

# ANNUAL REPORT

## Calendar Year 1997

### **1. PROJECT: NRSP-6: INTER-REGIONAL POTATO INTRODUCTION PROJECT**

Introduction, Preservation, Classification, Distribution and Evaluation of  
*Solanum* Species.

### **2. COOPERATIVE AGENCIES AND PRINCIPAL LEADERS**

#### **State Agricultural Experimental Stations**

#### **Representative**

|                      |               |                   |
|----------------------|---------------|-------------------|
| Southern Region      |               | J. C. Miller, Jr. |
| Western Region       | Chairman      | A. R. Mosley      |
| North Central Region | Vice Chairman | F. I. Lauer       |
| North Eastern Region | Secretary     | A. F. Reeves      |

#### **United States Department of Agriculture**

|   |  |               |
|---|--|---------------|
| Agricultural Research Service                             |  |               |
| Technical Representative                                  |  | J. J. Pavek   |
| National Program Staff                                    |  | H. L. Shands  |
| Area Director, Midwest Area                               |  | R. L. Dunkle  |
| Cooperative States Research Education & Extension Service |  | C. Stushnoff  |
| Animal and Plant Health Inspection Service                |  | A. T. Tschanz |
| Inter-Regional Potato Introduction Project                |  | J. B. Bamberg |

#### **Agriculture and Agri-Food Canada**

T. R. Tarn

#### **Administrative Advisors**

|                      |      |             |
|----------------------|------|-------------|
| North Central Region | Lead | R. L. Lower |
| Western Region       |      | M. J. Burke |
| Southern Region      |      | E. Young    |
| North Eastern Region |      | R. C. Seem  |

### **3. PROGRESS AND PRINCIPAL ACCOMPLISHMENTS**

#### **A. Introduction of New Stocks**

Dr. Spooner, in collaboration with Drs. Antonio Rivera-Pena (Mexico), Ronald G. van den Berg (The Netherlands), and Konrad Schuler (Germany) participated in a successful expedition to collect wild species of potato in Mexico from August 21st to October 31st. This collection trip procured 95 new accessions of 24 different *Solanum* species.

Dr. Bamberg collected five accessions in two expeditions to the southwestern-region of the United States and had five accessions sent to NRSP-6 by cooperators from that region.

A total of 158 accessions were brought through Quarantine in 1997, assigned PI's, and are now available from the NRSP-6 *Solanum* germplasm collection, 110 accessions as true seed and 48 as in vitro clones.

In 1997, 183 accessions were planted out in the spring quarantined increase. Of the 183 accessions, 119 germinated and were grown out. One hundred fourteen of these were released and added into the collection (five were virus suspect and not released). Of the 114, 12 were CCC donations from Columbia, one was a Lopez collection from Columbia, 94 were from Spooner's 1993 Bolivia collection, and seven were collected in Mexico by Hjerting. Four of the accessions released from quarantine were assigned PI's in 1996, thus the discrepancy between number of accessions released and number of accessions assigned PI's.

An additional 48 clones were added to the in vitro collection in 1996 as foreign varieties or genetic stocks, including 19 R-free late blight resistant clones from CIP.

#### **B. Preservation and Increase of Stocks**

In 1997, 238 accessions were increased. From US Quarantine 183 accessions were received for a joint seed increase and quarantine virus testing at NRSP-6. Of the 183 accessions, 64 failed to germinate, five were virus suspect and not released, and 114 are being incorporated into the NRSP-6 inventory.

This year a total of 700 potato spindle tuber viroid (PSTV) tests were performed on seed increases, seed lots and research materials. Germination tests were performed on 972 accessions, and ploidy determinations were done on 91 accessions.

### **C. Classification**

Dr. Spooner continues to resolve problems in taxonomic classification which impede efficient documentation and use of the germplasm. This year an extensive study of the *S. canasense* complex of species was continued. Molecular analysis of relationships of *S. astleyi* and *S. boliviense* were completed. Insights gained from this study will allow accessions to be assigned stable species' names based on empirical differences.

### **D. Distribution**

NRSP-6 distributed 7,204 units of seed (50 seeds per unit), 40 tuber families and 1,146 in vitro stocks to clientele in 23 states of the United States and 16 other countries. Internally, NRSP-6 used 6,883 units of seed for chromosome counts, germination tests, identification and taxonomic check plantings, in-vitro maintenance, seed increases, PSTV tests, and miscellaneous plantings. The volume and types of stocks sent to various consignee categories are summarized in the table below.

#### **VOLUME AND TYPES OF STOCKS DISTRIBUTED**

| Category            | Units <sup>1</sup> |    |       |        | PI's  |
|---------------------|--------------------|----|-------|--------|-------|
|                     | S                  | TF | IVS   | TOTAL  |       |
| Domestic            | 4,285              | 9  | 682   | 4,976  | 3,074 |
| Foreign             | 2,919              | 31 | 464   | 3,414  | 1,298 |
| NRSP-6 <sup>2</sup> | 6,883              | 0  | 0     | 6,883  | 1,134 |
| Total               | 14,087             | 40 | 1,146 | 15,273 | 5,506 |

<sup>1</sup> Types of stocks sent/(number of seeds, tubers or plantlets per standard shipping unit):

S= True Seeds/(50), TF= Tuber Families/(10), IVS=in vitro stocks/(1).

<sup>2</sup> Includes chromosome counts, germination tests, ID and Taxonomic check plantings, in vitro maintenance, seed increases, PSTV tests, and miscellaneous plantings and NSSL seed backup.

### **E. Evaluation of Stocks**

#### **Mission**

The project's mission with respect to evaluation is to locate and characterize useful traits so that the best materials and most efficient approaches are available for subsequent germplasm enhancement.

### 1. Special Quarantine Seed Increases

This cooperative project with the US Quarantine Lab, by which quarantine testing and seed increases are done concurrently at NRSP-6, has greatly reduced time and effort required to import valuable germplasm. This year we successfully processed germplasm from Dr. Spooner's collecting expeditions to Bolivia.

### 2. Late Blight Screening

New forms of the late blight pathogen have developed into a severe threat to the US potato crop. In 1997 we continued three cooperative projects:

- 1) BC, Canada with Dr. Ken Ng: This project facilitated fine screening of non-Mexican species diploids of Series Tuberosa segregating for extreme resistance.
- 2) Cornell, New York: Dr. Fry evaluated the same material as Dr. Ng.
- 3) Lansing, Michigan with Dr. Douches: This project involves inoculated greenhouse testing of the best late blight resistant genotypes from the above screening projects.

### 3. Tuber Traits

Wild species do not produce tubers in the long days of North American summers, so their tuber traits cannot be assessed in the field. A project was initiated in 1993 in which wild accessions are being systematically crossed with adapted (cultivated) forms to produce F<sub>2</sub> true seed families. This moved the potentially valuable tuber traits of species to a background in which they can be revealed. We will advertise these to our cooperators as they become available.

### 4. Frost Hardiness

In cooperation with Dr. J. Palta and YuKuang Chen, work was continued on recurrent selection for earliness, good tuber characteristics, and frost resistance. Good progress in earliness and yield was evident this year in *S. acaule* - *S. commersonii* hybrids in the 2nd generation of crossing to very early *tuberosum* cultivars. Evaluation of frost hardiness and breeding potential of somatic fusions of *tuberosum* with *S. commersonii* continued. A study to assess the impact of the ratio of sensitive to hardy genomes in interspecific crosses was also continued.

### 5. Tuber Calcium

Tuber calcium has been shown to be closely associated with resistance to important storage rots and other tuber quality traits. F<sub>2</sub> hybrids between clones which accumulate very high calcium in a high calcium environment and clones which accumulate very little calcium in the same environment were generated and are in the process of being analyzed. A possible link between high calcium accumulation and sprouting vigor is also being investigated.

6. RAPDs to predict need for fine screening.

This study used two populations known to be highly insect and virus resistant from species *S. polytrichon* and *S. stoloniferum*. Since these species are facultative selfers, they might be very homogeneous, and could be expected to have little phenotypic variation within populations. On the contrary, we found that over 20% of the bands which are polymorphic within the species are also polymorphic among individuals within the resistant population. Therefore, resistance may not be uniform within these populations and a decision for fine screening is indicated.

7. Screening the Wild Species for Rooting Vigor

The mini-core collection was screened for rooting vigor in the screenhouse in Perlite. Data is being gathered on relative rooting vigor.

8. Characterization for Utility Traits

The success of using *Solanum* germplasm for breeding is influenced by relative plant vigor, flowering, pollen shed and pollen viability. Relative scores for these parameters were published in, '**Elite Selections of Tuber-bearing *Solanum* Species Germplasm**'. Characterization of the collection for these traits continued in 1997.

**F. Inter-genebank Collaboration**

The Association of Potato Intergenebank Collaborators (APIC) has initiated a joint research project to investigate the effects of seed increases on the genetic integrity of germplasm conserved *ex situ*, and whether germplasm in genebanks still represents the *in situ* populations from which they were collected. Two papers were published on the first two phases of this project (see publications by staff). Work on the third phase, finding factors which predict the patterns of diversity among accessions, nears completion. New samples of *S. jamesii* were collected in Utah, Colorado and New Mexico, expanding the range of our research samples and adding unique germplasm to the genebank. The first direct evidence of ancient use of potatoes in North America was gathered in cooperation with Dr. Linda Scott-Cummings. *Solanum jamesii* was determined to be the source of starch grains from a mano in central New Mexico, and the charred remain from a hearth in NW Colorado. Graduate student Alfonso del Rio conducted two additional experiments using *Solanum sucrense*. The first showed that a "mystery" accession (lacking origin data) was not a duplicate of any of the *sucrose* already in the collection. The second study revealed sampling techniques needed to differentiate heterogeneous *Solanum* species population using RAPDs.

#### **4. USEFULNESS OF FINDINGS**

NRSP-6's purpose is to provide a ready source of raw materials, technology and information which support potato enhancement, breeding and research in the US and around the world. Thus, one way the success of NRSP-6 can be measured is by the use of NRSP-6 germplasm in the pedigrees of new, improved potato cultivars. Another is in the use of NRSP-6 stocks in more basic research programs which also ultimately contribute to human utilization of the potato crop, these being reflected in publications.

Two cultivar and three germplasm releases were published in the American Potato Journal in 1997: 'Mainstay', 'NorDonna', 'ND2858-1'(CPB resistance), 'B0718-3', and 'B0767-2'(both late blight resistance). All are known to have wild species in their pedigrees.

Section 6 lists 83 papers, one abstract, and four theses which report the use of NRSP-6 *Solanum* introductions this year.

#### **5. WORK PLANNED FOR 1998**

Dr. Spooner will participate in a collecting expedition to Peru .

Evaluation experiments will be continued on *Solanum* species for the following traits: frost hardiness, rooting vigor, tuber calcium, late blight resistance, hormone mutants, glycoalkaloids, and fertility in heat stress.

The general objective of NRSP-6 to promote and facilitate potato research and breeding will be pursued by continuing high quality service with respect to introduction, preservation, classification, evaluation, and distribution of potato germplasm to clients in the U.S. and around the world.

We will continue APIC intergenebank research projects determining the cause of observed differences *in situ* and genebank accessions, and correlations of geographic/habitat data with partitioning of diversity.

An APIC meeting is planned for summer 1999 in India.

#### **6. PUBLICATIONS ISSUED DURING THE YEAR**

##### **A. Publications issued by NRSP-6 Personnel**

Castillo, R. and D.M. Spooner. 1997 Phylogenetic relationships of wild potatoes, *Solanum* series *Conicibaccata* (sect. *Petota*). Syst. Bot. 22:45-83.

- Miller, J.T. and D.M. Spooner. 1997. Introgression of *Solanum chacoense* (*Solanum* sect. *Petota*) upland populations reexamined. *Syst. Bot.* 21:461-475.
- Peralta, I.E., H.E. Ballard Jr., and D.M. Spooner. 1997. "Waxy" gene intron phylogeny of tomatoes, *Solanum* subsect. *Lycopersicum* (Solanaceae). *Am. J. Bot. Suppl.* 84:222. (Abstract).
- Rio, A.H. del, J.B. Bamberg, and Z. Huaman. 1997. Assessing changes in the genetic diversity of potato gene banks. 1. Effects of seed increase. *Theor. Appl. Genetics* 95(1/2):191-198.
- Rio, A.H. del, J.B. Bamberg, Z. Huaman, A. Salas, and S.E. Vega. 1997. Assessing changes in the genetic diversity of potato gene banks. 2. *In situ* vs *ex situ*. *Theor. Appl. Genet.* 95(1/2):199-204.
- Rodriguez, A. and D.M. Spooner. 1997. Chloroplast DNA analysis of *Solanum bulbocastanum* and *S. cardiophyllum*, and evidence for the distinctiveness of *S. cardiophyllum* subsp. *ehrenbergii* (sect. *Petota*). *Syst. Bot.* 22:31-43.
- Spooner, D.M. and R. Castillo. 1997. Reexamination of series relationships of South American wild potatoes (Solanaceae: *Solanum* sect. *Petota*): evidence from chloroplast DNA restriction site variation. *Am. J. Bot.* 84:671-685.
- Spooner, D.M., M.L. Ugarte, and P.W. Skroch. 1997. Species boundaries and interrelationships of two closely related sympatric diploid wild potato species, *Solanum astleyi* and *S. boliviense* based on RAPDs. *Theor. Appl. Genet.* 95:764-771.

**B. Journal Articles and Abstracts Reporting Research with NRSP-6 Stocks**

(Note: Publications from previous years are included if missed in previous Annual Reports.)

- Balbyshev, N.F. and J.H. Lorenzen. 1997. Hypersensitivity and egg drop, a novel mechanism of host-plant resistance to Colorado potato beetle (Coleoptera: Chrysomelidae). *J. Econ. Entomol.* 90:652-657.
- Barone, A. 1996. Characterization by RFLP markers of interspecific *Solanum* hybrids forming  $2n$  gametes. *Rivista di Agronomia* 39(1):58-62.
- Birhman, R.K. and M. Cappadocia. 1997. Ploidy of anther culture derived plants of *Solanum chacoense* Bitt. *Indian J. Exp. Bio.* 35(2):200-202.
- Borkowska, M., K. Kleczkowski, A. Pawetczak, and B. Wielgat. 1995. Transformation of diploid potato with an *Agrobacterium tumefaciens* binary vector system: II. Stability of transformation in tubers, micropropagated and greenhouse grown plants. *Acta Physiol. Plant.* 17(3):275-280.

- Bouafia, S., N. Jelti, G. Lairy, A. Blanc, E. Bonnel, and J. Dereuddre. 1996. Cryopreservation of potato shoot tips by encapsulation-dehydration. *Potato Research* 39(1):69-78.
- Brigneti, G., J. Garcia-Mas, and D.C. Baulcombe. 1997. Molecular mapping of the potato virus Y resistance gene *Ry<sup>sto</sup>* in potato. *Theor. Appl. Genet.* 94(2):198-203.
- Carputo, Domenico, Teodoro Cardi, Mario Speggorin, Astolfo Zoina, and Luigi Frusciante. 1997. Resistance to blackleg and tuber soft rot in sexual and somatic interspecific hybrids with different genetic background. *Am. Potato J.* 74(3):161-172.
- Cho HyunMook, Ahn Soo Yong, and Om YoungHyun. 1996. Characteristics of the floral organs in the progenies of 4x *Solanum tuberosum* x 2x *S. phureja* and pollen development of their male sterile dihaploids. *J. Korean Soc. Hort. Sci.* 37(2):232-237.
- Conicella, C., G. Genuardo, A. Errico, L. Frusciante, and L.M. Monti. 1996. Meiotic restitution mechanisms and 2n pollen formation in a *Solanum tuberosum* dihaploid and in dihaploid x wild species hybrids. *Plant Breeding* 115:157-161.
- Deahl, K. 1996. Germplasm research provides arsenal for protecting world food supplies of potato and wheat from disease threats. *Diversity* 12(2):8-10.
- Dorel, C., N. Hugouvieux-Cotte-Pattat, J. Robert-Baudouy, and E. Lojkowska. 1996. Production of *Erwinia chrysanthemi* pectinases in potato tubers showing high or low level of resistance to soft-rot. *Euro. J. Pl. Path.* 102(6):511-517.
- Douches, D.S., D. Maas, K. Jastrzebski, and R.W. Chase. 1996. Assessment of potato breeding progress in the USA over the last century. *Crop Science* 36(6):1544-1552.
- Douches, David S., William W. Kirk, Kazimierz Jastrzebski, Christopher Long, and Ray Hammerschmidt. 1997. Susceptibility of potato varieties and advanced breeding lines (*Solanum tuberosum* L.) to *Phytophthora infestans* (Mont.) de Bary in greenhouse screenings. *Am. Potato J.* 74(2):75-86.
- Flanders, K.L., E.B. Radcliffe, and J.G. Hawkes. 1997. Geographic distribution of insect resistance in potatoes. *Euphytica* 93(2):201-221.
- Fonseca, M.E.N., V.L.A. Marinho, D.C. Monte-Neshich, and L.S. Boiteux. 1996. Survey for beet western yellow luteovirus as a major component of the potato leaf roll disease in central Brazil. *Plant Disease* 80(9):1079.



- Frusciante, L., D. Carputo, M. Biagetti, and C. Ceoloni. 1996. Advanced cytogenetic techniques for the transfer of genes for biotic stress resistance in *Solanum* and *Triticum* species. In: Proceedings of the workshop: Plant breeding for resistance to biotic stresses: physiological and molecular bases, Monsampolo del Tronto, Italy, 19-20 May, 1994. *Petria* 6(Suppl.1):219-232.
- Fry, W.E. and S.B. Goodwin. 1997. Resurgence of the Irish potato famine fungus. *BioScience* 47(6):363-371.
- Goth, R. W. and E.W. Goins. 1997. Potato Carlavirus S (PVS) resistance of potato clone B6603-12. *Am. Potato J.* 74(4):277-281.
- Goth, R. W. and K.G. Haynes. 1997. The germplasm release of B0718-3 and B0767-2: Two late blight resistant potato clones. *Am. Potato J.* 74(5):337-345.
- Hamalainen, J.H., K.N. Watanabe, J.P.T. Valkonen, A. Arihara, R.L. Plaisted, E. Pehu, L. Miller, and S.A. Slack. 1997. Mapping and marker-assisted selection for a gene for extreme resistance to potato virus Y. *Theor. Appl. Genet.* 94(2):192-197.
- Hamernik, A.J. and R.E. Hanneman, Jr. 1997. Using wild species to improve potato chip color from cold storage. *The Badger Common Tater* 49(2):42-46.
- Hanzlik, M.W., G.G. Kennedy, D.C. Sanders, and D.W. Monks. 1997. Response of European corn borer (*Ostrinia nubilalis*, Hubner) to two potato hybrids selected for resistance to Colorado potato beetle. *Crop Pro.* 16(5):487-490.
- Hawkes, J.G. 1997. A database for wild and cultivated potatoes. *Euphytica* 93(2):155-161.
- He, Y., L. GengGuang, and Z. L.Ying. 1996. Mesophyll protoplast culture and plantlet regeneration from wild species of potato. *J. Tropical & Subtropical Botany* 4(3):72-74.
- Heijden, G.W.A.M. van der and R.G. van den Berg. 1997. Quantitative assessment of corolla shape variation in *Solanum* sect. *Petota* by computer image analysis. *Taxon* 46(1):49-64.
- Helgeson, J. 1997. Potatoes once again, under fungal attack. *Agric. Research* 45(5):10-13.
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- Jackson, S.A. and R.E. Hanneman, Jr. 1996. Studies on the crossability relationships between potato varieties and related wild species. *Biotechnology Risk Assessment: USEPA/USDA/Environment Canada/Agriculture and Agri-Food Canada*. University of Maryland, College Park, Maryland. p. 270-277.
- Jacobs, A. 1996. Molecular analysis of cold resistance in Chilean potato species. A minor field study. Working paper - Internatl Rural Dev. Centre, Swedish Univ. of Agric. Sciences No. 305, 15 pp.
- Jain, S.M., S.K. Sopory, and R.E. Veilleux (Eds.) 1997. *In vitro* haploid production in higher plants. Volume 5: oil, ornamental and miscellaneous plants. Dordrecht, Netherlands; Kluwer Academic Publishers. 256 pp.
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- Janssen, G.J.W., A. van Norel, R. Janssen, and J. Hoogendoorn. 1997. Dominant and additive resistance to the root-knot nematodes *Meloidogyne chitwoodi* and *M. fallax* in Central American *Solanum* species. *Theor. Appl. Genet.* 94(5):692-700.
- Janssen, G.J.W., A. van Norel, B. Verkerk-Bakker, R. Janssen, and J. Hoogendoorn. 1997. Introgression of resistance to root-knot nematodes from wild Central American *Solanum* species into *S. tuberosum* ssp. *tuberosum*. *Theor. Appl. Genet.* 95(3):490-496.
- Kang, S. and D.J. Hannapel. 1995. Nucleotide sequences of novel potato (*Solanum tuberosum* L.) MADS-box cDNAs and their expression in vegetative organs. *Gene* 166(2):329-330.
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## **7. APPROVED**

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A. R. Mosley, Chairman, Technical Committee

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Date

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R. L. Lower, Lead Administrative Advisor

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Date