Integrating Plant Trials into Teaching and Student Research Programs

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Summary. Plant trialing and marketing assistance programs have become popular in recent years with several state and some regional programs emerging. Successful implementation requires considerable labor, facilities, and monetary resources for evaluation of large numbers of taxa over several years to ensure that plants are well adapted to the region of interest. Research and development funds, dedicated facilities, and cooperator commitment to trialing programs can be limiting during the early years of the programs. Involvement in plant trialing programs allows students to be exposed to plot layout planning, statistical design, plant maintenance, data collection and analysis, and professional communication of trial results. Construction of facilities for conducting plant trials, growing plants for use in trials, trial installation, and maintenance of plants all provide practical hands-on horticultural training. Replicated plant trials provide the latest information on regionally adapted taxa for inclusion in classroom instruction and publications. Plant trialing programs benefit from labor assistance, development of dedicated facilities, and the opportunity to share equipment and supplies among teaching, trialing, and student research projects.

Various states have developed plant trialing and marketing assistance or consumer education programs to promote the use of locally adapted landscape plants (Arnold et al., 1998a, 1998b; Mackay et al., 2000). Regional plant trialing programs, such as the South Extension Research Activity Information Exchange Group-27, have emerged to provide wider based regional recommendations. State programs vary from simple selection committees to multi-year, multi-location field trialing and selection.

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Some are run independently by industry trade organizations or university personnel, others are joint efforts between university and industry. Cooperative ventures provide a framework to capitalize on the research and communication skills of university personnel and the marketing expertise present in industry organizations.

While many attributes are common to most trialing programs, the mechanisms for acquiring the necessary resources and expertise to run the trials vary among test sites. As programs mature, sources of recurring funding should be located more readily. However, during early stages of the program, industry may be reluctant to provide continuous funding as tangible results can require several years to produce. Integration of plant trialing activities into existing or new undergraduate and graduate courses and research programs provides an innovative way to enhance student educational experiences while accomplishing the applied research necessary for plant trialing programs. The objective of this paper is to describe mechanisms for incorporating plant trialing activities into undergraduate and graduate teaching and research programs and to describe some of the benefits to the various participants as a result of these activities.

Graduate thesis–dissertation work

Graduate student instruction/advisement consumes significant portions of faculty time and is very individualized. Most graduate projects are flexible enough to answer many prerequisite questions about the production and marketing of potential promotional plants if they are planned well in advance. Certainly those faculty with breeding programs can easily involve students directly in genetic manipulation and selection activities related to the trialing programs.

For those faculty whose plant trialing programs are not the principal focus of their research programs, graduate student participation may require more innovative strategies. Conventional propagation and tissue culture projects can be tailored to aid in elucidating propagation methods for promising taxa. Likewise, field or production oriented projects can be used to refine production methods for promising plants. Inclusion of these taxa as test subjects for substrate, fertility, growth regulator, or pesticide-oriented studies can be a useful tool for screening various taxa's adaptability to conventional production systems. For instance, one of our graduate students working on a substrate project concerning fertility interactions with kenaf stalk core and coconut coir dust was able to incorporate screening of several promising small tree species for their compatibility with conventional container production practices (Arnold et al., 1996; Goyne, 1998). Serendipitously, this work also yielded three thornless clones of wright acacia (*Acacia wrightii* Bentham and Gray) which are subjects of a propagation project for another student's masters work and will eventually be funneled into the CEMAP trialing program. The College Station, Texas, trial location serves as one of the primary screening sites. Additional preliminary screening may occur at selected locations around the state. Once a plant is deemed promising, adequate numbers of plants are provided by the sponsoring cooperator to include the plant in the statewide trials. The organizational structure and a flow chart of the process is described in the accompanying article in this symposium by Mackay et al. (2001).

Similarly, a supplementary research project conducted by a PhD student studying a new container production system allowed the screening of a number of lacebark elm (*Ulmus parvifolia* von Jacquin) seedlings from a mature tree with red autumn fruit and attractive bark (Arnold and McDonald, 1999). Fortunately, some of these seedlings exhibited weeping forms, with one yet to be named clone having a pronounced weeping habit reminiscent of weeping yaupon (*Ilex vomitoria* Ait. 'Pendula'). Determining propagation requirements of this plant is a portion of yet another masters project. Propagation projects are particularly germane to plant trialing programs because plants must be reliably produced in large quantities to satisfy the consumer demand created by successful educational and marketing efforts.

Special problem–research courses

Another opportunity to integrate the research and teaching programs into plant trialing is the judicious designing of undergraduate or graduate special problems or research courses. Undergraduate research projects can easily include comparisons of a number of related taxa for growth habit, flowering, and disease or pest resistance. For example, we had an undergraduate student project that involved direct data collection from the perennial verbena (*Verbena* L.), lantana (*Lantana* L.), and salvia or sage (*Salvia* L.) taxa in the 1996 CEMAP trials. An alternative to direct student assistance with the official statewide trials is to supervise students in the preliminary screening of large numbers of taxa within a particular species or genus to gauge the range of landscape responses for potential inclusion in formal state or regional trials. For example, one of our undergraduate students evaluated the disease and heat resistance of various species and cultivars of zinnia (*Zinnia* L.) (Morgan et al., 2000). Data from this study have pared the number of taxa to be evaluated in the full 20 location statewide trials to a more manageable five or six cultivars.

Advanced undergraduate or

Table 1. Direct involvement[z] of undergraduate students in lecture or laboratory activities related to the plant trialing programs at the College Station, Texas, Coordinated Education and Marketing Assistance Program trialing site from June 1999 through May 2000.

Course title	Semester	Enrollment
Directed studies in horticulture	Summer 1999	7
Landscape maintenance and construction	Fall 1999	26
Directed studies in horticulture	Fall 1999	3
Greenhouse management	Fall 1999	15
Nursery management	Fall 1999	19
Directed studies in horticulture	Spring 2000	1
Landscape plant materials	Spring 2000	90

[z]Direct involvement included at least one laboratory or lecture session held at the trialing site. Most courses involved multiple use dates.

graduate research projects may lend themselves to investigation of specific plant responses at a more fundamental level. Another of the small trees initially included in Goyne et al.'s work (Goyne et al., 1997, 1998) was promising, but propagation procedures for american smoke tree (*Cotinus obovatus* Raf.) were poorly defined. This led to an undergraduate honors project that investigated the effects of auxin concentration, cutting maturation, and substrate composition on rooting of american smoke tree that was the winner of the 2000 Southern Region ASHS undergraduate paper competition (Denny and Arnold, 2000).

Similar projects can be used to enrich the teaching program through the learning of research methodology and honing of presentation skills at industry and scientific meetings (Denny and Arnold, 2000; Morgan et al., 2000). Development of technical writing skills can be enhanced by publishing manuscripts in refereed journals (Arnold and McDonald, 1999), trade journal updates (Arnold et al., 1996; Goyne et al., 1997), or extension publications. If conducted in a replicated fashion, landscape trial results may be published in peer reviewed journals, such as *HortTechnology*, which has a specific section for reporting plant trials. This satisfies several needs: 1) that faculty publish refereed articles, 2) that students learn to quantify ornamental plant performance which has historically been rather subjective, and 3) that plant evaluations be verified by subjecting them to peer review. Such projects can also serve as a vehicle for exposing students to interdisciplinary efforts with other fields such as biology, botany, genetics, plant pathology, entomology, and agricultural economics. Morgan's project (Morgan et al., 2000), where she learned to identify and score pathogens of zinnia from our extension plant pathologist (Larry Barnes, Texas A&M University, Dept. Plant Pathology and Microbiology), was a good example of exposure to interdisciplinary work.

Enhanced classroom and laboratory instruction

Plant trials can serve as a source of valuable information for landscape plant materials and landscape design courses. Over time, results of these experiments can be incorporated into lecture content, laboratory activities, textbooks, course packets, or Internet materials developed for use in these courses (Arnold, 1999; Lineberger and Arnold, 2001). These publications can double as mechanisms for distributing long-term results to industry personnel and the general public. Use of trial results showing performance differences in various areas of the state or region, or in different cultural regimes, provides excellent illustrations of genotype by environment interactions. Such applied, discipline-relevant examples are more readily conveyed to nonbiological science majors, such as landscape architecture and urban planning students, than those from conventional genetic studies with model systems such as fruit flies (*Drosophila melanogaster* Meigen).

Laboratory exercises can provide labor for plant trialing programs by growing plants for trials as laboratory projects for nursery management and greenhouse production courses. Laboratories for landscape maintenance or public garden management courses can assist with maintenance of trial plantings. Such strategies have been shown to be successful in providing maintenance assistance in public garden settings, while adding to the hands-on experiences in a variety of landscape related courses (Hamilton, 1999; Lewis and Affolter, 1999; Stimart, 1999; VanDeranden and Cook, 1999). During the past year alone, 161 undergraduate students have benefited from direct classroom or laboratory contact with the plant trials at our College Station location (Table 1). Students from other disciplines at Texas A&M University, Botany and Entomology, and sister institutions, such as Stephen F. Austin State University, were also involved indirectly in field trips to visit the site.

Facilities development

Dedicated facilities for conducting replicated landscape trials where plant trials must be conducted in raised beds or when demonstration landscape plantings are required are expensive. Construction of demonstration landscape settings and trial beds make excellent laboratory activities in landscape construction courses or subjects for advanced special problems courses. Student participation at the Texas A&M University Nursery/Floral Field Laboratory has resulted in the construction of more than 325 m^2 (3,500 ft^2) of raised bed trial space and about 2 ha (5 acres) of demonstration gardens. The demonstration gardens and landscape trial beds were officially recognized in Summer 2000 as the Texas A&M University Horticultural Gardens bringing additional public and institutional recognition to the trialing programs. Similar strategies have been shown to work in various public gardens (Hamilton, 1999; VanDerZanden and Cook, 1999).

Conclusions

One of the common criticisms by our industry is that horticulture departments do not do a good job when preparing students for "real world" experiences. Many of the suggestions/examples in this paper help address this criticism, while at the same time teach students to better understand the academic pursuits of research and service. Landscape plant trialing programs offer outstanding opportunities for development of undergraduate and graduate research projects. These projects provide students opportunities to learn and apply research methodology to specific industry related problems. Undergraduate student involvement in activities that directly or indirectly support CEMAP plant trialing on the Texas A&M University campus have allowed us to test many more taxa than we could have if in-kind services by students would have been contracted for pay. Undergraduate teaching programs have been enhanced by direct replicated comparisons of various taxa and an expanded variety of taxa available for inclusion in plant materials courses. Landscape construction, landscape maintenance, and design courses have benefited from the availability of construction materials used to develop beds, arbors, irrigation systems, etc. Multiple use for equipment among plant trialing and teaching programs allows sharing of maintenance overhead and purchase costs. Student exposure to multidisciplinary approaches can be enhanced by facilitating faculty involvement from other disciplines while assessing disease and pest resistance or marketing potential. Student involvement augments the typical research and extension activities associated with plant trialing and marketing programs, exemplifying the 3-fold land-grant mission of teaching, research, and extension programs.

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