throughout the developing world. CIMMYT works to create, share, and use knowledge and technologies to increase food security, improve the productivity and profitability of farming systems, and sustain natural resources (http://www.cimmyt.org).

[***] The CGIAR, established in 1971, is a strategic partnership of countries, international and regional organizations and private foundations supporting the work of 15 international centers. In collaboration with national agricultural research systems, civil society and the private sector, the CGIAR fosters sustainable agricultural growth through high-quality science aimed at benefiting the poor through stronger food security, better human nutrition and health, higher incomes and improved management of natural resources (http://www.cgiar.org).

## IAEA/RCA Regional Training Course on Mutation Breeding Approaches to Improving Protein and Starch Quality RAS/5/045, Lismore, Australia, 23–27 March 2009

Technical Officer: Q.Y. Shu

Thirteen young scientists from Bangladesh, China, India, Indonesia, Malaysia, Myanmar, Pakistan, the Philippines, Sri Lanka, Thailand, and Vietnam, participated in the training course. Dr. Daniel Waters of Southern Cross University acted as the course director, and Dr. Slade Lee of Queensland University of Technology helped in organizing the course.

The training course addressed topics on recent development on genotyping and how they are used in mutation detection and utilization, particularly for improving quality traits especially of protein and starch. Various molecular genetic and bioinformatics tools related to mutant gene screening and characterization were demonstrated and/or practiced during the training course.

*Professor Robert Henry (Southern Cross University) lecturing at the training course*

## Regional Training Course on the Implementation of the Standard Material Transfer Agreement (SMTA) through Options and Guide on Practices, Procedures, Legal Matters and Policies in the Multilateral System, RAS/5/048, Seibersdorf, Austria, 20–24 April 2009

Project Officer: P.J.L. Lagoda
Training Course Director: C. Mba
Project Management Officer: M.S. Abdullah


This training course was organized under the auspices of the IAEA Regional TC project on Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (RAS/5/048). This project brings together the participating Member States of the Cooperative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA) for pooling resources in the use of induced crop mutations to address common themes. The aim of this training course was to train the participants in the practical use of the Standard Material Transfer Agreement (SMTA) for transfer of plant genetic resources for food and agriculture and to provide information on the legal and political underpinnings for the relevant global convention and treaty. There were 13 participants from six countries, Iraq, Jordan, Lebanon, Saudi Arabia, Syrian Arab Republic and Yemen.

The five-day training course comprising theoretical lectures and computer laboratory demonstrations was structured around the following modules:

- The International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA), the Multilateral System and the SMTA including overviews of the enabling legal instruments;
- Implementing the SMTA under the Multilateral System (MLS) of the International Treaty for PGRFA including group practical exercises and roundtable discussions on modalities for using the SMTA;
- Customizing and using Gene-IT: a computer-based standalone tool for exchanging PGRFA under the MLS of the International Treaty including exercises on creating an SMTA, managing related germplasm collection and exchanging related information;
- Using induced crop mutations in crop genetic improvement.

The resource persons were Mr. Roland Cottin of the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Montpellier, France; Mr. Nigel Ruaraidh Sackville Hamilton of the International Rice Research Institute (IRRI), Los Baños, the Philippines; and Mr. Daniele Manzella of the Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Additionally, instructions relating to induced crop mutations were provided. Each participant received a CD-ROM of the instructional materials including the websites and instructions for downloading and installing the Gene-IT locally.

It was evident that the participants, a highly motivated group of scientists, were very enthusiastic to acquire the requisite skills for the use of the SMTA, especially for transferring plant genetic resources amongst themselves. Also, a number of the participants clearly indicated a desire for mounting similar training programmes within their Member States and in the region in order to reach a wider spectrum of technocrats and policy makers having implemental roles in the use of the SMTA. Of importance to policy makers was the observation that many participants had reservations regarding the provisions for benefit sharing with a number of them concerned that the rights of the small scale-farmers and indigenous peoples might not be adequately protected under the Multi Lateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture.

## IAEA/RER Coordination Meeting on Evaluation of Natural and Mutant Resources for Increased Phytonutrient Levels in Solanaceous Food Crops, RER/5/013, Plovdiv, Bulgaria, 27–29 April 2009

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

The improvement of quality traits in food crops is one of the most important goals in plant breeding and is gaining more and more attention for nutritional, health and marketing purposes. In 2006, the Agency approved the regional technical cooperation project RER/5/013 “Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques”, which aims at evaluating and increase genetic diversity in major cereals using nuclear techniques, molecular genetics and biotechnological tools. For the 2009-2011 TC cycles a new project on evaluation of natural and mutant resources for increased phytonutrient levels in vegetable crops and potato was proposed. During the project design

stage between staff of the IAEA and counterparts, it was decided that this project be included in the existing project RER/5/013 as a new component with separate funding and participating counterparts for its activities. Under the regional TC project RER/5/013 "Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques" a second project on evaluation of natural and mutant resources for increased phytonutrient levels in vegetable crops and potato was included in the existing project RER/5/013. Following a consultant's meeting convened in November 2008 to formulate the proposal for this new component of the TC project, it was recommended that this new component would focus on solanaceous food crops (Potato, pepper, tomato, eggplant) and antioxidants (carotenoids, anthocyanins, flavonoids, vitamins), the use of a questionnaire, to identify suitable counterparts and key activities of the project including the first coordination meeting.

The objective of the meeting was to review the proposals made by the consultation meeting in November 2008; review the status of evaluation of natural and mutant resources for increased phytonutrient levels particularly antioxidants (carotenoids, anthocyanins, flavonoids, vitamins) in solanaceous food crops in the Europe and related activities in respective countries; and to discuss and agree on the final strategy, workplan and activities of the project for 2009-2011. The meeting was attended by project counterparts form Albania, Bulgaria (four), Hungry, Macedonia, Moldova, Turkey (two), Ukraine and Uzbekistan.

Participant gave technical presentations on the use of mutant genetic resource in breeding and genetics of tomato; methods in improving and screening for antioxidants in breeding; the importance of standardization of antioxidant levels in food crops; and country reports on the status of breeding for improved levels of antioxidants in the target solanceous food crops including the use of mutants. Each presentation was discussed and the key points were incorporated in the later discussions on the main activities to be carried out with the project. At the end of the meeting key group activities identified as important for the successful implementation of the project were agreed upon.

## First Research Coordination Meeting on Enhancing the Efficiency of Induced Mutagenesis through an Integrated Biotechnology Pipeline, D2.40.12, Vienna, Austria, 25–29 May 2009

Technical Officers: C. Mba and B. Till

The overall objective of the project is to increase the efficiency of mutation induction for crop breeding and genetic research through the generation of genetic resources and development of technology packages which can be transferred to, and shared by, Member States.

The strategy of this CRP, which parallels technology development and validation activities at the Plant Breeding Unit, is to use four crops, banana, barley, cassava and rice, to validate the interlacing of relevant biotechnology procedures into seamless induced mutagenesis pipelines. The data to be generated from this CRP will be enriched by the differing biological systems, varying density of relevant genomics tools and protocols for cell and tissue biology of these crops. By so doing, the outputs will cover a wide spectrum of conditions that are encountered in induced crop mutagenesis in Member States and thereby make the ensuing guidelines to be produced by the end of the CRP widely applicable.

During the RCM, seven scientists from Austria, Denmark, Germany, Ghana, Poland and Vietnam worked with staff of the Joint FAO/IAEA Programme to fine-tune workplans aimed at evaluating and validating biotechnology packages for the major steps in using induced mutations for developing crops with improved traits and for generating functional genomics resources. Other participating Member States in this CRP that were absent were Cuba, Sierra Leone and USA. Cuba participated in some of the deliberations through teleconferencing. The individual workplans developed included the evaluation of the optimal tissues for mutagenesis, determining the spectrum and density of induced mutations as a decision making parameter, and high-throughput phenotyping and reverse genetic screening methods that have significant potentials for mitigating the most serious drawbacks to induced crop mutagenesis, e.g. the imperative of screening large mutagenic populations. To validate these pipelines, activities in this CRP will focus on biological processes that impact significantly on crop productivity such as abiotic and biotic stresses resistance and various components of quality attributes and yield.

## Fourth and Final Research Coordination Meeting on Effects of Mutagenic Agents on the DNA Sequence in Plants, D2.40.11, Vienna, Austria, 25–29 May 2009

Technical Officer: P.J.L. Lagoda

For the final RCM of this CRP, 13 scientists from nine Member States (Bulgaria, Colombia, China, India, the Philippines, Poland, Republic of Korea, South Africa and USA) met in Vienna to discuss their excellent results obtained in this CRP and how to transform these outputs into guidelines and protocols for efficient mutation induction applications.

The subjects discussed during the meeting were:

- Mutation discovery activities (banana, cassava, rice) at the Plant Breeding Unit (FAO/IAEA);
- Genome-wide analysis of spontaneous and induced mutations in plants (USA);
- Oxidative stress/DNA damage and DNA repair (NIST/USA);
- Analysis of mutation types and frequencies induced in plant genome (barley) by physical and chemical mutagens (Poland);
- Chromosomal and DNA alterations in barley mutant lines produced by gamma irradiation (Bulgaria);
- Effects of heavy ion beam on the DNA sequence in wheat (China);
- The effects of mutagenic agents on genes responsible for amylase content and hygromycin resistance in (transgenic) rice (China);
- Molecular analysis of regenerated soybean plants from EMS-treated immature embryo culture (Republic of Korea);
- The use of representational difference analysis for the identification of genome alteration in drought-tolerant cowpeas induced by radiation (South Africa);
- Evaluation of effect of gamma radiation on targeted DNA sequence in tomato mutants (India);
- Development of deletion mutants of tomato Hawaii 7996 for resistance to *Ralstonia solanacearum* and other important traits by targeted EMS and irradiation mutagenesis (the Philippines);
- Mutagenesis of cassava (*Manihot esculenta* Crantz) for the generation, identification and molecular analysis of novel traits (Colombia).

Part of the output of this CRP is bound to integrate the much-awaited third Edition of the Manual on Mutation Breeding (second Edition, 1977, IAEA Technical Reports Series No. 119) from the Joint FAO/IAEA Division, which is being finalized end of this year.

## First Research Coordination Meeting on Improving Nutritional Quality by Altering Concentrations of Enhancing Factors Using Induced Mutation and Biotechnology in Crops, D2.30.28, Vienna, Austria, 28 June–3 July 2008

Technical Officer: Y. Lokko

In addition to providing the major calories in human diets required to sustain life, plants are also the major source of health-beneficial agents, such as vitamins and minerals required for vital physiological processes. The major staple crops, however, do not provide the essential vitamins and minerals in adequate quantities and qualities. A sustainable way to ensure that adequate amounts of vitamins and minerals can be obtained through diets is to develop crops that provide the required amounts in their edible tissues. Induced mutations are proven tools in creating desirable genetic variability in plants that translate to enhanced accumulation of essential minerals; synthesis of precursors of vitamins; modified quantities and qualities of starch, proteins and oils as well as secondary plant metabolites that play critical roles in improving human health and nutrition.

The CRP aims at utilizing the wealth of mutant germplasm in model crops, such as rice, tomato and barley, to understand and identify genes involved in the biosynthesis of nutritional quality enhancing factors and to develop efficient screening methods to facilitate the genetic improvement of nutritional quality. The goal is to transfer knowledge and technologies of beneficial mutants associated with nutritional factors from model crops to improve nutritional quality into other crops.

Eleven Scientists from Botswana, Bulgaria, China, Denmark, Ghana, Germany, India, Kenya, South Africa, Ukraine, the United Kingdom (UK) and USA attended the meeting in Vienna to discuss the individual project activities, adapt the workplans, and facilitate possible collaboration between the research teams.

# Status of Coordinated Research Projects

## Enhancing the Efficiency of Induced Mutagenesis through an Integrated Biotechnology Pipeline, D2.40.12

Technical Officers: C. Mba and B. Till

This CRP was initiated in 2008. The first RCM was held in Vienna, Austria, 25–29 May 2009.

For detailed information, see 'Past Events'.

## Improving Nutritional Quality by Altering Concentrations of Enhancing Factors Using Induced Mutation and Biotechnology in Crops, D2.30.28

Technical Officer: Y. Lokko

This CRP was initiated in 2008. The first RCM was held in Vienna, Austria, 29 June–3 July 2009.

For detailed information, see 'Past Events'.

## Isolation and Characterization of Genes Involved in Mutagenesis of Crop Plants, D2.40.13

Technical Officer: Q.Y. Shu

This new CRP started in May 2009 and the first RCM is planned to be held in October 2009. Currently, eight research groups from developing countries (Argentina, Bulgaria, China, India, Republic of Korea, and Poland) and three groups from developed countries (Germany and USA) are participating in the CRP. Two technical contracts and agreement contracts are still open for application; interested researchers should contact the technical officer.

Induced mutations have been widely used in plant breeding and more recently in plant functional genomics research, e.g. isolation of genes and determination of their function. Progress has been made towards understanding the genetic control of mutagenesis, which is mainly limited to model plants and is caused by internal mutagenic chemicals (e.g. reactive oxygen species). Therefore, the understanding of genetic control in plant mutagenesis, which is vital for the proper application and manipulation of mutation induction for enhancing genetic variation and plant mutation breeding, is still very limited. This project aims at identifying and characterizing genes involved in mutagenesis in crop plants using recently emerging molecular and genomics tools, to determine their function in response to treatment of different mutagens, and to find out the spectrum of mutations induced by various mutagens. Through this CRP, a Plant Mutagenesis Database, publicly accessible to all Member States, will be established, containing information on genes involved in DNA damage response and repair genes from a variety of plant species, as well as a list of mutants defective in these genes. Homologous genes involved in DNA repair and mutagenesis in crop plants will be characterized; their function will be determined using genetic variants produced through chemical and/or physical mutagenesis or other biological means. Some of the genetic variants will constitute valuable genetic resources for efficient mutation induction. Furthermore, the spectrum (the molecular genetic feature) of mutations induced by various mutagens will be investigated using high throughput mutation screening technology platform. Based on the research findings, improved protocols for mutation induction and screening, as well as their application will be developed for breeding new varieties that are better adapted to climate change and produce more and/or better foods.

## Effects of Mutagenic Agents on the DNA Sequence in Plants, D2.40.11

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 took place in Stellenbosch, South Africa, 24–28 September 2007. The fourth and final RCM was held in Vienna, Austria, 25–29 May 2009.

For detailed information, see 'Past Events'.

## Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality, D2.30.25

Technical Officer: Q.Y. Shu

This CRP was initiated in 2004 and will be completed by the end of 2009. The Fourth and Final RCM will be held in Plovdiv, Bulgaria in November 2009.

The project deals with several crop plant species, including some major staples (rice, barley, wheat), cotton, potato, and some less well-studied 'orphan' crops (okra and groundnut). The targeted traits represent a wide range such as yield and quality characters, as well as biotic and abiotic stresses that have an impact on crop quality. Good progress has been achieved in all target crops. Mutants and advanced breeding lines derived from mutants have been produced for most species under study. In some cases, where mutants are not available (e.g. potato), the natural diversity of the crop is being used to exploit naturally occurring variability. Mapping populations have been established for the genetic analysis of mutant phenotypes, and significant progress has been made in accurate localization of genes and QTLs for target traits. Moreover, there is a substantial development of other germplasm for breeding and further genetic analysis (e.g. NILs, RILs, advanced backcross lines, intogression lines).

A wide range of marker technologies (RAPD, AFLP, ISSR, SSR, SNP, MFLP, isozyme) are being used by the participants to tag and pyramid mutant genes including the use of multiplex marker technologies (e.g. multiplex SSR) in wheat and barley. Other advanced marker technologies, such as, eQTL, cDNA-AFLP, microarrays and high-throughput SNP-based markers) are being exploited. Some groups (e.g. rice) are making good use of the available genome sequence data and such resources should prove useful for targeted marker development. Other groups are employing candidate gene approaches in attempts to isolate genes corresponding to target traits. Many publications have been generated from the participants of this CRP. Several new varieties derived from mutant lines will be available by the end of the project. Moreover, the project should produce many molecular and biochemical markers for use in plant breeding programmes. The project has made significant progress in pyramiding multiple genes (including mutated genes) and QTLs using molecular marker technologies.

## Identification and Pyramiding of Mutated Genes: Novel Approaches for Improving Crop Tolerance to Salinity and Drought, D2.30.26

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 RCM took place in Vienna, Austria, 11–16 August 2008 in conjunction with the International Symposium on Induced Mutations in Plants (ISIMP).

## Molecular Tools for Quality Improvement in Vegetatively Propagated Crops Including Banana and Cassava, D2.30.27

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.

The third RCM took place in Vienna, Austria, 11–16 August 2008 in conjunction with the International Symposium on Induced Mutations in Plants (ISIMP).

**IAEA Coordinated Research Activities Web Site:**

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

# Technical Cooperation Projects

## Active Projects

| Project Number | Title and Objective(s) | Technical Officer |
|---|---|---|
| AFG/5/003 | Sustainable Increase in Crop Production in Afghanistan<br>***Objective:*** 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. | Y. Lokko in collaboration with Soil and Water Management Section |
| AFG/5/004 | Enhancing Crop Productivity through Mutation Breeding and Pest Control<br>***Objective:*** To build a thorough knowledge base in the use of nuclear technology to enhance crop productivity through mutation breeding and pest control. | Y. Lokko in collaboration with Insect Pest Control Section |
| ALG/5/023 | Protection of Date Palm Trees Against Bayoud Disease<br>***Objective:*** Rehabilitation and development of date palm oasis using mutation induction in Algeria. | M. Spencer |
| ALG/5/024 | Improvement of Cereals for Tolerance to Drought and Resistance to Disease<br>***Objective:*** 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. | M. Spencer |
| ANG/5/006 | Improvement of Food Crops Through Mutation Breeding and Biotechnology<br>***Objective:*** 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<br>***Objective:*** To increase agricultural production in coastal areas through integrated and efficient management of crop, water, soil and land resources. | Q.Y. Shu |
| BKF/5/007 | Improving Voandzou and Sesame Based Cropping Systems through the Use of Integrated Isotopic and Nuclear Techniques<br>***Objective:*** To improve crop production in the interest of food security and to combat poverty through induced mutagenesis and modern biotechnology to improve the agricultural productivity of voandzou and sesame, and to improve soil fertility management in voandzou sesame based cropping systems. | M. Spencer |

| Project Number | Title and Objective(s) | Technical Officer |
|---|---|---|
| BOT/5/003 | Mutational Improvement of Groundnut Varieties<br>***Objective:*** 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<br>***Objective:*** To develop manioc varieties with resistance to the African Cassava Mosaic Virus (ACMV) through mutation breeding and biotechnology techniques. | M. Spencer |
| COL/5/023 | Enhancing Mutagenesis and Biotechnology Used in the Improvement of Rice<br>***Objective:*** To increase the genetic variability of rice in Colombia through radiation induced mutagenesis for use in the national Programme for the Genetic Improvement of Rice. | Y. Lokko/Q.Y. Shu |
| COS/5/027 | Generation of Promising Strains of Beans through Induced Mutations in Calluses and Seeds to Increase Competitiveness<br>***Objective:*** To contribute to an increase in the competitiveness and productivity of beans by strengthening the National Programmes for Bean Improvement. | M. Spencer |
| COS/5/028 | Generating Promising Strains of Beans through Induced Mutations in Calluses and Seeds to Increase Competitiveness (Phase II) | M. Spencer |
| CPR/5/017 | Construction of Radiation-Induced Mutant Libraries and Function Analysis of Mutated Genes in Crop Plants<br>***Objective:*** 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. | M. Spencer/Y. Lokko |
| ECU/5/023 | Inducing Mutations in Agriculture with the Aid of Radiation<br>***Objective:*** To improve varieties of maize, potato and barley using mutagenic techniques leading to an increase in the productivity of these subsistence crops. | M. Spencer |
| ECU/5/025 | Inducing Genetic Variability in Soya, Banana and Rice<br>***Objective:*** To induce genetic variability using physical or chemical mutations in soya, banana and rice in order to obtain cultivars that meet the requirements of food and environmental security protection. | M. Spencer |
| ERI/5/004 | Improving Crop Productivity and Combating Desertification<br>***Objective:*** 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. | Y. Lokko in collaboration with Soil and Water Management Section |
| GHA/5/032 | Enhancing Production and Use of Cassava<br>***Objective:*** 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 |

| 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<br>***Objective:*** 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 |
| INS/5/036 | Genetic Improvement of Artemisia Cina Using Irradiation Technique<br>***Objective:*** To improve crop productivity for sustainable agricultural development in coastal areas through crop genetic improvement and development of soil, water and nutrient management practices. | M. Spencer/Q.Y. Shu |
| INS/5/037 | Applying Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands<br>***Objective:*** To improve crop productivity for sustainable agricultural development in coastal areas. | Q.Y. Shu |
| INS/5/038 | Using Induced Mutations to Improve Rice Productivity through a Hybrid Rice Breeding Programme<br>***Objective:*** To breed high yielding hybrid rice varieties with good grain quality and resistance to main pests and diseases. | Q.Y. Shu |
| INT/5/150 | Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99)<br>***Objective:*** To facilitate and coordinate a network of laboratories as a defence line against the Wheat Black Stem Rust (Ug99) disease in high risk countries. | P.J.L. Lagoda/Q.Y. Shu |
| IRQ/5/015 | Induction of Mutations in Crops Through *In Vitro* Culture<br>***Objectives:*** To develop mutants of crops with high yield and tolerance to salinity, drought and heat, using in-vitro techniques. | Q.Y. Shu |
| IRQ/5/017 | Optimization of Land Productivity Through the Application of Nuclear Techniques and Combined Technologies<br>***Objective:*** 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. | Q.Y. Shu |
| IVC/5/031 | Improving Plantain and Cassava Yields thought the Use of Legume Cover Crops<br>***Objective:*** To increase the yield of plantain and cassava in smallholder farming systems by improving fertility of degraded soils in coastal areas through the use of leguminous cover crops. | M. Spencer |
| JAM/5/010 | Plant Breeding and Diagnostics Technologies<br>***Objective:*** To enhance capacities in crop improvement in Jamaica so as to increase food production using induced mutations and related biotechnologies. | Y. Lokko |
| KAZ/5/002 | Improving Wheat and Maize Using Nuclear and Molecular Techniques<br>***Objective:*** To increase availability of genetic resources and techniques for the improvement of quality characteristics of wheat and maize and their tolerance to abiotic stresses such as drought and salinity. | Q.Y. Shu/Y. Lokko |
| KEN/5/029 | Developing Appropriate Artemisia Varieties for Management of Malaria<br>***Objective:*** To develop high artemisinin producing varieties of Artemisia annua, adapted to different agro-ecological zones in Kenya, through induced mutation breeding and biotechnologies. | Y. Lokko/M. Spencer |

| Project Number | Title and Objective(s) | Technical Officer |
|---|---|---|
| MAG/5/018 | Improving Cereal Production (Rice and Maize) through Mutation Breeding for Tolerance/Resistance to Striga (Striga asiatica)<br>***Objective:*** To increase cereal productivity by developing mutant rainfed upland rice and maize varieties tolerant or resistant to the parasite plant Striga asiatica. | M. Spencer |
| MAK/5/006 | Improving Wheat, Barley and Triticale for Food and Feed in Drought-Prone Areas, Using Nuclear Techniques<br>***Objective:*** To improve wheat, barley and triticale for food and feed in drought-prone areas via nuclear techniques. | Y. Lokko |
| MAL/5/028 | Enhancing the Production of Bioactive Compounds in a Local Herbal Plant by a Soilless Planting System and *In Vitro* Mutagenesis<br>***Objective:*** To enhance the productivity of bioactive compounds extracted from local herbal plants using soilless planting systems, radiation induced mutagenesis technology and supportive biotechnologies. | Y. Lokko/M. Spencer |
| MAR/5/018 | Improvement of Banana and Tomato Varieties Through the Use of Nuclear Techniques for Mutation Induction and Biotechnology<br>***Objective:*** 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)<br>***Objective:*** 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. | Q.Y. Shu |
| MYA/5/016 | Development of Rice Varieties with Improved Iron Content/Bioavailability Through Nuclear Techniques<br>***Objective:*** To combat iron deficiency through food based strategies. | Q.Y. Shu/Y. Lokko |
| MYA/5/017 | Studying Yield Improvement of Local Rice Varieties though Induced Mutation<br>***Objective:*** To strengthen food security through increased yield in rice by induced mutation. | Q.Y. Shu/Y. Lokko |
| MYA/5/019 | Developing Thermo-Insensitive (Cold-Tolerant) Green Gram Genotypes, Using Mutation Techniques<br>***Objective:*** To create genetic viability and to develop thermo-insensitive (cold-tolerant) black gram varieties. | Q.Y. Shu/Y. Lokko |
| NAM/5/009 | Using Mutation Breeding and Integrated Soil Plant Management Techniques to Develop Sustainable, High Yielding and Drought Resistant Crops<br>***Objective:*** To improve germplasm of pearl millet and cowpea and to evaluate the nitrogen economy of intercropped pearl millet and water uptake ability of drought stressed pearl millet. | Y. Lokko in collaboration with Soil and Water Management Section |
| NER/5/012 | Improvement of the Productivity and Sustainability of Cowpea with Finger Millet<br>***Objective:*** 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 in collaboration with Soil and Water Management Section |

| Project Number | Title and Objective(s) | Technical Officer |
|---|---|---|
| NER/5/014 | Improving the Productivity of Cowpea/Finger Millet Based Cropping Systems<br>***Objective:*** To develop improved drought resistant lines and soil fertility management practices using nuclear, isotopic and mutation breeding techniques for cowpea-finger millet based cropping systems. | M. Spencer in collaboration with Soil and Water Management Section |
| NIR/5/035 | Adding Value to Root and Tuber Crops Through the Use of Mutation Induction and Biotechnologies<br>***Objective:*** 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/Q.Y. Shu |
| PAK/5/044 | Improvement of Drought Tolerance in Chickpea Through Induced Mutations<br>***Objective:*** 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/5/030 | Genetic Improvement of Quinoa and Kiwicha Using Mutation Induction and Biotechnology<br>***Objective:*** 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<br>***Objective:*** 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 |
| QAT/5/002 | Developing Biosaline Agriculture in Salt-Affected Areas in Qatar<br>***Objective:*** 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. | Q.Y. Shu in collaboration with Soil and Water Management Section |
| RAF/5/056 | Field Evaluation and Dissemination of Improved Crop Varieties Using Mutation Breeding and Biotechnology Techniques<br>***Objective:*** To assist AFRA Member States in the development and dissemination of improved mutation induced staple and market oriented crops. | M. Spencer |
| RAS/5/045 | Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology (RCA)<br>***Objective:*** 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. | 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)<br>***Objective:*** 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<br>***Objective:*** 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<br>***Objective:*** 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 |
| RLA/5/056 | Improving Food Crops in Latin America though Induced Mutation (ARCAL CV)<br>***Objective:*** To increase food production in drought affected areas through the development and dissemination of drought tolerant advanced mutant lines of different food crops (legumes, cereals, pseudocereals, fruit trees etc.) traditionally cultivated in marginal and semi-arid areas in Latin America. | M. Spencer/Y. Lokko |
| ROK/5/035 | Using a Gamma Phytotron for Mutant Induction to Improve Food and Ornamental Crops<br>***Objective:*** To improve the production of food and ornamental crops through the use of a gamma phytotron for mutant induction; to determine low-energy and chronic effects of a gamma ray on crop mutagenesis; to provide diverse mutants for plant improvement and genomics study. | Q.Y. Shu |
| SAF/5/008 | Mutant Amaranth, Bambara Groundnut and Cowpea with Enhanced Abiotic Stress Tolerance<br>***Objective:*** 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<br>***Objective:*** 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 |
| SAU/5/003 | Improving Fertilization under Saline Conditions for Sustainable Crop Production<br>***Objective:*** To improve use efficiency of water and fertilizer applied through fertigation and to establish criteria for optimum doses of fertilizer and water salinity for sustainable crop production. | Q.Y. Shu in collaboration with Soil and Water Management and Crop Nutrition Section |

| Project Number | Title and Objective(s) | Technical Officer |
|---|---|---|
| SEN/5/030 | Integrated Approach to Develop Sustainable Agriculture in Senegal<br>***Objective:*** 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 |
| SEN/5/032 | Improving the Productivity of Jatropha Curcas Plantations in Semi-Arid Areas<br>***Objective:*** To develop new varieties of Jatropha curcas. | M. Spencer |
| SIL/5/007 | Development of High-Yielding Rice Varieties for Low-Input Agriculture Systems Using Mutation Techniques<br>***Objective:*** 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<br>***Objective:*** 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<br>***Objective:*** 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 |
| THA/5/049 | Increasing Productivity of Selected Crops Using Nuclear Related Techniques<br>***Objective:*** To set up an ion beam biotechnology centre for mutation induction of agricultural and horticultural crops for quality and quantity improvements and pest resistance. | Q.Y. Shu |
| TUN/5/023 | Radiation-Induced Mutations for Improvement of Cactus<br>***Objective:*** To develop improved varieties of cactus by induced mutations, which are relatively high in nitrogen for use as feed for sheep and goats. | Y. Lokko |
| TUN/5/024 | Development of Improved Strains of Olive Tree Through Mutation Breeding and Biotechnology<br>***Objective:*** To develop a routine protocol for mass micropropagation of high yielding olive varieties. | Y. Lokko |
| TUR/5/023 | Application of Nuclear and Gene-Based Biotechnology in Agriculture<br>***Objective:*** 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 |
| TUR/5/025 | Using Molecular Techniques for Enhancing the Efficiency of Mutation Induction and Utilization of Mutants in Agriculture<br>***Objective:*** To upgrade the laboratory for using molecular techniques for enhancing the efficiency of mutation induction and utilization, developing new techniques for mutant screening and characterization as well as new mutant varieties of important plant species. | Q.Y. Shu |

| Project Number | Title and Objective(s) | Technical Officer |
|---|---|---|
| URT/5/023 | Enhancing Crop Productivity through Radiation Technology<br>***Objective:*** 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 United Republic of Tanzania. | Q.Y. Shu |
| URT/5/026 | Improving Rice Varieties through Mutation Breeding and Biotechnology in Zanzibar<br>***Objective:*** To improve the capacity of Zanzibar rice researchers in the field of radiation technology. | Q.Y. Shu |
| UZB/5/004 | Development of Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity<br>***Objective:*** 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 |
| VIE/5/015 | Enhancement of Quality and Yield of Rice Mutants Using Nuclear and Related Techniques<br>***Objective:*** 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<br>***Objective:*** 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. | Y. Lokko |
| YEM/5/008 | Introduction of Gamma Ray Irradiation Techniques for Agriculture Purposes<br>***Objective:*** To support the use of gamma ray irradiation techniques, such as mutation induction enhanced breeding, for service and applied research purposes. | Y. Lokko |
| YEM/5/010 | Using Induced Mutations and Efficiency Enhancing Bio-molecular Techniques for Sustainable Crop Production<br>***Objective:*** To select wheat, barley, lentil, sesame and cotton mutants with drought and salt tolerance, disease resistance, early maturity and good yield | Y. Lokko |
| ZAI/5/016 | Mutation Techniques for Improving Nutritional and Medicinal Plants with a Curative Effect on Human Diseases and Alimentary Plants<br>***Objective:*** To build the basis for a long-term national strategy to fight malaria and improve food security. | M. Spencer |
| ZAM/5/026 | Improving Crop Varieties through Use of Nuclear Techniques<br>***Objective:*** To develop crop (beans and cassava) varieties with high yields that are resistant to multiple pests and diseases together with the establishment of a sustainable crop and land management system. | Y. Lokko in collaboration with Soil and Water Management Section |
| ZIM/5/013 | Development of Drought Tolerant and Disease Resistant Grain Legumes, Phase I<br>***Objective:*** To develop drought and/or disease tolerant mutant grain legume varieties suitable for resource poor smallholder farmers in Zimbabwe. | Y. Lokko |

## Recently closed TC Projects

| Project Number | Title and Objective(s) | Technical Officer |
|---|---|---|
| INS/5/031 | Mutation Breeding of Horticultural Crops<br>***Objective:*** 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 |
| PER/5/028 | Use of Nuclear Techniques to Improve Cotton Production<br>***Objective:*** To improve cotton production, particularly that of short vegetative period, using nuclear and related techniques. | Y. Lokko |
| RAF/5/049 | Field Evaluation of Bayoud-Resistant Date Palm Mutants<br>***Objective:*** To assist Algeria, Morocco, and Tunisia in producing date palm trees with improved fruit yield, short height, and resistance to Bayoud disease. | M. Spencer |

**IAEA Technical Cooperation Programme's Web Site:**

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

# TC Project Highlights

### Successful Mutation Breeding Programmes in Vietnam

Vietnam is a developing agricultural country having 73.5% of its population living in the rural area. Crop production plays an important role in national food security and the rural development of Vietnam. Nuclear techniques have been applied in food and agriculture for improving national food security since the 1970's with support from IAEA. Great achievements have been made in mutation breeding for crop improvement by the use of nuclear techniques and related biotechniques. More than 50 mutant varieties were developed, in which most of the varieties are cereal crops, especially rice. At present, about 15% of the rice production area is covered annually by mutant varieties in Vietnam.

*Three-quarters of Vietnamese populations are living in rural areas (Photo courtesy of Q. Liang, NAFA)*

Since the 1980's, the Agricultural Genetics Institute (AGI), Vietnam Academy of Agricultural Sciences (VAAS), has been engaged in R&D activities and contributes much to the technology transfer to the agricultural sector of Vietnam. Mutation breeding is one of the major fields of the Institute in crop improvement, in which the biggest accomplishments have been achieved in the development of mutant varieties for crop production.

*Mutant rice varieties are part of the national poverty alleviation programme of Vietnam (Photo courtesy of Q. Liang, NAFA)*

With support from the IAEA through TCPs and CRPs, 30 mutant varieties were developed and released officially to farmers for their production, including 17 rice cultivars, 10 soybean varieties, two maize varieties and one chrysanthemum variety. Most of these crop varieties are high

yielding with insect pest resistance, disease resistance/tolerance and high quality. More than 50% of the soybean cultivation area is covered by mutant varieties developed in the Institute, which is contributing to oil crop production of Vietnam. The application of modern biotechnology, such as tissue culture and molecular marker-assisted-selection methodologies, are increasing the efficiency of mutation breeding.

A visit was paid to the well organized and conducted trials of soybean mutant lines in experimental fields and production farms. Several mutant lines were well outperforming local control varieties. Based on the results of trials in the past few years and their performance in the visited fields, it is expected that more mutant varieties will be released in the coming years.


*Mutant soybean trials (Photo courtesy of Q. Liang, NAFA)*

The Institute of Agricultural Science of South Vietnam (IAS) in Ho Chi Minh City is the oldest national research institute founded in 1925 and has more than 450 staff. The Institute was organized into 11 research departments, seven applied research centers, one laboratory of high technologies and three supporting offices. IAS plays an important and leading role of R&D activities for agriculture and rural development in Vietnam.

The institute has also succeeded in mutation breeding by use of nuclear techniques and related biotechniques. Over the past decade, the Institute has developed eight excellent mutant rice varieties with high yielding, improved quality, disease resistance, tolerance to pests and lodging resistance. Since 2008, the total cultivated area of these mutant rice varieties was more than 2.54 million ha in Southern Vietnam. According to the statistics from the Institute, these mutant rice varieties have increased income by about $374 million at the end of 2008. One of these excellent mutant rice varieties (VND9S-20) become one of the top five varieties for export rice production. It covered the largest cultivation area of rice production in Southern Vietnam in 2007 and recently was grown on more than 300 000 ha per year in South Vietnam, due to its high yielding, good quality and tolerance to brown plant hopper. Not only has this variety been widely cultivated in the lowlands, but also expanded to the highlands and remote mountain areas, where poor farmers are benefiting from growing it.

*High yielding mutant rice varieties are being widely cultivated in remote mountain areas for the profit of poor farmers (Photo courtesy of Q. Liang, NAFA)*

It is very clear that it is the great support form the Vietnam Government that makes the application of nuclear techniques in food and agriculture so successful. Due to the excellent performance of the mutant rice varieties mentioned above, some of these mutant varieties were adopted for the Vietnam national strategy program of "Eradicate hunger and alleviate poverty" in different areas, particularly for central highland region of Vietnam, where there are many ethnic minorities living in remote mountain areas. The central highland region of Vietnam has a natural area of 5.5 million ha, population of 4.3 million with 37 different ethnic peoples. This region is an under-developed poor area where the agricultural production is vulnerable and unsustainable.

With the joint support of IAEA and Vietnamese Government, a project for yield trial and demonstration of mutant rice varieties was carried out in Buon Me Thuot, in order to evaluate and identify the mutant varieties adapted to local conditions for extension production.

Most of the eight mutant varieties have shown outstanding performance under local production conditions. These promising varieties were identified in the trials with improved characters, such as high yielding, increased disease and insect resistance/tolerance, short growth duration, good quality and better adaption to environment stress. Some of mutant varieties (VND 95-20, VND 99-3 VN121) have increased more than 30% of yield, compared to the control of the local variety. These mutant varieties have been well accepted by local farmers and will be cultivated in expanding areas. During a field visit, many farmers expressed their appreciation of mutant varieties for their contribution in increasing yield and income for poor formers.

*Mutant varieties' outstanding performance under local production conditions ensure sustainable food security (Photo courtesy of Q. Liang, NAFA)*

In order to help local farmers increase intensification of rice production, and obtain maximum yield potential of mutant varieties, IAS and the local government have made great efforts in technical transfer through a series of training courses in the field. These training courses have focused on rice cultivation techniques, good fertilization practice, efficient water management and proper use of pesticides for the purpose of sustainable rice production. It has been proved that the farmers have extensively benefited from the techniques transferred through these training courses.

*Local farmers obtain maximum yield potential of mutant varieties (Photo courtesy of Q. Liang, NAFA)*

## Conclusions

This field visit provided a good opportunity to have a full picture on the progress and achievement made in Vietnam, with support from the IAEA. Mutation breeding has become the most successful field of application of nuclear techniques in food and agriculture. More and more mutant crop varieties, especially in rice have been released to farmers and make great contributions to local and national food security. The outcome of the IAEA TCPs and CRPs has indeed increased the capacity building of the countries and further contributed to improved national food security.

The integrated application of mutant crop varieties with good agricultural practices (efficient soil and water management) shows a great potentiality for the extension of outcome based cooperation with the IAEA. Vietnamese Government officials expressed their sincere expectation for further cooperation with the IAEA. The IAEA, through the Joint FAO/IAEA Division, can continue to contribute to improve national food security in order to achieve sustainable agricultural production not only in the field of mutation breeding but also in other areas, such as efficient soil and water management practices, livestock production and the control of transboundary animal disease.

***Qu Liang***
***Director Joint FAO/IAEA Division (NAFA)***

## First Steering and Coordination Meeting on the Transboundary Threat of Wheat Black Stem Rust (Ug99), INT/5/150, Vienna, Austria, 4–8 May 2009

Scientists are accelerating research into new varieties of wheat to identify those resistant to an aggressive fungus that is destroying harvests in African and Middle Eastern countries. An FAO/IAEA technical meeting brought together 26 experts (including video and telephone conference calls) from 17 Member States (Algeria, Australia, China, Ethiopia, Jordan, India, Iran, Kenya, Pakistan, South Africa, Sudan, Syria, Tunisia, Turkey, Uganda, USA and Yemen) and nine international and national institutions and organizations (Borlaug Global Rust Initiative BGRI, Cornell University, Ithaca, NY, USA; International Maize and Wheat Improvement Centre (CIMMYT), Mexico, Kenya; Food and Agriculture Organization of the United Nations (FAO), Rome, Italy; International Atomic Energy Agency (IAEA), Vienna, Seibersdorf, Austria; International Centre for Agricultural Research in the Dry Areas (ICARDA), Syria; Western Australia Department of Agriculture (DAFWA), Perth, Australia; Bhabha Atomic Research Centre (BARC), Mumbai; Chinese Academy of Agricultural Sciences (CAAS), Beijing, China; United States Department of Agriculture Agricultural Research Service (USDA-ARS),

University of Missouri, USA) on an Interregional TC project on Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99) (INT/5/150). Further, six additional Member States (Bangladesh, Egypt, Iraq, Lebanon, Morocco and Oman) have been invited as a complement to the existing list of project members.

CAAS, Cornell University, DAFWA and USDA-ARS have extensive expertise, genetic resources, human resources and track records of successful activities relevant to this project. Their contributions will include genetic resources, experimental protocols, capacity building and several aspects of mentoring to developing Member States project members with less developed capabilities. The strategic location of BARC in the epidemiology of the disease and extensive expertise in the use of induced mutations to develop better crop varieties makes the participation of this institute of special interest to the project.

The pandemic of Wheat (black) stem rust, caused by the fungal pathogen *Puccinia graminis* f. sp. *tritici* race Ug99, a virulent stem rust race, is able to override existing resistance on several cultivated wheat and barley varieties. Wheat stem rust is among the most serious diseases of wheat worldwide and represents a major immediate threat to wheat and barley production in the East Africa and the Near East regions. Noble Peace Prize Winner, Dr. Norman E. Borlaug, believes that Ug99 is the most serious threat to wheat and barley in 50 years. The threat might be compared to the Avian Flu as this "Wheat Influenza" is not only threatening the world bread basket - it has already caused an increase in wheat prices, as all commercial varieties are sensitive to the disease - but it also threatens barley. The occurrence of Ug99 that has triggered a Global Rust Initiative shows the great danger for important yield losses on the currently grown wheat cultivars. Wide spread of Ug99 (http://www.globalrust.org) in Ethiopia and its detection in Yemen in 2006 and in Iran in 2007, has lead to global action by the international community that lead to the establishment of the BGRI that calls for global collaboration to combat the eminent threat of Ug99.

The IAEA TC programmes recognize that their work with Member States is relevant to the BGRI. The aim of INT/5/150 is to generate genetic variation for resistance to Ug99 based on mutation technology. IAEA has good track records to use the technology and assist Member States through transfer of relevant nuclear technologies to solve emergent problems through national programme management approaches. IAEA has 144 Member States with a 35 Member Governing Board, 2200 professional and support staff, and 51 years of international collaboration on agriculture research. IAEA is an ideal partner in the BGRI as it could easily streamline collaboration with national programmes and contribute effectively to the control of Ug99 through mutation assisted breeding by broadening the genetic base as well as the integration of bio-/molecular technologies, such as e.g. double haploids to accelerate breeding efficiency of national programmes.

End users will include all stakeholders in the wheat and barley growing regions in Africa, the Near East and Asia. Beneficiaries are all wheat growers and consumers through enhanced productivity and favourable wheat price development as a result of threat control. Wheat prices are not gender dependent, thus the outcome of the project profits both genders.

The project will complement the ongoing international activities and provide a platform for the coordination of a network of upgraded research laboratories (based on the previously established laboratory infrastructure though the IAEA's TC projects). The project meets IAEA central criteria as it clearly relates to national programmes that are committed to collaborate in the achievements of the project goals.

Operative coordination shall include: The IAEA (Vienna: scientific backstopping, Seibersdorf: adaptive R&D/training/technology transfer) in close collaboration with ICARDA in Syria, backstopped by DAFWA, Australia and USDA-ARS, USA. The FAO (Rome) is entrusted with the normative coordination. Screening is under the supervision of CIMMYT in Kenya. Sustainability is warranted by the BGRI (http://www.globalrust.org).

*Production/screening of resistant mutant wheat and barley germplasm (including previously produced mutant germplasm in national and regional TCPs):*

All collaborating countries have the following ongoing and/or completed mutation breeding projects: RAS/5/048 (active), Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA): Improving regional partnership in the field of mutation induction to enhance breeding for food security and socio-economic development (target crops including wheat and barley); RAF/5/056 (active), Field Evaluation and Dissemination of Improved Crop Varieties Using Mutation Breeding and Biotechnology Techniques (AFRA II-5): Assisting AFRA Member States in the development and dissemination of improved mutation induced staple and market oriented crops; ALG/5/024 (active), Improvement of Cereals for Tolerance to Drought and Resistance to Disease: Increasing cereal production (wheat and barley) by introducing new high yield varieties tolerant to biotic and abiotic stresses at the farmer's level; SUD/5/030 (active), Increasing Productivity of Selected Crops Using Nuclear Related Techniques: Using nuclear techniques to expand production of established varieties including wheat lines and increasing the productivity of new varieties; TUR/5/023 (active), Application of Nuclear and Gene-based Biotechnology in Agriculture; KEN/5/024 (successfully completed in 2007), Crop Improvement and Management through Application of Nuclear and Biotechnology Techniques: Establishing a

biotechnology laboratory for molecular characterization of induced mutants and thus enhancing the efficiency and widening the application of induced mutations in crop improvement, e.g. quality, yield, biotic stress and disease tolerance in Turkey; PAK/5/040 (successfully completed in 2007), Improvement of Heat-Tolerant Semi-Dwarf Bread Wheat Through Radiation-Induced Mutations.

The implementation of the project will be conducted in four interlinked phases for a duration of five years (2009-2013). During the first three years (2009-2011) the project activities (Activities 1-4) will focus on the assessment of existing mutant germplasm, initiation of induced mutagenesis of selected wheat and barley germplasm targeting resistance to Ug99 and its variants, upgrading research facilities, and on human resource development (capacity building, technology transfer). The last two years (2012-2013), the project will focus on multisite testing and selection for additional traits at countries' level.

*Activity 1. Screening of existing mutant germplasm from different countries at Kenya Critical Screening Facilities*

The participating countries will send elite material to Kenya critical screening facilities by end May 2009. The material will be exchanged under the Standard Material Transfer Agreement (SMTA) in agreement of screening guidelines at the Kenya Agricultural Research Institute (KARI), Njoro (www.globalrust.org). The material will be assembled under the first International Mutant Wheat Evaluation Nursery (IMWEN) and planted in June. Stem rust will be induced by inoculations with local Ug99 lineage pathotypes. The collaborators will visit their material in November 2009 and screen the nurseries. Evaluation will be conducted for adult plant response to stem rust.

*Activity 2. Countries establish mutant breeding programme*

Member countries will establish their mutation breeding programme at respective labs based on 1-2 elite varieties and will develop $M_1$. The $M_2$ will be sent to secondary hot spot in Kenya for preliminary screening to Ug99 races.

*Activity 3. Screening of $M_2$-cycles from countries in Kenya secondary hot spot*

$M_2$ received from each country (activity 2) will be screened in Kenya secondary hot spot. The elite resistant lines will be selected and potential lines will be selected and assembled under second IMWEN.

*Activity 4. Screening of IMWEN at critical facilities in Kenya*

The third IMWEN will be screened at primary hot spot of BGRI critical facilities at Kenya (Njoro) primary hot spot. Any resistant material identified will be tested at multi-location hot spots. Resistant lines will be assembled under second IMWEN and tested in Ethiopia (Kulumsa, Debra Zeit), and Yemen (Tehama, Dhamar).

Activities 2-4 will be repeated in 2010 and 2011 using different parental sources, thus producing 300 000 mutant wheat lines screened for resistance to Ug99.

***Pierre J.L. Lagoda***
***Technical Officer***

***Thabisile Moleah***
***Programme Management Officer***

## Main results obtained in Cuba through mutation breeding to drought tolerance in tomato, RLA/5/056

Having in mind the need to have tomato varieties growing under low water input conditions, not only to save this valuable liquid but also to diversify production in drought-affected areas, a tomato breeding programme using nuclear techniques was started with the purpose of obtaining adequate yielding-potential cultivars under drought conditions using the Cuban tomato varieties INCA 9-1 and Amalia. Seeds from INCA 9-1 and Amalia varieties were irradiated with $^{60}$Co gamma rays using doses of 300 Gy and 500 Gy. Selection of high yield potential genotypes under low water supply conditions was made during four generations from $M_2$ generation. The Individual selection was done, taking into account healthy plants, determinate growth habit, high number of fruits per plant, high yielding and good fruits quality. The farmers participated in the selection of advanced mutant lines every year.

The most frequent variations observed in each generation were: plant cycle, fruit size, number, shape, color and yield. Highly significant differences were appreciated in the genetic material analyzed for yield per plant, fruit number per plant and average fruit weight in relationship with the donor. It was possible to select four high yielding genotypes under low water input conditions.

Taking into account the values reached for each selected genotype and based on the established parameters about internal fruit quality, all varieties could be appraised for industrial use and one of them additionally as a double purpose variety, considering its average fruit weight. These varieties are being adopted by the farmers and have made possible the increase of tomato production in several areas of our country with low input of water and fertilizers.

Currently, the Breeding Programme for Drought Tolerance in Tomato continues with the support of a national project and the IAEA project ARCAL RLA/5/056.

*Participatory selection in low water input in different areas*

*Mutant selected under low water input condition (Mali, Carucha, Maybel y Domi)*

These results have been obtained with the support of IAEA through TC project CUB/5/016.

***María C. González Cepero, Jean Pierre Mukandama, Mansoor Mohamed Alí, Iralis Ferradas and Delfina Trujillo, National Institute of Agricultural Science (INCA)***

## Genetic Improvement of Quinoa (*Chenopodium quinoa*) and Kiwicha (*Amaranthus caudatus*) Using Mutation Induction and Biotechnology, PER/5/030

In the Andean highlands of Peru, native crops such as quinoa (*Chenopodium quinoa*) and amaranth "*kiwicha*" (*Amaranthus caudatus*) are important food security crops. Under the TC project on Genetic Improvement of Quinoa (*Chenopodium quinoa*) and Kiwicha (*Amaranthus caudatus*) using Mutation Induction and Biotechnology (PER/5/030), counterparts of La Molina National Agrarian University through their partners (Cereals and Native Grains Research Program) lead by Prof. Luz Gomez Pando, carried out the project with the aim to improve national capacity to increase the yields and market competitiveness of the native pseudo-cereals quinoa and amaranth.

Building on the skills and laboratory capacities from a previous TC project on Expansions of the Mutant Barley Variety UNA La Molina 95 in the Andean Highlands of Peru (PER/5/024), the counterpart during the current project has provided farmers, NGOs, and marketing companies with seeds of their new mutant varieties of barley (*Centenario II*) and amaranth "*kiwicha*" (*Centenario*). The amaranth *"Kiwicha"* mutant variety Centenario is currently the second most important cultivar of amaranth in Peru. Furthermore, this variety is suitable for export due to its high quality grain, the environmental friendly agronomic practices with little or no chemically maintained weed, pest, or disease management interventions. It is certified as an organic product, through which the farms generate more income. During the period under review (2007–2008), the counterpart's institution held a

series of field days and workshops, in different locations on good agronomic practices and post harvest processing of the mutant variety. The counterpart also produces and distributes seeds of this variety to farmers in various locations covering the three main agroecologies in the countries, namely the Peruvian coast lands, the Andes highlands and the Amazon rainforest.

To date, the variety is cultivated in about 463.25 ha of land by farmers, NGOs, enterprises, as well as private and public institutions. The reported productivity by farmers ranged from 1 500 to 5 000 kg per ha, with the low yields being attributed to frost and late planting.

In addition to the expansion of these new varieties, the programme has applied induced mutation and double haploids to develop several mutant lines of quinoa and amaranth "*kiwicha*", Amazon rice, barley, durum wheat and oats, which are under various stages of evaluation for tolerance to a range of abiotic stresses and for improved quality. The emphasis of the induced mutagenesis work was to develop consumer-preferred white and cream seeded varieties of these grains from existing cultivars with good agronomic traits, which are purple and black seeds. Mutant populations of an early maturing purple seed quinoa variety "*Pasankalla-INA*" and the drought and salt tolerant amaranth accession "*Huacho*", with black seeds, were developed and are currently under various stages of evaluation in the target agroecologies. The genetics and tissue culture laboratories were also strengthened and comprehensive studies were carried out to develop protocols for doubled haploid production in quinoa and genetic characterization with molecular markers in both quinoa and amaranth, using the standard protocols for barley.

One of the objectives of the Cereal Programme is to provide alternative cereals including barley, quinoa and amaranth, with competitive market value of flour quality compared to wheat flour and to improve the nutritive value of bread and other baking products for consumers. As such, capacities in the grain quality laboratory were strengthened through equipment and training, to enhance the breeding programme's ability to select mutants with improved flour quality of its barley and pseudo-cereals, performing most of the essential analysis for amylose and gluten content of the grains.

***Yvonne Lokko***
***Technical Officer***

## Enhancing Crop Productivity through Radiation Technology, URT/5/023

The project aimed at developing improved varieties of basic crops such as rice, banana and barley through tissue culture, radiation-induced mutations and molecular techniques and enhancing the crop breeding capacity in Tanzania. It has been in implementation since 2005.

Apart from capacity building, the project has so far successfully released two mutant rice varieties, Mwangaza and SUPA BC. Mwangaza is a new variety released for cultivation in the inland of Tanzania. It is resistant to rice yellow mottle virus (RYMV) disease, a devastating disease mainly occurring in the African region. This variety performs well in areas of high RYMV infection; it is also being used as RYMV resistant germplasm for breeding new varieties. SUPA BC is a new variety released for cultivation in Zanzibar, particularly in irrigated systems. It has gained acceptance of farmers due to its high yielding and acceptable quality characters.

*Researchers artificially inoculating yellow mottle virus to rice seedlings for evaluation of their resistance (Sokoine Agricultural University, Morogoro, Tanzania)*

Apart from the two released varieties, there are also dozens of rice and barley breeding lines being developed. Some of them have been under field trials and appeared promising for eventual release as new varieties. For example, five rice elite lines were selected after on-station trials for their shorter stature, earlier maturity and resistance to RYMV; three barley mutant lines at $M_8$ have shown to be early maturing, of high quality and resistant to lodging.

A banana micropropagation system has been established. Twenty banana cultivars, preferred by farmers, were sub-

ject to tissue culture and propagation. More than 3 000 clones each were propagated from 20 varieties and distributed to banana production zones in the eastern and southern parts of Tanzania.

*Banana seedlings are being multiplied through micro-propagation for distribution to farmers (Sokoine Agricultural University, Morogoro, Tanzania)*

***Qingyao Shu***
***Technical Officer***

## Kiwicha (*Amaranthus caudatus*) improvement by mutation induction in Peru, PER/5/030

Kiwicha (*Amaranthus caudatus*) from the *Amaranthaceae* family and native of the Andes, is with other crops such as Quinoa (*Chenopodium quino)* also called "pseudocereal" owing to the very high number of edible seeds (popped grains and as flour) comparable to grains produced. Kiwicha also has a good balance of protein, fat, oil and starch. Amaranth protein has proven to be highly rich in essential amino acids including lysine and methionine, which give it a nutritive value comparable to that of casein in milk.

*Kiwicha (Amaranthus caudatus) cultivar Ancash traditionally and widely cultivated in Peru and well-known for its good tolerance to drought and diseases caused by sclerotinia sp.*

The research conducted in Peru aimed at improving the traditional cultivar of *Amaranthus caudatus*; Ancash through gamma ray radiation induced mutations. Following a basic and well crafted protocol, the authors developed five mutant lines, which in field trials produced higher yield than the parental cultivars. From these lines the Centenario Cultivar was selected and released in March 2006 with similar nutrition quality, better yield and most importantly, a pleasant yellowish colour very appealing for amaranthus flour based meals. At farmers' location in the coast, the yield has a variation of 3 500 to 5 500 kg/ha and in the highland from 2 500 to 3 700 kg/ha. The area seeded with Centenario is near to 40% of the total Peruvian land dedicated to kiwicha crop.

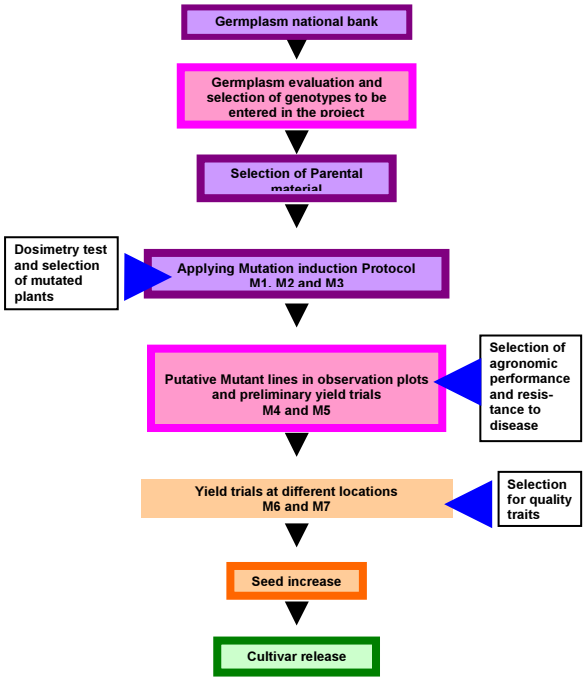


*Diagram of the genetic improvement of Kiwicha using γ ray irradiation*

*Centenario cultivar*

***Elizabeth Heros, Ana Eguiluz and Luz Gómez***
***Universidad Nacional Agraria La Molina, Programa de Cereales y Granos Nativos, La Molina, Lima***

# Ongoing Activities at the Plant Breeding Unit, Seibersdorf

## Introduction

The Plant Breeding Unit (PBU) has continued to leverage its laboratory-based activities in partnering with the Plant Breeding and Genetics Section to support the capacity of the Member States in using induced mutations to develop better crop varieties. PBUs' contributions to this mandate derive from the three-pronged approach of:

- Technology development and adaptation;
- Provision of technical and analytical services; and
- Supporting human capacity development.

The main thrust of our activities in the recent past has been the development and dissemination of validated technology packages aimed at significantly enhancing the efficiency of the processes involved in the induction, detection and deployment of mutation events in crop improvement and genomics.

The Unit has continued to rely on the strategy of developing and validating relevant technologies involving the integration of biotechnologies (cell and tissue biology and molecular genetic techniques) in induced crop mutagenesis. It makes use of the three-commodity crop platform of bananas, rice and cassava for this purpose. The crops contrast in both their biological characteristics and the production constraints that form their breeding objectives. Bananas whose productivity is constrained by biotic stresses are mostly sterile, are vegetatively propagated, and are cultivated for their edible fruits. On the other hand, the seed propagated rice is a cereal whose productivity is hampered by abiotic stresses. Also, quite contrastingly, cassava, a vegetatively propagated crop with shy flowering and very low seed set, is grown mostly for the starchy storage roots; its main genetic improvement need is the diversification of end-use through the modification of the starch characteristics.

We highlight below the status of ongoing activities for the first half of 2009 relating to reverse genetic strategies for uncovering mutation events as well as an initiative to fine-tune screening mechanisms for salinity tolerance in rice. Our training activities and the support we provided to ongoing activities in Member States, especially through the provision of technical and analytical services are also presented.

## Technology development and adaptation

### *Reverse genetics*

An important issue in induced mutagenesis in vegetatively propagated crops is the efficient and complete dissolving of chimeric cell types in plantlets prior to phenotypic assessment. We have developed a system in cassava aimed at evaluating when in plant growth, after mutagenesis, cells become genotypically homogeneous. In collaboration with counterparts from the Democratic Republic of Congo, we are scaling this up by establishing a gamma irradiated mutant population of approximately 3000 unique individuals. This material will be used for forward genetic screens in Democratic Republic of Congo. At the PBU, DNA is being collected from individuals for reverse genetic screens and for testing when tissue became homogeneous.

Reverse genetic screening of an EMS mutagenized population of triploid banana by TILLING continues. Sequence-validated mutations are of the type expected from treatment with EMS, suggesting a high density of induced mutations in the population. We have begun a beta–test with counterparts at the Katholieke Universiteit in Leuven, Belgium to evaluate the feasibility of providing reverse genetics based mutation screening as an additional service to support Member States' activities.

Ecotilling analysis of about 50 diploid and triploid banana accessions is nearly complete, with over 150 unique haplotypes now discovered. Through the evaluation of technical replicates we estimate assay accuracy above 90% with low failure rates. Working with counterparts at the Katholieke Universiteit in Leuven, we are combining data sets and evaluating genetic differences in a variety of different banana accessions.

### *Comparative phenotypic screening for salinity tolerance in rice*

The bottleneck of the imperative of screening large mutant population sizes is a major handicap in challenging putative induced rice mutants to salt stress. Currently, we make use of a hydroponics culture system that permits the modulation of salt concentration and the identification of tolerant variants at the seedling stage. We have recently initiated an elaborate experiment aimed at generating empirical data for the comparative analysis of the efficacies of this system and the isotope tracer (C-13, O-18) techniques for selecting rice varieties at the vegetative growth stages in salinity environments. It is expected that the quantitative information to be generated on the candidate mechanisms for salt tolerance by rice varieties will lead to the establishment of an integrated efficient screening protocol for selecting rice varieties tolerant to salinity.

### *Drought tolerance profiling of the global Musa accessions*

PBU and the Soil Science Unit of Agency's Laboratories, Seibersdorf, in partnership with the University of Agriculture in Krakow, Poland, have initiated a collaborative project aimed at the use of a combination of novel physiological, isotopic and molecular biology assays to characterize *Musa* genotypes for drought tolerance. This project proposes the elucidation of the drought tolerance profiles of a set of 42 *Musa* genotypes used globally as the reference accessions in the crop's genetic improvement and genomics. The outputs of this project will contribute to populating the suite of tools being deployed in efforts aimed at crop adaptation to climate change and variations and the mitigation of the consequences of the rapidly changing farming conditions. The following are the expected outputs:

- Benchmark data on drought tolerance for *Musa* reference accessions.
- Comparative data on the efficacy of the different assays methods (physiological, isotopic and molecular biology) for providing reliable predictive estimates of field responses of these genotypes to drought conditions.
- Guidelines for the rapid assay of *Musa* accessions for drought.
- Molecular tools for marker-aided selection and *Musa* germplasm characterization based on drought will be provided.
- Other spin-off benefits will be found in the adaptation of the most efficacious assays to other crops.

## Training activities

The Unit has continued to support capacity building for the use of induced mutations in crop improvement in Member States through both group and individual training activities. The following are highlights of training activities in the Unit in the first half of 2009.

## Individual trainees

Seven Fellows sponsored by the IAEA technical cooperation programme and four Interns, have been in the Unit for varying lengths of time gaining hands on experience in the use of a combination of induced crop mutations and biotechnologies in developing superior crop varieties and in understanding the underlying genetic bases driving mutation events:

### Fellowships

| Name | Country |
|---|---|
| Mr. Mohamed MAALEJ | Tunisia |
| Ms. Samah AL-AGHABRI | Yemen |
| Ms. Huijun GUO | China |
| Mr. Aime DIAMUINI NDOFUNSU | Democratic Republic of Congo |
| Mr. Orane Norman SAVAGE | Jamaica |
| Mr. Qamar ZIA UL | Pakistan |
| Ms. Bibi Sabinaz TAGAULY | Mauritius |

### Interns

| Name | Country |
|---|---|
| Mr. Mohammed ELAGABANI | Austria |
| Mr. Danilo MORENO | Ecuador |
| Mr. Joseph Okechukwu NWOZOR | Nigeria |
| Ms. Weronika BARCIK | Poland |

### Scientific visitors

| Name | Country |
|---|---|
| Mr. Ali FERCHICHI | Tunisia |
| Mr. Abdul Hameed ABDULLAH | Yemen |
| Mr. Mahama OUEDREAGO | Burkina Faso |
| Ms. Ann Marie SMITH | Jamaica |

## Plant Breeding Unit's Staff Travel to the Member States

**Mr. B. Till**

- In January 2009, Mr. B. Till attended the Plant and Animal Genome XVII Conference in San Diego, California, where he presented an oral presentation on the PBU's work on banana and a poster describing reverse genetics activities in banana, cassava and rice.
- In March 2009, Mr. B. Till taught the TILLING technique at the Regional Training Course on Mutation Breeding Approaches to Improving Protein and Starch Quality held at the Centre for Plant Conservation Genetics at Southern Cross University in Lismore, Australia. While in Australia, he also gave a seminar on the PBU TILLING and Ecotilling efforts to the Plant Breeding Institute of the University of Sydney.

**Ms. J. Jankowicz-Cieslak**

- Also in March 2009, Ms. J. Jankowicz-Cieslak, presented a poster, "Tilling for Detection of Mutations in a Vegetatively Propagated Crop, Banana" at the Adaptation Potentials in Plants-FEBS Workshop, Vienna, Austria.

## Visits to the Unit by collaborating scientists

| Name | Country | Affiliation | Period |
|---|---|---|---|
| Ms. Margit LAIMER | Austria | University of Natural Resources and Applied Life Sciences (BOKU) | 23 February 2009 |
| Ms. Fatemeh MAGHULY | Austria | University of Natural Resources and Applied Life Sciences (BOKU) | 23 February 2009 |
| Mr. Laszlo SAGI | Belgium | Laboratory of Tropical Crop Improvement, Katholieke Universiteit Leuven | 14-15 April 2009 |
| Ms. Makila KOZAK | Poland | Faculty of Agriculture, Wroclaw University of Environmental and Life Sciences in Poland | 29 April 2009 |

## Services in support of activities in Member States

The following irradiation service requests from Member States were handled in the first half of 2009:

| Member State | Crop species |
|---|---|
| Spain | • Castor beans;<br>• Jatropha and<br>• Arabidopsis |
| Germany | • *Dendrathema spp*<br>• *Hypericum spp*<br>• *Euphorbia spp* |
| Tanzania | Rice |
| Jamaica | • Yam *in vitro* (mutagenic population of 1620 plantlets);<br>• Ginger *in vitro* (900 plantlets) |
| United Kingdom | Wheat |
| Austria | • Wheat and<br>• Soybean |
| St. Vincent | Cocoyam |
| Democratic Republic of Congo | • Cassava *in vitro* ( 3000 plantlets); and<br>• *Phyllanthis* spp. |
| Kenya | • Wheat,<br>• barley and<br>• cassava |
| Turkey | Sesame |
| Tunisia | Olive |
| Ghana | Sorghum |
| Burkina Faso | Bambara groundnut |

### TILLING and Ecotilling positive control kit

The Plant Breeding Unit in Seibersdorf has developed a positive control kit for TILLING and Ecotilling that it is now sending to researchers in Member States upon request. The kit contains genomic DNA with known nucleotide polymorphisms, gene-specific oligonucleotide primers, buffers and enzymes for mutation and polymorphism discovery. Along with protocols, examples of high quality data produced with these materials are provided that serve as a reference point for assay optimizations.

# Announcements

## Fifth Brazilian Plant Breeding Congress – 5º Congresso Brasileiro de Melhoramento de Plantes, Guarapari, ES, Brazil, 10–13 August 2009

As pesquisas em melhoramento de plantas conduzidas por instituições públicas e privadas têm proporcionado expressivas mudanças na história das diferentes espécies e contribuído, efetivamente, para os grandes avanços da atividade no Brasil e em muitas outras regiões produtoras de todo o mundo. Tais pesquisas têm gerado conhecimentos básicos, fundamentais à constante evolução da ciência, além de tecnologias e produtos de apropriação imediata pelos produtores.

For more details visit:

http://www.incaper.es.gov.br/congressos/cbmp/index.php

This conference is organized by the Sociedade Brasileira de Melhoramento de Plantas - SBMP (Brazilian Plant Breeding Society).

## The World Soybean Research Conference VIII, Beijing, China, 10–15 August 2009

The Chinese Academy of Agricultural Sciences and Crop Science Society of China are pleased to jointly host WSRC VIII on August 10-15, 2009 in Beijing, China. An excellent opportunity will be provided for participants from various regions of the world to share the latest global progress of science and technology in soybean research. Traditional areas where papers will be presented include soybean germplasm, genetics and breeding, molecular biology and biotechnology, physiology and crop production, crop protection, soybean storage and processing, soybean product and use, global demand / trade / strategy.

The conference organizers are expanding the conference to include 'Soybean Industry Forum' to 'Discuss and Develop a Global Blueprint for a Safe, Secure, and Sustainable Supply of Soy for Food, Feed, Fuel, and Fiber'.

Apart from the scientific exchange and Soybean Industry Forum, we will also showcase new varieties, new products, new technologies and latest publications. Furthermore, post conference tours to soybean farms and processing plants in China and the scenic and/or cultural sites will feature your tour in China with both academic atmosphere and ancient cultural immersion of China. The Organizing Committee of WSRC VIII sincerely welcomes the soybean experts and entrepreneurs to be involved in the conference planning, academic exchange and achievement exhibition. And we believe that WSRC VIII will be an unprecedented landmark in WSRC history under our joint effort.

For more information, visit:

http://www.wsrc2009.cn/en/jianjie.asp

## Second World Congress of Agroforestry (WCA2), Nairobi, Kenya, 23–28 August 2009

The objective of the Congress is to share lessens and experiences by assessing opportunities to leverage agroforestry in promoting sustainable land use worldwide.

The Congress will serve as a forum for researchers, educators, practitioners and policy makers from around the world to share new findings, explore new opportunities, strengthen partnerships and engage with communities of practice.

For more information, visit:

www.worldagroforestry.org/wca2009

## First IFOAM Conference on Organic Animal and Plant Breeding – Breeding Diversity, Santa Fe, New Mexico, USA, 25–28 August 2009

IFOAM and Seeds of Change will jointly host the Breeding Diversity conference in Santa Fe to bring together experiences and views from a wide range of perspectives on organic breeding.

The Call for Papers is out! Find the criteria for your contribution on the Download list and use the opportunity to directly submit it with the Abstract Submission Form.

**Conference Topic:** The time is right to bring together all endeavors to focus on organic breeding. Fostering the sustainable development of new successful low input breeds is urgent in the face of future challenges of food insecurity and massive threats to the livelihoods of millions of people caused by climate change. Through the conservation and promotion of Agro-Biodiversity of both animal and plant genetic resources, organic agriculture will again prove to be a viable alternative to genetically modified organisms. Both organic plant and animal breeding are therefore gaining momentum in several parts of the world. Successful organic breeding is the basis of organic production, but it is only in early phases of development.

For more details, visit:

http://www.ifoam.org/events/ifoam_conferences/2009_Animal_and_Plant_Breeding/animal_plant_breeding.html

## XXXIX$^{th}$ Annual Meeting of the European Society for New Methods in Agriculture (ESNA), Brno, Czech Republic, 25–29 August 2009

This meeting will be held at Mendel University of Agriculture and Forestry in Brno.

For more information, visit:

http://esna.czweb.org/esna09/index.html

## 23$^{rd}$ EUCARPIA Symposium – Colorful Breeding and Genetics, Leiden, the Netherlands, 31 August–4 September 2009

For more information, visit the Symposium website:

http://www.ornamentalbreeding.nl/

## International Conference on Heterosis in Plants: Genetic and Molelcular Causes and Optimal Exploitation in Breeding, University of Hohenheim, Stuttgart, Germany 7–9 September 2009

A total of 16 research groups from various Universities and Max-Planck-Institutes in Germany have participated in a special research priority program on 'Heterosis in Plants'. During the past 5 years this initiative studied the optimal exploitation of heterosis contributed to a large proportion of tremendous yield increases in many important crops during the past decades. However, despite all intensive efforts, the genetic and molecular bases of heterosis have remained largely unknown. Recent developments in molecular biology and bioinformatics allow a comprehensive analysis of the phenomenon of heterosis at various biological levels.

Sixteen research groups from several Universities and Max-Planck-Institutes in Germany have participated in a special research priority program on 'Heterosis in Plants'. Likewise did a comprehensive research project in China. During the past years, these multidisciplinary research networks studied the molecular and genetic causes of heterosis in Arabidopsis, maize and rapeseed. Together with invited speakers and world leaders of heterosis research, these research priority programs will present the latest results from heterosis research at the conference.

For more information, visit the following website:

https://www.uni-hohenheim.de/heterosis/home.htm

## International Banana Symposium: Global Perspectives on Asian Challenges, Guangzhou, China, 14–18 September 2009

ProMusa, in collaboration with the Guang Dong Academy for Agricultural Sciences (GDAAS), the International Society for Horticultural Science (ISHS) and Bioversity's Banana and Plantain Regional Network for Asia and the Pacific (BAPNET), has the pleasure to announce this Symposium.

For more information, visit the Symposium website:

http://www.promusa.org/symposium_2009/home.html

## Science and Technology Supporting Food Security in Africa, Cape Town, South Africa, 28 September–1 October 2009

The African Crop Science Society (ACSS) Conference series is held every odd year in one of the African countries. The goal of the conferences are to promote the active exchange of crop sciences information, innovation, and new ideas and usually attended by experts of the highest caliber, distinguished keynote speakers, Ministers of Irrigation, higher Education, Agriculture, Environment and eminent scientists from Africa and the four corners of the globe. The Board of the ACSS and the local organizing committee of South Africa cordially invite you to attend the next conference with the objective to promote food security in Africa.

For more information visit:

http://www.acss.ws/?t=a_conf&s=4

## Ninth International Congress on Plant Molecular Biology – Leading Biology through Plant Science, St. Louis, Missouri, USA, 25–30 October 2009

For more information, visit the Congress website:

http://www.ipmb2009.org/

## Exploiting Genome-wide Association in Oilseed Brassicas: A Model for Genetic Improvement of Major OECD Crops for Sustainable Future Farming, University of Western Australia, Perth, Australia, 9–12 November 2009

Thanks to the hard work of Professor Wallace Cowling, this conference is sponsored by the international Organization for Economics Co-operation and Development (OECD) Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems, whose financial support makes it possible for many of the invited speakers from OECD countries to participate in the conference. The key note speaker is Professor Carlos Bustamante, from Cornell University, USA, speaking on "Association mapping- from humans to Arabidopsis and rice". Over the next few months the proceedings will be finalized, so to be included in the next announcement, please sent your contact details to:

Ms. Sarah Mawson at ICPBER

Email: icpber@cyllene.uwa.edu.au

http://km.fao.org/gipb/images/pdf_files/icpber_oecd_conference2009.pdf

## Australian Postharvest Conference and Managing Quality in Chains, Napier, New Zealand, 15–19 November 2009

For more information, visit the Conference website:

www.postharvestpacifica.org.nz

## International Meeting on Resources Valorization and Biotechnological Applications in Arid and Saharan Agrosystems, Djerba, Tunisia, 15–17 December 2009

Institut des Régions Arides (IRA) organizes the third international meeting on the resources management and biotechnology applications in agriculture of the arid and Saharan regions.In order to evaluate the impact of biotechnologies, research and development programs on the arid and Saharan agrosystems, the topic chosen for this meeting is:**RESOURCES VALORIZATION AND BIOTECHNOLOGICAL APPLICATIONS IN ARID AND SAHARAN AGROSYSTEMS**

The organizing committee of the meeting is pleased to present this first announcement to invite you to join this meeting in Djerba (Tunisia) in December 2009. The conference will address key issues regarding the conservation, rehabilitation valorization and management of arid and Saharan agro-systems.

The fact that the meeting will bring together scientist and representatives of agencies and organizations actives in developments ensure that it will yield practical as well as policy relevant results

For more information, please contact:

Prof. Ali Ferchichi, Institut des Régions Arides (IRA)

Email: ferchichi.ali1@yahoo.fr

## The 28th International Horticultural Congress – IHC, Lisbon, Portugal, 22–27 August 2010

The world conference on horticultural sciences is under the patronage of the International Society for Horticultural Science (ISHS). The theme of the Congress, Science and Horticulture for People, emphasizes horticulture's scientific components and interactions with scientists, producers, consumers and society-at-large. People are also the target of horticulture for development. Lisbon is a magical city on the Atlantic coast of Portugal, with a delightfully cool-summer Mediterranean climate. The city, home of fado, fine dining and monuments, is close to major growing regions of horticultural crops in the Iberian Peninsula.

For more information visit:

http://www.ihc2010.org/content.asp?page=welcome

# Publications

## Recent Staff Articles Published in Scientific Journals

### Effects of two low phytic acid mutations on seed quality and nutritional traits in soybean (*Glycine max* L. Merr)

Yuan, F.J., Zhu, D.H., Deng, B., Fu, X.J., Dong, D.K., Zhu, S.L., Li, B.Q. and Shu, Q.Y.

J. Aric. Food Chem. 57 (9) pp 3632-3638


### Abstract

Reduction of phytic acid in soybean seeds has the potential to improve the nutritional value of soybean meal and lessen phosphorus pollution in large scale animal farming. The objective of this study was to assess the effect of two new low phytic acid (LPA) mutations on seed quality and nutritional traits. Multilocation/season comparative analyses showed that the two mutations did not affect the concentration of crude protein, any of the individual amino acids, crude oil, and individual saturated fatty acids. Among other traits, Gm-lpa-TW75-1 had consistently higher sucrose contents (+47.4−86.1%) and lower raffinose contents (−74.2 to −84.3%) than those of wild type (WT) parent Taiwan 75; Gm-lpa-ZC-2 had higher total isoflavone contents (3038.8−4305.4 μg/g) than its parent Zhechun # 3 (1583.6−2644.9 μg/g) in all environments. Further tests of homozygous $F_3$ progenies of the cross Gm-lpa-ZC-2 × Wuxing # 4 (WT variety) showed that LPA lines had a mean content of total isoflavone significantly higher than WT lines. This study demonstrated that two LPA mutant genes have no negative effects on seed quality and nutritional traits; they instead have the potential to improve a few other properties. Therefore, these two mutant genes are valuable genetic resources for breeding high quality soybean varieties.


**(2009)**

# Publications within Coordinated Research Projects (CRPs) as of 2004

### Effects of Mutagenic Agents on the DNA Sequence in Plants

Contreras Rojas M., Pérez J.C., Ceballos H., Baena D., Morante N. and Calle F. (2009) Introduction of inbreeding and analysis of inbreeding depression in eight $S_1$ cassava families. Crop Sci. 49:543-548.

Rice Starch Quality Research and Utilization. Edited by Wu D.X. and Shu X.L. China Agriculture Publishing House. May 2009.

Sánchez T., Salcedo E., Ceballos H., Dufour D., Mafla G.T., Morante N., Calle F., Pérez J.C., Debouck D., Jaramillo G. and Moreno I.X. (2009) Screening of starch quality traits in cassava (*Manihot esculenta* Crantz).Starch/Stärke 61:12-19.

van der Vyver C. (2009) Submited paper: "RDA, RAPD and SSR analysis of radiation-induced genome alterations in *Vigna unguiculata",* Annals of Botany.

Wang M., Caetano-Anollés G. (2009) The evolutionary mechanics of domain organization in proteomes and the rise of moduarity in the protein world. *Structure* 17:66-78.

Ceballos H., Sánchez T., Denyer K., Tofiño A.P., Rosero E.A., Dufour D., Smith A., Morante N., Pérez J.C. and Fahy B. (2008) Induction and identification of a small-granule, high-amylose mutant in cassava (*Manihot esculenta* Crantz). Journal of Agricultural and Food Chemistry 56(16):7215-7222.

Ceballos H., Sánchez T., Denyer K., Tofiño A.P., Rosero E.A., Dufour D., Smith A., Morante N., Pérez J.C. and Fahy B. (2008) Induction and identification of a small-granule, high-amylose mutant in cassava (*Manihot esculenta* Crantz). Journal of Agricultural and Food Chemistry 56(16): 7215-7222.

Cullis C.A., Vorster B.J., van der Vyver C. and Kunert K.J. (2008) Transfer of Genetic Material Between the Chloroplast and Nucleus: How is it Related to Stress in Plants? Annals of Botany doi: 10.1093/aob/mcn173.

Dimitrova A., Todorovska E., Christov N., Gecheff K., Stoilov L. and Atanassov A. (2008) Molecular analysis of the ionizing radiation induced genetic variability in barley. Poster presentation IAEA-CN 167-076, FAO/IAEA International. Symposium on Induced Mutations in Plants, Vienna, Austria.

Georgieva M., Manova V., Liu L. and Stoilov L. (2008) Induction of DNA damage by Li-ions and gamma rays in barley genome. Poster presentation IAEA-CN-167-075, FAO/IAEA International Symposium on Induced Mutations in Plants, Vienna, Austria.

Georgieva M. and Stoilov L. (2008) Assessment of DNA double-strand breaks produced by bleomycin in barley

genome by the comet assay, Environmental and Molecular Mutagenesis, 49, 381-387.

Guo H.J., Liu L.X., Han W.B., Zhao S.R., Li J.C., Zhao L.S. and Wang J. (2008) Mutagenic Effects of Mixed Particle Field Irradiation on Wheat. Scientia Agricultura Sinica, 41(3): 654-660.

Hu Y.L., Liu L.X., Guo H.J., Zhao L.S., Zhao, S.R. (2008) SSR analysis of dwarf mutants derived from mixed particle field irradiation in wheat. Journal of Nuclear Agricultural Sciences, 22(4): 399-403.

Janiak A., Kim M.Y., Van K. and Lee S.-H. (2008) Application of degenerate oligonucleotide primed PCR (DOP-PCR) for SNP discovery in soybean. *Euphytica*, 162:249-256.

Manova V., Georgieva M., Borisov B., Stoilova B., Gecheff K. and Stoilov L. (2008) Genomic and gene-specific induction and repair of DNA damage in barley. Invited lecture IAEA-CN-167-056 FAO/IAEA International Symposium on Induced Mutations in Plants, Vienna, Austria.

Suzuki T., Eiguchi M., Kumamaru T., Satoh H., Matsusaka H., Moriguchi K., Nagato Y. and Kurata N. (2008) MNU-induced mutantpools and high performance TILLING enable finding of any gene mutation in rice. Mol. Genet. Genomics. 279: 213-223.

Van K., Jang H.J., Jang Y.-E. and Lee S.-H. (2008) Regeneration of plants from EMS-treated immature embryo cultures in soybean [*Glycine max* (L.) Merr.]. *J Crop Sci Biotechnol*, 11:119-126.

Yang S.-R., Liu L.-X., Zhao L.-S. (2008) Current Status and Prospective of Crop Improvement for Low Phytic Acid Content, Journal of Plant Genetic Resources, 9 (2): 263-265.

Ceballos H., Fregene M., Pérez J.C., Morante N. and Calle F.(2007) Cassava Genetic Improvement, In: Breeding Major Food Staples (M.S. Kang and P.M. Priyadarshan eds.). p. 365-391, Blackwell Publishing. Ames, IA. USA.

Ceballos H., Sánchez T., Tofinño N.A.P., Rosero A., Doufor D., Smith A.M., Danyer K., Pérez J.C., Morante N., Calle F., Lentini Z., Fregene M. and Mestres C. (2007) Development and identification of cassava clones with special starch characteristics. Proceedings of the Starch Update Conference. Bangkok, Thailand. November 6-7.

Ceballos H., Sánchez T., Morante N., Fregene M., Dufour D., Smith A.M., Denyer K., Pérez J.C., Calle F. and Mestres C. (2007) Discovery of an amylose-free starch mutant in cassava (*Manihot esculenta* Crantz). Journal of Agricultural and Food Chemistry 55(18):7469-7476.

Ceballos H., Sánchez T., Morante N., Fregene M., Dufour D., Smith A.M., Denyer K., Pérez J.C., Calle F. and Mestres C. (2007) Discovery of an Amylose-free Starch mutant in cassava (*Manihot esculenta* Crantz) Journal of Agricultural and Food Chemistry 55(18): 7469-7476.

Guo H.J., Liu L.X., Han W.B., Zhao S.R., Zhao L.S., Sui L., Zhao K., Kong F.Q. and Wang J. (2007) Biological effects of high energy 7li ion beams implantation on wheat. Plant Mutation Reports, 1(3):31-35.

Jia L.M., Zhang Z.Z., Shu X.L., Li C.D. and Wu D.X. (2007) Starch Properties and Structure of A Wheat Mutant High in Resistant starch. The Open Agriculture Journal, 1, 5-10 5.

Liu L.X., Guo H.J., Zhao L.S., Zhao K., Zhao S.R., Sui L. and Kong F.Q. (2007) Bio-effects of $^{7}$Li ion beams irradiation on wheat, 2005 Annual report for Beijing National Tandem Accelerator Laboratory, Beijing: Atomic Energy Press, p104-105.

Liu L.-X., Zhao L.S. and Guo H.-J. (2007) Current status and perspective outlook of space induced mutation breeding in crop plants, Review of China Agricultural Science and Technology, 9(2)26-29.

Martin N., Ruedi E.A., LeDuc R., Sun F.-J. and Caetano-Anollees G. (2007) Gene-interleaving patterns of synteny in the Saccharomyces cerevisiae genome: are they proof of an ancient genome duplication event? Biology Direct 2: 23.

Sharma S. and Sharma R. (2007) Phototropin-1 cDNA isolation using RACE PCR amplification. *http://www.ncbi.nlm.nih.gov/entrez/viewer.fcgi?db=nuccore&id=151176132*

Sharma S., Tyagi A. and Sharma R. (2007) Phototropin-2 full length cDNA isolation by screening a tomato cDNA library and RACE PCR amplification. *http://www.ncbi.nlm.nih.gov/entrez/viewer.fcgi?db=nuccore&id=154000864*

Shu X.L., Jia L.M., Gao J.K., Zhao H.J., Wu D.X. (2007) Metabolite profiling of rice high in resistant starch. Journal of Agricultural and Food Chemistry, Accepted.

Shu X.L., Gao J.K., Jia L.M., Song Y.L., Wu D.X. (2007) The influence of chain length of amylopectin on resistant starch in rice (*Oryza sativa* L.). Starch, Accepted.

Shu X.L., Gao J.K., Jia L.M., Song Y.L. and Wu D.X. (2007) The influence of chain length of amylopectin on resistant starch in rice (*Oryza sativa* L.). Starch, 59(9):504-509.

Sun F.-J., Fleurdepine S., Bousquet-Antonelli C., Caetano-Anollés G. and Deragon J.-M. (2007) Common evolutionary trends for tRNAderived SINE RNA structures. Trends in Genetics 23: 26-33.

Van K., Kim M.Y. and Lee S.-H. (2007) Genomics of root nodulation in soybean. In *Genomics Assisted Crop Improvement, Vol 2. Genomics Applications in Crops* Edited by: Varshney RK, Tuberosa R. Springer, 425-442.

Wang M., Yafremava L.S., Caetano-Anollés D., Mittenthal J.E. and Caetano-Anollés G. (2007) Reductive evolution of architectural repertoires in proteomes and the birth of the tripartite world. *Genome Res* 17:1572-1585.

Xin Q.-G., Liu L.-X., Guo H.-J., Zhao L.-S., Yu Y.-J., Zhao K., Sui L., Kong F.-Q. and Zhao S.-R. (2007) SSR Analysis of $M_1$ generation variation of dry seeds implanted by $^{7}Li$ ion beam in wheat, Journal of Triticeae Crops, 27 (4): 560-564.

Ceballos H., Fregene M., Lentini Z., Sánchez T., Puentes Y.I., Pérez J.C., Rosero A. and Tofiño A.P. (2006) Development and Identification of High-Value Cassava Clones. Acta Horticulturae 703:63-70.

Functional Rice Research and Utilization. Edited by Wu D.X. (2006) China Metrology Publishing House. August 2006.

Gecheff K.I. (2006) Inversion-derived cytological marking of the chromosome complement of barley (*Hordeum vulgare* L.). Genetics and Breeding, 35, 19-24.

Han W.B., Liu L.X., Guo H.J., Zhao L.S., Li J.C., Zhang S.P., Wang C.S. and Zhao S.R. (2006) SSR analysis on M1 variation of wheat irradiated by mixed high energy particle field. Acta Agriculture Nucleatae Sinica, 20: 165-168.

Kavitha M., Bauer P., Sharada M.S., Al-Hammadi A.S. and Sharma R. (2006) Genetic characterization of the *polycotyledon* locus in tomato. *Theoretical and Applied Genetics* 113: 673-683.

Kwasniewski M. and Szarejko I. (2006) Molecular cloning and characterization of β-expansin gene related to root hair initiation in barley. Plant Physiol. 141: 1149-1158.

Manova V., Gecheff K.and Stoilov L. (2006) Efficient repair of bleomycin-induced double-strand breaks in barley ribosomal genes, Mutation Research, 601, 179-190.

Shu X.L., Jiao G.A., Fitzgerald M., Yang C.Z., Shu Q.Y., Wu D.X. (2006) Starch structure and digestibility of rice high in resistant starch. Starch, 58(8): 411-417

Stoilova T.S., Dimitrova A., Angelova T.S. and Gecheff K. (2006) Assessment of the genetic diversity in barley mutant lines using biochemical markers. Genetics and Breeding, 35, 3-10.

Wang M. and Caetano-Anollés G. (2006) Global phylogeny determined by the combination of protein domains in proteomes. *Mol Biol Evol* 23:2444-2454.

Wu W., Liu X., Shu X.L. and Wu D.X. (2006) Progress in the study of resistant starch and functional rice for prevention of diabetes and hyperlipidemia. Journal of Nuclear Agricultural Science, 20(1):60-63.

Yang C.Z., Shu X.L., Zhang L.L., Wang X.Y., Zhao H.J., Ma C.X., Wu D.X. (2006) Starch properties of mutant rice high in resistant Starch. Journal of Agricultural and Food Chemistry 54(2): 523-528

Yang C.Z., Shu X.L., Zhang L.L., Wang X.Y., Zhao H.J., MA C.X. and Wu D.X. (2006) Starch properties of mutant rice high in resistant Starch. Journal of Agricultural and Food Chemistry, 54(2): 523-528.

Zuo X.X., Zheng T., Shu X.L., Shu Q.Y. and Wu D.X. (2006) Advances in screening and characterization study of rice endosperm mutants. Journal of Nuclear Agricultural Science, 20(2):118-122.

Caetano-Anollés G. (2005) Genome size evolution in the grasses. Crop Science 45:1809-1816.

Caetano-Anollés G. (2005) Grass evolution inferred from chromosomal rearrangements and geometrical and statistical features in RNA structure. Journal of Molecular Evolution 60:635-652.

Cai C.M., Van K., Kim M.Y. and Lee S.-H. (2005) Optimization of SNP genotyping assay with fluorescence polarization detection. *Kor J Crop Sci*, 50:361-367.

Galvez H.F., Narciso J.O., Opina N.L., Canama A.O., Colle M.G., Tongson E.J.U., Latiza M.A., Caspillo C.L., Bituin J.L., Tiongco R.L., Frankie R.B. and Hautea D.M. (2005) Towards allele mining of bacterial wilt disease resistance gene in tomato. The Philippine Journal of Crop Science vol. 30 supplement no. 1, pp.65.

Guo H.J., Liu L.X. and Zhao S.R. *et al.* (2005) Biological effects of 43MeV 7Li ion beam implantation in wheat Paper Abstracts Collections of National Workshop on Crop Biotechnology and Mutation Techniques, 7-9 November 2005, Fujian Prov. p163.

Guo H.J., Liu L.X. and Zhao L.S. (2005) DNA damages induced by mixed particle field irradiation. Paper Abstracts Collections of National Workshop on Crop Biotechnology and Mutation Techniques, 7-9 November 2005, Fujian Prov. p198.

Kim M.Y., Van K., Lestari P., Moon J.-K. and Lee S.-H. (2005) SNP identification and SNAP marker development for a *GmNARK* gene controlling supernodulation in soybean. *Theor Appl Genet*, 110:1003-1010.

Guo H.J., Liu L.X. and Han W.B. *et al.* (2005) Biological effects of mixed particle field irradiation in wheat Paper Abstracts Collections of National Workshop on Crop Biotechnology and Mutation Techniques, Nov 7-9, 2005, Fujian Prov. p196.

Liu L.X., Zhao L.S. and Guo H.J. *et al.* (2005) Study on mutagenic effects of mixed particle field irradiation in winter wheat. Science Technology and Engineering, 22:1641-1644.

Liu L.X., Han W.B. and Guo H.J. *et al.* (2005) Cytological effects of mixed particle field irradiation in wheat. Acta Agriculturae Nucleatae Sinica, 19(5):1-5.

Manova V. and Stoilov L. (2005) Repair of DNA double-strand breaks in eukaryotic genome. Genetics and Breeding, 34, 39-61.

Manova V., Gecheff K. and Stoilov L. (2005) Induction and repair of bleomycin-induced DNA damage in barley genome- Abstract, Keystone Symposia "Genome Instability and Repair (C2)", Sagebrush Inn and Conference Center, New Mexico, USA.

Sánchez T., Chávez A.L., Ceballos H., Rodriguez-Amaya D.B., Nestel P. and Ishitami M. (2005) Reduction or delay of post-harvest physiological deterioration in cassava roots with higher carotenoid content. Journal of the Science of Food and Agriculture 86(4): 634-639.

Zhao L.S., Liu L.X. and Guo H.J. *et al.* (2005) Production of mutants with high inorganic phosphorus content in seeds by germplasm reselection and mutation techniques in wheat. Paper Abstracts Collections of National Workshop on Crop Biotechnology and Mutation Techniques, 7-9 November 2005, Fujian Prov. p130.

Caldwell D.G, McCallum N, Shaw P, Muehlbauer J.G, Marshall D.F and Waugh R. (2004) A structured mutant population for forward and reverse genetics in Barley (*Hordeum vulgare* L.) The Plant Journal vol: 40, 143-150.

Dimitrova A., Stoilov L. and Gecheff K. (2004) Loop organization of ribosomal DNA in barley. Compt. Rend. Acad. Bulg. Sci., 57, 57-60.

Liu L.X., Wang J. and Zhao L.S. *et al.* (2004) Research progress in mutational effects of aerospace on crop and ground simulation on aerospace environment factors, Acta Agriculturae Nucleatae Sinica, 18(4):247-251.

van der Vyver C., Kunert K.J. and Cullis C. (2004) Detection and characterization of a labile DNA region in the tobacco genome using representational difference analysis. Annals of Botany.

Van K., Hwang E.-Y., Kim M.Y., Kim Y.-H., Cho Y.I., Cregan P.B. and Lee S.-H. (2004) Discovery of single nucleotide polymorphisms in soybean using primers designed from ESTs. *Euphytica*, 139:147-157.

**In press:**

Dimitrova A., Todorovska E., Christov N., Stoilov L., Atanassov A. and Gechef K.. Molecular characterization of ionizing radiation-induced mutational alterations in barley. Genetics and Breeding.

Gecheff K., Manova V., Bonchev G., Kitanova M., Vlahova M. and Stoilov L. Position-specific effects in the action of mutagenic agents on the chromosomes of barley (*Hordeum vulgare* L.) Genetics and Breeding.

Sanchez, T., A. Rosero, A.P. Tofiño, K. Denyer, A. Smith, H. Ceballlos, N. Morante, and J.C. Pérez. (2009). Induction and identification of useful mutations for root quality traits in cassava. FAO/IAEA International Symposium on Induced Mutations in Plants. 12-15 August, Vienna, Austria.

**Under review:**

Kharshiing E., Sharma S., Srinivas A., Zikihara K., Tokutomi S., Behera R.K., Bodanapu B. and Sharma R. (2009) A Dominant Mutation in the *PHOTOTROPIN1* Homologue of Tomato impairs Phototropin 1 and Phototropin 2 Signaling. *Plant Journal.*

**In preparation:**

Kharshiing E., Pavan Kumar G., Ditengou F.A., Li X., Palme K. and Sharma R. (2009) The *polycotyledon* (*pct1-2*) mutant of tomato shows enhanced accumulation of PIN1-like auxin transport facilitator protein. *Plant Cell Physiol.*

Todorovska E., Dimitrova A., Stoilov L., Christov N., Vassilev D. and Gecheff K. Molecular variability in barley structural mutants produced by gamma-rays. Manuscript.

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

Tomlekova N., Grozeva S. and Rodeva V. (2006) AFLP polymorphism in tomato after gamma-rays callus mutagenesis. Ecology and Future, 3: 30-34.

Tomlekova N., Atanassova B., Marinova D., Baralieva D. and Ribarova F. (2006) Study on the Variability of Lycopene and ß-carotene Content in Tomato (*Lycopersicon esculentum* Mill.). Acta Horticulturae.

Tomlekova N., Todorova V. and Daskalov S. (2006) Creating variation in pepper (*Capsicum annuum* L.) through induced mutagenesis, Plant Science.

Tomlekova N., Todorova V., Daskalov S. and Denev I. (2006) Biochemical evaluation of increased beta-carotene levels in pepper mutants. Proceedings of 3rd Central European Congress on Food, 22-24 May 2006, Sofia, Bulgaria.

Tomlekova N. (2006) Molecular characterization of interspecific tomato (Lycopersicon) hybrids. Proceedings of 3rd Central European Congress on Food, 22-24 May 2006, Sofia, Bulgaria.

Tomlekova N. (2006) Development of molecular markers for F1 tomato hybrids. Ecology and Future, 4.

Hasterok R., Wolny E., Hosiawa M., Kowalczyk M. Kulak-Ksiazczyk S., Ksiaczyk T., Heneen W. and Maluszynska J. (2006) Comparative Analysis of rDNA Distribution in Chromosomes of Various Species of Brassicaceae. Annals of Botany 97: 205-216.

Scaldaferro M.A., Seijo J.G., Acosta M.C., Barboza G.E., Ducasse D.A., and Moscone E.A. (2006) Genomic characterization of the germplasm in peppers (*Capsicum* - *Solanaceae*) by fluorescent in situ hybridization. - Plant Science 43 (4): 291-297.

## Identification and Pyramiding of Genes Contributing to Crop Quality Characters and Quality-Affecting Tolerance


Badigannavar A.M. (2008) Genetic diversity among the gamma ray induced mutants of groundnut, *Arachis hypogaea* cultivar, TAG 24. J. Oilseeds Res. 25: 13-18.

Badigannavar A.M. and Mondal S. (2008) Integration of mutation with recombination breeding for genetic improvement of cultivated groundnut (*Arachis hypogaea* L.). Abstract. Third International Conference of the Peanut Research Community on Advances in *Arachis* through Genomics and Biotechnology (AAGB-2008). 4-8 November 2008 ICRISAT, Hyderabad, India. Pp: 5.

Bao J.S., Xie J.K., Hu B.L. (2008) Isolation and characterization of mutants from *indica* rice 93-11 and Guanluai (*Oryza sativa* L.) induced by gamma irradiation. In: Abstracts of FAO/IAEA International Symposium on Induced Mutations in Plants, 12-15 August 2008, Vienna, Austria, P19.

Bao J.S. (2008) Unlocking naturally occurring variation fro starch quality by gene-tagged markers in rice. In: Abstracts of FAO/IAEA International Symposium on Induced Mutations in Plants, 12-15 August 2008, Vienna, Austria, P196.

Bao J.S., Jin L., Xiao P., Sun M., Corke H. (2008) Starch physicochemical properties and their associations with microsatellite alleles of starch-synthesizing genes in a rice RIL population. Journal of Agricultural and Food Chemistry, 56 (5): 1589-1594

Boonsirichai K., Phadvibulya V., Adthalungrong A., Srithongchai W. and Puripunyavanich V. (2008) Genetics of the Radiation-Induced Yellow Vein Mosaic Disease Resistance Mutation in Okra. FAO/IAEA International Symposium on Induced Mutations in Plants. 12-15 August2008. Vienna, Austria. p. 149.

Phadvibulya V., Boonsirichai K., Adthalungrong A. and Srithongchai W. (2008) Selection for Resistance to Yellow Vein Mosaic Virus Disease of Okra by Induced Mutation. FAO/IAEA International Symposium on Induced Mutations in Plants. 12-15 August 2008. Vienna, Austria. p. 148.

Boonsirichai K. and Phadvibulya V. (2008) Development of DNA markers for the yellow vein mosaic disease resistance in okra. TINT Magazine 4: 7-10 (in Thai).

Mondal S., Sutar S.R. and Badigannavar A.M. (2008) Comparison of RAPD and ISSR marker profiles of cultivated peanut genotypes susceptible or resistant to foliar diseases. J. Food Agric. Environ. 6(2): 181-187.

Mondal S., Badigannavar A.M. and D'Souza S.F. (2008) Mutational origin of genetic diversity in cultivated groundnut (*Arachis hypogaea* L.). Abstract. International Symposium on Induced Mutations in Plants. 12-15 August 2008 IAEA, Vienna, Austria. Pp: 22.

Mondal S. and Badigannavar A.M. (2008) Identification of SSR marker for resistance to late leaf spot in cultivated groundnut (*Arachis hypogaea* L.). Abstract. 5th International Crop Science Congress (ICSC), April 13-18, 2008, Jeju, Republic of Korea. Pp: 266.

Badigannavar A.M. and Mondal S. (2007) Mutation experiments and recent accomplishments in Trombay groundnuts. IANCAS Bulletin Vol. VI (4): 308-318.

Badigannavar A.M. (2007) Inheritance of flower colour mutant in groundnut. Indian J Genet. 67 (3): 266-267.

Lacape J.-M., Dessauw D., Rajab M., Noyer J.L. and Hau B. (2007) Microsatellite diversity in tetraploid Gossypium gene pool: assembling a highly informative genotyping set of cotton SSRs. Molecular breeding, 19:45-58

Lancon J., Pichaut J.-P., Djaboutou M., Lewicki S.D., Viot C. and Lacape J.-M. (2007) Use of molecular markers in participatory plant breeding: assessing the genetic variability in cotton populations bred by farmers. Annals of Applied Biology, 152:113-119

Mondal S., Badigannavar A.M., Kale D.M. and Murty G.S.S. (2007) An induced dominant seed coat colour mutation in groundnut. Indian J Genet. 67 (2): 177-179.

Li C.D., Lance R., Tarr A., Harasymow S., Gupta S., Cakir M., Jones M.G.K., and Appels R. (2006) Marker assisted breeding in barley: the winners and the losers. 13th Australian Plant Breeding Conference, New Zealand.

Guo R.X., Sun D.F., Tan Z.B., Rong D.F. and Li C.D. (2006) Two Recessive Genes Controlling Thermo-photoperiod Sensitive Male Sterility in Wheat. Theoretical & Applied Genetics, 112: 1271-1276.

Guo R.X., Sun D.F., Tan Z.B., Rong D.F. and Li C.D. (2006) Inheritance of Thermo-photoperiod Sensitive Male Sterility in Wheat. Australian Journal of Agricultural Research, 57:187-192.

Gill R, Li C., Appels R., Falk D. and Lance R. (2006) Mapping and development of a marker system for use in male sterile facilitated recurrent selection in Barley (*Hordeum vulgare*). 13th Australian Plant Breeding Conference, pp 164, Christchurch, April 2006, New Zealand.

Li C., Lance R., Tarr A., Harasymow S., Gupta S., Cakir M., Jones M.G.K. and Appels R. (2006) Marker assisted breeding in barley: the winners and the losers. 13th Australian Plant Breeding Conference, Christchurch, April 2006, New Zealand.

Kim, H.S., Suh S.J., Baek S.B., Kim J.G., Kim D.H., and Kim S.J. (2005) Molecular mapping of barley yellow mosaic virus disease resistance. Korean J. of Crop Science. Vol. 50. Suppl. 1.: 198-199. (Abstract).

Manasievska-Simic S., Angelov I., Ivanovska S., Gjorgovski I., Simeonova E., Ivanovski M. and Jankulovska M. (2006) Relationship between HMW glutenin subunits

and 1B/1R translocation in wheat cultivars. Cereal Research Communications.

Manasievska-Simic S., Angelov I., Ivanovska S., Simeonova E., Ivanovski M. and Jankulovska M. (2006) Quality of Macedonian Soft Wheat Cultivars I. HMW Composition. XI Symposium on Biotechnology. Proceedings. 285-291. Vol. 11. (11-12), Book I. Cacak, 3-4 March.

Simeonovska E. Application of wheat induced mutations and selection of mutant lines in M2 and M3 generation on the basis of quality and productive features. Doctoral Thesis.

Shen X., Zhang T., Guo W., Zhu X. and Zhang X. (2006) Mapping QTLs with main effects, epistatic effects and QTL × environment interaction for fiber and yield traits in RILs of Upland cotton. Crop Sci. 46: 61-66.

Shen X., Guo W., Zhu X., Yuan Y. and Zhang T. (2007) Genetic Mapping of Quantitative Trait Loci for Fiber Quality and Yield Trait by RIL Approach in Upland Cotton. Euphytica, DOI 10.1007/s10681-006-9338-6.

Bao J. *et al.* (2006) Analysis of genotypic diversity in the starch physicochemical properties of nonwaxy rice: Apparent amylose content, pasting viscosity, and gel texture. Starch: 58:259-267.

Bao J.S., Corke H. and Sun M. (2006) Microsatellites, single nucleotide polymorphisms and a sequence tagged site in starch-synthesizing genes in relation to starch physicochemical properties in nonwaxy rice (*Oryza sativa* L.). Theor Appl Genet, 113, 1185-1196.

Bao J.S., Corke H. and Sun M. (2006) Nucleotide diversity in starch synthase IIa and validation of single nucleotide polymorphisms in relation to starch gelatinization temperature and other physicochemical properties in rice (*Oryza sativa* L.).Theor Appl Genet, 113, 1171-1183.

Toyota, K., *et al.* (2006) Expression profiling of starch metabolism-related plastidic translocator genes in rice. Planta 223: 248-257.

Toyota K., Tamura M., Ohdan T. and Nakamura Y. (2006) Expression profiling of starch metabolism-related plastidic translocator genes in rice. Planta 223: 248-257.

Fujita N., Yoshida M., Asakura N., Ohdan T., Miyao A., Hirochika H. and Nakamura Y. (2006) Function and characterization of starch synthase I using mutants in rice. Plant Physiol. 140: 1-15.

Boonsirichai K., Puripunyavanich V., Phadvibulya V., Adthalungrong A. and Srithongchai W. (2006) Comparison between the DNA fingerprints obtained from the yellow vein mosaic disease tolerant Okra mutants and their parental variety. 44th Kasetsart University Annual Conference, 30 January - 2 February 2006, Bangkok, Thailand. Book 1, pp: 547-555.

Mondal S., Badigannavar, A.M., Kale, D.M. and Murty, G.S.S. (2006) Induction of genetic variability in a disease resistant groundnut breeding line. 2nd National Plant Breeding Congress, March 1-3 2006, Tamil Nadu Agricultural University, Coimbatore, India (Abs.) pp: 83-84. (Best Poster Award).

Mondal S., Sutar S.R., Badigannavar A.M. and Murty G.S.S. (2006) Genetic diversity in cultivated groundnut revealed by Inter Simple Sequence Repeat markers. Abstract. BARC Golden Jubilee and DAE-BRNS Life Sciences Symposium 2006 (LSS - 2006) on Trends in Research and Technologies in Agriculture and Food Sciences, December 18-20 2006, BARC, Mumbai. pp: 93.

Blenda A., Scheffler J., Scheffler B., Palmer M.B., Lacape J.-M., Yu J., Jesudurai C., Jung S., Muthukumar S., Yellambalase P., Ficklin S., Staton M., Echelman R., Ulloa M., Saha S., Burr B., Liu S., Zhang T., Fang D., Pepper A.E., Kumpatla S.P., Jacobs J., Tomkins J.P., Cantrell R.G. and Main D. (2006) CMD: A cotton microstallite database resource for Gossypium genomics. BMC Genomics, 7:132.

## Identification and pyramiding of mutated genes: novel approaches for improving crop tolerance to salinity and drought

Ozbas M.O. and Cagirgan M.I. (2006) Variation in morpho-physiological traits in barley genotypes selected by carbon isotope discrimination for a high and low water use efficiency. *Gene-Plant-Crop Relations; Scale and Complexity in Plant Systems Research*, Wageningen, Netherlands, 23-26 April 2006.

Gadjev I., Vanderauwera S., Gechev T.S., Laloi C., Minkov I.N., Shulaev V., Apel K., Inzé D., Mittler R. and Van Breusegem F. (2006) Transcriptomic footprints disclose specificity of reactive oxygen species signaling in *Arabidopsis*. Plant Physiology (accepted).

Brini F., Hanin M., Lumbreras V., Irar S., Pagès M., and Masmoudi K. (2006) Functional Characterization of DHN-5, a dehydrin showing a differential phosphorylation pattern in two Tunisian durum wheat (*Triticum durum* Desf.) varieties with marked differences in salt and drought tolerance *Plant Science* 172: 20-28.

Brini F., Hanin M., Mezghani I., Berkowitz G.A. and Masmoudi K. Overexpression of wheat Na+/H+ antiporter *TNX1* and H+-pyrophosphatatase *TVP1* improve salt and drought stress tolerance in *Arabidopsis thaliana* plant.

Pareek A., Singh A., Kumar M., Kushwaha H.R., Lynn A.M. and Singla-Pareek S.L. (2006) Whole-Genome Analysis of *Oryza sativa* Reveals Similar Architecture of Two-Component Signaling Machinery with Arabidopsis. Plant Physiology 142:380-397.

Moustafa R.A.K. and EL-Gendy R.W. (2006) Breeding for drought tolerance in barley following hybridization between a high yielding mutant line and local varieties.

Eighth Arab Conference on the Peaceful Uses of Atomic Energy. Amman, 3-7 December 2006.

## Molecular characterization of mutated genes controlling important traits for seed crop improvement

Carneiro N.P., Guimarães C.T., Lana U.G.P., Lana J.G.P. and Paiva E. (2004) Characterization of genes expressed in the maize endosperm Indian Bol II mutant. XXV Brasilian Nacional Congress of Maize and Sorghum - CD ROM.

Spetsov P., Ruseva T.S., Belchev I., Daskalova N. (2004) Development and investigation of initial breeding material obtained by crossing common wheat *T. aestivum* with Aegilops species. II. Biological characterization of amphiploids, Res. Commun. of USB, branch Dobrich, vol.6 (1): 20-28 [www.geocities.com/fcr-abstracts/2004-Sp.htm].

Spetsov P., Hsam S.L.K., Zeller F.J. and Daskalova N. (2004) Increased resistance to powdery mildew and leaf rust in *Triticum aestivum* x *Aegilops variabilis* cross by gamma irradiation (submitted to Field Crops Research).

Oh C.S., Choi Y.H., Lee S.J., Yoon D.B., Moon H.P., Ahn S.N. (2004) Mapping of quantitative trait loci for cold tolerance in weedy rice. Breeding Sci. 54: 373-380.

Oh C.S., Lee S.J., Yoon D.B., Suh J.P., Ahn S.N. (2004) QTLs for domestication-related and agronomic traits in temperate Japonica weedy rice. Korean Journal Breeding 36: 20-30.

Kim M.Y., Van K., Lestari P., Moon J.-K. and Lee S.-H. (2005) SNP identification and SNAP marker development for a GmNARK gene controlling supernodulation in soybean. Theor. Appl. Genet. (in press, online published).

Van K., Kim K.-S., Ha B-K, Jun T.-H., Jang H.-J., Kim M.Y. and Lee S.-H. (2005) Molecular marker characterization of a supernodulating soybean mutant SS2-2. Korean J. Breeding.

Rutger J.N., Raboy V., Moldenhauer K.A.K., Bryant R.J., Lee F.N. and Gibbons J.W. (2004) Registration of KBNT lpa 1-1 low phytic acid germplasm of rice. Crop Sci. 44: 363.

Rutger J.N. and Bryant R.J. (2004) Registration of aromatic se rice germplasm. Crop Sci. 44: 363-364.

Rutger J.N., Moldenhauer K.A.K., Gravois K.A., Lee R.N., Bryant R.J. (2004) Registration of six semidwarf mutants of rice. Crop Sci. 44: 364-366.

Rutger J.N., Moldenhauer K.A.K., Gravois K.A., Lee F.N., Norman R.J. and Bryant R.J. (2004) Registration of five induced semidwarf mutants of rice. Crop Sci. 44: 1496-1497.

Rutger, J.N., Moldenhauer K.A.K., Gibbons J.W., Anders M.M. and Bryant R.J. (2004) Registration of LGRU ef early flowering mutant of rice. Crop Sci. 44: 1498.

Rutger J.N., Bryant R.J., Moldenhauer K.A.K. and Gibbons J.W. (2004) Registration of goldhull low phytic acid (GLPA) germplasm of rice. Crop Sci. 44: 1497-1498.

Eizenga G.C., Lee F.N., Jia Y. (2004) Identification of blast resistance genes in wild relatives of rice (*Oryza* spp.) and newly introduced rice (*O. sativa*) lines. p. 29-36. In R.J. Norman. J.F. Meullenet and K.A.K. Moldenhauer (eds.), B.R. Wells rice research studies 2003. Univ. Arkansas, Agric. Exp. Stn. Res. Series 517.

Kumar A., Jain A., Sahu R.K., Shrivastava M.N., Nair S., Mohan M. (2005) Genetic analysis of resistance genes for the rice gall midge in two rice genotypes. Crop Sci.

Jain A., Ariyadasa R., Kumar A., Srivastava M.N., Mohan M., Nair S. (2004) Tagging and mapping of a rice gall midge resistance gene, Gm8, and development of SCARs for use in marker-aided-selection (MAS) and gene pyramiding. Theor Appl Genet 109:1377-1384.

Rajyashri K.R. and Mohan M. (2004) Gene pyramiding: A transgenic approach to enhancing resistance durability in plants. In Transgenic Crop Protection: Concepts and Strategies, O. Koul and G.S. Dhaliwal (eds.) pp. 219-260 Science Publishers Inc., Enfield, USA.

Coimbra J.L.M., Carvalho F.I.F. de, Oliveira A. Costa de, Silva J.A.G., Lorencetti, C. (2005) Comparison between chemical and physical mutagens in oat populations.Ciência Rural, Santa Maria -RS, v. 35, n. 1. In Portuguese with English abstract.

Silva J.A.G., Carvalho Fernando I.F. de, Oliveira A. Costa de, Marchioro V.S., Lorencetti C., Benin G., Schmidt D., Hartwig I. (2004) Correlations and path analysis to identify characters associated to plant stature and aluminum tolerance in double-haploid wheat under hydroponics. Revista Brasileira de Agrociência, Pelotas, v. 10, n. 4, p. 419-425. In Portuguese with English abstract.

Coimbra J.L.M., Carvalho F.I.F. de, Oliveira A. Costa de, Chocorosqui V., Guidolin A.F. (2004) Criation of genetic variability for the character vegetative cycle in oat: artificial hybridization versus induced mutation. Revista Brasileira de Agrociência, Pelotas, v. 10, n. 2, p. 159-166. In Portuguese with English abstract.

Coimbra J.L.M., Carvalho F.I.F. de, Oliveira A. Costa de, Guidolin A.F. (2004) Criation of genetic variability for the character plant stature in oat: artificial hybridization versus induced mutation Revista Brasileira de Agrociência, Pelotas, v.10, n.3, p. 273-280. In Portuguese with English abstract.

Vieira E.A., Castro C.M., Oliveira, A. Costa de, Carvalho, F.I.F. de, Zimmer P.D., Martins L.F. (2004) Genetic structure of annual ryegrass (*Lolium multiflorum*) populations estimated by RAPD. Scientia Agricola, Piracicaba, v. 61, n. 4, p 407-413.

Coimbra J.L.M., Carvalho F.I.F. de, Oliveira A. Costa de (2004) Genetic variability in populations of oat induced by chemical and physical mutagenic agents. Crop Breeding and Applied Biotechnology, Viçosa, v. 4.

Lannes S.D., Zimmer, P.D., Oliveira, A. Costa De; Carvalho, F.I.F. de, Vieira E.A., Magalhães Jr. A., Kopp M.M., Freitas F.A. de. (2004) *In vitro* regeneration of rice anthers of irrigated rice (*Oryza sativa* L.) and mapping of associated QTL. Ciência Rural, Santa Maria, v. 34, n. 5, p. 1355-1362. In Portuguese with English abstract.

Silva J.A.G., Carvalho F.I.F. de, Oliveira A. Costa de, Silva S.A., Marchioro V.S., Lorencetti C., Benin G., Schmidt D., Hartwig I. (2004) Doublé-haploid wheat with potential for aluminum tolerance and sensitivity to gibberellic acid in hydroponic culture. Revista Brasileira de Agrociência, Pelotas, v. 10, n. 1. In Portuguese with English abstract.

Coimbra J.L.M., Carvalho F.I.F. de, Oliveira A. Costa de. (2004) Use of induced mutation and artificial crosses for increasing genetici variability for the character vegetative cycle in oats. Revista Científica Rural, Bagé - RS. In Portuguese with English abstract.

## Mutational analysis of root characters in annual food plants related to plant performance

Martínez A.E., Franzone P.M., Aguinaga A., Polenta G., Murray R., Prina A.R. (2004) Nuclear gene controlling seminal root growth response to hydroponic cultivation in barley. Environmental and Experimental Botany 51(2): 133-144.

Forster B.P., Ellis R.P., Moir J., Talamè V., Sanguineti M.C., Tuberosa R., This D., Teulat-Merah B., Ahmed I., Mariy S.A.E.E., Bahri H., El Ouahabi M., Zoumarou-Wallis N., El-Fellah M. and Ben Salem M. (2004) Genotype and phenotype associations with drought in barley tested in North Africa. Annals of applied Biology 144: 157-168.

Ozbas M.O. and Cagirgan M.I. 2004. Variability and Interrelationships for Root Traits in a Subset of Induced Barley Mutant Collection. Cereal Res. Commun. 32(1):119-126.

Çagirgan M.I., Özbas M.O., Heng L. and Afza R. (2005) Genotypic Variability for Carbon Isotope Discrimination in the Mutant and Improved Lines of Barley. Isotopes in Environment and Health Studies.

Jackson L.E. (2005) Soil biology: root architecture and growth. Encyclopedia of Soils in the Environment. Elsevier Ltd. Pp. 411-421.

Martínez A., Landau A., García P.T., Polenta G., Arias M.C., Murray R., Pensel N. and Prina A.R. (2005) Two Mutants Affecting Adaptative Responses to Abiotic Stresses in Barley Seedlings. Czech J. Genet. Plant Breed. 41 (1): 1-10.

Cabrera Lejardi M., Gutiérrez L., Pérez C., Lago E., Pérez M., Mendoza M.J., Díaz M. and Marrero S. (2004) Caracterización fisiológica de radiomutantes de trigo. En: Taller Fisiología Vegetal y Bioquímica. Congreso Científico del INCA (14: 2004, Nov. 9-12, La Habana). Memoria CD-ROM, ISBN 959-7023-27-X.

Gutierrez L., Cabrera Lejardi M. y colaboradores (2004) Algunas consideraciones para el cultivo del trigo en Cuba. En: Taller Alternativas para la producción Agrícola. Congreso Científico del INCA (14: 2004, Nov 9-12, La Habana). Memoria CD-ROM, ISBN 959-7023-27-X.

Cabrera Lejardi M., Gutiérrez L, Pérez C. Lago E., Pérez M., Mendoza M.J., Díaz M. and Marrero S. (2004) Tolerancia de radiomutantes de trigo a la sequía y salinidad. En: Convención Trópico (2004, Abril 4-8, La Habana). Memoria CD-ROM, ISBN 959-7167-02-6.

Gutierrez L., Cabrera Lejardi M. y colaboradores (2004) El cultivo del trigo en Cuba, un siglo de trabajos. En: Convención Trópico (2004, Abril 4-8, La Habana). Memoria CD-ROM, ISBN 959-7167-02-6.

# List of Plant Breeding and Genetics Section's Publications

## Plant Mutation Reports

| Year | Edition | Contents (a sampling of the papers are listed below): | Reference No. |
|---|---|---|---|
| 2007 | Vol. 1, No. 3 | • Mutation breeding and genetics in Korea<br>• Genetic enhancement of groundnut<br>• Virus resistant banana<br>• Ion beams implantation on wheat<br>• Trombay mutant groundnut varieties<br>• Lodging tolerant rice variety | ISSN 1011-260X |
| 2006 | Vol. 1, No. 2 | • 30 years rice mutation breeding and genetics<br>• Mutant groundnut varieties in Bangladesh<br>• Shortening durum wheat plants<br>• Seedless mutant sweet orange<br>• Colorful chrysanthemum mutations<br>• Radiosensitivity of cassava *in vitro* culture | ISSN 1011-4289 |
| 2006 | Vol. 1, No. 1 | • Rice mutation breeding in China<br>• Long grain aromatic rices and induced mutations<br>• Significant contribution of mutation techniques to rice breeding in Indonesia<br>• Use of induced mutants in rice breeding in Japan<br>• Katy deletion mutant populations<br>• Rice mutation breeding in Vietnam | ISSN 1011-260X |

## Mutation Breeding Newsletter and Reviews

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| 2005 | No. 1 | • High yielding mutants in cotton<br>• Drought resistant tomato<br>• Groundnut resistant to foliar diseases<br>• Lodging resistant glutinous rice<br>• First ever oilseed mustard mutant | ISSN 1011-260X |

## Mutation Breeding Review (published until 2004)

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|---|---|---|---|
| 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 |

| Year | Edition | Title | Reference No. |
|---|---|---|---|
| 1999 | No. 11 | Oilseed cultivars developed from induced mutations and mutations altering fatty acid composition | ISSN 1011-2618 |

## Mutation Breeding Newsletter (published until 2003)

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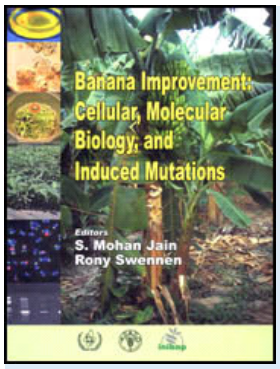
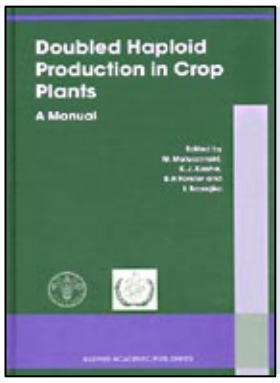
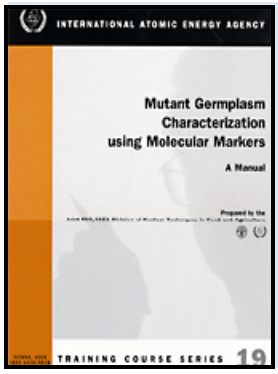
| 2004 | | Banana Improvement: Cellular, Molecular Biology, and Induced Mutations |  | ISBN 1-57808-340-0 |
| 2003 | | Doubled Haploid Production in Crop Plants – A Manual |  | ISBN 1-4020-1544-5 |
| 2002 | Training Course Series No. 19 | Mutant Germplasm Characterization using Molecular Markers – A Manual |  | ISSN 1018-5518 |

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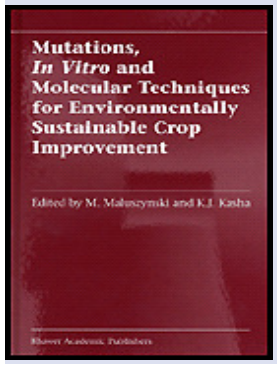
| 2002 | | Mutations, *In Vitro* and Molecular Techniques for Environmentally Sustainable Crop Improvement |   | ISBN 1-4020-0602-0 |

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Welcome to our new FAO/IAEA Database of Mutant Varieties and Genetic Stocks! At the moment, we just completed construction of the part for Mutant Variety Database, which is still in the process of information updating. We will add the other part for Mutant Genetic Stocks in due time. The new database has improved over the FAO/IAEA Mutant Variety Database in many ways. We are working to make the new database as the global information source of mutant varieties and mutant genetic stocks, as well as activities and events related to plant mutation breeding and research.


The key feature of the database is that you can register your mutant varieties from your desktop. For this purpose, you need first register an account; then you will be authorized to submit or edit a mutant variety.

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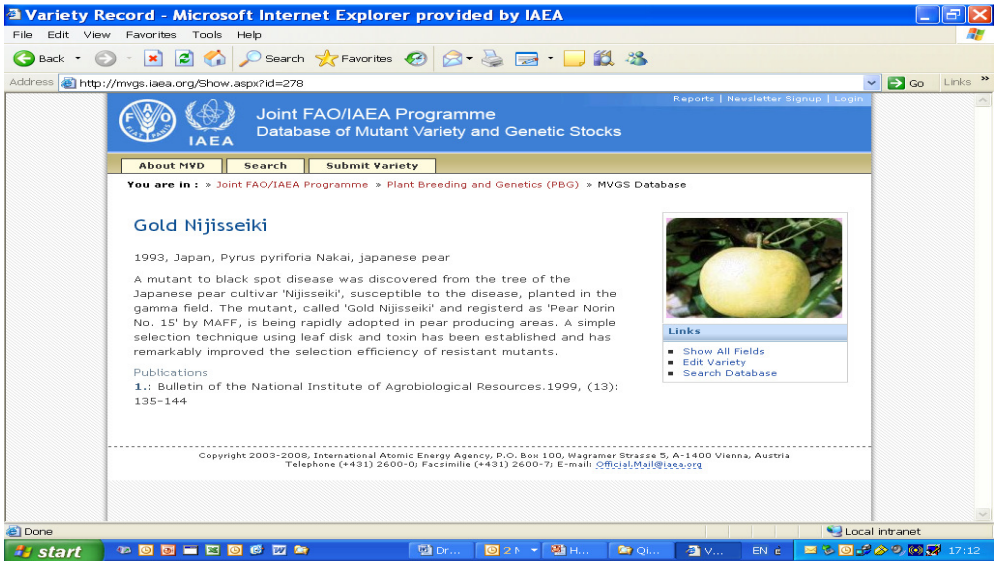


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# IMPORTANT!

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### 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.

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The manuscript should be concisely written with the following sections:

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