THE SUNFLOWER COLLECTION AT THE NORTH CENTRAL REGIONAL PLANT INTRODUCTION STATION

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Abstract

We have described the *Helianthus* L. germplasm collection in the National Plant Germplasm System of the United States. This collection is held at the North Central Regional Plant Introduction Station in Ames, Iowa, USA where we work to acquire, maintain and characterize the collection as well as to conduct germplasm-related research. Sunflower germplasm is available at no cost for research, crop improvement and product development worldwide.

Introduction

The sunflower (*Helianthus* L.) germplasm collection in the National Plant Germplasm System (NPGS) of the United States is held at the North Central Regional Plant Introduction Station (NCRPIS) in Ames, IA. The collection contains 47 of the 49 recognized *Helianthus* species (Seiler and Rieseberg, 1997), 36 of which are perennials and 13 of which are annuals, including the cultivated species, *Helianthus annuus*. Sunflower originated in North America and is well distributed across North America, although a number of *Helianthus* species have restricted ranges. Three of the species are on the U.S. Fish and Wildlife list of threatened and endangered species.

At NCRPIS, we work to acquire, maintain and characterize sunflower germplasm, conduct germplasm-related research, and provide sunflower accessions for research, crop improvement and product development worldwide. This article describes the sunflower collection at NCRPIS and briefly outlines some of the recent research we have conducted using this germplasm.

Materials and Methods

New germplasm is obtained by donations and field collections. In 2003, we received seed for 28 wild sunflower accessions donated after a field collecting trip by Gerald Seiler and Tom Gulya (USDA Sunflower Research Unit, Fargo, ND).

Increases of cultivated *H. annuus* accessions are direct seeded except for accessions with a low quantity of seed or with low germination. These accessions are started in the greenhouse and transplanted to the field. Wild sunflower accessions are germinated either on germination paper or in germination boxes. Germination paper in the boxes is saturated with a low concentration of gibberellic acid (usually 1 mM). The seeds are incubated for 2 weeks at 4C before being moved to germinators (20/30C, 12/12 hr light/dark cycles or 15/25C, 14/10 hr light/dark cycles). For the 2004 increases, we have experimented with clipping the non-embryo end of the seeds to improve germination and to eliminate the two week cold treatment. Seedlings are transplanted to book flats and established in the greenhouse before transplanting to the field. Wild accessions are caged before flowering to maintain the genetic integrity of each accession. Bees are introduced into the cages to insure adequate pollination. For most of the cultivated accessions we bag the primary inflorescence and hand pollinate to encourage maximum seed set. Efforts are made during hand pollination to mix the pollen within each population. Seed is stored at 4C, 35% humidity after harvesting, drying and cleaning.

We use a two-part disease management plan to ensure production of *Plasmopara halstedii* (Farl.) Berl. and de Toni free seed. *Plasmopara halstedii* causes downy mildew and is the major phytosanitary issue for seed exported from the United States. Seeds intended for direct seeding in the field are treated with Allegiance (metalaxyl) fungicide. Well before flowering (V6-V8), all plants in the field are visually inspected for systemic downy mildew infection. Infected plants are rarely found, but when encountered are physically removed from the field. A second inspection is done 5-7 days later. Plants are also inspected for symptoms of bacterial and viral diseases. Field inspections have been conducted since 1990. Seed lots produced before 1990 are generally treated with metalaxyl fungicide prior to overseas shipment.

Observations are collected over the growing season. Descriptor information is also contributed by our collaborators at the USDA Sunflower Research Group in Fargo, ND. The 176 descriptors defined for sunflower observations are sorted into 12 categories. All information is entered into the Germplasm Resources Information Network (GRIN) database maintained by the Database Management Unit of NPGS. GRIN is accessed at http://www.ars-grin.gov/npgs/searchgrin.html. Descriptor information is available in the 'research crops and descriptor evaluation data queries' option. Accession information is available in the 'accession area queries' option.

Results

The NCRPIS collection currently contains 3860 accessions representing 47 *Helianthus* species (Table 1). There are also several categories of hybrid accessions in the collection (*Helianthus* sp., *Helianthus* hybrid, *H.* x *laetiflorus* and *H.* x *multiflorus*). The largest proportion of the collection represents wild (26%) and cultivated (43%) *H. annuus* accessions of which 89% are available for distribution. Non-*Helianthus annuus* wild accessions account for 30% of the collection. Non-*H. annuus* annual wild accessions are 71% available; perennial wild accessions are 18% available. *Helianthus* accessions in the hybrid groups represent 1% of the collection and are 48% available. In 2003, we distributed 1485 items representing 1007 different accessions, 26% of the accessions in the collection. More than

half of the distributed items (58%) were wild *Helianthus* accessions. Sixteen percent of the distributed items were sent overseas.

Table 1. *Helianthus* species in the NCRPIS collection. Perennial species are shown in bold face type.

Species	# of accessions	# available accessions
H. agrestis	5	0
H. angustifolius	19	0
H. annuus (cultivated)	1670	1579
H. annuus (wild)	1006	798
H. anomalus	12	2
H. argophyllus	48	8
H. arizonensis	2	0
H. atrorubens	18	2
H. bolanderi	44	0
H. californicus	3	0
H. carnosus	1	0
H. ciliaris	6	1
H. cusickii	4	0
H. debilis subsp. *cucumerifolius*	7	7
H. debilis subsp. *debilis*	26	12
H. debilis	1	0
H. debilis subsp. *silvestris*	22	22
H. debilis subsp. *tardiflorus*	5	5
H. debilis subsp. *vestitus*	3	3
H. decapetalus	33	17
H. deserticola	12	1
H. divaricatus	42	7
H. eggertii	2	0
H. floridanus	5	0
H. giganteus	34	2
H. glaucophyllus	2	0
H. gracilentus	6	0
H. grosseserratus	48	11
H. heterophyllus	9	0
H. hirsutus	21	0
H. (hybrid)	21	12
H. laevigatus	8	0
H. longifolius	1	0
H. maximiliani	80	37
H. microcephalus	15	0
H. mollis	29	8
H. neglectus	28	28
H. niveus subsp. *canescens*	16	13

Table 1. (Continued)		
H. niveus subsp. *tephrodes*	2	1
H. nuttallii	10	6
H. nuttallii* subsp. *nuttallii	22	13
H. nuttallii* subsp. *rydbergii	12	12
H. occidentalis	1	0
H. occidentalis* subsp. *occidentalis	2	1
H. occidentalis* subsp. *plantagineus	14	3
H. paradoxus	10	0
H. pauciflorus	12	6
H. pauciflorus* subsp. *pauciflorus	13	0
H. pauciflorus* subsp. *subrhomboideus	19	5
H. petiolaris subsp. *fallax*	31	29
H. petiolaris	15	13
H. petiolaris subsp. *petiolaris*	108	97
H. praecox subsp. *hirtus*	8	7
H. praecox	2	2
H. praecox subsp. *praecox*	8	8
H. praecox subsp. *runyonii*	24	24
H. pumilus	6	1
H. radula	18	0
H. resinosus	10	0
H. salicifolius	3	0
H. schweinitzii	1	0
H. silphioides	5	0
H. simulans	4	1
H. smithii	2	0
H. (species ?)	14	10
H. strumosus	42	8
H. tuberosus	116	5
H.* x *laetiflorus	12	1
H.* x *multiflorus	1	0

Discussion

Previous seed increase efforts at NCRPIS focused on making at least 90% of the cultivated *H. annuus* accessions available. Discounting accessions not distributable due to CSR restrictions, that portion of the collection is now 91% available. Over the past 10 years, available wild *H. annuus* increased to 79%. Non-*H. annuus* wild accessions are 39% available and we are now focusing our efforts on expanding the availability of these accessions. The wild accessions tend to have various dormancy requirements that affect germination. Perennial species from the southern and southwestern United States and Mexico do not overwinter well in Ames. In addition, the growing season in Ames can be too short for wild annual accessions from southern regions. To address some of these regeneration issues, a sunflower nursery has been established at the NPGS site in Parlier, CA (National Arid Land

Plant Genetic Resources Unit). We have 20 perennial accessions established there for 2004 harvest and Parlier will increase the nursery to 40 accessions during the 2005 growing season.

Brothers and Miller (1999) established a core subset of cultivated *H. annuus* species based on a statistical analysis of passport and descriptor data which grouped cultivated accessions into 10 clusters. The core subset is comprises 112 accessions selected from the 10 clusters (roughly 10% from each cluster). We manage our seed increases so that seed is available for all core accessions. Preliminary isozyme analyses using the core species and a set of 112 random accessions identified some rare alleles not present in the core subset, which suggests that the core subset needs to be enlarged. However, the current core subset of cultivated accessions remains useful as starting germplasm for preliminary screening of the sunflower collection for new traits.

As part of our mission to conduct germplasm-related research, we conduct germplasm screening for disease resistance. Roughly 1000 accessions of cultivated and 400 accessions of wild *H. annuus* were evaluated for *Alternaria* leaf blight resistance caused by *Alternaria helianthi* (Hansf.) Tub. and Nish. Little resistance was found in cultivated accessions, but excellent resistance existed in some of the wild species accessions. In addition, 128 wild *H. annuus* accessions were evaluated for *Septoria* leaf blight resistance, caused by *Septoria helianthi* Ell. and Kell. Two populations of wild *H. annuus* germplasm were developed through recurrent phenotypic selection for resistance to both *Alternaria* and *Septoria* leaf blights. These populations exhibited a hypersensitive type of leaf spot resistance not found in cultivated sunflower. The resistance has not been transferred into cultivated sunflower, but the populations are available to those interested in developing *Alternaria* and *Septoria* resistant germplasm.

The sunflower collection maintained by the NCRPIS is a very diverse collection. Sunflower germplasm is available for research purposes at no cost to the user. Samples may be obtained by ordering through GRIN or by contacting the senior author at lmarek@iastate.edu. Photographs of our germination and field conditions are available in the ISC2004 folder at http://www.ars-grin.gov/ars/MidWest/Ames/Crops_New/Sunflower.html.

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