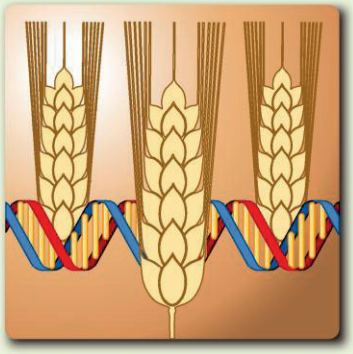
Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Plant Breeding & Genetics Newsletter

No. 30 January 2013

http://www-naweb.iaea.org/nafa/index.html
http://www.fao.org/ag/portal/index_en.html

ISSN 1564-2569



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VIP visitors at the Plant Breeding and Genetics Laboratory – Left: HRH Princes Bajrakitiyabha (Thailand); Right top corner: Prof Steven Chu (USA); Right bottom corner: Dr José Graziano da Silva (FAO)

To Our Readers

Dear Colleagues,

Yes, it is this time of the year again: time to look back and evaluate the work done, celebrate the results achieved and to assess the challenges lying ahead.

We had an eventful second half of the year 2012, and a milestone was the Scientific Forum at the 56th IAEA General Conference tackling global food insecurity and highlighting the IAEA's activities, based on the peaceful application of nuclear technologies to meet this challenge. You can read about this important happening in the 'Past Events' section of this Newsletter. In this respect, I also want to draw your attention to a video clip that perfectly illustrates the work and positive impact of the IAEA on poor farmers' livelihoods: 'The Birth of Centenario' (http://www.youtube.com/watch?v=nRptApU7GFk&feature=plcp). The Scientific Forum focused on sustainable food security in all its aspects. Plant Breeding and Genetics's (PBG) activities, which are demand driven, results based and outcome oriented, are already targeted towards broadening crop adaptation and change. In the future we will use the paradigm of 'climate smart agriculture' to even better meet the needs of the Member States. A central aspect of resilience to climate change, or adaptation to erratic weather variations, is broad biodiversity. According to the Convention on Biological Diversity (CBD) biodiversity 'includes all

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plants, animals, microorganisms, the ecosystems of which they are part and the diversity within species, between species, and of ecosystems' (CBD, 2003, p. 1). Thus biodiversity refers to the number and variety of species, of ecosystems, and of the genetic variation contained within species. Induced mutation is key method in broadening genetic diversity in our crop plants.

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture is actively supporting Member States in adaptation strategies for climate change based on mutation induction and efficiency enhancing biotechnologies through various coordinated research projects (CRPs) and technical cooperation project (TCPs). Major thematic areas of the Plant Breeding and Genetics subprogramme are 'Crop improvement for high yield and enhanced adaptability to climate change' with major activities targeted towards fostering crop improvement (e.g. yield, quality, nutritional factors, market-preferred traits) as well as biodiversity protection, through applying mutation induction and efficiency enhancing bio-/molecular technologies, and 'Integrated soil-water-plant approaches to enhance food production and biomass productivity' with special emphasis on enhancing Member State capacities to advance food security through climate change mitigation and adaptation using integrated soil-plant approaches.

The details of the coordinated research projects (CRPs) related to the issue of crop adaptability and supporting biodiversity implemented as part of the sub-programme are as follows:

(1) The activities under the CRP 'Approaches to improvement of crop genotypes with high water and nutrient use efficiency for water scarce environments' focusses on assessing resources, in order to define and adapt best fit soil and water management practices depending on the available mutant varieties to be extended in nine Member States from Asia, Africa and Latin America, including Bangladesh, China, Indonesia, Kenya, Malaysia, Mexico, Peru, South Africa and Uganda.

(2) The CRP on 'Climate proofing of food crops: genetic improvement for adaptation to high temperatures and drought prone areas and beyond' is being implemented in 11 developing countries across Asia, Africa and Latin America (Columbia, China, Cuba, India, Mexico, Myanmar, Pakistan, the Philippines, Senegal, United Republic of Tanzania, Zimbabwe), as well as in Australia, two Member States in Europe (Spain, United Kingdom (UK)) and the United States of America (USA). The project focusses on improving the grain yields of rice and common bean (essential staple foods in the diets of millions of impoverished and vulnerable populations) to high temperature stress in the face of climate change.

(3) The CRP on 'Integrated utilization of cereal mutant varieties in crop/livestock production systems for climate smart agriculture' has the objective to develop and assess dual purpose cereal cropping systems (food and feed) in nine Member States from Europe, Asia, Africa and Latin America, including Austria, China, Indonesia, Kuwait, the Former Yugoslav Republic of Macedonia, Malaysia, Mongolia, Peru and the UK.

We had the extreme honour and pleasure to host illustrious visitors to the Plant Breeding and Genetics Laboratory in Seibersdorf, starting with HRH Princess Bajrakitiyabha Mahidol from Thailand, Prof Steven Chu, the US Secretary of State for Energy and the new Director General of FAO, Dr José Graziano da Silva.

We are also pleased to announce the publication of the flagship FAO/IAEA resource on mutation breeding under the title 'Plant Mutation Breeding and Biotechnology'. This comprehensive book aims to set the foundation for future work in plant mutation breeding and to stimulate the generation of protocols for a wide range of very specific breeding targets. It is available from CABI Publishing at:
(http://bookshop.cabi.org/?site=191&page=2633&pid=2515).

In our drive to inform visitors from Member States about specific country achievements and impacts of mutation breeding, we have started a series of information sheets for visitors, we currently have ten (Afghanistan, Bangladesh, China, Indonesia, Mongolia, Nigeria, Peru, Thailand, Turkey and the USA). You can read more about this initiative inside this issue.

We are pleased to announce that funds have been recently secured for the refurbishment of our 30-year old greenhouses. Also, due to a resolution proposed by our Member States at the last session of the IAEA General Conference, our labs will be able to further develop our technology platforms and to generally modernize our lab facilities for the coming biennia. This will allow us to serve our Member States even better in the future. In this context, we are also consolidating and strengthening our collaboration with the BOKU (University of Natural Resources and Life Sciences, Vienna) – read more in the section on 'Developments at the Plant Breeding and Genetics Laboratory, Seibersdorf'.

Last but not least I want to draw your attention to the new CRP on dual purpose crops (already mentioned above) initiated this year. Coordinated Research Project (D2.30.30) on 'Integrated Utilization of Cereal Mutant Varieties in Crop/Livestock Production System for Climate Smart Agriculture', aims at increasing crop and animal productivity by developing agronomic practices for dual purpose (food and feed) mutant cereal varieties in developing countries.

This CRP is but one stepping stone on our path towards a future focus of our subprogramme on climate smart agriculture. Climate smart agriculture is being promoted by the Food and Agriculture Organization of the United Nations (FAO) and its partners, with the aim to sustainably increase productivity, resilience (adaptation), reduc-

es/removes greenhouse gases (mitigation) while enhancing the achievement of national food security and development goals (FAO 2011).

The High Level Panel on Food Security and Nutrition that supports the World Committee on Food Security reported in 2012 the importance of developing strategies for climate resilient agriculture and food security. In this context climate smart agriculture revitalizes food production and rural development, particularly in developing countries in an economically, socially and environmentally sustainable manner. It is a low emission agriculture that does not compromise food security as resources are used more efficiently with reduced energy consumption. Enhanced biodiversity is a key requirement to protect against adverse environments and this will be created through improved mutation induction methods, e.g. X rays, ion beams, alone or in combination with traditional methods. Climate smart crop varieties need to be bred with traits that protect against adverse environments. Examples include, mutant ratooning rice for high yields and high economic impact when grown using best fit soil and water management practices which can reduce land preparation (no tillage) and land clearing for agriculture. A second example is hardy barley mutant varieties that withstand harsh weather conditions at 5000m above sea level. This barley is the basis of improved food security and livelihoods of seven million Andean native people in Peru. Coastal areas of Bangladesh can be reclaimed for soil salinity with mutant salt tolerant crops such as rice. The greatest step forward will be the development of accelerated breeding methods for desired mutant traits, which have the potential to shorten the breeding cycle from 10–15 years to 2–3 years in annual crops, thus providing a rapid response to Member State needs such as shorter growing period, water and salinity stresses and extreme temperatures.

Finally, I want to thank you all for your extensive support and invaluable input during the past six months and to wish a productive and fruitful year 2013.

Peace, health and prosperity to all of us.

Pierre J.L. Lagoda
Head,
Plant Breeding and Genetics Section

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Forthcoming Events

Plant and Animal Genome Conference XXI, San Diego, CA, USA, 12–16 January 2013

Technical Officer: B.P. Forster

The Plant and Animal Genome (PAG) Conference is a top international conference for plant research and development. Brian P. Forster has been invited to give an oral presentation at the 'Gene introgression Section'. The talk will highlight ongoing work at the Plant Breeding and Genetics Laboratory with respect to accelerated breeding of mutant traits in barley. Mr Forster has also been invited to attend the Musa genomics and other sessions at PAG. In addition Mr Forster has been invited to a convention on cassava hosted by the Bill and Melinda Gates foundation while in San Diego to discuss opportunities for mutation breeding in cassava.

Inter-regional Training Course on Doubled Haploids and In Vitro Techniques, RAS/5/058, Amman, Jordan, 10–14 February 2013

Technical Officer: P.J.L. Lagoda
Course Directors: A.M.A. Ghanim and Y. Shakhatreh (NCARE)

As part of the project 'Supporting Mutation Induction and Supportive Breeding and Biotechnologies for Improved Wheat and Barley – Phase II' (RAS/5/058) Mr Ghanim of the PBGL will be involved in conducting a training course on Supportive Biotechnologies in Mutation Breeding at the National Center for Agriculture Research and Extension (NCARE), Amman, Jordan. The course is open to 18 candidates from six countries. The purpose of the training is to develop capacities in deploying appropriate biotechnologies that provide greater efficiency, particularly in accelerating the breeding of mutant varieties of wheat and barley. The course will describe the various methods available for doubled haploids production (anther/microspore culture, ovule culture, wide crossing and natural haploid production) and companion biotechnologies for selection (genotyping and phenotyping) and other in vitro methods such as embryo culture that can speed up the breeding process.

ARASIA Training Course on Supporting Mutation Induction and Supportive Breeding and Biotechnologies for Improved Wheat and Barley – Phase II, RAS/5/058, Muscat, the Sultanate of Oman, 2–6 March 2013

Technical Officer: P.J.L. Lagoda
Course Directors: A.M.A. Ghanim and A.H. Al-Muamari

Mr Ghanim of the PBGL will provide lectures and training in basic principles in mutation breeding covering, mutation induction, mutation detection, breeding logistics and accelerated breeding methods. The course will include instruction on related biotechnologies such as doubled haploidy and marker assisted selection.

Regional AFRA Training Course on Basic Mutation Breeding Techniques, RAF/5/066, Cotonou, Benin, 8–12 April 2013

Technical Officer: F. Sarsu

This training course will be organized by the International Atomic Energy Agency in cooperation with the Government of Benin, Université d'Abomey-Calavi (UAC), Faculté des Sciences et Techniques (FAST). It is open to candidates from AFRA project RAF/5/066 on Improving Crops Using Mutation Induction and Biotechnology through a Farmer Participation Approach.

The purposes of the training course are to provide participants with:

- Mutation breeding basic concepts, knowledge on mutagenic agents, the establishment of dosimetry assays, determination of LD 50 doses for various crops;
- Basic statistical analysis, breeding programme, principles of experimental design;
- Identification, evaluation and screening of mutants;
- Mutation breeding techniques in vegetatively propagated crops;
- Establishment of adequate mutation induction protocols for specific crops;
- Handling of mutated population.

The training course will include lectures, roundtable discussions, consultations on methodologies and their application in various field situations. The participants are from all participating Members States involved in the project RAF/5/066. Additionally they should be currently and actively working on mutation breeding and have basic knowledge in crop breeding. The training course will be conducted in English; participants should be capable of freely expressing themselves and following lectures.

Third Research Coordination Meeting (RCM) on Isolation and Characterization of Genes Involved in Mutagenesis of Crop Plants, D2.40.13, Jeju Island, Republic of Korea, 16–19 April 2013

Technical Officer: P.J.L. Lagoda

Session: Plant Mutation Genomics

Since 40 years ago mutation induction and chemical agents demonstrated to be extremely successful in im-

proving crop varieties, the Food and Agriculture Organization of the United Nations (FAO) and the International Atomic Energy Agency (IAEA) through their Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture efficiently supported, both financially and scientifically, research around the world in the field of mutation induction and breeding. As a result of these research activities, many developing countries experienced growing economic benefits through mutation induction and achieved enhanced genetic diversity in many crop germplasm. Therefore, we are pleased to announce that 'Plant Mutation Genomics', as a part of the third RCM on 'Isolation and Characterization of Genes Involved in Mutagenesis in Crop Plants', will be held in Jeju Island, Republic of Korea, on 18 April 2013. In this GPGR3 session, the CRP Member States from FAO and IAEA will give talks on their recent research activities and discuss genome stability and its interactions.

Second Research Coordination Meeting (RCM) on Approaches to Improvement of Crop Genotypes with High Water and Nutrient Use Efficiency for Water Scarce Enviroment, D1.50.13, Kuala Lumpur, Malaysia, 17–21 June 2013

Technical Officers: K. Sakadevan and P.J.L. Lagoda

This project is in the second year of implementation and the second RCM will be held in Kuala Lumpur, 17–21 June 2013. Dr Khairuddin Abdul Rahim from the Malayian Nuclear Agency will be the local coordinator for the meeting. Thirteen research contract and agreement holders from Bangladesh, China, Indonesia, Kenya, Malaysia, Mexico, Pakistan, Peru, South Africa, Uganda and Vietnam are expected to participate in the meeting.

The aims are to increase crop productivity and resource use efficiency in harsh environments by using best fit soil and water management practices and improved crop varieties through demonstration in small farmers' field. The overall objective of this CRP is to increase crop productivity and food security by developing and extending rapidly to farmers the improved crop varieties and soil, water, nutrient and crop management technologies that make cropping systems resilient to environmental stresses. The specific objectives are (1) to increase the productivity of improved mutant varieties of crops tolerant to environmental stresses under existing soil and climatic conditions, and (2) to enhance nitrogen and water use efficiencies of crops tolerant to environmental stresses through best practice soil, water, crop and fertilizer management.

The first RCM of the CRP was held in Vienna, Austria, 12–16 December 2011 and eleven participants attended the meeting. During the first RCM revised country work plans were developed for all research contract holders. Since the first RCM field studies have been established in different agro-ecological zones and initial soil samples from the fields have been collected and analyzed to identify the chemical and physical characteristics of soils. The first year progress report and renewals are currently being evaluated.

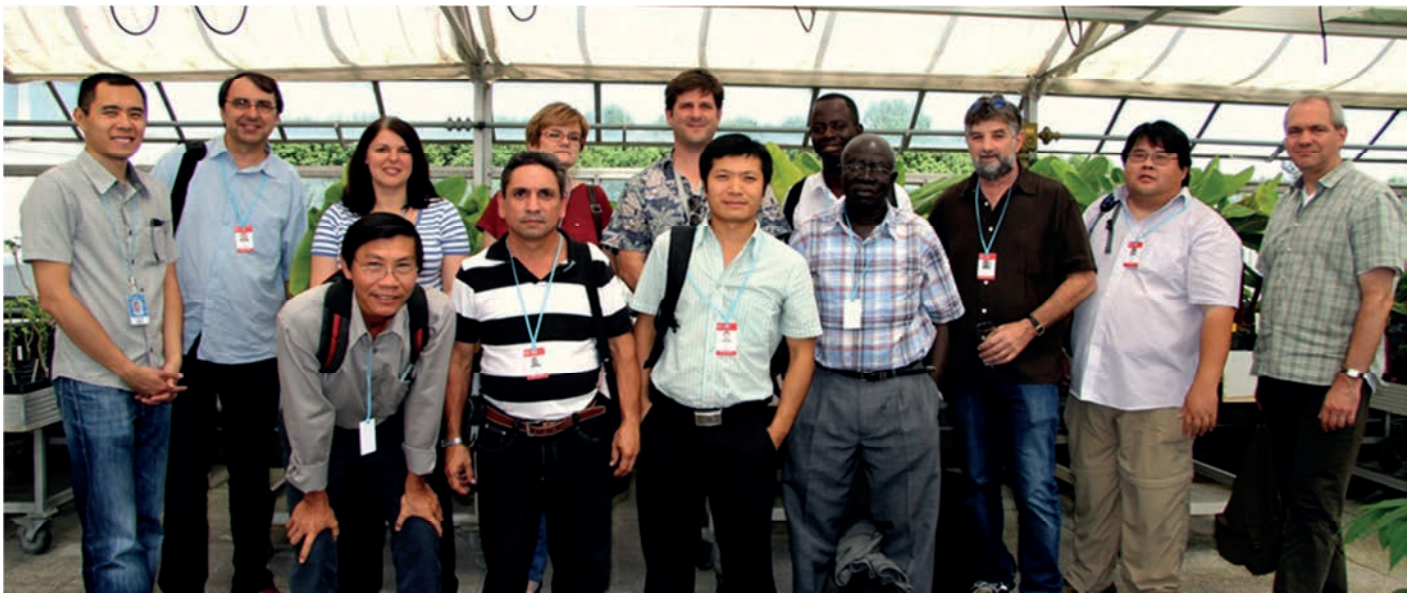
This RCM will focus on monitoring the implementation so far, assess progress and identify gaps for efficient steering of the project. Project progress made since December 2011 will be discussed and the individual national work plans will be reviewed and adjusted during the meeting.

Past Events

Third Research Coordination Meeting (RCM) on Enhancing the Efficiency of Mutagenesis through an Integrated Biotechnology Pipeline, D2.40.12, Vienna, Austria, 18–22 June 2012

Technical Officer: B.J. Till

Ten scientists from nine countries (Austria, China, Cuba, Germany, Ghana, Poland, Sierra Leone and United States of America), the technical officer and staff of the Plant Breeding and Genetics Section and Laboratory participated in the meeting. Progress was reported from each participant and work plans updated. In addition, presentations were made by IAEA staff members on activities in the areas of plant Near Infrared Spectroscopy of rice, mutation induction and detection in vegetatively propagated crops, low cost assays, and seed phenotyping strategies. Progress has been very good in this CRP and new methods are being developed and tested for enhanced efficiency of mutation induction and screening. Highlights of scientific achievements are described under Coordinated Research Projects (CRPs) section of this newsletter.



Regional Training Course on Maximization of Resourced for Sustainable Increase of Wheat and Barley Productivity, RAS/5/058, Dundee, Scotland, UK, 9–13 July 2012

Technical Officer: P.J.L. Lagoda

The purpose of this training course was to develop capacities in ARASIA State Parties in the comprehensive field of maximization of resources for sustainable increase of wheat and barley productivity.

The training course included:

- Lectures from the 'Crops for the Future' course provided by Andy Flavel of Dundee University;
- 'Hands-on' experience based on the Bowman iso-line barley collection as a demonstration;
- Simple genetic studies;
- Utilising mutant series for gene targeting and candidate gene identivication.

Drought, disease, heat and salinity are major constraints affecting sustainable agricultural productivity in ARASIA States Parties. Most of cultivated areas depend on rainfall. Where cropping relies on limited rainfall, the concerned areas are already affected by drought. Where the complementary part depends on irrigation, disease infection results in significant reduction in yield. This situation requires an integrated approach to develop technology packages of mutant lines (resistance to diseases, salinity and heat traits, and sustainable high yield under variable climatic conditions) with proper water utilization practices. In this context, mutation induction technique has shown potential as a valuable tool in developing drought / salinity tolerant and disease resistant mutant lines of wheat and barley. In order to address these agricultural constraints, ARASIA States Parties Iraq, Jordan, Lebanon, the Sultanate of Oman, Saudi Arabia, Syrian Arab Republic and Yemen started a mutation breeding programme under the RAS/5/048 project in 2007 with the assistance of the IAEA. Under this project some segregating mutant lines with the aforementioned targeted agronomic characters have been developed. These mutant genetic stocks need to be further evaluated, in order to ascertain their utility for breeding programmes (breeding a new cereal variety takes 8–10 years, mutation induction has proven to shorten this period by at least two years). It is now a matter of urgency that new varieties should be released with higher and more stable yield potentials, superior quality, and multiple resistances to disease and

insects. The use of mutation induction 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.

Participants were 20 senior implementing staff of the regional project, including the counterparts from the ARASIA project.

Regional Training Course on Mutation Induction Techniques, RAS/5/058, Muscat, the Sultanate of Oman 2–6 September 2012

Technical Officers: P.J.L. Lagoda and B.P. Forster

The purpose of this training course was to initiate implementation staff of ARASIA States Parties to modern techniques in mutation breeding and in the use of integrated technology packages based on best fit soil and water management practices and mutation induction combined with efficiency enhancing biotechnologies.

The training course included lectures on:

- Mutation induction techniques.
- Accelerated breeding.
- Best fit soil and water management practices.
- Screening methodologies for biotic stress resistance and abiotic stress tolerance.

Capacity has to be developed in ARASIA States Parties Iraq, Jordan, Lebanon, the Sultanate of Oman, Saudi Arabia, Syrian Arab Republic and Yemen in order to use mutation induction and breeding to their most efficient level. RAS/5/058 builds on the progress made under the TC project RAS/5/048, which already produced some segregating mutant lines improved for targeted agronomic characters including resistance to diseases, salinity and heat traits, and sustainable high yield under variable climatic conditions. These mutant genetic stocks need to be further developed, using technology packages developed and adapted at the IAEA in order to ascertain their utility for breeding programmes.

IAEA Scientific Forum 2012 at the 56th General Conference

Food for the Future: Meeting the Challenges with Nuclear Applications, Vienna, Austria, 18–19 September 2012

Plant Breeding and Genetics Focal Point: P.J.L. Lagoda

The Scientific Forum at the 56th General Confernce was tackling global food insecurity on three levels:

1) Food Production: The world is facing an unprecedented food crisis. The challenge is to sustainably produce enough food for a growing global population that is projected to reach nine billion by 2050. Worldwide close to a billion people are chronically hungry and up to two billion people are chronically lacking food security. Most of the world's hungry people are found in the developing world. Six million children die of hunger every year – 17000 every day. Climate change affects food production directly (droughts, flooding and snow cover) and indirectly (pests and diseases). Furthermore, the globalisation of trade in food commodities along with animal movement has brought about an unprecedented increase of emerging and re-emerging animal and plant diseases and pests with significant socio-economic consequences.

The overall objective of the Joint FAO/IAEA Programme in Food and Agriculture is to help Member States produce and make more quality food available to their respective populations. Specifically:

- Increase animal production using radio isotopic technologiesthrough development of cost-effective feeds and feeding strategies, marker-based genetic improvement and improved reproductive efficiency;
- Increase the quantity and quality of food and feed crops produced through radiation-induced plant mutation breeding;
- Improve the management of natural resources through isotopic techniques to measure and monitor nutrients in the crop-livestock interface system.

Through our programmatic activities:

- For almost five decades, the Agency, together with its partner FAO has guided development of new nuclear-based technologies and facilitated their adaptation.
- The application of nuclear technology has a proven record in increasing agricultural production and protecting crops and animals.
- Higher and more reliable yields not only improve farmers' livelihoods, they also mean better quality and safer food for consumers.

2) Food Protection: Food insecurity is inherently linked to pests and diseases that harm or kill livestock and crops. Investing land, seeds, water, fertilizer, animal feed, labour and other inputs, only to have an average of 30–40% of the agricultural outputs destroyed at both the pre- and post-harvest levels is a very inefficient use of the shrinking resources available for feeding the human population that is currently growing by a billion every 12 years. As a result of globalisation of crop and animal movement/trade in conjunction with climate changes and severe weather events, the world is currently facing an unprecedented increase of invasive or emerging and re-emerging animal and plant diseases and pests with dire socio-economic consequences.

Animal and plant pests and diseases:

(a) Threaten food security by causing serious losses in production;

(b) Increase the input in production through the application of costly control measures;

(c) Are the reason for increased use of pesticides, resulting in residues in food commodities, the contamination of the environment, outbreaks of secondary pests and the development of resistance of insects to pesticides;

(d) Are a threat to public health in the case of zoonotic diseases;

(e) Are serious barriers to national and international trade, causing major losses in export incomes.

Pesticide and drug use is costly and not sustainable. Nuclear techniques can effectively:

- Address the rising demand for more effective, target-specific and environment-friendlier animal and plant pest and disease control methods,
- Allow overcoming sanitary and phyto-sanitary barriers to international trade of agricultural products.

Four areas of Agency involvement are centred on:

- Animal pests: Capacity to prevent losses of livestock and to eradicate insect pests that transmit vectors borne diseases affecting livestock and humans.
- Plant pests: Capacity to reduce losses and manage key insect pests in a sustainable and environment-friendly way, to facilitate international trade and to eradicate invasive insect pest outbreaks.
- Animal diseases: Capacity to contribute to global animal health, to prevent losses in animal production, to improve quality of animal products, and to reduce risks of human health hazards.
- Plant diseases: Capacity to prevent damages to crop production systems or the large scale loss of crops from infectious plant diseases and to safeguard yield.

3) Food Safety: Producing safe and high quality food is a prerequisite to ensure consumer health and successful domestic and international trade and is critical to the sustainable development of national agricultural resources. Traceability systems play a key role in certifying food origin and authenticity. State of the art analytical methodologies can help in the detection of fraudulent practices and adulteration of foods and in the control of food contamination. Current monitoring programmes in many countries are targeted response systems, thus missing the opportunity for intervention. Nuclear applications can play a key role in ensuring traceability. Food safety is also impacted by global trends and agricultural practices throughout the food production chain that have the potential to increase the risk of contamination of food and feeds and consequently jeopardize consumer protection. Integrated monitoring and surveillance of food and the environment is critical for the early identification of emerging problems and changing trends. New, rapid analytical tools based on isotopic, biological and chemical approaches are required.

Emergency planning, preparedness and response to nuclear emergencies and radiological events affecting food and agriculture is also of growing importance to governments, including increasing the capabilities of FAO as a critical counterpart in defining and implementing agricultural countermeasures in response to such events.

The Agency's programmatic activities focus on:

1. Application of agricultural product and contaminant traceability mechanisms using novel radio-assay and isotope dilution techniques for the detection of emerging and multiple contaminants in complex food matrices.
2. Applications of food irradiation for sanitary and phytosanitary purposes to ensure food safety and quality and facilitate international trade, including quarantine measures related to fresh produce.
3. Strengthening emergency planning and response to nuclear and radiological emergencies affecting the production of safe and wholesome food supplies.

In this context, nuclear and related technologies play a unique role in the detection, monitoring, tracing and control of food safety hazards and the facilitation of international trade throughout the food production chain. Food irradiation provides a unique technology for meeting international requirements related to food safety and quality. It is a proven and effective post-harvest treatment to improve food safety through the reduction of bacterial contamination and the extension of the shelf-life of foodstuffs as well as for the control of insect pests, including pests of quarantine importance, in agricultural commodities. Other new areas being explored include the use of irradiation for special dietary purposes (immunocompromised patients) and for emergency food rations for use during natural disasters. Emergency planning and response to nuclear and radiological emergencies is a critical element to mitigate negative consequences arising from these events and to re-establish food productions systems that ensure the distribution of safe and wholesome food supplies.

Third Research Coordination Meeting (RCM) on Improving Nutritional Quality by Altering Concentrations of Enhancing Factors Using Induced Mutation and Biotechnology in Crops, D2.30.28, Hangzhou, Republic of China, 15–19 October 2012

Technical Officer: S. Nielen

The RCM was organized in cooperation with the Institute of Nuclear Agricultural Sciences, Zhejiang University, Hangzhou, China. The main purposes of the meeting were to:

- Assess the current status and progress achieved since the last meeting;

- Review and adapt individual work plans;
- Discuss CRP activities for the remaining period of the project including developing a clear strategy for future dissemination of the CRP results.

Seven research contract holders from Bulgaria, China, India, Kenya, Peru, South Africa and Ukraine, two technical contract holders from South Africa and the United Kingdom and three research agreement holders from Denmark, Germany and the United States of America attended the meeting.

Meeting participants

Each participant presented the achievements made within the CRP, particularly considering the period after the last RCM in April 2011. The reports highlighted the methods used, results obtained in developing new mutant germplasm with improved nutrient quality traits in the range of crops of this CRP and screening methodologies for the respective nutrient quality traits based on phenotypic, biochemical or molecular methods.

Under this project new mutant germplasm of barley, wheat, maize, sorghum, soybean, pea, tomato, sweet potato and potato has been developed. This include advanced mutant lines with resistant starch, increased carotenoids and anthocyanin, decreased phytate, increased mineral concentration and enhanced level of oleic acid in oil. For example, in Peru a total of 750 advanced mutants of barley have been selected from the variety UNALM96, out of which 37 have improved phosphorus content. A new set of putative barley mutants from UNALM 96 with increased content of Mg (1), P (1), S (7), K (3), Mn (3), Fe (3) and Cu (4) were identified. Standard phenotypic evaluation schemes and a range of biochemical assays have been used, or adapted, in screening the mutant populations and stable mutant lines for nutritional quality characters. Among these assays is a method for quantifying resistant starch and amylose that has been optimized for barley grain in Denmark. Efficient genotypic screening methods for genes affecting synthesis of resistant starch, carotenoids and mineral concentration and a novel and robust system (ISAP) for mutant and germplasm characterization has been developed in Germany and transferred to Bulgaria. One of the reports highlighted the commercialization of two noodle products in China, made from 100% flower of high resistant starch (RS) rice and wheat advanced mutant lines as spinoff of the project.

Noodle product made from 100% flour of the high RS wheat mutant line W06-5R (Photo courtesy of Dr Xiaoli Shu)

Rice noodles made from 100% flour of the high RS rice mutant line RS4 (Photo courtesy of Dr Xiaoli Shu)

Most of the participants have supported training in the form of supervising BSc and MSc dissertations, PhD thesis, undergraduate internships, training courses as well as IAEA fellowships. All the participating institutions in the CRP have active collaborations with at least one other institution in their respective countries. In addition, several collaborations have developed between the participants in the CRP. Results have been disseminated in peer reviewed publications and conference proceedings.

The group has planned the remaining life span of this project as regards to the individual work plans and the work that has to be done to reach the overall project objective. Recommendations were formulated and a road map for publication of the CRP results was drafted and agreed upon. It has been decided that the final RCM shall be held during the second quarter of 2014 (April 2014), in Cusco, Peru.

A one-day excursion including a field visit to the Jiaxing Academy of Agricultural Sciences, Jiaxing and a lab tour in the College of Agriculture and Biotechnology of the Faculty of Agriculture, Life and Environmental Sciences, Zheijang University, Hangzhou, was organized. The field visit gave the participants an interesting overview on some of the present research activities of the host institute related to rice mutation breeding.

The meeting was excellently organized by the host institute, namely by Dr Xiaoli Shu and Prof Qing-Yao Shu. In addition, local staff greatly contributed through their support of all activities, also outside the venue, to the success of the meeting.

First Coordination Meeting on Improving Crops Using Mutation Induction and Biotechnology through a Farmer Participation Approach (AFRA), RAF/5/066, Windhoek, Namibia, 15–19 October 2012

Technical Officer: F. Sarsu

Meeting participants

The meeting was organized by Ms Lydia Ndinelao Horn (the Project Coordinator for RAF/5/066 in Namibia). The main objectives of this first coordination meeting were:

- To review and discuss details of the activities stated in the work plan to be implemented under the project RAF/5/056 since 2007 and review national achievements;
- To assess and readjust, where necessary, the regional project activities in the project document for 2012–2016.

The meeting was officially opened by Mr Joseph S. Iita, Permanent Secretary. Mr Axel Tibinyane, the Director of Namibia Atomic Energy Radiation Protection Regulation Authority addressed the opening session and welcomed the IAEA delegates. They both expressed their thanks to the IAEA for the continuing support to Namibia.

Mr Eric Cole, programme management officer (PMO) gave a warm welcome to the participants and started by emphasizing the importance of the project and stating the objective of the meeting. The technical officer (TO), Ms Fatma Sarsu, gave a presentation on 'Crop Improvement and Induced Mutation Technology'.

Representatives of Benin, Egypt, Ghana, Kenya, Madagascar, Mauritius, Namibia, Niger, Senegal, South Africa, Sudan and Zimbabwe participated in the meeting in Namibia.

Participants presented progress achieved and results obtained under the project RAF/5/056 in 2007–2011 for their respective countries. The presentations included country work plans and arrangements for future project activities under the project RAF/5/066 in 2012–2016. A SWOT analysis was performed and future work plans and prioritization of the regional needs for 2012–2016 regional programmes were finalized. Discussions made after each presentation were very useful and areas for improvement were suggested to enhance and speed up the acquisition and results in mutation induction. It was stated that the rate of mutant varieties released in Africa is low and participants were urged to improve the release of mutant varieties.

In the project cycle under review (2007–2011) progress was documented on plant tissue culture infrastructures. Efforts are still needed in the molecular biology aspects. Furthermore, the project assisted the introduction of new methodologies (such as drought screening) and technologies (doubled haploid, molecular markers) in some participating countries. The group emphasized that the project should currently focus on strengthening of regional capability for developing and promoting drought tolerant varieties of traditional and neglected African crops.

The group decided to work together in common groups to contribute to sustainable food production and improved livelihoods in AFRA Member States through development and dissemination of improved mutation-induced varieties. The following was decided by common crop working groups, crop working group (CWG) leaders and participanting countries:

1. Cassava (**CWG Leader** – Kenneth Danso from Ghana) — Kenya, Madagascar, Democratic Republic of the Congo, Namibia, Ghana, Benin, Sierra Leone, Nigeria and Central African Republic;
2. Millet (**CWG Leader –** Sani Daouda Ousmane from Niger) — Senegal, Sudan, Namibia, Niger, Kenya, Eretria, Burkina Faso and Zimbabwe;
3. Cowpea (**CWG Leader –** Prince Mchapondwa Matova from Zimbabwe) — South Africa, Namibia, Zimbabwe, Kenya, Burkina Faso, Mauritius, Niger and Nigeria;
4. Rice (**CWG Leader** – Noronirina Victorine Rakotoarisoa from Madagascar) — Egypt, Sierra Leone, Sudan, Tanzania, Madagascar, Namibia, Benin and Senegal;
5. Taro/edible aroids (**CWG Leader** – Mala Gungadurdoss from Mauritius) — South Africa, Mauritius, Cameroon, Ghana and Nigeria.

Participants agreed to improve the sharing of protocols and other mutation related information and germplasm through networking. Adoption of the SMTA protocol should be encouraged in participating countries.

In addition, the group agreed to prepare a TECDOC. Grouped by plant species type, six working groups were tasked to develop a chapter on related and relevant research activities and results in these crop groups, which resulted from the previous project life cycle (1993–2012).

Sierra Leone, Zambia, United Republic of Tanzania, Burkina Faso, Ethiopia, Tunisia, Mali, Central African Republic, Eritrea, Libya, Democratic Republic of the Congo, Algeria, Cameroon, Morocco, Uganda and Nigeria did not attend the meeting. It was decided that the report of the meeting should be sent to those participants and also that they should be invited to present their progress reports and work plans for 2012–2016 in the same format as suggested in the meeting for inclusion and distribution to all participants.

National Training Course on Advanced Molecular Breeding for Selection of Traits under Climage Change, MAL/5/029, Bangi, Malaysia, 15–19 October 2012

Technical Officer: S. Nielen
Course Director: R. Ibrahim

This national training course is part of the TC project MAL/5/029 'Applying Mutation Breeding and Optimized Soil, Nutrient and Water Management for Enhanced and Sustainable Rice Production' and has been organized at the Malaysian Nuclear Agency, Agrotechnology and Biosciences Division in Bangi, Kajang, Selangor. Twenty six participants from four national research institutions attended the course, which provided lectures and practical exercises on plant physiology and molecular marker techniques for selection of desired traits under biotic and abiotic stress conditions. Two external lecturers from the International Rice Research Institute (IRRI), Los Baños, the Philippines, were invited to give lectures and conduct practical work focusing on the application of molecular marker technology and physiological traits for drought screening in rice: Dr Arvind Kumar, an expert in breeding drought-tolerant rice varieties and Dr Amelia Henry, a drought physiologist. In addition, two local experts, Prof Dr Wickneswari Ratnam and Prof Dr Wan Kiew Lian from the Universiti Kebangsaan Malaysia (UKM) gave lectures in marker assisted breeding and advanced molecular techniques using transcriptome analysis. The Course Director was Dr Rusli Ibrahim, Senior Scientist at the Malaysian Nuclear Agency, Agrotechnology and Biosciences Division, and main counterpart of project MAL/5/029.

The course has contributed to enhancing the knowledge on current techniques of plant physiology and advanced molecular breeding for crop improvement in the country and also provided opportunities from networking and sharing of experience among researchers and institutions for effective project collaborations.

Technical visit to Gamma Greenhouse (Photo courtesy of Dr Rusli Ibrahim)

Regional AFRA Training Course on Mutation Breeding Techniques, and Handling of Mutated Populations, RAF/5/066, Cairo, Egypt, 4–8 November 2012

Technical Officer: F. Sarsu
Course Director: A.S.I. Ragab

Under the Regional Project RAF/5/066 - AFRA III on Improving Crops Using Mutation Induction and Biotechnologies through a Farmer Participatory Approach, the International Atomic Energy Agency (IAEA) in cooperation with the Government of Egypt, Nuclear Research Centre and the Atomic Energy Authority (AEA) in Cairo, organized this training course, which was facilitated by the staff of AEA. The training course was attended by 17 trainees from 12 African Countries (Benin, Central African Republic, Egypt (5), Ghana (2), Madagascar, Namibia, Nigeria, Sierra Leone, Sudan, Democratic Republic of the Congo (2) and Zimbabwe).

The main objectives of this training course were to provide core scientific knowledge on mutation induction including knowledge on mutagenic agents, the establishment of dosimetry assays, determination of LD 50 doses for various crops, establishment of adequate mutation induction protocols for specific crops, handling of subsequent mutated populations and establishment of proper screening protocols for drought tolerance.

Meeting participants

The participants were given lectures and practical exercises in the green houses as well as in the fields on mutation breeding and establishment of improving sesame and safflower protocols. The candidates were thoroughly tutored on the key steps on mutation breeding techniques, such as:

- Mutation breeding basic concepts — physical and chemical mutagens treatments and guidelines for success in mutation induction breeding;
- Application of mutation breeding in self-pollinated and cross pollinated crops — Handling of M_1–M_5 generations;
- Basic statistical analyses related to breeding programmes;
- Identification, evaluation and documentation of mutants;
- Breeding for improved drought tolerance and stem rust resistance;
- Protocols for improving sesame and safflower through mutation breeding from seed irradiation (M_0) to the release of mutant varieties.

The participants visited gamma cell irradiator and were explained the mechanism of gamma irradiator. There were also field demonstrations (one experiment for legume crops and two for cereal crops).

At the end of the training course, the participants were given certificates issued by IAEA and signed by both IAEA and AEA. The course director, Prof. Abdel Shafy Ibrahim Ragab, and staff of the Nuclear Research Centre and the Atomic Energy Authority are commended for the excellent training provided.

Radiosensitivity test trail for wheat cultivar in Cairo (Photo courtesy of Dr A.S.I. Ragab)

Regional (IAEA/RCA) Training Course on Application of Molecular Markers to Mutation Breeding Programme with Focus on Traits Contributing to Better Adaptation (Biotic and Abiotic Stress Tolerance), RAS/5/056, Perth, Australia, 5–9 November 2012

Technical Officer: S. Nielen
Course Director: R. C. Li

The Department of Agriculture and Food Western Australia (DAFWA) hosted this regional training course, which is part of the Asia and Pacific regional technical cooperation project RAS/5/056 'Supporting Mutation Breeding Approaches to Develop New Crop Varieties Adaptable to Climate Change'. Nineteen delegates from Bangladesh, China, India, Indonesia, Malaysia, Mongolia, Myanmar, the Philippines, Sri Lanka, Thailand and Vietnam participated in the training course.

Molecular markers lab - Sampling

The purpose of the training course was to provide young scientists involved in the project with advanced knowledge and skills related to mutation breeding for improving adaptation of crop plants to biotic and abiotic stresses and with methodologies and protocols for marker assisted breeding. 'Food security is still a major concern for the rapidly growing Asia-Pacific region and the issue is further exacerbated by climate change and water availability', said Dr Mark Sweetingham, Director of the Department Grains Industry, in a media statement about the importance of this training course.

Molecular markers lab - Instructions

The training course included theoretic lectures and hand-on bench works. The lectures covered six topics:

(1) Introduction to molecular marker technologies;

(2) Advances in genomics and the challenge of translating outcomes to industry;

(3) Mapping mutant genes and molecular marker-assisted breeding;

(4) Advanced molecular technologies and genomics;

(5) Construct linkage map and QTL analysis;

(6) Basic bioinformatics and PCR primer design.

The bench work included seven sections:

(1) High throughput DNA extraction from leave or seed samples;

(2) Mapping a mutant gene using SNP marker;

(3) Mapping a mutant gene using microsatellite markers and bulk segregation analysis;

(4) Pyramiding mutant genes using gene-specific SNP markers;

(5) Convert experimental images into digital data;

(6) Construct a linkage map and QTL analysis;

(7) Design PCR primers.

The course lecturers were Dr Chengdao Li, Prof Rudi Appels, Prof Mike Jones and Dr Qisen Zhang.

The training course was very positively evaluated by the participants and most of them stated that the acquired knowledge and skills are highly relevant for their future work in their home countries.

Molecular markers lab – Gel casting (Photos courtesy of Dr Chengdao Li)

Second Research Coordination Meeting (RCM) on Climate Proofing of Food Crops: Genetic Improvement for Adaptation to High Temperatures in Drought Prone Areas and Beyond, D2.30.29, Mexico City, Mexico, 26–30 November 2012, and

AquaCrop Training Course, Mexico City, Mexico, 3–5 December 2012

Technical Officer: M. Spencer

All participating countries were invited to present the progress and achievements of the first 18 months of research and field screening. The RCM was associated with a training course on the application of FAO AquaCrop system in the prospection and prediction of agricultural responses to climate change.

Further details will be presented in the next issue of the newsletter (No. 31, July 2013).

First Research Coordination Meeting (RCM) on Integrated Utilization of Cereal Mutant Varieties in Crop/Livestock production Systems, D2.30.30, Vienna, Austria, 10–14 December 2012

Technical Officer: B.P. Forster

Nine representatives (plant breeders, geneticists, agronomists and animal production specialists) from Austria, China, Indonesia, Kuwait, the Former Yugoslav Republic of Macedonia, Malaysia, Mongolia, Peru and the UK met in Vienna. The meeting began with introductions of ongoing work (crops, mutant varieties, major limitations and objectives) by each participant.

The main objective of the meeting was to discuss project activities and the formulation of a work plan and strate-

gies. The CRP aims to maximise yields of mutant varieties by developing soil and water management practices and identifying optimal harvest times for food and feed. Specific issues of the coordination meeting were:

- Review of mutant varieties already developed, or advanced mutant lines available in each country. How much material is available? What mutant trait is present? How much acreage does the mutant variety currently occupy? What are current yields?
- Review current agronomic practices with respect to soil, water and fertiliser management.
- Field trialing. Design of soil, water and fertiliser field trials and evaluation of harvests.
- Evaluation of food and feed production and quality.
- Production of guidelines and recommendations for enhancing productivity of mutant cereal varieties.
- Transfer of germplasm, plant breeding technologies and soil and water management practices to Member States.

Coordinated Research Projects (CRPs) and Research Coordination Meetings (RCMs)

Project Number	Ongoing CRPs	Scientific Secretaries
D2.30.28	Improving nutritional Quality by Altering Concentrations of Enhancing Factors Using Induced Mutation and Biotechnology in Crops	S. Nielen
D2.30.29	Climate Proofing of Food Crops: Genetic Improvement for Adaptation to High Temperatures in Drought Prone Agreas and Beyond	M. Spencer
D2.40.12	Enhancing the Efficiency of Induced Mutagenesis through an Integrated Biotechnology Pipeline	B. Till
D2.40.13	Isolation and Characterization of Genes Involved in Mutagenesis of Crop Plants	P.J.L. Lagoda
D1.50.13	Approaches to Improvement of Crop Genotypes to High Water and Nutrient Use Efficiency for Water Scares Environment	K. Sakadevan and P.J.L. Lagoda
D2.30.30	Integrated Utilization of Cereal Mutant Varieties in Crop/Livestock Production System	B. Forster

Integrated Utilization of Cereal Mutant Varieties in Crop/Livestock Production System, D2.30.30

Technical Officers: B.P. Forster

This CRP will run for five years and sets out to maximize yields of mutant cereal varieties for food and feed production by tailoring agronomic practices. This CRP is multi-disciplinary and involves three FAO/IAEA Sections (1) Plant Breeding and Genetics; (2) Soil and Water Management and Crop Nutrition; and (3) Animal Production and Health. The CRP is composed of seven research contracts (China, Indonesia, Kuwait, Macedonia, Mongolia, Malaysia and Peru) one technical contract (Austria) one Agreement Holder (UK) and observers from the FAO. Mutant varieties and advanced mutant lines in four cereal crops are to be investigated, including barley, rice, sorghum and wheat. Mutant varieties of these crops are adapted to a wide range of environments and, depending on purpose, may be harvested at various stages in the life cycle. The CRP aims to provide flexibility in harvesting; the crop may be grown to maximize food for human consumption, or alternatively, grain, seedlings, green fodder or hay may be grown to feed cattle, camels, goats, guinea pigs, sheep and yaks.

Objectives

(1) To increase crop and animal production by developing agronomic practices for dual purpose (food and feed) mutant cereal crops in developing countries.

(2) To evaluate mutant cereal varieties for agronomic performance and feed quality.

(3) To multiply seed of superior lines for fodder production trials.

(4) To evaluate the nutritive value of mutant lines in animal production systems.

(5) To determine biomass, harvest index and nitrogen-use efficiency of mutant varieties and advanced mutant lines.

(6) To publish protocols and guidelines for speeding up the establishment of useful mutants in desirable genetic backgrounds.

(7) To develop locally adapted breeding material.

(8) To deliver useful mutant genetic stocks to interested Member States, including those not participating directly in the CRP.

More information may be found on the Coordinated Research Activities (CRA) website: http://www-crp.iaea.org/.

Climate Proofing of Food Crops: Genetic Improvement for Adaptation to High Temperatures in Drought Prone Areas and Beyond, D2.30.29

Technical Officer: M. Spencer

This CRP was initiated in 2010. The first RCM was held in Vienna, Austria, 2–6 May 2011. Eleven research contract holders (Colombia, China, Cuba, India, Mexico, Pakistan, the Philippines, Senegal, the United Republic of Tanzania and Zimbabwe) and five agreement holders (China, International Rice Reserch Institute (IRRI), Japan, Spain and the United Kingdom) attended the RCM.

According to the progress reports registered this year, this CRP is being steadily implemented in all participating

countries. The M_2 generations of rice and common bean are being screened, in laboratories, in screen houses and in the fields. Even though it is quite early to account for solid achievement, it could be noted that most efforts have been placed in establishing reliable and solid screening protocols, which in turn should later ensure the selection of the most suitable mutated genotypes. On the other hand the efforts in the analysis of the genomic responses have also been substantial. Thanks to the release of the common bean genome sequence early this year, we should foresee a wealth of genes and other genomics involvement in tolerance to heat being clarified and documented.

The second RCM was held in Mexico City, Mexico, 26–30 November 2012. Further details based on the countries presentations during the RCM in Mexico as well as the outline of the work plan for the next cycle will be presented in the next issue of Plant Breeding and Genetics Newsletter.

Approaches to Improvement of Crop Genotypes with High Water and Nutrient Use Efficiency for Water Scarce Environments, D1.50.13

Technical Officers: K. Sakadevan and P.J.L. Lagoda

This CRP has a total of 12 research contract holders from Bangladesh, China, Indonesia, Kenya, Malaysia (two contracts), Mexico, Pakistan, Peru (two contracts), Uganda and Vietnam, and one agreement holder from South Africa, The first RCM of the CRP was held in Vienna, Austria, 12–16 December 2011 and eleven participants attended the meeting. During the first RCM revised country work plans were developed for all research contract holders. Since the first RCM field studies have been established in different agro-ecological zones and initial soil samples from the fields have been collected and analysed to identify the chemical and physical characteristics of soils. The first year progress report and renewals are currently being evaluated.

This CRP aims to increase crop productivity and resource use efficiency in harsh environments by using best fit soil and water management practices and improved crop varieties through demonstration in small farmers' field. The overall objective of this CRP is to increase crop productivity and food security by developing and extending rapidly to farmers the improved crop varieties and soil, water, nutrient and crop management technologies that make cropping systems resilient to environmental stresses. The specific objectives are (1) to increase the productivity of improved mutant varieties of crops tolerant to environmental stresses under existing soil and climatic conditions, and (2) to enhance nitrogen and water use efficiencies of crops tolerant to environmental stresses through best practice soil, water, crop and fertilizer management.

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

Technical Officer: S. Nielen

This CRP aims to make available new germplasm resources with improved yield and nutrient quality. It addresses the problem that most of the major staple crops are often deficient in essential vitamins and minerals and that more than 40% of the world's population suffer from malnutrition, with respect to micronutrients like vitamin A, iron and zinc. The strategies applied to reach the project's goal comprise utilizing efficient phenotypic screens and genotypic markers to identify in mutant collections individuals exhibiting traits of interest that would be incorporated into breeding programmes. Both the resulting genetic resources and the methodologies for identifying them constituted the main expected outputs from this CRP.

The project started beginning 2009 and had its first RCM in Vienna, Austria, 29 June–3 July 2009 and the second meeting in Pretoria, South Africa, 11–15 April 2011. Currently, 15 research groups from 13 countries (Botswana, Bulgaria, China, Denmark, Germany, Ghana, India, Kenya, Peru, South Africa, the United Kingdom, Ukraine and the United States of America) participate in the project, 10 under research contracts, three under research agreements and two under technical contracts. In course of the project, new mutant germplasm collections from elite varieties of the target crops wheat, barley, sorghum, soybean, groundnut, sweet potato and tomato have been developed. Efficient phenotypic screening methods for resistant starch, increased carotenoids and increased tocopherols were developed. These include colorimetric assays for phosphate and phytate for barley and wheat flour and for starch composition in maize and wheat and a method for HPLC analysis of some carotenoids (lutein, zeaxanthin, lycopene, beta-carotene). Various molecular marker techniques have been developed or adapted to local conditions and are being used to screen for genes affecting synthesis of resistant starch, increased carotenoids, decreased oxalate, decreased phytate and increased tocopherols. Among the markers systems developed are retrotransposon based marker for screening *solanaceae* and QTLs associated with Zn, Fe, Ca, Mg identified in potato.

The third RCM was held in Hangzhou, China; 15–19 October 2012 (see 'Past Events' section). The fourth and final RCM, where the outputs and outcome of this CRP are going to be assessed summarized and manuscripts for publication will be finalized is planned to be held in Cusco, Peru in April 2014.

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

Technical Officer: B.J. Till

Effective and efficient integration of induced mutations into breeding programmes for the development of improved crop varieties consists of a series of modules. These modules include optimized mutation induction to produce a population of plants harboring a mutation spectrum and density that increases the chance of recovering useful alleles controlling targeted traits. Phenotypic and genotypic screenings for mutants are two important modules in the pipeline in producing an improved mutant variety. Reverse-genetic strategies and special optimizations for vegetatively propagated crops are also modules to enhance efficiency in what might be considered prebreeding steps for mutant varietal development. This CRP focuses on these modules for enhancing the efficiency of induction and screening for induced mutations. The focus is on four target crops to serve as models for seed (barley and rice) and vegetative (banana and cassava) propagation. Counterparts continue with their work plans and progress was reported in all areas at the third RCM which was held in Vienna in June of this year. Highlights include (1) barley microspore mutagenesis that can be used to create, instantly, 100% homozygous true breeding lines, (2) next generation sequencing approaches being applied to rice and cassava for rapid mutation discovery, (3) methods for rapid dissolution of chimeric sectors in banana, (4) TILLING in barley for abiotic stress, and (5) friable embryogenic callus mutagenesis techniques developed for cassava. In the past six months, work has been initiated to develop low cost methods for rapid genotypic evaluation of putative doubled haploid barley plants in order to confirm that plants are truly homozygous and not escaped diploids. To expand datasets of mutation density and spectrum in cassava and to prepare a small pilot population for reverse-genetics by TILLING, a technical contract has recently been awarded to Mr Hua-Bing Yan of the Guangxi Academy of Agricultural Sciences in Guangxi, China. The work of this contract will produce approximately 800 mutagenized lines, from which DNA will be extracted and sent to the Plant Breeding and Genetics Laboratory in Seibersdorf for evaluation. The major outputs of this CRP will be protocols and guidelines aimed at supporting Member States in the efficient use of induced mutations for plant improvement.

The CRP was initiated in 2008. The first RCM was held in Vienna, Austria, 25–29 May 2009 and the second RCM was held in Vienna 13–17 December 2010. The third RCM also took place in Vienna 18–22 June 2012.

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

Technical Officer: P.J.L. Lagoda

This CRP started with a consultants meeting in 2008 in Vienna, Austria, gathering five experts (Austria, Germany, Israel, Switzerland and the United States of America), who were invited to present their work in the concurrent session number two of the International Symposium on Induced Mutations in Plants (ISIMP, Vienna, Austria). They worked out the proposal for this CRP on Plant DNA Damage, Repair and Mutagenesis. The first RCM was held in St. Louis, Missouri, USA in conjunction with the ninth International Plant Molecular Biology Congress (IPMB), 26–31 October 2009. Eight research contract holders from Argentina, Bulgaria, China, India, Republic of Korea and Poland and four agreement holders and consultants from Germany, Switzerland and the United States of America (two agreement holders), participated in this RCM. The second RCM was held in Vienna, Austria, 30 May–3 June 2011. The third RCM is scheduled to take place in Jeju Island, Republic of Korea as a satellite meeting during the third International Workshop on Plant Genetic Resources, 16–19 April 2013.

So far, a strategy for mutation breeding based on mismatch repair (MMR) suppression to widen the genetic diversity after mutagenesis is being developed. Suppression was achieved by reverse genetic selection of mutants or cultivars defective in MMR in tomato. The mutant lines are expected to have a wider spectrum of genetic alterations, such as base substitutions leading to enhanced mutation frequencies. It was also reported that deficiency in MMR can lead to both base substitutions and deletion mutations in the population even without mutagenic treatment, thus increasing frequency of spontaneous mutations in the population. This may allow targeting of novel loci which may not be amenable to chemical or physical mutagenesis. Since these lines are hypermutable, the mutant lines can be crossed back to the wild relative to restore the wild copy gene and stabilize the selected mutant trait.

A strategy for mutation breeding based on genetically unstable mutants (GUMs) is being studied. Interesting genetic observations about GUMs inducing narrow spectra of cytoplasmically inherited mutants from the barley chloroplast mutator genotype suggest that the gene responsible for the syndrome is DNA repair-related. It would be involved in maintaining genetic stability of the plastome. The normal vigour observed in some homozygous mutator plants indicates that failure of the repair mechanism involved in the mutator activity has no severe

effects in plant/cell viability, which opens up new perspectives for enhancing the efficiency of the process of mutation induction.

Fifty rice mutant lines were identified and catalogued (according to knowledge in Arabidopsis and other plant species), potentially harbouring genes involved in DNA damage response and repair. These lines will be the basis for further gene discovery and gene function analyses.

Technical Cooperation Field Projects

The Plant Breeding and Genetics Subprogramme currently has technical responsibility for the following technical cooperation projects that are managed by the IAEA's Department of Technical Cooperation.

Project Number	Country	Title and Objective(s)	Technical Officer
AFG/5/003	Afghanistan	Sustainable Increase in Crop Production in Afghanistan	S. Nielen/P.J.L. Lagoda in collaboration with Soil and Water Management and Crop Nutrition Section
ALG/5/026	Algeria	Increasing the Genetic Variability for the Improvement of Strategic Crops (Wheat, Barley, Chickpeas and Dates) for Enhanced Tolerance to Biotic and Abiotic Stresses and the Development of Biotechnology Capacities	M. Spencer/P.J.L. Lagoda
ANG/5/008	Angola	Using Nuclear Technology to Select Mutants of Cassava Resistant to the African Cassava Mosaic Virus and Various Diseases Affecting this Crop	S. Nielen/M. Spencer
BKF/5/009	Burkina Faso	Improving Voandzou and Sesame Based Cropping Systems through the Use of Integrated Isotopic and nuclear Techniques for Food Security and Poverty Alleviation	M. Spencer/P.J.L. Lagoda
BOT/5/009	Botswana	Using Radiation Technology and biotechnology to Develop Mutant Lines of Important Crops with Increased Yield and Improved Nutritional and Hygienic Qualities	A.M.A. Ghanim/S. Nielen
CAF/5/006	Central African Republic	Improving Cassava Production through High Yielding Varieties and Sustainable Soil Fertility Management by Using Isotopic and Nuclear Techniques to Ensure Sustainable Farming	M. Spencer/B. Till
COL/5/024	Colombia	Supporting Mutagenesis and Functinal Genomics Applied to the Improvement of Rice	B. Till/S. Nielen
ERI/5/008	Eritrea	Supporting the Livelihood of Barley Farmers thorugh Mutation Techniques and N15 Technology to Improve Malting, Food and Feed Barley Production	A.M.A. Ghanim/S. Nielen in collaboration with Soil and Water Management and Crop Nutrition Section
INS/5/037	Indonesia	Applying Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands	B.P. Forster/M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
INS/5/039	Indonesia	Enhancing Food Crop Production Using Induced Mutation, Improved Soil and Water Management and Climate Change Adaptation	B.P. Forster/M. Spencer
INT/5/150	Interregional	Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99)	P.J.L. Lagoda/B.P. Forster
INT/5/152	Interregional	Supporting Mutation Breeding Impact Assessment	P.J.L. Lagoda/B.P. Forster
IVC/5/031	Cote d'Ivoire	Improving Plantain and Cassava Yields thought the Use of Legume Cover Crops	M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section

Project Number	Country	Title and Objective(s)	Technical Officer
KAZ/5/002	Kazakhstan	Improving Wheat and Maize Using Nuclear and Molecular Techniques	F. Sarsu/S. Nielen
KAZ/5/003	Kazakhstan	Increasing Micronutrient Content and Bioavailaility in Wheat Germplasm by Means of an Integrated Approach	F. Sarsu/S. Nielen in collaboration with Soil and Water Management and Crop Nutrition Section
KEN/5/029	Kenya	Developing Appropriate Artemisia Varieties for Management of Malaria	F. Sarsu/M. Spencer
KEN/5/032	Kenya	Characterising and Improving Germplasm of Selected Crops at the Molecular Level Using Nuclear and Biotechnology Techniques	F. Sarsu/P.J.L. Lagoda
LES/5/001	Lesotho	Improving Crop Yield, Quality and Stress Tolerance for Sustainable Crop Production to Alleviate Hunger, Poverty and Environmental Degradation	M. Spencer/S. Nielen
MAG/5/022	Madagascar	Strengthening Food Security	M. Spencer/F. Sarsu
MAK/5/006	Macedonia, the Former Yugoslav Republic of	Improving Wheat, Barley and Triticale for Food and Feed in Drought-Prone Areas, Using Nuclear Techniques	F. Sarsu/S. Nielen
MAL/5/029	Malaysia	Applying Mutation Breeding and Optimized Soil, Nutrient and Water Management for Enhanced and Sustainable Rice Production	S. Nielen/M. Spencer
MAR/5/020	Mauritius	Developing Stress Tolerant Banana and Tomato Varieties by Enhancing the National Capacity in Mutation Induction and Biotechnology	M. Spencer/B. Till
MON/5/021	Mongolia	Improving the Productivity and Sustainability of Farms Using Nuclear Techniques in Combination with Molecular Marker Technology	M. Spencer in collaboration with Animal Production and Health Section
MOR/5/033	Morocco	Using Nuclear Techniques to Support the National Programme for the Genetic Improvement of Annual and Perennial Plants and to Develop Agricultural Production	M. Spencer/P.J.L. Lagoda
MYA/5/020	Myanmar	Strengthening Food Security through Yield Improvement of Local Rice Varieties with Induced Mutation (Phase II)	S. Nielen/P.J.L. Lagoda
NAM/5/009	Namibia	Using Mutation Breeding and Integrated Soil Plant Management Techniques to Develop Sustainable, High Yielding and Drought Resistant Crops	F. Sarsu/M. Spencer in collaboratin with Soil and Water Management and Crop Nutrition Section
NAM/5/010	Namibia	Developing High Yielding and Drought Resistant Pearl Millet (*Pennisetum glaucum* L.), Sorghum Bicilor (L) Moench, Bambara Groundnut (*Vigna subterranea*) and Cowpea (*Vigna unguiculate* (L) Walp) Following Up a Previous Project (Phase II)	F. Sarsu/M. Spencer
NEP/5/001	Nepal	Improving Nepalese Cardamom Using nuclear and Molecular Techniques	S. Nielen/F. Sarsu
NER/5/015	Niger	Improving Productivity of Millet-Cowpea Cropping System through Development and Dissemination of Improved Varieties and New Water and Fertiliser Management Techniques	M. Spencer/S. Nielen in collaboration with Soil and Water Management and Crop Nutrition Section

Project Number	Country	Title and Objective(s)	Technical Officer
OMA/5/002	Oman	Assessing the Suitability of Sterile Insect Technique (SIT) and Related Techniques for Combating Date Palm Insect Pests	P.J.L. Lagoda in collaboration with Insect Pest Control Section
PAK/5/047	Pakistan	Developing Germplasm through TILLING in Crop Plants Using Mutation and Genomic Approaches	B. Till/S. Nielen
PAL/5/005	T.T.U.T.J. of T. Palestinian A.	Improving Local Palestinian Wheat and Barley Varieties for Salt and Drought Resistance through Mutation Breeding and Biotechnology	B.P. Forster/P.J.L. Lagoda
RAF/5/056	Regional Africa	Field Evaluation and Dissemination of Improved Crop Varieties Using Mutation Breeding and Biotechnology Techniques	F. Sarsu/M. Spencer
RAF/5/066	Regional Africa	Improving Crops Using Mutation Induction and Biotechnology through a Farmer Participation Approach (AFRA)	F. Sarsu/M. Spencer
RAS/5/048	Regional Asia	Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA)	P.J.L. Lagoda/F. Sarsu
RAS/5/056	Regional Asia	Supporting Mutation Breeding Approaches to Develop New Crop Varieties Adaptable to Climate Change	S. Nielen/P.J.L. Lagoda
RAS/5/058	Regional Asia	Supporting Mutation Induction and Supportive Breeding and Biotechnologies for Improved Wheat and Barley – Phase II	P.J.L. Lagoda/F. Sarsu
RAS/5/064	Regional Asia	Enhancing Productivity of Locally-Underused Crops through Dissemination of Mutated Germplasm and Evaluation of Soil, Nutrient and Water Management Practices	P.J.L. Lagoda/S. Nielen in collaboration with Soil and Water Management and Crop Nutrition Section
RAS/5/065	Regional Asia	Supporting Climate-Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications	P.J.L. Lagoda/S. Nielen in collaboration with Soil and Water Management and Crop Nutrition Section
RER/5/017	Regional Europe	Enhancing Productivity and Quality of Major Food Crops	S. Nielen/F. Sarsu
RLA/5/056	Regional Latin America	Improving Food Crops in Latin America though Induced Mutation (ARCAL CV)	M. Spencer/S. Nielen
RLA/5/063	Regional Latin America	Supporting Genetic Improvement of Underutilized and Other Important Crops for Sustainable Agricultural Development in Rural Communities (ARCAL CXXVI)	M. Spencer/S. Nielen
SAF/5/012	South Africa	Analysing the Level of Drought Tolerance in Mutant Gerplasms of Cowpea and Amaranthus Using Molecular Biotechnology	S. Nielen/M. Spencer
SEN/5/034	Senegal	Using an Integrated Approach to Develop Sustainable Agriculture in a Context of Degrading Soil Fertility, Climate Change and Crop Diversification	F. Sarsu/M. Spencer
SUD/5/030	Sudan	Increasing productivity of Selected Crops Using Nuclear Related Techniques	F. Sarsu/M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section

Project Number	Country	Title and Objective(s)	Technical Officer
SUD/5/033	Sudan	Enhancing Productivity of Major Food Crops (Sorghum, Wheat, Groundnut and Tomato) under Stress Environment Using Nuclear Techniques and Related Biotechnologies to Ensure Sustainable Food Security and Well-Being of Farmers	F. Sarsu/M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
TUR/5/025	Turkey	Using Molecular Techniques for Enhancing the Efficiency of Mutation Induction and Utilization of Mutants in Agriculture	F. Sarsu/M. Spencer
UZB/5/004	Uzbekistan	Development of Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity	S. Nielen/P.J.L. Lagoda
UZB/5/005	Uzbekistan	Developing Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity (Phase II)	F. Sarsu/S. Nielen
YEM/5/008	Yemen	Introduction of Gamma Ray Irradiation Techniques for Agriculture Purposes	F. Sarsu/S. Nielen
YEM/5/010	Yemen	Using Induced Mutations and Efficiency Enhancing Bio-molecular Techniques for Sustainable Crop Production	S. Nielen/P.J.L. Lagoda
ZAI/5/019	Democratic Rep. of the Congo	Developing Mutations, In Vitro and Molecular Techniques for Further Dissemination to Breeders and Pharmaceutical Plant Producers to Enhance the Livelihood of Target Populations	M. Spencer/F. Sarsu
ZAM/5/027	Zambia	Developing Maize Genotypes for Drought and Low Soil Fertility Tolerance	F. Sarsu/M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
ZIM/5/013	Zimbabwe	Development of Drought Tolerant and Disease Resistant Grain Legumes, Phase I	M. Spencer/S. Nielen
ZIM/5/015	Zimbabwe	Development of Drought Tolerant and Disease/Pest Resistant Grain Legume Varieties with Enhanced Nutritional Content, Phase II	M. Spencer/S. Nielen

For details, see the IAEA Technical Cooperation Programme's Website at:

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

TC Project Highlights

Supporting Genetic Improvement of Underutilized and Other Important Crops for Sustainable Agricultural Development in Rural Communities (ARCAL CXXVI), RLA/5/063

The symposium on 'Induced Mutations in Crop Plants: A Powerful Tool for Biology and Plant Breeding' was held at the XV Latin American Congress of Genetics in the city of Rosario, Argentina, 28–31 October 2012. One thousand researchers and students from different universities out of 26 different countries (mostly from Latin America) participated in this congress. The symposium was coordinated by Dr Alberto Prina, from 'Ewald A. Favret Genetics Institute' (IGEAF), INTA, Argentina. Dr Prina presented an overview on the history and success of plant improvement through induced mutations worldwide in general and specifically for Argentina. The panel of speakers included three eminent lecturers from IAEA/ARCAL projects on induced mutations for plant breeding. These projects aim at the dissemination of the use of nuclear energy for peaceful purposes in Latin America:

(1) Dr Luz Gomez Pando from the Cereals Improvement Programme, Faculty of Agronomy, Agricultural University of La Molina, Peru on 'Native Grains Breeding Using Mutation Induction in Peru',

(2) Dr Augusto Tulmann Neto from the Nuclear Energy Center for Agriculture, University of Sao Paulo, Brazil on 'Induction and Use of Mutations In Vivo and In Vitro for Improvement of Vegetatively Propagated Plants',

(3) Dr Alejandra Landau from IGEAF, Argentina on 'TILLING and its Adaptation for Detection of Mutations in the Barley Plastome'.

The private sector was represented by Dr Carlos Sala from NIDERA SA, who talked about 'Getting Genes and Development of Technologies for Herbicide Tolerance through Mutagenesis'. This symposium was the result of the impetus coming from ARCAL projects for the interaction of the research groups from different Latin American countries. It is worth mentioning that despite the existence of several activities in parallel to this symposium, the subject attracted a large number of attendees. This could be taken into account for planning future activities or courses on induced mutations in the region.

Dr Alberto Prina
Instituto de Genética Ewald A. Favret
Instituto Nacional de Tecnología Agropecuaria
Argentina

News

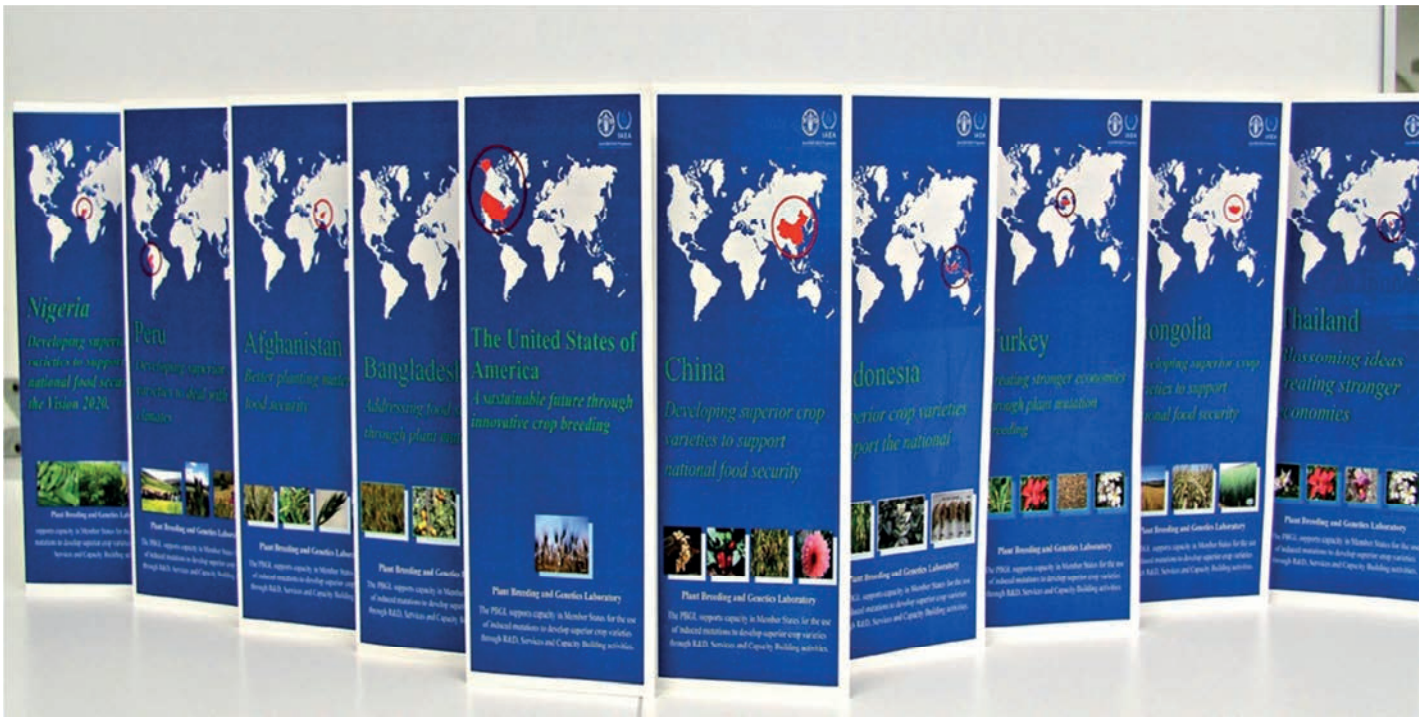
Information sheets for visitors

A sad fact of life is that plant breeders are a modest bunch of people. This can be a problem in a world where '*the baby that cries the most gets the most milk*'. It is imperative that we advertise our successes (and we have plenty of them); there are over 3000 officially registered mutant varieties in over 200 crops species. One way in which the PBGL flags successes in mutation breeding is we now ask our fellows to produce 'Information Sheets for Visitors (ISfV)' for their country, which gives information on problems, crops, recently released mutant varieties and collaborations with the Joint FAO/IAEA Division.

Many of the fellows at the Plant Breeding and Genetics Laboratory (PBGL) come for training in mutation breeding specifically to tackle problems in their home country, such as drought and salinity tolerance. But these fellows also come with great success stories. Hand-out gives information on target crops, breeding objectives, mutant varieties released (successes), training at the PBGL and collaborations with the Joint FAO/IAEA Division. Each ISfV is unique; each country has its own problems and each can boast success in mutation breeding. We currently have fliers for:

- Afghanistan
- Bangladesh
- China
- Indonesia
- Mongolia
- Nigeria
- Peru
- Thailand
- Turkey
- USA

Do you have a mutation breeding success story in your country and would like to produce an ISfV? If so, please contact us.



Information Sheets for Visitors (ISfV)

Press Release

Five Decades of Achievement, Future Challenges in Focus at Ceremony Marking IAEA Labs Anniversary

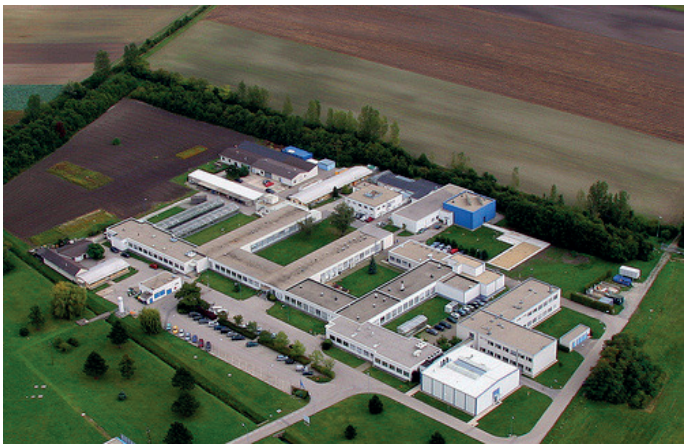


Photo credit: Claus Gaggl, IAEA

In the 50 years since they opened, the IAEA's laboratories in Seibersdorf have improved the lives of millions of people through work using sophisticated scientific techniques, IAEA Director General Yukiya Amano said at a ceremony to mark the anniversary.

Work at the labs has made a difference in controlling animal diseases in more than 30 countries in Africa and Asia, and contributed to the development of hardier and more nutritious crops such as barley that can grow in the High Andes of Peru. Scientists at the labs have helped communities identify the best sources of underground water and ensure that this scarce resource is used effectively. They have worked on safe ways to preserve food, and provided vital technical support for cancer treatment and other medical uses of nuclear technology.

New challenges abound in the present and the future, Director General Amano said.

'Member States want us to do more in almost all areas of nuclear applications. This includes climate-smart agriculture, with priority on helping countries to adapt to climate change while improving food security'.

'It includes improving preparedness for responding to nuclear emergencies and especially for dealing with radiological contamination in food and agriculture'.

Photo credit: Dean Calma, IAEA

The Director General also said the IAEA would contribute more to controlling mosquitoes that transmit malaria by using techniques that, together with pest control programmes, have helped control other insects.

IAEA scientists at the eight nuclear applications laboratories and the safeguards laboratories carry out research and development and provide technical services to the IAEA's 158 Member States. The labs also regularly host fellows and scientific visitors, with more than 10000 benefiting from this opportunity to learn in the past 50 years.

28 November 2012, Vienna

Staff of the Plant Breeding and Genetics Laboratory and Plant Breeding and Genetics Section at the celebration of the 50th anniversary of the Seibersdorf NA Laboratories

Developments at the Plant Breeding and Genetics Laboratory, Seibersdorf

2012 has been a dynamic and exciting year for the Plant Breeding and Genetics Laboratory (PBGL). We are delighted that our staffing has been reinforced by the appointment of Mr Abdelbagi Mukhtar Ali Ghanim, who takes up responsibilities for developing efficient high-throughput phenotypic screens for target mutant traits, and in developing accelerated methods for advancing mutant lines (pre-breeding). Both of these activities are seen as being essential in responding to urgent needs of our Member States. The appointment of Abdelbagi allows us to build bridges between genotype and phenotype by assigning traits (functions) to gene mutations, and importantly provides a bridge between our R&D activities and practical plant breeding in developing protocols for screening. Salt tolerance screening has been high on our agenda for many years and this year we have provided a protocol on a hydroponics screen for rice. New developments in phenotyping include extending the salt tolerance screen to other cereal crops and developing a new simple screen for drought tolerance.

Other news items include: the 50th Laboratory Anniversary celebrations; glasshouse refurbishments; and protocols (see below). But perhaps the most exciting news is the planned modernisation of the IAEA Laboratories at Seibersdorf in 2017. At the IAEA's annual General Conference a resolution was passed to modernise the Agency's Laboratories. Each laboratory has been asked for its 'Vision' and the vision for the PBGL is:

- To be relevant and ready to meet future demands of Member States in crop production.
- Help more countries, especially developing countries; establish plant mutation breeding programmes to safeguard food security.
- To have state of the art training facilities so that more fellows can be trained in the best conditions.
- Develop and provide better induced mutation methods using nuclear technologies.
- Develop and provide more efficient mutation detection methods (protocols) for efficient screening in plant breeding programmes.
- Speed up mutation breeding so that the time from mutant induction to mutant variety release is cut, e.g. from 10–15 years to 2–5 years for annual crops.
- To be fully engaged in cutting edge science and technology by forming strategic collaborations with centres of excellence.

Mutation breeding to meet the challenges of the Millennium

Demand on mutation breeding to contribute to sustainable global food security and livelihood is increasing with experiences of climate change in the form of warming, drought and flooding and the limited crop genetic variability for adaptation. Mutation breeding is the lasting hope to generate genetic variability needed to enable our food crops to adapt to changing environments. Mutation Breeding needs to be more visible and streamlined in the national crop breeding programmes through building of simple technology and efficient pre-breeding techniques to handle mutant populations. Emphasis will be on development of mutation induction protocols using X rays in combination with chemical mutagenesis. Considering the restrictions and difficulties of installing new gamma sources, X ray machines provide a viable option to facilitate wide use of mutation breeding. Protocols to screen for desirable mutants through phenotyping of mutant populations are crucial to identify lines tolerant to heat stress, drought and salinity and resistant to threatening pests and diseases. Specific areas that will be emphasized in the short term are:

- Developing and disseminating protocols for mutation inductions and detections e.g. X ray mutagenesis with or without chemical mutagenesis and use of non-destructive X ray imaging for mutant detection.
- Enhancing pre-breeding capability for efficient mutation breeding through development of crossing protocols for major crops (cereals) and integration of irradiation technology for haploid production to accelerate identification of mutants and development of diverse pure lines for new hybrid varieties production.

Create and validate phenotyping protocols for mutant identification and evaluation e.g. drought tolerance in glass-house and drought prone areas

Genotyping to detect mutation

One focus of adaptive research and development in the Plant Breeding and Genetics Laboratory is the development of low-cost molecular methods that are suitable for developing Member States. Pre-prepared kits for basic applications such as DNA extraction have been a boon for molecular biologists as they combine ease-of-use with speed, precision and accuracy. The downside, however, is that many such kits are costly, and some require specialized equipment. Costs can be greatly reduced by creating

home-made kits. Yet, such methods require extensive testing to ensure that accuracy and precision are suitably high for downstream applications. The PBGL is currently developing and testing methods for DNA extraction that use standard buffers and inexpensive binding agents. Preliminary results show that high quality DNA for downstream applications such as molecular markers and TILLING can be produced for less than 10 cents per sample. Long term stability tests and optimizations are ongoing. We hope to have a standardized method to share with MSs in 2013. Tests are also ongoing for species that are recalcitrant for DNA extraction due to high levels of secondary metabolites or other compounds. While high quality DNA has been achieved from species such as grapevine, optimization to increase DNA yield per gram weight of tissue are currently being performed. Another low-cost method, mutation discovery using crude celery juice extract followed by agarose gel electrophoresis for band detection, has been previously developed by the PBGL. Positive controls for this method are available as a kit we supply to MSs (see http://mvgs.iaea.org/laboratoryprotocols.aspx). Combined with low cost DNA extraction, basic mutation discovery methods can be applied in most laboratories with minimal infrastructure for molecular biology.

The PBGL has also been adapting these low cost methods to evaluate the frequency of successful production of doubled haploid (DH) plants. Doubled haploidy is a major tool in plant breeding as it allows the immediate fixation of nucleotide variation in a homozygous state resulting in true breeding plants. This can reduce the time to create a new crop variety by years. One issue, however, is that in the process of creating DH plants, some may not be DH, but rather heterozygous diploids. These plants need to be detected rapidly and removed from the test population. As part of the Coordinated Research Project on Enhancing the Efficiency of Mutagenesis through an Integrated Biotechnology Pipeline (D2.40.12), the PBGL has been working with Mr Jochen Kumlehn of the IPK in Gatersleben, Germany to develop a low cost method to evaluate loss of heterozygosity in putative DH lines. We are currently comparing the efficacy of molecular marker approaches alongside of anchored SNP discovery methods with the goal of establishing a low-cost method that maximizes the chance of discovering potentially rare heterozygosity in diploids so that these plants can be excluded from true DH material.

The PBGL continues its efforts to develop methods to enhance the efficiency of induction and screening of induced mutations in plants. In vegetatively propagated species, one issue affecting the efficiency of using induced mutations is chimerism. Chimerism results from mutagenesis of multicellular tissues where different cells accumulate different mutations randomly throughout their genomes. In seed propagated species, chimerism is largely only an issue with M_1 material. In vegetatively propagated species, however, chimerism can potentially remain throughout many mitotic cell divisions. The PBGL has been investigating the effect of meristem mutagenesis on chimerism in triploid banana. With the chemical mutagen EMS, mutagenized meristem cells rapidly sort and a single genotype is fixed in most plants within one month post-treatment. This is much faster than previous studies suggested. This may be due to the type of mutagen or genotype tested, or may be due to the fact that this is the first study evaluating specific changes in the DNA sequence caused by mutagenesis, allowing for a much more sensitive investigation. This work is now published in the Plant Biotechnology Journal (see publications list). To investigate DNA changes in the banana genome we used what can be considered the traditional TILLING techniques of enzymatic mismatch cleavage followed by fluorescence band detection. Higher throughput methods are now becoming available to discover and characterize mutations in plant genomes. The PBGL has recently begun developing a next generation sequencing laboratory based on the Illumina MiSeq platform. Equipment is still arriving to the laboratory and it is expected that it will be fully operational in early 2013. Initial efforts are aimed at reduced representation genome sequencing to get a snapshot of the effects of different mutagens and dosages on the genomes of different seed and vegetatively propagated crops.

Professional networking

Frequent readers of our newsletter are aware that the PBGL and Plant Breeding and Genetics Section developed a LinkedIn profile (http://at.linkedin.com/pub/iaea-plant-breeding-and-genetics/31/4b6/aa3). If you have not already done so, we encourage you to link with us. We hope to create a large network of scientists interested in induced mutations and crop improvement. We have now accepted 21 members to our LinkedIn discussion group called IM PLANTS (Induced Mutations in Plants). The aim is to create a resource where experts can share views and advice on topics surrounding induced mutations and plant breeding.

Irradiation services

In 2012 a total of 37 requests were made for gamma and X ray irradiation for mutation induction. Our July 2012 Newsletter lists seven requests during the first six months of 2012, since then 30 further requests for our irradiation services have been made, these are listed in the table below. In some cases the requestors provide details of the irradiation dose to be used, but in others we perform radio-sensitivity tests to determine the most effective dose for mutagenesis, or in some cases to improve seed germination. Mutation induction is required to provide the necessary genetic variation for exploitation in breeding, this is particularly critical in crop species that have a very narrow genetic base, such as groundnut.

Member State	Species
Yemen	Garlic
Spain	Arabidopsis
Netherlands	Ornamentals (Argyranthemum, Geranium, Persicaria and Helenium)
Italy	Strawberry
Mongolia	Barley and Wheat
Bangladesh	Jute
India	*Withania somnifera*
UK	Barley, Wheat and Ornamentals (*Alcea rosea, Ipomea purpurea* and *Petunia multiflora*)
Botswana	Cowpea and Maize
Nigeria	Okra
Zimbabwe	Cowpea (*Vigna ubuiculata* and *V. subterrannea*) and Groundnut
Sudan	Sorghum and Wheat
Kenya	Cowpea, Sorghum and Wheat
Kuwait	Barley

Celebration of the 50th anniversary of the Seibersdorf NA Laboratories

IAEA Director General Amano visits the PBGL display as part of the 50th anniversary celebration

The IAEA Laboratories at Seibersdorf were honoured in a ceremony held on 28 November at the Vienna International Centre (VIC). Eight Nuclear Applications laboratories and Safeguards-related laboratories make up the different components of the IAEA Laboratories at Seibersdorf.

An exhibit with interactive display, opened by IAEA Director General Yukiya Amano outside the Boardroom, remained on show for two days. Journalists were invited to the ceremony and the exhibit opening as well as a press tour of the laboratories ahead of the anniversary.

The Nuclear Applications laboratories provide support to the IAEA's Member States in their efforts to address developmental needs through the peaceful uses of nuclear science and technology. Work carried out at the laboratories includes food and agriculture, human health, environmental monitoring and assessment, and the use of nuclear analytical instruments. The laboratories provide applied research and development, training and capacity-building, and technical and analytical services. Hundreds of trainees and young scientists from developing countries take part each year in training courses, workshops and seminars.

Thanks to research carried out at the laboratories in the past five decades, farmers in several developing countries are better off: for example, tools developed by the Joint FAO/IAEA Agriculture and Biotechnology Laboratories helped to develop improved plant varieties such as drought tolerant wheat, barley that can be grown at higher altitudes, and varieties of rice that flourish in saline and acidic coastal soils.

At the IAEA's 56th General Conference, held in September 2012, Member States called for the modernization of the Nuclear Applications laboratories, which were first opened in 1962. An extension of the Safeguards Clean Laboratory was inaugurated in 2011, and a new safeguards-related Nuclear Materials Laboratory is under construction.

Protocols

A major activity for the PBGL is the development and publication protocols, these are primarily targeted for practical use in mutation breeding programmes and teaching aids. Relevant protocols are made available to all interested parties including our fellows, visitors and trainees.

New

- Mutation induction using X ray irradiation of seed
- Salt tolerance hydroponics
- Barley crossing, normal and with irradiated pollen
- Wheat crossing, normal and with irradiated pollen

Up-dated

- Laboratory manual: Molecular characterization of mutant germplasm, 2012.

Human capacity development

Fellowship training – Individual training

Name	Country	Area of training	Period
Mr Sekander HUSSAINI	Afghanistan	• Enhancing crop productivity through mutation breeding and pest contro	16 May–17 September 2012
Mr Mohammad ALI	Bangladesh	• Mutation induction and detection, with special reference to abiotic stress tolerance. Training in collaboration with the Soil and Water Management and Crop Nutrition Laboratory	4 June–1 September 2012
Ms Mayada BESHIR	Sudan	• Mutation induction and detection using molecular techniques such as TILLING	19 November 2012–19 February 2013

Fellowship training – Individual training

Regional training course on 'Methodologies and mechanisms for screening against stresses', 4–8 June 2012:

Participants	Country
Mr Waleed AL-DOORI	Iraq
Mr Adel AL-GAYYAR	
Mr Hussein AL-MAHDAWI	
Ms Maisa'a HADDADIN	Jordan
Ms Afaf MADADHA	
Ms Faten RAAD	Lebanon
Ms Ibtihal AL-RAISI	The Sultanate of Oman
Mr Mohammed ALMUWALLD	Saudi Arabia
Mr Abdulmajeed KHASHOGGI	
Mr MAjeid ABOD	Syrian Arab Republic
Mr Nawrez TAHIER	
Mr Mansour THABET	Yemen
Mr Nagi ZAID	
Mr Sekander HUSSAINI	Afghanistan[1]

Participants	Country
Mr Mohammad ALI	Bangladesh[1]
Ms Prabhavathi TALLOJI	India[2]
Ms Svetlana TURASHEVA	Kazakhstan[2]

[1]Fellows at the PBGL, who also attended the training course

[2]Students from BOKU, who also attended the training course

Fellows receiving training on methods for genetic crosses of cereals

Cost-free scientific visitors

Cost-free scientific visitors come to the PBGL for training using their own funds.

Name	Country	Areas of training	Period
Ms Myagmarsuren YAD-AMSUREN	Mongolia	• Mutation breeding in wheat, drought tolerance	6–17 August 2012
Mr Rezq SALIMIA	T.T.U.T.J. of T. Palestinian A.	• Mutation breeding in cereals	1–15 October 2012
Mr Ayed SALIMIA	T.T.U.T.J. of T. Palestinian A.	• Mutation breeding in cereals	1–15 October 2012
Mr Garuba OMOSUN	Nigeria	• Mutation induction in vegetable crops	1–30 October 2012
Mr Ndiku Sebastien LUYINDULA	Democratic Republic of the Congo	• Mutation breeding technologies	5–14 November 2012

Consultants

Name	Country	Areas of expertise	Period
Mr Heru RUSFIANDI	Indonesia	• Pollen irradiation	15 May–16 November 2012
Ms Biguang HUANG	China	• Mutation breeding	1 July–31 December 2012

PhD student

Name	Country	Topic (University	Period
Ms Farzaneh TAASSOB SHIRAZI	Islamic Republic of Iran	Rapid introgression strategies for mutant genes (BOKU University, Austria)	January 2012–December 2014

Barley chromosome walk

A popular field demonstration set up by the PBGL and used for training purposes is the 'Barley Chromosome Walk'. This demonstration exhibits barely mutants backcrossed into a common genetic background, the cultivar 'Bowman' (work carried out by Prof Jerome Franckowiak, Agri-Science Queensland, DEEDI, Australia). For demonstration purposes the mutants are organized according to their chromosomal location (chromosome group and aligned according to locus position along the chromosome). A list of selected mutants grown in 2012 is given in the table below. Many of these mutants have been utilized in plant breeding, notably the semi-dwarf and early maturity mutants; others are of interest in current and future breeding. The PBGL is not a repository for germplasm, but we can facilitate seed transfer and have made seed available to workers in Islamic Republic of Iran, Mongolia, Peru and Poland.

Fellows from the regional group training course with demonstrator, Dr William Thomas (the James Hutton Institute, UK) at the 'Chromosome walk demonstration'

Chromosome 1H	
Mutant gene	**Phenotype**
Cer-yy.849	Eceriferum, glossy spike
fch3.d	Chlorina seedling, pale green leaves
lel1	Leafy lemma
vrs3.f	Six-rowed spike
nec1.a	Necrotic leaf spot
Blp1.b	Black lemma and pericarp
trd1.a	Third outer glume
eam8.k	Early maturity
Sil1.a	Short sub-crown internode
cur5.h	Short coiled leaves, coiled awns
cer-zi.68	Reduced wax on spike, leaf sheath and stem
cer-e.8	Greatly reduced or no wax coating on spike
ert-b.2	Compact spike, reduced rachis internode length
cud2.b	Curly lemma and awn, curved stem internodes
rvl1.a	Rolled leaf tips
Chromosome 2H	
gsh1.a	Lazy dwarf
Eam1.c	Albino lemma

cal-a.1	Brachytic dwarf
com2.g	Slender dwarf
eog1.a	Slender dwarf
cur4.f	Multiflorous
acr1.a	Semi-dwarf (denso)
Vrs1.t	Pubescent, hairy leaf blade
vrs1.a	Lack of anthocyanin pigment
Lks1.b	Yellow streaks on leaf, stem and spike.
Pre2.b	Incomplete cover of caryopsis by lemma and palea
lig1.my	Yellow streaks on leaf, stem and spike develop in cold temperatures
gsh5.m	Plants about 75% shorter than Bowman
glo-c.1004	Brevi-aristatum, ahort awn
sdw.aw	Reduced surface wax on spike
cer-n.20	Very narrow white stripes
wst4.d	Leaf sheath and blade develop white stripes in low temperatures
ant2.h	Additional spikelets
Pvc1.a	Glossy sheath due to reduces surface wax
fol-a.1	Semi-dwarf, short narrow erect leaves
wst7.k	Numerous thin tillers with narrow leaves and short
Chromosome 3H	
alm1.a	Albino lemma
Brt1/Brt2	Brachytic dwarf
sld1.a	Slender dwarf
sld5.h	Slender dwarf
mul1.a	Multiflorous
sdw1.d	Semi-dwarf (denso)
Pub1.a	Pubescent, hairy leaf blade
seg3.c	Lack of anthocyanin pigment
yst3.c	Yellow streaks on leaf, stem and spike
smn1.a	Incomplete cover of caryopsis by lemma and palea
yst2.b	Yellow streaks on leaf, stem and spike develop in cold temperatures
brh8.ad	Plants about 75% shorter than Bowman
ari-a.6	Brevi-aristatum, ahort awn
cer-zn.244	Reduced surface wax on spike
wst1.a	Very narrow white stripes
wst6.j	Leaf sheath and blade develop white stripes in low temperatures
int-e.58	Additional spikelets
gsh2.f	Glossy sheath due to reduces surface wax
sdw2.b	Semi-dwarf, short narrow erect leaves

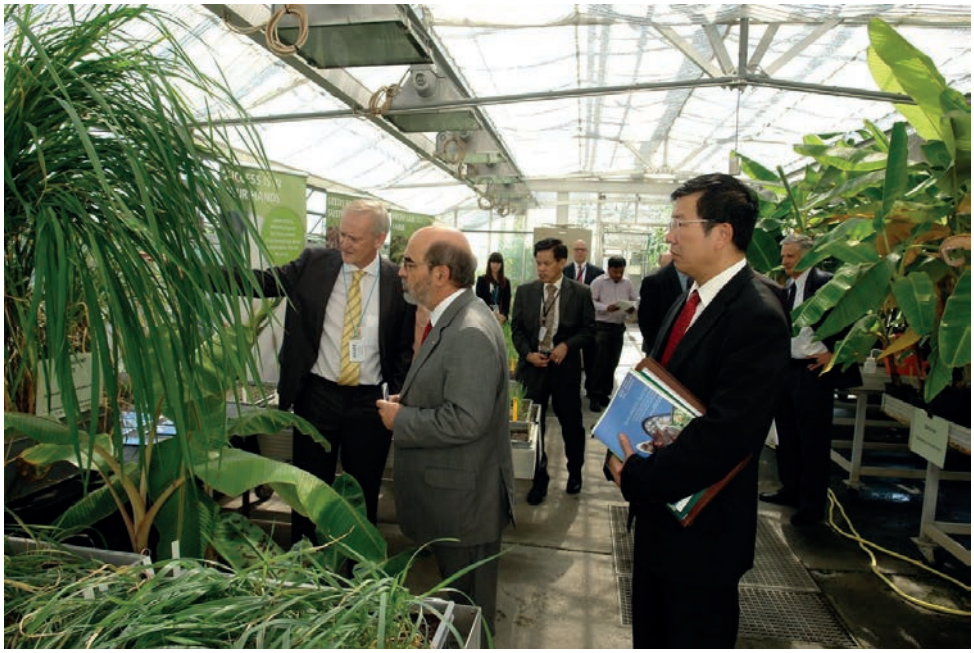
gra-a.1	Numerous thin tillers with narrow leaves and short
eam10.m	Early maturity
Chromosome 4H	
int-c.5	Intermedium 2-6 row spike
glo-a	Globosum, round caryopsis
flo-a.1	Extra floret
Kap1.a	Hooded lemma
lks5.f	Short awn
mnd1.a	Many noded dwarf
fch9.k	Seedlings yellow/green, pale colour persists until near maturity
Zeo3.h	Short, compact spike
sld3.e	Short plant, 75% fewer spikelets per spike
glo-a.1003	Globosum, globe-shaped kernels
lgn4.d	Light green seedlings and plants
eam9.l	Early maturity, photoperiod insensitivity
brh2.b	Short plants, short awns and low vigour
glf3.d	Glossy leaf due to lack of surface wax
Blx1	Blue aleurone
Hin1.a	Hairs on lateral lemma nerve
Hsh1.a	Hairy leaf sheath base
yhd1.a	Ivory or pale yellow spike
Chromosome 5H	
cul	Uniculm, non-tillering
brh18.ac	Brachytic dwarf
Ert-r.52	Erectoides, compact spike, dwarf plant
fst1.d	Fragile stem
lax-a.8	Laxatum, lax spike, 5 anthers per floret.
com1.a	Compositum, branched spike
ari-e.GP	Brevi-aristatum, short awn, erect dwarf
raw1	Smooth awn (in Bowman)
crl1.a	Curly lateral
mnd6.6	Many noded dwarf
desi6.i	De-synaptic, partial sterility
brh17.ab	Short stature, reduced awn length, short rachis internodes
Rph2.y	Seedling rust resistance
fst1.a	Fragile stem and leaves
blf1.a	Broad leaf blades, crinkled leaf margins
cer-zp.313	Reduced wax on leaf blade, leaf blades rolled with light green and white zones

cer-ye.267	Reduced wax on leaf blade
ert-g.24	Compact spikes due to reduced rachis internodes
srh1.a	Short rachilla hairs
cer-i.16	Glossy spike due to lack of surface wax
mtt2.b	Mottled, yellow-ivory banding on leaf blades in young plants
dsk1.a	Premature dehydration of spikes after heading, turning olive-grey
var1.a	Narrow white stripes on young leaves
Eam5.x	Early heading in short days
mnd4.e	Many noded dwarf, many tillers
brh6.s	Reduced height and leaf length
yst5.e	Second and subsequent leaves yellow-green
Chromosome 6H	
nec3.d	Necrotic leaf spot
rob1.a	Orange lemma
lys6.i	High lysine in kernels
lax-c.3	Laxatum, lax spike
cur3.e	Curly
dsp9.i	Dense spike
ari-i.38	Short awn, dwarf
fch11.7	Pale green seedlings often with white blotches, remains pale green until maturity
mtt5.f	Mottled bands on leaf blade and sheath
Chromosome 7H	
Lga1.a	Long glume awn
wnd1.a	Winding dwarf, winding peduncle
ert-a.6	Erectoides,erect dwarf
sex6.h	Shrunken endosperm xenia
nud1.a	Naked caryopsis
seg1.a	Shrunken endosperm
Nec6.h	Necrotic leaf spot
cur	Curly
ops1	Opposite spikelets
pyr.af	Pyramidal spike

Visitors to the PBGL

The PBGL welcomes and receives a wide range of visitors. These include students, researchers, reporters, national representatives, ministers, directors and ambassadors.

Some VIP visitors to the PBGL: Dr José Graziano da Silva, FAO Director-General; Prof Steven Chu, US Secretary of Energy; HRH Princes Bajrakitiyabha, ambassador and resident representative of Thailand to the IAEA.



From left to right - foreground: Mr Brian P. Forster (Laboratory Head, NAFA), Dr José Graziano da Silva (FAO Director-General), Mr Qu Liang (Director, Joint FAO/IAEA Division)

From left to right: Ms Katherine Long (Programme Officer, NAFA), Mr Brian P. Forster, Mr Andy Garner (NA Programme Coordinator), Ms Meera Venkatesh (Director, Physical and Chemical Sciences Division), Prof Steven Chu (US Secretary of Energy), Mr Bradley J. Till (Plant Breeder/Geneticist, NAFA); Mr Rethy Kieth Chhem (Director, Human Health Division)

Mr Brian P. Forster showing country fliers to HRH Princes Bajrakitiyabha (Ambassador and Resident Representative of Thailand to the IAEA) in in vitro culture laboratory

Plant Breeding and Genetic Laboratory staff travels to Member States

Mr B.P. Forster

Muscat, the Sultanate of Oman

- Four day visit to the Sultanate of Oman: Expert mission mutation breeding with respect to a TC project, OMA/5/002, 13–16 October 2012.

Invergowrie, Scotland, UK

- Two day visit to the James Hutton Institute, Invergowrie, Scotland, UK to collect barley mutant lines for collaborative research and development activities, 22–23 October 2012.

Makassar, Indonesia

- Assessment and Planning Meeting on Enhancing Food Crop Production Using Induced Mutation, Improved Soil and Water Management and Climate Change Adaptation, INS/5/039, 18–22 February 2013.

Brian P. Forster will be visiting Batan and Makassar in Indonesia to help set up this TC project. The objectives of the mission are to visit the research sites in Java and Sulawesi and to assist in developing a work plan, team and strategy. As part of this project a training course is to be held at the PBGL in 2013 on 'Plant Mutation Breeding' involving six trainees from Indonesia.

Mr B.J. Till

Quatre-Bornes, Mauritius

- To review progress in activities associated with TC project MAR/5/020 on Developing Stress Tolerant Banana and Tomato Varieites by Enhancing the National Capacity in Mutation Induction and Biotechnology, 26–30 November 2012.

New faces in the PBGL

Mayada Beshir (Fellow, Sudan), Biguang Huang (Consultant, China) and Abdelbagi Ali Ghanim Mukhtar (Technical Officer, Sudan)

Glasshouse refurbishments

The glasshouses at the PBGL were donated by the USA some thirty years ago and designed specifically for growing tropical crops. Work has focused on rice, banana and cassava. We estimate that over a thousand fellows have been trained in these glasshouses over the years. The glasshouses are an essential resource for both our R&D and training activities, but are now showing their age and in need of up-grading. The PBGL along with the Soil and Water Management & Crop Nutrition Laboratory (SWMCNL) have received €300 000 for glasshouse refurbishments. Safety issues are our primary concern, but in addition the glasshouses will be refurbished to provide growing conditions for temperate crops such as wheat and barley and to provide facilities for 'Climate smart agriculture', such as investigations into temperature tolerant mutants.

Collaborations with BOKU University

A paradigm in today's research environment is that science cannot be done in isolation. The best science is done in collaboration with centres of excellence that share common interests but which have complementary skills. We are very pleased to report that 2012 has seen increased collaborations between the PBGL and BOKU (Agricultural University). In 2011 BOKU moved into new buildings in Tulln, Austria and have specialized facilities for crop research including purpose built laboratories and glasshouses and extensive field trialing capabilities.

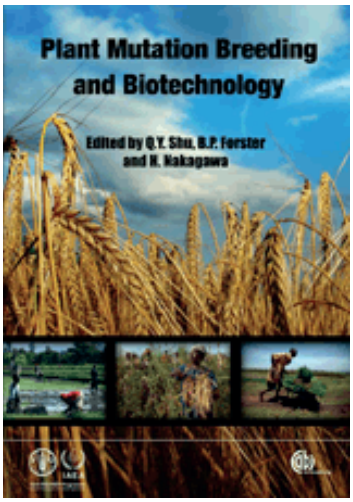
Collaborations with BOKU include: 1) joint research projects on seed quality mutants using near infrared spectroscopy; 2) support for training programmes (lectures and site visits); 3) BOKU participation as a technical contract holder in the new CRP on food and feed; and 4) two co-supervised PhD students researching on mutation breeding projects. BOKU University has signed a Memorandum of Understanding with the IAEA and we look forward to increasing this synergistic collaboration.

Publications

Staff Publication in the Field of Plant Breeding and Genetics

Plant Mutation Breeding and Biotechnology

Edited by Q.Y. Shu, B.P. Forster, H. Nakagawa



This comprehensive book covers the underlying scientific principles, state of the art technologies and methodologies of plant mutagenesis. It covers historical development and commonly used terminologies, chemical and physical mutagenesis, mutation induction, mutation breeding and mutations in functional genomics research. Suitable both as a book for professionals and a resource for students in plant breeding and research, the book includes exemplary cases of practical applications and an appendix of recommended doses of gamma and fast neutron irradiation for almost 200 plant species. Researchers, students and breeders in plant sciences and genetics may be equally interested in this book.

Introduction

Before the turn of the 21st century, experiments in plant mutagenesis were driven by the potential use of mutants in plant improvement. During the past ten years, genomics and molecular techniques have become part of plant mutagenesis research and induced mutants have become an established resource in genomics studies. Although plant-induced mutagenesis has been used widely as a tool in basic studies and practical breeding programmes, it is seldom considered to be an independent subject by plant scientists or plant breeders. There are only a very limited number of books or other publications with comprehensive treatments of this subject, particularly its principles and technologies, which sometime leads to ambiguous concepts and misuse of scientific terms. This book describes the underlying principles of plant experimental mutagenesis, its associated enabling technologies and its application to research and plant breeding. Examples and success stories are given to illustrate the practicality of methods. In order to understand these and subsequent subjects the reader must become acquainted with the common terminology of the discipline.

2012

CAB International and FAO

ISBN-13 978-925107-022-2 (FAO)
978-178064-085-3 (CABI)

Journal Publications/Book Chapters and Published Abstracts

Peer-reviewed

FORSTER, B.P., SHU, Q.Y. Plant Mutagenesis in Crop Improvement: Basic Terms and Applications. In: Plant Mutation Breeding and Biotechnology. Q.Y. SHU, B.P. FORSTER, H. NAKAGAWA (eds.) CABI, Oxfordshire UK, Cambridge USA, ISBN 978-92-5-107022-2. Chapter C01 (2012) 9–20.

LAGODA, P.J.L. Effects of Radiation on Living Cells and Plants. In: Plant Mutation Breeding and Biotechnology. Q.Y. SHU, B.P. FORSTER, H. NAKAGAWA (eds.) CABI, Oxfordshire UK, Cambridge USA, ISBN 978-92-5-107022-2. Chapter C11 (2012) 123–134.

TILL, B.J., ZERR, T., COMAI, L., HENIKOFF, S. A Protocol for TILLING and Eco-TILLING. In: Plant Mutation Breeding and Biotechnology. Q.Y. SHU, B.P. FORSTER, H. NAKAGAWA (eds.) CABI, Oxfordshire UK, Cambridge USA, ISBN 978-92-5-107022-2. Chapter C22 (2012) 269–286.

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MAGHULY, F., JANKOWICZ-CIESLAK, J., TILL, B., LAIMER, M. The use of ECO-TILLING for the genetic improvement of *Jatropha curcas*. In: SUJATHA M., BAHADUR B. AND CARELS N., Compendium of Bioenergy Crops: *Jatropha curcas*. 2 (2012) Science Publishers, USA.

MAYADA, M.B., Abdelbagi, M.A., Okori, P. Inheritance of resistance to *Trucicum* leaf blight in sorghum. African Crop Science Journal **20** (2012) 155–161.

WENING, S., CROXFORD, A.E., FORD, C.S., THOMAS, W.T.B., FORSTER, B.P., OKYERE-BOTENG, G., NELSON, S.P.C., CALIGARI, P.D.S., WILKINSON, M.J.. Ranking the value of germplasm: new oil palm (*Elaeis guineensis*) breeding stocks as a case study. Annals of Applied Biology **160** (2012) 145–156.

WANG, T.L., UAUY, C., ROBSON, F., TILL, B. TILLING in extremis. (2012) Plant Biotechnology Journal in press.

Published conference abstracts

KYAW, M.T., BADO, S., MATIJEVIC, M., HUYNH, O.A, MYINT, T.T. Phylogenetic analysis of Myanmar rice and its mutant varieties. Myanmar Health Research Congress 2011, 9–13 January 2012.

JANKOWICZ-CIESLAK, J., DUSSORUTH, B., FORSTER, B.P., TILL, B.J. Characterization of Musa Germplasm using Low-cost SNP and Indel Discovery. Book of Abstracts: International Conference on: Molecular Mapping & Marker Assisted Selection, Vienna, Austria 8–11 February 2012.

MAGHULY, F., RAMKAT, R., TAASSOB-SHIRAZI, F., JANKOWICZ, J., LAIMER, M. Analysis of genetic variation among and within Jatropha species using dominant markers. In: Molecular Mapping & Marker Assisted Selection, Vienna, Austria, 8–11 February 2012.

HUYNH, O.A., JANKOWICZ-CIESLAK, J., KOZAK-STANKIEWICZ, K., DUSSORUTH, B., CUI, H., FORSTER, B.P., TILL, B.J. Developing low cost mutation discovery methods suitable for developing countries. Book of Abstracts: International Conference on: Molecular Mapping & Marker Assisted Selection, Vienna, Austria, 8–11 February (2012) 27.

TILL, B.J., JANKOWICZ-CIESLAK, J., HUYNH, O.A., BADO, S., FORSTER, B.P. Mutation based approaches for functional genomics in vegetatively propagated plants. Book of Abstracts: International Conference on: Molecular Mapping & Marker Assisted Selection, Vienna, Austria, 8–11 February (2012) 28.

MATIJEVIC, M., LAGODA, P.J.L., FRANCKOWIAK, J.D., FORSTER, B.P. Evaluation of barley mutants for improved fodder production. Book of Abstracts: International Conference on: Plant Growth, Nutrition & Environmental Interactions, Vienna, Austria, 18–21 February (2012) 80.

JANKOWICZ-CIESLAK, J., SCHARL, T., BROZYNSKA, M., ADU-GYAMFI, J., FORSTER, B.P., RAPACZ, M. (2012). Diversity in Physiological Responses to Drought by Musa Genotypes. Book of Abstracts: International Conference on: Plant Abiotic Stress Tolerance II, Vienna, 22–25 February (2012) No. 167.

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MAGHULY, F., JANKOWICZ-CIESLAK, J., RAMKAT, R.C., TILL, B.J., LAIMER, M. Reverse genetics and dominant markers to determine the genetic variation in *Jatropha curcas*. In: Plant and Animal Genomes XX Conference, San Diego, USA (Abstract P0731), 14–18 January 2012.

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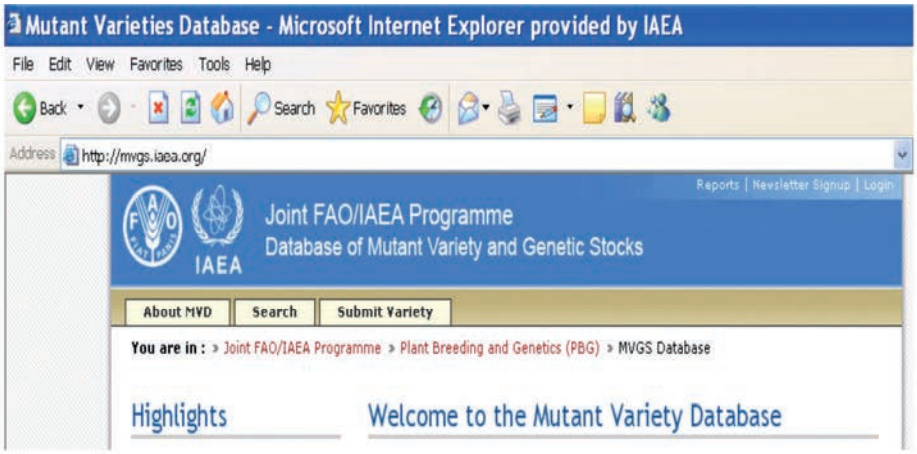
TILL, B.J., JANKOWICZ-CIESLAK, J., HUYNH, O.A., BADO, S., HENRY, I., COMAI, L., FORSTER, B.P. Mutation Induction And Reverse-Genetics for Vegetatively Propagated Plants. In: Plant and Animal Genomes XX Conference, San Diego, USA (Abstract W450), 14–18 January 2012.

TILL, B.J., JANKOWICZ-CIESLAK, J., MAGHULY, F., HUYNH, O.A., BADO, S., FORSTER, B.P., LAIMER, M. Mutation based approaches for functional genomics and trait development in vegetatively propagated plants. In: Plant and Animal Genomes XX Conference, San Diego, USA (Abstract W547), 14–18 January 2012.

For details on IAEA Publications, visit: http://www-pub.iaea.org/MTCD/publications/publications.asp

FAO/IAEA Database of Mutant Varieties and Genetic Stocks

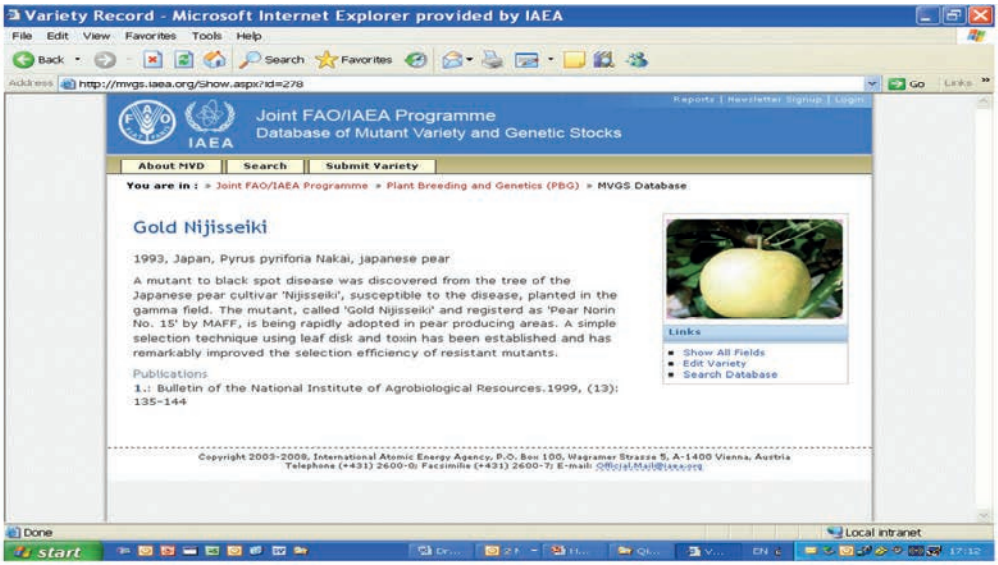
Welcome to our FAO/IAEA Database of Mutant Varieties and Genetic Stocks! At the moment, we just completed construction of the part for Mutant Variety Database, which is still in the process of information updating. We will add the other part for Mutant Genetic Stocks in due time. The database has improved over the former FAO/IAEA Mutant Variety Database in many ways. We are working to make the new database 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 to first register an account; then you will be authorized to submit or edit a mutant variety.

We would greatly appreciate your support by registering your mutant varieties in our database. Once the variety is registered, it will have its own 'homepage' (see below). Therefore, you can use it as an important platform to showcase your new varieties (the introduction of each variety may also be shown in local language).

Please visit the website http://mvgs.iaea.org and send us your suggestions and comments regarding the structure and content of this database. Please also send us other information and related to plant mutation breeding, mutant varieties and genetic stocks; we may post them on the website.



YOU MAY STILL SEND US INFORMATION ON YOUR MUTANT VARIETY AND WE WILL UPLOAD THEM INTO THE SYSTEM, IF IT IS DIFFICULT FOR YOU TO DO SO.

Impressum

Plant Breeding and Genetics Newsletter No. 30, January 2013

The PBG Newsletter is prepared twice yearly by the Plant Breeding and Genetics Section, Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture and FAO/IAEA Agriculture and Biotechnology Laboratory, Seibersdorf.

International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Printed by the IAEA in Austria, January 2013

12-49191