ANNUAL REPORT
FY 2020

NRSP-6: UNITED STATES POTATO GENEBANK

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

COOPERATIVE AGENCIES AND PRINCIPAL LEADERS

State Agricultural Experimental Stations	Representative
Technical Representatives	
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Western Region	D. Holm
North Central Region	D. Douches
Northeastern Region	W. De Jong
Administrative Advisors	
Southern Region	J. Meullenet
Western Region	J. Loper
North Central Region	B. Barker
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	J. Munyaneza
Midwest Area	A. Pantoja & P. Simon
NIFA	E. Kaleikau
APHIS	R. French
NRSP-6 Project Leader	J. Bamberg
Agriculture & Agrifood Canada	B. Bizimungu
Industry	J. Parsons

PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

A. Acquisitions and associated work

The 2020 new acquisitions: 9 IV clones from NCGRP (listed in our new clones pdf on our Genebank Holdings web page). Also *in vitro* we received 97 RIL clones from S. Jansky and 200 plants for a core collection for evaluation from D. Halterman.

We collected new germplasm accessions from southeastern Colorado. These two new sites (see 695155 and 695156 in GRIN) represent the only pure *jamesii* from this area, despite looking several times previously in habitat that looked very promising (↓).

We continued the process of acquiring clones for which PVP has expired. 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 2020, 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.

B. Classification

Dr. Spooner completed work on his final taxonomy books (→) and distributed them before retiring this year. We continued research on crafting core collections within species *fendleri, boliviense* and *kurtzianum*, and summarized data and wrote papers on cores of *phureja* and *demissum*.

C. Preservation and Evaluation

Propagation: In 2020, we hand-pollinated (↓) 155 families of 20 plants each in the greenhouse for seed increase and performed 18,352 *in vitro* transfers to maintain fresh propagules of clonal stocks.

Germplasm health monitoring: We did 1,225 tests for viruses.

Viability monitoring: We did 1,224 replicated germination tests. These statistics do not include the hundreds of assays performed researching ways to improve the efficiency of seed germination and ploidy determinations.

Trait evaluation and Technology:

Potato germplasm has a broad spectrum of traits that can benefit both the grower and consumers. The genebank's supporting role for research is not just to supply propagules, but to facilitate discovery and characterization of these traits through evaluation and technology development (→).

Field plots, four large screenhouses, ten greenhouse compartments and a tissue culture lab were available at the UW Ag Research Stations at Hancock (→) and Sturgeon Bay, Wisconsin. These were used for seed, tuber and *in vitro* multiplication, and numerous evaluation experiments.

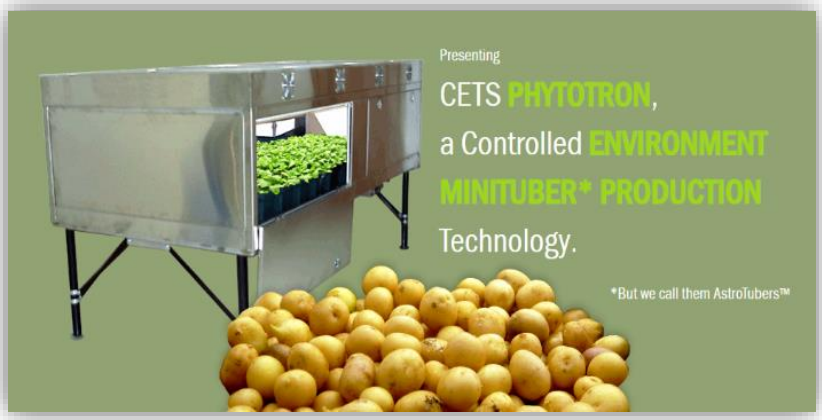
Peru connection: In 2020, we continued building evaluation partnerships with many expert cooperators. Particularly notable among these is our cooperation with Peru (↓), deploying novel germplasm in breeding that has now resulted in new registered cultivars.

Egg-yolk specialty potatoes: This year's mass selection population with 100% individuals with dark golden flesh demonstrated good yield and type as an unselected family. The initiative to produce a selfing line also appears to be succeeding, with some S4 families with uniform golden flesh (→).

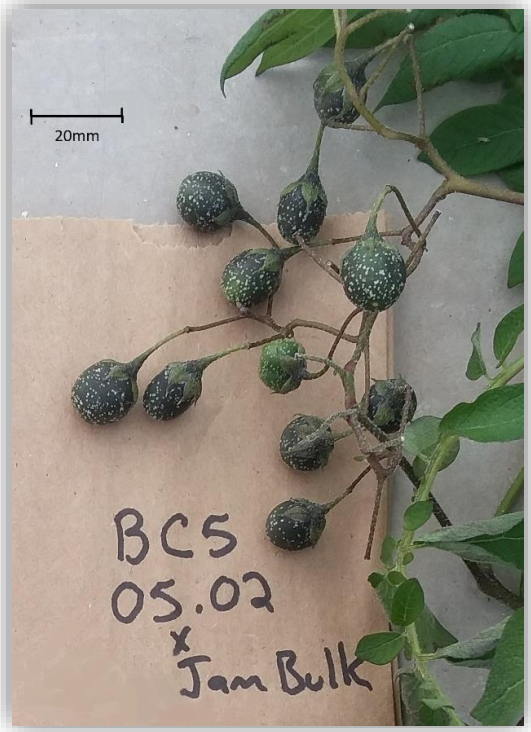
Root vigor and drought screening: We continued evaluation of the nearly 100 populations of *S. kurtzianum* in the NRSP6 genebank, repeating a screen of root vigor and drought tolerance.

Zebra chip: We did cooperative testing of the *microdontum* core collection for the *Lso* bacterium with cooperator R. Cooper, USDA, at Washington state.

Tuber trait characterization technology: Since the inception of the genebank, we have not had an adequate way to generate tubers for systematic analysis of tuber traits. For this we need optimized conditions to stimulate tuberization, even for species with unusual daylength and temperature requirements. We needed a way to produce replicate batches of tubers over time in exactly the same conditions. We needed the ability to precisely apply test environments like varying fertilizer, water, etc. Finally, we needed to be able to do all this with tight phytosanitary control to minimize the risk of disease spread. This year we produced the first harvest of tubers from the two specialized tuberizing chambers (←) generously donated by the CETS company.



Crossing technology: NRSP6 germplasm is already in the pedigrees of many commercial cultivars, but we could expand that benefit of exotic species by making hybridization easier. This year we advanced the synthesized and selected a line of *verrucosum* backcrossed into *tuberosum* cytoplasm to the BC6 generation and confirmed its superior qualities as a bridge species include self-incompatibility, very vigorous flowering, buds that do not fall off, and high female fertility. With this unique stock, we were able to make novel interspecific hybrids (→) and showed crossability to *tuberosum* stocks when doubled to the tetraploid level.



Exploring novel approaches to drought tolerance: Last year we followed up on a longstanding hunch that mutants deficient in the plant hormone gibberellin might be more drought tolerant. We now have made segregating populations with cultivated stocks for further testing (←). We made similar populations with drought tolerant individuals from the wild species *kurtzianum*.

D. Distribution

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. In 2020, a total of 3,183 units of germplasm were sent as 160 domestic orders to requesters in 35 states, and 813 units of germplasm as 18 foreign orders to 13 other countries. About 1/3 of the domestic orders are for public breeders and geneticists, 1/3 for pathology, physiology, entomology, taxonomy and education, and the remaining 1/3 for private germplasm users. See Impact Statement section for how this germplasm is being put to work.

In 2020 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). We produced the same set with the CETS phytotrons.

	Units of germplasm sent						
Category	Seed	TU	IV	DNA	Plants	Total	Accns
Domestic	1129	1348	560	6	140	3183	2911
Foreign	534	0	279	0	0	813	627
Total	1663	1348	839	6	140	3996	3538

[1] Types of stocks sent/(number of seeds, tubers or plantlets per standard shipping unit): Seed = True Seeds/(50), TU = Tuber Clones/(3), IV = *in vitro*/(3), DNA = dried leaf or tuber samples/(1), Plants = Rooted Cuttings/(1)

E. Outreach – remote seed increase in New Mexico

This year we expanded the borders of the genebank by organizing a remote seed incease at the New Mexico State University research farm at Farmington in cooperation with Kevin Lombard. It proved to be an excellent site for bumble bee activity and seed production when greenhouse pollinations had failed.

IMPACT STATEMENT

In recent years breeders have engaged in the revolutionary remaking of potato as a diploid inbred crop. This is only possible because haploidizing technology and selfing mutants were both discovered in NRSP6 germplasm-- *by NRSP6 staff*. And NRSP6 further supported the effort in the current project term by testing techniques and importing valuable new stocks. The ploidy manipulation technique that resulted in Yukon Gold was also developed with NRSP stocks--*by NRSP6 staff*. Wisconsin cooperators isolated and incorporated the gene providing durable resistance to late blight from a wild species that had been collected in Mexico and preserved and studied in the genebank long before its potential was recognized. Washington state collaborators incorporated potent nematode resistance. In 2017, Idaho collaborators reported incorporation of resistance to greening (responsible for 10-15% waste)-- *discovered by NRSP6 staff*. Cooperators used NRSP6 stocks to develop breeding stocks resistant to verticillium and scab, and donated those back to the genebank. NRSP6 staff helped Oregon State researchers identify germplasm with strong resistance to nematodes. We produced custom hybrids and propagules to help Industry partners breed lines with much greater levels of an anti-appetite compound aimed at reducing obesity. At least 70% of named US cultivars have our exotic germplasm in their pedigrees. For example, in Wisconsin, of the past 8 cultivar releases from the breeding program, 6 have wild species germplasm as parents obtained directly from NRSP6 (see detail below). NRSP6 staff bred cold tolerant families from which a new cultivar, Winay, was released in 2018 in Peru. Sequencing the potato genome depended on the use of genetic stocks from NRSP6 developed by cooperators at Virginia Tech. The revolutionary intragenic Innate potato lines from Simplot in Idaho were developed through the use of exotic germplasm from NRSP6. Two new potato pests—Zebra chip and *Dickeya*-- have become very serious in recent years. In the current NRSP6 project, we are cooperating with state and federal scientists in Colorado, Texas, New York, and Washington state, screening for and finding potent resistance in exotic germplasm from NRSP6. Folate deficiency causes severe birth defects. With help of NRSP6 staff, state scientists from Oregon identified wild species selections and custom hybrids available only from NRSP6 with high folate and a way to make screening for folate much easier. All these advances would not have been possible using germplasm in the common breeding pool. They needed to be accessed from exotic germplasm. And that exotic germplasm is *only* available in the USA from NRSP6. The use of NRSP6 germplasm by stakeholders has been very robust in the past, increasing knowledge and breeding products that have had a great positive impact on the crop-- and this process is increasing in the current project term.

WORK PLANS / STAFF & FUNDING / ADMINISTRATION

After 70+ years of multistate partnership, SAES decided NRSP6 should not be renewed, so it ended on September 30, 2020 and this is the final report. The exercise of writing the rejected request to continue FY21-25 at least provides a comprehensive report of activities for the past five years, as well as goals for the future (download from USPG website along with related docs for details). In summary the genebank will now continue with USDA/ARS funding pursuing these goals…

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. Continue study of status and dynamics of genetic diversity: core collection, cogs, how best to collect from the wild. 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. Continue service to industry partners that has been attracting their strong support, and similarly maintain strong ties with our sister genebanks around the world. Continue developing germplasm-use technology like big-tuber mutants, double pollination, and look for more efficient ways to evaluate germplasm, like specialized tuber-generating growth chambers. Continue screening for traits of high priority to both producer and consumer.

PUBLICATIONS

Many other scientists are publishing research that directly or indirectly originated from NRSP6 stocks. The search below in Digitop produced hits which the reader can regenerate. Staff publications (for 2020 and previous) which give details on the initiatives summarized above can be readily accessed through the personnel links for Bamberg, Spooner, and Jansky at the genebank website.

The search 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 2019 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. The result for 2019 is **147 papers**.

Keyword Anywhere(Solanum) AND Keyword Anywhere(abancayense or acaule or achacachense or acroglossum or acroscopicum or aemulans or agrimonifolium or ajanhuiri or alandiae or albicans or albornozii or ambosinum or andreanum or arnezii or astleyi or avilesii or aymaraesense or berthaultii or blanco-galdosii or boliviense or brachistotrichum or brachycarpum or brevicaule or buesii or bukasovii or bulbocastanum or burkartii or cajamarquense or canasense or candolleanum 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 dolichocremastrum 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 hypacrarthrum 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 paucissectum 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 spegazzinii or stenophyllidium or stipuloideum 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) AND Keyword Anywhere(USDA and Solanum and tuberosum)(DATE=2018-2018).