Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Plant Breeding & Genetics Newsletter

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

ISSN 1564-2569

No. 39, July 2017

Contents

To Our Readers

H.E. Prof. H. Mohammad Nasir, Indonesia's Minister of Research, Technology and Higher Education, spoke about the longstanding collaboration with the IAEA, and the contribution of released mutant varieties to food security in Indonesia

Tempe kita, an Indonesian dish, prepared from mutant soybean varieties, presented to visitors at the IAEA International Conference "Sixty Years and Beyond – Contributing to Development"

Dear colleagues,

Plant mutation breeding continues to be relevant throughout the world. In this context, the National Nuclear Energy Agency of Indonesia, BATAN, showcased 'Indonesian Soybeans: Paving the Way for Micro Enterprises and Social Wellbeing' during the International Conference on the International Atomic Energy Agency (IAEA) Technical Cooperation Programme: Sixty Years and Beyond – Contributing to Development. H.E. Prof. H. Mohammad Nasir, Minister of Research, Technology and Higher Education, spoke about the longstanding collaboration with the IAEA, through Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, and the contribution of released mutant varieties to food security in Indonesia. Tempe kita, an Indonesian dish, prepared with the mutant soybean varieties Rajabas, Mutiara 2 and Mutiara 3, was presented to the visitors.

A new coordinated research project (CRP) on 'Improving Resilience to Drought in Rice and Sorghum through Mutation Breeding' will be launched this year, with the first research coordination meeting (RCM) planned for October 2017. This CRP, related to current and future climate change scenarios, will focus on improving drought tolerance in rice and sorghum. These two crops together are essential staples in the diets of almost half of humanity so that any attempt at increasing yields under drought stress should have major and positive impacts in terms of food security and income generation. This CRP aims at improving drought resilience of rice and sorghum germplasm through mutation induction and the development/adaptation of robust screening protocols for rapid generation advancement, efficient screening of mutant populations for drought tolerance, to generate drought tolerant rice and sorghum mutant germplasm and to disseminate methods and guidelines to the broader plant breeding and research communities.

In response to Member States' requests to consider the possibilities of developing and applying mutation breeding techniques on tolerance to biotic stresses in crops, we will organize a Consultants' Meeting in Vienna, Austria, in November 2017 to develop a new CRP on Improving Crop Resistance to Biotic Stresses through Mutation Breeding. Taking into account the anticipated effects of climate change, the new CRP will focus on crop improvement to disease resistance through mutation breeding techniques. During the meeting, project objectives, activities and a work plan will be discussed in details. The call for proposals will be announced at our website (http://www-naweb.iaea.org/nafa/pbg/) in the beginning of 2018.

The Plant Breeding and Genetics Laboratory (PBGL) continues to focus its R&D efforts on practical applications that benefit plant breeders in the field and farmers in Member States. One R&D area is focused on the development of molecular marker systems to accelerate mutation breeding for climate-smart agriculture and food security in vulnerable regions. Our pilot project on marker development through mapping-by-sequencing in sorghum for reduced height and earliness, useful for lodging, mechanical harvesting and terminal drought is advancing as planned; genetic analysis and phenotyping of F1 populations will be conducted in the Seibersdorf fields this summer. Likewise, the barley project on reduced-lignin phenotype, a trait useful to improve forage digestibility for livestock, has progressed: a total of six different mutations in barley accessions have now been identified as likely causative mutations for the reduced lignin phenotype. This latter project is conducted in the context of the CRP on 'Integrated Utilization of Cereal Mutant Varieties in Crop/Livestock Production System'. Under the CRP on 'Efficient screening techniques to identify mutants with disease resistance for coffee and banana' several mutant banana lines with field resistance to banana bunchy top virus disease and Fusarium wilt tropical race 4 (TR4) have been identified by the partner in the Philippines. The PBGL is currently multiplying these lines *in vitro* for genetic stability testing and TR4 phenotyping. If confirmed, it would prove a major step forward in this important CRP.

An R&D cooperation with BATAN in Indonesia was established in 2017. Focal crops include rice and sorghum. One goal is to establish a laboratory network on crop mutation breeding to strengthen capacity building and create R&D synergies. This was proposed to over 20 Member States and was met with great enthusiasm. Indeed, it would create an important platform to advance mutation breeding programs globally and serve the Member States well in finding solutions for sustainable food security and climate-smart agriculture.

Looking to the year ahead, we'll be organizing an FAO/IAEA International Symposium on Plant Mutation Breeding and Biotechnology, in Vienna, Austria, from 6–10 August 2018. The programme will cover both scientific and applied topics. Prominent speakers will be invited to debate new developments and trends in plant mutation breeding and related biotechnologies. We look forward to seeing many of you at this event.

I would like to thank all our collaborators and counterparts for your dedicated support and input to our joint activities as well as the staff of the Plant Breeding and Genetics Subprogramme for their dedication and competence in supporting the often very specific needs of Member States.

Ljupcho Jankuloski
Acting Head
Plant Breeding and Genetics Section

Staff

Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture			
Name	**Title**	**Email**	**Extension**
Qu Liang	Director	q.liang@iaea.org	21610

Plant Breeding and Genetics Subprogramme			
Name	**Title**	**Email**	**Extension**
Vacant	Section Head		
Ljupcho Jankuloski[1]	Plant Breeder/Geneticist	l.jankuloski@iaea.org	21623
Stephan Nielen	Plant Breeder/Geneticist	s.nielen@iaea.org	21617
Fatma Sarsu	Plant Breeder/Geneticist	f.sarsu@iaea.org	21618
Marie Madeleine Spencer Lopes[2]	Consultant	m.spencer@iaea.org	26844
Katayoun Allaf	Programme Assistant	k.allaf@iaea.org	21621
Luis Mauricio Alfonzo Godoy	Team Assistant	l.m.alfonzo-godoy@iaea.org	21620
Ivan Ingelbrecht	Laboratory Head	i.ingelbrecht@iaea.org	28285
Adelbagi Mukhtar Ali Ghanim	Plant Breeder/Geneticist	a.mukhtar-ali-ghanim@iaea.org	28268
Vacant	Plant Breeder/Geneticist		
Mirta Matijevic	Technician	m.matijevic@iaea.org	28317
Joanna Beata Jankowicz-Cieslak	Technician	j.jankowicz@iaea.org	28275
Bernhard Hofinger[3]	Technician	b.hofinger@iaea.org	28279
Guenter Berthold	Technician	g.berthold@iaea.org	28418
Adel Ali[4]	Technician	a.ali@iaea.org	28427
Joanna Malgorzata Mletzko	Team Assistant	j.mletzko@iaea.org	28362

Plant Breeding and Genetics Section
Vienna International Centre, Wagramer Strasse 5, P.O. Box 100, 1400 Vienna
Phone: +431 2600 + extension; Fax: +431 26007; Email: Official.Mail@iaea.org

Plant Breeding and Genetics Laboratory
FAO/IAEA Agriculture & Biotechnology Laboratories, 2444 Seibersdorf, Austria
Phone: +431 2600 + extension; Fax: +431 26007; Email: Official.Mail@iaea.org

[1] Acting Section Head
[2] Joined in April 2017
[3] Separated in May 2017
[4] Joined in June 2017

Staff News

Consultant

Madeleine Spencer will assist the Plant Breeding and Genetics Section as a consultant for nine months.

Ms Spencer has served eight years at the IAEA as a Technical Officer and Research Coordinator, being involved in the organization and implementation of the Plant Breeding and Genetics subprogramme activities. She based her job on her research and teaching expertise to ensure the efficient and effective development and implementation of research projects, trainings and scientific as well as technical knowledge dissemination, and assisting in the evaluation and implementation of technical cooperation for IAEA and FAO.

Ms Spencer is Associate Professor at the Université Cheikh Anta DIOP in Dakar, Senegal, with 20 years of experience in teaching. Her research is mostly related to plant tissue culture, plant genome analysis, and plant mutation breeding with a focus on cowpea and soybean at the Université Cheikh Anta DIOP, Dakar, Senegal and University of Tennessee, Knoxville (USA).

Ms Spencer will support PBG subprogramme in the preparation of internal and public relations' documents related to nuclear and other advanced technologies in plant breeding.

Technician

Adel Ali joined the Plant Breeding and Genetics Laboratory (PBGL) on 1 June 2017. Mr Ali was born in Egypt and holds a BSc in Natural Sciences and Biology and an MSc in Biochemistry from the Faculty of Science, Monifya University, Egypt. He worked at a pharmaceutical company in Egypt as a Quality Control Specialist. He has previously worked at the PBGL as an intern for three months and was more recently a staff at the FAO/IAEA Insect Pest Control Laboratory for two years where he was involved in mosquito rearing. Mr Ali brings with him strong experience in research related to mutation induction using both gamma irradiation and X-ray devices as well as in data collection and analysis. He has also experience in molecular biology techniques and handling various types of analytical instrumentation. We warmly welcome Mr Ali to our team.

Forthcoming Events

IAEA/RCA Coordination Meeting to review the progress of the field trials, Developing Bioenergy Crops to Optimize Marginal Land, Productivity through Mutation Breeding and Related Techniques, Hanoi, Vietnam, 3–7 July 2017

Technical Officers: F. Sarsu and M. Zaman

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 land and crops' productivity will increase, ecosystem balance will be enhanced and the farmers' welfare will improve in the region. The project started in 2015 and this meeting will be the second coordination meeting.

The purpose of this coordination meeting is to:

- review the project progress and update the project work plan in line with activities implemented so far and emerging needs of the government parties;
- review the current status of soil, nutrient and water management and plant mutation breeding practices of marginal land using nuclear and isotopic techniques;
- address the gaps and needs for the application of soil and water management techniques and mutation breeding activities for increasing soil fertility and productivity of bioenergy crops on marginal land.

Nominees must be National Project Coordinator (NPCs) for plant mutation breeding and soil and water management & crop nutrition, directly contributing to the project, with a background in soil science, agronomy and practical experience in the use of nuclear and isotopic techniques.

The alternate NPC or a senior member of the national team may be nominated if the NPC is unable to attend, in which case they should be actively involved and work in the field of bioenergy crops and in particular on marginal land. Participants should have sufficient proficiency to present and follow discussions and express themselves in English.

Regional Training Course on Mutation Breeding and Biotechnology Techniques for the Development of Heat Tolerant Cotton Mutants, RAS/5/075, Hangzhou, People's Republic of China, 3–7 July 2017

Technical Officer: L. Jankuloski

Cotton has a special significance and plays an important role in the economies of Australia, Bangladesh, China, India, 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. People's Republic of 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.

Use of induced mutations in recent years has become an important approach to plant breeding for improvement of crops and a large number of early, high yielding, disease and insect resistant varieties of various crops have been released in different countries by use of induced mutations. Development of high yielding, heat/drought tolerant and nutrient use efficient germplasm is necessary for sustainable cotton production in the region.

This training course will be organized in cooperation with the Government of People's Republic of China through Institute of Crop Sciences, Agronomy Department, College of Agriculture and Biotechnology, Zhejiang University, Hangzhou.

The purpose of this training course is to introduce participants of TC project RAS/5/075 to mutation breeding and biotechnology techniques applied in cotton breeding for abiotic stress, particularly for heat tolerance.

The training course will include lectures, demonstrations (laboratory, greenhouse and field), and practical exercises on plant mutation breeding and related biotechnologies applied for cotton improvement. Participants will be trained on cotton improvement through mutation breeding techniques, *in vitro* techniques in cotton breeding and plant biotechnologies applied in cotton breeding for development of heat tolerant cotton varieties.

Participants should be plant breeders and geneticists from participating Member States involved in the TC project RAS/5/075 on Improving Sustainable Cotton Production through Enhanced Resilience to Climate Change and 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.

IAEA/RCA Regional Training Course on Advanced Mutation Techniques for Induction and Screening of Green Traits in Crops, RAS/5/077, Beijing, People's Republic of China, 14–18 August 2017

Technical Officer: S. Nielen

This is the first training course under the new regional project RAS/5/077 'Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA)'. This project has the objective to develop new types of crop varieties referred to as 'Green Crop' with high quality traits such as high yield, high photosynthetic efficiency, ideal plant type, resistance to abiotic and biotic stresses and less agricultural inputs (pesticides and fertilizer) under environmental-friendly manner.

The purpose of this course is to provide scientific and technical information on optimization and application of new mutagenesis techniques for crop plant improvement programmes aimed at development of mutant plants with 'green' traits. The focus will be on mutation induction methodologies and include physical- (gamma irradiation, heavy ion beams irradiation and simulated cosmic rays irradiation), as well as chemical mutagenesis techniques. Both, seed- and vegetatively propagated crops, will be subject of mutagenesis approaches. The course will also provide knowledge on molecular methods for mutation discovery and application of molecular markers, and introduce into latest methods for site specific mutagenesis in crops (genome editing). The training course will consist of lectures, demonstrations, and practical exercises in the lab and field. Participants will also be able to discuss their specific breeding problem and learn about the most suitable mutagenesis approach for their target crops. Participants will be plant breeder and geneticists directly involved in the national work team of project RAS/5/077.

Technical Meeting on Plant Mutation Breeding, Bali, Indonesia, 4–7 September 2017

Technical Officer: L. Jankuloski

The International Atomic Energy Agency (IAEA) in partnership with Food and Agriculture Organization (FAO) through Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture in cooperation with the Government of the Republic of Indonesia through the Centre for Isotopes and Radiation Application (CIRA), National Nuclear Energy Agency (BATAN) will organize Executive Technical meeting on Plant Mutation Breeding in Indonesia.

The purpose of the meeting is to discuss regional approach and strategy and the role of plant mutation breeding on socio-economic impacts for national and regional development and in supporting the Sustainable Development Goals (SDGs) for the Asia region.

The meeting will consist of presentations, discussions and technical/field visits:

- Overview of national and regional strategy on plant mutation breeding to support the SDGs;
- Review of current status, lessons learned from and discussion on success story of plant mutation breeding in some regional countries, as well as future challenges;
- Sharing of national plant mutation breeding programme and mapping challenges in the region;
- Dissemination and partnership in developing crop mutant varieties to stakeholders including to academic, company/industry and farmer society;
- Technical/field visit to crop mutant varieties developed by stakeholders, to traditionally Balinese Agricultural Management System (SUBAK) and to the garden of plant genetic resource collection in Bali Province;
- Discussion to promote and strengthen collaboration in plant mutation breeding among the regional Asia Pacific countries, including for capacity building;
- Follow up actions and recommendations.

Participants will also be able to discuss their specific breeding problem and learn about the most suitable mutagenesis approach for their mutation breeding programme.

The meeting is open to eligible participants from IAEA Member States in the Asia region. Participants should be in the position as a manager, policy maker or a decision maker in food and agricultural field, particularly in crop improvement programmes.

First Research Coordination Meeting (RCM) on Improving Crop Resistance to Abiotic Stresses through Mutation Breeding for Sustainable Agriculture, D2.30.31, Vienna, Austria, 9–13 October 2017

Technical Officer: F. Sarsu

Drought is the most devastating abiotic stress factor worldwide affecting crop production and is projected to worsen with anticipated climate change. Improving drought tolerance in crops, and to enhance agricultural water productivity under rain-fed conditions is among top priority for most countries. The project seeks to combine expertise in the field, green house and laboratory to enhance mutation breeding and to develop robust protocols for rapid advancement of generations, and efficient screening packages of mutant populations for drought tolerance. Screening packages will be optimized for phenotyping and genotyping for drought tolerance to develop/adapt technology for accelerated identification of drought tolerant rice and sorghum mutants. Accelerating techniques such as rapid cycling of crop generation and efficiency enhancing technologies of doubled haploid, genomics and molecular markers will be adapted in the CRP as appropriate.

The meeting objectives are to consolidate the work plan, build the networking of the team and coordinate the work to maximize the use of resources to achieve the targeted objectives. It is expected to have 15 participants (agreement, technical and research contract holders) from different Member States attending the RCM.

Regional Training Course on Genetic Improvement to Enhance the Quality of Crops through Mutation Induction (Latin American and the Caribbean), RLA/5/068, Lima, Peru, 16–20 October 2017

Technical Officer: S. Nielen

This course is part of the regional TC project RLA/5/068 on Improving Yield and Commercial Potential of Crops of Economic Importance (ARCAL CL).

Many of the countries of Latin America and the Caribbean have a deficit in food production, leading to serious problems of poverty and malnutrition, especially in rural areas. This situation is compounded by the effects of climate change and population growth in the region. The productivity of the fields of small farmers are affected by adverse weather conditions (drought, floods, extreme temperatures), soil impoverishment caused by inappropriate agricultural practices (salinization, acidification, loss of nutrients) and by using the inadequate technology and growing old underperforming cultivars often susceptible to pests and diseases. The project is based on the use of induced mutation, mutation detection and pre-breeding technologies to develop new crop varieties with the required characteristics.

The purpose of the course, which will be implemented at the Universidad Nacional Agraria La Molina, is to build capacities for the application of selection techniques that allow the identification of mutant plants with quality characteristics for human and animal feeding. Additionally, training will be given on the management of equipment and methodologies for the determination of quality characters that allow the evaluation of a large number of genotypes. The course will include lectures and practical sessions on breeding for quality characters in wheat, rice, root and tuber crops and vegetables. Physical and chemical quality will be evaluated in mutant populations of cereals and native grains. Also, near infrared spectroscopy will be used to perform quality analysis in quinoa mutants.

Regional AFRA Training Course on Methodologies and Mechanisms for Screening of Mutants against Biotic Stresses, RAF/5/076, Yaoundé, Cameroon, 23–26 October 2017

Technical Officer: F. Sarsu
Course Director: H.N. Mafouasson Apala

This training course will be organized in cooperation with the Government of Cameroon, Ministry of Agriculture and Rural Development (MINADER). It is open to candidates and project partners in the project RAF/5/076 (AFRA) on Improving Crops Using Mutation Induction and Biotechnology through a Farmer Participation Approach.

The purpose of this course is to provide participants with theoretical as well as practical information on mutation induction, mutation screening and breeding for biotic stress resistance in crop breeding.

The course will include lectures, and practical sessions on:

- Mutation breeding procedures/methodologies and handling of mutated population;
- Identification, evaluation and selection of breeding lines;
- Genetics/mechanisms of biotic stress resistance;
- Pre field, laboratory, screen house/field screening methodologies for biotic stress resistance;
- Breeding for biotic stress resistance, mutation breeding, classical breeding and utilization of appropriate biotechnologies;

- Field demonstration and practical screening of selected crop (maize).

The participants should be from participating Member States involved in the project RAF/5/076 and actively working in mutation breeding and have 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 RAS/5/074 on Enhancing Wheat and Barley Productivity through Induced Mutation with Supportive Breeding and Related Biotechnology Techniques, Phase III, Safat, Kuwait, 27–29 November 2017

Technical Officer: F. Sarsu

Cereals are the most important food crops contributing to food security in ARASIA Member States. However, Arab countries are the largest net importers of cereal in the world. Also 35 percent of daily calories consumed in Arab countries come alone from wheat; this is driving the region’s heavy dependence on cereal imports. One of the solutions is improvement of agricultural productivity through investments in research and development; therefore, improved technology will boost cereal yields in the region. Water shortage problem is very important and much of the land in the region too dry for cultivation and grazing. Introducing new drought-tolerant crops combined with water-use efficiency in the area could be an alternative. In addition to water and land constraints, cereal-yield growth has been slower in Arab countries than the rest of the world.

It is urgent need to develop new wheat and barley varieties with improved tolerance to abiotic and biotic stresses and sustainable high yield under variable climatic conditions. In this context, mutation induction technique has shown potential as a valuable tool in developing drought/salinity tolerant and disease resistant mutant lines of wheat and barley. In order to address these agricultural constraints, ARASIA States Parties started a regional mutation breeding programme under the RAS/5/048 project in 2007 with the assistance of the IAEA. Under this project, some segregating mutant lines with the above mentioned agronomic characters have been developed.

The purpose of this meeting is to:

- Review the national project progress according to the work plans in line with activities implemented in 2016/2017 of the government parties;
- Report on the progress made over the last four years under the RAS/5/0/58 and over the last two years under RAS/5/074;
- Discuss on exchange of genetic plant material between participating countries which is generated under the project discuss on using of techniques and protocols provided through regional training courses in the breeding programmes;
- Discuss another important crops in the region and to identify needs for the next phase of the project;
- Prepare completion report of the TC project RAS/5/074.

The meeting is open to participants of ARASIA Member States through their designated project coordinators.

Past Events

Regional AFRA Training Course on Improving Resilience to Drought through Mutation Breeding, RAF/5/076, Tsumeb, Namibia, 24–28 October 2016

Technical Officer: F. Sarsu
Course Director: L. Ndinelao Horn

This training course was organized in cooperation with the Government of the Republic of Namibia, Ministry of Agriculture, Water and Forestry. It was open to candidates from RAF/5/076 on Improving Crops Using Mutation Induction and Biotechnology through a Farmer Participation Approach. The training course was attended by 15 international and five national participants from 16 African countries (Benin, Burundi, Cameroon, Central African Republic, Cote d'Ivoire, Democratic Republic of Congo, Egypt, Ethiopia, Ghana, Libya, Mauritius, Namibia, Senegal, Sudan, Tunisia and Zambia).

The purpose of this course was to provide participants with theoretical as well as practical information on mutation induction, mutation screening and breeding drought tolerance in crop breeding.

Training course participants

The course included lectures and practical session on:

- Mutation breeding procedures/methodologies and handling of mutated population;
- Identification, evaluation and selection of breeding lines;
- Genetics of drought stress tolerance;
- Physiology of drought tolerance;
- Pre field/field screening methodologies for drought stress tolerance;
- Breeding for drought tolerance, mutation breeding, classical breeding and utilization of appropriate biotechnologies;
- Field demonstration and practical sessions.

Professor H. Shimelis from KwaZulu-Natal University (RSA) and Dr A. Ashok Kumar were invited as resource person for the course. The training course was successfully completed. Both, theoretical and practical aspects, were conducted including mutation induction, handling of mutant populations, selection for advancement, identification and evaluation of promising mutant lines identified and their release. Basic statistical analysis for use in crop improvement was also presented and discussed. The crop specificity was brought in by providing lecture and practical sessions on genetics of drought stress tolerance; physiology of drought tolerance; pre field/field screening methodologies for drought stress tolerance, and breeding for drought tolerance, and utilization of appropriate biotechnologies including genomics. The phenotyping and genotypic techniques were given high thrust to take the current mutation breeding programme to the next level. Recent advances in sorghum improvement for food, feed, nutrition and biofuel was also presented to the participants. The following conclusions were made from the training course:

- Mutation breeding provides great opportunity to improve cowpea, sorghum and pearl millet for yield and yield-related traits;
- Combined with conventional breeding methodology, mutation breeding can be successfully deployed in crop improvement programmes with reduced timeframe and minimal investments;
- The participants received hands-on training and shared experience in prioritizing breeding goals, breeding approaches to be adopted in their research, the role of mutation breeding in their research, induction of mutation, selection and advancement of mutant lines and their evaluation and release;
- The participants benefitted from peer learning and experience. They developed draft ideas and proposal on the application of mutation breeding to improve traits of interest in their respective crops.

Cowpea field

Sorghum field

The training course offered new opportunities for collaboration between researchers from various countries in Africa, particularly in the area of mutation breeding in crop research.

Regional Review Meeting on Supporting Climate-Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications, RAS/5/073, Kota Kinabalu, Malaysia, 6–10 February 2017

Technical Officer: L. Jankuloski

Meeting participants

The host organizer of this meeting was Malaysian Nuclear Agency. This Regional meeting was attended by 18 participants from Bangladesh, Cambodia, Indonesia, Lao, P.D.R., Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Thailand, Viet Nam and Mr Jagdish Kumar Ladha, expert from IRRI. The Regional Review Meeting was officially opened by Dr Mohd Ashhar Bin HJ. Khalid, Director General of Malaysian Nuclear Agency.

The work done for the past one year in each of the participating countries was presented. Country presentations were provided by counterparts from Bangladesh, Cambodia, Indonesia, Lao, P.D.R., Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Thailand and Viet Nam. A general discussion with feedback and summarizing the results in each participating country were compiled.

A technical visit to Kota Belud, the Rice Bowl of Sabah, and to Kawasan Pembangunan Pertanian Bersepadu (IADA) in Kota Belud was made on the third day of the meeting. After a brief introduction of the IADA as an agency for infrastructure and irrigation development, there was a tour to the rice field and farmhouse in which different advanced rice farm machineries were stored.

The regional review meeting was perfectly organized by the local host organizer. The objectives of the regional review meeting were fully achieved. During the meeting, the regional project was reviewed and discussions with Counterparts were successful.

Participant's technical visit to Kawasan Pembangunan Pertanian Bersepadu (Integrated Agricultural Development Area-IADA) in Kota Belud

Some achievements include development of new advanced mutant lines in Bangladesh, Indonesia, Malaysia, Thailand and Pakistan tolerant to submergence, drought and diseases, and number of mutant lines developed in other participating countries with improved agronomic performance. Based on request and needs for participating countries next training course will be in drought tolerance screening in rice and IRRI was suggested as a potential host for this training.

The project has been successfully promoting collaboration between developing and least developing countries for exchange of expertise and networking within the region.

The meeting was also successful in strengthening collaboration and partnerships between developing and least developing countries for exchange of expertise and networking within the region. Mutant lines and varieties developed were shared among participating countries in order to evaluate adaptability of rice mutant varieties/lines in their countries and to use in their rice breeding programmes.

First Coordination Meeting on Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA), RAS/5/077, Nay Pyi Taw, Myanmar, 20–24 February 2017

Technical Officer: S. Nielen

Meeting participants

As a result of previous regional projects in Asia and the Pacific region 28 mutant varieties were developed and officially released. More than 350 advanced mutant lines were developed and tested in regional multi-location trials for release and more mutant populations are in the pipeline for further selection and development. The main driver of these projects is to develop new crop varieties adapted to the emerging challenges of climate change. These challenges need continuously to be addressed due to the increasingly frequent occurrence of pests and diseases, water shortages and drought. This issue is further exacerbated by the growing human population and disappearing areas of crop lands with economic development. It is believed that one of the most economic, effective and ecological approaches to address these challenges will be to develop new types of crop varieties, referred to as 'Green Crops', with high quality traits, such as high yield, high photosynthetic efficiency, ideal plant type, resistance to abiotic and biotic stresses and less agricultural inputs (pesticides and fertilizer) under environmental-friendly manner.

In collaboration with the Department of Technology Promotion and Coordination, Ministry of Education, Myanmar, the project coordination meeting of this regional technical cooperation project was held at the Hotel Aureum Palace in Nay Pyi Taw, Myanmar, from 20 to 24 February 2017. The objectives of the meeting were:

1. To review the current status of mutation breeding approaches and crop varieties in the RCA Government Parties;
2. To identify and address gaps and needs for advanced mutation breeding approaches and techniques to develop new crop varieties targeted for improved and environmentally friendly crop productivity;
3. To discuss and amend the national work plans to be implemented under the project RAS/5/077;
4. To discuss and finalize the details of the activities stipulated in the work plan to be implemented under the project RAS/5/077;
5. To discuss and strengthen the role of the Asia and Oceania Association of Plant Mutagenesis (AOAPM).

Eighteen National Project Coordinators (NPCs) from 18 Asian and Pacific countries (Australia, Bangladesh, People's Republic of China, India, Indonesia, Japan, Lao P.D.R., Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Palau, the Republic of Korea, Sri Lanka, Thailand and Vietnam), and national observers from Myanmar and the Technical Officer (TO) of the project participated in the meeting. From these countries Japan, Lao and Palau are new in the regional project.

The current national activities were presented, as well as the national project work plans, which were discussed and amended in order to contribute to the overall objective of the project. In addition, the regional work plan was adapted to the needs and the activities were specified with regards to contents, objectives, venues and time. The meeting also was very useful to reinforce the work of the Asia and Oceania Association of Plant Mutagenesis (AOAPM). A technical visit and several technical presentations stimulated the scientific discussion among the group. The meeting has formulated 11 Recommendations aimed at efficient implementation of the project.

The NPCs have prepared national reports that include background information, the objective of their project, information on the national project team and facilities at their institutes, partnerships and details on existing mutant varieties and on mutant lines that will be subject of the new project. These reports provide useful baseline data at the beginning of the project.

National Training Course on Application of *In Vitro* Techniques in Mutation Breeding, RAF/5/076, Abidjan, Côte d'Ivoire, 27–31 March 2017

Technical Officer: F. Sarsu
Course Director: M. Kouassi

This training course was organized in cooperation with the Government of Côte d'Ivoire, Centre National de Recherche Agronomique (CNRA), Abidjan. The training course was attended by 15 participants from different institutes in Côte d'Ivoire. The purpose of the training course was to provide participants with theoretical lectures on mutation induction, mutation breeding and related biotechnologies, and practicals on phenotyping, screening and selection of mutant lines for desired traits of crops in field greenhouse and laboratory condition. Beside theoretical lectures and practical sessions, the training course included roundtable discussions on how the participants will use obtained knowledge and skills from the training course in their breeding programmes.

The one-week training course consisted of lectures and hands-on experiments on:

1. Mutation Breeding for crop improvements;
2. Mutation breeding for improvement of tropical crops in Côte d'Ivoire;
3. Basis of plant biotechnology and mutation induction;
4. Mutagen application *in vivo*/*in vitro* in vegetatively propagated crops;
5. Phenotyping mutants — Screening of mutant lines for desired traits of crops in the field/greenhouse/laboratories conditions;
6. Utilization of plant tissue culture techniques (e.g. DH techniques) for mutation breeding and screening for abiotic stresses;
7. Using *in vitro* techniques in mutation breeding;
8. Handling of sub-sequent *in vitro* derived mutated populations;
9. Practical's: Media preparation for anther and pollen culture;
10. Greenhouse visit to collect flower buds of cassava, moringa and other plants available at different stages of pollen development, identification of pollen stages using morphological markers as well as Cytological markers/staining, using light microscopy in the laboratory. Anther culture of cassava, moringa/other plants, in different media.

Dr Désiré Pokou, Plant Molecular Geneticist, CNRA-LCB Abidjan and Prof. Rajbir S. Sangwan, Université de Picardie Jules Verne, France, were the lecturers. The participants were delighted with the achievements, showed great interest in the training course, participated actively in the roundtable discussions and asked many questions about the applications of *in vitro* techniques in Mutation Breeding. They also gained practical experience in phenotyping of mutant plants/lines for desired traits in the field/greenhouse/laboratories conditions and the establishment of the proper screening protocols *(in vitro* and/or *in vivo*) to be used in the field conditions. The training course was well appreciated and was highly evaluated by the participants. They acknowledged that the knowledge and skills gained, during this training course, are greatly relevant for their future work.

Participants visiting the fields and greenhouse: Identification of anther/pollen stages of development

National Training Course on Mutation Breeding for Crop Improvement, KUW/5/002, Kuwait City, Kuwait, 5–9 March 2017

Technical Officer: L. Jankuloski

The National Training Course (NTC) on Mutation Breeding for Crop Improvement was held under TC Project KUW/5/002 and was organized in cooperation with the Kuwait Institute for Scientific Research. The NTC was attended by eight participants from Kuwait and one participant from Qatar. Mr Nader M. Al-Awadhi, National Liaison Officer (NLO), welcomed the participants at the opening ceremony.

This one-week training course was officially opened by Mr Nader M. Al-Awadhi, NLO for Kuwait.

The purpose of this NTC was to provide participants with theoretical as well as practical information on techniques in mutation breeding combined with efficiency enhancing biotechnologies to improve the capacity to generate and develop barley mutants tolerant to abiotic and biotic stresses. The training course included theoretical lectures, practical session in the experimental field and roundtable discussions. Theoretical lectures and practicals related to the topics were given by the invited expert, Dr Bill Thomas from the James Hutton Institute, UK, and Technical Officer (TO) Mr Ljupcho Jankuloski.

The training course included lectures and practical sessions on:

- Basic concepts and knowledge on mutagenic agents;
- Induced mutation in plants;
- Concept of plant mutation breeding;
- Handling of mutant population in self-pollinated crops;
- Barley breeding, genetics and genotyping;
- Breeding for abiotic stress tolerance;
- Protocol for pre-field screening of mutants for salt tolerance in rice, wheat and barley;
- Application of plant tissue culture techniques, including doubled haploids in mutation breeding for barley improvement.

Practical session was held in Sulaibiya Experimental Field Station, where participants had opportunity to see M_2 barley mutant population and opportunity practically to select putative mutant plants in M_2 generation, manly earliness, dwarfism, chlorophyll mutation and number of tillers in plants.

Participants showed great interest in the training course and participated actively during the theoretical lectures, practical sessions and in the roundtable discussions. Trainees obtained practical knowledge and experience in the screening M_2 generation in barley. The practical demonstrations and hands-on experience were of particular value for the success of this NTC, which was very positively acknowledged by participants.

Experimental field with M_2 generation barley at the Sulaibiya Experimental Field Station

Invited expert Dr Bill Thomas explaining trainees how to detect mutants in barley

Regional Training Course on Biotic Resistance and Plant Pathology (Latin America and the Caribbean), RLA/5/068, Heredia, Costa Rica, 6–10 March 2017

Technical Officer: S. Nielen

This course was part of the regional TC project RLA/5/068 on Improving Yield and Commercial Potential of Crops of Economic Importance (ARCAL CL).

Many of the countries of Latin America and the Caribbean have a deficit in food production, leading to serious problems of poverty and malnutrition, especially in rural areas. The productivity of the fields of small farmers are affected by adverse weather conditions (drought, floods, extreme temperatures) and growing old underperforming cultivars often susceptible to pests and diseases. The project is based on the use of induced mutation, mutation detection and pre-breeding technologies to develop new crop varieties with the required characteristics. The purpose of this training course was capacity building on the implementation of screening techniques to identify plants with qualitative and quantitative resistance to diseases caused by fungi, bacteria, viruses and other pathogens. Additionally basic training on the mechanisms of plant defence was provided, as well as the criteria to apply the most appropriate improvement method, including application of molecular markers or genomics for studying resistance to pests and diseases.

The training course was organized at the Escuela de Ciencias Agrarias, National University of Costa Rica, Heredia, and the Course Director was Mr Juan Félix Argüello Delgado. Fifteen scientists from 15 countries of the region were selected to participate in the course. Another 16 local participants came from various institutes and Universities in Costa Rica. Apart from lecturers of the host and other Costa Rican institutes, one invited lecturer, Mr Guillermo A. Galván from the Universidad de la República, Progreso, Canelones, Uruguay, supported the course by providing lectures and practical courses. The course consisted of theoretical lectures (75%) and practicals (25%) and in all sessions ample room was given for discussions and clarifying questions and answers. The majority of participants evaluated the course very positively with regards to the course content, organization, duration and practicals that took place during the week.

Participants evaluating a radiosensitivity test

Participants, organizers and lecturers of the training course

IAEA/AFRA Workshop on Improving Selected Seed Propagated Crops Using Mutation Breeding in Africa, RAF/5/076, Vienna, Austria, 3–5 May 2017

Technical Officer: F. Sarsu
Course Director: I. Ingelbrecht

A three-day workshop was organized at the Vienna International Centre (VIC), Vienna and Plant Breeding and Genetics Laboratory (PBGL), Seibersdorf, Austria within the context of the RAF/5/076 project on 'Improving Crops Using Mutation Induction and Biotechnology through a Farmer Participation Approach'. The main purpose of the workshop was to review progress of the crop mutation breeding programme in the respective countries under this regional project and to identify any needs in terms of capacity building, technical backstopping or joint R&D with the PBGL. The meeting was attended by some 12 participants from nine Member States who had the opportunity to present their programmes: Burkina Faso, Egypt, Madagascar, Namibia, Senegal, Sierra Leone, Sudan, United Republic of Tanzania and Zimbabwe. Zambia was unable to attend but provided valuable inputs for this workshop. Drought tolerance was a major breeding target for countries in Southern Africa and advanced mutant lines for drought tolerance in cowpea have been produced by several countries. In case of rice, there is a clear demand for quality rice that better meets consumer demands in several African countries. Overall, the workshop proved a great success and identified areas for strengthening capacity building as well as new opportunities for co-development of technologies by the PBGL and several Members States including Zambia, Namibia, Zimbabwe and also Burkina Faso.

Workshop participants

Regional Training Course on Methodologies and Mechanisms for Screening against Abiotic Stresses Using Mutation Breeding and Molecular Markers, RAS/5/070, Khon Kaen, Thailand, 22–26 May 2017

Technical Officer: F. Sarsu

Course Directors: W. Ponrakdee and S. Sakuanrungsirikul

This training course was organized in cooperation with the Government of Thailand, Ministry of Agriculture and Cooperatives. It was open to candidates from TC project RAS/5/070 on Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques.

The course was attended by 27 RAS/5/070 project participants from 16 Asian countries (Bangladesh, Cambodia, People's Republic of China, India, Indonesia, Republic of Korea, Lao P.D.R., Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand and Viet Nam) and two national participants.

Training course participants

The one-week training course consisted of lectures and hands-on experiments on:

- Basis of plant biotechnology and mutation induction;
- DNA, 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;
- Establishment of adequate screening protocols *in vitro* and/or *in vivo* integrating to mutation breeding programmes;
- Utilization of appropriate technologies for mutation screening for abiotic stress in bioenergy crops.

Isolation of DNA from sugarcane leaves

Ms Tomlekova and Mr Reflinur were invited as resource persons for the course. The training course was successfully completed. It included theoretical as well as practical information on application of molecular markers in mutation breeding including screening of target traits for bioenergy crops. The participants acquired information and hands on skills in mutation breeding and using molecular markers which will assist them in their efforts to establish/conduct crop mutation breeding in their home institutes.

Second Research Coordination Meeting (RCM) on Efficient Screening Techniques to Identify Mutants with Disease Resistance for Coffee and Banana, D2.20.05, Lisbon, Portugal, 29 May–2 June 2017

Technical Officers: S. Nielen and I. Ingelbrecht

The meeting was hosted by the Instituto Superior de Agronomia (ISA) of the University of Lisbon, to which the Coffee Leaf Rust Research Centre (CIFC), one of the counterparts in this CRP, belongs to. Project participants and observers from 12 different countries (Austria, Costa Rica, Islamic Republic of Iran, Malaysia, Mauritius, Nigeria, Peru, the Philippines, People's Republic of China, Portugal, Mauritius, South Africa and United Kingdom), and two International Organizations (Bioversity International and the Joint FAO/IAEA Division) came together to review the progress that has been made during the first 18 month of this project and to discuss the way ahead.

RCM group and CIFC team at the main entrance of the Instituto Superior de Agronomia (ISA). Photo: Courtesy of Ms Mariana Castro, ISA

The main objective of this CRP is to develop technology packages for the use of induced mutations for developing new banana and coffee varieties resistant to important diseases such as Fusarium wilt caused by *F. oxysporum* f.sp. cubense (Foc) tropical race four (TR4) and coffee leaf rust (CLR) caused by *H. vastatrix*, respectively. The main goals are to adapt and develop efficient mutation induction protocols for the two crops as well as screening protocols that are suitable for mass screening of mutant lines to identify rare plants showing enhanced resistance to disease.

The first two days of the meeting were dedicated to presentations and discussions of the individual projects and the results achieved so far. After this the meeting continued in working groups, one each for coffee and banana. Here the individual work plans were discussed, changed where necessary, and updated with clear and time-bound indicators. Based on the working group results, the meeting has adapted the overall work plan for the CRP and formulated recommendations that will help to achieve the goals of this CRP. For a list of achievements that have been made so far, please see Coordinated Research Projects on page 18.

A very informative half-day technical visit was organized to the CIFC, which shares its unique expertise in characterization of rust races within the CRP. CIFC was founded in 1955 through an agreement between the USA and Portugal, aimed at providing a centre for international cooperation on CLR research and pre-breeding outside the coffee growing regions in order to avoid inadvertently spreading of new virulent races to coffee countries. At CIFC the meeting participants were introduced by Mr Vítor Varzea (Chief Scientific Investigator (CSI) in this CRP) into the work and germplasm collections at the institute. Also, the technique for inoculation of fungal spores to coffee leafs for screening purposes was demonstrated to the participants.

The next RCM will be held end of 2018 or beginning of 2019 at the Guangdong Academy of Agricultural Sciences, Guangzhou, China.

Mr Vítor Varzea, researcher at CIFC and CSI in this CRP, explaining CIFC's work on coffee in one of the heated greenhouses, which together cover an area of more than 3.000 m^2

Coordinated Research Projects

Project Number	Ongoing CRPs	Scientific Secretaries
D2.30.30	Integrated Utilization of Cereal Mutant Varieties in Crop/Livestock Production System	L. Jankuloski/I. Ingelbrecht
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
	New CRP	
D2.30.31	Improving Resilience to Drought in Rice and Sorghum through Mutation Breeding	F. Sarsu

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

Scientific Secretary: 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 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 among 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.

This CRP will focus on improving rice and sorghum to drought tolerance for current and future climate change scenarios. These two crops are essential staples in the diets of millions of impoverish 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 income generation.

The project seeks to combine expertise in field, green house and laboratory to enhance mutation breeding and to develop robust protocols for rapid advancement of generations and efficient screening packages of mutant populations for drought tolerance. Screening packages will be optimized for phenotyping and genotyping for drought tolerance to develop/adapt technology for accelerated identification of drought tolerant rice and sorghum mutants. Accelerating techniques such as rapid cycling of crop generation and efficiency enhancing technologies of doubled haploid, genomics and molecular markers will be adapted in the CRP as appropriate.

Up to eight research contracts are expected to be awarded and five no-cost agreement holders from advanced laboratories and 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 advance. The expected duration of the CRP is five years (2017-2021). For more information, see Forthcoming Events on page 6.

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

Scientific Secretaries: 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). Detailed reports from the contract holders will be received by the end of the first year of the contract mostly during June to September 2017 to be reviewed for extension to the send year of the CRP.

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

Scientific Secretaries: S. Nielen and I. Ingelbrecht

The CRP officially started in November 2015 and had its first RCM 7–11 December 2015 in Vienna, Austria. 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. 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.

Many challenges need to be addressed for successful coffee and banana mutation breeding. Polyploid bananas are vegetatively propagated and therefore require in vitro propagation pre- and post-mutagenesis. In addition to disease screening methods, low-cost tissue culture and efficient methods to dissolve chimeric sectors that result from mutagenesis of multicellular tissues are needed. Very little work on mutation breeding has been done on coffee. We therefore focus some efforts of this CRP on developing and validating mutation induction techniques in the perennial tetraploid *Cafea arabica*.

At the second RCM that was held from 29 May to 2 June 2017 in Lisbon, Portugal, participants reported on their results of the first period of the project (for more information, see Past Events on page 15). These include:

1. Protocol and guideline for sending samples of coffee leaf rust to CIFC for race identification;
2. Protocol for screening for resistance to Coffee Leaf Rust (CLR);
3. Determination of radiosensitivity of seeds for some coffee varieties;
4. Establishment of methods for in vitro culture, somatic embryogenesis and anther culture in two *C. canephora* and nine *C. arabica* cultivars coffee for in vitro mutation induction;
5. Generation of mutant populations in banana and first screening tests in lab and field.

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

Scientific Secretary: L. Jankuloski

This CRP began in the third quarter of 2012 and will be concluded in the third quarter of 2017. In December 2012, we held our first RCM in Vienna, Austria, the second RCM was held in August 2014 in Bogor, Indonesia and the third and final RCM was held in 2016 in Darkhan, Mongolia.

The objectives of this CRP are:

1. To identify cereal mutant varieties or advanced mutant lines for food and feed;
2. To evaluate mutant cereal varieties/lines for agronomic performance and feed quality;
3. To develop crop management systems for cereal mutant varieties with respect to improved yield and quality;
4. To determine biomass, harvest index and nitrogen use efficiency of mutant varieties and advanced lines;
5. To validate and publish protocols and guidelines for speeding up the establishment of useful mutants in desirable genetic backgrounds;
6. To perform pilot tests of superior mutant varieties/lines on-farm through participatory farmer approaches.

The crops chosen are those that can be used for both human food and animal fodder. The project involves nine participating countries and four major crops, namely wheat (the Former Yugoslav Republic of Macedonia, Mongolia), rice (Malaysia), barley (Austria, People's Republic of

China, Kuwait and Peru) and sorghum (Indonesia). The project aims to improve the agronomy of the crop especially in respect to soil and water management, improve nutritional value and improve the knowledge and skills base of participating MSs.

All participants have identified promising mutant lines that are now subject to farming management practices to maximize yields in challenging conditions. Success in tailoring agronomy for mutant varieties will be judged by take up by farmers but there are already impressive outcomes, particularly in Indonesia where mutant varieties are now grown in several regions on an increasing area. In barley, relevant germplasm with natural variation for reduced lignin content trait has been identified and progress is made to identify the underlying sequence variations in several barley lines. In cooperation with technical contract holder, Mr Heinrich Grausgruber (BOKU University, Vienna, Austria), PBGL is developing molecular marker to reduce lignin in barley. Final reports are expected by end of 2017 and project will be closed in 2018.

General information applicable to all coordinated research projects

Submission of Proposals

Research contract proposal forms can be obtained from the IAEA, the National Atomic Energy Commissions, UNDP offices or by contacting the Technical Officer. The form can also be downloaded from the URL:
http://www-crp.iaea.org/html/forms.html.

Complementary FAO/IAEA Support

IAEA has a programme of support through national Technical Cooperation (TC) projects. Such support is available to IAEA Member States and can include additional support such as equipment, specialized training through IAEA training fellowships and the provision of technical assistance through visits by IAEA experts for periods of up to one month. Full details of the TC Programme and information on how to prepare a project proposal are available at the URL:
http://pcmf.iaea.org/.

Technical Cooperation Field Projects

Project Number	Country/Region	Title	Technical Officer(s)
ALG/5/026	Algeria	Increasing the Genetic Variability for the Improvement of Strategic Crops (Wheat, Barley, Chickpeas and Dates) for Enhanced Tolerance to Biotic and Abiotic Stresses and the Development of Biotechnology Capacities	L. Jankuloski
BGD/5/029	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
BUL/5/014	Bulgaria	Screening of Cereal Germplasm Stress Response and Adaptation Potential by Advanced Nuclear, Omics and Physiological Approaches	L. Jankuloski/S. Nielen
BKF/5/016	Burkina Faso	Using Nuclear Techniques for Improving Rice Yield and Quality	L. Jankuloski/I. Ingelbrecht
BDI/5/001	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
CAF/5/008	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
COL/5/024	Colombia	Supporting Mutagenesis and Functional Genomics Applied to the Improvement of Rice	S. Nielen
ZAI/5/025	Congo, Democratic Rep. of the	Increasing Genetic Variability in Cassava and Maize for Enhanced Tolerance to Biotic and Nitrogen Stresses	L. Jankuloski/F. Sarsu
IVC/5/039	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
GHA/5/036	Ghana	Screening Oil Palm M2 Population for Useful Mutants	L. Jankuloski/F. Sarsu
IRA/5/014	Iran, Islamic Republic of	Improving Wheat Yield and Stress Tolerance for Sustainable Production	L. Jankuloski
KEN/5/034	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
KEN/5/037	Kenya	Using Climate Smart Bracharia Mutants to Develop Integrated Farm Model Technologies for Improved Livelihood Among Smallholder Farmers	S. Nielen/F. Sarsu
KUW/5/002	Kuwait	Implementing Mutation Induction to Improve Barley Production under Harsh Environmental Conditions	L. Jankuloski/A.M.A. Ghanim

Project Number	Country/Region	Title	Technical Officer(s)
LAO/5/002	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
LES/5/004	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
LES/5/005	Lesotho	Improving Crop Yield, Quality and Stress Tolerance for Sustainable Crop Production, Phase II	S. Nielen/A.M.A. Ghanim
MAG/5/023	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
MAU/5/006	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
MAR/5/023	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
MON/5/021	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
MOZ/5/007	Mozambique	Enhancing Mutation Breeding of Sorghum and Pearl Millet to Develop High Yield, Disease Resistance and Drought Tolerance	S. Nielen/A.M.A. Ghanim
MYA/5/020	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
NAM/5/012	Namibia	Developing High Yielding and Drought Tolerant Crops through Mutation Breeding	F. Sarsu/S. Nielen
NAM/5/014	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
NEP/5/003	Nepal	Improving Crop Yield for Food Security and Economic Growth by Using Nuclear and Molecular Techniques	S. Nielen/L. Jankuloski
NER/5/019	Niger	Improving Sesame Plant Productivity by Obtaining High-Yielding Induced Mutants Adapted to Semi-Arid Conditions	I. Ingelbrecht/A.M.A. Ghanim
OMA/5/004	Oman	Building Capacity for the Improvement of Major Crops through Induced Mutation Using Nuclear and Related Techniques	A.M.A. Ghanim/I. Ingelbrecht
PAL/5/009	Palestine	Enhancing the Performance of Durum Wheat Landraces by Induced Mutation (Phase II)	L. Jankuloski/A.M.A. Ghanim

Project Number	Country/Region	Title	Technical Officer(s)
QAT/5/006	Qatar	Enriching Genetic Diversity and Conserving Plant Genetic Resources Using Nuclear Techniques and Related Technologies	A.M.A. Ghanim/L. Jankuloski
RAF/5/076	Regional Africa	Improving Crops by Using Mutation Induction and Biotechnology through a Farmer Participatory Approach	F. Sarsu/S. Nielen
RAS/5/069	Regional Asia	Complementing Conventional Approaches with Nuclear Techniques towards Food Risk Mitigation and Post-Flood Rehabilitation Efforts in Asia	L. Jankuloski/S. Nielen
RAS/5/070	Regional Asia	Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RCA)	F. Sarsu/S. Nielen
RAS/5/073	Regional Asia	Supporting Climate-proofing Rice Production Systems (CRiPS) Based on Nuclear Applications-Phase II	L. Jankuloski/S. Nielen
RAS/5/074	Regional Asia	Enhancing Wheat and Barley Productivity through Induced Mutation with Supportive Breeding and Related Biotechnology Techniques (Phase III) (ARASIA)	F. Sarsu/L. Jankuloski
RAS/5/075	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
RAS/5/077	Regional Asia	Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties (RCA)	S. Nielen/F. Sarsu
RLA/5/068	Regional Latin America	Improving Yield and Commercial Potential of Crops of Economic Importance (ARCAL CL)	S. Nielen/L. Jankuloski
SEN/5/034	Senegal	Using an Integrated Approach to Develop Sustainable Agriculture in a Context of Degrading Soil Fertility, Climate Change and Crop Diversification	F. Sarsu in collaboration with Soil and Water Management and Crop Nutrition Section
SIL/5/014	Sierra Leone	Enhancing Nutritional and Other End-User Postharvest Qualities of Rice and Cassava through Mutation Breeding	S. Nielen/L. Jankuloski
SIL/5/017	Sierra Leone	Selecting and Analyzing Bio-Enriched and Bio-Fortified Rice and Cassava Lines and their Efficient Postharvest Transformation to Popular Food Products	S. Nielen/I. Ingelbrecht
SRL/5/045	Sri Lanka	Establishing a National Centre for Nuclear Agriculture	F. Sarsu
SUD/5/037	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
URT/5/030	Tanzania, United Rep. of	Improving Rice and Barley Production through Application of Mutation Breeding with Marker Assisted Selection	L. Jankuloski/F. Sarsu
URT/5/032	Tanzania, United Rep. of	Developing Maize Cultivars for Improved Yield and Resistance to Viral Disease	F. Sarsu/L. Jankuloski
THA/5/054	Thailand	Increasing Adaptability for Adverse Environment Tolerance in Rice Germplasm Using Nuclear Techniques	F. Sarsu/S. Nielen

Project Number	Country/Region	Title	Technical Officer(s)
VIE/5/020	Viet Nam	Enhancing the Capacity for Research and Applications of Nuclear Techniques in Plant Breeding	L. Jankuloski
ZIM/5/021	Zimbabwe	Assessing and Promoting Sustainable Agricultural Production in Communal and Newly Resettled Farms	F. Sarsu/A.M.A. Ghanim in collaboration with Soil and Water Management and Crop Nutrition Section

Developments at the Plant Breeding and Genetics Laboratory

The Plant Breeding and Genetics Laboratory (PBGL) continues to align its R&D efforts with the Coordinated Research Projects (CRPs) and focus on practical applications in the field that benefit plant breeders and farmers in the Members States (MSs).

In this Newsletter, R&D progress is reported on the recently initiated *Striga* CRP (D2.50.05) as well as on the work on reduced-lignin barley that was initiated in 2016 in the context of the barley food/feed CRP (D2.30.30).

Briefly, for the *Striga* CRP, PBGL's R&D is focused on developing efficient screening technologies in rice and sorghum to increase the genetic variability for resistance to this devastating disease. In case of barley, the objective is to develop molecular markers for introgression and/or more efficient selection of a reduced-lignin trait which has applications for animal feed. The latter project is carried out in close cooperation with Prof H Grausgruber, BOKU, Vienna, Austria.

In 2016, a programme on development of molecular markers through mapping-by-sequencing was initiated. The programme focuses on mutant traits that are of major interest to plant breeders and farmers in MSs. The approach integrates genetic studies, phenotyping with whole-genome sequencing. As pilot study, mutant sorghum lines, showing reduced height and an early maturing phenotype compared to the parent were chosen. Progress in this area is reported here as well.

Establishing close linkages between PBGL and crop mutation breeding programmes in MSs is an important mechanism to better align PBGL's capacity building efforts with MSs' needs. With support from the TC Department, one Meeting and one Group Training Course were held during this reporting period attended by a total of 20 different MSs. Priority areas to strengthen capacity building and new opportunities for R&D cooperation were identified. PBGL also proposed to establish a Laboratory Network on Crop Mutation Breeding which was well received by the participating MSs.

As usual, this newsletter also provides an overview of PBGL's crop irradiation service and human capacity building efforts which are an inherent part of PBGL's activities. A list of visitors to the PBGL during the first half of 2017 is included as well. Many MSs continue to show a great interest in our work, recognizing the contributions of mutation breeding for food security and climate-smart agriculture.

Developing Screening Methods for Selection of *Striga* Resistance in Sorghum Mutation Breeding

Striga hermonthica and *S. asiatica* are the major parasitic weeds inflicting devastating damage to cereal production in most of sub-Sahara Africa and semi-arid tropical regions of Asia constituting a major threat to food security in these regions. Host resistance is seen as the main component for integrated management of *Striga* infestation. Mutation breeding is expected to generate genetic variability for resistance in elite lines and farmer-preferred varieties. A CRP was launched for 2016–2020 to adapt or develop efficient and robust screening methods/protocols to screen large mutant populations for resistance to *Striga* in sorghum and upland rice. The laboratory component of this CRP is to contribute to screening and histological protocols. Furthermore, the CRP is anticipated to undertake allelism studies among different resistant mutants and to analyse mechanisms of resistance to enable development of molecular markers for marker-assisted selection and for pyramiding different sources of resistance in the breeding programmes. During the reporting period, the PBGL collected relevant standard sorghum and upland rice material with known reaction to the *Striga* (sensitive vs resistant). Different laboratory and glasshouse methods of screening were initiated. These included optimization of different factors and conditions such as soil mixture, pot size, amount of *Striga* seeds and growth condition for reliable and sensitive screening of large scale mutant populations to identify the very few mutant plants. From these experiments, the conditions for *Striga* preconditioning (temperature and light), inoculation rate (number of *Striga* seeds/pot), depth of inoculation were optimized. The optimization experiments will be expanded to reduce the error and fine-tune the protocols (see figure). Furthermore, laboratory optimization of screening is attempted with gel-assay and rizotron using Rockwool. The process will continue to expand the scale and further integrate histological analysis to differentiate between different mechanisms of resistance. Fellows from Mauritania, Sudan and United Republic of Tanzania and an intern from Slovenia contributed to these optimization experiments.

Optimization of screening method for resistance to Striga in sorghum grown in soil/pots using susceptible (left) and resistance (right) genotypes.

Genetic Analyses and Molecular Marker Development for Mutant Traits in Barley and Sorghum

In 2016, the PBGL initiated two projects aimed at developing markers to accelerate breeding for important mutant traits. The objective is to develop molecular markers that MSs can apply to, for example, introduce important mutant traits into farmer-preferred varieties, thus enhancing local agrobiodiversity. Our goal is to develop a pipeline of markers for key mutant traits to accelerate the impact of mutation breeding for climate change adaptation and sustainable food security in vulnerable regions.

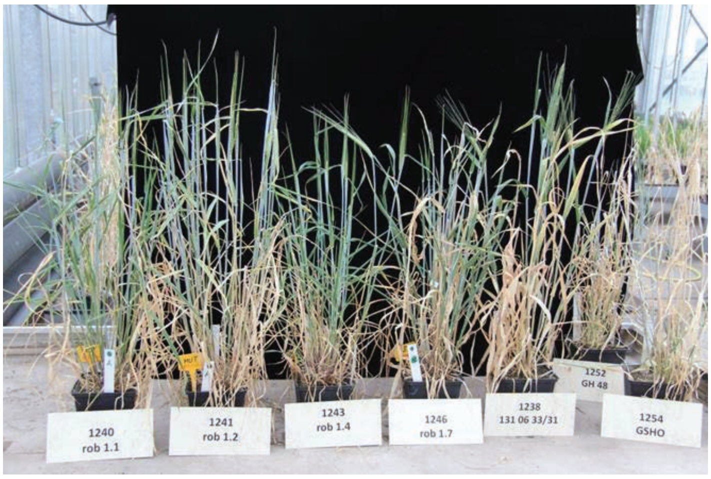
A number of conditions must be met for marker development, including of course the added value to a plant breeding programme. For example, molecular markers can significantly shorten the introgression of recessive traits. Developing markers is a process that takes multiple steps and the availability of well characterized germplasm will greatly facilitate a successful outcome.

A first project focuses on barley mutants with reduced lignin content. This project is carried out in the context of the CRP D2.30.30 on Integrated Utilization of Cereal Mutant Varieties in Crop/Livestock Systems for Climate Smart Agriculture.

The orange lemma mutation (*rob1*) in barley results in reduced lignin content and has applications for animal feed due to its higher digestibility (see figure).

Orange lemma mutant barley.

In cooperation with Prof Grausgruber (BOKU University, Vienna, Austria) a collection of 14 barley accessions with the orange lemma phenotype was assembled. Based on similar phenotypes in other plant species, the *cad2* gene is a likely candidate to carry mutation(s) for the *rob1* phenotype. Using amplicon based sequencing a total of six different mutations, all SNPs, were identified in the *cad2* gene of the 14 genotypes. All six mutations are predicted to disrupt *cad2* gene function and thus are strong candidates for causing the *rob1* phenotype. Representative barley accessions carrying these mutations are shown in figure.



Barley accessions with a reduced-lignin phenotype (rob1) carrying different mutations in the cad2 gene.

Crosses were made between accessions carrying the different mutations and their parental lines. F_1 seed have been obtained for several crosses. The aim of these experiments is to verify the recessive nature of the orange lemma phenotype and also to use the ensuing populations for validating the markers that we are currently developing.

A second project is focused on developing molecular markers for a semi-dwarf and earliness mutant trait in sorghum. These traits are expected to improve yield, enable mechanized harvesting, and ensure drought escape in the event of terminal drought. This project is intended as a model for identifying causative mutations through mapping-by-sequencing. In the absence of any clear candidates' genes, a whole-genome sequencing approach will be followed.

The targeted six dwarf mutant lines (D1-D6) and their wild parent Wad Ahmed were planted in the glasshouse during the reporting period for inter-crossing to produce F_1 seeds. On the one hand, crosses were made among the mutants in all combinations to produce F_1 for allelism test among the mutants. In addition, each mutant line was also crossed with the wild parent Wad Ahmed to verify the inheritance of the mutant gene(s) and further produce F_2 plants (see figures).

PBGL team and fellows doing sorghum crossing among the semi-dwarf mutant and parent in the glasshouse.

Based on our previous studies, we expect the F_2 plants to segregate for the mutant trait(s) and to enable producing bulk segregants for whole genome sequencing and development of functional molecular marker for these trait(s). We are happy to report that sufficient F_1 seeds were produced for all combinations of crosses for the planned downstream analyses. The F_1 seeds have been sown in the field in Seibersdorf, Austria for phenotyping and production of F_2 seeds this summer.

Professional Networking: Towards a Laboratory Network for Crop Mutation Breeding

Throughout its history, the PBG Laboratory has shown great commitment towards strengthening human capacities in MSs, especially through the fellowship programme supported by the Technical Cooperation Department. Establishing closer linkages between PBGL and the crop mutation breeding programmes in MSs could further enhance PBGL's capacity building efforts towards MSs' needs and could also create R&D synergies between PBGL and national mutation breeding programmes. Towards this end, a meeting on Improving Selected Seed Propagated Crops Using Mutation Breeding in Africa was held under RAF/5/076 — Improving Crops by Using Mutation Induction and Biotechnology through a Farmer Participatory Approach (3–5 May 2017). Participants presented an overview of their mutation breeding programmes focusing on selected seed propagated crops, rice, cowpea and sorghum. There was consensus among the participants that closer links between PBGL and relevant institutions in MSs could add significant value to ongoing mutation breeding programmes and could ultimately enhance impact in the field. During this meeting, the PBGL also proposed to establish a Laboratory Network on Crop Mutation Breeding. This proposal was well received by all participants who further requested to organize similar meetings in the future.

Irradiation services provided to Member States in 2017

During the first half of 2017, the PBGL has received a total of 18 irradiation service requests (see table). The type of request is indicated in this table: CRP – in context of CRP; F – by fellow request; TCP – under Technical Cooperation programmes. Several requests included dose-response experiments to determine optimal irradiation doses. To enhance the efficiency of our service, we have started to conduct dose-response experiments in cooperation with the requestor (e.g. in case of conifers and chamomile), i.e. the growth and measurement of irradiated plant materials are done by the requestor while the ensuing data analysis to determine the optimal irradiation dose(s) is done by the PBGL.

Request number	Country	Request type	Crop
1495	Germany		Ornamental
1496	Burkina Faso	CRP	Sorghum, Rice
1497	Germany		Cassava
1498	Romania	TCP	Pea
1499	UK		*Brassica napus* (rape)
1500	Sierra Leone		Rice
1502	Uzbekistan		Paulownia
1502	Sudan	F	Pearl millet, Sorghum, Tomato, Onion, Cowpea
1503	Uzbekistan		Cotton
1504	Tanzania, United Rep. of	F	Maize
1505	Hungary		Ornamental
1506	Poland		Conifers
1507	Austria		Chamomile
1508	Cote d'Ivoire	TCP	Maize
1509	Austria		*Cannabis sativa*
1510	Iraq	TCP	Rice
1511	Iraq	TCP	Watermelon, Squash, Cucumber, Okra, Eggplant
1512	Senegal	TCP	Cowpea

Human Capacity Development

Regional Training Course on Induced Mutations and Supportive Biotechnologies for Cereal Breeding

Technical Officer: F. Sarsu
Course Director: A.M.A. Ghanim

A two-week regional training course was organized by the International Atomic Energy Agency within the framework of the IAEA Technical Cooperation project RAS/5/074 on Supporting Mutation Induction and Supportive Breeding and Biotechnologies for Improved Wheat and Barley – Phase III, at PBGL, Seibersdorf, Austria, during 8–19 May 2017. The purpose of the training course was to provide participants with theoretical and practical skills in mutation breeding and related efficiency enhancing technologies. In total 19 trainees from 11 Member States participated in the course. Fourteen participants, two each from seven Member States; Iraq, Jordan, Lebanon, Oman, Saudi Arabia, Syrian Arab Republic and Yemen, were supported by the regional project, while five participants were fellows and scientific visitors to the PBGL from Burkina Faso, Lesotho, Oman, Qatar and Zimbabwe, nominated through their respective national TC projects. Lecturers, practical and demonstrations covered the following main areas:

1. Mutation induction and development of mutated populations;
2. Screening protocols for biotic and abiotic stresses (wheat rust, drought, heat stress and salinity) in cereals;
3. Efficiency enhancing technologies with emphasis on; i) rapid generation cycling, ii) doubled haploid technologies, iii) Flow-cytometry and iv) NIRS for seed quality analysis;
4. Next Generation Sequencing and related bioinformatics tools for development of molecular markers and marker-assisted selection.

In addition to PBG staff, two guest experts on Flow-cytometry and NIRS and one invited expert on Next Generation Sequencing and related Bioinformatics contributed to the theory and practical sessions of the training course. Participants were given the opportunity to introduce their respective ongoing mutation breeding projects and express their interest in networking with PBGL for technical support and collaboration in characterization and advancing mutant lines with agronomically important mutant traits they have identified to facilitate their wider utilization in breeding

programmes through marker-assisted breeding. Most participants showed keen interest in joining a PBGL

Network Initiative for advancement of applied mutation breeding for food security and welfare in climate changing era. The participants expressed great satisfaction for the training course with a high rating (4.5/5) in the closing session on 19 May.

Participants carrying out DNA extraction for marker assisted selection in sorghum (top) and checking the suitable spike stage for doubled haploid production in wheat (bottom).

Group photo of the participants of the RAS/5/074 Training Course.

Individual Training Activities

During the first half of 2017, PBGL hosted 10 individual trainees in total, including seven fellows (F), two Visiting Scientists (VS) and one intern (I).

Name	Country	Status	Topic	Period
Mr N. Mheni	Tanzania, United Rep. of	F	Doubled haploid, *Striga* screening	2 months
Mr O. Hassan	Sudan	F	*Striga* screening	7 weeks
Mr N. Kabore	Burkina Faso	F	Mutation induction, marker-assisted selection	3 months
Mr A. Doubro Bombi	Central African Republic	F	Mutation induction, marker-assisted selection	3 months
Mr L.D. Sefume	Lesotho	F	Mutation induction bean, marker assisted selection	3 months
Ms M.S.M. Al Hinai	Oman	F	Doubled haploid, marker assisted selection	3 months
Mr L. Jarc	Slovenia	I	Mutation discovery, marker development	8 months
Mr P.M. Matova	Zimbabwe	SV	Induced mutations and supportive biotechnologies	2 weeks
Mr I.H.N. Bassole	Burkina Faso	SV	Induced mutations and supportive biotechnologies	2 weeks
Mr E.M. Elazazi	Qatar	SV	Induced mutations and supportive biotechnologies	2 weeks

F: Fellowship; SV: Scientific Visit

Visitors to the PBGL

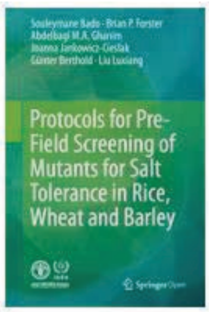
In the first half of 2017, the PBGL has welcomed visitor groups from different Member States including Australia, Guatemala, Malaysia, UK, Jordan, Dominican Republic, Ireland and The Netherlands. In addition, the PBGL provided guided tours and explanations on crop mutation breeding to participants of the International Conference on the IAEA Technical Cooperation Programme: Sixty years and Beyond – Contribution to Development, a delegation of National Liaison Officers from the Asia/Pacific Region, various IAEA internal visitors, a delegation from the RED countries as well as several companies and officials from other international organizations including FAO, Italy and ICARDA, Morocco.

Publications

Books

JANKOWICZ-CIESLAK, J., Th.H. TAI, J. KUMLEHN, B.J. TILL, (2016) Biotechnologies for Plant Mutation Breeding. Springer ISBN: ISBN 978-3-319-45019-3 (Print) 978-3-319-45021-6 (Online).

http://www.springer.com/book/9783319450193.



BADO, S., B.P. FORSTER, A.M.A. GHANIM, J. JANKOWICZ-CIESLAK, J. BERTHOLD, L. LUXIANG (2016) Protocols for Pre-Field Screening of Mutants for Salt Tolerance in Rice, Wheat and Barley. Springer ISBN: 978-3-319-26588-9 (Print) 978-3-319-26590-2 (Online).

http://rd.www.springer.com/book/10.1007%2F978-3-319-26590-2.

Peer-reviewed Book Chapters

JANKOWICZ-CIESLAK, J., MBA, C., TILL, J.B. (2016). Mutagenesis for Crop Breeding and Functional Genomics. Chapter 1 in: Biotechnologies for Plant Mutation Breeding. Jankowicz-Cieslak et al. (eds), Springer.

MAGHULY, F., BADO, S., JANKOWICZ-CIESLAK, J., LAIMER, M. (2016). Chemical and Physical Mutagenesis in Jatropha curcas. Chapter 2 in: Biotechnologies for Plant Mutation Breeding. Jankowicz-Cieslak et al. (eds), Springer.

JANKOWICZ-CIESLAK, J., TILL, B.J. (2016). Chemical Mutagenesis and Chimera Dissolution in Vegetatively Propagated Banana. Chapter 3 in: Biotechnologies for Plant Mutation Breeding. Jankowicz-Cieslak et al. (eds), Springer.

JOHNSON, S.D., TAYLOR, D.R., TAI, Th. H., JANKOWICZ-CIESLAK, J., TILL, B.J., JALLOH, A.B. (2016). Field Evaluation of Mutagenized Rice Material. Chapter 9 in: Biotechnologies for Plant Mutation Breeding. Jankowicz-Cieslak et al. (eds), Springer.

VOLLMANN, J., JANKOWICZ-CIESLAK, J. (2016). Utilising NIRS for Qualitative and Non-destructive Identification of Seed Mutants in Large Populations. Chapter 12 in: Biotechnologies for Plant Mutation Breeding. Jankowicz-Cieslak et al. (eds), Springer.

HUYNH, O.A., JANKOWICZ-CIESLAK, J., SARAYE, B., HOFINGER, B., TILL, B.J. (2016). Low-Cost Methods for DNA Extraction and Quantification. Chapter 14 in: Biotechnologies for Plant Mutation Breeding. Jankowicz-Cieslak et al. (eds), Springer.

HOFINGER, B.J., HUYNH, O.A., JANKOWICZ-CIESLAK, J., TILL, B.J. (2016). A Protocol for Benchtop Extraction of Single-Strand-Specific Nucleases for Mutation Discovery. Chapter 15 in: Biotechnologies for Plant Mutation Breeding. Jankowicz-Cieslak et al. (eds), Springer.

TILL, B.J., HOFINGER, B.J., SEN, A., HUYNH, O.A., JANKOWICZ-CIESLAK, J., GUGSA, L., KUMLEHN, J. (2016). A Protocol for Validation of Doubled Haploid Plants by Enzymatic Mismatch Cleavage. Chapter 16 in: Biotechnologies for Plant Mutation Breeding. Jankowicz-Cieslak et al. (eds), Springer.

JANKOWICZ-CIESLAK, J., B.J. TILL (2016). Forward and Reverse Genetics in Crop Breeding. Chapter 8 in: Advances in Plant Breeding Strategies Volume In: Breeding, Biotechnology and Molecular Tools. J.M. Al-Khayri et al. (eds.), Springer.

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

Peer-reviewed Journal Articles

KENZHEBAYEVA, S.S., DOKTYRBAY, G., CAPSTAFF, N.M., SARSU, F. Omirbekova, N.Zh. EILAM, T., TASHENEV, D.K., MILLER, A.J. (2017). Searching a spring wheat mutation resource for correlations between yield, grain size, and quality parameters, Journal of Crop Improvement, DOI: 10.1080/15427528.2016.1276990.

TOMLEKOVA, N.B., WHITE, P.J., THOMPSON, J.A., PENCHEV, E.A., NIELEN, S. (2017). Mutation increasing ß-carotene concentrations does not adversely affect concentrations of essential mineral elements in pepper fruit. PLOSONE, DOI: 10.1371/Journal.pone.0172180, pp. 1–9.

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.

BADO, S., RAFIRI, M.A., EL-ACHOURI, K., SAPEY, E., NIELEN, S., MUKTHAR, A.A., FORSTER, B.P., LAIMER, M. (2016). *In vitro* methods for mutation induction in potato (Solanum tuberosum L.). African Journal of Biotechnology. Vol. 15(39), pp. 2132-2145.

BADO, S., LAIMER, M., GUEYE, N., DEME, N.F., SAPEY, E., MUKTHAR, A.A., BLOK, V.C., FORSTER, B.P. (2016). Micro-Tuber Production in Diploid and Tetraploid Potato after Gamma Irradiation of in Vitro Cuttings for Mutation Induction. American Journal of Plant Sciences, 7, 1871-1887.

BADO, S., FORSTER, B.P., PADILLA-ALVAREZ, R., RESCH, C., MIGLIORI, A., DIAWARA, Y., JAKSIC, M., MUKTHAR, A.A., NIELEN, S., LAIMER, M. (2016). Prediction of Salt Tolerance in Rice (Oryza sativa) Based on Shoot Ion Content under Non-Stressed Conditions. Journal of Materials Science and Engineering A 6 (1-2) 1-16.

NANDKANGRE, H., OUEDRAOGO, M., SAWADOGO, M., BADO, S., SAWADOGO, N., OUOBA, A., KONATE, M.N. (2016). Morphometric and agronomic characterization of 56 ginger landraces in Burkina Faso. Journal of Applied Biosciences 100:9545 – 9556.

NANDKANGRE, H., OUEDRAOGO, M., NANEMA, R.K., BADO, S., OUEDRAOGO, N., SAWADOGO, M. (2016). Variability, Correlations, Heritability and Genetic Advance of Rhizome Yield and Yield Related Traits in Ginger (Zingiberofficinale Rosc.) Landraces from Burkina Faso. Journal of Applied Environmental and Biological Sciences 6(8)54-60.

OLASUPO, F.O., ILORI, C.O., FORSTER, B.P., BADO, S. (2016). Mutagenic Effects of Gamma Radiation on Eight Accessions of Cowpea (Vigna unguiculata [L.] Walp.). American Journal of Plant Sciences, 7, 339-351.

TOMLEKOVA, N. SOFKOVA-BOBCHEVA, S.Y., SARSU, F. AND BAUDIN, J.-P. (2016). Genetic diversity of Bulgarian Phaseolus vulgaris L. Based On phaseolin type and seed-coat colour. Bulgarian Journal of Agricultural Science, Agricultural Academy. 22 (No 3) 447–451.

TOMLEKOVA N., YANCHEVA S., SARSU F., CHUPOV A., PENCHEV E., MASHEVA S. (2016). Adaptation of HPLC analysis for quantification of main carotenes in tomato. Comptes rendus de l'Académie Bulgare des sciences, 69(7): 869–876.

MASHEVA, S., V. YANKOVA, D. MARKOVA, T.S. LAZAROVA, M. NAYDENOV, N. TOMLEKOVA, F. SARSU, T.S. DINCHEVABADO (2016). Use of Mocrobioagants to Reduce Soil Pathogens and Root-knot Nematodes in Greenhouse-grown Tomatoes. Bulgarian Journal of Agricultural Science 22(1): 91–97.

VELKOV, N., N. TOMLEKOVA, F. SARSU (2016). Sensitivity of Watermelon Variety Bojura to Mutant Agents 60Co and EMS. Journal of BioSci Biotech. 5:105–110.

JANKOWICZ-CIESLAK J., B.J. TILL. Chemical Mutagenesis of Seed and Vegetatively Propagated Plants using EMS. Current Protocols in Plant Biology (*in press*).

JHURREE-DUSSORUTH, B., J. JANKOWICZ-CIESLAK, B.J. TILL (2016). Genetic Diversity Study of Dessert-type Banana Accessions in Mauritius using Low-Cost SNPs Detection Technology Acta Horticultura 1114. ISHS 2016. DOI 10.17660/ActaHortic.2016.1114.6 XXIX IHC – Proc. Int. Symp. Banana: ISHS-ProMusa Symposium on Unravelling the Banana's Genomic Potential Eds.: I. Van den Bergh et al.

BESHIR M.M., P. OKORI, N.E. AHMED, P. RUBAIHAYO, A.A. MUKTHAR, S. KARIM (2016). Resistance to Anthracnose and Turcicum Leaf Blight in Sorghum under Dual Infection. Plant Breeding Blackwell Verlag GmbH doi:10.1111/pbr.12370.

BESHIR M.M., A.M. ALI, P. RUBAIHAYO, N.E. AHMED, P. OKORI (2016). Simple Sequence Repeat Markers Associated with Anthracnose and Turcicum Leaf Blight Resistance in Sorghum. African Crop Science Journal, Vol. 24, No.1, pp. 97–107, ISSN 1021-9730/2016 $4.00.

Referred Journals

BESHIR, M.M., A.M.A. GHANIM, P. RUBAIHAYO, N.A. AHMED, P. OKORI (2016). Simple sequence repeat markers associated with anthracnose and turcicum

leaf blight resistance in sorghum. African Crop Science Journal. Accepted for publication.

Conference Abstracts

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.

TILL, B.J., J. JANKOWICZ-CIESLAK, S. BADO, A. SOCHACKA, S. DATTA, A. DAVSON, C-P. CHAO, S-H. HUANG, A. VILJOEN (2016). A Pipeline for Generating Mutant Bananas Resistant to Fusarium Wilt TR4. Plant & Animal Genome Conference XXIV, 9–13 January 2016, San Diego, USA.

TILL, J.B. (2016). Mutation Discovery Technologies for Forward and Reverse-Genetics. International Conference on Plant Genetics & Breeding Technologies II, Vienna, Austria, 1–2 February 2016, Abstract Book pp.14.

DATTA, S., J. JANKOWICZ-CIESLAK, B.J. HOFINGER, S. BADO, S. NIELEN, I. HENRY, L. COMAI, B.J. TILL (2016). TILLING by Sequencing. International Conference on Plant Genetics & Breeding Technologies II, Vienna, Austria, 1–2 February 2016, Abstract Book pp.15.

HOFINGER, B.J., R. ELIAS, M. JAWHAR, A. ALBATERNI, A. SKIHEITA, Y. BAKRI, M.I.E. ARABI, N.M. ALI, B.J. TILL (2016). Ecotilling as A Low-Cost Screening Method for Gene Variations in the Plant Pathogenic Fungus Cochliobolus sativus. International Conference on Plant Genetics & Breeding Technologies II, Vienna, Austria, 1–2 February 2016, Abstract Book pp.27.

KAFURI, L., D. TELLO, S. DATTA, B.J. HOFINGER, H. CEBALLOS, B.J. TILL (2016). Ecotilling for Common and Rare Variants in Cassava by Pooled Amplicon Sequencing. International Conference on Plant Genetics & Breeding Technologies II, Vienna, Austria, 1–2 February 2016, Abstract Book pp.27.

GHANIM, A.M.A., N.S. MUSTAFA, N.M.K. OMER, S. BADO, F. SARSU, S. NIELEN (2016). Optimization of Doubled Haploid Production for Enhancing Efficiency of Wheat Mutation Breeding. International Conference on Plant Genetics & Breeding Technologies II, Vienna, Austria, 1–2 February 2016, Abstract Book pp.30.

Websites and Links

- Plant Breeding and Genetics Section:

  http://www-naweb.iaea.org/nafa/pbg/index.html

- InfoGraphic on Mutation Breeding:

  http://www-naweb.iaea.org/nafa/resources-nafa/Plant-Mutation-breeding.mp4

- Mutant Variety Database:

  http://mvd.iaea.org

- IAEA Plant Breeding and Genetics LinkedIn:

  http://at.linkedin.com/pub/iaea-plant-breeding-and-genetics/31/4b6/aa3

- 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/

Impressum

Plant Breeding and Genetics Newsletter No. 39

The Plant Breeding and Genetics Newsletter is prepared twice per year by the Plant Breeding and Genetics Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and FAO/IAEA Agriculture & Biotechnology Laboratories, Seibersdorf.

International Atomic Energy Agency
Vienna International Centre, PO Box 100, 1400 Vienna, Austria
Printed by the IAEA in Austria, July 2017

17-2353