

Investing in Germplasm to Generate Value for the Nursery Industry[©]

Mark P. Widrechner

Iowa State University, Departments of Horticulture and of Ecology, Evolution & Organismal Biology, Bessey Hall, Ames, Iowa 50011, USA

Email: mpwskd@aol.com

INTRODUCTION

The economic success of nursery production is intimately connected with the array of plants being grown for sale. This array is a constantly changing mix of species and cultivars. Tastes change, resource availability and costs change, pests and pathogens evolve, and, every day, those involved with breeding and cultivar development deliver new choices bred and selected from a very diverse range of plants to propagators and growers. The ultimate goal for each firm is to develop an inventory of selected plants that gives value and satisfaction to their customers while ensuring profitable production.

If we look carefully at this situation, it's clear that plant biodiversity is the foundation of the new cultivars that feed changing tastes, allow for more efficient resource use, and hold the keys to pest and pathogen resistance. That diversity, which I'll refer to as germplasm, exists in many forms and places, from natural plant communities to public gardens, private collections and genebanks. In this paper, I'd like to present information about how the U.S. National Plant Germplasm System (NPGS) has gone about involving its customers in the process of building valuable, comprehensive germplasm collections for plant genera of interest to IPPS members, along with a few budding success stories.

Those who select and breed new cultivars or who seek out choice, but forgotten ones, can access germplasm in many ways. They can explore the wilds or they can search seedling beds and production fields, private collections, or gardens. Most of that requires special knowledge of the range of cultivars already in the trade (and their strengths and weaknesses), of where and when to look, and of ways to get permission from land, nursery, or garden owners. Of course, some public gardens and arboreta do make their collections available via web-based inventories and procedures that facilitate access for research and cultivar development. The North American Plant Collections Consortium (NAPCC), coordinated by the American Public Gardens Association (APGA), is designed to promote both straightforward access to significant germplasm collections held by its member gardens and high curatorial standards to ensure their long-term conservation (APGA, 2013). But the focus of this paper is on the NPGS, an extensive network of genebanks coordinated by the U.S. Department of Agriculture – Agricultural Research Service (USDA-ARS). The NPGS conserves one of the world's largest national collections of crop germplasm, including many ornamental plants, and it makes that germplasm freely accessible for research and education, with many potential (if sometimes indirect) benefits to IPPS members.

THE U.S. NATIONAL PLANT GERMPLOSM SYSTEM & CROP GERMPLOSM COMMITTEES

The Combined Proceedings of the IPPS includes a fairly recent paper that describes the NPGS and how its collections can meet members' needs (Widrechner, 2009). In relation to ornamental plants, the overall network of genebanks noted therein has changed relatively little in the last few years. In addition, guidelines concerning members' access to NPGS germplasm for research and education have also remained stable. However, the NPGS's holdings have continued to expand in attempts to fill important collection gaps, and considerable knowledge has been gained about many of its collections. These advancements have been, in large part, due to two important granting programs, ones that receive significant input from 42 Crop Germplasm Committees (CGCs).

The CGCs were first established in the 1980s to help the NPGS establish standard lists of descriptors used to describe collections (Robbins et al., 2008). These committees are organized by crop, or by groups of related crops. A list of all CGCs and links to their

activities can be found on the Germplasm Resources Information Network (GRIN) website (USDA-ARS, 2012). GRIN is working database of the NPGS. It contains a wealth of publicly accessible information, including plant taxonomy and distribution (with an emphasis on cultivated plants and their wild relatives), original sources of collections, descriptive data, and imagery. It allows customers to request germplasm through its “shopping cart” feature and also serves as an internal NPGS management tool for quality assurance and inventory monitoring. GRIN software has recently been totally reworked for broader applicability across the world’s genebanks, and a new version, GRIN-Global, is now being implemented (Postman et al., 2010).

The two CGCs of greatest interest to IPPS members are the Woody Landscape Plant and the Herbaceous Ornamental CGCs. These are large committees that include members from academia, government agencies, public gardens, trade associations, and commercial seed and nursery firms. These two CGCs have very wide-ranging mandates both in terms of crop genera and production environments. Their members are typically chosen to represent a broad range of crop specialties, disciplinary expertise, and geographic locations.

Crop Germplasm Committees members share expertise and consult with NPGS curators and site managers through regular (often annual) physical meetings or via teleconferences and electronic communications. In addition to the development of descriptor lists (their original mandate), CGCs develop crop vulnerability statements and advise NPGS personnel about threats to germplasm, anticipated uses, opportunities for acquisition, and efficient methods for safe conservation (Robbins et al., 2008). The Woody Landscape Plant and Herbaceous Ornamental CGCs are also deeply involved with two key granting programs funded by USDA-ARS that are relatively small, but significant investments in germplasm and, when successful, ultimately generate value for users.

BUILDING COMPREHENSIVE COLLECTIONS

One big challenge in the search for germplasm is that most germplasm holders have relatively few collections of any given species. Without large, comprehensive collections, it is hard to judge the merits of any given plant, because plant performance can be so closely tied to local growing conditions. Even major arboreta often maintain only a handful of accessions of a given species, and those accessions are typically represented by few individuals, sometimes a single plant (which in the case of a clonal cultivar may be all that is needed).

The NPGS and its users have long recognized the need to assemble extensive collections to provide broad genetic and phenotypic representation. For many field crops and for fruits and vegetables, collections numbering into the thousands of accessions were often brought together even before the CGCs were established in the 1980s. But many ornamental genera were not initially well represented within the NPGS. Fortunately, the USDA-ARS’s Plant Exchange Office coordinates an annual granting program to support germplasm exploration, and that office looks to the CGCs to work together with curators to identify the most important collection gaps and solicit proposals for explorations that attempt to fill those gaps (Williams, 2005).

Here I will mention three notable examples where the granting program has been successful in building comprehensive collections of ornamental genera. In 1997, funds were granted to Kathy McKeown to coordinate the collection of a broad cross-section of native *Echinacea* populations from across its native range in the United States (Widrechner and McKeown, 2002). This grant was successful in generating the core of one of the world’s premier collections of wild *Echinacea* germplasm, which is widely used by both biomedical and horticultural researchers (McCoy et al., 2005; Birt et al., 2008).

The unintentional introduction of emerald ash borer (*Agrilus planipennis*) into North America in the 1990s has resulted in the tragic loss of millions of ash trees from both forested stands and managed landscapes. Given the importance of *Fraxinus* as a landscape and timber tree and its uses in conservation, the NPGS along with many other

agencies has mounted a national effort to conserve ash seeds before native populations are driven to extinction. These efforts were described in a recent volume of the Combined Proceedings IPPS (Widrechner, 2012), but to update the role of the exploration grants, I can report that this program has now awarded 11 grants to collect *Fraxinus* (both in the USA and China) since 2007, and that the North Central Regional Plant Introduction Station in Ames, Iowa presently conserves 376 ash accessions.

More recent exploration efforts to build comprehensive collections of herbaceous ornamentals have been undertaken by the Ornamental Plant Germplasm Center (OPGC) in Columbus, Ohio, where the granting program has funded trips to collect seeds and vegetative propagules of *Rudbeckia*, *Coreopsis*, and *Phlox*. Explorations to expand the *Phlox* collection have been particularly successful and are summarized in a recent paper by Zale and Jourdan (2012).

GERMPLASM EVALUATION AND VALUE

By surveying hundreds of germplasm users, Day-Rubenstein et al. (2006) were able to determine that the extent and quality of descriptive information about each available germplasm collection have a significant influence on the perceived value of those collections. Without such information, searching for useful traits can be like seeking the needle in the proverbial haystack. The more that targeted evaluation and characterization data are captured and linked to specific germplasm accessions, the more likely one can efficiently limit searches for the most promising accessions. This is particularly important when navigating large collections of hundreds, if not thousands, of accessions.

About 30 years ago, the USDA-ARS Office of National Programs (ONP) realized that there were major gaps in the evaluation and characterization of horticultural crops. Parallel to the exploration granting program, ONP established a small granting program to support the evaluation and characterization of horticultural crop genera, based on priorities set by the pertinent CGCs. In addition, the CGCs annually solicit and rank proposals to support research that meets their priorities and generates data to populate GRIN. Since 2004, there have been 15 highly ranked proposals forwarded to ONP by the Herbaceous Ornamental and Woody Landscape Plant CGCs that have received funding (P. Bretting, pers. commun.). In closing, I will focus on two genera: *Aronia* and *Phlox*.

In 2007, Mark Brand at the University of Connecticut received a grant to conduct horticultural evaluation and cytological characterization of *Aronia* accessions. At that time, Brand had already been investigating the range of variation within the genus and its potential as an alternative to invasive non-native shrubs in the landscape and as a new fruit crop. He has collaborated closely with the North Central Regional Plant Introduction Station in Ames, Iowa, to assemble comprehensive collections of native *Aronia* populations and a sampling of cultivars. Many of these collections have now been assessed for a range of morphological, phonological, and aesthetic traits and for ploidy level (Brand, 2010; Leonard et al., 2013). Research is also underway to evaluate variation in fruit biochemistry related to potential human-health benefits (Taheri et al., 2013). The data generated by such efforts should be instrumental in selecting the best germplasm accessions for both landscape and nutraceutical applications.

The *Phlox* accessions that are being conserved by the OPGC have been subjected to many evaluations. Two projects supported by ONP's grants are studying the storage life of cut stems of *Phlox* and variation in petal color and pigment composition. In addition, Zale and Jourdan (2012) reported on interspecific hybridization among *Phlox* accessions and ploidy-level determinations. And work is now underway to assess these accessions for powdery-mildew resistance (P. Jourdan, pers. commun.), a pathogen that typically limits the use of *P. paniculata* cultivars (Hawke, 2011).

As these evaluation and characterization data are loaded into the GRIN database where they can be analyzed and used for cultivar selection and development, relatively small investments (most of these grants are for less than \$20,000) in NPGS collections have the potential to pay big dividends, ultimately creating new value for those who use these

comprehensive NPGS collections to improve the array of plants available for growers and gardeners alike.

QUESTIONS AND ANSWERS

Tony Sanchez: Is the ONP funding the *Aronia* collection?

Mark Widrlechner: The ONP funded the evaluations. The collections have been funded primarily through the University of Connecticut.

Tony Sanchez: Who does most of the collecting around the country. Is it individuals, people related to the UCs or other universities or someone else?

Mark Widrlechner: Most collecting projects are initiated by curators of the germplasm sites or by university researchers who are interested in working with a particular crop. There hasn't been a great deal of industry involvement directly with the exploration proposals; however, there has been considerable interest from botanical gardens. For example, the Chinese ash collections were all done in conjunction with the Morton Arboretum.

ACKNOWLEDGMENTS

I'd like to thank Mark Brand, Peter Bretting, Jeff Carstens, Pablo Jourdan, and Karen Williams for sharing information and images and to Chris Ames and all the organizers of the Western Region IPPS meeting for inviting me to speak.

Literature Cited

- APGA. 2013. What is the NAPCC? Accessed online Sept 2013 at <<http://www.publicgardens.org/napcc>>
- Birt, D.F., Widrlechner, M.P., LaLone, C.A., Wu, L., Bae, J., Solco, A.K.S., Kraus, G.A., Murphy, P.A., Wurtele, E.S., Leng, Q., Hebert, S.C., Maury, W.J. and Price, J.P. 2008. *Echinacea* in infection. *Amer. J. Clinical Nutr.* 87(suppl.):488S-492S.
- Brand, M. 2010. *Aronia*: Native shrubs with untapped potential. *Arnoldia* 67(3):14-25.
- Day-Rubenstein, K., Smale, M. and Widrlechner, M.P. 2006. Demand for genetic resources and the U.S. National Plant Germplasm System. *Crop Sci.* 46:1021-1031.
- Hawke, R.G. 2011. A comparative study of *Phlox paniculata* cultivars. *Chicago Bot. Gard. Plant Eval. Notes* 35:1-10.
- Leonard, P.J., Brand, M.H., Connolly, B.A. and Obae, S.G. 2013. Investigation of the origin of *Aronia mitschurinii* using Amplified Fragment Length Polymorphism analysis. *HortScience* 48:520-524.
- McCoy, J., Widrlechner, M. and Carstens, J. 2006. A comprehensive *Echinacea* germplasm collection located at the North Central Regional Plant Introduction Station, Ames, Iowa. *Comb. Proc. Intl. Plant Prop. Soc.* 55:439-440.
- Postman, J., Hummer, K., Ayala-Silva, T., Bretting, P., Franko, T., Kinard, G., Bohning, M., Emberland, G., Sinnott, Q., Mackay, M., Cyr, P., Millard, M., Gardner, C., Guarino, L. and Weaver, B. 2010. GRIN-Global: An international project to develop a global plant genebank information management system. *Acta Hort.* 859:49-55.
- Robbins, J., Widrlechner, M., Olsen, R., Reed, S., Meerow, A., Hummer, K., Bretting, P., Allenstein, P. and Krautmann, M. 2008. Genebanks offer breeders access to germplasm: Germplasm collections help to preserve genetic diversity. *Nursery Mgt. Prod.* 24(5):53-56, 58.
- Taheri, R., Connolly, B.A., Brand, M.H. and Bolling, B.W. 2013. Underutilized chokeberry (*Aronia melanocarpa*, *Aronia arbutifolia*, *Aronia prunifolia*) accessions are rich sources of anthocyanins, flavonoids, hydroxycinnamic acids, and proanthocyanidins. *J. Agric. & Food Chem.* 61:8581-8588.
- USDA-ARS. 2012. National Plant Germplasm System: Crop Germplasm Committees. Accessed online Sept 2013 at <<http://www.ars-grin.gov/npgs/cgcweb.html>>
- Widrlechner, M.P. 2009. Ornamental plants and the U.S. National Plant Germplasm System: Conserving, evaluating, seeking and sharing. *Comb. Proc. Intl. Plant Prop. Soc.* 58:213-217.

- Widrechner, M.P. 2012. Building a comprehensive collection of ash germplasm before it's too late. *Comb. Proc. Intl. Plant Prop. Soc.* 61:329-333.
- Widrechner, M.P. and McKeown, K.A. 2002. Assembling and characterizing a comprehensive *Echinacea* germplasm collection. p.506-508. In: J. Janick and A. Whipkey (eds.), *Trends in new crops and new uses*. ASHS Press, Alexandria, Virginia.
- Williams, K. 2005. An overview of the U.S. National Plant Germplasm System's exploration program. *HortScience* 40:297-301.
- Zale, P. and P. Jourdan, P. 2012. Germplasm development and preliminary interspecific hybridization in *Phlox*. *Acta Hort.* 953:71-78.

