Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Potato Gene Resources

Number 18 – 2011

Somaclonal Selection for Improved NB 'Russet Burbank'

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The North American French fry industry is dominated by one extraordinary cultivar, 'Russet Burbank'. In 2014, 'Russet Burbank' will be 100 years in cultivation! It is believed to have originated as a variant of 'Burbank' and to have immediately supplanted it in importance due to its superior type. This included a thicker, brownish, "netted" skin, a smoother, more uniform oval shape, and greater resistance to potato scab (*Streptomyces scabies*) and the dreaded Late blight disease *Phytophthora infestans*.

Over the years, numerous breeders have attempted to improve this cultivar; first through conventional technologies and more recently using tissue culture techniques. There were limited successes. These included the high protein hybrid 'Butte' and the potato leafroll virus resistant calliclone 'AC LR Russet Burbank'. However, neither was preferred over 'Russet Burbank' by the French fry industry. For more than 30 years, starting in the 1970s, many research groups around the world investigated somatic embryogenesis from potato, with mixed results. In 2005, McGill researchers initiated a "somatic breeding program" for 'Russet Burbank' and were first to bring potato somaclones to the field.

Over the next few years, 800 somaclones of 'Russet Burbank' were produced *in vitro* and evaluated at Greenfield, the McCain Foods Canada test plot near Florenceville, NB. Control cultivars were required from not one, but three germplasm repositories to perform these studies! These included the Plant Propagation Centre (NB Department of Agriculture, Aquaculture and Fisheries, Fredericton, NB, Canada) for the NB clone of 'Russet Burbank'; the United States Department of Agriculture (USDA), Research Service, Inter-Regional Potato Introduction Station (Sturgeon Bay, WI, USA) for 'Burbank'; and AAFC's Potato Gene Resources Repository (Fredericton, NB) for 'Early Rose' and others. These controls were essential to determine whether some somaclones of 'Russet Burbank' resembled 'Burbank' or its progenitor, 'Early Rose'.

No differences in average yield components occurred between NB 'Russet Burbank' plantlet-derived and somaclone-derived plants. From 2-9% of somaclones had improved processing quality, with lesser reducing sugars during late storage (5-9 months) and better fry colour compared with controls. Among the somatic lines with putatively improved processing characteristics were some with interesting

phytonutrient profiles; very different from control plantlet-derived tubers. These may have future applications as functional foods.

The best of these somatic lines were entered into the Plant Propagation Centre for their continuance. This process illustrates another important feature of germplasm repositories – to preserve and increase new, variant plant material with potentially important characteristics. Each of these somatic lines will be further examined and tested for stability over the next few years, first as minitubers, then as field tubers. This is a necessary step to confirm the utility of somaclonal plantlet-based field and processing selections towards new cultivar development. Early results indicate that field-based somaclonal selection is a robust technology with the potential to significantly improve 'Russet Burbank'.

Somaclone regeneration on tuber tissue *in vitro*.

Harvest of somaclonal plantlet lines.

Jerusalem artichoke - in Italian "patata de Canada" - in the Canadian genebank

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Genebanks are about diversification and the Canadian Potato Gene Resources Newsletter may be a good place to report briefly about a crop Italians refer to as "patata de Canada" the Canadian potato. There are only a few crops that have truly their origin in what is today the continental United States of America and Canada. The economically most important is the sunflower (*Helianthus annuus* L.). Another crop is Jerusalem artichoke *H. tuberosus* L., a close relative of sunflower, which is native to the eastern United States and Mexico. It was already used by the Native American Indians before the advent of the Europeans. Jerusalem artichokes found in the wild in Canada have escaped from cultivation.

The species was firstly associated with Canada by European scientists, because France and its connections to Canada played an important role in the introduction of this crop to Europe. In 1607, Jerusalem artichokes were known in France. Some botanists used names such as *Batata canadensis* or *Chrysantemum canadense* and also Carolus Linnaeus, who suggested in 1753 the currently accepted name *Helianthus tuberosus*, thought that this crop came from Canada and later associated it with Brazil. In France, the name "Canadas" was used for the crop and the Italian "patata de Canada" (Canadian potato) points in the same direction. Later, the name "topinambour", derived from the name of a tribe of American Indians, became more common in Europe. The English name Jerusalem artichoke has its origin in an anglization of the Italian word "girasole" for sunflower and the fact that the taste of the tubers has been associated with the old world artichoke.

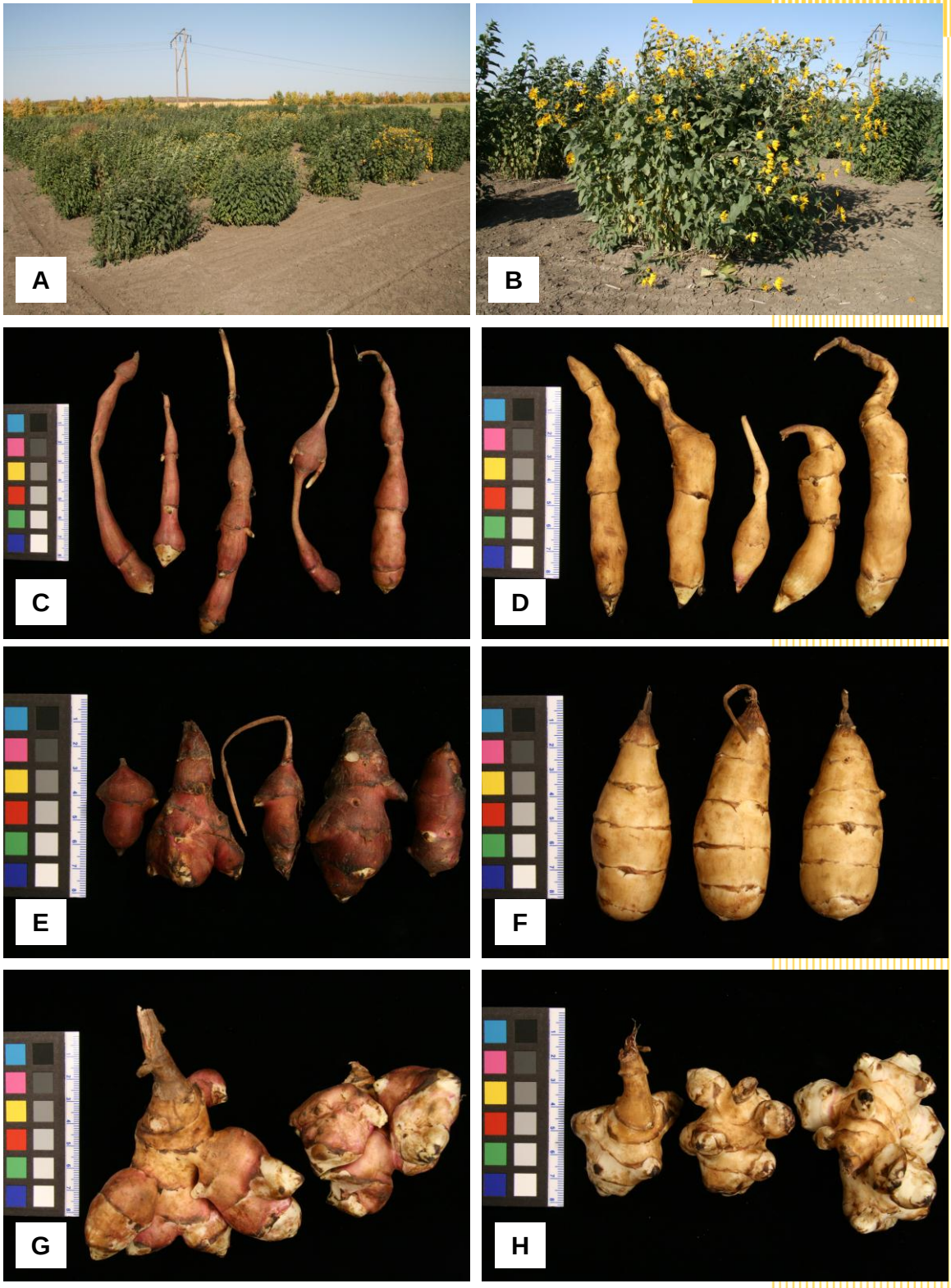
Both *Helianthus* species were improved through selection and breeding in Europe after they had been introduced there. Interspecific hybrids between these two species have been made and are cultivated as tuber plants (sunchokes) or used in sunflower breeding programs. While sunflower became an important source of vegetable oil in the world, Jerusalem artichokes remained a cultivated plant of marginal importance.

During food shortages in times of war, *H. tuberosus* received more attention by scientists and farmers because of its multiple uses as a vegetable, medicinal plant, forage plant and source for biofuel. The energy crisis of the 1970s motivated Canadian research on Jerusalem artichoke for biofuels, as the above-ground plant biomass and the tubers can be used for this purpose. The most intense breeding was conducted in the former Soviet Union. The high inulin content (15% of fresh matter) which is a carbohydrate (fructose polymers of 2–70 fructose units) in the tubers makes it an important source of fructose for the health-food industry. The use of Jerusalem artichoke as an exotic vegetable has ensured preservation of this species by hobby gardeners and biodiversity enthusiasts in Canada and other countries. Groups such as Seed Savers in the USA or Seeds of Diversity in Canada have contributed to preserving this crop. The threat of global climate change reinforces the concept that Jerusalem artichoke is a highly productive low-input crop. Tuber yields of up to 75.5 t/ha, and above-ground fresh green matter up to 120 t/ha have been reported.

The Canadian Jerusalem artichoke collection preserved at Plant Gene Resources of Canada (PGRC) with presently 160 accessions is relatively large. It was assembled at the Morden Research Centre, Agriculture and Agri-Food Canada, in Manitoba during the 1970s. The collection was transferred to the Saskatoon Research Centre in Saskatchewan in 2000. It is preserved as a field collection at the Saskatoon Research Farm. Jerusalem artichokes often do not flower under Canadian growing conditions, as the plants are adapted to short days. If they flower, they have very poor seed fertility and the seeds are not true breeding. Therefore, they have to be kept as clones similar to the common potato. Presently, PGRC keeps the collection only as field collection, and there is a risk to losing germplasm due to diseases (fusarium root rot and sclerotinia) or winterkill.

The Jerusalem artichoke accessions preserved by PGRC were recently characterized for 13 rated and 10 measured descriptors for leaf, stem, tuber and phenological characters. A wide range of phenotypic variation was found. Earliness of flowering, tuber width, tuber weight, tuber shape, tuber epidermis colouration and below-ground growth habit (tubers clustered vs. spread) were the most informative characteristics for describing variation among Jerusalem artichoke accessions. Leaf dimensions and leaf margin serration could also be used to distinguish extreme genotypes. A suggestion for categorizing the PGRC collection into large-tuber and primitive material based on single tuber weight and tuber width is made. Six categories of tuber types based on tuber colour (white vs. red) and tuber shape (elongated, round, irregular) are presented in the following photos.

It is important that PGRC preserves this germplasm of Jerusalem artichoke for the following reasons: i) the crop is native to Canada; ii) it has potential as low-input crop due to drought tolerance and low fertilizer requirement; iii) it is a potential source of biofuels; and iv) it is an important source of fructane for nutrition of people with diabetes, and for industrial purposes. The task of PGRC is to keep options open for Canadian producers and consumers, and the efforts made in Jerusalem artichokes are an example for this.



Field plots (A and B) and six tuber types (C–H) of *Helianthus tuberosus* in the PGRC collection. A: Field nursery in second year. B: Plot in full flowering. C and D: Narrow-elongated tubers. E and F: rounded tubers. G and H: irregular shaped tubers. Shapes in types with red and white epidermis. **C**: CN 112871 'Jack's Copperclad'; **D**: CN 112714; **E**: CN 112870 'Mansell Sunroot'; **F**: CN 112856; **G**: CN 112716; **H**: CN 112823.

PROCINORTE-NORGEN GRIN-Global Workshop Centro Nacional de Recursos Genéticos Tepatitlán de Morelos, Jalisco, Mexico

Teresa Molen

The original Germplasm Resources Information Network (GRIN), developed by the United States Department of Agriculture, has been in use in the United States since 1986 and Canada (GRIN-CA) since 2001. The requirement for an affordable world-wide platform was initiated by the Global Crop Diversity Trust who awarded a grant to the Agricultural Research Service (ARS) of the USDA and Bioversity International to enhance and expand GRIN to meet global germplasm information and management needs.[1]

GRIN-Global was developed to provide the world's crop genebanks with a powerful yet versatile plant genetic resource information management system poised to be the cornerstone of a global network of genebanks whose data will be available to researchers, breeders, and farmer-producers alike. Data obtained from genebanks using this global accession-level information system will provide an enhanced assessment of the "State of the World" for plant genetic resources.[2] GRIN-Global is free of charge and is currently available in English, Spanish, Russian, French and Arabic.

In November 2011, PROCINORTE, a cooperative program promoting collaboration in Agricultural research to the countries of IICA's (Inter-American Institute for Cooperation on Agriculture) Northern Region (Canada, Mexico and USA) funded training under the NORGEN task force which focuses on Plant Genetic Resources[3].

This nine-day PROCINORTE-NORGEN GRIN-Global workshop was held at the new, state of the art, National Genetic Resources Center in Tepatitlán de Morelos, Jalisco, Mexico. The workshop's objective was to provide participants with the essential skills and knowledge for effectively using and customizing the GRIN-Global application to manage a genebank's data. The workshop was conducted by Pete Cyr and Martin Reisinger from the USDA/ARS and Tito Franco from Bioversity International. The workshop was attended by 27 participants from Belize, Canada, Ecuador and Mexico. This two-part workshop focused on user interaction using the Curator Tool while the second week concentrated on the installation and administration of the system. Canada and Mexico both plan to implement GRIN-Global as the new information system for handling all plant genetic resource collections.

[1]GRIN-Global powerpoint presentation available at: http://www.grin-global.org/index.php/Training#Introduction_to_the_GRIN-Global_Project

[2]GRIN-Global Main Page http://www.grin-global.org/index.php/Main_Page

[3]United States of America Office of Inter-American Institute for Cooperation on Agriculture http://www.iica.int/Eng/regiones/norte/USA/Pages/PROCINORTE.aspx

Trainers and participants of the PROCINORTE-NORGEN GRIN-Global workshop pose in front of the new National Genetic Resources Center in Tepatitlán de Morelos, Jalisco, Mexico in November 2011.

How Research Helps Support Agri-Businesses

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The results of agricultural research at Agriculture and Agri-Food Canada contribute billions of dollars annually to the Canadian economy. Research is key to helping our agricultural and agri-food sectors remain competitive, continue to innovate and grow new markets. In 2009, Canada's agriculture and agri-food industry directly provided one in eight jobs, employing two million people and accounted for nearly 10 per cent of Gross Domestic Product (GDP). Our agri-food sector is now the leading manufacturing employer, with productivity having jumped by 300 per cent since the 1950s. As well, more than 85 per cent of Canadian agricultural products are now being exported.

- Industrial Program helps food companies develop and implement production management and quality control systems
- New malting barley dominates market and is prized by growers, maltsters and brewers throughout the world
- Harovinton establishes Canada as preferred source of premium quality soy for tofu in Japan
- Since 1986, 48 new cereal varieties have been released to provide farmers, Canadians and exporters with superior products to help maintain Canada's international recognition for high-quality cereal grains – 92 per cent of the durum wheat and nearly 50 per cent of the spring wheat grown in western Canada trace its origins to the Centre
- HarvestWatch™ technology used internationally to improve storage conditions and extend shelf life of apples
- New late-ripening, high-quality sweet cherry varieties improve financial returns to growers, enhancing Canadian presence on world markets
- New classification models identify Potato Virus Y to help Canada respond to disease outbreaks and resolve important trade issues, and the creation of new molecular tests for potato virus detection helps to avoid new outbreaks
- A new technology to produce natural food colouring is transferred to industry
- New methods and technologies extend the shelf-life of cultivated blueberry crops, helping growers capture a larger market share
- New high-yielding mustard varieties keep Canada on top of world's condiment mustard production

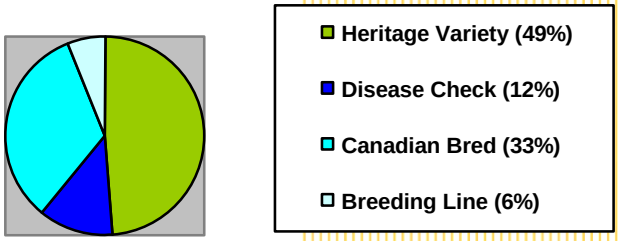
Annual Report 2011
Potato Gene Resources Repository

Teresa Molen

The Collection

1. Holdings

The Potato Gene Resources Repository contains 163 clones. Of this total, 161 are maintained *in vitro*, and 33 clones were grown for tubers at our Benton Ridge Potato Breeding Substation, Benton, New Brunswick. A full listing of accessions may be found on the attached request form. The following chart shows the percentage of clones in each Repository category.



2. New Accessions

Two *in vitro* clones were added to the Repository in 2011. The new accessions are Newfoundland Elephant which was acquired from the Agricultural Certification Laboratory in Fredericton, NB, and Blue Victor acquired from The Maine Seed Potato Board, Presque Isle, ME, which has since removed it from its collection. Unfortunately, no descriptions are presently available for these new accessions. Information will be provided in future newsletters as it becomes available.

In 2010, Katahdin and Makah were added to the Repository. The following is a brief description of each.

Katahdin – Released by the USDA in 1932, it was an important white-skinned variety in the US Northeast well into the 1970s. This main season maturing variety was primarily used for tablestock with round to oblong tubers with buff, smooth skin and creamy white flesh.[1]

Makah – Introduced by the Spanish in 1792 and otherwise known as Ozette, Makah is a cultural heirloom of the Makah Nation of Neah Bay, Washington.[2] Growing from an over four-foot tall plant, this very elongated variety has tan skin and yellow flesh.[2]

References

[1]The Potato Association of America website http://potatoassociation.org.

[2]USDA, ARS, National Genetic Resources Program. *Germplasm Resources Information Network – (GRIN)*. (Online Database) National Germplasm Resources Laboratory, Beltsville, Maryland. Available: http://www.ars-grin.gov/cgi-bin/npgs/acc/display.pl?1000936

No accessions were lost from the inventory in 2011.

3. Evaluations

Fourteen varieties were grown in an evaluation trial at the Potato Research Centre. Two replications of 15 hills of the following varieties: Bauer Grün Rote Auge, Chieftain, Congo, Early Rose, Elmer's Blue, Epicure, Eramosa, La Ratte, Matsuyama, Purple Peruvian, Shepody, Six Weeks, Superior and Yellow Fin. Chieftain and Superior were grown as checks. Samples were also taken for Total Glycoalkaloid Analysis (TGA), photographs and culinary evaluation.

Thirty-one clones were grown in 20 hill plots at the Benton Ridge Potato Breeding Substation, Benton, NB, to provide material for demonstration and cooking quality evaluation throughout the winter and spring.

4. Management

Passport data for Potato Gene Resources (PGR) accessions is available online at the Genetic Resources Information Network-Canadian Version (GRIN-CA). GRIN-CA may be accessed through the Plant Gene Resources of Canada (PGRC) web site http://pgrc3.agr.ca/.

Disease testing of new *in vitro* accessions and clones which have been maintained *in vitro* for five years was completed. Forty-five clones were grown in the greenhouse and tested twice in 2011. All clones were negative for PVA, PLRV, PotLV, PVS, PVX, PVY, PSTV and BRR. Extra mini tubers from the greenhouse grow-out will be offered to PGR clients in the spring of 2012.

In vitro clones were screened for bacterial and fungal contamination using Potato Dextrose Broth and Richardson's Broth, once during 2011. All clones currently in the Repository are negative for these contaminants.

A total of 1011 microtubers were harvested from 158 of the PGR clones in 2011. Approximately half of the microtubers were

sent to Saskatoon in June 2011 to be stored at Plant Gene Resources of Canada, AAFC. The viability of the Repository is protected by this remote location, long-term storage arrangement. Dallas Kessler, of Plant Gene Resources Canada, Saskatoon SK, continues to monitor and evaluate the microtubers. The remaining microtubers are stored as backup at the Repository.

5. Distribution

Thirty-one requests for 612 clones were received in 2011. Of this number, 212 clones were distributed as *in vitro* plantlets, 394 clones as field grown tubers, and 6 clones as greenhouse grown minitubers. All Red, Lumpers and Six Weeks were the most requested clones in 2011. They were followed closely by Candy Cane, Crotte D'Ours, Garnet Chili, Kerr's Pink, Kifli and Purple Viking.

Distribution of Clones by Purpose - 2011

Purpose of request	Number of clients requesting	Clones	*In vitro*	Tubers	Mini tubers
Research	6	26	25	71	0
Teaching or Demonstration	3	13	25	61	0
Conservation	23	587	162	318	6
Totals	32	626	212	450	6

Requests by Destination – 2011

Destination	Number of Requests
Newfoundland and Labrador	1
Prince Edward Island	1
Nova Scotia	1
New Brunswick	9
Quebec	4
Ontario	5
Saskatchewan	2
Alberta	3
British Columbia	2
USA	4
Total	32

Five-Year Compilation of Clone Distribution for Potato Gene Resources 2007-2011

Year	Research	Education	*Conservation	Total	Tubers or mini tubers	*In vitro*	Micro tubers	Total
2007	15	34		49	220	210	122	552
2008	9	39		48	345	210	0	555
2009	9	48		57	311	203	141	655
2010	4	15		19	295	171	0	466
2011	6	3	23	32	456	212	0	668
Total	**43**	**139**	**23**	**205**	**1627**	**1006**	**263**	**2896**

*This category of clone request was added in 2011.

Our clones were sent from coast to coast. Bruce McDonald, curator of the Heirloom Vegetable Garden at VanDusen Botanical Garden in Vancouver, BC, used heritage varieties from the Repository to recreate an heirloom garden circa 1850-1860 England. The garden was to celebrate Mrs. Isabella Beeton and the 150th anniversary of the publishing of her book, Mrs. Beeton's Book of Household Management. Similarly, King's Landing Historical Settlement located in Prince William, NB, grew heritage accessions obtained as tubers from the Repository as examples of 19th century varieties as part of their heritage potato program. In Carmanville, NL, George Brinson continues to evaluate PGR accessions for potato wart resistance.

Selected clones from the Repository were also used locally at The Potato Research Centre by Dr. B. Bizimungu to investigate starch properties for breeding purposes.

Repository Items of Interest

Communication

In addition to the requests for clones, many requests for information about the Repository, the availability of clones, clone descriptions and pedigrees, and techniques for handling *in vitro* material were received throughout 2011.

The annual Potato Gene Resources newsletter has a distribution of 257 and is made possible with the administrative support of Ms. Sylvie LaForest.

During an Open House at the Potato Research Centre in February 2011, a Canadian Broadcasting Corporation (CBC) segment was filmed, including an interview with AAFC Scientist/Breeder/PGR Curator, Dr. Benoit Bizimungu, and also featured the Repository collection. This segment aired on the New Brunswick CBC evening news on February 16, 2011.

This newsletter and several back issues may be accessed on the Weekly Checklist of Government of Canada Publications. Browse for the newsletter by title at: http://publications.gc.ca/.

Displays

An AAFC exhibit featuring posters and material from the Potato Gene Resources Repository was featured at the Benton Ridge Potato Breeding Substation Open House held on July 20, 2011.

In October 2011, *in vitro* potato clones from the Repository and the Potato Breeding Program were featured in a hands-on display at Science East, located in Fredericton, NB as part of National Science and Technology Week.

Visitors

In January 2011, 22 visitors from the Crop Development Branch of the New Brunswick Department of Agriculture, Aquaculture and Fisheries toured the new Potato Gene Resources Repository and the Potato Breeding laboratory where they viewed displays and heard presentations given by scientists Dr. Benoit Bizimungu and Agnes Murphy.

Students from the University of New Brunswick Renaissance College along with integrator Michael Carr visited the Potato Gene Resources Repository in February 2011.

In March 2011, Dr. Gilles Saindon, Director General in AAFC, visited the Potato Research Centre (PRC). During his tour of the Centre, Dr. Saindon visited the new Repository and viewed displays of Canadian Bred and Heritage accessions.

Twenty-eight members of the Austrian Potato Farmer's Seed Co-op Niederoesterreichische Saatbaugenossenschaft visited the Repository in May 2011.

Students from the University of New Brunswick Renaissance College listen to a presentation given by Dr. Benoit Bizimungu during their visit to the Potato Gene Resources Repository.

(Left to right) PRC Research Manager, Edward Hurley, PRC Science Director, Dr. Claudel Lemieux and Director General of Agriculture, Dr. Gilles Saindon look on as Research Scientist/Germplasm Curator, Dr. Benoit Bizimungu discusses the *in vitro* storage of plantlets at the Repository during a visit in March 2011.

Training

Teresa Molen, Potato Gene Resources Technician, attended training on the new Germplasm Resources Information Network (GRIN) – Global held at the National Genetic Resources Center in Tepatitlán de Morelos, Jalisco, Mexico, from October 30 to November 11, 2011. For more information, please see the detailed article also included in this newsletter.

Update on the Repository's New Lab

The renovation and development of a new laboratory space for the Potato Gene Resources Repository at the Potato Research Centre discussed in previous newsletters is almost complete. The secure room to house controlled environment cabinets (Growth Cabinet Room) as well as the Media preparation and sterile transfer room (Laboratory) are completed and fully functional, however, the separate glassware preparation room remains incomplete. It is our expectation that this room be operational in 2012. The facility now meets international standards by providing adequate security of the germplasm in the repository as well as the required space to support the work in an efficient and secure manner.

The Repository and the Seed Potato System

The Potato Gene Resources Repository provides *in vitro* plantlets and greenhouse or field tubers for breeding, research and heritage preservation. While extensively tested for freedom from disease, the plantlets and tubers distributed by the Potato Gene Resources Repository are produced outside the Canadian Seed Certification System and are not eligible for Certification.

The Canadian Seed Potato Certification System operates under the Seed Act and its Regulations. Certification begins with tested plantlets established *in vitro* in a facility accredited for this task by the Canadian Food Inspection Agency. The

plantlets are used to produce greenhouse tubers which then go to the field in a limited generation system, at each step meeting strict standards specified in the Regulations. The Potato Gene Resources Repository is not accredited for seed production by the CFIA.

Potato Research Centre Website

http://www.agr.gc.ca/researchcentre/fredericton offers an overview of the mandate, resources and achievements of the Centre. The research studies being conducted at the Centre as well as the staff associated with those studies is highlighted. Links to the Potato Research Network and to other agriculture and potato related websites are also available.

Plant Gene Resources of Canada

Canada's Plant Germplasm System is a network of Centres and people dedicated to preserving the genetic diversity of crop plants, their wild relatives and plants present are unique in the Canadian biodiversity system. The system plays a significant part of Agriculture and Agri-food Canada's commitment to the Canadian Biodiversity Strategy in response to the Convention on Biological Diversity.

The Plant Gene Resources of Canada (PGRC) website located at http://pgrc3.agr.ca/ includes information on the PGRC and the multi-nodal system of germplasm conservation in Canada as well as opportunities to search for germplasm information on the Genetic Resources Information Network- Canadian version (GRIN-CA). Dr. Yves Laplante, Acting Research Manager, Plant Gene Resources of Canada, may be contacted at Yves.Plante@agr.gc.ca.

Potato Gene Resources Newsletter

The Potato Gene Resources Newsletter is an annual publication of the Potato Gene Resources Repository, Potato Research Centre, Agriculture and Agri-Food Canada.

The Newsletter provides information on potato germplasm in the Repository and on issues related to the genetic diversity in the potato. The opinions expressed by authors may not necessarily represent the views of Agriculture and Agri-Food Canada.

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Teresa Molen – Potato Gene Resources Technician
Deborah Campbell – Potato Breeding Technician
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Stephen Allaby – Potato Breeding Technician
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