Collection of *Helianthus anomalus* (Sand Sunflower) from the Southwestern United States

Gerald J. Seiler[1] and Laura Fredrick Marek[2]

[1]USDA-ARS, Northern Crop Science Laboratory, Fargo, ND

[2]Iowa State University and USDA-ARS, NCR Plant Introduction Station, Ames, IA

Abstract

Genetic resources are the biological basis of global food security. Collection and preservation of wild relatives of important crop species such as sunflower provides the basic foundation to promote and sustain the crop. Acquisition through exploration is the initial step in the germplasm conservation process. There are 53 species of wild *Helianthus* (39 perennial and 14 annual) native to North America. An exploration covering 3700 km to the desert southwest US in June of 2015 led to the collection of eight *H. anomalus* (sand sunflower) accessions. All populations were collected throughout the broad distributional range of the species. *Helianthus anomalus* is a rare endemic xerophytic annual species found in desert sand dune and swale habitats of Utah and northern Arizona. Sand sunflower is a diploid species of hybrid origin endemic to active sand dunes, an extreme environment differing from that of its parents, *H. annuus* and *H. petiolaris*. It has been frequently recognized as drought tolerant, with the largest achenes of any wild species and high oil concentration potential, and thus is a candidate for improving cultivated sunflower. Population size, habitat, soil type, seed set, the presence of diseases and insects, and other wild sunflower species located near the collection sites were recorded for each population. This germplasm will be important in the future as a genetic resource to combat emerging pests, and environmental challenges helping to maintain sunflower as a viable global crop and to preserve it for future generations.

Introduction

Collection and preservation of wild relatives of important crop species such as sunflower provides the basic foundation to promote and sustain the crop. Genetic resources are the biological basis of global food security. Acquisition through exploration is the initial step in the germplasm conservation process. There are 53 species of wild *Helianthus* (39 perennial and 14 annual) native to North America (Heiser et al.,1969; Schilling, 2006). The narrow genetic base of cultivated sunflower has been broadened by the infusion of genes from the wild species, which have provided a continuous source of agronomic and economic traits for cultivated sunflower (Seiler and Rieseberg, 1997; Seiler and Marek, 2011; Kane et al., 2013; Seiler and Jan, 2014).

Helianthus anomalus (sand sunflower) is a diploid annual species endemic to active desert dunes and swale habitats in Utah and Arizona. It is of hybrid origin occupying an extreme environment compared to its parental species, *H. annuus* and *H. petiolaris* (Ludwig et al., 2004). It has been frequently recognized as drought tolerant, with the largest achenes of any wild species and high oil concentration potential (Seiler, 2007), and thus is a candidate for improving cultivated sunflower (Nabhan and Reichhardt, 1983; Seiler and Marek, 2006). It also appears to be more tolerant of nutrient stress than its ancestral parents based on a lower relative growth rate and higher nutrient-use efficiency (Brouillette and Donovan, 2011).

Unfortunately, very few populations of *H. anomalus* have been collected and only a few are available in the USDA-Agricultural Research Service sunflower germplasm collection for research purposes. Also, there are difficulties in regenerating the limited seed from the original populations. The objective of the study was to undertake an exploration in Utah and Arizona in June instead of September-October to collect the winter-spring populations of this species from its distributional range.

Materials and Methods

The sunflower exploration for *H. anomalus* took place from June 14 to June 22, 2015. The exploration covered 3700 km in two states, Utah and Arizona. Seed heads were collected from 10 to 250 plants within each population and bulked into a single sample. Herbarium specimens were deposited in the USDA-ARS wild *Helianthus* herbarium at Fargo, ND. The achene samples were deposited at the USDA-ARS North Central Regional Plant Introduction Station, Ames, Iowa, where they are maintained and distributed.

All populations were collected from the restricted distributional range of the species in Utah and Arizona (Figure 1). Prior locations and generalized distribution maps were used to locate populations. Population size (number and extent), habitat, soil type, seed set per head, and the presence of diseases, insects, and other wild sunflower species were recorded for each population.

Results and Discussion

The exploration was successful in collecting eight representative populations of *H.* anomalus from its distributional range in Utah (Table 1). A single population was located in Arizona, but the plants were just flowering and no seeds were collected (Figure 2). It has been 15 years since this species was last collected for the wild sunflower germplasm collection (Seiler and Brothers, 2003). Attempts to recollect this endemic species over the last quarter century have met with mixed results. An attempt in September of 2000 was made to recollect 12 populations collected in the fall of 1980 which failed to relocate any of the 1980 populations (Seiler and Brothers, 2003). The species appears to be very sensitive to the prevailing fall-winter and spring-summer moisture conditions. The current exploration during June located several populations of sand sunflower mainly due to the excessive spring rains in several parts of the species distributional range.

Figure 2 shows the typical habitat of the only population of *H. anomalus* located in Arizona. Unfortunately, few plants were found with no mature seeds to collect. Figure 3 shows one of the diverse habitats where *H. anomalus* grows on top of sandy hummocks with the wind causing the sand to shift and appear as waves in the sand. Figure 4 shows typical plants with multiple branches and heads, light shiny green leaves, and whitish stems. Figure 5 shows the unique tap root that develops to help plants survive the constant shifting sand on the dunes. Figure 6 shows a unique habitat for *H. anomalus* in a draw on the steep slope of a shifting sand dune. Figure 7 shows dried white plant stalks from the previous season(s) confirming that the population is thriving.

Figure 2. Gerald Seiler standing next to the single *Helianthus anomalus* population found near Dennehesto, AZ in a shifting sand dune. Only a few plants with no mature seed were found.

Figure 3. *Helianthus anomalus* (ANO-2810) on hummock sand dunes in San Juan County, Utah, SW of Cal Black Airport. Notice the wave pattern in the sand from the wind shifting the sand in the dunes.

Figure 4. Population AN0-2811 in San Juan County, Utah, SE of Halls Crossing in shifting sand dunes. Typical plants with multiple branches, light shiny green leaves, and whitish stems.

Figure 5. Population ANO-2813 in Garfield County, Utah along Burr Trail Rd in shifting sand dunes near roadside. Notice the spangled root that developed to anchor the plant in the actively shifting sand dunes.

Figure 6. Population AN0-2817 in Garfield County, Utah, SE of Fry Canyon with the sunflowers growing in a draw of steep slope of the shifting sand dune.

Figure 7. Laura Marek collecting seed in population ANO-2813 in Garfield County, Utah along Burr Trail Rd in shifting sand dunes. Note the dead white plant stalks from the previous season(s).

Figure 1. Distribution of *Helianthus anomalus* (sand sunflower) in Utah and Arizona in the desert southwest US.

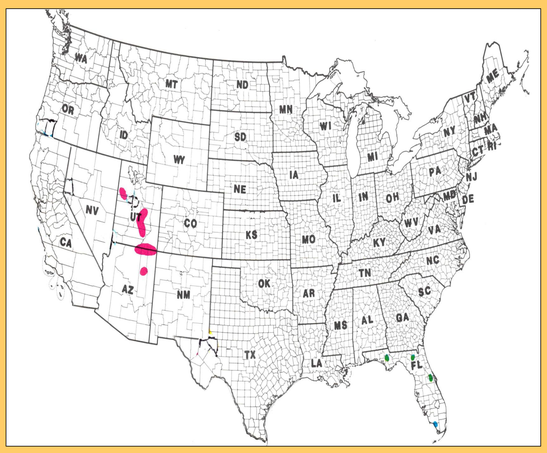

Table 1. *Helianthus anomalus* identification number**,** elevation, location, habitat, and population size collected in June, 2015.

Identification Number	Elevation (ft)	Location	Habitat	Population Size
ANO-2810	4308	San Juan Co., SW of Cal Black Airport	Shifting sand dunes, roadside	200
ANO-2811	4770	San Juan Co., SE of Halls Crossing	Shifting sand dunes, roadside	750
ANO-2813	3771	Garfield Co., Burr Trail Rd	Shifting sand dunes, roadside	1000
ANO-2815	5820	Kane Co., Hole-in-the-Rock Rd	Shifting sand dunes, roadside	200
ANO-2817	4584	Garfield Co., SE of Fry Canyon	Shifting sand dunes, steep slope	250
ANO-2818	4686	Wayne Co., near Hanksville	Shifting sand dunes, roadside	200
ANO-2819	5463	Wayne Co., Hans Flat Rd	Shifting sand dunes	100
ANO-2820	5147	Emery Co., Hans Flat Rd	Shifting sand dunes	1000

Conclusion

The addition of eight populations of *Helianthus anomalus* to the wild sunflower germplasm collection represents the first germplasm collected in almost 15 years. The added populations are important as a genetic resource to combat emerging pests and environmental challenges, helping to maintain sunflower as a viable and competitive global crop and to preserve it for the future generations.

References

Brouillette, L.C., and L.A. Donovan. 2011. Relative growth rate and functional traits of a hybrid species reflect adaption to a low fertility habitat. Int. J. Plant Sciences 172(4):509-520.

Heiser, C.B., D.M. Smith, S.B. Clevenger, and W.C. Martin. 1969. The North American sunflower (*Helianthus*). Mem. Torr. Bot. Club 22:1-218.

Kane, N., J. Burke, L. Marek, G.J. Seiler, F. Vear, G. Baute, S. Knapp, P. Vincourt, and L. Rieseberg, L. 2013. Sunflower genetics, genomics and ecological resources. Mol. Ecol. Resour. 13:10-20.

Ludwig, F., D.H. Rosenthal, J.A. Johnston, N. Kane, B.L. Gross, C. Lexar, S.A. Dudley, L.H. Rieseberg, and L. Donovan. 2004. Selection on leaf ecophysiological traits in a desert hybrid *Helianthus* species and early generation hybrids. Evolution 58(12):2682-2692.

Nabhan, G.P., and K.L. Reichhardt. 1983. Hopi protection of *Helianthus anomalus*, a rare sunflower. Southwest Nat. 28:231-235.

Schilling, E. E. 2006. *Helianthus*. In: Flora of North America Editorial Committee, eds. Flora of North America North of Mexico. New York and Oxford. Vol. 21, pp. 141-169.

Seiler, G.J. 2007. Wild annual *Helianthus anomalus* and *H. deserticola* for improving oil content and quality in sunflower. Ind. Crops Prod. 25:95-100.

Seiler, G.J., and M. Brothers. 2003. Exploration for wild *Helianthus anomalus* and *H. deserticola* in the desert southwest USA. Proc. 25th Sunflower Research Forum, Fargo, ND, January 16-17. http://www.sunflowernsa.com/uploads/research/90/90.PDF.

Seiler, G.J. and C.C. Jan. 2014. Wild sunflower species as a genetic resource for resistance to sunflower broomrape (*Orobanche cumana* Wallr.). Helia 37(61):129-139.

Seiler, G.J., and L. Marek. 2006. Exploration for wild *Helianthus* species from the desert southwestern USA for potential drought tolerance. Helia 29(49):1-10.

Seiler, G.J., and L. Marek. 2011. Germplasm resources for increasing the genetic diversity of global cultivated sunflower. Helia. 34(55):1-20.

Seiler, G.J., and L.H. Rieseberg. 1997. Systematics, origin, and germplasm resources of wild and domesticated sunflower. In: Schneiter, A.A. (Ed.), Sunflower Technology and Production. Crop Science Society of America, Madison, WI., pp. 21-65.