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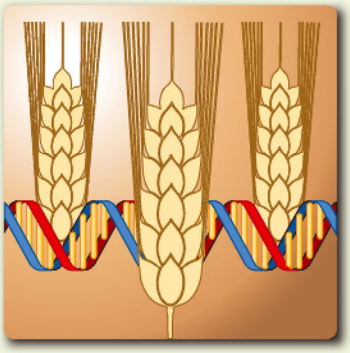

Contents

Barley mutant variety, UNA La Molina 95, at 5000 m altitude, Peru (for details please refer to TC Project Highlights).

To Our Readers

The Plant Breeding and Genetics (PBG) Section of the Joint FAO/IAEA Programme (NAFA/AGE) currently implements six coordinated research projects (CRPs), ranging from fundamental aspects of the effects of mutagens on the DNA sequence to the assessment of nutrient uptake from biofortified crops. I wish here to focus your attention on one of these CRPs, "Identification and Pyramiding of Mutated Genes: Novel Approaches for Improving Crop Tolerance to Salinity and Drought". The Second Research Coordination Meeting took place in Accra, Ghana, 6–10 November 2006 with Ms. Madeleine Spencer serving as the Scientific Secretary of the meeting.

Salinity is the most widespread soil problem in rice-growing countries. There are approximately 400 million ha of salt-affected land in the world, of which 56 million are found in South and Southeast Asia. It is estimated that 10 million ha are now being lost every year as a result of salinity and/or waterlogging. Drought is a condition of climatic dryness that is severe enough to reduce soil moisture and water below the minimum necessary for sustaining plant, animal, and human life systems. Drought affects water levels for use by industry, agriculture and individual consumers. Mutation induction has demonstrated its potential to develop salinity and drought tolerant crops.

IAEA
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Most countries in the tropics and subtropics have weather patterns and soil characteristics that constrain crop production over large tracts of land. Thus, a major challenge for making better use of these marginal lands is to select, improve and develop crop genotypes that can produce under conditions of high temperatures and low rainfall, or where soils suffer from drought, salinity or acidity or have been "mined" of nutrients. Significant opportunities exist for meeting this challenge by harnessing nuclear techniques in conjunction with newly emerging techniques in cellular and molecular biology.

One salient event this last semester was the successful launch of the Shijian–8 breeding satellite (SJBS) by China. Exposure of plant materials to space environment can cause mutagenic effects on plants and induce genetic variations. The most significant characteristics of the space environment include microgravity, weak geomagnetic field, supervacuum and strong cosmic radiation. Amongst the payload of SJBS were also rice samples provided by the Joint FAO/IAEA Programme. We started a tighter collaboration with the Institute of Crop Science (Space Breeding Center), Chinese Academy of Agricultural Sciences (CAAS), and will have a closer look at what is becoming known as "space breeding".

In this newsletter, we will share information on several national and regional training courses implemented in the framework of different Technical Cooperation (TC) projects. The final coordination meeting of the Interregional TC project, INT/5/147 on "Developing Salt-tolerant Crops for Sustainable Food and Feed Production in Saline Lands" was held in Vienna (27–30 November 2006) along with a Consultants Meeting in Sfax, Tunisia (18–22 December 2006), for the regional TC project: RAF/5/049 on "Field Evaluation of Bayoud-Resistant Date Palm Mutants".

Two important meetings are scheduled for next semester, one on the establishment and implementation of mutant multi-location trials and the establishment of a Mutation Germplasm Network (MGN) for crop improvement, and the second one on farmer participatory selection and evaluation of drought tolerant mutant crop varieties. Mutant varieties adapted to harsh environments will stay one of our focal points of interest. At "Forthcoming Events", you will find information about these and on three Research Coordination Meetings, as well as on the Seventh Interregional Training Course on "Mutant Germplasm Characterization Using Molecular Markers".

Another focus of our activities during this period will be mid-term reporting for the biennium 2006–2007. This exercise allows us to critically appraise our activities for the Member States, to spot weaknesses and to develop strategies and action plans to improve our work. We appreciate your input in this respect, and wish to express here our gratitude for the innumerable inputs we receive from you. In a related note, I would encourage all of you to tell us about your personal success stories, associated with mutation induction in general and especially linked to contacts with the Agency.

I would like to take this opportunity to congratulate our Peruvian colleague, Professor Luz Gomes Pando for receiving the 2006 Prize of Good Governmental Practices, as a recognition of the socio-economic impact of improved barley varieties through mutation induction using nuclear techniques (see also TC Project Highlights).

In closing, I would like to take the liberty of wishing all of you a peaceful new year and the very best in your future endeavours.

Pierre J.L. Lagoda

Staff

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Forthcoming Events

Final IAEA/RCA Project Progress Review Meeting on "Mutant Multi-location Trials and Mutation Enhancement of Genetic Diversity", RAS/5/040, Mumbai, India, 15–19 January 2007

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

The project was first approved in 2002 and is further extended to 2006, with two main objectives: the establishment and implementation of mutant multi-location trials in the participating countries, and the establishment of a Mutation Germplasm Network (MGN) for crop improvement, materials and information exchange in the region. The meeting will provide an opportunity to review the progress made in the individual participating research institutes and in the region as a whole. A summarizing report will be made available after the meeting.

The future trends of nuclear and related biotechnologies in crop improvement will be dicussed, particularly with reference to the technology development and crop production situation in the region. A booklet summarizing the achievements of the project will be finalized and published after the meeting.

This meeting was originally planned for December 2006.

Second Research Coordination Meeting on "Molecular Tools for Quality Improvement in Vegetatively Propagated Crops including Banana and Cassava", Thiruvananthapuram, Kerala, India, 5–9 February 2007

Technical Officer: C. Mba

Seventeen scientists from 13 countries (Bangladesh, Brazil, China, Cuba, Czech Republic, Ghana, India, Indonesia, Kenya, Mexico, Nigeria, Philippines, United Kingdom) and 2 International Organizations, the International Center for Tropical Agriculture (CIAT, its Spanish acronym), Cali, Colombia and the International Network for the Improvement of Banana and Plantains (INIBAP) of Bioversity, France are working together on this Coordinated Research Project (CRP). The main thrust of the activities include the development and characterization of induced mutants of both crops for critical quality traits; development of genomic tools; and the use of molecular genetic marker systems and proteomics to trawl through the genomes of these two crops in order to develop neutral molecular marker-based tools for enhancing efficiency in their genetic improvement. The discovery of the genes implicated in the critical steps of the expression of these quality traits also forms an important component of this CRP.

The CRP has begun its second year, with significant progress being made in the production of mutant populations, the development of genomics resources and in gene discovery assays. This RCM will avail the participants of the opportunity to present the status of ongoing activities to critical peer review, propose and agree on future workplans, and plan collaborative endeavors aimed at achieving the set objectives of the CRP.

Farmer/Researcher Participatory Meeting on "Selection and Evaluation of Drought Tolerant Mutant Crop Varieties", SAF/5/008, Mafikeng, South Africa, tentatively scheduled for 5–9 March 2007

Technical Officer: Y. Lokko

The meeting will be organized by the Agricultural Research Council (ARC), Roodeplaat Vegetable and Ornamental Plant Institute, Pretoria, South Africa, with the technical and financial assistance from the IAEA within the framework of SAF/5/008. It will bring together breeders, researchers and technicians, who are involved in the development of improved mutant varieties of staple vegetables and legumes, farmers extension officers and NGOs involved in production of the crops. The objective of this meeting is to involve farmers in development, evaluation and utilisation of mutant cowpea, bambara and amaranth varieties. Activities during the meeting will include field evaluation and identification of desirable mutants based on farmer desired characteristics, as well as palatability tests.

Seventh FAO/IAEA Interregional Training Course on "Mutant Germplasm Characterization Using Molecular Markers", Seibersdorf, Austria, 21 May–22 June 2007

Technical Officer: C. Mba

The Seventh FAO/IAEA Interregional Training Course on Mutant Germplasm Characterization Using Molecular Markers will be held at the IAEA Laboratories, Seibersdorf, Austria, from 21 May to 22 June 2007. Nominations from developing Member States will be received until 15 January 2007. Detailed information can be obtained from Mr. Chikelu Mba (e-mail c.mba@iaea.org).

Third Research Coordination Meeting on "Physical Mapping Technologies for the Identification and Characterization of Mutated Genes Contributing to Crop Quality", Cordoba, Argentina, 19–23 March 2007

Technical Officer: M. Miranda

Participants from the Coordinated Research Project (CRP) on "Physical Mapping Technologies for the Identification and Characterization of Mutated Genes Contributing to Crop Quality" from Argentina, Bulgaria, China, Czech Republic, Germany, Iceland, Pakistan, Poland, United Kingdom, United States and Vietnam are invited to attend the Third Research Coordination Meeting (RCM) in Cordoba, Argentina, 19-23 March 2007 to discuss the progress made during the first four years of this project.

Mutation induction technology is able to address the need for improving quality traits in crops, especially those crops grown by small farmers that are adapted to local environmental conditions and contribute to food security, health and agricultural sustainability. Quality products give the farmer a competitive market advantage and high added value, which will result in increased farm income, and public health is improved by access to a better quality diet that prevents malnutrition and nutrient deficiency.

Physical and molecular mapping can provide the scientific basis for the establishment of an effective approach to manipulate and characterize various crop quality characters, including the transfer of genes between varieties and species. This CRP addresses issues related to the use of advanced molecular and mutation technologies in crop improvement, and aims to accelerate the improvement of quality traits through the use of physical mapping and complementary genomic technologies for the characterization of natural diversity and induced mutants. Excellent results have been produced during the four first years of this CRP. Among the highlights are the advanced mutant lines of sweet pepper, cotton, rice and rapeseed, as well as fine-mapping of quality traits in rice and rye.

Third Research Coordination Meeting on "Effects of Mutagenic Agents on the DNA Sequence in Plants", tentatively scheduled for the second half of 2007

Technical Officer: P.J.L. Lagoda

Physical, chemical and biological mutagenic agents cause genes to mutate at rates above the spontaneous baseline, thus producing a range of novel traits and broadening the genetic diversity of plants. The use of induced mutants in breeding has had a profound impact on world agriculture and more than 2500 new crop varieties, all carrying novel induced variation, have now been officially registered (IAEA Mutant Variety Database). This has all been achieved largely in the absence of knowledge of the precise changes induced at the DNA level. Indeed, there still is very little understanding of the nature of the mutations induced by different mutagens. With the advent of molecular genetics and genomics, induced mutations are finding new applications in modern plant breeding. Reverse genetics and deletion library methodologies capable of discovering new genes and their modes of action are often underpinned by variation induced by both physical and chemical mutagens. However, the efficiency of these new methods will be enhanced only when the type, frequency and distribution of mutations in a range of crop species can be predicted, and ideally directed.

On the molecular level, ionizing radiation and other mutagenic agents cause damage to DNA in living organisms by various mechanisms. Ionizing radiation causes formation of free radicals from water in cells, and direct ionization and excitation of biological molecules. Radiation-induced damage to DNA results from reactions of thus-formed free radicals with DNA, and from direct ionization of DNA constituents. These two modes of effect are referred to as indirect effect and direct effect of ionizing radiation, respectively. Free radicals, most notably hydroxyl radical, react with DNA to produce a variety of damages, such as modification of the base and sugar moieties, single- and double-strand breaks, and DNA-protein cross-links. Ionization of DNA and surrounding water molecules leads to the ejection of an electron to cause formation of radical cations of DNA and water. There is evidence that electron-loss centres formed in water molecules tightly bind to DNA, and electrons from these water molecules can be transferred to DNA, causing DNA damage, which is not distinguishable from damage caused by direct ionization of DNA.

In fact, mutation appears to be a random and highly heterogeneous process, as revealed by the patterns emerging from our comparative genomic exercises, and as described elsewhere. Our intermediate results tend to confirm that nucleic acid structure indeed, may be important in this regard, as well as the nature of the mutagen. The preliminary results hint at links between the sequence and structure of nucleic acid sequences, and the mutation effect. We are currently testing if the rise of mutations is constrained by the structure of nucleic acids. In particular, one participant will focus on DNA sequences that code for RNA molecules which are evolving at a relatively fast pace. Examples include ribosomal RNA (rRNA) spacers and other non-coding RNA (ncRNA) molecules. Other participants focus on genome/transcriptome wide scans (fingerprinting/profiling) of induced polymorphisms *vs*. mutation trap assays. Others will compare different mutagens in the same genomic setting. The goal is to reveal mutation rates and patterns at a genome-wide scale using bioinformatic and genomic approaches.

Our preliminary data confirm that mutation rates vary considerably across genomes. Explanations for the observed heterogeneities are needed, if these preliminary results can be confirmed. For example, focussing on the structure of SINE elements present in *Brassica*, considerable diversity expressed at the RNA secondary structure levels were found. This could explain scales of mutational variation in repetitive DNA in plants.

Insertion and deletion (indel) events occur during induced mutagenesis. In plants, genomic rearrangements and transposable element activity are also fundamental processes that drive genomic evolution. Interestingly, both of these processes leave indel footprints in genomes. On this aspect, the phenomenon of microsyntenic patterns as evolutionary footprints of the genomic rearrangement process is being explored. The role of gene-interleaving patterns in the evolution of chromosomal rearrangement is being studied. The preliminary results suggest patterns in the evolution of genomic architecture.

Project Formulation Meeting of IAEA/RCA Project on "Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology", Malaysia, June 2007

Technical Officer: Q.Y. Shu

This new IAEA/RCA project will address the problems associated with the improvement of quality and stress tolerance in selected crops that contribute to food security, health, and agricultural sustainability, by mutation techniques and biotechnology, and will use MAS (marker-assisted selection) to accelerate crop quality and stress tolerance improvement. Assistance will be provided to participating RCA countries through technical trainings, expert service, and technology transfer and information sharing. The following will be the core components of the project:

1. enhancing genetic variability for quality and stress tolerance traits using mutation techniques;
2. investigating the genetic basis of quality traits and stress tolerance;
3. applying molecular markers techniques for manipulating or pyramiding crop quality and stress tolerance genes.

Based on the nominations of the RCA countries, a national coordinator will be assigned for this project to coordinate activities in each participating country. Implementation working plans will be developed during the project formulation meeting, which is tentatively planned for June 2007 in Malaysia.

Past Events

IAEA/RCA Regional Training Course on "Target-selected Mutagenesis in Plants", RAS/5/040, Hangzhou, China, 7–16 August 2006

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

Seventeen IAEA-supported trainees from 10 countries (Bangladesh, China, India, Indonesia, Korea, Mongolia, Pakistan, Sri Lanka, Thailand and Vietnam) participated in the RTC. Another four local research scientists also took part in the first week's program. In addition to IAEA recruited lecturers, eight local experts lectured on various subjects for the RTC, including Dr. Shi-Hua Cheng, Director General of China National Rice Research Institute, Dr. Lu-Xiang Liu, Chinese Academy of Agricultural Science (CAAS), Beijing, Dr. Guo-Zheng Liu, Beijing Genomic Research Institute, Chinese Academy of Science. The training course covered a wide range of subjects from research and breeding frontiers in crop improvement, i.e., space-induced mutations for crop improvement, Chinese super-rice breeding, the improvement of functional components in rice, to up-to-date knowledge and technologies, such as gene regulation and functional genomics, gene chips and gene cloning techniques. These lectures were integrated into the main subject of the RTC, that is, target-selected mutagenesis and their application in plant improvement. Lectures and practical exercises were especially arranged for the TILLING technology and its application in functional genomics and plant breeding.

The executive dean of College of Agriculture and Biotechnology (CAB), Zhejiang University, Professor Dr. Guo-Ping Zhang, together with the reporter, opened the above-mentioned RTC. Professor Zi-Yuan Chen, Academician of the Chinese Academy of Science, and Professor Bu-Jin Xu, Chairman of Chinese Association of Atomic Energy Application for Agriculture attended the opening ceremony.

Prof. Dr. Ziqiang Wang of CAB, ZJU served as the course director.

IAEA National Training Course on "Techniques and Strategies for Rice Quality and Nutrition Improvement", Ho Chi Minh City, Vietnam, 7–12 August 2006

Technical Officer: Q.Y. Shu

The training course was organized by the Institute of Agricultural Sciences for Southern Vietnam, with technical and financial assistance from the IAEA within the framework of VIE/5/015. Twenty six young researchers from 21 organizations (eight research institutes/centres; nine provincial departments of agriculture & rural development and two colleges) participated in this training course.

The course started with a two-day lecture on:

1. rice quality standards in major rice producing countries;
2. various methods for rice quality evaluation;
3. breeding methods and strategies for selection of high quality and aromatic rice, as well as enhancement of micronutrients such as high content Fe, Zn, vitamins etc.
4. rice improvement using mutation techniques and its achievement in Vietnam and other countries.

The course was followed by a three-day pratical laboratory training session. It covered methods for evaluation of:

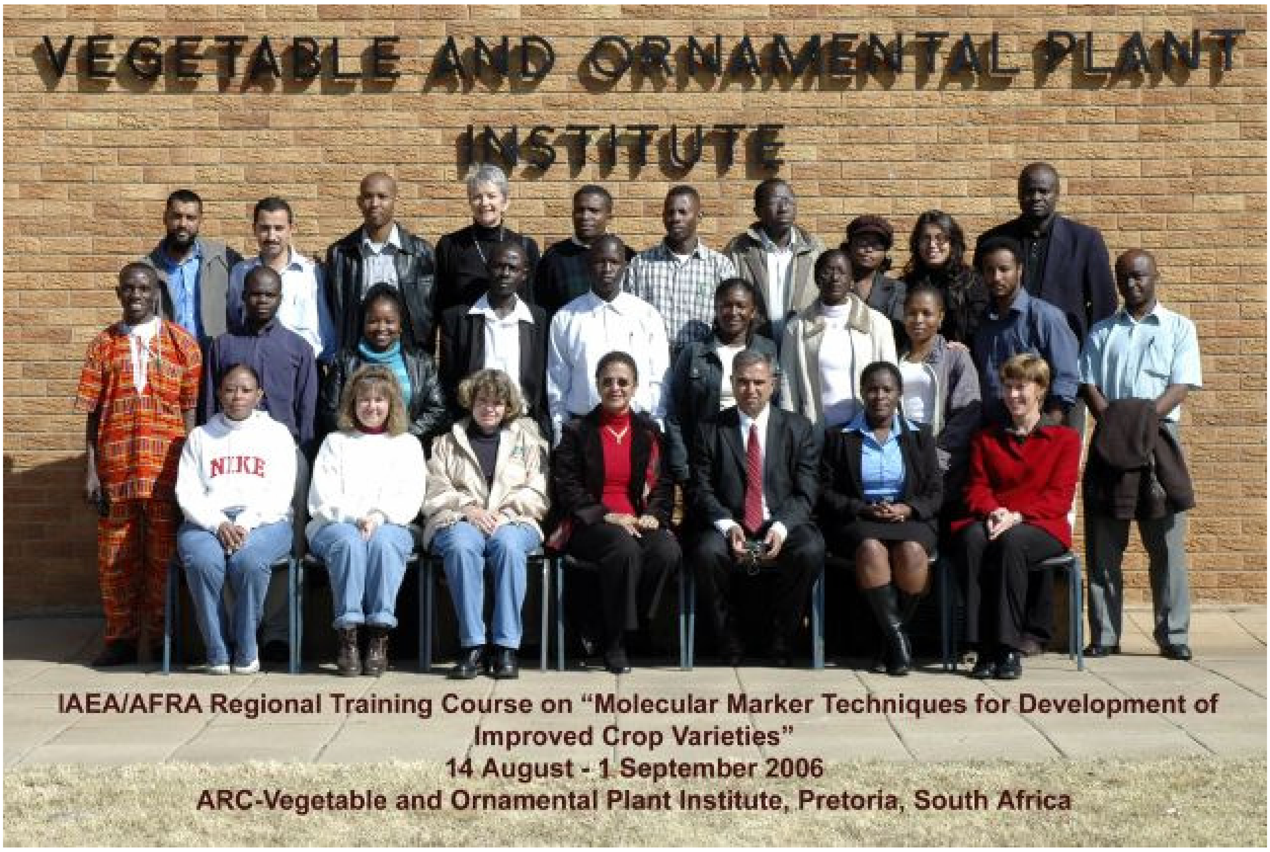
1. low phytic acid trait;
2. milling quality;
3. apparent quality, such as grain size, translucence, chalkiness, color;
4. cooking quality (aromatic, softness, waxiness, whiteness, alkali digestion);
5. nutrient quality (protein content and taste quality, such as amylose content).

IAEA/AFRA Regional Training Course on "Molecular Marker Techniques for Development of Improved Crop Varieties", RAF/5/050, Roodeplaat, South Africa, 14 August – 1 September 2006

Technical Officer: M. Spencer

This training course, which is part of the work plan for RAF/5/050 aimed to give young scientists an opportunity to learn about molecular markers applications in mutation induction breeding programmes. Tweenty-one participants from Cameroon, Egypt, Ethiopia, Ghana, Kenya, Madagascar, Mauritius, South Africa, Senegal, Sierra Leone, Tunisia, Uganda, Democratic Republic of the Congo, Zambia, and Zimbabwe attended the course and expressed their genuine enthusiasm for the quality of the lectures and workshops, as well as for the perfect organisation by the South African research team.

A series of lectures on Mutation induction, Molecular markers, *in vitro* techniques, and computational analysis were presented. The participants had the opportunity to conduct basic experiments in plant tissue culture and molecular techniques and also to discuss the applicability of these techniques to their own programmes by drafting a proposal based on their own crop, using relevant knowledge gained from the course.



National Consultant Meeting on "Development of Curriculum for Induced Mutation in Crop Improvement", RAF/0/023, Vienna, Austria, 4–8 September 2006

Technical Officers: Q.Y. Shu

Dr. Reuben M. Muasya, Dean, School of Agriculture and Biotechnology and Dr Oliver K. Kiplagat, Head, Department of Biotechnology, Moi University, Kenya, held a consultation meeting with colleagues of the Plant Breeding and Genetics Section of the Joint FAO/IAEA Programme and the Plant Breeding Unit of the Agricultural Biotechnology Laboratories of the Agency. They also visited the Institute of Plant Production Biotechnology in Tulln.

With assistance from the Agency's staff, a curriculum for an M. Phil degree in induced mutations and biotechnology was developed, to be used at Moi University.

Second Research Coordination Meeting on "Identification and Pyramiding of Mutated Genes: Novel Approaches for Improving Crop Tolerance to Salinity and Drought", Accra, Ghana, 6–10 November 2006

Technical Officer: M. Spencer

20 participants from countries as diverse as China, Cuba, Egypt, Ghana, India, Indonesia, Israel, Italy, Pakistan, Thailand, Tunisia, Turkey, United States of America, Vietnam and from an international organization, International Rice Research Institute (IRRI), Manila, Philippines, attended this RCM. These participants have been working for two years on identifying and selecting promising mutant lines through induced mutation and *in vitro* techniques with tolerance to drought and/or salinity. Several advanced mutant lines (M4 to M7) of different varieties, including Soybean, Rice, Chickpea, Wheat, and Arabidopsis are being tested and characterised for toler-

ance to drought and/or salinity. Several molecular markers and genomic regions associated with salinity and/or drought tolerance were also identified:

- 9 QTL for partial gene Gmsk1in Soybean
- 5 SSR and 5 AFLP markers linked to known drought tolerance genes in Rice
- 1 gene: 2 Oxoglutarate-dependent dioxigenase involved in oxidative stress response in Arabidopsis
- Gene *osBADH* from Indica Rice variety has been identified in local genotype; the registration process in the gene bank has been initiated.

Final Coordination Meeting on "Developing Salt-Tolerant Crops for Sustainable Food and Feed Production in Saline Lands", Interregional Project INT/5/147, Vienna, Austria, 27–30 November 2006

Technical Officer: M. Spencer

This meeting was attended by eight participants from Costa Rica, China, Guatemala, Iran, Pakistan, Thailand, Tunisia, and Vietnam. During the meeting the participants highlighted the achievements of the project at the level of each country and emphasized the signaficant improvement gained through interregional exchanges, such as scientific visits and exchange of screening protocols for salinity tolerance (Pakistan, China, Guatemala, Vietnam and Cuba).

Status of Coordinated Research Projects

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

Technical Officer: M. Miranda

This CRP was initiated in 2002. The second RCM was held in Reykjavik, Iceland, 22–26 August 2005. The third RCM is planned to take place in Cordoba, Argentina in 2007.

(For details, please refer to FORTHCOMING EVENTS)

Effects of Mutagenic Agents on the DNA Sequence in Plants

Technical Officer: P.J.L. Lagoda

This CRP was initiated in 2003. The first RCM was held in Vienna on 1–5 March 2004. The second RCM was held in Seoul, Republic of Korea, 14–18 November 2005.

The third RCM is tentatively planned for April 2007 in Turkey.

(For details, please refer to FORTHCOMING EVENTS)

Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality

Technical Officer: Q.Y. Shu

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 13–17 September 2004. The second RCM was held in Nanjing, China, 10–14 April 2006.

The third RCM is tentatively planned for October 2007 in Perth, Australia.

Identification and Pyramiding of Mutated Genes: Novel Approaches for Improving Crop Tolerance to Salinity and Drought

Technical Officer: M. Spencer

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 14–18 March 2005. The second RCM was held in Accra, Ghana, 6–10 November 2006.

(For details, please refer to PAST EVENTS)

Molecular Tools for Quality Improvement in Vegetatively Propagated Crops Including Banana and Cassava

Technical Officer: C. Mba

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 18–22 July 2005.

The second RCM is planned to take place in Thiruvananthapuram, Kerala, India, 5–9 February 2007.

(For details, please refer to FORTHCOMING EVENTS)

Assessment of Nutrient Uptake from Biofortified Crops in Populations from Developing Countries

Technical Officers: T.P. Trinidad and P.J.L. Lagoda

This CRP was initiated in 2005. The first RCM was held in Vienna, Austria, 17–19 May 2006.

The second and last RCM is tentatively planned for the end of 2008.

Technical Cooperation Projects

Currently Active Projects

Project Number	Title	Technical Officer
COS/5/025	Development of Induced Mutations and Biotechnology for Improved Productivity and Competitiveness	M. Miranda, M. Spencer
GHA/5/032	Enhancing Production and Use of Cassava	M. Spencer, Y. Lokko
INS/5/030	Sustainable Agricultural Development in Yogyakarta	M. Spencer
INS/5/031	Mutation Breeding of Horticultural Crops	M. Spencer, M. Miranda
INT/5/147	Developing Salt-tolerant Crops for Sustainable Food and Feed Production in Saline Lands	M. Spencer, M. Miranda
IRQ/5/015	Induction of Mutations in Crops through *In Vitro* Culture	P.J.L. Lagoda
KEN/5/024	Crop Improvement and Management through Application of Nuclear and Biotechnology Techniques	Y. Lokko, Q.Y. Shu
MYA/0/007	Nuclear Science and Technology Training Centre (currently a Human Development Project)	Q.Y. Shu
MYA/5/010	Development of Improved Rice with Tolerance to Drought and Soil Salinity	Q.Y. Shu
NIR/5/031	Radiation-Induced Mutations for the Development of Cowpea Varieties	P.J.L. Lagoda
PAK/5/040	Improvement of Heat-Tolerant Semi-Dwarf Bread Wheat through Radiation Induced Mutations	P.J.L. Lagoda
PAK/5/042	Induced Mutation to Improve Salt-tolerance in Non-aromatic Rice Varieties	Q.Y. Shu
PAK/5/044	Improvement of Drought Tolerance in Chickpea through Induced Mutations	M. Spencer
PER/5/028	Use of Nuclear Techniques to Improve Cotton Production	Y. Lokko
PHI/5/029	Enhancing Agricultural Productivity through Radiation Technology in Mindanao	M. Spencer, Y. Lokko
RAF/5/049	Field Evaluation of Bayoud-Resistant Date Palm Mutants	M. Spencer
RAF/5/050	Increasing Production of Nutritious Food through Mutation Breeding and Biotechnology (AFRA III-3)	M. Spencer, Q.Y. Shu
RAS/7/014	Monitoring of Food Fortification Programmes Using Nuclear Techniques	P.J.L. Lagoda
RAS/5/040	Enhancement of Genetic Diversity in Food, Pulses and Oil Crops and Establishment of Mutant Germplasm Network (RCA)	Q.Y. Shu, Y. Lokko
SAF/5/008	Mutant Amaranth, Bambara Groundnut and Cowpea with Enhanced Abiotic Stress Tolerance	Y. Lokko
SIL/5/007	Development of High-yielding Rice Varieties for Low-input Agriculture Systems using Mutation Techniques	Q.Y. Shu, Y. Lokko
SUD/5/026	Improvement of the Productivity and Sustainability of Industrial Crops	Q.Y. Shu
TUN/5/023	Radiation-Induced Mutations for Improvement of Cactus	M. Miranda
TUR/5/023	Application of Nuclear and Gene-Based Biotechnology in Agriculture	M. Miranda
TUR/5/024	Improving Crop Productivity through Radiation Technology	Q.Y. Shu

Project Number	Title	Technical Officer
URT/5/023	Enhancing Crop Productivity through Radiation Technology	M. Miranda, Q.Y. Shu
VIE/5/015	Enhancement of Quality and Yield of Rice Mutants using Nuclear and Related Techniques, Phase II	Q.Y. Shu
YEM/5/007	Use of Induced Mutations and *In Vitro* Culture for Improving Crops	P.J.L. Lagoda
ZAI/6/009	Mutation Techniques for Improving Medicinal Plants with a Curative Effect on Human Diseases	M. Miranda, M. Spencer
ZAM/5/022	Crop Improvement through *In Vitro* Mutation Technique	Q.Y. Shu

TC Project Highlights

The impact of mutant varieties in the Andes is recognized by the Peruvian Government

Barley is an important component of food security for the three million people living off of subsistence agriculture in the Peruvian Andes. Planted in areas above 3,000 m, where harsh and extreme climatic conditions make this environment inhospitable to many crops, barley is often the only source of nutrients locally available to the Andean population.

Through an effort initiated by the late Mr. Marino Romero in the 1970s, and now led by his wife Prof. Luz Gomes Pando, at the Universidad Nacional Agraria La Molina, the IAEA and the Peruvian Backus Foundation have supported the development of nine improved varieties of barley that were produced through mutation induction using nuclear techniques. These mutant varieties now cover 90% of the barley producing area in Peru.

Since gaining access to improved mutant seeds of barley, the Andean population has been experiencing not only a sustainable improvement in food security, but also a steadily increasing income originating from the sale of the production surplus. In recognition for the socio-economic impact of the improved barley mutant varieties, the Peruvian government has awarded the 2006 Prize of "Good Governmental Practices" to Prof. Gomes Pando.

Starting in 2007, a new IAEA Technical Cooperation Project led by Prof. Gomes Pando will aim at producing new improved varieties of the native crops quinoa and kiwicha through mutation induction, as well as increasing the area planted with mutant varieties of barley and kiwicha that have been released in 2006. This new mutant variety of barley has the potential to produce 5,500Kg/ha, representing a six-fold increase in productivity of the original barley variety grown in 1978. This project is expected to further improve the livelihood of the Andean population through a sustainable increase in food security and reduction of rural poverty. Through our technical support and cooperation, we, at the Joint FAO/IAEA Programme, are looking forward to Prof. Gomes Pando's next success story.

The 2006 National Peruvian Prize of "Good Governmental Practices" was awarded to Prof. Gomes Pando for the impact of her work on the barley mutant varieties in the Andean region.

Photo: Courtesy of Prof. Gomes Pando

Ongoing Activities at the Plant Breeding Unit, Seibersdorf

Introduction

The Plant Breeding Unit (PBU), one of the five component Units of the FAO/IAEA Agriculture and Biotechnology Laboratory (ABL), Agency's Laboratories, Vienna and Seibersdorf, works with the Plant Breeding and Genetics Section of the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture to support capacity in Member States for the use of induced crop mutagenesis in producing superior crop varieties. This support is provided under the genetic resources components of the Sustainable Intensification of Crop Production Systems subprogramme. The PBU has responsibility for the laboratory components of these activities that include carrying out research and development activities (R&D), and the provision of services and training.

An overview of the current R&D activities using the platforms of three crops, rice, banana and cassava; the human capacity development activities for developing Member States and services carried out in support of these activities in Member States during the period under review are presented in the following sections.

Research and development

In accordance with the mandate of developing and deploying technologies that enhance the ability of developing Member States to integrate induced mutagenesis into crop improvement programmes, which address specific national and regional needs, the PBU has been traditionally sought to enhance the level of efficiency in the production, detection and deployment of crop mutants. By using three crops: rice, banana and cassava, with differing biological systems and production constraints, this aim (of enhanced efficiency) is pursued in tandem with developing rice variants with elevated tolerance to abiotic stresses (especially salinity); banana with tolerance to biotic stresses (especially black sigatoka disease, with the causative agent, *Mycosphaerela fijiensis*); and cassava with added value in terms of modified starch characteristics to suit industrial needs and possession of better nutritional qualities.

The thrust of the Unit's activities has traditionally involved the combined use of *in vitro* techniques (for the rapid multiplication of putative mutants; achievement of homozygousity; and the production of homohistont plants) and molecular genetic methodologies (that permit the querying of the genome *in lieu* of elaborate morphological assays) for increasing the efficiency of the production and detection of desirable mutants.

With the increasing tendency towards the focussing of efforts on the use of above traits in these three crops to develop and deploy efficient methodologies for induced crop mutagenesis, reverse genetics has become an important integral part of the Unit's activities. The strategy is to assay the putative mutants for mutation events in target genes that are known to be implicated in the expression of the desired traits, once DNA can be extracted. A novel reverse genetics platform that is adapted to high throughput assays on account of the pooling of samples, Targeting Induced Local Lesions in Genomes (TILLING), permits the identification of (induced) single nucleotide polymorphisms. The method that is being used in the laboratory relies on the selective cleavage of mismatches in heteroduplexes.

Services

The services provided by the Unit in support of activities in Member States for the period May to December 2006 are summarized below:

Irradiation

Number of requests	11
Number of species	10
Number of varieties	111
Number of treatments	254
Number of requesting Member States	10

Research collaboration with International Ogranizations and National Agriculture Research Institutes

Collaborations with National Agricultural Research Systems (NARS) and Centres of the Consultative Group for International Agricultural Research (CGIAR) continue to form the core of our activities in the Unit. For rice, we actively collaborate with the International Rice Research Institute (IRRI), Manila, the Philippines, while for banana, collaborations with NARS and advanced laboratories are fostered under the auspices of Promusa, a global network coordinated by the International Network for the Improvement of Banana and Plantains (INIBAP) of Bioversity International, Montpellier, France. Collaborations on cassava R&D are with NARS and the two CGIAR centres with mandates for this crop, the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria and the International Centre for Tropical Agriculture (CIAT, its Spanish acronym), Cali, Colombia.

During the period under review, highlights of these collaborative endeavours have involved the production of putative mutants in the Unit and shipping them to collaborators for evaluation for suitability for eventual use as genetic stocks for crop improvement programmes and/or genomics resources for gene discovery studies. Putative mutants developed in this endeavour and their test sites are summarised below:

Crop	Subject Area
Cassava	• IITA, Ibadan, Nigeria • National Root Crops Research Institute (NRCRI) • Umudike, Nigeria
Potato	• National Plant Breeding Research Centre (NPBRC) Kenya • Agricultural Research Institute (KARI), Njoro, Kenya
Rice	• National Agricultural Research Coordinating Council • (NARCC), Rice Research Station, Rokupr, Sierra Leone

Travel

As part of the collaborative activities, the Unit Head, Mr. Chikelu Mba traveled to CIAT, Cali, Colombia and IITA, Ibadan, Nigeria, where induced cassava and rice mutants are being evaluated in order to establish additional linkages.

Visitors to the Unit

The Unit regularly hosts scientists from Member States for varying purposes, ranging from brief facilities tours and exposition of activities of less than a day to structured scientific visits of about one week, to fellowships ranging from three months to one year.

Visiting Scientists

Name	Subject Area	Period
Abdul Jabbar KHAN Principal Scientist, NIFA Peshawar, Pakistan	• Induced mutations for crop improvement (Chickpea & Wheat) • molecular markers for mutants' characterization • collaboration for germplasm exchange of particular interest • screening techniques for drought & salinity tolerance • establishment of molecular biology lab	25 September to 6 October 2006

Consultant

The following consultant worked with us on a short-term basis during the period under review:

Name	Purpose	Period
Mr. Matthias STEINBERG PARTEC, Germany	Current trends in the use of flow cytometry for cytomics and cell analysis	15 to 16 Nobember 2006

Fellows/Cost-Free Interns

Name	Country	Area of Training	Period
Mr. Masoud RAHIMI	Iran	Induced mutation and related biotechnologies in rice improvement	1 April to 31 July 2006
Mr. Tet Htut SOE	Myanmar	Induced mutation in seed propagated crops and application of molecular marker techniques for germplasm and mutant characterization	1 May to 30 September 2006
Ms. Nay Chi WIN	Myanmar	Induced mutation in seed propagated crops and application of molecular marker techniques for germplasm and mutant characterization	1 May to 31 September 2006
Ms. Omowunmi OWOSENI	Nigeria	Induced mutation in crop improvement, *in vitro* techniques in combination with mutation induction for crop improvement with special emphasis on cassava, application of molecular genetic markers for germplasm characterization	1 April to 30 August 2006
Ms. Ria GREYLING	South Africa	Induced mutation in seed propagated crops, screening techniques for salt tolerant and phenotypic characterization based on seeds sizes and shape	1 to 31 July 2006
Ms. Pham Ngoc Nga DON	Vietnam	Induced mutation in seed propagated crops, application of molecular genetic markers for germplasm characterization and mutants identification, screening techniques for salt tolerant and phenotypic characterization based on seeds sizes and shape	14 August to 13 November 2006
Mr. Aminu A. ZARIA	Nigeria	Induced mutations in seed propagated crop, e.g. cowpea improvement, molecular markers for germplasm characterization, hands on experience with measuring the ploidy levels of plant species using the Flow Cytometer	13 November 2006 to 13 March 2007

Announcements

Joint FAO/IAEA Programme announces an International Symposium on "Induced Mutations in Higher Plants" International Atomic Energy Agency, Vienna, Austria, 12-14 August 2008

The application of gamma rays and other physical and chemical mutagens to plant breeding in the past 70 years has increased crop biodiversity and productivity in different parts of the world. The number of officially released crop mutant varieties has already exceeded 2350. A large number of these varieties are food crops released in developing countries. This has resulted in the widespread use of these mutants in plant breeding programs throughout the world and has brought about an enormous economic impact, e.g. in barley, sunflower, soybean, rice and many other crops.

"International Symposium on Induced Mutations in Higher Plants" (ISIM) will be the eighth in the Joint Programme's symposium series dedicated exclusively to harnessing and disseminating information on current trends in induced mutagenesis in higher plants with the first and last symposia held in 1969 and 1995, respectively. The previous symposia have dealt with themes relating to the development of efficient protocols for induced mutagenesis and its role in the enhancement of quality traits as well as resistance biotic and abiotic stresses in crops and the integration of *in vitro* and molecular genetic techniques in mutation induction.

Since the last symposium in 1995, there has been an increase in interest within the scientific community, not only in the use of induced mutations for developing improved crop varieties and for the discovery of genes controlling important traits and understanding their functions and mechanisms of actions, but also in deciphering the biological nature of DNA damage, repair and mutagenesis. A symposium that brings together the key players in basic research and in the development and application of technologies relating to the efficient use of induced mutations for crop improvement and empirical genetic studies is therefore warranted.

It is envisaged that this proposed symposium will not only attract eminent basic research scientists, but also active plant breeders from all over the world. Therefore, the Symposium will not only provide the platform for the exposition and rigorous discourse on current research and technology development in this field, but will also establish working linkages between molecular geneticists and plant breeders to develop knowledge-based breeding strategies. It could also be a venue for project managers of international and national organizations as well as multinational and private companies supporting or interested in plant breeding projects to review the potential and trends of mutation techniques for decision-making.

Topics to be addressed by the Symposium:

- DNA damage, repair and mutagenesis
- Mutational analysis of important crop characters (tolerance to abiotic stresses, resistance to diseases and insects, quality and nutritional characters, etc.)
- Novel induced mutations for crop improvement
- Induced mutations in crop breeding programs: integration with molecular, bio- and other relevant technologies
- Mutation induction, targeted selection and mutated genes in functional genomics
- Economic impact of widespread mutant varieties.

Publications

Introduction of A Xantha Mutation for Testing and Increasing Varietal Purity in Hybrid Rice

Xiang-sheng Zhou, Sheng-quan Shen, Dian-xing Wu, Jun-wei Sun and Qing-yao Shu

Field Crops Research, 96, 71-76.

Abstract

A xantha mutant (yellow plant) was induced by gamma rays irradiation of a cytoplasmic male sterile (CMS) maintainer line II32 B of rice (*Oryza sativa* L.). It was identified earlier as a low gelatinization temperature mutant and named as Mgt-1. Through a series of backcrosses of Mgt-1 to CMS line II32 A, a new CMS line was developed and named as Huangyu A (B). Genetic analysis showed that the xantha mutation was controlled by a single recessive locus, and all F1 plants from crosses of Huangyu A (B) with other normal green varieties showed normal green leaves. The xantha mutation resulted in reduction of photosynthetic pigments content at various levels, e.g., 48% of chlorophyll a (Chl a), 71% of chlorophyll b (Chl b), and 30% of carotenoids (Car), and consequently increased the ratios of Chl a/Chl b and Car/Chl in Huangyu A (B) against II32 A (B). Unexpectedly, Huangyu A (B) had higher photosynthetic rates in comparison with II32 A (B), and so did the F1 plants of Huangyu A / R3027 as against those of II32 A / R3027. Huangyu A had similar male sterility completeness and stability as II32 A, but the former showed significantly better combining ability than the latter. The yellow color made the seedlings and plants of Huangyu A (B) visually distinguishable from the green ones and thus it was a very distinct marker applicable for rapid testing and efficient increasing varietal purity in seed and paddy production of hybrid rice.

(2006)

Molecular and Biochemical Analysis of the Gelatinization Temperature Character in Rice (*Oryza sativa* L.)

Xiao-li Shu, Sheng-quan Shen, Jinsong Bao, Dian-xing Wu, Yasunori Nakamura and Qing-yao Shu

J. Cereal Sci., 44(1): 40-48.

Abstract

Through integrated molecular and biochemical investigations and by using a common mutant line in molecular mapping, our present study proved that the SSIIa gene, previously reported to be responsible for the gelatinization temperature (GT) differences between indica and japonica rice varieties, might also control the GT variations among certain indica varieties, through synthesizing different types of amylopectin molecules due to the differences of SSIIa protein amounts bound to starch granules. Our study further demonstrated, for the first time, that the amylopectin type could only account for the GT differences between varieties with different SSIIa alleles, but not among varieties carrying a common SSIIa allele. In the latter case, another gene, alk2(t), with a genetic distance of 3.93 cM from the Wx gene, was identified out to be responsible for the GT variations. Based on the thermal properties and amylopectin chain length profile characteristics, it is postulated that the SSIIa gene has at least three different alleles, one in japonica rice and two in indica rice varieties, while the alk2(t) has at least two alleles for either low or high GT, and the rich diversity of the GT character is very probably resulting from various combinations of these gene alleles in rice.

(2006)

BOOK REVIEW

Flower Breeding and Genetics: Issues, Challenges and Opportunities for the 21st Century

Edited by Neil O. Anderson. Springer, Dordrecht, The Netherlands. 822 pages.

http://www.springer.com/east/home/life+sci/plant+sciences?SGWID=5-10038-22-142115571-0

Summary

Flowers are essential crops which beautify interiorscapes, outdoor landscapes and enhance human health. Floriculture is one of the fastest-growing sectors of commercial agriculture world-wide with many highly profitable crops. Such a diversity of new and domesticated flower crops is created by public and private sector flower breeders. This book provides a unique and valuable resource on the many issues and challenges facing flower breeders, as well as plant breeders at-large. In these volumes, the first comprehensive assemblage of its kind, a team of 32 international authorities has contributed to making this book a ‘must-have’ reference for researching and developing flower crops for the 21st century consumers. Part 1 of this book (flower breeding program issues) contains unique features of interest to horticultural professionals and students, including coverage of plant protection strategies, cultivar trialing methodology, germplasm collection/preservation, preventing invasiveness, and other timely topics. The collective body of knowledge for 24 flower crops (Part 2; crop-specific breeding and genetics) represents the in-depth science and art of breeding technology available for bedding plants, flowering potted plants, cut flowers, and herbaceous perennials. Each author provides crop-specific history, evolution, biology, taxonomy, state-of-the-art breeding/genetics,

classical/molecular technologies, species traits, interspecific hybridization, and directions for future development/enhancement.

Of particular interest to all plant breeders is the chapter on Protection (by Penny Aguirre) which covers all forms of plant protection for seed and vegetative crops worldwide. A chapter on the factors controlling flowering (John Erwin) provides new and vital information which can be used during plant collection, breeding, selection, and domestication. The issue of invasiveness (Anderson), a priori prevention before market release, provides specific traits causing invasiveness which breeders can eliminate during domestication, and other topics are also valuable for all private and public sector plant breeding programs.

Numerous chapters on crop-specific breeding concern the use and applicability of mutation breeding for crop improvement. Drs. Jvoslef-Eide and Munster, authors of the Begonia (Chapter 9) contribution, note that mutation breeding has been an important means of creating sport families of specific hybrid seedlings with commercial potential. The techniques commonly used include irradiation of detached leaf sections and adventitious buds with 1,5-2,5 kR. More than 25 Begonia mutants are currently contained in the FAO/IAEA database as a result of mutation breeding. Dr. Boyle authors the Cacti section (Chapter 13), discussing the extensive use of mutation breeding in the Cactaceae, particularly Hatioria and Schlumbergera. Optimal doses of gamma rays have resulted in new mutants with new flower coloration, increased branching, and dwarf plant growth. Boyle also points out the pros and cons of mutation breeding in these genera which are vegetatively propagated, self-incompatible, and highly heterozygous. Mutation breeding is extensively covered in other flowering crops such as Chrysanthemum (Chapter 14), Exacum (Chapter 22), Tulipa (Chapter 23), Rosa (Chapter 26), and Clematis (Chapter 29).

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IMPORTANT!

AUTHOR'S GUIDELINES FOR MANUSCRIPT SUBMISSION TO PLANT MUTATION REPORTS

Articles will be indexed and abstracted in CABI beginning with our next issue!

Scope

Plant Mutation Reports (PMRs) publishes (mini) reviews, short communications and complete research papers in all areas of plant mutation research which focuses on mutagenesis, mutation induction, mutant characterization, and mutant applications. It also publishes description papers on mutant germplasm and mutant varieties. Papers on social-economic impact analysis of induced mutations and mutant varieties are also accepted.

Style

The manuscript should be concisely written with the following sections:

Title page

- Title: the title should be as short as possible, but should contain adequate information regarding the contents.
- Authors: Initials of given name followed by full family name.
- Affiliation(s)/Address(es):
- Email address: the corresponding author's email address should be given.

Abstract and Keywords

A brief and informative summary of the paper not exceeding 150 words. Optional for short communications. Each paper should have 3-5 keywords.

Main text

- Review articles may be organized according to their specific requirements.
- Research articles should include: Introduction, Materials and Methods, Results (and) Discussion (this could be combined for Short communications).
- New mutant germplasm should include a short description of initial material used and the mutagen and doses applied; selection process; mutated characteristics and its genetic and agronomic analysis. Description of mutant variety should, in addition, include its performance in yield trials for varietal release and the releasing committee, when applicable.

Acknowledgements

- Acknowledgements of grants, support etc, should follow the text and precede the references.

References

The literature references should be cited either as John (1990) for single author paper, John and Johnson (2000) for papers with two authors, or John et al. (2000) for papers with more than two authors throughout the text, and alphabetically listed in the Reference following the style shown below:

- Periodicals: Shamsuzzaman K.M. and Shaikh M.A.Q. (1991) Early maturing and high seed yielding chickpea mutant. Mut Breed Newslett 37: 4-5.
- Books (edited by someone other than author of article): Maluszynski M. (1990) Gene manipulation in plant improvement. In: Gustafsson J.P. (ed), Induced Mutations in Plant Improvement. Plenum press, New York. Pp239-250.
- Books (identical author and editor) van Harten A.M. (1998) Mutation Breeding, Theory and Practice. Cambridge University Press, Cambridge, U.K. pp. 237-240.

Figures and Tables

- All tables and figures, i.e., photographs, graphs and diagrams should be referred to as either "Table" or "Fig." and be numbered consecutively (1, 2, etc.) in the text.
- In tables, footnotes are preferred over long explanatory material in the heading or table body. Such explanatory footnotes, identified by superscript letters, should be placed immediately below the table.
- Do not use boxes; use horizontal lines only. Figures and tables should be placed on separate pages.

Units and symbols

The standard SI units and symbols should be used throughout (www.scenta.co.uk/tcaep/science/siunit/index.htm).

Publication

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