Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Plant Breeding & Genetics Newsletter

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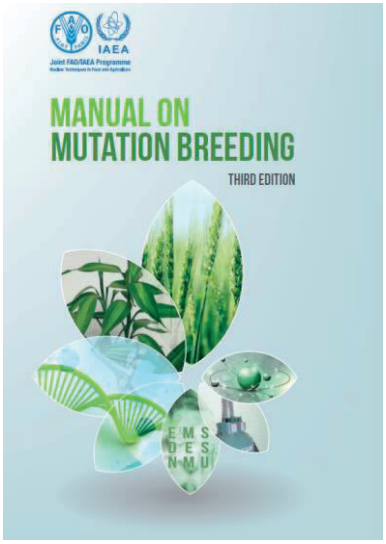
To Our Readers

Dear colleagues,



We are proud to announce the publication of our new *Manual on Mutation Breeding*, co-published by the IAEA and FAO. The previous (second) edition of the *manual* was published in 1977. After nearly 40 years there was an urgent need to update it as there have been several major developments in the intervening years. This third edition describes advances in plant mutation breeding, including basic irradiation techniques as well as chemical mutagenesis, in both seed-propagated and vegetatively propagated crops. The manual provides comprehensive overviews and guidelines for new high-throughput screening methods – both phenotypic and genotypic – that are currently available to enable the detection of rare and valuable mutant traits, and reviews techniques for increasing the efficiency of crop mutation breeding. Most of all, it provides practical, hands on methods in plant mutation breeding techniques, with clear, illustrated step-by-step protocols. The manual is founded on the experience and knowledge of the past and present staff of the Plant Breeding and Genetics Section and Laboratory of the Joint FAO/IAEA Division and was written in close collaboration with external and internationally renowned experts in the specific fields. The combined contributions, backed by the richness of the Mutant Variety Database (MVD) of the Joint FAO/IAEA Division, represent a valuable resource for all those interested in the resurgence of plant mutation breeding.

On 13 April 2018 the Long Night of Research again took place at the Vienna International Centre (VIC) to promote science and research, in particular amongst the younger generation. More than 1000 external visitors were welcomed by nuclear scientists and had the chance to learn about the huge variety of nuclear applications in various fields and how nuclear science and technology are used to improve lives around the world. At this event, many activities of the FAO/IAEA Agriculture & Biotechnology Laboratories were highlighted and our booth was visited by many people. The visitors learned about mutation breeding for crop improvement, the broad usage of mutant crops in our daily food and the high socioeconomic impacts of many of these mutant varieties. This was a unique chance for a little hands-on experience and for discussions with scientists about each process and the science behind these methods.

The Plant Breeding and Genetics Section (PBG) currently provides technical support to four Coordinated Research Projects (CRPs). A new CRP on 'Disease resistance in rice and wheat for better adaptation to climate change' (D2.30.32) will be launched this year, with the first research coordination meeting (RCM) planned for the fourth quarter. These two crops are essential staples in the diets of almost half of humanity, so that any successful attempt at developing disease resistant varieties should have huge impacts in terms of food security and income generation. Diseases are among the major obstacles to improving yield both in rice and wheat. Changing climatic conditions help spread of diseases to new destinations and exacerbate their impact. In addition to the already widespread diseases of rice, such as blast, sheath blight and bacterial leaf blight, threats of emerging diseases, such as false smut in rice and blast in wheat, are becoming more serious. Thus, to

minimize the impacts of these diseases, environmentally friendly and cost-effective technologies are needed for their prevention and management. Development and utilization of disease resistant varieties is the most effective, affordable and environmentally friendly approach for the management of these threats and the use of mutation breeding is a viable tool in development of such germplasms and varieties. This CRP aims to generate genetic diversity and develop rice and wheat lines resistant to important diseases, to develop protocols for screening disease resistant rice mutants and to develop molecular markers for disease resistance using in rice from available mutant germplasm. We invite you to look out for the Call for Proposals at https://cra.iaea.org/cra/explore-crps/all-opened-for-proposals.html and to submit your proposals if you would like to participate.

As of January 2018, the new cycle of technical cooperation projects (TCPs) started. PBG currently provides technical support to 69 active TCPs focusing on crop improvement through mutation breeding techniques. These projects contribute to transferring the capacity of Member States to develop mutant crop varieties resilient to climate change and thereby help ensuring food security in Member States. As a direct result of past TCPs, out of 3.1 million hectares planted with cotton in Pakistan, 15–25 percent are planted with mutant varieties, a number expected to increase to 30–40 percent in the next years. Three recent mutant varieties, released in 2013, 2016 and 2017, have been well accepted by farmers because of their ability to withstand high temperatures and heavy rains, resist pests and diseases, and sustain yields in this time of climate change while also producing a very high quality fibre that brings a higher price than standard varieties. Another example from Pakistan is the mandarin mutant variety NIAB Kinnow, released in 2017; it has an increased yield of more than 30 percent and a seed count reduced from around 50 to just 3–5 seeds per fruit. In Namibia, seven cowpeas and three sorghum mutants with better drought tolerance and better yields have now been officially released by the Ministry of Agriculture, Water and Forestry. Seed multiplication was carried out during the 2017–2018 cropping season and newly certified seeds will be available to farmers for planting in the 2018–2019 season.

During the first half of 2018, the PBGL continued its applied R&D to advance technologies for mutation breeding in FAO and IAEA Members States. The greenhouse-based screening protocol for resistance to the parasitic weed *Striga* in sorghum is being validated using an irradiated mutant population. These experiments indicate that this protocol will be effective to select *Striga* resistance in sorghum under greenhouse conditions, thus providing an alternative and more standardized selection system compared to field-based selection, which is often erratic. Further, the allele-specific marker for a reduced lignin trait in barley was shown to correctly predict the reduced lignin phenotype in one experimental population of barley. The marker could differentiate homozygous from heterozygous plants, thus showing its potential for use in marker-assisted backcrossing of reduced lignin in barley. Research institutions in several MS have already expressed interest in testing both protocols in their breeding programs. Also, a journal article on irradiation-induced mutations in banana was published. The article provides new insight into the type and frequency of gamma-induced genetic changes in the banana genome. More details on these developments can be found further in this Newsletter. Finally, PBGL is pleased that some of our greenhouses have been upgraded and that the new LED lighting system has now become fully operational, offering much-improved control of light conditions and greatly helping to extend the growing season of our crops into the winter season.

The FAO/IAEA International Symposium on Plant Mutation Breeding and Biotechnology, will be held in Vienna, Austria, on 27–31 August 2018. This event will mark the 90th anniversary of the successful use of induced mutations in crop breeding and genetics research. The widespread use of induced mutants in plant breeding programs throughout the world has led to the official release of thousands of mutant crop varieties, resulting in enormous economic impacts. Induced mutations have also become an important genetic resource for genomic research and gene discovery during the past decades, which in turn will greatly help further crop improvement activities. Since our last International Symposium ten years ago, this event will highlight specific challenges faced by Member States, including emerging transboundary threats to crop production, and will assess the overall importance of mutation breeding to food security. It will highlight new developments, trends and challenges in the field of plant mutation breeding and biotechnology, and foster a broad exchange of information within the scientific community as well as with the private sector. About 400 researchers from about 80 countries and international research institutes have registered or been nominated by their governments for participation in the symposium. More than 80 lectures and about 250 posters will be presented at the symposium.

Finally, I want to thank you all for your extensive support and invaluable input during the past six months and, hopefully, to wish a productive, fruitful and successful participation at the upcoming Symposium.

Ljupcho Jankuloski
Acting Head
Plant Breeding and Genetics Section

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[3] Joined in May 2018

Staff News

Molecular Geneticist

Norman Warthmann

We are very pleased to welcome Norman Warthmann from Germany as a new member of the Plant Breeding and Genetics Laboratory (PBGL).

After his Diploma in Biology from the University of Tűbingen, Germany, Norman joined the Laboratory of Detlef Weigel, first at the Salk Institute for Biological Studies in La Jolla, California, USA, and later at the Max Planck Institute for Developmental Biology, again in Tűbingen, Germany, where he obtained his PhD. For the past five years, Norman held a position as Lecturer in the Research School of Biology at the Australian National University in Canberra, Australia, conducting research in species and population diversity and teaching courses in Molecular Biology, Bioinformatics and their use in Functional Genomics.

Norman has been exposed to international agricultural research through collaborations with several CGIAR centres and as a guest researcher at Bioversity International in Rome. In addition, he has contributed expertise to FAO as a consultant for the International Treaty on Plant Genetic Resources for Food and Agriculture, where he wrote a document on the opportunities of genomics for international agriculture.

Norman is an expert in DNA sequencing technologies. While mainly exploring sequencing to drive genetic mapping experiments and genome wide association studies, his research made contributions to improve second and third generation sequencing applications, which include developing cost-efficient sequencing library preparations, pioneering reference sequence graphs, and inventing innovative metrics to compare samples.

With his broad experience in forward and reverse genetics, practical molecular biology, high-throughput approaches, and bioinformatics we expect Norman to make meaningful contributions to the work of our multidisciplinary team at the PBGL, where we strive to further improve the efficiency of crop mutation breeding. Norman is an advocate of open source and data sharing, and is excited to contribute to the work of the Joint FAO/IAEA Division with its important goals to further peace and development, improve livelihoods and food security. In his free time, Norman enjoys playing all sorts of sports and flying aeroplanes. You can reach him at N.Warthmann@iaea.org.

Consultant

Indra Giri was born in Indonesia and holds a BSc in Industrial Engineering from STT TELKOM, Bandung, Indonesia. He started his career as aproduction and process engineer at Indofood, a major processed food company in Indonesia. He was later appointed to be a manager at Indofood's sister company in Lagos, Nigeria, where his main duty was to manage supply chains for its main factories. His dealings with raw materials such as wheat flour and palm oil brought him a new passion to be a researcher in agriculture. Indra is now completing his master's study at the University of Natural Resources and Life Sciences (BOKU), Vienna, Austria. He is conducting a research on 'Evaluation of Drought-tolerant Rice Mutants for Molecular Marker Development in Collaboration with Indonesia and Bangladesh' in the PBGL, Seibersdorf. If you want to contact Indra, please feel free to use the following electronic address: I.Giri@iaea.org.

Farewell

It is time to say goodbye to our dear friend and colleague, Mr Guenter Berthold, who served the PBGL for over 30 years and who retired at the end of February 2018. We thank him for his friendship, candour and his many contributions to our work, especially for taking such good care of the plants in the greenhouse and field. Guenter also greatly contributed to the *in vitro* tissue culture work, especially in his early years working for the Joint Division when the banana mutation breeding protocol was developed and perfected. Guenter always served with dedication and an eye for detail and tidiness. His former FAO and IAEA colleagues and friends all attended a farewell lunch near to his hometown, Mannersdorf. In his final working months at the PBGL, he took the lead in upgrading PBGL's greenhouse facilities by installing new light and watering systems. We wish Guenter all the best, many enjoyable bike rides through the beautiful Austrian countryside and well-deserved time with family and friends!

Forthcoming Events

Coordination Meeting and Workshop on Improving Sustainable Cotton production through Enhanced Resilience to Climate Change, RAS5075, Mandalay, Myanmar, 2–6 July 2018

Technical Officer: L. Jankuloski

Cotton has a special significance and plays an important role in the economies of Australia, Bangladesh, China, India, Islamic Republic of Iran, Myanmar, Pakistan and Viet Nam. This leading fibre crop is grown on 20.5 million hectares in the three-main cotton producing countries of the Asia and Pacific region i.e. China, India and Pakistan, with their annual contribution of about 60–65% in total world cotton production. Emerging demands from Viet Nam and Bangladesh for their cotton mill use signifies the increased role of cotton production in the economy of regional countries.

During the first coordination meeting in 2016, network among participants was established. Seed material of two promising heat tolerant cotton mutant lines which were developed in Pakistan were disseminated to the participants. Seed material of these two mutant lines was multiplied and an adaptation trial will be performed in participating countries in 2018.

Mutation breeding programmes in the Islamic Republic of Iran, Syrian Arab Republic and Viet Nam is in the initial phase, at the stage of M_1 generation, with expectation of M_2 generation in 2018.

The purpose of the coordination meeting is to:

- review the current status of cotton mutation breeding in participating countries,
- address the gaps and needs for cotton improvement through mutation breeding, and
- fine-tune the work plan/activities for the next years.

Counterparts from Bangladesh, Cambodia, China, Indonesia, the Islamic Republic of Iran, Myanmar, Pakistan, Syrian Arab Republic and Thailand will attend this meeting, and provide presentations on the current status of cotton breeding in their respective countries, the expected roles of nuclear techniques and related biotechnologies in the project, as well as gaps and needs for the application of mutation breeding techniques.

Meeting participants must be a National Project Coordinator (NPC) for plant mutation breeding and nominated by their respective Members State.

Regional Training Course on Methodologies and Mechanisms for Screening against Abiotic Stresses, RAS5077, Jakarta, Indonesia, 9–20 July 2018

Technical Officer: S. Nielen
Course Director: S. Human

The local organizer of this training course is the National Nuclear Energy Agency of Indonesia (BATAN), through the Center for Isotopes and Radiation Application (CIRA). This is an important capacity building event of regional TC project RAS5077 on Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA). Its objective is to improve the capacity in the region in the development of green crop varieties that can thrive under adverse conditions with less agricultural input.

The two-week training course will provide thorough theoretical background and hands on training on screening techniques for crop tolerance to drought, salt and heat stress. Various pre-field screening methods in the laboratory and greenhouse will be practiced using rice and soybean as model crops. Furthermore, the use of morphological and physiological markers for screening abiotic stress tolerance in the field will be part of the training.

Eighteen scientists from Bangladesh, China, Indonesia, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand, and Viet Nam will participate in the training course. Local lecturers from CIRA BATAN and collaborating institutes in Indonesia, as well as external lecturers from Japan and Brazil will provide lectures and direct hands-on training.

International Symposium on Plant Mutation Breeding and Biotechnology, Vienna, Austria, 27–31 August 2018

Scientific Secretaries: L. Jankuloski and I. Ingelbrecht

It is our great pleasure to invite you to participate in the International Symposium on Plant Mutation Breeding and Biotechnology that will be convened jointly by FAO and IAEA, through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, and held in Vienna, Austria, from 27 to 31 August 2018.

This event will mark the 90th anniversary of the first successful use of induced mutations in crop breeding and genetics research by Lewis John Stadler. The widespread

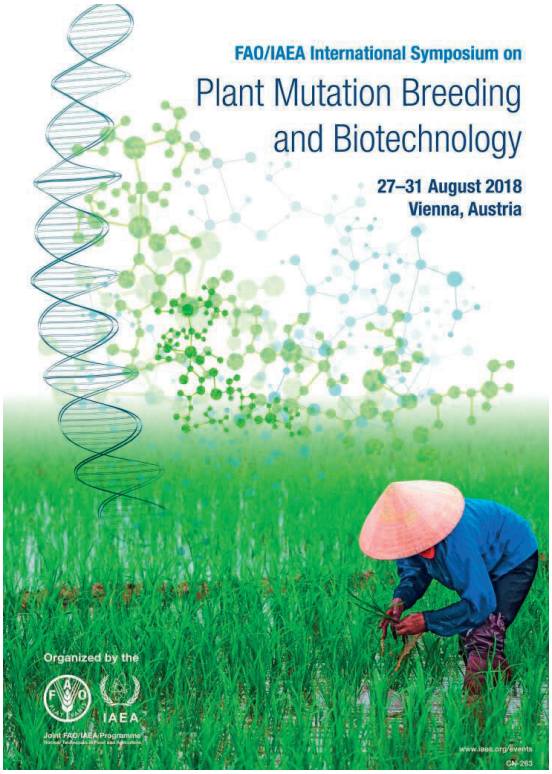
use of induced mutants in plant breeding programmes throughout the world has led to the official release of thousands of mutant crop varieties, resulting in economic impacts measured in billions of USD. Induced mutations have also become an important genetic resource for genomic research and gene discovery during the past decades, which in turn will greatly aid crop breeding activities.

The purpose of this symposium is to review achievements; highlight new developments, trends and challenges in the field of plant mutation breeding; and foster a broad exchange of information within the scientific community, as well as with public and private sectors. The symposium will provide opportunities to present and discuss research and technology development in this field and establish linkages among stakeholders in order to develop knowledge-based breeding strategies and ensure rapid dissemination to farmers. It will also highlight specific challenges faced by Member States, including the effects of climate change on emerging transboundary threats to crop production, assess the overall importance of mutation breeding to food security and will discuss future opportunities.

About 400 scientists and science managers from about 80 countries and international research institutes have registered to participate in the symposium, which will field more than 80 speakers and about 250 poster presentations.

Detailed information on this event can be found on:

https://www.iaea.org/events/plant-mutation-breeding-symposium-2018



Regional Training Course on Advanced Tissue Culture Techniques Combined with Mutagenesis for Crop Improvement, RAS5070, Hanoi, Viet Nam, 10–14 September 2018

Technical Officer: F. Sarsu
Course Director: L. Huy Ham

This training course will be organized in collaboration with the Government of Viet Nam through the Institute of Agricultural Genetics; Centre for Agricultural Biotechnology, Hanoi, Viet Nam. It is open to candidates and project partners in the project RAS5070 on Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RCA).

The purpose of this training course is to provide participants with theoretical as well as practical information using mutation induction on advanced tissue culture techniques combined with mutagenesis for crop improvement and application of *in vitro* techniques and *in vitro* screening for biotic and abiotic stress tolerance in crop breeding.

The course will include lectures and practical sessions on:

- Plant tissue culture for mutation breeding;
- Handling mutant plant populations;
- *In vitro* mutation screening methods;
- Application of advanced tissue culture techniques to crop improvement;
- Using haploid techniques in plant breeding;
- Practical examples of *in vitro* mutagenesis; and
- Security and safety in the laboratory.

The participants should be from all participating Member States involved in the project RAS5070 and actively working in mutation breeding and have a basic knowledge in crop breeding and *in vitro* techniques.

Regional Training Course on Applications of *In Vitro* Mutagenesis on Pacific Crops to Better Resilience to Climate Change, RAS5079, Suva, Fiji, 1–12 October 2018

Technical Officer: F. Sarsu
Course Director: L.M. Waqainabete

This training course will be organized in collaboration with the Pacific Community (SPC). It is open to candidates and project partners in the project RAS5079 on Improving Crops Resilience to Climate Change through Mutation Breeding in the Pacific Islands.

The purpose of this training course is to provide participants with theoretical as well as practical information using mutation induction on pacific crops to better their resilience to climate change, specifically biotic and abiotic stress.

The course will include lectures and practical sessions on:

- Mutation induction and application to pacific crops specifically taro, sweet potato, banana, yam, bread fruit;
- Application of *in vitro* mutagenesis techniques to pacific crops;
- Handling mutant plant populations/lines in laboratory and field conditions;
- *In vitro* screening methods;
- Application of advanced tissue culture techniques to crop improvement (such as somatic embryogenesis);
- Practical examples of *in vitro* mutagenesis;
- Security and safety in the laboratory;

The participants should be from all participating Member States involved in the project RAS5079 and actively working in mutation breeding and have a basic knowledge of crop breeding and *in vitro* techniques. The course will surely enrich scientists with at least a M.Sc. degree in plant breeding and genetics. Participants should have a strong affinity and interest in modern plant breeding methods involving induced mutation and mutation screening (high-throughput phenotyping).

Second Research Coordination Meeting on Mutation Breeding for Resistance *Striga* Parasitic Weeds in Cereals for Food Security, D2.50.05, Vienna, Austria, 15–19 October 2018

Project Officers: A.M.A. Ghanim and L. Jankuloski

The second RCM of the CRP D2.50.05 will be organized at the IAEA Vienna International Center (VIC). The meeting objectives are to present progress made in the activities of the project after the first meeting and to review and consolidate the work plan for the next cycle. The team is expected to report on the developed/adapted and validated screening protocols for resistance to *Striga asaitica* and *hermonthica* in sorghum and upland rice and efficiency enhancing technologies. In addition, reports are expected on the induced putative resistant mutants during the validation on M_2 populations of sorghum and upland rice. It is expected that 14 participants including agreement, technical and research contract holders from Africa, Asia, Europe and the USA will attend the meeting.

Regional Training Course on Mutation Induction and Molecular Marker Applications for Crop Improvement, RAF5076, Morogoro, United Republic of Tanzania, 22–26 October 2018

Technical Officer: F. Sarsu
Course Director: P.M. Kusolwa

This training course will be organized in cooperation with the Government of United Republic of Tanzania through Sokoine Agricultural University. It is open to candidates and project partners from RAF5076 (AFRA) on Improving Crops Using Mutation Induction and Biotechnology through a Farmer Participation Approach.

The purpose of this training course is to provide participants with opportunities to familiarize themselves with these important aspects of crop breeding:

i) Molecular techniques to be applied;

ii) Data collection, data handling and analysis of field data as well as laboratory data generated by molecular marker technologies (SSRs, AFLP, SNPs etc.).

The course will include lectures and practical sessions on:

- Scientific background of mutation induction and its application to crop breeding;
- DNA as the source of genetic information;
- Introduction to molecular marker systems;
- Principles of the polymerase chain reaction (PCR);
- Principles of mapping [Recombination, Linkage data and segregation analysis, Quantitative Trait Loci (QTL) analysis];
- Other molecular biology techniques used in crop improvement;
- Genotypic screening for desired mutations in genes of interest;
- Utilization of appropriate technologies for mutant phenotyping and genotyping.

The participants should be from participating Member States involved in the project RAF5076 and actively working in mutation breeding and have a basic knowledge in crop breeding. The course will surely enrich scientists with at least a M.Sc. degree in plant breeding and genetics. Participants should have a strong affinity and interest in modern plant breeding methods involving induced mutation, mutation screening (high-throughput phenotyping and genotyping) and techniques that can facilitate the breeding process.

Final Regional Coordination Meeting of RAS5070 on Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques, Jakarta, Indonesia, 22–26 October 2018

Technical Officer: F. Sarsu

Many countries in the Asia and Pacific region are facing an energy crisis. Yet, the region has great plant diversity with the potential to be developed for energy sources (i.e. plants producing oil and plants producing carbohydrate which can be converted to bioethanol), as well as large amounts of unproductive land known as 'marginal land', which can be utilized through the application of improved agricultural technologies such as mutation breeding and nutrient and water management practices. The productivity of these marginal lands may be enhanced by the development and growing of bioenergy crops, which in turn, have the potential to benefit the environment, increase rural incomes and offer a more robust crop in the region. By developing potential bioenergy crops through the application of nuclear techniques (mutation breeding; N-15 or C-13 isotopic techniques), it is expected that the land and crops' productivity will increase, the ecosystem balance will be enhanced and the farmers' welfare will improve in the region. This project focuses on strengthening the regional capability of Member States for developing and disseminating mutant varieties by establishing strong and reliable capacity in the use of mutation induction, and by creating the conditions for the association of modern and advanced plant biotechnologies. Additionally, this project is jointly supported by the Plant Breeding and Genetic Section and the Soil and Water Management & Crop Nutrition Section.

This will be the final coordination meeting after the second coordination meeting in Hanoi, Viet Nam in 2017. The meeting will be organized in collaboration with the Government of Indonesia through the Center for Application of Isotopes and Radiation (CAIR), National Nuclear Energy Agency (BATAN).

The purpose of this final coordination meeting is to:

- Review the national project progress in soil, nutrient and water management and plant mutation breeding practices of marginal land using nuclear and isotopic techniques according to the work plans in line with the activities implemented in 2017/2018;
- Report on the progress made over the last four years under the RAS5070;
- Discuss and decide on exchange/preservation arrangements of mutant germplasm/lines/varieties, which is generated under the project;
- Discuss using the techniques/protocols provided through regional training courses;
- Discuss and identify needs of the region for other crops and/or agricultural activities which could be provided by the IAEA.

The meeting is open to two participants from each of the IAEA Government Parties participating in project RAS5070: one responsible for plant breeding activities and another one for soil, nutrient and water management. The meeting will consist of presentations on the progress of the project implementation and achievements in each country, an exchange of information and knowledge, and discuss the project outputs and outlook. NPCs will provide a verbal presentation and a one-page country report on the project implementation and achievements in their countries, including:

- Individual country presentations on the status/achievements/challenges of work on the project and related activities,
- Draft completion report on the: (i) status of plant mutation breeding activities on marginal land; (ii) status of soil and water management practices on marginal land.

Past Events

Expert Meeting on Compiling of Screening Protocols for Target Green Traits in Selected Crops, RAS5077, Faisalabad, Pakistan, 12–16 March 2018

Technical Officer: S. Nielen

Ad hoc meeting of experts and hosts with the IAEA Director General, Mr Yukiya Amano, who was visiting NIBGE and NIAB.

The meeting was an activity of the regional TC project RAS5077 on Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA) and was aimed at drafting protocols with a focus on screening techniques for abiotic stresses and efficient nutrient uptake. The protocols shall serve as guidance for RAS5077 project participants in screening their mutant populations for abiotic stresses, including drought and salinity tolerance as well as for improved nutrient use efficiency (nitrogen, phosphorus, potassium) with the aim of selecting high yielding mutant plants with significantly reduced consumption of chemical fertilizers and water.

The meeting was hosted by the National Institute for Biotechnology and Genetic Engineering (NIBGE) of the Pakistan Atomic Energy Commission, in Faisalabad, Pakistan. The local organizer was Dr Muhammad Ashraf. The meeting was opened with welcoming remarks given by Dr Javed Akthar (Advisor to Chairman, PAEC) and Dr Shahid Mansoor, Director NIBGE, as well as by the Technical Officer and the Lead Country Coordinator (LCC) of project RAS5077, Dr Luxiang Liu, China. Invited experts came from Australia, China, Indonesia and Pakistan. Six protocols have been drafted during the meeting and further upgraded in the weeks following the meeting. They will be published as an IAEA working document and distributed initially to RAS5077 participating institutes. Later, distribution to a wider audience is envisaged after users of the protocols (training courses and project participants) provide feedback for possible refinements.

The meeting had the opportunity for a short encounter with IAEA Director General, Mr Yukiya Amano, who was on a visit to Pakistan and on Tuesday morning came to NIBGE and the Nuclear Institute for Agriculture and Biology (NIAB).

Regional Training Course on Advanced Tissue Culture Techniques Combined with Mutagenesis for Crop Improvement, RAF5076, Accra, Ghana, 7–11 May 2018

Technical Officer: F. Sarsu
Course Director: K.E. Danso

This training course was organized by the PBG in cooperation with the Government of Ghana through the Ghana Atomic Energy Commissions (GAEC). Eighteen scientists from Benin, Burundi, Cameroon, Central African Republic, Cote d'Ivoire, Democratic Republic of Congo, Egypt, Ethiopia, Ghana, Mali, Mauritius, Namibia, Senegal, Sierra Leone, Sudan, United Republic of Tanzania and Zimbabwe attended the training course.

The purpose of this course was to provide participants with theoretical as well as practical information on Advanced Tissue Culture Techniques combined with mutagenesis for crop improvement and application of *in vitro* techniques and *in vitro* screening for biotic and abiotic stress tolerance in crop breeding. The training course included the following sessions:

Plant tissue cell/culture for mutation breeding: provided trainees with knowledge on types of explants used in cell/tissue cultures for mutant population development. Some practical examples of tissue culture of bud versus stem cuttings from initiation to multiplication steps were presented to participants through: cassava (stem cutting), banana (bud cutting), potato (stem cutting, micro-tuber) and sweet potato (stem cutting) as major vegetatively propagated crops in AFRA countries.

The trainees have learned to sample bud explants (cocoyam) and stem cuttings (cassava and sweet potato). The collected explants were sterilized by the trainees and introduced to tissue culture under our guidance.

Example of cocoyam tissue culture practicals: A) Discussion on choice explants, B) Sampling bud cutting, C) Pilling and tap water cleaning of buds, D) Flow bench sterilization, E) Explants preparation, F) View of bud explant and G) Transfer to growth medium.

Using haploid techniques in breeding: doubled haploid production has highlighted the uses and importance of gametic cell culture in plant breeding with special focus on plant mutation breeding. Some practical examples on floral buds (Tomato) and tassel or florets (Maize) were presented to trainees to guide them through the practical exercises. Additionally, some examples of tree crop doubled haploid production were shown and highlighted the importance of this technique in perennial crop species, e.g. coffee.

Doubled haploid production practical exercise: A) Demonstration of floret removal for sterilization, B) Demonstration of anther search and removal before in vitro isolation and plating. C) Floret or bud sterilization for anther plating. D) In vitro plating of anthers.

Plant mutation breeding for crop improvement was introduced to trainees and mutation induction as a plant breeding option highlighted. Some important terms/ definitions used in plant mutation breeding were explained and its differences and advantages compared to other breeding options (conventional and other methods).

Additionally, radio sensitivity test was presented with practical exercises on measurement and computation of data from different radiation tests (cowpea, maize and royal palm). The trainees learned the computation of radiation tests on excel with determination of optimal dose (lethality dose at 50% or 30%, LD_{50}/LD_{30} or growth reduction at 50%, 30%, GR_{50}/GR_{30}). This brought the trainees to understand the importance and assessment of mutation induction dose for a specific cultivar, because of the variation between and within species, hence, the varietal difference.

Practical exercise of optimal dose determination from radio-sensitivity test of: A) Cowpea (0, 100, 150, 200, 250, 300, 350, 400 and 450Gy); B) Maize (0, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600 and 700Gy) and C) Royal palm (0, 10, 15, 20, 25 and 30Gy).

This very successful training course was much appreciated by participants especially the provided lectures, demonstrations and practical exercises with skills on applying that technique in the present and future crop breeding programme.

Workshop on Mutation Breeding and Supportive Biotechnologies for Crop Improvement in the Pacific Islands, RAS5079, Seibersdorf, Austria, 14–25 May 2018

Technical Officer: F. Sarsu
Training Workshop Director: A.M.A. Ghanim

The new Technical Cooperation project on Improving Crop Resilience to Climate Change through Mutation Breeding in Pacific Islands (RAS5079) was initiated in 2018 with the objective to enhance capacity building and food security in the Pacific Islands. So far, the use of nuclear technology and related biotechnologies for crop improvement has not been explored by the Pacific Islands. This is the first mutation breeding project in the Pacific Islands with the objective to develop improved crop varieties tolerant to biotic/abiotic stresses and adaptable to climate change. The workshop on 'Mutation Breeding and Supportive Biotechnologies for Crop Improvement in Pacific Islands' was the first activity of this project which was hold from 14–25 May 2018. The purpose of this workshop was to launch the project and to have discussions on the specific needs from participating countries to finalize the activities and workplan, and to provide participants with basic theoretical and practical knowledge on crop mutation breeding with special attention to vegetatively propagated crops. The joint opening session was organized with INT0093 (SIDS)/RAS5079 TC Workshop on the Use of Nuclear Techniques in Nutrient and Water Management for SIDS. Directors from Joint FAO/IAEA Division, Technical Cooperation Division for Asia and Pacific, Technical Cooperation Division for Latin America and Caribbean Countries and Technical Division for Africa gave opening speeches and welcomed the projects participants (picture 1).

During the first two days of the workshop, a coordination meeting was organized with project participants and the discussion was on in improving their own crop breeding programmes through the use of radiation induced mutation techniques, establishing strong and reliable capacity in the use of mutation induction, and also by creating the conditions for the association of modern and advanced plant biotechnologies to their on-going breeding programmes.

Meeting participants and lecturers.

The second segment of the workshop, was the training course on Mutation Breeding and Supportive Biotechnologies organized by Plant Breeding and Genetics Laboratory from 16 to 26 May 2018 in Seibersdorf. Eight participants from the Pacific Islands (Fiji, Marshall Islands Papua New Guinea), two participants and one MSc student from Indonesia and a scientific visitor from Nicaragua attended the workshop. In addition to the PBGL staff, two experts, Prof Rajbir Singh Sangwan (Université de Picardie Jules Verne, France) and Prof Stefaan Werbrouck (University Ghent, Belgium) provided lectures and practicals during the training course. The training course provided lectures on theory and practical's covering the following major areas:

1. Principle of mutation induction and development of mutant population;
2. Overview of efficiency enhancing technologies in mutation breeding including *in vitro* and molecular techniques;
3. Mutation induction and development of mutant population for vegetatively propagated plants including fruit trees;
4. Basis of plant biotechnology and mutation induction;
5. Cell suspension and culture for mutation induction;
6. *In vitro*/*in vivo* screening of mutants for desired traits;
7. Genetic variability through mutation induction including the development of genetic diversity in pacific islands crop plants (taro, sweet potato, yam, cassava, etc;
8. *In vitro* techniques for vegetative crop plants problem solving;
9. Juvenile/mature phase change in trees;
10. A meristem perspective; induction of new meristem;
11. New plant growth regulators.

Group photo of the participants of the training workshop, including PBG staff and invited experts.

Participants presented their workplans and had a very useful discussion on the most relevant *in vitro* techniques for the targeted plant species in their respective projects. Participants expressed full satisfaction with the content and organization matters of the training workshop.

Mid-Term Project Coordination Meeting on Improving Yield and Commercial Potential of Crops of Economic Importance (ARCAL CL), RLA5068, Panamá City, Panamá, 11–15 June 2018

Technical Officer: S. Nielen

Many countries in the Latin American and the Caribbean Region have a deficit in food production leading to serious problems of poverty and malnutrition mainly in the rural area. This situation is exacerbated by the effects of climate change and population growth in the region. The productivity of small farmer fields is particularly affected by adverse climatic conditions (drought, flood, extreme temperatures), soil impoverishment caused by inappropriate agronomic practices (salinization, acidification, loss of nutrients) and by using out-dated technology and cultivation of old underperforming cultivars, often susceptible to pests and diseases. The objective of this project is the use of mutation induction technologies in combination with biotechnology, efficient mass screening techniques and molecular mutation detection to develop new crop varieties with the required characteristics. The project is in its third year of implementation and will end in December 2019.

The national counterparts from 15 countries of the region (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Jamaica, Mexico, Nicaragua, Panamá, Paraguay and Peru), as well as the Project Management Officer (PMO), Mr Javier Romero, and the Technical Officer (TO) participated in the meeting. The opening of the meeting was also joined by the ARCAL coordinator for Panamá, Mr Reynaldo Lee, and Mr Jorge Samaniego, Production and Plant Protection Officer of the Food and Agriculture Organization of the United Nations (FAO), who presented the initiatives of FAO in the region and how to explore possible synergies with the project.

Each country representative has presented the results achieved so far. These reports revealed that many advanced mutant lines of wheat, rice, bean, soybean, tomato and quinoa with tolerances to drought, extreme temperatures, salinity or resistance to diseases and herbicides have been developed and a few of them are in tests to be released as new varieties. Also, the individual workplans for each country were discussed by the meeting participants and amended if necessary.

The plan of activities for the 2018–2019 period covering training needs and materials was discussed and elaborated. Among the activities discussed is a training course in molecular techniques and bioinformatics for the genetic improvement of agricultural crops obtained by induced mutations and training in participatory selection methodologies in crops of agricultural importance for the region. Additionally, a specific training in gene expression analysis using RNA-Seq technology was agreed upon.

The meeting showed the strong commitment of the counterparts to the project's objectives and it is expected that the planned outputs will be delivered at the end of the project.

Field visit to the Finca Experimental de Ollas Arriba of the Instituo de Investigación Agropecuaria de Panamá (idiap).

In Memoriam

It is with great sadness to announce that the long time national counterpart from the Instituto Nacional de Investigaciones Agrícolas of Venezuela, Dr Efrain Gerardo Salazar Yamarte, passed away recently. Efrain was a very active and knowledgeable scientist, and a cheerful person, who spread a lot of joy and energy. All team members will keep Efrain in their thoughts. Efrain was greatly missed at the meeting.

Coordinated Research Projects

Project Number	Ongoing CRPs	Project Officers
D2.20.05	Efficient Screening Techniques to Identify Mutants with Disease Resistance for Coffee and Banana	S. Nielen I. Ingelbrecht
D2.50.05	Mutation Breeding for Resistance to *Striga* Parasitic Weeds in Cereals for Food Security	A.M.A. Ghanim L. Jankuloski
D2.30.31	Improving Resilience to Drought in Rice and Sorghum through Mutation Breeding	F. Sarsu
D2.30.32	Disease Resistance in Cereals for Better Adaptation to Climate Change	L. Jankuloski

Disease Resistance in Cereals for Better Adaptation to Climate Change, D2.30.32 (New)

Project Officer: L. Jankuloski

The IAEA, in cooperation with the Food and Agriculture Organization of the United Nations (FAO), is announcing a new Coordinated Research Project (CRP) on disease resistance in rice and wheat with a time frame of four years.

A range of diseases are responsible for hindering yield improvements in both rice and wheat. Changing climatic conditions are helping diseases spread to new localities and exacerbating their impact. In addition to the already widespread diseases of rice, such as blast, sheath blight, false smut and bacterial leaf blight, emerging diseases, like wheat blast, are increasingly becoming serious threats.

To minimize the impact of such diseases, environment-friendly and cost-effective technologies are needed to help prevent and manage them. The use of mutation breeding techniques to develop disease resistant varieties is a viable tool in the development of appropriate germplasms and varieties.

Mutations are one of the primary sources of genetic variation in any organism, including plants. The use of mutation induction in generating new germplasm and developing new disease resistant varieties in rice and wheat is an efficient and valuable approach in crop improvement and has been very successful in rice and wheat breeding. More than 820 rice varieties and 255 wheat varieties have been developed by mutation breeding using mostly physical mutagens (https://mvd.iaea.org/#!Home).

CRP Overall Objective

This CRP aims to improve disease resistance in rice and wheat through induced mutation/mutation breeding and development of screening techniques for sustainable food security.

Specific Research Objectives

1. To generate genetic diversity and develop rice lines resistant to important diseases (blast, sheath blight, bacterial blight, false smut).
2. To develop protocols for the screening of rice mutants resistant to diseases.
3. To develop molecular markers for disease resistance using available mutant germplasm.
4. To generate mutant wheat populations and develop screening methods for resistance to wheat blast.

Outputs

1. Improved rice and wheat mutant germplasm as novel sources of disease resistance generated.
2. Efficient laboratory, screen-house or field-based screening protocols and techniques for identification of mutants with improved resistance to diseases developed.
3. Molecular marker/s developed.
4. Publications from the findings of the research activities generated.

How to join this CRP

Up to ten research contracts are expected to be awarded and up to five no-cost agreement holders from advanced laboratories. Research institutes with recognized expertise in the targeted technologies will be invited to share their experience with the contract holders and contribute to the development and validation of the planned technical packages. In addition, it is foreseen that two technical contracts will be awarded for services in advanced areas such as marker development and mutant characterization. Coordination and technical management will be handled by

the scientific secretary in the Plant Breeding and Genetics Section with involvement of Plant Breeding and Genetics Laboratory.

Please submit your Proposal for Research Contract or Agreement by email, no later than 10 July 2018, to the IAEA's Research Contracts Administration Section, using the appropriate template on the CRA web site.

For further information related to this CRP, potential applicants should contact the Research Contracts Administration Section.

Improving Resilience to Drought in Rice and Sorghum through Mutation Breeding, D2.30.31

Project Officer: F. Sarsu

Drought is the most devastating abiotic stress factor worldwide affecting crop production and is projected to worsen with anticipated climate change. It severely limits plant growth and development as well as agricultural characteristics resulting in a reduction of crop yields. Improving drought tolerance in crops to increase the efficiency of water use and to enhance agricultural water productivity under rain-fed conditions is a top priority for most countries. Among various agro-ecologies, Africa and South Asia are considered to be the most vulnerable to climate change and both have large numbers of poor populations constrained with meagre access to basic resources of water and productive land.

The breeding of hardy, input use-efficient, 'smart crop varieties' that are inter alia drought tolerant, which produce more yields with fewer inputs, would constitute part of the solution to the envisaged abiotic stresses arising from climate change.

The main objective of this CRP is to adapt and develop robust protocols for efficient screening of mutant populations for drought tolerance. The target crops are improved rice and sorghum tolerant to drought for current and future climate change scenarios. These two crops are essential staples in the diets of millions of impoverished and vulnerable populations and therefore, any attempt in increasing their yields under drought stress could have a major and positive impact in terms of food security and improved health and income generation. The results from the first year of the CRP are being reviewed and the second RCM is planned to be held in the first quarter of 2019.

Mutation Breeding for Resistance to *Striga* Parasitic Weeds in Cereals for Food Security, D2.50.05

Project Officers: A.M.A. Ghanim and L. Jankuloski

The CRP D2.50.05 on Mutation Breeding for Resistance to Striga Parasitic Weeds in Cereals for Food Security has effectively started with eight research contracts from Burkina Faso, People's Republic of China, Ethiopia, Islamic Republic of Iran, Kenya, Madagascar, Sudan, and Turkey, two technical contacts from Japan and USA, and four agreement holders from FAO, Rome, Japan, the Netherlands, and USA. The main objective is to develop effective screening protocols to identify and advance resistant mutants and to adapt efficiency enhancing technologies such as doubled haploid, rapid cycling and molecular markers.

During the reporting period, all contract holders initiated the work related to respective activities related to the CRP. Screening packages are being optimized for laboratory, screen house and field to Striga asiatica and/or S. hermonthica. in Burkina Faso, Ethiopia, Kenya Madagascar, Sudan, while the remaining contract holders engaged in optimizing one or more of the efficiency enhancing technologies. The Plant Breeding and Genetic Laboratory (PBGL) is optimizing protocols related to laboratory screening using soil, gel and rizotron assay for resistance to Striga, and established platform for histological analysis of mechanisms of resistance which will be used to classify different sources and mechanisms of resistance (see more under PBGL activities in this Newsletter).

Efficient Screening Techniques to Identify Mutants with Disease Resistance for Coffee and Banana, D2.20.05

Project Officers: S. Nielen and I. Ingelbrecht

The CRP officially started in November 2015 and had its first RCM from 7–11 December 2015 in Vienna, Austria, and the second RCM was held from 29 May–2 June 2017 in Lisbon, Portugal. The project started with 12 participating institutes from ten countries (Austria, China, Iran, Malaysia, Nigeria, Peru, the Philippines, Portugal, South Africa and United Kingdom) and one International Organization (Bioversity International). Within the first year, two more

research contract holders from Costa Rica and Mauritius joined the project and two research agreements (Austria and Portugal) were transferred to Technical Contracts. The main objective of this CRP is to adapt and develop screening protocols that are suitable for mass screening of mutant lines to identify rare plants showing enhanced resistance to disease. The target crops for this CRP are banana and coffee. Cavendish bananas are clones and susceptible to diseases, including Fusarium wilt caused by *Fusarium oxysporum* f.sp. cubense (Foc) tropical race four (TR4). In recent years TR4 has been identified in nine countries suggesting that it is spreading geographically and threatening global banana production. Coffee is the second most traded commodity behind crude oil and derivatives. Coffee leaf rust (CLR) caused by *Hemileia vastatrix* is devastating to plantations. Global climate change and variation threaten to increase the negative impact of this disease.

At the end of the second year of this project considerable progress has been achieved as regards to the development of screening techniques as well as for mutation induction techniques in crops, banana and coffee. In banana, a robust and fast in-vitro bioassay for TR4 resistance has been established and applied for screening of 6000 *in vitro* rooted plants derived from mutation induction experiments. Also, a technique for greenhouse screening of small plants has been optimized, as well as a hydroponic system for lab-based screening of Fusarium wilt (TR4). In line with the defined expected project outputs new methods for low cost tissue culture have been developed. As for coffee, where very little work on mutation breeding has been done before the project, we focused on developing and validating mutation induction techniques, specifically in *Coffea arabica*. Effective methods for seed irradiation were developed and the optimum dosages determined. As an alternative to seed irradiation, methods for callus induction, formation and regeneration of embryogenic callus, germination of embryo and development of seedlings were established and different types of explants were irradiated with various dosages of gamma rays. Results from these experiments are expected to emerge in the third year of the project.

Technical Cooperation Field Projects

Project Number	Country/Region	Title	Technical Officer(s)
ALG5026	Algeria	Increasing the Genetic Variability for the Improvement of Strategic Crops (Wheat, Barley, Chickpeas and Dates) for Enhanced Tolerance to Biotic and Abiotic Stresses and the Development of Biotechnology Capacities	L. Jankuloski
ANG5015	Angola	Achieving Drought Tolerant Plants by Inducing Mutation with Gamma Rays	S. Nielen
AZB5002	Azerbaijan	Developing Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity through Mutation Breeding	F. Sarsu
BGD5029	Bangladesh	Evaluating Promising Abiotic Stress Tolerant Crop Mutants/Varieties and Measuring the Suitable Management Practices for the Promotion of Sustainable Production at Saline, Submergence and Drought Prone Areas	L. Jankuloski in collaboration with Soil and Water Management and Crop Nutrition Section
BUL5014	Bulgaria	Screening of Cereal Germplasm Stress Response and Adaptation Potential by Advanced Nuclear, Omics and Physiological Approaches	L. Jankuloski/S. Nielen
BUL5015	Bulgaria	Increasing Productivity and Quality of Basic Food Crops	F. Sarsu
BKF5016	Burkina Faso	Using Nuclear Techniques for Improving Rice Yield and Quality	L. Jankuloski/I. Ingelbrecht
BKF5019	Burkina Faso	Improving Food Crop Genotypes for Enhancing Yield and Adaptation to Climate Change Using Mutation Breeding and Isotopic Techniques	L. Jankuloski
BDI5001	Burundi	Improving Cassava Productivity through Mutation Breeding and Better Water and Nutrient Management Practices Using Nuclear Techniques	S. Nielen/I. Ingelbrecht in collaboration with Soil and Water Management and Crop Nutrition Section
CAF5008	Central African Republic	Improving Cassava Yield through Improved Crop Variety and Best Soil Management Practices Using Nuclear Techniques	I. Ingelbrecht/A.M.A. Ghanim in collaboration with Soil and Water Management and Crop Nutrition Section
CPR5024	China, People's Republic of	Enhancing the Accelerated Application of Mutant Germplasm and High-Efficiency Breeding in Crops	N. Warthmann
ZAI5022	Congo, Democratic Republic of the	Improving Productivity and Quality of Crops (Soybean and Maize) Using Induced Mutation and Biotechnology	L. Jankuloski

Project Number	Country/Region	Title	Technical Officer(s)
ZAI5025	Congo, Democratic Republic of the	Increasing Genetic Variability in Cassava and Maize for Enhanced Tolerance to Biotic and Nitrogen Stresses	L. Jankuloski/F. Sarsu
PRC5002	Congo, Republic of the	Developing Disease Resistant Varieties of Cassava and Banana	S. Nielen
IVC5039	Cote d'Ivoire	Improving Maize Production in Savannah Areas with Severe Pedoclimatic Degradation in the North of Cote d'Ivoire through the Cultivation of Induced Mutants Adapted to these Areas	F. Sarsu/I. Ingelbrecht
GHA5036	Ghana	Screening Oil Palm M2 Population for Useful Mutants	L. Jankuloski/F. Sarsu
GHA5037	Ghana	Using Irradiated Pollen for the Development of Provitamin A Rich, Drought Tolerant and Cassava Mosaic Disease Resistant Cassava Mutants	I. Ingelbrecht
INS5043	Indonesia	Intensifying Quality Soybean Production to Achieve Self-Sufficiency	A.M.A. Ghanim
IRA5014	Iran, Islamic Republic of	Improving Wheat Yield and Stress Tolerance for Sustainable Production	L. Jankuloski
JAM5013	Jamaica	Improving Crops by Using Experimental Mutagenesis and Diagnostic Technologies	S. Nielen
KAZ5004	Kazakhstan	Developing Drought Tolerant and Disease Resistant Wheat Varieties with Enhanced Nutritional Content Using Mutation Breeding	F. Sarsu
KEN5034	Kenya	Using Irradiated Improved *Brachiaria* Grass and *Dolichos Lablab* Species for Increasing Quantity and Quality of Milk Production and Reproduction for Smallholder Dairy Farms in Drought Prone Areas	S. Nielen/F. Sarsu
KEN5037	Kenya	Using Climate Smart *Brachiaria* Mutants to Develop Integrated Farm Model Technologies for Improved Livelihood Among Smallholder Farmers	S. Nielen/F. Sarsu
KEN5038	Kenya	Using Nuclear Techniques to Evaluate and Improve the Impact of Mutated Forages on the Performance of Smallholder Dairy Cows	S. Nielen
KUW5002	Kuwait	Implementing Mutation Induction to Improve Barley Production under Harsh Environmental Conditions	L. Jankuloski/A.M.A. Ghanim
KUW5003	Kuwait	Implementing Mutation Induction to Improve Barley Production under Harsh Environmental Conditions – Phase II	L. Jankuloski

Project Number	Country/Region	Title	Technical Officer(s)
LAO5002	Lao, P.D.R.	Improving Soil Fertility and Water Use Efficiency in the Cassava-Rice-Soybean Production System under Smallholder Farming Systems	L. Jankuloski in collaboration with Soil and Water Management and Crop Nutrition Section
LES5004	Lesotho	Using Nuclear Techniques for Improvement of Crop Yield, Quality and Stress Tolerance for Sustainable Crop Production (Continuation of the on-going project)	S. Nielen/A.M.A. Ghanim
LES5005	Lesotho	Improving Crop Yield, Quality and Stress Tolerance for Sustainable Crop Production, Phase II	S. Nielen/A.M.A. Ghanim
MAG5023	Madagascar	Promoting Climate Smart Agriculture to Face Food Insecurity and Climate Change with Regard to Basic National Foods (Rice and Maize)	L. Jankuloski/F. Sarsu
MAG5025	Madagascar	Enhancing Biocontrol of *Striga asiatica* (L.) Kuntze through the Development of Tolerant Rice and Maize Lines and its Links with Microbiological and Ecological Functioning of Soil	L. Jankuloski
MLW5003	Malawi	Developing Drought Tolerant, High Yielding and Nutritious Crops to Combat the Adverse Effects of Climate Change	F. Sarsu
MAL5031	Malaysia	Establishing an Environmentally Sustainable Food and Fodder Crop Production System	L. Jankuloski
MAU5006	Mauritania	Contributing to the Improvement of Rice Crop Yields through the Application of Nuclear Techniques to Water Management and Soil Fertility	L. Jankuloski/F. Sarsu in collaboration with Soil and Water Management and Crop Nutrition Section
MAR5023	Mauritius	Improving Landraces of Crucifers (Cauliflower and Cabbage) and Carrot through the Use of Nuclear Techniques for Mutation Breeding and Biotechnology	F. Sarsu/L. Jankuloski
MON5021	Mongolia	Improving the Productivity and Sustainability of Farms Using Nuclear Techniques in Combination with Molecular Marker Technology	L. Jankuloski/S. Nielen in collaboration with Animal Production and Health Section
MOZ5007	Mozambique	Enhancing Mutation Breeding of Sorghum and Pearl Millet to Develop High Yield, Disease Resistance and Drought Tolerance	S. Nielen/A.M.A. Ghanim

Project Number	Country/Region	Title	Technical Officer(s)
MYA5020	Myanmar	Strengthening Food Security through Yield Improvement of Local Rice Varieties with Induced Mutation (Phase II)	S. Nielen/L. Jankuloski in collaboration with Soil and Water Management and Crop Nutrition Section
NAM5016	Namibia	Developing Drought Tolerant Mutant Crop Varieties with Enhanced Nutritional Content	F. Sarsu/S. Nielen
NAM5014	Namibia	Evaluating Efficient Water and Nutrient Use, Molecular Characterization and Nutritional Composition of Mutant Germplasm Populations	F. Sarsu/S. Nielen in collaboration with Soil and Water Management and Crop Nutrition Section
NEP5003	Nepal	Improving Crop Yield for Food Security and Economic Growth by Using Nuclear and Molecular Techniques	S. Nielen/L. Jankuloski
NEP5006	Nepal	Enhancing Productivity of Corps and Fruit Employing Nuclear and Molecular Techniques	S. Nielen
NER5019	Niger	Improving Sesame Plant Productivity by Obtaining High-Yielding Induced Mutants Adapted to Semi-Arid Conditions	I. Ingelbrecht/A.M.A. Ghanim
NIC5011	Nicaragua	Broadening the Genetic Variation of Vegetative Propagated Crops Using Nuclear Techniques	S. Nielen
OMA5004	Oman	Building Capacity for the Improvement of Major Crops through Induced Mutation Using Nuclear and Related Techniques	A.M.A. Ghanim/I. Ingelbrecht
OMA5005	Oman	Enhancing the Application of Mutation Breeding and Supporting Biotechnology Techniques for the Improvement of Important Strategic Crops	A.M.A. Ghanim
PAL5009	Palestine	Enhancing the Performance of Durum Wheat Landraces by Induced Mutation (Phase II)	L. Jankuloski/A.M.A. Ghanim
QAT5006	Qatar	Enriching Genetic Diversity and Conserving Plant Genetic Resources Using Nuclear Techniques and Related Technologies	A.M.A. Ghanim/L. Jankuloski
RAF5076	Regional Africa	Improving Crops by Using Mutation Induction and Biotechnology through a Farmer Participatory Approach	F. Sarsu/S. Nielen
RAS5069	Regional Asia	Complementing Conventional Approaches with Nuclear Techniques towards Food Risk Mitigation and Post-Flood Rehabilitation Efforts in Asia	L. Jankuloski/S. Nielen

Project Number	Country/Region	Title	Technical Officer(s)
RAS5070	Regional Asia	Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RCA)	F. Sarsu/S. Nielen
RAS5073	Regional Asia	Supporting Climate-proofing Rice Production Systems (CRiPS) Based on Nuclear Applications-Phase II	L. Jankuloski/S. Nielen
RAS5074	Regional Asia	Enhancing Wheat and Barley Productivity through Induced Mutation with Supportive Breeding and Related Biotechnology Techniques (Phase III)	F. Sarsu/L. Jankuloski
RAS5075	Regional Asia	Improving Sustainable Cotton Production through Enhanced Resilience to Climate Change	L. Jankuloski/F. Sarsu in collaboration with Soil and Water Management and Crop Nutrition Section
RAS5077	Regional Asia	Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA)	S. Nielen/F. Sarsu
RAS5079	Regional Asia	Improving Crop Resilience to Climate Change through Mutation Breeding in Pacific Islands	F. Sarsu
RLA5068	Regional Latin America	Improving Yield and Commercial Potential of Crops of Economic Importance (ARCAL CL)	S. Nielen/L. Jankuloski
SEN5034	Senegal	Using an Integrated Approach to Develop Sustainable Agriculture in a Context of Degrading Soil Fertility, Climate Change and Crop Diversification	F. Sarsu in collaboration with Soil and Water Management and Crop Nutrition Section
SIL5014	Sierra Leone	Enhancing Nutritional and Other End-User Postharvest Qualities of Rice and Cassava through Mutation Breeding	S. Nielen/L. Jankuloski
SIL5017	Sierra Leone	Selecting and Analysing Bio-Enriched and Bio-Fortified Rice and Cassava Lines and their Efficient Postharvest Transformation to Popular Food Products	S. Nielen/I. Ingelbrecht
SIL5020	Sierra Leone	Enhancing the Concurrent Selection and Evaluation of Biofortified and Bio-enriched Varieties Derived from Mutant Rice, Cassava and other Crops	L. Jankuloski
SRL5045	Sri Lanka	Establishing a National Centre for Nuclear Agriculture	F. Sarsu
SUD5037	Sudan	Applying Nuclear Techniques to Improve Crop Productivity and Livelihood of Small-scale Farmers in Drought Prone Areas	F. Sarsu/S. Nielen in collaboration with Soil and Water Management and Crop Nutrition Section

Project Number	Country/Region	Title	Technical Officer(s)
TOG5002	Togo	Improving Crop Productivity and Agricultural Practices through Radiation Induced Mutation Techniques	L. Jankuloski
URT5030	Tanzania, United Rep. of	Improving Rice and Barley Production through Application of Mutation Breeding with Marker Assisted Selection	L. Jankuloski/F. Sarsu
URT5032	Tanzania, United Rep. of	Developing Maize Cultivars for Improved Yield and Resistance to Viral Disease	F. Sarsu/L. Jankuloski
THA5054	Thailand	Increasing Adaptability for Adverse Environment Tolerance in Rice Germplasm Using Nuclear Techniques	F. Sarsu/S. Nielen
TUN5029	Tunisia	Developing Barley and Durum Wheat Resilience to Drought and Heat Tolerance through Mutation Breeding	F. Sarsu
UGA5041	Uganda	Developing Disease Resistant High Yielding Farmer Preferred Cassava Varieties in Uganda through Induced Mutation Breeding	S. Nielen
NHE5001	Vanuatu	Enhancing the Productivity and Quality of Crops through the Application of Mutation Breeding Techniques	L. Jankuloski
VIE5020	Viet Nam	Enhancing the Capacity for Research and Applications of Nuclear Techniques in Plant Breeding	L. Jankuloski
ZAM5031	Zambia	Improving the Yield of Selected Crops to Combat Climate Change	F. Sarsu
ZIM5021	Zimbabwe	Assessing and Promoting Sustainable Agricultural Production in Communal and Newly Resettled Farms	F. Sarsu/A.M.A. Ghanim in collaboration with SWMCN

Success Story

UG99 Resistant Wheat Mutant Varieties in Uganda

Reporting Officer: S. Nielen

As reported earlier (Plant Breeding & Genetics Newsletters, No. 23, July 2009 and No. 25, July 2010), the threat to global wheat production by the spread of the wheat black stem rust causing Ug99 race of *Puccinia graminis* f. sp. tritici led to the establishment of the IAEA Interregional TC project INT5150 'Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99)', which involved 18 countries and five national and international institutions. The aim of INT5150 was to generate genetic variation for resistance to Ug99 based on mutation technology and by this, develop new, resistant varieties.

Mutation induction treatments were carried out at the PBGL in 2009 by determining the radio-sensitivity of each wheat variety and then irradiating seeds at optimum dose levels for mutation induction. The treatment provided enhanced biodiversity and treated seeds were sent for testing at Eldoret, Kenya, a hot spot for the disease.

In February 2014, the first mutant wheat variety resistant to Ug99 was officially released to farmers in Kenya. It was named, 'Eldo Ngano1' (Swahili for 'Eldoret Story1') and combines disease resistance with high yield. 'Eldo Ngano1' was followed swiftly by the mutant variety 'Eldo Mavuno' ('Eldoret Harvest'), which received Kenyan Government approval in May 2014 (Plant Breeding & Genetics Newsletter, No. 33, July 2014).

A Technical Officer recently visited the National Agricultural Research Organization (NARO) of Uganda and revealed that the project was continuously yielding successes.

In September 2015 three wheat mutant varieties with resistance to Ug99, high yields, and good quality characteristics were officially released: NAROWheat 1 (Sipi), NAROWheat 2 (Elgon) and NAROWheat 3 (Nyonyi). These varieties were developed through mutation induction of seeds of the highly susceptible local variety Pasa at PBGL, rigorous testing in the hot spots of Kenya, and subsequently evaluated in various trials in different zones in Uganda. In September 2015, the Department of Crop Inspection and Certification Board of the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) officially approved these varieties for distribution to the farmers and cultivation. The varieties are currently being grown in most wheat growing areas especially in eastern and south-western Uganda. More information on the varieties, their development, characteristics and contacts of breeders, can be found in the respective entries in the FAO/IAEA Mutant Variety Database (http://mvd.iaea.org): NAROWheat 1 – ID 4812; NAROWheat 2 – ID 4813; NAROWheat 3 – ID 4814.

Head appearance of the three wheat mutant varieties (submitted by Dr Bosco Chemayek, Leader of the Wheat Research and Development Program, NARO, Uganda).

Developments at the Plant Breeding and Genetics Laboratory

The Plant Breeding and Genetics Laboratory (PBGL) carries out applied R&D to enhance the scope and efficiency of crop mutation breeding. The PBGL is also mandated to provide hands-on training in protocols and techniques for crop mutation breeding to Member States and provides gamma and X ray irradiation services to all FAO and IAEA Member States. We are very pleased to announce that during this reporting period, the (partial) refurbishing of PBGL's greenhouses has been finalized. Overall, 11 new tables for pot experiments with an automated watering system have been installed as well as a new, fit-for-purpose LED lighting system. The new LED lighting system allows control of the duration, quantity and quality of light and will enable the expansion of the growing season of (sub)tropical crops to the winter period in Austria. The additional space and functionality has already been put to good use to grow and harvest a sorghum F_2 population for our marker development work under the CRP D2.30.31 on Improving resilience to Drought in Rice and Sorghum through Mutation Breeding. Below is a brief review of progress in select R&D activities, as well as an overview of PBGL's training and irradiation services provided in 2018 until the time of writing this newsletter (2 June 2018). Select examples of technology transfer from the PBGL to Members States are also provided to illustrate PBGL's capacity building activities.

A Functional Marker for a Reduced Lignin Mutant Trait in Barley

Barley is an important feed crop for a wide range of animals. The reduced-lignin mutation in barley (*rob1*) facilitates digestion in animals and is an important breeding goal to enhance barley feed quality. As mentioned previously, an allele-specific molecular marker was developed at the PBGL for a mutant allele in the Bowman genetic background in the context of CRP D2.30.30 on Integrated Utilization of Cereal Mutant Varieties in Crop/Livestock Production Systems. Phenotypically, the *rob1* mutation confers an orange lemma in the Bowman genetic background where it can be most easily scored at the heading stage. During this reporting period, a user-friendly and low-cost marker assay was developed based on PCR and agarose gel electrophoresis. Secondly, we genotyped and phenotyped a segregating F_2 population derived from a Bowman *rob*1 X Optic cross for reduced lignin. These experiments showed perfect linkage between genotype and phenotype and the marker could reliebly differentiate heterozygous from homozygous plants. These results open perspectives to use this marker for accelerate breeding of reduced lignin through marker-assisted-backcrossing using Bowman *rob1* as genetic stock, for introgression or for gene pyramiding in combination with other traits. To verify whether the marker is useful in different genetic background, we will in a next phase test the marker system in ongoing barley breeding programmes in Member States, starting with the barley breeding programme of Prof H. Grausgruber, BOKU, Austria (see pictures).

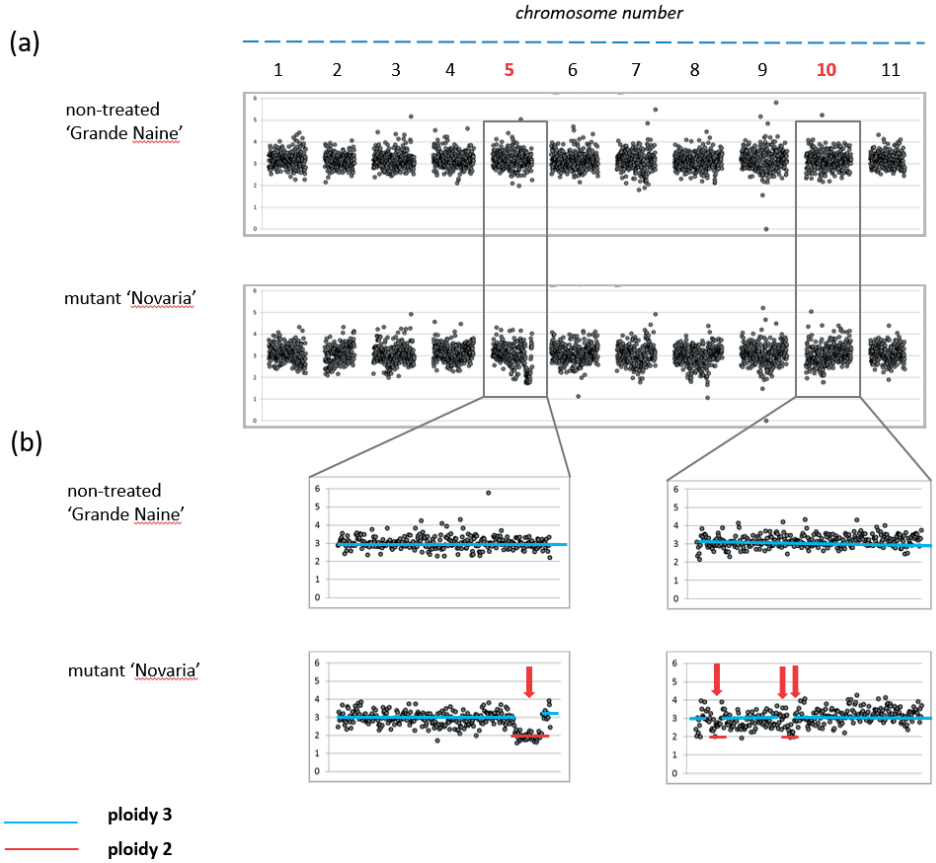
Collecting barley samples from the field, Rasdorf, Austria.

Comparing wild type and mutant orange stem of barley.

Adapting Genomics Tools to Determine Copy Number Variation in Novaria, a Released Mutant Banana

Banana remains our model crop for technology development in vegetatively propagated plants. Edible bananas are sterile and triploid hindering traditional breeding methods. This results in a narrow genetic base with limited resilience to various stresses in banana and other vegetatively propagated crops. PBGL has previously shown that induced mutagenesis through irradiation and chemical mutagenesis are effective methods to broaden the genetic base in banana. We have also shown that these changes are stably maintained through successive generations. The majority of officially released mutant

banana varieties have been created using gamma rays, a mutagen that can induce large genomic insertions and deletions (indels). Such dosage mutations may be important for generating observable phenotypes in polyploids. In the current study we have established a low-coverage whole genome sequencing method to identify large genomic indels caused by gamma irradiation in triploid bananas. The method was applied to the officially released mutant variety 'Novaria' and its parental line Grande Naine. Using low-coverage whole genome sequencing, we could identify multiple deletions in Novaria, ranging from 0.3 to 3.8 million base pairs (Mbp), when compared to Grande Naine.



Sequence read coverage plots of non-treated 'Grande Naine' and mutant 'Novaria' for detection of gamma induced dosage variations. (a) Relative sequence read coverage plots (RSRC) for all 11 chromosomes. (b) RSRC plots for chromosome 5 and 10 with red arrows pointing at selected regions with dropping copy number (from 3 to 2) due to deletion of a chromosomal fragment.

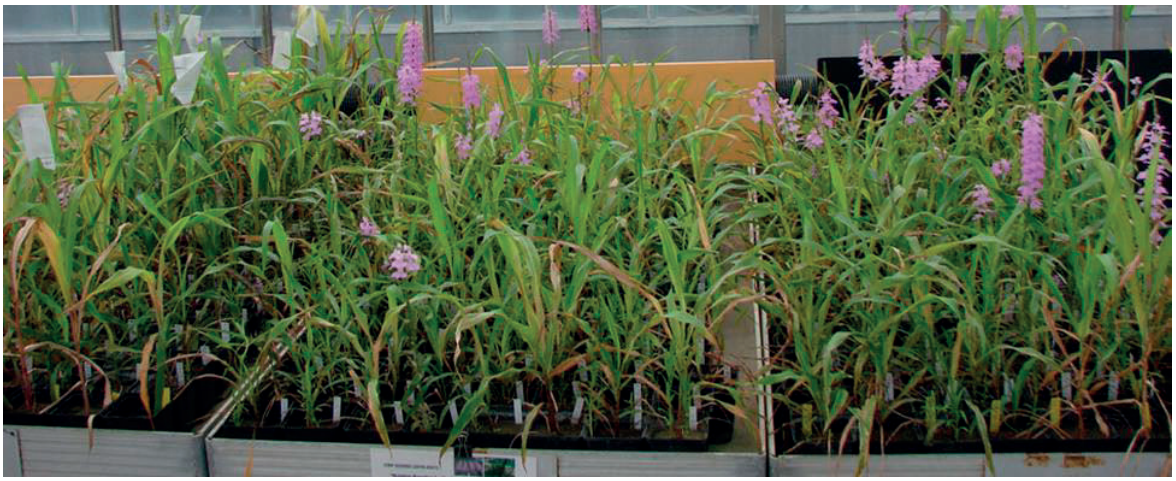
Gene Ontology (GO) analysis performed on the affected mutated regions revealed genes involved in diverse processes such as gene expression, cellular biogenesis, protein phosphorylation, protein and DNA binding, and membrane components. Additional information can be found in Datta et al., 2018.

Based on these results, we developed a rapid system for mutation induction using gamma irradiation and screening of *in vitro* banana cultures through low-coverage whole genome sequencing of the banana variety Williams. Putative mutations were recovered in 70% of Williams lines treated with 20 Gy and 60% of the lines treated with 40 Gy of gamma irradiation. Overall, our work in banana shows that gamma irradiation effectively induces genetic variation by creating copy number variation and thus changes in ploidy level in different chromosomes. Mutagenized bananas coming from the same treatment as the material screened for copy number variation are currently being evaluated for response to *Fusarium oxysporum* TR4, the causative agent of Panama disease in banana, under CRP D2.20.05.

Mutation Breeding for Resistance to *Striga* Parasitic Weeds in Cereals for Food Security

In continuation of the on-going R & D activities related to the CRP on *Striga* (D2.50.05), the PBGL has conducted validation trials of the adapted protocol for the screening of mutant population for resistance to *Striga hermonthica*. Last year protocol of pot-screening was optimized using varieties of known reaction to *Striga* (resistant vs susceptible) both in sorghum and upland rice. During the reporting period, the screening protocol was validated on the M_2 population of sorghum. The seeds of the sensitive sorghum variety were treated with three doses (200, 300, 400 Gy) using the Cobalt 60 gamma irradiator with the dose rate of about 140 Gy/min. M_1 plants were grown in

the glass-house following the routine practice at the PBGL and the heads were covered with paper bags before flowering to ensure self-fertilization to produce M_2 seeds. M_2 seeds from the central dose (300 Gy) were used for the validation trial. About 500 M_2 seeds from representative M_1 heads were planted in medium size pots, filled with a soil mixture containing about 1g of uniformly mixed seeds of *Striga hermonthica*. Pots were arranged in an augmented design including control of wild parent in four set of pots with and without *Striga* seeds distributed evenly among the pots containing M_2 plants with *Striga* seeds. Plants were maintained in a glass-house under 25°C temperature and natural light during January to May 2018 at the PBGL facility in Seibersdorf. Seedlings were irrigated two times a week until the establishment of the 4–6 leaf stage (about four weeks from planting) and then continued with one watering per week. No fertilizer was applied and the soil was a mix of Seibersdorf clay soil and sand in 2:1 ratio. In about two months from the initial sowing, *Striga* plants started to emerge. After three months, the experiment was uniformly covered with *Striga* plants at different stages including many flowering plants and then the damage became clear on the host sorghum plants with many completely dead. Generally, about 2–4 *Striga* plants were scored for most pots, and only a few pots did not show *Striga* plant in about 1% of the M_2 population. This clearly proves the efficiency and accuracy of the adapted protocol in screening mutant populations for the detection of putative resistant mutant plants. The protocol can also be used to verify resistant mutants identified in the field of the participating Member States. The protocol will be disseminated to Member States through group and individual training and publications. Identified putative resistance will be confirmed in M_3 progenies and further evaluated for dissemination to Member States to be utilized in their breeding programmes especially in *Striga* prone areas. Mapping populations will be produced for the development of molecular markers for pyramiding of the induced resistance to facilitate wide utilization by Member States.



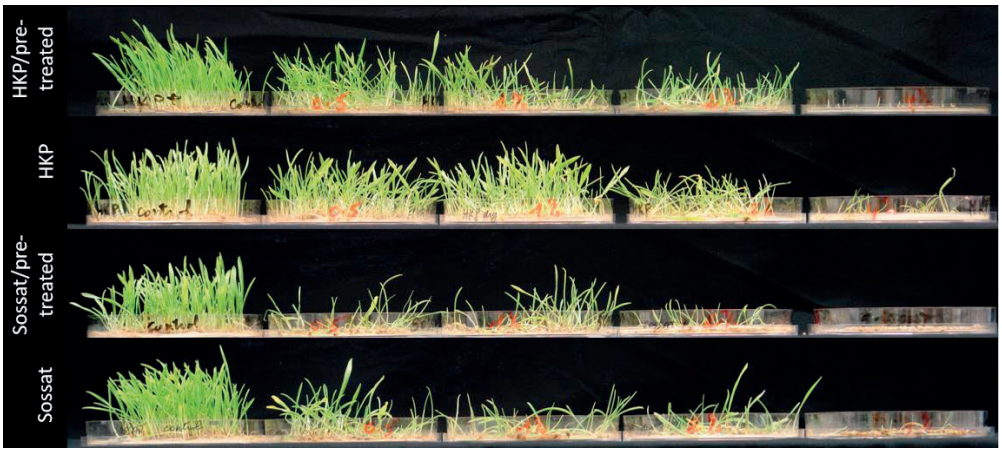
General view of the validation experiment of screening protocol for resistance to Striga in M_2 population of sorghum in the glass-house of PBGL May 2018 with Striga parasitic plants showing unique violet flower of Striga. hermonthica.

Close up of the screening experiment showing variation in the number of Striga plants per pot while in one pot indicated by the arrow no Striga plant suggesting that M_2 plant is a putative resistance mutant.

PBGL technology transfer to Member States

PBGL is mandated to support Member States in technology transfer. This is especially important for the so called 'orphan crops' that are less well studied compared to the major food crops and staples. During this reporting period, several protocols and methods have been transferred from the PBGL to Member States, in particular to Niger through two fellowships. Pearl millet plays a key role for food security in Niger, due to its high level of drought tolerance. However, pearl millet suffers from several pests and diseases, including susceptibility to the parasitic weed *Striga* and the millet head miner (*Heliocheilus albipunctelle* de Joannis) that can drastically reduce its yield in the field. The following protocols and methods were transferred or adapted to pearl millet: (1) *Striga* greenhouse-based screening protocol (see earlier section); (2) development and testing of molecular markers to accelerate breeding (see earlier section); and, (3) chemical mutagenesis of pearl-millet using ethyl methylsulphonate (EMS) which is summarized below.

The protocol for chemical mutagenesis using EMS has been adapted to pearl-millet. Two pearl millet varieties (Sossat, HDK) with susceptibility to the parasitic weed *striga* and the millet head miner were tested for response to EMS. A strong genotype-dependent effect was observed within genotypes tested and treatment combination used. Pre-treated Sossat variety reached 100% lethality at 4% EMS concentration and two hours incubation time, whereby non-pre-treated Sossat and pre-treated HDK has shown a similar response pattern to the highest concentration of EMS with approximately 10% survival. Non-pre-treated HDK exhibited the highest tolerance to EMS with >30% survival at 4% EMS. It should be noted that plant height differences were observed among mutagenized material within the treatment combination. This is due to the non-homogenous character of pearl-millet seeds available. Therefore, only the germination rate was used as a scored parameter. LD30 was estimated to be in the range of 0.1 to 0.3% EMS for both cultivars. These experiments laid the foundation to develop an EMS-induced mutant population in pearl millet and for identification of mutations in the M_2 generation *via* reverse-genetics.



Varietal differences in the response of pearl-millet to the chemical mutagen EMS under different pre-treatment conditions.

Irradiation Services Provided to Member States

At the time of writing (2 June 2018), the PBGL has received a total of 19 irradiation service requests this year. Under the new TC project cycle 2018-2019, we have received several requests for vegetatively propagated crops, including taro, cocoa yam and sweet potato. Where needed, such as in the case of sweet potato, radio-sensitivity testing has been conducted. A comprehensive list of irradiation requests received so far is presented in the following table.

Request Number	Country	Request Type	Crop
1541	UK		Wheat
1542	Hungary		Ornamental
1543	Austria	CRP	Coffee
1544	France/ Vanuatu	TC	Sweet Potato
1545	Nepal	TC	Sweet Potato
1546	Ireland		Eucalyptus
1547	Mongolia	TC	Wheat, Barley, Rape
1548	Germany		Ornamental
1549	Kazakhstan	TC	Wheat
1550	Togo	TC	Rice
1551	Niger	TC	*Neocarya macrophylla*
1552	The Netherlands		Ornamental
1553	Austria, PBGL	CRP, Training	Coffee, Petunia
1554	Congo, Democratic Republic of	TC	Soybean
1555	The Netherlands		Ornamental
1556	Hungary		Ornamental
1557	Czech Republic		*Papaver sominiferum*
1558	Mongolia	TC	Rape
1559	Fiji	TC	Sweet Potato, Yam, Breadfruit

Individual Training Activities at the PBGL

At the time of writing (2 June 2018), the following fellows (F), scientific visitors (SV) or interns (I) were hosted at the PBGL for training and technology transfer in mutation breeding and related (bio)technologies. An additional three fellows are expected to arrive at the PBGL later in the month of June.

Name	Country	Status	Topic	Period
Mr Guillermo REYES CASTRO	Nicaragua	SV	*In vitro* tissue culture	10 days
Mr Seyni BOUREIMA	Niger	F	*Striga* screening protocol, marker development; EMS mutagenesis pearl millet	2 months
Mr Hamissou ZANGUI	Niger	F	Allelic diversity of key traits for sesame breeding, marker development	2 months
Ms Samira TAJEDINI	Iran	I	Haploid in rice and sorghum; mutant population development *Striga*	7 months

PBGL Visitors and Outreach

During this reporting period, the PBGL has welcomed high-level officials from over 15 different Member States, as well as other visitor groups such as students from the Lycee Français who were very enthusiastic to learn about mutation breeding. Among the many visitors were Dr J. Mignouna, Director, BioSciences East and Central Africa from ILRI, Nairobi, Kenya to discuss possible R&D cooperation and capacity building in plant mutation breeding; Mr S. Gaiji, Head of the Research and Extension Unit of the Agriculture and Consumer Protection Department of FAO, Rome, Italy and a delegation from the UK interested to learn more about the application of X ray technology for mutation breeding. The IAEA Director General Mr Yukiya Amano, joined by his spouse, also visited the PBGL for a tour of the facilities and to provide feedback on the new infographic on Crop Mutation Breeding.

Thomson Reuters Foundation journalist Ms Thin Lei Win visited PBGL and wrote a multimedia feature story on

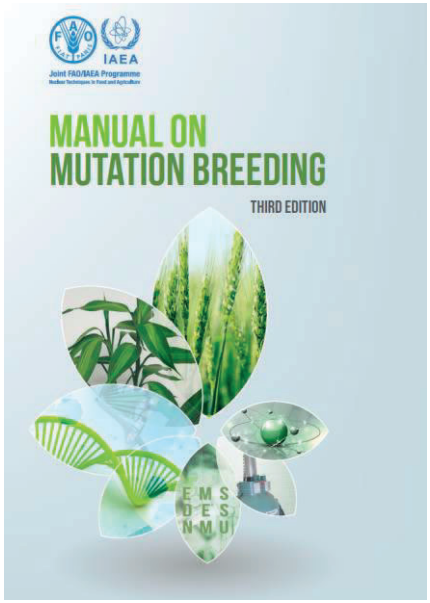
'**Rebooting Food - Finding New Ways to Feed the Future'**, highlighting also the work of the Joint FAO/IAEA Division, including crop mutation breeding (http://news.trust.org/shorthand/rebooting-food/).

Finally, the PBG(L) team did an excellent job explaining and promoting crop mutation breeding at the Long Night of Research which was held at the VIC, Vienna on 13 April 2018 (see picture). As in 2016, the event proved a unique opportunity to reach out and educate the general public on the application of nuclear techniques for crop improvement through mutation breeding.

Long Night of Research, Vienna International Centre (VIC), 13 April 2018.

Publications

Books



Manual on Mutation Breeding, Third Edition

Edited by Madeleine Spencer-Lopes, Brian P. Forster and Ljupcho Jankuloski

Co-published by the International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization (FAO) of the United Nations

The previous (2nd) edition of the Manual on Mutation Breeding was published in 1977. After nearly 40 years it is time to up-date this manual as there have been several major developments in the intervening years. There has been an upsurge in the use of induced mutations – for both classical crop improvement and for functional genomic studies – and at the same time, there is an ever increasing and urgent need to generate novel variation in improving crop production: more nutritious, hardy, input use-efficient and productive crop varieties, to underpin 'green' sustainable food production for the 21st century, especially in safe-guarding food security which is challenged by climate change, hunger and world population growth.

This 3rd edition of the Manual on Mutation Breeding that you now peruse, describes advances in plant mutation breeding, including basic irradiation techniques as well as chemical mutagenesis, in both seed-propagated and vegetatively propagated crops. The manual provides comprehensive overviews and guidelines for new high-throughput screening methods – both phenotypic and genotypic – that are currently available to enable the detection of rare and valuable mutant traits and reviews techniques for increasing the efficiency of crop mutation breeding. Most importantly, the manual provides practical, hands on methods in plant mutation breeding techniques with clearly illustrated step-by-step protocols.

The Manual on Mutation Breeding is founded on the experience and knowledge of the staff of the Plant Breeding and Genetics Section and Laboratory of the Joint FAO/IAEA Division – past and present – and has been written in collaboration with external scientists who are internationally renowned experts in specific fields. The combined contributions, backed by the richness of the Mutant Variety Database of the Joint FAO/IAEA Division, represents a valuable resource for all those interested in the resurgence of plant mutation breeding.

URL: http://www.fao.org/3/I9285EN/i9285en.pdf

ISBN 978-92-5-130526-3

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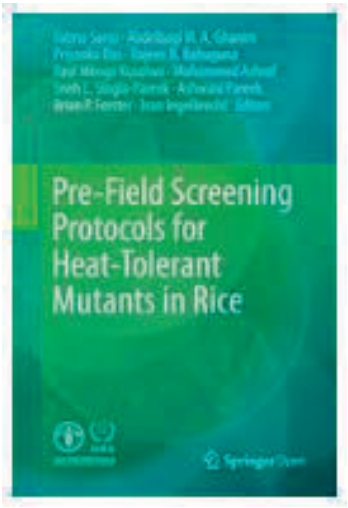

Pre-Field Screening Protocols for Heat-Tolerant Mutants in Rice

Sarsu, F., Ghanim, A.M.A., Das, P., Bahuguna, R.N., Kusolwa, P.M., Ashraf, M., Singla-Pareek, S.L., Pareek, A., Forster, B.P., Ingelbrecht, I. (2018) Springer.
ISBN: 978-3-319-77338-4

https://www.springer.com/de/book/9783319773377

This protocol book presents simple, robust pre-field screening protocols that allow plant breeders to screen for enhanced tolerance to heat stress in rice. Two critical heat-sensitive stages in the lifecycle of the rice crop are targeted – the seedling and flowering stages – with screening based on simple phenotypic responses. The protocols are based on the use of a hydroponics system and/or pot experiments in a glasshouse in combination with a controlled growth

chamber where the heat stress treatment is applied. The protocols are designed to be effective, simple, reproducible and user-friendly.

The protocols will enable plant breeders to effectively reduce the number of plants from a few thousands to less than 100 candidate individual mutants or lines in a greenhouse/growth chamber, which can then be used for further testing and validation in the field conditions. The methods can also be used to classify rice genotypes according to their heat tolerance characteristics. Thus, different types of heat stress tolerance mechanisms can be identified, presenting opportunities for pyramiding different (mutant) sources of heat stress tolerance.

Peer-reviewed Book Chapters

2018

TILL, B.J., DATTA, S., JANKOWICZ-CIESLAK. J. (2018) TILLING: The Next Generation. In: Advances in Biochemical Engineering/Biotechnology. Rajeev K. Varshney et al. (eds.), Springer.
DOI: 10.1007/10_2017_54

Peer-reviewed Journal Articles

2018

AMRI, W.T., LAOUAR, M., ABDELGUERFI, A., JANKOWICZ-CIESLAK, J., TILL, B.J. (2018) Genetic Variability Induced by Gamma Rays and Preliminary Results of Low-Cost TILLING on M_2 Generation of Chickpea (*Cicer arietinum* L.). Frontiers in Plant Science-Plant Breeding.

DATTA, S., JANKOWICZ-CIESLAK. J., NIELEN, S., INGELBRECHT, I., TILL, B.J. (2018) Induction and Recovery of Copy Number Variation in Banana through Gamma Irradiation and Low Coverage Whole Genome Sequencing. Plant Biotechnology Journal.
DOI: 10.1111/pbi.12901

GRONENBORN, B., RANDLES, J.W., DENNIS KNIERIM, BARRIÈRE, Q., VETTEN, H.J., WARTHMANN, N., CORNU, D., SILEYE, T., WINTER, S., TIMCHENKO, T. (2018) Analysis of DNAs Associated with Coconut Foliar Decay Disease Implicates a Unique Single-Stranded DNA Virus Representing a New Taxon. Scientific Reports 8, Article number: 5698. DOI:10.1038/s41598-018-23739-y.

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2017

DUITAMA, J., TELLO, D., LEIVA, A.M., HOFINGER, B., DATTA, S., LENTINI, Z., ARANZALES, E., TILL, B., CEBALLOS, H. (2017). Deep Assessment of Genomic Diversity in Cassava for Herbicide Tolerance and Starch Biosynthesis. Computational and Structural Biotechnology Journal 5: 185–194.

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https://doi.org/10.1016/j.cj.2017.10.002

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DOI: 10.3389/fpls.2017.01780.

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Conference Abstracts

2017

DATTA, S., JANKOWICZ-CIESLAK, J., DAVSON, A., CHIC-PING, C., SHIH-HUNG, H., VILJOEN, A., NIELEN, S., INGELBRECHT, I., TILL, B.J. (2017). A Low Coverage NGS Based Pipeline for Rapid Screening of Gamma Irradiated Mutant Bananas for Resistance to Fusarium Wilt TR4. 4th International Symposium on Genomics of Plant Genetic Resources, 3–7 September 2017, Giessen, Germany, Book of Abstracts.

HAWLICZEK-STRULAK, A., TILL, B.J., JANKOWICZ-CIESLAK, J., BORZECKA, E., TOFIL, K., KRAL, A., BOLIBOK-BRAGOSZEWKSKA, H. (2017). Development of an Efficient Ecotilling Protocol for Rye. 8th International Triticeae Symposium, 12–16 June 2017, Wernigerode, Germany, Book of Abstracts, Abstract Number 113.

SARSU, F., GHANIM, A.M.A., DAS, P., BAHUGUNA, R., MBOGO, K.P., ASHRAF, M., PAREEK, S.L.S., PAREEK, A., FORSTER, B.P., INGELBRECHT, I. (2017); Pre-Field Screening for Heat Tolerant Mutants in Rice, Inter Drought V, 21–25 February 2017, Book of Abstracts, p156, abstract number 444.

Websites and Links

- Plant Breeding and Genetics Section:
  http://www-naweb.iaea.org/nafa/pbg/index.html
- FAO/IAEA International Symposium on Plant Mutation Breeding and Biotechnology:
  https://www.iaea.org/events/plant-mutation-breeding-symposium-2018
- InfoGraphic on Mutation Breeding:
  http://www-naweb.iaea.org/nafa/resources-nafa/Plant-Mutation-breeding.mp4
- Mutant Variety Database:
  http://mvd.iaea.org
- Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture:
  http://www-naweb.iaea.org/nafa/index.html
  http://www-naweb.iaea.org/nafa/news/index.html
- Joint FAO/IAEA Division Publications
  http://www-naweb.iaea.org/nafa/resources-nafa/publications.html
- Food and Agriculture Organization of the United Nations (FAO):
  http://www.fao.org/about/en/
- FAO Agriculture and Consumer Protection Department:
  http://www.fao.org/ag/portal/index_en/en/

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