

ANNUAL REPORT
Calendar Year 2013 - June 2014

NRSP-6: UNITED STATES POTATO GENE BANK

Acquisition, Classification, Preservation, Evaluation and Distribution of tuber-bearing *Solanum* Species.

COOPERATIVE AGENCIES AND PRINCIPAL LEADERS

State Agricultural Experimental Stations

Representative

Technical Representatives

Southern Region		C. Yencho
Western Region	Chair (2014)	D. Holm
North Central Region		D. Douches
Northeastern Region	Secretary (2014)	W. De Jong

Administrative Advisors

Southern Region		C. Nessler
Western Region		L. Curtis
North Central Region	Lead AA	R. Lindroth
Northeastern Region		E. Ashworth

United States Department of Agriculture

ARS

Technical Representative	Vice Chair (2014)	C. Brown
National Program Staff		P. Bretting
		G. Wisler
Midwest Area		R. Matteri & P. Simon

NIFA

A. M. Thro

APHIS

J. Abad

NRSP-6 Project Leader

J. Bamberg

Agriculture & Agrifood Canada

B. Bizimungu

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

A. Acquisitions and associated work

In 2013, we collected 16 germplasm accessions from the southwest USA under the BdRFK (Bambers, del Rio, Fernandez, Kinder) prefix. Another major accomplishment was to collect DNA samples from *S. jamesii* Mega-populations at the top and bottom of the range, especially the huge population at Mesa Verde. We are using DNA markers to find out if such populations are such incubators for diversity that they are the only place one needs to collect. We also tested new ideas for collecting when propagules are poor: 1) collecting *in vitro* in PPM medium needs no sterile hood and rescues clones that will not root in soil, 2) AFLP data has shown that collecting pollen captures unique alleles, 3) simple insecticide application to collected fruit prevents fruit fly grubs from destroying seeds. We made the first reported discovery and collection of potato from the Dragoon mountains. We confirmed that *jamesii* still exists at the historic Faraway Ranch site, despite being unable to find it there since 1995. USDA/ARS/Plant Exploration Office supplied \$5K and has again in 2014. Detailed trip report for 2013 and plan for 2014 are available on request.



Mesa Verde *jamesii* mega-population-- millions of plants over 100+ acres

The genebank imported 7 elite breeding stocks from other countries and accepted 7 elite "M" clones from the Shelley Jansky program.

The NRSP-6 web page (<http://www.ars-grin.gov/nr6>) was updated to include all new stocks and screening information. Clients who have ordered from NRSP-6 within the past four years were contacted three times in 2013, informing them of new stocks of true seed, tubers, in vitro plantlets, or other samples. We used email and the website to extend technical instructions of various types. For example, a technique for breaking tuber dormancy was fine tuned to give reliable and uniform results, even for very deep dormancy tubers.



Better dormancy breaking techniques

B. Preservation and Evaluation

A total of 170 accessions were increased as botanical seed populations and 1900 clonally. Over 720 potato virus tests were performed on seed increase parents, seedlots and research materials. Germination tests were performed on 1489 accessions, ploidy determinations were made on 60 accessions, and tetrazolium seed viability tests were done on 50 seedlots. Taxonomic status was assessed on all stocks grown. A total of 7122 units of germplasm were distributed in 249 orders. Orders were filled within one week of receipt. Nearly 200 field plots were planted to verify that seed multiplication efforts last year resulted in offspring seedlots that matched their parents. We used SNPs (cooperator Douches from MI) to assess partitioning of genetic diversity in model potato species with a view to understanding their best management.

With help of cooperators, we made progress evaluating and improving germplasm on several ongoing projects. Over 1800 field plots at USPG, about 1500 seedlings tuberized in two sites in CA (cooperators Serimian and Pearson), and 4 large screenhouses at USPG full of stocks supporting screening for improved *Criolla* or "egg yolk" style specialty potato with golden flesh (cooperator Douglass from FL), folate (cooperator Goyer from OR), glycoalkaloids (cooperator Navarre from WA), anti-obesity (cooperator Kemin from IA), greening, K-screening, new *Coronita* fruit mutant (extra pistils in place of anthers), Zebra Chip resistance in *bulbocastanum* (cooperator Cooper in WA).



Improved *Criolla* selections



Coronita male sterile mutant

We detected a significant association of tuber pH (very fast, cheap and easy to screen) with glycoalkaloids and folate (much harder to screen) and organized an experiment to test this more systematically.

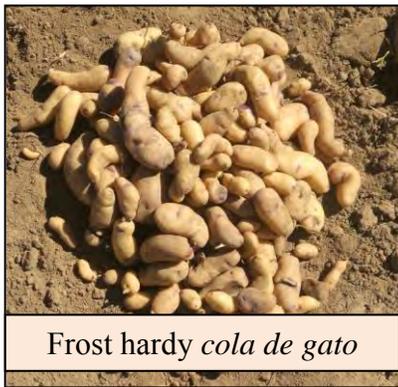


Zebra Chip resistance in *bulbocastanum*

This year, work with J. Palta (UW), International Potato Center (CIP), and colleagues in the Peruvian national potato program (INIA) progress was made in the frost hardiness breeding project with *S. commersonii*. An elite selection was informally named "*Cola de gato*". We also initiated a program to re-breed the non-bitter, frost hardy *S. ajanhuiri*, a primitive cultivated species with reputed progenitor *S. megistacrolobum* native to the Puno Altiplano.



Bamberg, Palta, del Rio, Gomez and locals at Potato Park near Cusco, Peru



Frost hardy *cola de gato*

Dr. Jansky's Enhancement:

The germplasm release of clone M6 was published in the Journal of Plant Registrations. M6 is an inbred line derived from seven generations of self-pollination. It is homozygous for the *Sli* gene that confers self-compatibility, and it is male and female fertile.

Jansky, S.H., Y.S. Chung, and P. Kittipadukal. 2014. M6: A diploid inbred line for use in breeding and genetics research. Journal of Plant Registrations. doi: 10.3198/jpr2013.05.0024crg.

Yong Suk Chung completed his Ph.D. thesis entitled "Bacterial soft rot resistance and calcium enhancement in wild and cultivated potato." A polymorphism in the *CAX3-like* candidate gene for calcium uptake by roots was found to be associated with tuber calcium levels. An additional 12 SSR markers also co-segregated with calcium in tubers. SSR4743 is located near the *CAX3* homolog on chromosome 7. Predictivity of taxonomy and biogeography for late blight resistance was completed (Alexander Khiutti, visiting scientist, St. Petersburg, Russia). A collection of 143 accessions representing 34 wild *Solanum* species was screened for foliar late blight resistance using whole plants and for tuber late blight resistance using greenhouse-generated tubers. A manuscript is in preparation.

Recombinant inbred lines are being developed in populations derived from wild species carrying resistance to early blight (*S. raphanifolium*) and common scab (*S. chacoense*). In addition, an F2 population derived from self-pollinating a clone from a cross between DM1-3 and M6 is segregating for a number of agronomic and disease resistance traits. It is being genotyped using the SolCAP SNP array and will be used for trait mapping. RILs are also being developed in this population.

A population derived by crossing US-W4 with M6 has been grown in replicated field trials for three years. Yield comparable to that of cultivars is common among clones in this population. Phenotyping (tuber yield, size set; chip color) and genotyping are underway.

C. Classification

Dr. Spooner is working on monographs that will fully document the taxonomic reduction of the genebank's species to about 100 species.

D. Distribution service



Distribution of germplasm is at the heart of our service. The volume and types of stocks sent to various consignee categories are summarized in the table below. **We filed almost 1/3 more orders in 2013 than 2012:** 230 domestic orders to clients in 39 states of the USA and 19 foreign orders to 10 other countries. About 1/2 of domestic orders are for breeding and genetics, about 1/4 for home gardeners, and the remaining 1/4 for pathology, physiology, entomology, taxonomy, and education. In 2013 we maintained the popular offering of 100 cultivars as tubers by devising and implementing an iron-clad disease control and quarantine program for their production (full details available at our website).

Category	Units of Germplasm Sent ¹							Total	PIs
	Seed	TU	TC	IV	DNA	Plants	Herb		
Domestic	2,762	71	2,484	1,181	50	2	0	6,550	4,688
Foreign	480	0	12	80	0	0	0	572	501
Total	3,242	71	2,496	1,261	50	2	0	7,122	5,189

¹ Types of stocks sent/(number of seeds, tubers or plantlets per standard shipping unit): Seed= True Seeds/(50), TU = Tuber families/(12), TC = Tuber Clones/(3), IV = *in vitro* stocks/(3), DNA = dried leaf samples/(1), Plants = rooted cuttings /(1), Herb= herbarium specimens/(1).

E. Outreach

Media coverage, Tours, Teaching, TechTran and Trips with presentations done

Bamberg served as PhD committee member for Cinthya Zorrilla-C, and Yong Soek Jung.

Summer student interns participated in experiments: Ahna Keilar (seed germ and seedling transplant tech), Abe Keilar (crossing tech for jam and blb), Hannah Haight (prebiotic assay and nutrient microbial bioassays), Jana Suriano (*Matryoshka* floral mutant and tuber greening with publication authorship, attended and made formal presentation at PAA, participated in Arizona collecting).

NCR potato genetics group in Chicago presentations; Potato Association of America meeting in Quebec-- four research presentations/abstracts.

Chinese, Russian, and Japanese potato scientists, UW River Falls Horticulture students, and Southern Door HS Spanish class tour genebank.

Leadership: Bamberg continued as Editor in Chief for the American Journal of Potato Research, and Chair of the USDA/ARS Potato Crop Germplasm Committee.



Undergrad intern
Jana Suriano, presenter at 2013

Reports & Plans: ARS: PGOC, CGC, CRIS, Annual Performance, Budget. NRSP6: Annual Report, TAC meeting minutes. PAA: AJPR Editor in Chief report, Outstanding Paper. UW-Hort: Annual Performance. PARS: Tour guide & field book.

Management of Grants & Awards: Potato CGC grants, AJPR Outstanding Paper

IMPACT STATEMENT

In 2013, seed increase success was steady, and number of germplasm orders increased substantially, supporting the needs of the nation and world for resources to genetically improve the potato crop.

The payoff in funding the genebank is in discovering and deploying traits that are useful to the public and the industry. We participated in successful selection of better stocks for golden flesh, frost resistance in Peruvian highlands, folate, potassium, resistance to tuber greening, glycoalkaloids, and a natural appetite suppressing protein.

We continued work on improving germplasm management. We again collected germplasm in-country, finding and making available populations at sites never before reported or collected, and developing novel technology to improve the genebank's representation of diversity in the wild.

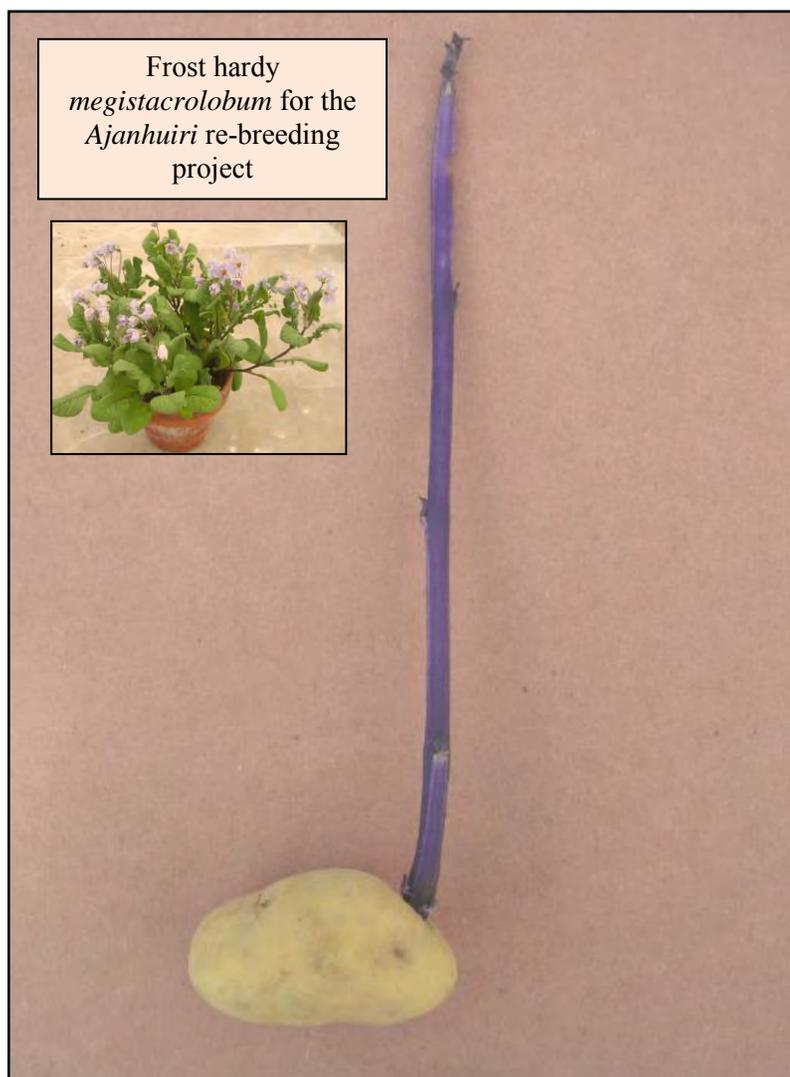
Salary and travel support plus cash gifts from industry totaled \$40K in 2013.

The ability to efficiently evaluate traits is rapidly improving. We are on the brink of a leap forward in breeding through molecular markers and genetic technology. Potato is an increasingly important world food. Climate is changing, and health issues and their economic impact are increasing in our aging population. Because of these factors, there has never been a more important (or exciting) time to be involved in improving potato through mining the rich deposits of traits in the US Potato Genebank.

WORK PLANS / STAFF & FUNDING / ADMINISTRATION

In FY15, we plan to continue the service program to acquire, preserve, classify, and promptly distribute high quality germplasm and data to all requesters. We will endeavor to say "yes" to requests for custom service and advice whenever we are able.

We plan to restore the ½ position of A. del Rio that was cut due to funding shortfalls in recent years, thus rebuilding our program in the area of genetic diversity management research (making use of the new, more powerful DNA markers now available), collecting research (predicting sites likely threatened by climate



change), and benefit sharing collaborations with Andean germplasm donor countries (in particular, the successful frost resistance breeding effort in Puno described above).

We expect to continue participation in "teaching" activities by hiring summer student interns who learn about potato science and help us explore promising new research and technology ideas (this has resulted in students participating in germplasm collecting, formal presentations at PAA, and authorship on peer reviewed publications). Rapport with potato science and scientists will be maintained by service as editor of American Journal of Potato Research, and participation in the Potato Association of America.

We expect to continue the service to industry partners that has been attracting their strong support, and similarly maintain strong ties with our sister genebanks around the world.

We intend to seek opportunities to evaluate and deploy germplasm in ways that impact the consumer, notably with respect to nutritional traits, thus enhancing the reputation, demand, and positive health and economic impact of the potato crop on society.

We expect to continue and expand approaches to evaluation and technology that multiply information gathering:

- 1) Multiple data collection schemes for a single grow-out
- 2) Synergistic cooperation with specialists in various disciplines
- 3) Testing for links between easily assessed traits and more difficult traits
- 4) Making use of our *in vitro* facilities and expertise to investigate microbial bioassays and selecting agents.
- 5) Characterizing visual (cog), genetic, geographic, and trait differences within species as predictors of germplasm application

METHODS: *Solanum okadae* (14 pops)

Validate "Boka" cog...

- ✓ Scored by eight people, three times
- ✓ Compare DNA similarity
- ✓ Check country of origin
- ✓ Check leaf hairiness



S. okadae visual "cog" exercise demonstrates method for initial detection of difference within species (slide of presentation at PAA2013)

PUBLICATIONS

NRSP6 and associated USDA/ARS project staff publications

Bamberg del Rio, Martin, Suriano and coauthors: Five journal articles now available online will be documented in this report when in print: AFLP core set of <i>microdontum</i> , Zebra chip resistance screening in <i>bulbocastanum</i> , New <i>Matryoshka</i> floral mutant, Selection for tuber quality in a Superior x Atlantic hybrid population, History and origin of Russet Burbank.
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Duangpan, S., W. Zhang, Y. Wu, S.H. Jansky, and J. Jiang. 2013. Insertional mutagenesis using <i>Tnt1</i> retrotransposon in potato. <i>Plant Physiology</i> 163:21-29.
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Fajardo, D., S.S. Jayanty, and S.H. Jansky. 2013. Rapid high throughput amylose determination in freeze dried potato tuber samples. <i>Journal of Visualized Experiments</i> . 80: e50407-e504407.
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Jansky, S.H., H. Dempewolf, E.L. Camadro, R. Simon, E. Zimnoch-Guzowska, D. Bisognin, and R. Simon, and M. Bonierbale. 2013. A case for crop wild relative preservation and use in potato (<i>Solanum tuberosum</i> L.). <i>Crop Science</i> . 53:1-9.
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Jansky, S.H., Y.S. Chung, and P. Kittipadukal. 2014. M6: A diploid inbred line for use in breeding and genetics research. <i>Journal of Plant Registrations</i> . doi: 10.3198/jpr2013.05.0024crg.
Lindqvist-Kreuze, H., K. Cho, L. Portal, F. Rodríguez, R. Simon, LL. A. Mueller, D. M. Spooner, and M. Bonierbale. 2013. Linking the potato genome to the conserved ortholog set (COS) markers. <i>BMC Genetics</i> 2013. 14: 51.
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Uribe, P., S. Jansky, and D. Halterman. 2014. Two CAPS markers predict <i>Verticillium</i> wilt resistance in wild <i>Solanum</i> species. <i>Molecular Breeding</i> . 33:465-476.

Publications by others using NRSP6 stocks

Many other scientists are publishing research that directly or indirectly originated from NRSP6 stocks. Publications that mention potato species (both old and new taxonomy) are likely to have such a connection to USPG germplasm and service. The search below produced 153 hits which the reader can regenerate independently, or which can be accessed through our website: <http://www.ars-grin.gov/nr6>.

The search net below does not catch cultivars, breeding stocks and genetic stocks, which have some 900 particular names to search, or are *tuberosum* and therefore more likely to be of independent origin. Note that even when the publication is of foreign origin, and the researcher probably received materials from another genebank, that foreign genebank may have originally received those materials from USPG. Since potato research and breeding is a slow process, materials published in 2013 could, of course, have been ordered many years previously. Similarly, these articles may only cite previous work with exotic species as related background information published by others, not because they were the materials used in the present experiment.

Digitop > browse by type: Databases > AGRICOLA > (log in) > cut and paste string below into "simple search" box > click "go"

This hits 153 records in Agricola or CAB abstracts for 2013 -- 140 for 2012 and 129 for 2011

Solanum and (abancayense or acaule or achacachense or acroglossum or acroscopicum or aemulans or agrimonifolium or ajanhuiri or alandiae or albicans or albornozi or ambosinum or andreanum or arnezii or astleyi or avilesii or aymaraesense or berthaultii or blanco-galdosii or boliviense or brachistotrichum or brachycarpum or brevicaulis or buesii or bukasovii or bulbocastanum or burkartii or cajamarquense or canasense or candolleianum or capsicibaccatum or cardiophyllum or chacoense or chancayense or chilliasense or chillonanum or chiquidenum or chomatophilum or circaeifolium or clarum or coelestipetalum or colombianum or commersonii or contumazaense or curtilobum or demissum or doddsii or dolichocephalum or edinense or edinense or ehrenbergii or etuberosum or fendleri or fernandezianum or flahaultii or gandarillasii or garcia-barrigae or gourlayi or guerreroense or hintonii or hjertingii or hondelmannii or hoopesii or hougasii or huancabambense or hypacarthrum or immite or incamayoense or infundibuliforme or iopetalum or irosinum or jamesii or juzepczukii or kurtzianum or laxissimum or leptophyes or leptosepalum or lesteri or lignicaule or limbaniense or lobbianum or longiconicum or macropilosum or maglia or malmeanum or marinasense or matehualae or medians or megistacrolobum or michoacanum or microdontum or minutifoliolum or mochiquense or morelliforme or moscopanum or multidissectum or multiinterruptum or nayaritense or neocardenasii or neorossii or neovalenzuelae or okadae or oplocense or orocense or orophilum or otites or oxycarpum or palustre or pampasense or papita or paramoense or pascoense or paucijugum or paucisectum or phureja or pinnatisectum or piurae or polyadenium or polytrichon or raphanifolium or rechei or sambucinum or sanctae-rosae or sandemanii or santolallae or scabrifolium or schenckii or soestii or sogarandinum or solisii or sparsipilum or spigazzinii or stenophyllidium or stoloniferum or subpanduratum or sucrense or sucubunense or tarijense or tarnii or trifidum or tundalomense or tuquerrense or ugentii or velardei or venturii or vernei or verrucosum or violaceimarmoratum or weberbaueri or yungasense or goniocalyx or stenotomum or andigenum or andigena or (USDA and "Solanum tuberosum")) (doc-type:Articles or doc-type:Books) pub-year:2013