

CONCLUSIONS OF A PLANT BREEDER SURVEY ON GERMPLASM PRESERVATION

Emily Russell; Whitney D. Phillips; Andrew Bunting; and Andrew C. Bell, Ph.D.
Chicago Botanic Garden

INTRODUCTION

Ornamental plant breeders create new introductions that increase the beauty, interest, and plant performance in our landscapes. As public gardens face the challenges of climate change and seek a more sustainable model of horticulture, plant selections are an important consideration. Yet ornamental plant breeders are struggling to locate and access germplasm, even as public gardens work to build their collections and preserve rare plants. This study assesses the germplasm needs of ornamental plant breeders and the role of the public gardening community in the preservation and distribution of valuable germplasm. An online survey was distributed to 66 ornamental plant breeders around the United States in October 2016. Plant breeders working with woody ornamental plants were targeted in particular. Twenty-seven plant breeders responded to the survey (see Tables 1 and 2 for types of plants and breeding methods used by survey respondents). A summary of responses follows.

WILD-COLLECTED, SPECIES, AND CULTIVAR GERMPLASM NEEDS

The vast majority of ornamental plant breeders who responded to the survey (25 out of 27) use germplasm from all three categories of origin: documented wild-collected, straight species (of cultivated origin), and cultivars. However, when asked which type of germplasm they use most frequently, more than half of breeders responded that they use cultivars the most frequently.

Breeders cited the following benefits of working with cultivars: they already possess desirable characteristics, there is no need to “reinvent the wheel,” and breeding behaviors may already be published. On the other hand, wild-collected material is like “starting from scratch.” It has a less refined habit and needs multiple cycles of improvement before release. Breeders may struggle with wild-collected material when there is a lack of information on propagation values. Phenotyping wild-collected material is also difficult and can lead to a dead end. The benefits of wild-collected germplasm are the possibility of exciting new traits, improved environmental tolerance, and heterosis. Some breeders are concerned that starting with cultivars may lead to progeny that are too similar to previously introduced material. Restrictions due to intellectual property rights must also be considered when working with cultivars. Overall, ornamental plant breeders favor cultivars and see much value in having access to cultivated germplasm for breeding purposes.

CHALLENGES IN LOCATING GERMPLASM

“Sometimes cultivars or species just are not being sold.”

“Can't always find newly advertised cultivars. Old cultivar standards are sometimes hard to come by as well.”

“Online inventories often inaccurate, hard to get to all the botanical gardens I need to during the short window to take cuttings. Nurseries have a small selection and are too pricey.”

“Good passport information. Exactly what is this germplasm? Where did it come from? Often not characterized.”

“Access to wild species, you often know they exist but have no means to acquire. Same for old cultivars - so many small seed companies are closing shop. The legal side of foreign acquisitions is often murky.”

A full 70 percent of the ornamental plant breeders surveyed have been unable to secure germplasm. It may be difficult to find the desired material, especially both new and old cultivars. When material can be located, it may still be difficult to access. Budget and time constraints impact visits to public gardens, nursery purchases, and wild collection. Of those surveyed, 30% experienced problems importing germplasm from other countries. USDA rules and quarantines, the Convention on International Trade in Endangered Species (CITES), and the Convention on Biological Diversity (CBD) were cited as difficult for plant breeders to navigate.

THE ROLE OF PUBLIC GARDENS IN THE PRESERVATION OF VALUABLE GERmplasm

“Public gardens serve a critical role in preserving genetics that would otherwise be lost.”

“Highly important. Especially collecting germplasm from wild populations in diverse countries. Conducting cultivar trials, for public and private education is valuable as well.”

“Maintenance of the older cultivars and continual evaluation of the newer ones.”

“We need organizations with a long term commitment to maintain important germplasm because independent breeders and nurseries have very limited resources and pressure to keep cycling through plant materials, so it can be difficult to justify maintaining wild species or early cultivars that serve as stepping stones in advancement.”

“Botanical gardens should strive to maintain genetic diversity over time to serve as a breeding resource as environmental and pest problems change. USDA is doing a good job with agronomic and fruit crops but not landscape plants. If gardens don't maintain material, who will?”

Eighty-one percent of breeders surveyed have asked a public garden to share germplasm for breeding. Respondents agree that public gardens are essential in serving as germplasm repositories. Plant breeders think the role of public gardens is to collect and maintain taxa according to their location and mission. Cultivars, species, and wild-collected material are all important, especially for woody taxa that are difficult to preserve in gene banks or by seed. Many respondents feel that public gardens have potential to serve as the perfect intermediary between collections expeditions and breeders. Accurate plant records are invaluable to plant breeders, documenting the “passport data” or origin of plants, as well as the current status and location at the garden. Plant breeders also appreciate when public gardens evaluate cultivar performance and publish the results. From the perspective of plant breeders, gardens must not only preserve valuable germplasm, but also be willing to share the germplasm when requested.

HOW PUBLIC GARDENS CAN BETTER SERVE THE NEEDS OF PLANT BREEDERS

“Having a complete inventory online is priceless.”

“Continue to keep good records of the exact location where accessions originated. This is useful not only for plant breeders, but for ecologists as well. Good record information will make the collection more useful across a variety of scientific disciplines.”

“Please consider plant breeders as allies and colleagues, not as competitors.”

“Ask breeders which germplasm should be included in collection trips to fill gaps in our collective germplasm of North American public institutions.”

“One gap in the plant breeder's knowledge continues to be pedigree information and cultivar redundancy. I would like to see more collaborative efforts to produce DNA fingerprints (SSR markers) on cultivated material. This would help breeders determine genetic distances between cultivars, provide a

new tool to screen progeny and identify hybrids, and would contribute to the phylogeny / systematics projects already underway at many public gardens.”

One third of respondents said the most important thing a public garden can do is maintain an accurate inventory that is accessible to plant breeders online. Many breeders would appreciate a designated contact person to field requests for germplasm, as well as access to the organization’s policy on sharing of germplasm. While some respondents have had positive experiences with public gardens, others have had difficulties. In some instances, requests for germplasm went unanswered, plants in the inventory could not be located, or material that was promised was never delivered. Some respondents expressed frustration that gardens can be hesitant to allow collection by plant breeders and that researchers from other institutions may receive precedence over private researchers. One respondent suggested they would be willing to pay a small fee to cover costs. Plant breeders are also interested in seeing research produced at public gardens, be it plant evaluation trials or genetic studies. As mentioned in the previous section, plant breeders are interested in accessing wild-collected or imported germplasm. Public gardens could collaborate with breeders on target lists for expeditions.

IDEAS TO IMPROVE THE ACCESSIBILITY OF GERMPLASM AND SUGGESTIONS FOR COLLABORATION

“A website that serves as a collective database, allowing gardens, arboreta and universities to upload their germplasm collections to an individual server. Allow the public to search this database, the website could then connect the user to the institution that offers the material of interest.”

“External groups (like APGA? others?) could provide a connection between breeders and gardens - perhaps by hosting annual or quarterly announcements about materials available at specific gardens.”

“Perhaps the USDA should make inquiries to ornamental plant breeders to obtain ideas on collection priorities and to solicit needs for specific genera in specific programs.”

Several respondents wished for a database compiling the inventories of public gardens so that plant breeders could locate germplasm without sifting through records of each institution individually. A solution to this quandary already exists, but is apparently not well known. Only 6 of the 27 plant breeders have used Botanic Gardens Conservation International (BGCI) to locate germplasm. BGCI’s PlantSearch is the only global database of plants in cultivation at gardens. More than 1,000 institutions contribute to the database, including botanic gardens, seed banks, zoos, and even private gardens. It is freely accessible online and anyone can query the public database to find plants that gardens have reported in their collections. Users can then fill out a request form online to generate a blind email request for material, information, images, etc. Members of BGCI may log in and query PlantSearch directly, to see which gardens hold which plants. BGCI also offers bulk data reports to support research, education, and conservation projects.

One respondent suggested collaboration with the American Public Gardens Association (APGA). The Plant Collections Network of APGA is certainly a valuable resource for plant breeders. Participating institutions commit to holding and developing a collection of documented living plants according to professional standards of collections management. As a policy, Nationally Accredited Plant Collection holders make germplasm available for selection and breeding, taxonomic study, evaluation, utilization, and other research purposes. They may serve as reference collections for plant identification and cultivar registration. PCN participants compare their holdings with other institutions to identify duplications and gaps, and must replicate taxa to ensure germplasm preservation. Currently, 73 accredited collections are shown on their website with key information including the institution, the number of taxa, the collection focus, and a contact person. The scope of usefulness to breeders is limited by the number of genera with an accredited collection, but it is continually expanding.

These two examples show that public gardening umbrella organizations could improve their outreach to

and connection with plant breeders. Plant breeders are a relatively small interest group and their perspective and needs are not always at the forefront, even within the horticulture community.

CONCLUSION

New plant introductions directly benefit the public gardening community. For ornamental plant breeders to create appealing plants that require less resource input (less water, fertilizer, insecticides and herbicides, etc.) and can respond to a changing climate, they must have access to a wide variety of germplasm. Most plant breeders have experienced obstacles with the availability, accessibility, and importation of germplasm. Public gardens are playing a critical role in the preservation and distribution of valuable germplasm, yet opportunities exist to improve collaboration.

Plant Type	Percent of Plant Breeders Using Each Type (Out of 27 Respondents)
Shrubs	89%
Trees	67%
Herbaceous Perennials	48%
Annuals (Asexual)	30%
Food Crops	26%
Annuals (Seed Strains)	22%
Vines	19%

Table 1: Plant Types Used by Survey Respondents

Breeding Method	Percent of Plant Breeders Using Each Method (Out of 27 Respondents)
Controlled Pollination/ Crosses	96%
Chemical/Physical Mutation	78%
Open-Pollination/Chance Seeding Selection	78%
Sport Selection	56%
Embryo Rescue	11%
Ploidy Manipulation	11%
Gene Editing/Marker Assisted	11%
Collecting/Evaluating Northern-most Seed	4%
F1 Male Sterile System	4%

Table 2: Breeding Methods Used by Survey Respondents

List of Woody Plant Genera Survey Respondents Are Working On (Currently or Historically):

Acer, Aesculus, Aronia, Berberis, Betula, Buddleja, Buxus, Camellia, Cercidiphyllum, Cercis, Chaenomeles, Clethra, Cornus, Corylus, Cotoneaster, Deutzia, Distylium, Franklinia, Halesia, Hamamelis, Hibiscus, Hydrangea, Ilex, Kalmia, Lagerstroemia, Lantana, Lilac, Liquidambar, Loropetalum, Magnolia, Malus, Nyssa, Osmanthus, Philadelphus, Physocarpus, Platycladus, Prunus, Pyrus, Rhododendron, Rosa, Sambucus, Sarcococca, Spiraea, Stewartia, Styrax, Syringa, Thaphiolpeis, Thuja, Ulmus, Vaccinium, Viburnum, Vitex, and Weigela

ACKNOWLEDGEMENTS

This project was made possible in part by the Institute of Museum and Library Services MA-30-14-0336-14. Thanks are also expressed to Joseph Rothleitner for assistance with the development of this survey.