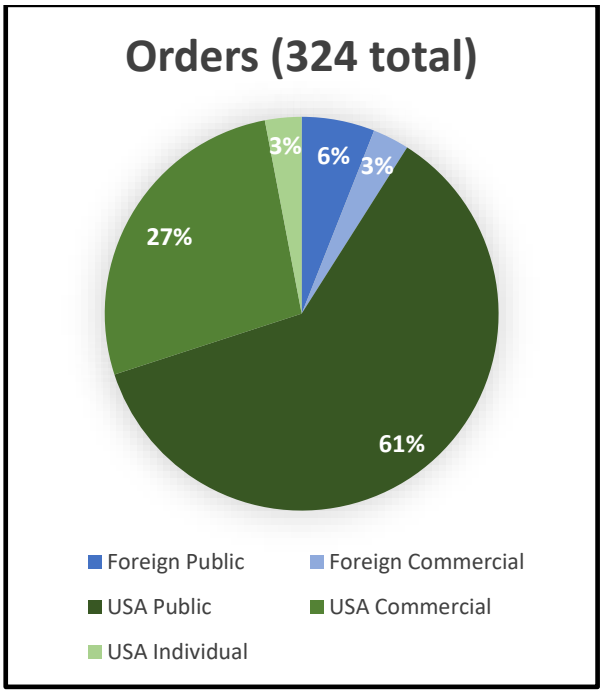
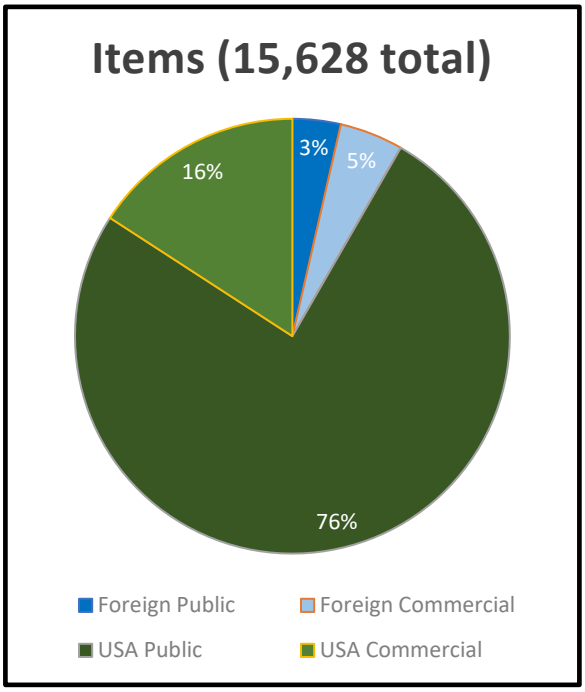
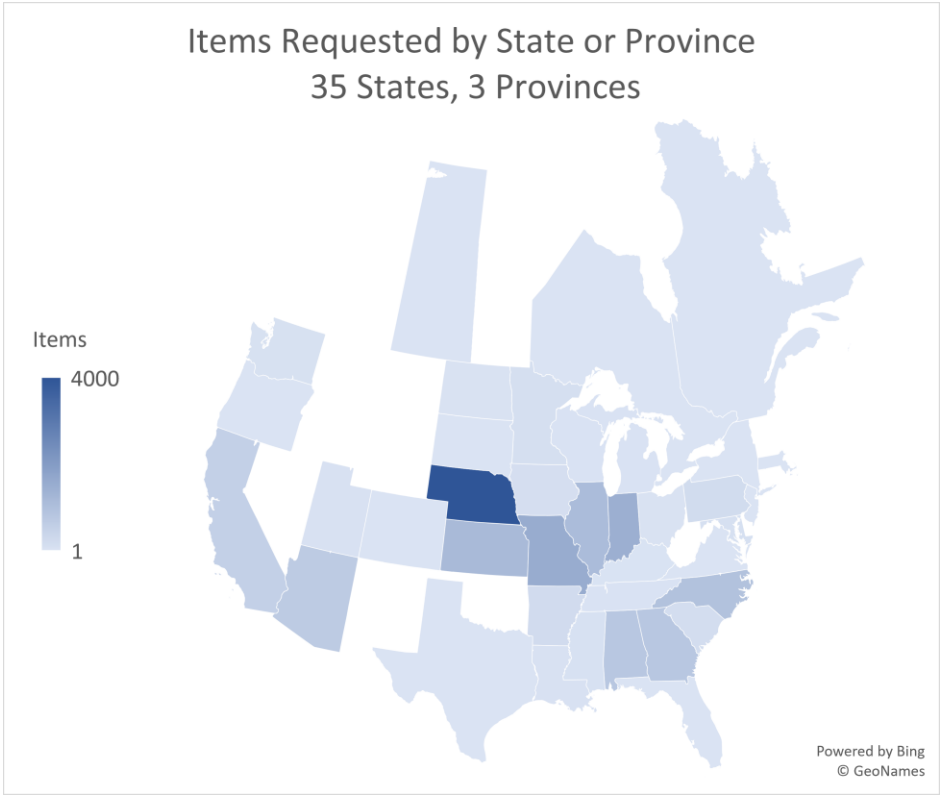
USDA SOYBEAN GERMPLASM COLLECTION REPORT -- 2020

February 2021

In 2020, we distributed 15,628 seed lots from 9,896 accessions from the USDA Soybean Germplasm Collection in response to 324 requests from 231 individuals in the United States and 18 countries. This included 9 requests for 86 seed packets of 73 perennial *Glycine* accessions. Requestors used the GRIN shopping cart accounted for 81% of the total orders filled. We also sent backup seeds of 164 accessions to the National Center for Genetic Resources Preservation (NCGRP).







We grew 2,656 accessions of *G. max* for seed replacement in the Collection: 1,635 accessions at Urbana, Illinois, 621 accessions at Stoneville, Mississippi and 400 accessions in Upala, Costa Rica planted in January. In Stoneville, 200 accessions of *G. soja* were increased. Due to COVID-19 travel restrictions, we were unable to visit the plots in Costa Rica to take notes but the staff took photos of the plots for us and included pods in the harvested seed that was sent back. In the greenhouse in Urbana, 32 perennial Glycine accessions were increased. Green plant, leaf, mature plant, and pod photos were taken of all plots grown in Urbana, and seed is being photographed from all seed lots as they are put away. Some images still need uploading, but a total of 3,500 were uploaded to GRIN in 2020 with a total of 16,479 Glycine images in GRIN.

Thirty-one accessions with expired Plant Variety Protection certificates were added to the collection. These included 3 germplasm releases, 4 modern cultivars, and 11 private varieties. One perennial accession that had been received as an unknown species was identified as Kudzu and inactivated.

Adam Mahan was hired as the new soybean curator, and Eric Moody as an Agricultural Scientist Research Technician.

Although not official, personnel changes are being made to the Urbana soybean germplasm CRIS project. The changes in appointment time are indicated below in bold with current appointment in parenthesis. David Walker's background is in plant breeding and the intent of these changes is to have him concentrate more with plant genetics research and phase out a portion of his work with plant pathology. David Neece will still be available to extract DNA and run marker analysis when necessary for the collection.
The current staff assigned to the Urbana soybean germplasm CRIS project are:

Adam Mahan, Geneticist (plants)	100%
Steve Clough, Research Geneticist (plants)	**0%** (50%)
Esther Peregrine, Agronomist	100%
Clint Heimann, Agricultural Scientist Research Technician (plants)	100%
Todd Bedford, Program Support Assistant	100%
Eric Moody, Agricultural Scientist Research Technician (plants)	100%
David Neece, Molecular Biologist	**0%** (50%)
David Walker, Research Geneticist (plants)	**100%** (50%)
Gad Yousef, Biological Science Technician	**100%** (50%)
Nancy Sanders, Program Support Assistant OA	26%

Susan Sherman-Broyles and Jeffery Doyle, Cornell University, have offered to conduct GBS on some of the perennial Glycine accessions to help clarify taxonomic classifications. DNA has been collected but work has been stopped due to COVID-19 restrictions.

David Hyten has continued to screen the collection targeting a 1x genome sequence coverage under a USB grant at the University of Nebraska. 4000 accessions were sent to him in 2020.

The National Plant Germplasm System will be adding transgenic cultivars to the active collection when the patents and PVPs on these cultivars expire. There are 20 Roundup Ready varieties off-patent with expired PVPs. General policies and procedures on how to handle such material have been established but specific procedures are still being finalized for approval by the NPGS.

Related to this, we have begun having the Illinois Crop Improvement Association test the rest of the collection for the adventitious presence of either version of the Roundup Ready gene. Seed lots were initially screened with lateral flow strip test immunoassays on bulk samples of several accessions, and then with greenhouse tests of 200 plants/accession if a strip test was positive. There were 5,159 seed lots tested, and all were negative. Lines that had very low levels of contamination in 2019 were re-pure lined in Urbana or Stoneville. Sampling is continuing with the goal to test all distributable seed lots but are limited by available personnel and funding. Tests for other genetically engineered traits such as Liberty will likely be needed in the future.

Illinois Crop Improvement Association also conducted a field inspection of our germplasm increases and identified all predominant foliar diseases present. It is often a requirement of international import permits to have the field inspected and certified free of diseases that are not even present in Illinois. We plan to make the field inspection an annual part of our operations into the future.

Germination tests were made on 1014 seed lots. Testing the seed viability is necessary to make informed decisions about when a particular seed lot should be regenerated. A request has also been made for CPRL funds to convert the portion of cold room space that contains the distributable seed lots from 10C to -18C. With colder storage, most seed can be kept longer before needing regeneration as evident from the backup samples now stored at -18C at NCGRP. With the collection currently housed in an aging facility which is past it's intended lifespan, there is great hesitancy to spend the required capital on cold room improvements until this issue is rectified. This is becoming more important as the collection increases in size and personnel decreases. Extending the time needed before regenerating seed also lessens the chances for errors and contamination which can occur during packaging, planting, growing, and harvesting.

Due to the addition of germination testing, we can readily identify seed lots with decreased germination rate due to mold and fungal infection. This planting season we are running a split-plot test on a subset of our increases with low germination rate. We are applying a seed treatment to half of a four-row plot and leaving the other half untreated. This should tell us to what degree seed treatment can improve our stands of 10-year old seed.

Improving and expanding cold storage capacity is priority 1. Priority 1a is rapidly cleaning and quality checking harvested seed increases. Currently seed lots are picked for clean seed by hand at an average of 30 minutes per seed lot, varying widely based on seed quality. A Vmek optical sorter (color sorter) can clean a large portion of the germplasm accessions in 5 minutes or less per sample, with very little hand picking needed. A small set of samples were analyzed with a color sorter at Purdue this year. This Spring, a trip will be made to the USDA North Central Region Plant Introduction Station in Ames, IA to run hundreds of samples through their color sorter. The goal is to show that the color sorter would indeed be highly useful for the soybean germplasm collection and to obtain a color sorter for the collection with end-of-year funding. The Vmek optical sorter costs $100,000+ and is cost prohibitive without a deliberate infusion of internal or external funds.

We have started to scan historical documents as PDFs to store in GRIN before they disintegrate. Reading each document to record which accession or inventory it refers to is a time-consuming process. At the moment, there are attachment tables for almost every main table in GRIN but the software necessary to upload them has only been written for order and inventory attachments. In the meantime, we are organizing our scanned documents so they will be ready to upload when the GRIN software is available. These are critical paper documents that are slowly deteriorating year by year as labor and resources are currently unavailable for this work.

We have two critical germplasm evaluation needs. Germplasm evaluation involves taking data on a host of phenotypes for two consecutive years. Upon completion, these observations are officially added to GRIN and visible to requestors. The first need is fatty acid analysis. For many years, this analysis was done for us by the USDA in Peoria, IL. Recently, budget cuts have resulted in them discontinuing the analysis for us. We have not been able to find a replacement for these services. The second need is a tropical environment to conduct a complete evaluation of MG 8-10 germplasm accessions.

Adam Mahan and Esther Peregrine
USDA Soybean Germplasm Collection
1101 W. Peabody Drive, Urbana, Illinois 61801

As of December 31, 2020, the Collection contained the following entries:

USDA Soybean Germplasm Collection Inventory

Annual subcollection	**Entries**
Introduced *G. max*	17546
G. soja	1179
Germplasm releases	245
Modern cultivars	560
Old cultivars	208
Private cultivars	716
All isolines	604
Pigment mutants	47
Genetic types	197
Annual subtotal	**21,302**

Perennial species	**Entries**
G. *arenaria*	5
G. *argyrea*	14
G. *canescens*	151
G. *clandestina*	112
G. *curvata*	9
G. *cyrtoloba*	50
G. dolichocarpa	13
G. *falcata*	30
G. *latifolia*	53
G. *latrobeana*	7
G. *microphylla*	35
G. peratosa	7
G. *pescadrensis*	68
G. *pindanica*	4
G. *rubiginosa*	37
G. *stenophita*	27
G. syndetika	6
G. *tabacina*	184
G. *tomentella*	354
G. unknown species	45
Perennial subtotal	**1,211**

Collection total 22,513

Number of accessions screened for which data is entered in GRIN:

Glycine max		
type	**descriptor**	**Accessions screened**
Chemical	ARGININE	5530
Chemical	CYSTEINE	5530
Chemical	human allergen P34	13304
Chemical	Iodine number	2820
Chemical	ISOLEUCINE	5530
Chemical	LEUCINE	5530
Chemical	Linoleic	22073
Chemical	Linolenic	22072
Chemical	LYSINE	5530
Chemical	METHIONINE	7515
Chemical	Oil	22165
Chemical	Oleic	21061
Chemical	Other fatty acid composition	5762
Chemical	Palmitic	21061
Chemical	Petiole Ureide	2497
Chemical	Protein	22165
Chemical	Stachyose	5522
Chemical	Stearic	21061
Chemical	Sucrose	5483
Chemical	THREONINE	5530
Chemical	TRYPTOPHAN	5530
Chemical	VALINE	5530
Disease	Bacterial pustule	3394
Disease	Bean Pod Mottle Virus	427
Disease	Brown stem rot	4031
Disease	Frogeye C-32 Isolate	1678
Disease	FROGEYE RACE 11	108
Disease	Frogeye race 2	2652
Disease	Frogeye, unspecified race	115
Disease	Northern Stem Canker	1467
Disease	Peanut Mottle Virus	2150
Disease	Phytophthora Rot Race 1	9950
Disease	Phytophthora Rot Race 10	623
Disease	Phytophthora Rot Race 12	640
Disease	Phytophthora Rot Race 17	2227
Disease	Phytophthora Rot Race 2	432
Disease	Phytophthora Rot Race 20	652
Disease	Phytophthora Rot Race 25	2834

Glycine max		
type	**descriptor**	**Accessions screened**
Disease	Phytophthora Rot Race 3	2816
Disease	Phytophthora Rot Race 30	115
Disease	Phytophthora Rot Race 30T	263
Disease	Phytophthora Rot Race 31	145
Disease	Phytophthora Rot Race 33	113
Disease	Phytophthora Rot Race 38	65
Disease	Phytophthora Rot Race 4	1472
Disease	Phytophthora Rot Race 5	791
Disease	Phytophthora Rot Race 6	139
Disease	Phytophthora Rot Race 7	2991
Disease	Phytophthora Rot Race 8	149
Disease	Phytophthora Rot Race 9	96
Disease	Pythium ultimum	1289
Disease	Southern Stem Canker	119
Disease	Soybean mosaic virus	15
Disease	Soybean mosaic virus Strain G1	236
Disease	Soybean mosaic virus Strain G2	107
Disease	Soybean mosaic virus Strain G3	236
Disease	Soybean mosaic virus Strain G4	26
Disease	Soybean mosaic virus Strain G5	107
Disease	Soybean mosaic virus Strain G6	236
Disease	Soybean mosaic virus Strain G7	236
Disease	Soybean Rust Mixed	434
Disease	Soybean Rust Red-Brown	102
Disease	Soybean Rust Tan	3084
Disease	Soybean Sudden Death Syndrome	6861
Growth	Height	17676
Growth	Stem termination type	25104
Insect	Beet armyworm	5
Insect	Corn Ear Worm	26
Insect	Defoliation	339
Insect	Leaf hopper injury	784
Insect	Mexican Bean Beetle damage	5046

Glycine max		
type	**descriptor**	**Accessions screened**
Insect	Soybean Aphid Resistance	4061
Insect	Soybean Looper	2278
Insect	Velvetbean caterpillar	126
Molecular	Maturity Locus E3	119
Morphology	Branching	2153
Morphology	Early shattering score	16063
Morphology	Flower color	25180
Morphology	Hilum color	22877
Morphology	Late shattering score	13266
Morphology	Lodging	17556
Morphology	Lower leaflet ratio	15
Morphology	Mottling score	14411
Morphology	Other leaf traits	1365
Morphology	Other plant traits	407
Morphology	Other seed traits	4234
Morphology	Pod color	26264
Morphology	Pod length	15
Morphology	Pubescence color	25188
Morphology	Pubescence density	25466
Morphology	Pubescence form	24521
Morphology	Seed coat color	22924
Morphology	Seed coat luster	21634
Morphology	Seed quality	17662
Morphology	Seed Shape of Glycine max	9571

Glycine max		
type	**descriptor**	**Accessions screened**
Morphology	Seed weight	17705
Morphology	Stem termination score	12556
Morphology	Upper leaflet length	15
Morphology	Upper leaflet shape	15
Nematode	Cyst Nematode Race 1	758
Nematode	Cyst Nematode Race 14	2548
Nematode	Cyst Nematode Race 2	234
Nematode	Cyst Nematode Race 3	12805
Nematode	Cyst Nematode Race 4	7404
Nematode	Cyst Nematode Race 5	11627
Nematode	Reniform Nematode	125
Other	Core Subset	1685
Other	Image	4120
Phenology	Flowering	18491
Phenology	Maturity date	23932
Phenology	Maturity group	18259
Phenology	Twining date	14
Production	Yield	17521
Root	Root Fluorescence	795
Stress	Chlorosis score	4617
Stress	High temperature	520
Stress	Salt reaction	564

Glycine soja		
type	**descriptor**	**Obs**
Chemical	human allergen P34	1118
Chemical	Linoleic	1243
Chemical	Chemical	1243
Chemical	Oil	1243
Chemical	Oleic	1243
Chemical	Other fatty acid composition	182
Chemical	Palmitic	1243
Chemical	Protein	1243
Chemical	Stearic	1243
Disease	Bean Pod Mottle Virus	117
Disease	Phytophthora Rot Race 3	448
Disease	Soybean mosaic virus	182
Growth	Height	182
Growth	Stem termination type	1
Insect	Beet armyworm	425

Glycine soja		
type	**descriptor**	**Obs**
Insect	Soybean Looper	379
Insect	Velvetbean caterpillar	408
Morphology	Flower color	185
Morphology	Hilum color	939
Morphology	Leaflet shape of Glycine soja	1060
Morphology	Leaflet size of Glycine soja	1060
Morphology	Lower Leaflet Area	1036
Morphology	Lower Leaflet Aspect	1049
Morphology	Lower Leaflet ratio	182
Morphology	Other leaf traits	38
Morphology	Other plant traits	3
Morphology	Other seed traits	299
Morphology	Pod color	1003
Morphology	Pod length	182
Morphology	Pubescence color	185

Glycine soja		
type	**descriptor**	**Obs**
Morphology	Pubescence density	1001
Morphology	Pubescence form	270
Morphology	Seed coat color	1040
Morphology	Seed coat luster	185
Morphology	Seed shape of G. soja	185
Morphology	Seed weight	182
Morphology	Upper leaflet length	182
Morphology	Upper leaflet shape	182
Nematode	Cyst Nematode Race 1	1078
Nematode	Cyst Nematode Race 3	545
Nematode	Cyst Nematode Race 4	1
Nematode	Cyst Nematode Race 5	547

Glycine soja		
type	**descriptor**	**Obs**
Other	Image	1847
Phenology	Flowering	1246
Phenology	Maturity date	1246
Phenology	Maturity group	185
Phenology	Twining date	182
Stress	Chlorosis score	21

Perennial *Glycine*		
Type	**Descriptor**	**Accessions screened**
	Core subset	115
	Image	3008
Chemical	Bowman-Birk Inhibitor	560
Cytologic	Chromosome number	861
Disease	Sclerotinia stem rot	777
Disease	Sudden death syndrome	754
Morphology	Adventitious roots	319
Morphology	Leaflet arrangement	291
Morphology	Upper pubescence type	290
Morphology	Upper terminal leaflet length	265
Morphology	Upper terminal leaflet shape	292
Morphology	Upper terminal leaflet width	293
Nematode	Soybean cyst nematode, race 3	490

Total orders items for all sites in the National Plant Germplasm System:

site	UARS	UFED	STA	UCOM	UPRU	UIND	UAID	INT	FGEN	FCOM	FPRU	FIND	Total
COR	11	7	81	81	41	876	0	0	0	6	6	3	1112
COT	2	0	15	7	0	52	0	0	0	0	1	0	77
DAV	8	0	58	49	17	87	0	0	2	3	3	0	227
GEN	2	1	24	24	10	191	0	0	0	0	1	25	278
GSOR	20	0	43	8	0	1	0	0	0	0	10	1	83
HILO	0	0	4	3	1	16	0	1	0	0	1	0	26
MAY	4	17	20	7	0	21	0	0	0	0	2	0	71
MIA	3	0	11	2	8	11	0	1	0	1	4	0	41
NA	3	1	28	14	6	35	0	0	0	1	3	0	91
NC7	56	4	330	235	44	179	0	3	4	124	125	20	1124
NE9	6	2	53	29	8	20	0	0	0	17	26	4	165
NR6	19	3	47	13	2	75	0	0	0	1	11	2	173
NSGC	41	1	156	70	5	47	0	1	1	37	112	8	479
NSSL	17	0	2	2	2	0	0	0	0	0	0	0	23
OPGC	0	0	8	2	1	5	0	0	0	1	1	0	18
PARL	6	0	7	5	1	7	0	0	0	4	8	0	38
PVPO	3	0	0	0	0	0	0	0	0	0	0	0	3
S9	25	5	219	86	20	161	0	1	2	58	48	6	631
SOY	45	2	149	86	0	10	1	0	0	9	21	1	324
TOB	1	1	22	7	1	14	0	0	0	4	5	1	56
W6	46	7	237	122	30	186	2	0	3	50	83	19	785