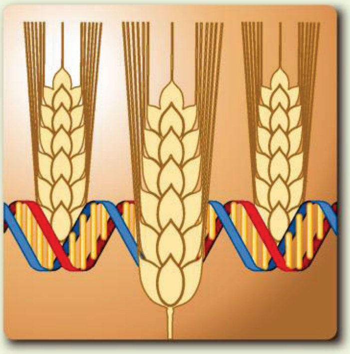
Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Plant Breeding & Genetics Newsletter

No. 27 July 2011

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

ISSN 1564-2569



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Prof Qingyao Shu (Zhejiang University) teaching IAEA fellows from Myanmar about rice mutation breeding in Hainan, China (Photo courtesy of Prof Qingyao Shu) — for more information, see 'Highlights' on page 19.

To Our Readers

As a year has half passed by now, we might look back and consider the frailty of human nature. Besides natural and human made hazards and disasters, the continuous pressure of food insecurity is heightened by the more and more evident effects of climate variability and change. Amongst others, a change in climate would have an effect on the world's vegetation zones. An increase in temperature would affect species composition and thus affect ecosystems. Up to two thirds of the world's forests would undergo major changes, deserts would become hotter, and desertification would extend and become harder to reverse. A change in the boundaries between grassland, forest and shrublands would occur. This change in vegetation zones could cause famine in arid areas such as Africa that depend on a certain type of crop. This could cause an increased population pressure on urban and peri-urban zones due to the exodus from afflicted arid rural regions. The range of pests could also change if the vegetation changed. This could bring about an increase in disease levels.
Global climate change has already had observable effects on the environment. Temperatures are rising, glaciers have shrunk, ice on rivers and lakes is breaking up earlier, plant and animal ranges have shifted, trees are flowering sooner, landscapes are changing also due to massive land erosion, there is an increased risk of drought, fire and floods, stronger storms cause increased storm damage and more heat-related spreads of diseases and pests put (agro-)biodiversity at risk and cause economic loss-

es. Consequently, the concern about sustainable food security is a red thread leading through this issue of our Newsletter. In this issue, you will find some of our modest contributions to consolidate food security under the pressure of climate change:

You might be interested in a new Coordinated Research Project (CRP) on 'Climate Proofing of Food Crops: Genetic Improvement for Adaptation to High Temperatures in Drought Prone Areas'. Please turn your attention to the report of the first Research Coordination Meeting (RCM) under **Past Events**. In the same section the report of a Consultants Meeting on 'Enhancing Productivity of Locally-underused Crops through Mutation Breeding and Optimized Soil, Nutrient and Water Management Practices under Climate Change and Variability', preparing a regional Technical Cooperation (TC) Project for Asia and the Pacific might draw your attention.

If you turn to **Sub-programme Highlights**, you will find a short review on the first IAEA Collaborating Center at Zhejiang University, Hangzhou, China. How breeding enhanced and supported by nuclear techniques can positively impact on livelihoods is illustrated therein.

Turning to **News from Ug99**, you get a continuous update on the positive developments in the IAEA TC Project INT/5/150 contributing to the global fight against a transboundary disease threatening wheat and barley worldwide: wheat black stem rust race Ug99.

How to breed hardy crops in harsh environments using technology packages complementing mutation induction and efficiency enhancing biotechnologies with best fit soil, water and nutrient management practices is touched upon in the different sections about Technical Cooperation and Coordinated Research Projects, as well as in the section from our **Seibersdorf** Laboratory.

Modern agriculture surely is part of the solution. Over the last 150 years, farmers achieved a 1.5% reduction in production costs per year (averaged and similar across cereals, fruit, milk, meat amongst others) with increased quality and security. This represents a remarkable total of 10-fold reduction in cost. Over the last 4500 years, farmers achieved a 0.1% per year cumulative reduction in long term 'effort': 4500 years ago, getting food was a full-time job for everyone (365*12=4380 hr/year/person), whereas at present, in Europe and North America, 2% of the population are farmers (0.02*8*300=48 hr/year/person spent farming). As an example, in 1949, statistically, one German farmer could feed 10 people. In 2002, one German farmer fed 131 people.

Mother Nature has proven to be a harsh headmaster, constantly reminding us, as she did again recently, not to become relaxed. The ascent of humankind is built on 'toil, tears and sweat', maintaining our rank depends on more of the same. Knowing that basically the threats to sustainability have not changed for more than 10 000 years — habitat destruction (including human-made and/or natural disasters), climate variability and change (abiotic stresses), diseases (biotic stresses), changes in what people want, blindness to what is happening, unwillingness to change — coping with hazards, human-made or natural, is a constant endeavour since the invention of agriculture and animal husbandry.

Or as late Dr Norman E. Borlaug (1914–2009) put it: 'We may be at high tide now, but ebb tide could soon set in if we become complacent and relax our efforts'.

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Forthcoming Events

Regional Meeting on Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA), RAS/5/048, Muscat, Oman, 3–5 July 2011

Technical Officer : P.J.L. Lagoda

The Regional Meeting is being organized within the framework of the regional technical cooperation (TC) project RAS/5/048 on 'Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity'. The purpose of this meeting is to exchange experience and data on mutation induction technology packages integrating mutation induction and efficiency-enhancing molecular and biotechnologies. Updated knowledge and know-how will be laid out for discussion. Further, socioeconomic impact of the above in the ARASIA Member States (MSs) will be discussed.

The use of induced mutation for creating useful new germplasm and developing now cultivars is a profitable approach to crop 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. ARASIA State Parties have recognized the prime importance of developing improved varieties of food crops through the application of mutation techniques. Wheat and barley amongst other crops are the most important contributors to food security and sufficiency in ARASIA Member States participating in this project. It is paramount to assess policies concerning the sustainability of breeding programmes vis-à-vis of the integration of enhancing technology packages based on mutation induction.

Expected output(s) include a regional overview on the utilization of mutation induction technology in plant breeding and genetics and a regional assessment of the socioeconomic impact of mutant varieties. The meeting will assist the participating Member States in taking reasoned policy decisions on the application of technology packages integrating mutation induction and efficiency enhancing molecular and biotechnologies for breeding programme support.

The meeting will include round table discussions on:

- Mutation induction technology packages;
- On-going programmes and projects in the region;
- Socioeconomic impact of mutant varieties and cultivars;
- Bio-safety of mutation induction and public awareness.

The meeting is open for 30 participants from ARASIA Member States and invited guests from the Arab Centre for the Study of Arid Zones and Dry Lands (ACSAD), the Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ), the Food and Agriculture Organization (FAO) regional and national representatives, the International Centre for Agricultural Research in the Dry Areas (ICARDA), and the International Maize and Wheat Improvement Centre (CIMMYT).

Nominated candidates should be (i) representatives from Ministries of Agriculture, (ii) representatives from non-governmental organizations, academia, or the private sector and/or (iii) national project counterparts.

Second Technical Meeting on Responding to the Transboundary Threat of Wheat Black Stem Rust Ug99, INT/5/150, Eldoret, Kenya, 22–26 August 2011

Technical Officer : P.J.L. Lagoda

A second technical meeting will be convened to unite all stakeholders of INT/5/150, 'Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99)', following the achievement of an important milestone. Major and minor resistance genes to Ug99 have been identified in wheat and barley, in the M_2 generation. On the occasion of the second screening campaign in 2011, all stakeholders are invited to this Kenyan region where the three most virulent derivatives of wheat black stem rust race Ug99 are endemic, in order to:

1. Evaluate progress from the first technical meeting.
2. Evaluate lessons learned from the mutant germplasm exchange pipeline.
3. Further harmonize cooperation between the IAEA and all its partners (ICARDA, CIMMYT; Agricultural Research Services of the United States Department of Agriculture (USDA); BGRI (Cornell University, USA); Chinese Academy of Agricultural Sciences (CAAS); BARC (Bhabha Atomic Research Centre, Mumbai, India); International Treaty on Plant Genetic Resources (FAO), Western Australia Department of Agriculture & Food of the Government of Western Australia).

It is expected, that representatives of Algeria, China, Egypt, Ethiopia, India, Iraq, Islamic Republic of Iran, Jordan, Kenya, Lebanon, Morocco, Oman, Pakistan, Sudan, Syrian Arab Republic, Tunisia, Turkey, and Uganda with contributions from the partnering International Organizations — mainly FAO, IAEA, ICARDA, and CIMMYT — will discuss their workplans and map the way ahead for INT/5/150.

Field visits to screen the germplasm and discussions related to the timetable for the project activities agreed upon during the third project steering and coordination meeting held in Ankara are scheduled, including:

1. Continuation of the iterative mutation induction process (M_0 to M_2) per participating Member State as agreed in the country workplan.
2. Dispatch of M_2 seed to areas in Kenya where the disease is endemic.
3. Confirmation of the resistance to Ug99 in:

   a) Moi, KENYA
   b) Tihama, YEMEN
   c) ETHIOPIA, (Site to be determined)
4. Advancing mutated lines until they are homozygous for resistance to Ug99.
5. Distribution of the confirmed advanced mutant lines (first homozygous mutant generation) to breeding programmes in the originating countries and participating/requesting Member States.
6. Screening of M_3 and other advanced material from participating Member States.
7. Exploration of the possibilities to create mutant genetic stocks settings for the conservation of the putative advanced mutant lines developed under this project:
   a) Hexaploid wheat (bread)
   b) Tetraploid wheat (durum)
   c) Barley
   d) Wide crosses (wheat and rye)
8. Opening the project to interested third parties for distribution of mutant germplasm.
9. Future mutation activities to target rust diseases in general, including yellow rust (stripe rust), brown rust (leaf rust), and Septoria.
10. Allelism determination.
11. Marker development and mapping.
12. Gene identification and gene function analyses.

Past Events

Third Coordination Meeting on Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99), INT/5/150, Ankara, Turkey, 6–10 December 2010

Technical Officer : P.J.L. Lagoda

The interregional TC project INT/5/150 entitled 'Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99)', aims to use mutation induction and supportive efficiency enhancing molecular and biotechnologies in plant breeding.

The third coordination and steering meeting was attended by 22 participants from 14 countries (Algeria, China, Egypt, India, Iraq, Islamic Republic of Iran, Jordan, Kenya, Lebanon, Pakistan, Sudan, Syrian Arab Republic, Tunisia, Turkey and Uganda) and three international organizations (IAEA, ICARDA, and CIMMYT). Australia and FAO representatives were not able to join the meeting. Ethiopia, Morocco, and Oman were encouraged to nominate representatives.

The meeting objectives and project action plan were reviewed, discussed and approved by the assembly of participants. The main objective of the meeting was to conduct a progress evaluation from the second coordination meeting to date: what activities were planned in Nairobi, which ones were accomplished, to identify bottlenecks and to plan the way forward to 2011 activities, which were reviewed by all MSs and adjusted accordingly.

Project governance action plan

May 2009: First steering and coordination meeting (IAEA, Vienna, Austria).
November 2009: First technical meeting and second steering and coordination meeting (Moi, Nairobi, Kenya).
December 2010: Third steering and coordination meeting (Ankara, Turkey).
August 2011: Second technical meeting (Moi, Nairobi, Kenya).
November 2011: Fourth steering and coordination meeting (IAEA, Vienna, Austria).
August 2012: Third technical meeting (Moi, Nairobi, Kenya).
November 2012: Fifth steering and coordination meeting (IAEA, Vienna, Austria).

Programme activities projected in the second coordination and steering meeting could only partially be accomplished in Njoro, Kenya. Compensation activities at Moi, Egerton, were enhanced.

Country reports highlighted past, current and planned activities. Country representatives also presented highlights of current collaborative research activities with the IAEA and CG Centers. Participants outlined workplans for the next season and provided lists for support needed from the IAEA.

The expected flow of the programme can be summarized in four stages:

- Parental seeds (M_0) will be tested for purity prior to the induction of mutations leading to the M_1 population.
- M_1 seed will be grown in isolated plots and self fertilized to produce the M_2 followed by the M_3 generation.

- Screening of the M_4 population derived from the M_3 generation will lead to the selection of mutant lines resistant to Ug99 and its derivatives. A large number of induced populations (M_2+) will be generated by member countries. Hence it is expected that at least 100 000 M_2s per year will be tested by limiting the countries' contribution to one to two induced populations (M_2). It has been decided that the participating Member States will recommend the parents to be mutated. The IAEA, in consultation with ICARDA and CIMMYT, will approve the list in order to ensure that the lines used by different country programmes are not genetically related. It is usual that a well performing genotype from ICARDA and/or CIMMYT international nurseries can be selected in different countries and different names attributed to it by national breeding programmes. It is therefore recommended that mutation activities should target resistance to wheat rusts and avoid duplications between countries. Induced populations from national programmes (M_2+) will be tested at Moi University where land and irrigation facilities are available and operational. The material will be exposed to natural rust infection (Ug99 and derivatives), selected and confirmed resistant mutants (M_3+) will be tested at Njoro where CIMMYT could provide assistance and national programmes will be able to visit and perform selection as needed. This segment of the activities has to be confirmed by the new resident representative of CIMMYT.
- Selected material will be sent back to the initial contributors and made available to any interested participating Member State for testing under local conditions for traits of interest as well as testing at rust hot spots that could be coordinated by ICWIP in CWANA. Secondary screening hot spots have been identified in Yemen and Ethiopia. Availability of the Ethiopian screening site has to be confirmed by the local representative.

The process of screening has been accomplished as planned. More about the results of this first round of screening can be found in this issue under 'News about Ug99' on page 18.

Support staff from participating countries was trained at Seibersdorf, Austria and Beijing, China, on mutation induction and efficiency enhancing biotechnologies for rust resistance wheat breeding.

The scientific discussions during this meeting were focused on the rust issue. The threat of Ug99 and its derivatives was stressed in three reports from South Africa, Saudi Arabia and Iraq, tentatively confirming the presence and virulence of Sr31 (Ug99) at least in trap nurseries. This shows that the spread of the rust diseases knows no barriers and the virulent derivatives can adapt to different environments if climatic conditions are favorable. It is still under scientific discussion if the altered spectrum of adaptability to different climatic conditions favors the spread of these more virulent races of Ug99. This emphasizes the need and usefulness of this international project.

The importance of linkages with national breeding programmes was stressed by participants and hence country representatives will ensure direct communication with respective national breeding programmes.

Final Project Review Meeting IAEA/RAC Regional TC Project RAS/5/045, Bangkok, Thailand, 21–25 March 2011

Technical Officer : Y. Lokko

In collaboration with the Thailand Department of Agriculture, the Field Crops Research Institute and the Thailand Office of Atoms for Peace, the final project review meeting of RAS/5/045 was held at the Rama Gardens Hotel in Bangkok. The objectives of the meeting were to (i) assess the project status and progress achieved since the last meeting (ii) discuss modalities for continuing these efforts into the next TC cycle (iii) examine project sustainability in participating countries after its closure and (iii) review recommendations for participation in Asia and Oceania Association of Plant Mutagenesis (AOAPM).

The meeting was attended by counterparts from Australia, Bangladesh, China, India, Indonesia, Malaysia, Myanmar, Pakistan, Republic of Korea, Thailand and Vietnam. Dr Qinyao Shu (China) and Dr Duncan Vaughn (Chief Technical Adviser and Plant Biotechnologist, FAO-RAP, Bangkok) were present as international experts. In the opening address, Dr Manthana Milne, Deputy Director General of the Thailand Department of Agriculture (DOA) welcomed the participants and highlighted the work being done by the department in mutation breeding and biotechnology. Dr Duncan Vaughn remarked on the relevance of the meeting in the face of the emerging food security situation in the region. Ms Yvonne Lokko thanked the host institutions and participants and detailed the expected outputs of the meeting. This included an assessment of the progress made towards establishement of efficient methodologies for mutation induction, mutant screening and selection protocols for nutritional quality characters, identification of molecular markers linked to stress tolerance and their use in developing improved crop varieties. This was followed by a technical session with presentations from the invited international experts and the national counterpart from Chiang Mai University. The dissemination and use of the mutants for genetic research, varietal development and by industry was also discussed. Technical visits to the Institute for Applied Radiation and Isotopes at Kasetsart University, the DOA Genebank and the Thailand Institute of Nuclear Technology were organized. The visits afforded the participants the opportunity to gain first-hand knowledge of research activities being undertaken using nuclear techniques and biotechnology in Thailand.

Second Research Coordination Meeting (RCM) on Improving Nutritional Quality by Altering Concentrations of Enhancing Factors Using Induced Mutation and Biotechnology in Crops, D2.30.28, Pretoria, South Africa, 11–15 April 2011

Technical Officer : Y. Lokko

The second RCM of this Coordinated Research Project (CRP) was held in collaboration with the ARC-Vegetable and Ornamental Plant Institute (ARC-VOPI) in Pretoria. The main aims of the meeting were (i) to assess the progress achieved since the last meeting (ii) review mid-term achievements (iii) and where necessary, adjust activities to deliver the specific outputs of the CRP. Ten research contract holders from Botswana, Bulgaria, China, Ghana, India (2), Kenya, Peru, South Africa and Ukraine, three research agreement holders from Denmark, Germany and the United Kingdom respectively and three researchers from the host institution attended the meeting.

The meeting was formally opened by Dr Adebola, Head of Plant Breeding, VOPI. Ms Yvonne Lokko gave a brief introduction on the expected outputs of the meeting:

- Evaluation of the progress made towards generating new mutant germplasm with improved nutrient quality traits in a range of crops,
- New protocols and methods developed to screen for the desired nutrient quality traits,
- Characterization of new mutant lines and the resulting scientific publications.

Project participants gave detailed presentations on the work done since the last RCM. The reports highlighted the methods used, results obtained in developing new mutant germplasm with improved nutrient quality traits in a range of crops, screening methodologies for the respective nutrient quality traits using biochemical or molecular methods. Participants also visited the laboratories and experimental fields at ARC-VOPI for an overview of the research activities being undertaken by the host institution.

First Research Coordination Meeting on Climate Proofing of Food Crops: Genetic Improvement for Adaptation to High Temperatures in Drought Prone Areas and Beyond, D2.30.29, Vienna, Austria, 2–6 May 2011

Technical Officer : M. Spencer

The meeting attained its main objective, which was to discuss and integrate the individual workplans of the CRP participants on the basis of the outputs as specified in the project document and the country presentations. The meeting was attended by 16 participants from Australia, China, Colombia, Cuba, India, Japan, Mexico, Pakistan, the Philippines, Senegal, Spain, the United Republic of Tanzania, the United Kingdom and Zimbabwe. The International Centre for Tropical Agriculture (CIAT) was also represented. The meeting was opened by Mr Pierre J.L. Lagoda, Section Head, Plant Breeding and Genetics, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. He spoke on the challenges posed by climate change and the opportunity for breeding climate proof crop varieties through mutation breeding and biotechnology. Already, several decades of successful mutation breeding supported by the IAEA has resulted in the development of 3200 mutant varieties worldwide from 170 species (18% legumes/pulses) as recorded in the Mutant Varieties and Genetic Stocks Database (http://mvgs.iaea.org).

Ms Spencer presented the CRP and highlighted the objectives, expected outputs and the methodologies proposed to achieve them. Rice and bean are the two target crops. The participants presented structured projects aimed at developing advanced mutant lines with improved tolerance to increased temperatures using mutation breeding along with the use of sophisticated high throughput molecular techniques. Speakers also pointed out the extensive integration between mutation breeding and molecular genetics including state of the art technologies, such as QTL and deep sequencing. Data using techniques for identifying positive mutations and shortening screening procedures in order to more accelerate development of advanced mutant lines was also presented and discussed. The participants recommended that specific additional objectives be added, namely (i) the establishment of robust experimental protocols for physiological, genetic and molecular studies and screening mutants (ii) the screening of germplasm for heat tolerance and (iii) identification of the genes along with associated molecular markers to facilitate tagging and marker assisted selection. The participants agreed to establish, with IAEA support, a web-based platform for communication and efficient exchange of technical information.

Consultants Meeting on Enhancing Productivity of Locally-underused Crops through Mutation Breeding and Optimized Soil, Nutrient and Water Management Practices under Climate Change and Variability, RAS/0/058, Vienna, Austria, 9–13 May 2011

Technical Officers : P.J.L. Lagoda and M.-L. Nguyen

Six consultants from China, India, Indonesia and Malaysia met at IAEA Headquarters with the Joint FAO/IAEA staff to further develop a regional TC concept note to enhance productivity of underused crops currently cultivated in specific and confined regions for better adaptation and further dissemination in the Asian and Pacific Region under the foreseen climate change and variability.

The project strategy is to combine mutation breeding and optimized soil, nutrient and water management practices into locally adapted technology packages for underused crops under local conditions and climate change and variability. Project actions will include (a) surveys of available resources (varieties and advanced lines) of pigeon pea, mungbean, soybean, sorghum and plantain in the participating countries such as Australia, Bangladesh, Bhutan, Cambodia ,China, India, Indonesia, Laos, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Papua New Guinea, Sri Lanka, Thailand, by the counterparts for the project implementation that will allow them to be shared by all the participants; (b) assessment of adaptation of these resources in the participating countries under local conditions; (c) improvement of traits through mutation induction; (d) optimization of soil, nutrient and water management practices and (e) promotion and adaptation of technology packages to the end-users, and enhancement of collaboration in the region and beyond.

Over the past decades, the IAEA has been assisting the Asian Member States in using nuclear technologies to increase agricultural production. As a result, improved breeding lines of cereals, oilseed crops, and food legumes have been produced, and a high return on the investment has already been achieved in several countries. More recently, similar efforts have been made, under the regional programmes, to further assist in the evaluation of the performance of the improved crops as well as the initiation of new breeding programmes to improve drought tolerance as well as the yield of some staple food crops which play a major role in the nutrition of most of the Asian populations.

Impacts of climatic and anthropogenic factors (deforestation, over population and overgrazing) such as drought, soil salinity, soil acidity and depletion of soil organic matter leading to reduced soil productivity continue to be a constraint and will become more serious under climate change and variability. Diminishing land and water resource base, environmental degradation, erosion of biodiversity, natural disasters, new and destructive pest and disease complexes, and changing market demands pose major challenges to Asian agriculture in the foreseeable future. Plant breeding in conjunction with optimized soil nutrient and water management practices is probably the most viable approach to stabilizing food production.

Moreover, there are many traditional Asian food crops, which are adapted to the agro-climatic and biotic stresses in the region and used by local communities as a primary source of carbohydrate, protein, minerals and other micronutrients. Some of these crops are locally grown to supplement basic dietary needs. Little or no attention has been paid to develop improved lines of these crops compatible with modern farming. It is therefore essential that locally-underused crops be genetically improved in yield, quality, agronomic traits, disease resistance and stress tolerance through conventional breeding, in vitro and mutation techniques as well as be optimizing soil nutrient and water management practices.

With more than 600 million people suffering from malnutrition and poverty in the Asia and Pacific region, there is a need to continue IAEA support to help Member States validate and officially release their promising crop varieties. Further improvement of traditional underused crops and promotion of the exchange of mutant germplasm and accompanied by optimal soil and water management practices among scientists in the region is needed. Policy makers and end-users will benefit from increased awareness of the effectiveness of nuclear techniques in overcoming production constraints of these crops.

There is a continuing need for IAEA support in improving the productivity of these crops in the region where high population growth rates and low productivity call for concerted efforts and continuing attention of both member countries and international development agencies to enhance sustainable food security through increased production of a variety of crops providing balanced nutrition. The proposed project does not intend to create or establish entirely new facilities for crop improvement. However, it aspires to build on achievements attained through assistance from the IAEA and national efforts in participating Member States. The existing capabilities in the participating countries will be upgraded and the exchange of mutant germplasm and accompanied technology packages between the scientists in the region will be promoted. This regional project intends to enhance close collaboration among scientists in plant breeding, soil, nutrient and water management practices by strengthening the ties with national, regional and international institutions (such as ICRISAT, IBSRAM, Bioversity International) involved in agricultural research in the Asia and Pacific Region.

The main output (new varieties and technologies) will be extended to more end-users in the region and beyond. Upgraded laboratory facilities and infrastructures, and trained staff will contribute to further development for enhancing food security under climate change and variability. Considering the importance of the project, in addition to the IAEA, financial resources will also be provided by national (including ministries, universities, research centres), international and non-governmental organizations with an interest in sustainable practices in the region.

Second Research Coordination Meeting on Isolation and Characterization of Genes Involved in Mutagenesis of Crop Plants, D2.40.13, Vienna, Austria, 30 May–3 June 2011

Technical Officer : P.J.L. Lagoda

For this RCM, 12 agreement and research contract holders from Argentina, Bulgaria, China, Germany, India, Republic of Korea, Poland, Portugal, Switzerland and the United States of America met with Plant Breeding and Genetics staff of the IAEA to coordinate efforts on the CRP entitled Isolation and Characterization of Genes Involved in Mutagenesis of Crop Plants.

Progress was assessed and workplans plotted and harmonized for the continuation of the CRP. The suggestion, put forth at the first RCM in St. Louis, Missouri, that two model plants of the project (*Pisum sativum*, and *Lathyrus sativus*) could be substituted by *Medicago truncatula* was further discussed: this suggestion would allow focusing on obtaining fundamental scientific results on a model leguminous plant, under greenhouse controlled conditions, ensuring a much higher probability of success. Some highlighted results (for detailed information, see 'Coordinated Research Projects (CRPs) and Research Coordination Meetings (RCMs)' — page 10) in the following are promising indicators for the successful continuation of this research endeavour, *inter alia*:

A strategy based on mismatch repair (MMR) suppression to widen the genetic diversity after mutagenesis was proposed. 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.

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

Project Number	Ongoing CRPs	Scientific Secretary
D2.30.28	Improving Nutritional Quality by Altering Concentrations of Enhancing Factors Using Induced Mutation and Biotechnology in Crops	Y. Lokko
D2.30.29	Climate Proofing of Food Crops: Genetic Improvement for Adaptation to High Temperatures in Drought Prone Areas 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
	CRP Closed in 2010	
D2.30.27	Molecular Tools for Quality Improvement in Vegetatively Propagated Crops Including Banana and Cassava	B. Till

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

Technical Officer: Y. Lokko

Increasing crop production and providing adequate nutrition are key issues in many countries in the world. In addition to providing basic nutrition for sustaining life, edible crops must also deliver essential vitamins and minerals required to prevent deficiency disorders. However, the major staple crops are often deficient in some of these micronutrients. Consequently, micronutrient deficiencies like those of vitamin A, iron (Fe) or zinc (Zn), affect greater than 40% of the world's population. It is estimated that of the 6.8 billion people in the world, 60–80% suffer from Fe deficiency and over 30% from Zn deficiency. In many societies, certain social groups do not receive sufficient calcium (Ca) and magnesium (Mg) in their diets. Bio-fortification, which is defined as the enrichment of nutritional properties of edible crops, can be achieved through the combination of agronomy and plant breeding. An essential requirement for plant breeders to develop nutrient rich crops is the availability of suitable germplasm. Induced mutations provide a highly efficient tool to alter the genetic constitution of plants and create a wealth of genetic variability, including desirable changes in nutrient content and composition.

Over the years, mutant varieties and lines in crops such as barley, rice and tomato with varying starch quality, fatty acid composition, concentration of essential minerals, vitamins and beneficial compounds such as carotenoids and tocopherol have been developed. Moreover, advances in molecular biology, have allowed investigations of whole genomes by integrating genetics with informatics and automated systems. This has led to the identification of key genes in micronutrient biosynthetic pathways and provided new insights into breeding for enhanced nutrition related traits. This CRP aims to utilize mutant collections in selected model crops, integrate tools from genomics and provide resources to facilitate the development of breeding programmes for improved nutritional quality in Member States. The resulting mutant germplasm and the protocols developed used to breed them will constitute the main outputs of this proposed CRP.

The first RCM was held at the IAEA Headquarters in Vienna, Austria, 29 June–3 July 2009. The meeting focussed on (i) planning research activities of the CRP (ii) reviewing and reworking individual workplans in order to achieve the the specific outputs of the CRP. Eleven research contract holders from Botswana, Bulgaria, China, Ghana India (2), Kenya, Peru, South Africa and Ukraine, and four research agreement holders from Denmark, Germany, the United Kingdom and the United States of America attended the meeting. It was agreed that the CRP will focus on improving nutrient quality in elite varieties of six food security crops — groundnut, wheat, rice, soybean, barley and sweet potato. Some activities, such as testing of mutagenesis techniques, would be undertaken for Solanaceous food crops (such as potato, tomato and pepper), sugar beet and *Brachypodium.* Since 2007 when the CRP proposal was initially submitted to the IAEA, substantial genomic and metabolomic information has been generated in many of the target crops. As such, the original intention to extrapolate information from model crops into the target crops is now being complemented with direct information from targetcrops. There was also a general consensus during the first RCM to slightly modify the CRP title to accurately reflect the project objective. The title agreed upon was Improving Quality of High Yielding Crops for a Changing Climate, by Altering Concentrations of Nutritional Factors Using Induced Mutation and Biotechnology.

Over the last two years, significant progress in research and capacity development has been reported from most of the CRP participants. These include:

- The development of new mutant germplasm in all the target crops and the generation of new mutant populations in some of the model crops.
- The establishment of efficient methods to screen mutant populations and stable mutant lines for phenotypes such as resistant starch, enhanced carotenoid content, decreased oxalate and increased tocopherol levels. A range of biochemical assays have also been developed or adapted.
- The use of genetic and molecular methods to identify genes responsible for the phenotypes observed when screening mutant lines.
- The publication of 25 peer reviewed publications and nine conference proceedings to date.
- Dissemination of the techniques and results through supporting national, regional and international training programmes.

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

Climate change is now largely accepted as a real and pressing global problem. It has recently been estimated that developing countries will bear 70–80% of the costs of climate change damage with agriculture being the most impacted sector. The main impacts of climate change on agriculture will most probably be experienced through higher temperatures (increase in minima and maxima), altered changes in rainfall patterns (in amount, spatial and temporal distributions), increased rates of evaporation, increased intensity and frequency of extreme events (floods and droughts), and raise of sea level affecting coastal areas where large quota of cultivated land are located (intrusion of salty water). The responses that agriculture systems worldwide can be put in place to cope with the expected impact of climate change and to reduce the food insecurity range from institutional and policy levels to the best management practices and technology advancement. An important opportunity in terms of technology advancement is offered by the genetic improvement of crops that can adapt to the future climate conditions; i.e., 'climate proofing' crops. Additionally, data collected from the selected crops: rice and common bean during the course of the CRP may be useful for a study of mathematical models for responses to high temperature in association with AquaCrop — FAO.

This CRP will focus on improving the grain yields of rice (cereals) and the common bean (legumes), two essential staples in the diets of millions of impoverished and vulnerable populations, to high temperature stress in the face of climate change. The approach is to use (1) the whole plant (2) gene expression markers and (3) physiological/biochemical responses to high temperature to identify valuable germplasm.

- Exploit genetic diversity (existing mutated populations, M_2 and up) to assess tolerance to high temperature in terms of yield and yield components.
- Analyse and exploit mutations in functional genomics using molecular tools such as positional cloning of critical genes, whole genome sequencing projects, SNP diversity analysis, global genomes expression analysis, and associated bioinformatics tools to evaluate large datasets and visualize metabolic pathways affected by stresses and/or genotypes.

Apply existing tools to characterize physiological and biochemical responses to high temperature on nodulation/nitrogen fixation and/or water use efficiency by application of stable isotope techniques.

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 Research Institute (IRRI), Japan, Spain and the United Kingdom) attended the RCM.

(Detailed information on the first RCM can be found under 'Past Events' — page 5.

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

Technical Officer: B. Till

New technologies and strategies for exploiting induced mutations for functional genomics and crop development promise to greatly enhance efficiencies and reduce the time to gain new knowledge and develop novel varieties. This CRP takes a modular approach to investigate and improve the different steps involved in a typical mutation breeding pipeline. Modules include phenotyping, the development of suitably mutagenized and sized populations for both forward and reverse-genetics, dissolution of chimeric sectors, the development of TILLING (Targeting Induced Local Lesions IN Genomes) reverse-genetics platforms for vegetatively propagated species, and investigations into novel technologies for mutation discovery and characterization. The four target crops chosen for this CRP are banana, barley, cassava and rice. The goal is to develop modules that can be combined for the rapid creation and selection of desired mutants. For example, mutagenesis of barley microspores could provide a means to generate instantly homozygous mutant populations, and mutagenesis of banana and cassava cell suspensions could obviate the need for time consuming tissue culture techniques to dissolve chimeric sectors. Advanced mutation discovery technologies can provide information on mutation densities and spectrums to allow a precise estimation about the population size and mutagenesis dose needed for a high probability of recovering useful alleles, and so on. The major outputs 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 also held in Vienna 13–17 December 2010.

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, Drs K. Riha (Austria), H. Puchta (Germany), A. Levy (Israel), B. Hohn (Switzerland), and A. Britt (USA), who were invited to present their work in the concurrent session number two of the International Symposium on Induced Mutations in Plants (ISIMP). 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 (Argentina, Bulgaria, China, India, Republic of Korea and Poland) and four agreement holders and consultants (Germany, Switzerland and the United States of America (2)), participated in this RCM.

The second RCM was held in Vienna, Austria, 30 May–3 June 2011. The CRP is progressing well as exemplified by some highlighted intermediate results below:

- Similar induction kinetics of DNA double-strand breaks were observed after treatment with Li-ions and gamma rays in the model plants under investigation.
- 50 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.
- Interesting genetic observations about genetically unstable mutants (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.
- In barley seedlings, photorepair is the main mechanism efficiently removing Cyclobutane Pymidine Dimers (CPD) from both total genomic DNA and ribosomal genes. Acute exposure to short-wave UV irradiation induces oxidative DNA damage in barley seedlings. Under dark recovery conditions, no repair of oxidative DNA damage occurs in the differentiated leaf cells up 24 hours after irradiation. Thus, in UV-C irradiated barley leaves incubated under dark there seems to be no alternative repair mechanism for CPD removal able to compensate for the lack of photoreactivation. This might be a workable way to increase the efficiency of mutation induction in barley. The ability of young barley leaves to remove efficiently CPD depends primarily on the intensity and the spectrum of photoreactivating light. The light-dependent repair mechanism operating in the barley genome is able to remove completely high levels of UV-C induced CPD but within the first hours after irradiation, light-grown seedlings have higher CPD photorepair activity in comparison to the dark-grown ones. At the meeting, it was reported, that the barley genome contains homologous DNA sequences to the class II photolyase, responsible for the repair of CPD in model plants. In barley chloroplasts, an efficient light-dependent repair mechanism removes UV-induced photoproducts from the rpoC2 and psaB-A genes, whereas excision repair pathways are not active in barley plastid genome throughout the dark recovery period under study

IAEA Coordinated Research Activities Web Site:

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

Technical Cooperation Field Projects

The Plant Breeding and Genetics subprogramme currently has technical responsibilities 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	Y. Lokko in collaboration with Soil and Water Management and Crop Nutrition Section
AFG/5/004	Afghanistan	Enhancing Crop Productivity through Mutation Breeding and Pest Control	Y. Lokko in collaboration with Insect Pest Control Section
ALG/5/023	Algeria	Protection of Date Palm Trees Against Bayoud Disease	M. Spencer
ALG/5/024	Algeria	Improvement of Cereals for Tolerance to Drought and Resistance to Disease	M. Spencer
ANG/5/006	Angola	Improvement of Food Crops Through Mutation Breeding and Biotechnology	M. Spencer
BKF/5/007	Burkina Faso	Improving Voandzou and Sesame Based Cropping Systems through the Use of Integrated Isotopic and Nuclear Techniques	M. Spencer
BOL/5/018	Bolivia	Enhancing Food Security Using Conventional and Nuclear Techniques for the Acquisition of Climate-Change Tolerant Commercial Potato Seed	M. Spencer/S. Dharmapuri
CAF/5/003	Central African Republic	Development of New Varieties of Cassava Through Mutation Breeding and Biotechnology Techniques	M. Spencer
COL/5/023	Colombia	Enhancing Mutagenesis and Biotechnology Used in the Improvement of Rice	Y. Lokko/S. Dharmapuri
COS/5/027	Costa Rica	Generation of Promising Strains of Beans through Induced Mutations in Calluses and Seeds to Increase Competitiveness	M. Spencer
COS/5/028	Costa Rica	Generating Promising Strains of Beans through Induced Mutations in Calluses and Seeds to Increase Competitiveness (Phase II)	M. Spencer
CPR/5/017	China	Construction of Radiation-Induced Mutant Libraries and Function Analysis of Mutated Genes in Crop Plants	M. Spencer/Y. Lokko
ECU/5/023	Ecuador	Inducing Mutations in Agriculture with the Aid of Radiation	M. Spencer
ECU/5/025 **Awaiting Financing**	Ecuador	Inducing Genetic Variability in Soya, Banana and Rice	M. Spencer
ERI/5/004	Eritrea	Improving Crop Productivity and Combating Desertification	Y. Lokko/P.J.L. Lagoda in collaboration with Soil and Water Management and Crop Nutrition Section

Project Number	Country	Title and Objective(s)	Technical Officer
INS/5/035	Indonesia	Application of Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands	S. Dharmapuri/M. Spencer
INS/5/036 **Awaiting Financing**	Indonesia	Genetic Improvement of Artemisia Cina Using Irradiation Technique	M. Spencer
INS/5/037	Indonesia	Applying Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands	S. Dharmapuri/M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
INS/5/038	Indonesia	Using Induced Mutations to Improve Rice Productivity through a Hybrid Rice Breeding Programme	S. Dharmapuri/M. Spencer
INT/5/150	Interregional	Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99)	P.J.L. Lagoda/S. Dharmapuri
IRQ/5/017	Iraq	Optimization of Land Productivity Through the Application of Nuclear Techniques and Combined Technologies	S. Dharmapuri/P.J.L. Lagoda in collaboration with Soil and Water Management and Crop Nutrition Section
IVC/5/031	Cote d'Ivoire	Improving Plantain and Cassava Yields thought the Use of Legume Cover Crops	M. Spencer
JAM/5/010	Jamaica	Plant Breeding and Diagnostics Technologies	Y. Lokko
KAZ/5/002	Kazakhstan	Improving Wheat and Maize Using Nuclear and Molecular Techniques	Y. Lokko/P.J.L. Lagoda
KEN/5/029	Kenya	Developing Appropriate Artemisia Varieties for Management of Malaria	Y. Lokko/M. Spencer
MAG/5/018	Madagascar	Improving Cereal Production (Rice and Maize) through Mutation Breeding for Tolerance/Resistance to Striga (*Striga asiatica*)	M. Spencer
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	Y. Lokko
MAL/5/028 **Awaiting Financing**	Malaysia	Enhancing the Production of Bioactive Compounds in a Local Herbal Plant by a Soilless Planting System and In Vitro Mutagenesis	Y. Lokko/M. Spencer
MAR/5/018	Mauritius	Improvement of Banana and Tomato Varieties Through the Use of Nuclear Techniques for Mutation Induction and Biotechnology	M. Spencer/Y. Lokko
MYA/5/016	Myanmar	Development of Rice Varieties with Improved Iron Content/Bioavailability Through Nuclear Techniques	S. Dharmapuri/Y. Lokko
MYA/5/017	Myanmar	Studying Yield Improvement of Local Rice Varieties though Induced Mutation	S. Dharmapuri/Y. Lokko
MYA/5/019 **Awaiting Financing**	Myanmar	Developing Thermo-Insensitive (Cold-Tolerant) Green Gram Genotypes, Using Mutation Techniques	Y. Lokko
NAM/5/009	Namibia	Using Mutation Breeding and Integrated Soil Plant Management Techniques to Develop Sustainable, High Yielding and Drought Resistant Crops	Y. Lokko in collaboration with Soil and Water Management and Crop Nutrition Section

Project Number	Country	Title and Objective(s)	Technical Officer
NER/5/014	Niger	Improving the Productivity of Cowpea/Finger Millet Based Cropping Systems	M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
PAK/5/044	Pakistan	Improvement of Drought Tolerance in Chickpea Through Induced Mutations	M. Spencer
PER/5/030	Peru	Genetic Improvement of Quinoa and Kiwicha Using Mutation Induction and Biotechnology	Y. Lokko
QAT/5/002	Qatar	Developing Biosaline Agriculture in Salt-Affected Areas in Qatar	S. Dharmapuri/P.J.L. Lagoda in collaboration with Soil and Water Management and Crop Nutrition Section
RAF/5/056	Regional Africa	Field Evaluation and Dissemination of Improved Crop Varieties Using Mutation Breeding and Biotechnology Techniques	M. Spencer/S. Dharmapuri
RAS/5/045	Regional Asia	Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology (RCA)	Y. Lokko/P.J.L. Lagoda
RAS/5/048	Regional Asia	Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA)	P.J.L. Lagoda
RER/5/013	Regional Europe	Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques	Y. Lokko/S. Dharmapuri
RLA/5/056	Regional Latin America	Improving Food Crops in Latin America though Induced Mutation (ARCAL CV)	M. Spencer/Y. Lokko
SAF/5/010	South Africa	Development of New Maize and Sorghum Germplasm with Enhanced Nutritional Content	Y. Lokko
SAF/5/012	South Africa	Analysing the Level of Drought Tolerance in Mutant Gerplasms of Cowpea and Amaranthus Using Molecular Biotechnology	Y. Lokko
SAU/5/003	Saudi Arabia	Improving Fertilization under Saline Conditions for Sustainable Crop Production	S. Dharmapuri/P.J.L. Lagoda in collaboration with Soil and Water Management and Crop Nutrition Section
SEN/5/030	Senegal	Integrated Approach to Develop Sustainable Agriculture in Senegal	M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
SEN/5/032	Senegal	Improving the Productivity of Jatropha Curcas Plantations in Semi-Arid Areas	M. Spencer
SIL/5/009	Sierra Leone	Improving Sorghum Productivity Through Nuclear and Biotechnology	S. Dharmapuri/Y. Lokko
SUD/5/030	Sudan	Increasing productivity of Selected Crops Using Nuclear Related Techniques	M. Spencer/P.J.L. Lagoda in collaboration with Soil and Water Management and Crop Nutrition Section

Project Number	Country	Title and Objective(s)	Technical Officer
THA/5/049	Thailand	Increasing Productivity of Selected Crops Using Nuclear Related Techniques	Y. Lokko/P.J.L. Lagoda
TUN/5/023	Tunisia	Radiation-Induced Mutations for Improvement of Cactus	Y. Lokko
TUN/5/024	Tunisia	Development of Improved Strains of Olive Tree Through Mutation Breeding and Biotechnology	Y. Lokko
TUR/5/025	Turkey	Using Molecular Techniques for Enhancing the Efficiency of Mutation Induction and Utilization of Mutants in Agriculture	Y. Lokko/P.J.L. Lagoda
URT/5/026	United Republic of Tanzania	Improving Rice Varieties through Mutation Breeding and Biotechnology in Zanzibar	S. Dharmapuri/Y. Lokko
UZB/5/004	Uzbekistan	Development of Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity	Y. Lokko
UZB/5/005	Uzbekistan	Developing Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity (Phase II)	Y. Lokko/P.J.L. Lagoda
YEM/5/008	Yemen	Introduction of Gamma Ray Irradiation Techniques for Agriculture Purposes	Y. Lokko
YEM/5/010	Yemen	Using Induced Mutations and Efficiency Enhancing Bio-molecular Techniques for Sustainable Crop Production	Y. Lokko
ZAI/5/016	Democratic Republic of the Congo	Mutation Techniques for Improving Nutritional and Medicinal Plants with a Curative Effect on Human Diseases and Alimentary Plants	M. Spencer
ZAM/5/026	Zambia	Improving Crop Varieties through Use of Nuclear Techniques	Y. Lokko 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	Y. Lokko

TC Projects Closed in 2010/2011

Project Number	Country	Title and Objective(s)	Technical Officer
BGD/5/026	Bangladesh	Increasing Agricultural Production in the Coastal Area through Improved Crop, Water and Soil Management	S. Dharmapuri/Y. Lokko in collaboration with Soil and Water Management and Crop Nutrition Section
BOT/5/003	Botswana	Mutational Improvement of Groundnut Varieties	S. Dharmapuri/M. Spencer
NIR/5/035	Nigeria	Adding Value to Root and Tuber Crops Through the Use of Mutation Induction and Biotechnologies	Y. Lokko
ROK/5/035	Republic of Korea	Using a Gamma Phytotron for Mutant Induction to Improve Food and Ornamental Crops	P.J.L. Lagoda

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

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

TC Project Highlights

Adding Value to Root and Tuber Crops Through the Use of Mutation Induction and Biotechnologies, NIR/5/035

The genetic improvement of root and tuber crops is hampered by several factors including asynchronous flowering, low seed set, long growth circles, inherent high levels of heterozygosity and narrow genetic base of putative parents for hybridization schemes. These hinder the ability of scientists to introgress desired traits into well adapted germplasm leading to a continued dependence on cultivars with low nutritive values, high levels of anti-nutrients (such as cyanogenic glycosides in young leaves of cassava) and other undesirable quality traits. Furthermore, the continuous use of vegetative propagules from disease infected plants results in a progressive decline in yield. These also compromise the market values of these crops with dire consequences for the incomes and health status of the resource-poor farming households who subsist on these crops.

Generating novel genetic variation in elite varieties of cassava is important to overcome these constrains. Induced mutagenesis through the use of nuclear techniques supported with biotechnologies such as meristem culture, micro-propagation, ELISA and PCR based techniques are suitable for genetic improvement of root and tuber crop. For the 2007/2008 TC cycle, Nigeria requested support from the IAEA to develop new varieties of root and tuber crops with enhanced quality traits. These efforts were to be channelled through the National Root Crops Research Institute (NRCRI) in Umudike to the eventual beneficiaries — resource-poor rural farmers (predominantly women) who subsist on root and tuber crop production as well as scientists who would have access to a wider germplasm resource.

As part of the capacity building activities in the project, two staff members of NRCRI were trained for a total of 12 months in (i) evaluation and screening for root quality traits and statistical analysis of data and (ii) in mutation induction using both in vivo and in vitro methods, handling and advancing of initial mutant generations, evaluation and recording of mutagenic effects. Laboratory and screen house facilities at NRCRI were upgraded and the project supplied necessary equipment and consumables for development and propagation of mutant populations. Nine distinct cultivars of cocoyam, three of *Xanthosoma* spp. and six of *Colocasia* spp. were propagated in vitro for improvement through mutation induction under the project. In vitro cultures were initiated using either meristem tips or shoot tips. Plantlets were subsequently multiplied by shoot sub-cultures. In the first year of the project corms and cormels of two Xanthosoma spps cultivars were subjected to 5Gy and 10Gy of gamma radiation. Using the minisett technique, 25g sett segments were planted in the field as the first generation of irradiated materials M_1V_1. After a full growth period in the field they were harvested and the resultant M_1V_2 corms and cormels were planted in polybags and stored in the screen house during the dry season. They were then planted individually for the second year to raise the M_1V_2 plants. To date, a 5Gy M_1V_2 population of 2255 plants and a 10Gy M_1V_2 population of 978 plants have been raised which will be propagated by minisett technology to raise the M_1V_3 generation in the 2011 planting season.

In addition the counterpart institution has contributed to the dissemination of the techniques and knowledge in Nigeria. Being the only agriculture research institute in South Eastern Nigeria, NRCRI provides an enabling environment for much needed practical experience in agricultural biotechnology for students mostly from the south eastern universities who take advantage of the plant tissue culture and molecular biology facilities available in the institute. There are undergraduate student trainees attached to the programme as well as postgraduate students carrying out their research projects. In 2009, 36 undergraduate students from eight institutions of higher learning used the upgraded facilities. This TC project has thus contributed immensely to enhancing scientific learning in Nigeria and was closed in 2010.

Y. Lokko
Technical Officer

Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology, RAS/5/045

Under the Regional Cooperative Agreement (RCA) for Asia and the Pacific, the IAEA approved a new regional technical cooperation project RAS/5/045 in 2006. This project aims to accelerate crop quality and stress tolerance improvement through the use of mutation techniques and biotechnology.

The first planning and coordination meeting of this project was organized in collaboration with the Malaysian Nuclear Agency, in Kuala Lumpur, Malaysia, 25–29 June 2007. The meeting was attended by 20 participants from Australia, Bangladesh, China (2), India (2), Indonesia, Malaysia (3), Mongolia, Myanmar, Pakistan, the Philippines, Republic of Korea, Sri Lanka, Thailand (2) and Vietnam. The meeting reviewed and discussed the issues pertinent to each participating RCA country in the context of the overall objectives of this project. Consensus was reached on both overall project and country-wise workplans. The progress achieved was reviewed at the mid-term meeting which was held in Ho Chi Minh City, Vietnam 16–20 February 2009. The meeting was attended by 22 participants from the participating Member States. This meeting provided an opportunity to further strengthen collaboration between the research teams, discuss and critically assess individual workplans and recommend suitable changes where required.

In addition to technical work done within each country, three regional training courses were conducted to ensure that a platform of key technologies was made available to all participanting countries. The courses were on (i) Mutation breeding approaches to improving salinity, drought and heat stress tolerance (held in Beijing, China, 13–22 October 2008), (ii) Mutation breeding approaches to improving disease resistance (organized in Mumbai, India, 5–9 October 2009) and (iii) Mutation breeding approaches to improving protein and starch quality (held in Lismore, Australia, 23–27 March 2009) and were attended by 20, 14 and 13 participants respectively. In addition, a national training course on TILLING techniques was organised in Ho Chi Minh City, Vietnam, 7–11 December, 2009 where 44 participants were trained. The training courses in China, Australia and Vietnam were facilitated by at least one to two international experts, while the course in India was facilitated by staff of the Bhabha Atomic Research Centre (BARC). Furthermore, four expert missions aimed at the preparation of training materials and manuals were implemented. An IAEA expert mission to assess impact and dissemination of rice mutant varieties developed under a previous TC project (RAS/5/037) was also implemented. In March 2010, the final review meeting of this project was held in Bangkok, Thailand. A consultants meeting to review the modalities for the establishment of a regional network, Asian Association of Mutagenesis in Crop Plants, was held in Xi'an, China, 6–8 September 2010.

Significant progress has been made towards achieving the expected specific outputs. These include the:

- Generation of well characterised and stable crop mutants for important agronomic traits such as improved yield, resistance to diseases, protein, oil, starch and sugar content that are currently in yield trials or national pre-release trials.
- Evaluation of selected mutants and their use in breeding programmes and population improvement.
- Development of several mutant varieties developed under previous IAEA assisted TC and CRP projects that have been disseminated to farmers and officially released as new varieties.
- Production of training materials including procedures and manuals on the use of mutation techniques and biotechnology for routine application in identifying specific desirable plant/crop characteristics.
- Training of personnel in the use of mutation breeding and biotechnology for improving water use efficiency and tolerance to drought stresses, salinity and crop quality and nutritional characters.
- Formation of an Asia and Oceania Association of Plant Mutagenesis (AOAPM).

Y. Lokko
Technical Officer

News from Ug99

Responding to the transboundary threat of wheat black stem rust (Ug99), INT/5/150

In June 2010, INT/5/150 participants sent induced populations and lines to be tested in Kenya. A total number of 283 000 individuals (40 genotypes of wheat and barley) from 11 countries were screened. Moi, Egerton, Kenya is an endemic hotspot for three of the most virulent derivatives of Ug99.

Wheat black stem rust screening field at Moi University, Egerton, Kenya (photo courtesy of Prof Miriam Kinyua)

The careful screening for resistance to the disease allowed the identification of fifteen putatively resistant lines in M_2 generations in 11 countries. In addition, more than 100 M_2 plants were scored and selection made for (i) medium susceptibility (65 MS), and (ii) medium resistance (42 MR). These lines were also screened based on traits other than rust resistance to include other diseases, drought tolerance, quality, plant height, maturity, and salt tolerance. These results mark a major milestone for the project implementation and the highest priority now will be the validation of these results.

Wheat Ug99 resistance scoring at Moi, Kenya (photos courtesy of Prof Miriam Kinyua)

Future mutation activities of this project will be extended to target rust diseases in general, including yellow rust (stripe rust), brown rust (leaf rust), and *Septoria* to contribute to an eventual broadening gene base for rust resistance, albeit with an emphasis on Ug99 and its derivatives. This IAEA project will focus on advancing the mutant lines, identifying and characterizing the resistance genes and applying double haploid (DH) techniques to advance generations.

Pierre J.L. Lagoda
Technical Officer

Highlights

Zhejiang University, Hangzhou, China is an IAEA collaborating centre for mutant germplasm enhancement and exploitation of plants. It has been intensively working on mutation breeding, genetics and biotechnology of crop plant especially rice. In the past ten years, eight rice mutant varieties have been released for commercial production. Dozens of induced mutant lines with enhanced agronomic or quality and nutritional traits have been generated and utilized in breeding programmes. Six important mutant genes have been cloned. The collaborating centre has also become a hub for human resources development supported by the IAEA's technical cooperation projects. More than a dozen fellows from Asia, Africa and South America have been trained here in the past decade.

Research highlights

1. **Development of high resistant starch rice and wheat.** Dianxing Wu and his colleagues at the centre have developed a series of rice and wheat mutant lines with elevated resistant starch levels. Resistant starch is a special type of edible fibre and considered to be a healthy food ingredient. High resistant starch rice has shown to be suitable for patients with type II diabetes; patients can maintain their blood glucose index after eating this special rice variety which is not possible when normal rice is consumed. A new product named 'Yitangmi' or rice suitable for diabetes patients has already been commercialized using the high resistant starch rice as the key ingredient.

YITANGMI: Rice suitable for diabetes patients

2. **Development of mutant traits for hybrid seed production.** Hybrid crops have higher and more stable yields and thus are considered to be of great importance for food security. In China, hybrid rice varieties cover about 40% of the rice growing area. Male sterile lines — either due to cytoplasmic male sterility (CMS) or photoperiod/thermal-sensitive genic male sterility (P/TGMS) — are the key genetic tools in hybrid seed production. However, they can also produce certain amounts of self-pollinated seeds due to leaky sterility particularly under extreme temperature variations. This can result in losses to farmers and seed companies because hybrid seeds with a high percentage of self-pollination in male sterile lines cannot be cultivated profitably. To cope with this issue, the centre has generated two mutant traits that are embedded in male sterile lines. These traits are leaf colour markers (albino seedlings that revert to green and grow into yellow plants) and herbicide susceptibility. These traits assist in the easy identification of self-pollinated escapee seedlings derived from male sterile lines. They can be easily removed at the seedling stage to generate a pure population of hybrid plants in the field.

JIAYOU 99: Hybrid rice variety with super quality and yield being grown in Zhejiang Province, China. A herbicide susceptible mutant trait was embedded into its male sterile line (Jiazhe A) via mutagenesis (Photo courtesy of Prof Qingyao Shu)

3. **Low phytic acid mutant germplasm of both nutrition and environment importance.** Commonly known as phytic acid (PA), inositol 1,2,3,4,5,6-hexa*kis*phosphate [Ins(1,2,3,4,5,6)P_6, InsP_6] is the major phosphorus storage form in plant seeds. It often exists in the form of a mixed salt (phytate or PA-P) with mineral cations such as Zn^{2+} and Fe^{3+}. Phosphorus in PA or PA-P form is almost indigestible for monogastric animals. Undigested PA-P excreted in manure has become an important source of environmental phosphorus pollution as it can cause eutrophication and impaired water quality. Therefore,

the abundance of PA-P in grain food/feed has a number of nutritional, agricultural and environmental consequences and there is considerable interest in generating low phytic acid (LPA) crops. The collaborating centre has been working on this subject for the past ten years and has generated a dozen LPA rice, soybean and barley mutant lines. The underpinning genes have been identified for nine mutant lines and allele-specific molecular markers have been developed for marker-assisted selection. The mutant lines have been introduced into breeding programs by other groups in China as well as in Australia, Canada and the Philippines. An elite LPA line of soybean has already undergone national yield trials and is expected to become a new variety within 2–3 years

For more information, contact Prof Qingyao Shu (Email: qyshu@zju.edu.cn)

Participants at the Workshop on Breeding Low Phytic Acid Crops — organized in December 2010 by Zhejiang University, Hangzhou, China (Photo courtesy of Prof Qinyao Shu)

Prof Qingyao Shu
Zhejiang University

Developments at the Plant Breeding and Genetics Laboratory, Seibersdorf

Introduction

Readers picking up this newsletter for the first time may be unaware of the decades-long commitment of the Plant Breeding and Genetics Laboratory (PBGL) in supporting capacity in Member States to use mutations to develop superior crops. The PBGL has the distinction of being the only laboratory dedicated to Plant Breeding and Genetics in the United Nations system. Efforts to support capacity in Member States are carried out through a three pronged approach of providing technical services, training, and in technology development, adaptation and dissemination. The work is both challenging and rewarding. Below you will find a brief overview of activities since the last newsletter.

Technology development and adaptation

Summer is the perfect time to witness the awesome biodiversity the Earth has to offer. Flowers are in bloom, trees covered with leaves, birds fill the air with their songs, and the ground comes alive with insects when a picnic is prepared. A rich biodiversity provides a pleasant backdrop for human activities. Biodiversity is also the cornerstone for productive and sustainable agriculture. The diversity of polymorphisms in genes and controlling elements provides a deep resource for plant breeders to develop crops with improved traits in order to meet the growing challenges of a changing climate, increasing population and a shift to more resource demanding meat based diets. Where extant diversity is unavailable or difficult to employ, novel diversity can be induced through the process of mutagenesis. This has been successfully applied for many decades for the development of superior crops, and is the cornerstone of the Plant Breeding and Genetics Laboratory. The R&D activities of the PBGL are aimed at developing and adapting technologies, protocols and guidelines for the more efficient use of induced mutations for functional genomics and breeding.

Phenotypic characterization of mutants and accessions

As previously reported, a mutated population of Grande Naine banana has been generated and studied for the presence of induced mutations with the use of the TILLING reverse-genetics method. A high density of induced and heritable mutations has been observed, suggesting the efficacy of induced mutation approaches for forward and reverse-genetics approaches in vegetatively propagated species. In addition to genotypic analysis, the population was subjected to phenotypic evaluation. Putative mutants were transferred into the greenhouse at the M_1V_{10} stage and subjected acclimatized in vivo. Morphological measurements were taken following standardized banana descriptors. A variety of traits were observed that deviated from measurements in the non-mutagenized wild-type plants. These included changes in leaf morphology, leaf coloration such as discoloration, darker green and various forms of variegation; leaf deformation, uneven lamina; leaves with decreased size, and many other deformations such as narrow or erect leaves, long but weak, broad and oval; with tendency to roll up at edges; changes in leaf texture such as waxy, leathery or rough, crumpling and rough veins. The maintenance of plants through successive rounds of mitotic propagation raises questions with regards to the causative nature of phenotypic variation. Future efforts will aim to determine if phenotypic variation arises via gene function defects caused by the presence of induced mutations, rapid accumulation of natural DNA polymorphism, or epigenetic changes.

The PBGL continues with comparative studies of the effect of gamma and X ray irradiation on rice plants. The main objective is to produce optimized protocols for X ray treatment and subsequent early evaluation of mutagenized plants, especially the development of methods for accurate dose selection for bulk irradiation of investigated varieties. For this purpose, five Malagasy rice accessions have been used and irradiated with gamma and X ray with the following doses: 75, 150, 300, 450 and 600 Gy. This work began as part of a TC fellowship training in the PBGL (MAG/5/018). The effect of irradiation has been observed on the M_1 generation, to make a general estimation of the utility of the different doses. One of the five accessions has been selected for further analyses in the M_2 stage. Four thousand and six hundred M_2 rice plants have been germinated. Phenotypic characterisation of the M_2 plants has been performed for a variety of traits including growth rate, chlorophyll content, and cytological studies of microspore viability. Phenotypic characterisation of the M_2 plants showed differences in the response to the various mutagens and sources of irradiation. Furthermore, various morphological differences were observed in M_3 seeds using visual analysis methods. Several putative mutant lines with promising traits have recently been selected and the M_4 population is being grown for seed multiplication for NIRS analysis. This work is part of the Coordinated Research Project on Enhancing the Efficiency of Mutagenesis through an Integrated Biotechnology Pipeline (D2.40.12).

Low cost assays for mutation discovery and reverse-genetics

Reverse-genetics, the act of targeting the disruption of specific genes or other sequences prior to any investment in phenotypic evaluation, is a powerful hypothesis-driven method to probe and validate gene function and to direct the development of plants with desired traits. Such preselection of desired mutants can greatly reduce field propagation and phenotyping efforts. The TILLING (Targeting Induced Local Lesions IN Genomes) strategy combines induced mutations with mutation discovery methods for a generic reverse-genetics platform that can be applied to most species. A major bottleneck in the transfer of TILLING to developing countries is the expense and expertise needed for most mutation discovery methods. The PBGL is continuing efforts to develop, adapt, and disseminate low cost mutation discovery methods that can be used for TILLING and also for the characterization of DNA polymorphisms in natural populations (a procedure known as Ecotilling)

Recent objectives and research activities in the PBGL were concentrated on the usage of a simple and low cost agarose gels to detect digested fragments and compare data to that collected on a high-throughput genetic analyzer. So far, these approaches have been applied on both natural and mutated populations. Since the last newsletter, the PBGL continues its efforts in transferring TILLING/Ecotilling to other species. In conjunction with the fellowship training (TC project MAR/10005) the PBGL and TC research fellow Ms. Banumaty Saraye succeeded in adapting the method for the tomato. The tomato is an important commodity grown in Mauritius and is being used widely in the Mauritian cuisine. The broad goals of Ms Saraye's project are to develop climate-hardened tomatoes that can resist heat stress brought on by climatic variations, and plants with increased resistance to bacterial wilt. With climate change, the noted rise in temperature has a negative impact on tomato yield.

Candidate mutants with altered characteristics have been isolated and screened for induced mutations with the use of the TILLING method. Similar work has been done to develop a robust platform for low cost discovery and characterization of a natural variation. The experiment suggests that the low cost assay can be successfully used for both mutant and natural accessions characterization in the Mauritian tomato.

In related work, we have also initiated a study with the cooperation of Dr Kamila Kozak of the Wroclaw University of Environmental and Life Sciences, Poland, a current intern at PBGL, on *Lupinus*, a member of the *Leguminosae* family. These important crops are useful for agriculture (seeds are high in protein and oil content), biotechnology (ability to produce various alkaloids) and ecology (flexibility to adapt to environmental challenges). Special architecture of the long central tap and proteoid roots, as well symbiosis with *Bradyrhizobium* bacteria (free nitrogen fixation), allows using this plant group to remove contamination from soil (phytoremediation function), improve soil fertility, and help other plant species colonize the land. Ecotilling strategies were optimized for lupin accessions in order to study the natural nucleotide diversity and to identify promising genotypes as parental material for mutagenesis to create TLLING populations. The low cost agarose gel based SNP discovery approach has been successfully adapted and applied, and several natural point mutations have been identified. The method can be further utilized at the University of Wroclaw to enhance detection where induced mutation and crossing are common methods used by plant breeders.

Totamato varieties from Mauritius grown in PBGL greenhouse in Seibersdorf

Adapting platforms for other crops

While the core crops the PBGL work on are banana, cassava, and rice, the many research fellows trained in the lab bring with them the desire to improve a wide range of other crop species. As such, PBGL maintains competencies in tissue culture, phenotyping and molecular techniques for a variety of different plants, and continues to develop broadly applicable technology platforms. The most recent work is focused on Sorghum. Sorghum is the fifth most important cereal crop and is the dietary staple of more than 500 million people in more than 30 countries. Current research fellow, Ms Wajida Zaarawi, is learning techniques for the use of induced mutations to improve Sorghum production in Iraq. The PBGL has been devoting efforts to evaluate mutation discovery and TILLING platforms for Sorghum through collaborations with Dr Zhanguo Xin of the United States Department of Agriculture and Dr Clifford Weil of Purdue University. Dr Xin, the developer of a successful Sorghum TILLING platform in the USA, has supplied PBGL with DNAs from mutagenized lines. These are being used for primer development, gene target selection, and validation of assays. Dr Weil has shared with PBGL a set of lyophilized tissue from a mutagenized Sorghum population. These samples are being used for assay development of high quality and low cost DNA extraction, optimization of mutation discovery, and estimations of mutation spectrum and density. The use of lyophilized tissue is potentially advantageous as samples can be stored for long periods of time without the need for freezers that require a constant source of electricity.

Positive control kits

The PBGL continues to provide assistance on mutation detection through production and distribution of positive control kits that contain DNA with known mutations or polymorphisms, gene-specific primers, and other materials for mutation discovery by agarose gel or Li-Cor DNA analyzer. Fellows trained at the PBGL also benefit from using the kit for learning this low cost alternative for DNA mutation discovery. Two requests for the positive control kit were received in the first half of 2011 (Nigeria and the Philippines). Protocols for the positive control kits can be found online (see next section).

Protocols, guidelines and services

Readers are encouraged to visit the newly designed site called Mutation Enhanced Technologies for Agriculture (META, http://mvgs.iaea.org/). Here you will find the mutant varieties database that catalogues over 3000 mutant plant varieties (you are welcome to register your own variety here). META also connects to the laboratory protocols page for the PBGL (http://mvgs.iaea.org/LaboratoryProtocals.aspx) where readers can access laboratory protocols as well as information and request forms for various services provided by PBGL. Our aim is to make this protocols section demand driven. Please contact us if you have ideas for protocols or other content that you think would facilitate your work.

Services in support of activities in Member States

The table below summarises the irradiation service requests that were received from six Member States and carried out during the period from January to May 2011. The services included irradiation of seeds or propagules from seven different plant species and also two radiosensitivity tests performed on four crop varieties.

Member State	Crop species
Pakistan	• Wheat
Germany	• Ornamental plants (1700 cuttings)
Jamaica	• Sweet yam (300 cuttings) • Ginger (2200 cuttings)
Poland	• *Lupinus angustifolius*
Kenya	• *Hordeum vulgare*
Mauritius	• *Brassica oleracea V. capitata* • *Brassica oleracea V. botrytis*

Genotyping services include AFLP analysis of mutant varieties and DNA sequencing of identified mutations. Since the beginning of 2011, this work included analysis of samples from internal R&D projects, research fellowship projects (TC projects), other agricultural laboratories within Joint Programme (Animal Production and Health Laboratory) and external requests direct from Member States (Mauritius). A total of 2816 samples were analyzed in the first half of 2011.

Training and human capacity building

The PBGL remained active in the area of individual and group training in the last six months. The highlights include the following:

Individual trainees

A total of ten (10) individual trainees, made up of eight fellows and two interns, joined the PBGL between January and June 2011 and worked on specific research projects under the tutelage of PBGL staff members. The eight Fellows from eight countries were supported by the IAEA Technical Cooperation (TC) Programme to enhance capacities in areas where skills critical for the implementation of TC projects were lacking in their home institutions. Details of the Fellows and Interns are provided in the following tables.

Fellows

Name	Country	Areas of training	Period
Ms Banumaty SARAYE	Mauritius	• Genetic diversity study of different accessions of chilli and tomato from Mauritius • TILLING and Ecotilling for characterization of Mauritian chilli and tomato germplasms and putative mutants	January–May 2011
Ms Moe Thida KYAW	Myanmar	• Induced mutagenesis for crop improvement • Nutritional phenotyping of rice mutants lines	March–June 2011
Ms Wajida ZAARAWI	Iraq	• Mutation induction on sorghum spp. • Salinity phenotyping of wheat mutant lines	April–June 2011
Ms Raouia DHOUIBI	Tunisia	• Mutation induction on *Olea europea* • Tunisia Olea spp. Genetic diversity study	March–August 2011
Mr Stephen Kipchirchi KIMNO	Kenya	• Mutation induction on Artemisa • Germplasm characterization	March–May 2011
Mr Maman Dadamassi MAMAN	Niger	• Induced mutagenesis and molecular mutant characterization	Expected June–September 2011
Mr Harimialimalala J. RABEFIRAISANA	Madagascar	• Induced mutagenesis and molecular mutant characterization	Expected June–September 2011
Mr Ibrahima DIEDHIOU	Senegal	• Induced mutagenesis and molecular mutant characterization	Expected June–September 2011

Interns

Name	Country	Areas of training	Period
Ms Kamila KOZAK	Poland	• Cytological and phenotypic analyses of M_2 rice plants • Technology transfer to the *Lupines* spp.	August 2010–September 2011
Ms Farzaneh SHIRAZI	Iran	• Induced mutagenesis in in vitro propagated plants • TILLING and Ecotilling strategies for mutant germplasm characterization	June–November 2011

Scientific visitors

During the course of the first half of 2011, one scientist visited the Plant Breeding and Genetics Laboratory under this category.

Name	Country	Areas of training	Period
Ms Julia BROWN	Jamaica	• Induced mutations in crop improvement and related biotechnologies	18–22 October 2010

Group photo of PBGL staff, interns and fellows present in the lab in the first half of 2011

Professional networking

In an effort to enhance scientific networking and increase the quality of services provided to Member States, the PBGL and Plant Breeding and Genetics Section has recently developed a LinkedIn profile (http://at.linkedin.com/pub/iaea-plant-breeding-and-genetics/31/4b6/aa3). We have also created a LinkedIn discussion group called IM PLANTS (Induced Mutations in Plants). We hope that this can serve as a real time resource where experts can share views and advice on topics surrounding induced mutations and plant breeding. You are welcome to join our network!

IAEA Plant Breeding and Genetics page on LinkedIn

PBGL participation in international conferneces

Mr B.J. Till

San Diego, USA :

- Attended the International Plant and Animal Genome Conference XIX, 15–19 January 2011. Gave oral presentations on the adaptive R&D activities of the PBGL in the Gene Introgression workshop and also the Banana (Musa) Genomics workshop. Also presented data on Musa drought screening in the poster session and served as a representative at the Global Musa Genomics Consortium Meeting held in parallel with the conference.

Norwich, UK (scheduled at the press time) :

- Scheduled trip to visit the John Innes Centre to give a seminar on the activities of the PBGL in developing TILLING and Ecotilling platforms for vegetatively propagated crops.

Ms J. Jankowicz-Cieslak

Istanbul, Turkey :

- Attended the 9th Plant Genomics European Meeting (Plant GEM) meets global challenges, 4–7 May 2011. Gave an oral presentation on the TILLING and Ecotilling approaches to study biotic and abiotic stress responses in Musa during the Session 5 : Plant Biotechnology.

TILLING and Ecotilling positive control kit

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

Publications

Staff Publication in the Field of Plant Breeding and Genetics

Journal Publications/Book Chapters

JAIN, S.H., TILL, B.J., SUPRASANNA, P., ROUX, N., Mutations and cultivar development in banana, Chapter 10 In Banana Breeding : Progress and Challenges ; CRC Press (2011) 203–218.

LOKKO, Y., MBA, C., SPENCER, M., TILL, B.J., LAGODA, P., Nanotechnology and synthetic biology : Potential in crop improvement, International Journal of Food, Agriculture and Environment. ***In Press***

MBA, C., AFZA, R., BADO, S., JAIN, S.M., Induced mutagenesis in plant using physical and chemical agents, Plant Cell Culture : Essential Methods (2010) DOI : 10.1002/9780470686522.ch7.

TADELE, Z., MBA, C., TILL, B.J., TILLING for mutations in model plants and crops, In Molecular Techniqies iin Crop Improvement, 2nd edition, Springer, Netherlands (2010) 307–332.

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JANKOWICZ-CIESLAK, J., KOZAK, K., TILL, B.J., GALEK, R., SAWICKA-SIENKIEWICZ, E., Ecotilling as efficient SNP discovery tool to investigate genetic variation in *Lupinus* sp., 13th International Lupin Conference 6–10 June 2011, Poznań, Poland.

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MAGHULY, F., JANKOWICZ-CIESLAK, J., TILL, B.J., CALARI, A., RAMKAT, R., LAIMER, M., Ecotilling as efficient SNP discovery tool to investigate genetic variation in non-domesticated *Jatropha curcas*. Abstract book of the International Conference on Plant Gene Discovery Technologies, 23–26 February 2011, Vienna, Austria.

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Non-IAEA Publication in the Field of Plant Breeding and Genetics

Date Palm Biotechnology

S.M. Jain, J. Al-Khayri and D.V. Johnson (Eds.)

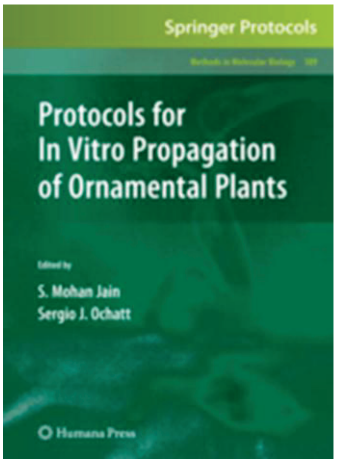
About this book

This important reference book is the first comprehensive resource that reflects research achievements in date palm biotechnology, documenting research events during the last four decades, current status, and future outlook worldwide. It brings together the principles and practices of contemporary date palm biotechnology. The book is essential for researchers, policy makers, and commercial entrepreneurs concerned with date palm. It is invaluable for date palm biotechnology students and specialists. This monument is written by an international team of experienced researchers from both academia and industry. Each chapter contains background knowledge related to the topic, followed by a comprehensive literature review of research methodology and results including the authors own experience and supported with illustrative tables and photographs. In addition to an introductory chapter, the book consists of thirty two review chapters highlighting progress and current research status covering various aspects of date palm biotechnology in five sections: (A) Discusses the research development, methodology, and commercial application of micropropagation in seven chapters, (B) Deals with the research development and applications of somaclonal variation and mutation in date palm, covered in seven chapters, (C) Describes the status of date palm germplasm and current techniques employed in conservation and molecular characterization are described in seven chapters, (D) Addresses research progress made in date palm genetics and breeding in eight chapters, (E) Describes up-to-date progress made in metabolites and industrial biotechnology in three chapters.

2011
Hardcover
ISBN 978-94-007-1317-8

Protocols for In Vitro Propagation of Ornamental Plants

S.M. Jain and S. Ochatt (Eds.)



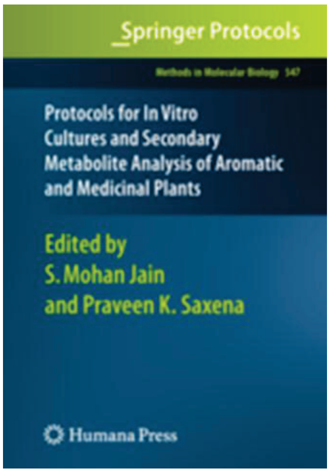
About this book

While ornamental plants are produced mainly for their aesthetic value, the propagation and improvement of quality attributes such as leaf types, flower colour and fragrance, longevity and form, plant shape and architecture, and the creation of novel variation are important economic goals for the expanding ornamental industry. In Protocols for In Vitro Propagation of Ornamental Plants, leading researchers in the field compile step-wise protocols for rapid plant multiplication and in vitro storage of major commercially viable ornamental plants. Divided into two sections, Section A contains chapters mainly on micropropagation of cut and pot flowers with detailed protocols involving in vitro culture-explants, medium preparation, detailed medium table, shoot initiation and proliferation, root induction, in vitro plant hardening, and field transfer, and Section B delves into reviews on topics such as in vitro production of sweet peas, the status of transgenics in ornamental plants, in vitro conservation, the status of floriculture in Europe, azalea phylogeny, and thin cell layers. As part of the highly successful Methods in Molecular Biology™ series, chapters include introductions to their respective topics, lists of the necessary materials, step-by-step laboratory protocols, and notes on troubleshooting and avoiding known pitfalls.
Comprehensive and clear, Protocols for In Vitro Propagation of Ornamental Plants presents key techniques that will be of great use to floriculturists, researchers, commercial companies, biotechnologists, and students dealing with ornamental plants.

2010
Hardcover
ISBN 978-1-60327-390-9

Protocols for In Vitro Cultures and Secondary Metabolite Analysis of Aromatic and Medicinal Plants

S.M. Jain and P.K. Saxena (Eds.)



About this book

Given the vital and far-reaching applications of medicinal plant metabolites worldwide, the quality and consistency of the products as well as the very survival of various species are of the utmost importance. In Protocols for In Vitro Cultures and Secondary Metabolite Analysis of Aromatic and Medicinal Plants, expert researchers provide detailed, step-by-step protocols for the establishment of in vitro cultures of key medicinal plants, their mass multiplication in a controlled environment, and step-wise secondary metabolite analysis, genetic transformation, large-scale metabolite production in a bioreactor, and molecular markers. In addition, many of these protocols will provide a basis for much needed efforts of in vitro germplasm conservation or cryopreservation of medicinal plant species at the brink of extinction as well as efforts to protect them from the adverse impact of rapid climatic changes. As a volume in the Methods in Molecular Biology™ series, chapters include introductions to their respective topics, lists of the necessary materials and reagents, readily reproducible laboratory protocols, and tips on troubleshooting and avoiding known pitfalls.

Comprehensive and authoritative, Protocols for In Vitro Cultures and Secondary Metabolite Analysis of Aromatic and Medicinal Plants is an ideal resource for scientists endeavoring to continue the research on this exciting natural branch of medicine.

2009
Hardcover
ISBN 978-1-60327-286-5

Publications within Coordinated Research Projects (CRPs) 2010–2011

Enhancing the Efficiency of Induced Mutegenesis through an Integrated Biotechnology Pipeline (D2.40.12)

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List of Plant Breeding and Genetics Section's Publications

Plant Mutation Reports

Year	Edition	Contents (a sampling of the papers are listed below):	Reference No.
2011	Vol. 2, No. 3	• In vitro mutagenesis in mangosteen • Floral variation in cotton • Chemical mutagenesis in wheat • Mutation breeding in Brazil • Improved shelf life of garden pea • Improvement of lablab bean	ISSN 1011-260X
2010	Vol. 2, No. 2	• Mutation breeding in Bulgaria • Mutagenesis in clusterbean • Doubled haploid durum wheat • Improvement of indigenous rice • Mutant variety of groundnut • Gamma phytotron • Gamma greenhouse • Gamma field	ISSN 1011-260X
2008	Vol. 2, No. 1	• Induced genetic variability in kacholam • Mutagenesis of guar • Cocoyam radiation sensitivity • Virus resistant rice variety • Cold tolerant mutant rice • Proton radiation • Tomato adapted to low water supply • Increasing crossability of mungbean	ISSN 1011-260X
2007	Vol. 1, No. 3	• Mutation breeding and genetics in Korea • Genetic enhancement of groundnut • Virus resistant banana • Ion beams implantation on wheat • Trombay mutant groundnut varieties • Lodging tolerant rice variety	ISSN 1011-260X
2006	Vol. 1, No. 2	• 30 years rice mutation breeding and genetics • Mutant groundnut varieties in Bangladesh • Shortening durum wheat plants • Seedless mutant sweet orange • Colorful chrysanthemum mutations • Radiosensitivity of cassava in vitro culture	ISSN 1011-260X
2006	Vol. 1, No. 1	• Rice mutation breeding in China • Long grain aromatic rices and induced mutations • Significant contribution of mutation techniques to rice breeding in Indonesia	ISSN 1011-260X

Year	Edition	Contents (a sampling of the papers are listed below):	Reference No.
		• Use of induced mutants in rice breeding in Japan • Katy deletion mutant populations • Rice mutation breeding in Vietnam	

Mutation Breeding Newsletter and Reviews

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

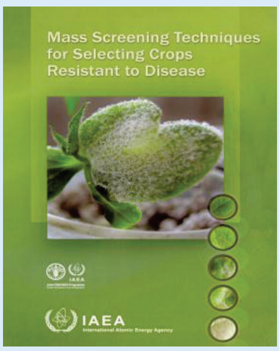
Mutation Breeding Review (published until 2004)

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

Mutation Breeding Newsletter (published until 2003)

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

Books

Year	Edition	Title	Book Cover	Reference No.
2010		Mass Screening Techniques for Selecting Crops Resistant to Disease		ISBN 978-92-0-105110-3

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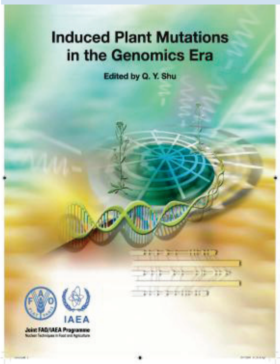
<tr><th>Year</th><th>Edition</th><th>Title</th><th>Book Cover</th><th>Reference No.</th></tr>
<tr><td>2009</td><td></td><td>Induced Plant Mutations in the Genomics Era</td><td>
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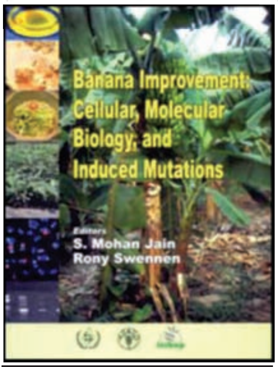
<tr><td>2004</td><td></td><td>Banana Improvement: Cellular, Molecular Biology, and Induced Mutations</td><td>
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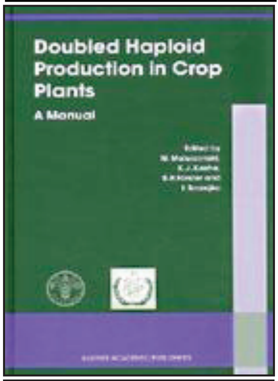
<tr><td>2003</td><td></td><td>Doubled Haploid Production in Crop Plants – A Manual</td><td>
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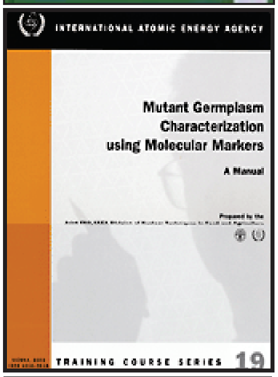
<tr><td>2002</td><td>Training Course Series No. 19</td><td>Mutant Germplasm Characterization using Molecular Markers – A Manual</td><td>
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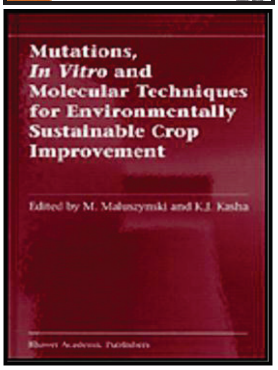
<tr><td>2002</td><td></td><td>Mutations, In Vitro and Molecular Techniques for Environmentally Sustainable Crop Improvement</td><td>
</td><td>ISBN 1-4020-0602-0</td></tr>
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Technical Documents

Year	Type of Publication	Title	Reference No.
2009	IAEA-TECDOC-1615	Induced mutation in tropical fruit trees	ISBN 978-92-0-1027-09-2
2006	IAEA-TECDOC-1493	Mutational analysis of root characters in food plants	ISBN 92-0-103106-8 ISSN 1011-4289
2004	IAEA-TECDOC-1384	Low cost options for tissue culture technology in developing countries	ISBN 92-0-115903-X ISSN 1011-4289
2004	IAEA-TECDOC-1426	Genetic improvement of under-utilized and neglected crops in low income food deficit countries through irradiation and related techniques	ISBN 92-0-113604-8 ISSN 1011-4289
2003	IAEA-TECDOC-1369	Improvement of new and traditional industrial crops by induced mutations and related biotechnology	ISBN 92-0-101603-4 ISSN 1011-4289
2001	IAEA-TECDOC-1195	Sesame improvement by induced mutations	ISSN 1011-4289
2001	IAEA-TECDOC-1216	Induced mutations in connection with biotechnology for crop improvement in Latin America	ISSN 1011-4289
2001	IAEA-TECDOC-1227	In vitro techniques for selection of radiation induced mutations adapted to adverse environmental conditions	ISSN 1011-4289
2001	IAEA-TECDOC-1253	Radioactively labeled DNA probes for crop improvement	ISSN 1011-4289
1998	IAEA-TECDOC-1010	Application of DNA based marker mutations for improvement of cereals and other sexually reproduced crop plants	ISSN 1011-4289
1998	IAEA-TECDOC-1047	Use of novel DNA fingerprinting techniques for the detection and characterization of genetic variation in vegetatively propagated crops	ISSN 1011-4289
1997	IAEA-TECDOC-951	Improvement of basic food crops in Africa through plant breeding, including the use of induced mutations	ISSN 1011-4289
1996	IAEA-TECDOC-859	Use of mutation techniques for improvement of cereals in Latin America	ISSN 1011-4289
1995	IAEA-TECDOC-800	In vitro mutation breeding of banana and plantains	ISSN 1011-4289
1995	IAEA-TECDOC-809	Improvement of root and tuber crops in tropical countries of Asia by induced mutations	ISSN 1011-4289
1994	IAEA-TECDOC-781	Mutation breeding of oil seed crops	ISSN 1011-4289

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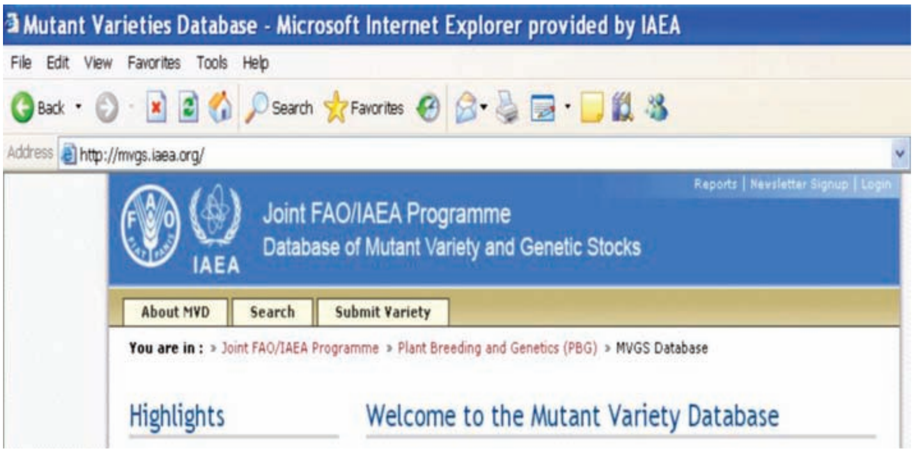
New FAO/IAEA Database of Mutant Varieties and Genetic Stocks

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



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

We would greatly appreciate your support by registering your mutant variety 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 this variety may be shown in local language).

Please visit the website http://mvgs.iaea.org and send us your valuable suggestions and comments regarding the structure and content of this database. Please also send us other information, related to plant mutation breeding and mutant varieties, 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.

Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Plant Mutation Reports

Author's Guidelines for Manuscript Submission

Scope

Plant Mutation Reports (PMR) publishes (mini) reviews, short communications and complete research papers in all areas of plant mutation research, focusing on mutagenesis, phenotyping and genotyping characterization of mutant populations and the application of mutation breeding and biotechnology in crop improvement. It also publishes description papers on mutant germplasm and mutant varieties. Papers on the socioeconomic impact analysis of induced mutations and mutant varieties are also accepted.

Style

The manuscript should be accurately and concisely written in English with the following sections:

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- Title: The title should be brief and informative, 10 to 12 words (excluding 'and,' 'of,' and similar conjunctions and prepositions). As much as possible use common names for crops and avoid abbreviations.
- Authors: The names of all authors should follow the title line initials of given names followed by full family name. Place an asterisk (*) after the name of the corresponding author (i.e., the person from whom reprints are to be requested). If authors are from different institutions, indicate institutional affiliation with numbers in *superscript font* (1, 2 …).
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- The main text should follow the title page and abstract.
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- Research articles should be arranged in the following order: Introduction (which includes the literature review), Materials and Methods, Results, Discussion, Conclusions (optional), Acknowledgements (optional), and References, followed by any figure captions, and then tables. Use the '*Title Case*' for each section.
- Results and discussion may be combined and conclusions can be given at the close of the discussion section.
- Start each section (including figure captions and tables) on a new page and number all pages.
- New mutant germplasm should include a short description of initial material used and the mutagen and doses applied; selection process; mutated characteristics and its genetic and agronomic analysis. Description of the mutant variety should, in addition, include its performance in yield trials for varietal release and the releasing committee, when applicable, and proof of entry in the MVGS (http://mvgs.iaea.org/).

Acknowledgements

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IAEA publishing style requires that references be keyed to the text by numbers in square brackets corresponding to the order in which they are first mentioned. If a reference is first cited in a table, figure or footnote, it should be numbered according to the place in the text where the table, figure or footnote is first mentioned (i.e. not where the table, figure or footnote happens to be located on the page). Normally references should be numbered serially throughout the document, including any appendices, and collected in a single list (headed REFERENCES) after the last appendix and before any annex. Each annex in which references are cited must have its own reference list.

A reference list should include only those references cited in the text. When cited in the text, references should be styled as numbers in square brackets corresponding to the order in which they are first mentioned (e.g. '…in improving productivity [17, 18].'). If the reference number is an integral part of a sentence, the abbreviation 'Ref.' should be included (e.g. 'This is discussed in Refs [2, 3].').

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[13] STEPHENSON, R., Introduction to Nuclear Engineering, 2nd edn, McGraw-Hill, New York (1958) 491 pp.

[14] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, Evaluation of Radiation Doses to Body Tissues from Internal Contamination due to Occupational Exposure, Publication 10, Pergamon Press, Oxford and New York (1968).

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- Figures, e.g. photographs, graphs and diagrams should be referred to as 'Fig.' numbered consecutively (1, 2, etc.).
- Submit figures in high resolution, individual files (one figure per file) and identify each file accordingly.
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Plant Breeding and Genetics Newsletter No. 27, July 2011

The PBG Newsletter is prepared twice a year 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, July 2011

11-21051