Field trials identify more native plants suited to urban landscaping

by S. Karrie Reid *and* Lorence R. Oki

California native plants that performed well at the UC Davis Arboretum were tested for their potential usefulness in Central Valley gardens. These "All-Stars," such as the California lilac 'Valley Violet' (shown), were able to thrive in hot, dry conditions, resist pests and diseases, and attract beneficial wildlife such as bees and birds.

There is a growing need in the state of California for landscape plants that require fewer inputs of water and chemicals. To address this issue, a program was initiated at UC Davis to test the landscape potential of California native plants not currently in widespread horticultural use. Ten unused or underused California native plants were screened in open-field conditions for low water tolerance during summer 2006. In all cases, there were no significant differences in the summer growth or physical appearance between four irrigation levels. Six species maintained a favorable appearance throughout the season and were advanced to demonstration gardens in seven climate zones throughout the state, where Master Gardeners are performing further assessments on their performance. These irrigation and climate zone trials are part of an ongoing program coordinated by UC Cooperative Extension, the UC Davis Arboretum and the California Center for Urban Horticulture to introduce more low water-use and low chemical-use plants through partnerships with the commercial horticultural industry.

For gardeners, California's climate both charms and challenges. Its charms include rainless summers with warm, sunny days and mild nights, and brief, mild winters. But most of these charms are also challenges. The long, hot summers with no precipitation require frequent irrigation, and the low humidity can further increase the water demand and pest susceptibility of humidity-loving plants. The brief, mild winters can render plants that require a long seasonal chill unsatisfactory in either fall color or fruit production, and allow many pests that would be killed elsewhere by winter freezing to survive and multiply from one year to the next. Because so many commonly used landscape plants are ill-adapted to these climatic conditions, large inputs of water, pesticides and fertilizers are needed to keep them looking their best.

With constantly increasing population pressures in the state, there is an increasing demand for water (Hanak and Davis 2006). Due to overwatering and the frequent use of pesticides and artificial fertilizers, an increase in undesirable chemicals in urban runoff is a growing and serious problem (Bailey et al. 2000; Weston et al. 2005; Wilen et al. 2001). In addition to all this, whereas other large states such as Texas have only four U.S. Department of Agriculture (USDA) plant hardiness zones (USNA 2006), California is home to at least seven USDA zones and 24 climate zones as described in *Sunset Western Garden Book* (Brenzel 2007). Nonetheless, large chain nurseries in particular often sell the same plants from one end of the state to the other, ensuring that many customers who bought something that was lovely in the garden center will eventually be disappointed with a plant unsuitable to their part of the state. So how does one create a lovely landscape with such difficult challenges?

The obvious answer is simply to garden with plants that have greater drought-tolerance, fewer pest problems and an adaptation to milder winters. In fact, in recent years there has been a trend in both public landscapes and home gardens to use more plants with these characteristics. These plants, usually native to California or other areas of the world with Mediterranean-type climates, are sometimes referred to as "low-input" because they require little supplemental water and no chemicals to look their best. Their proper maintenance leaves no negative impact on the environment. The horticulture industry, however, thrives on a constant input of new and beautiful plants to tantalize its customers year to year, and despite the growing demand, plants in the "low-input" category have been relatively few and slow in coming to the mainstream nursery market.

Those retail nurseries that do offer or specialize in native plants are often known only to a small, motivated market of knowledgeable gardeners who seek them out. Most are located in coastal areas, away from the large tracts of developing Central Valley urbanization, where polluted runoff into watersheds is an issue. Some are inaccessible to much of the public either by location or limited hours, and have limited distribution to the landscape trade.

Many California native plants would be beautiful in urban landscapes, but they have been underused in mainstream retail nurseries and the landscape industry because relatively few species have been available in the numbers needed for large-scale retail distribution. Most of the work on native-plant propagation protocols has been used to produce species for reforestation and revegetation by conservation agencies and affiliates, where the market is driven more by governmental than consumer forces.

Little attention, however, has been paid to developing commercially viable propagation protocols for the ongoing addition of new, low-input species to the nursery market, partly because of misconceptions among nurserymen and landscapers that all natives are difficult to propagate, and that few are attractive enough to be appealing to consumers. Nothing could be further from the truth. There are many native species that would be year-round assets to any garden, and any difficulty in propagation is simply a protocol waiting to be discovered.

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A workable answer to all these concerns is a statewide, coordinated, cooperative, low-input plant introduction program. Many other states and regions of the country have long-established, successful, plant introduction programs that benefit all stakeholders by combining the talents, knowledge and energy of university researchers, extension specialists, arboretum and botanical garden personnel, and members of the wholesale and retail horticulture industry. Just such a program is under way at UC Davis. UC Cooperative Extension (UCCE) researchers, UC Davis Arboretum staff and the California Center for Urban Horticulture (a nonprofit organization and university-based center at http://ccuh.ucdavis.edu) are partnering with members of the commercial horticulture industry to provide a channel for the ongoing introduction of beautiful new low-input plants to a wide landscape horticulture market.

Although this introduction program is in its infancy, it will entail four basic stages: (1) initial selection, (2) a low water-tolerance field trial, (3) zone garden trials and (4) commercial introduction. The overriding goal of the project is to provide consumers with a source of beautiful landscape materials that will thrive in a wide variety of California climate zones with little input of water or chemicals. A corollary goal is to provide the nursery industry with a source of new and interesting, economically advantageous and environmentally sound plant revenue. With increasing pressure from state and regional water-quality control boards for zero runoff in the nursery industry (CalEPA 2007), plants requiring fewer inputs will be a welcome addition.

TABLE 1. Species in plant trial, from UC Davis Arboretum All-Stars and potential All-Stars

Common name (species)	Plant type	Result
Apache plume (*Fallugia paradoxa*)	Evergreen woody perennial	Eliminated: untidy appearance and free-seeding
California beach aster (*Lessingia filaginifolia*)	Herbaceous evergreen groundcover	Eliminated: froze in winter 2005
California lilac 'Valley Violet' (*Ceanothus maritimus*)	Evergreen woody perennial	Advanced
Coast gum plant (*Grindelia stricta*)	Low-growing herbaceous perennial	Eliminated: died in heat or froze in winter 2005
Creeping sage (*Salvia sonomensis*)	Herbaceous ground cover	Eliminated: rotted in spring transplant 2005 or froze in winter 2005
Eyelash grass or blue grama grass (*Bouteloua gracilis*)	Warm-season bunch grass	Advanced
Serpentine columbine (*Aquilegia eximia*)	Evergreen herbaceous perennial	Advanced
Rosy coral bells (*Heuchera rosada*)	Evergreen herbaceous perennial	Advanced
San Diego sedge (*Carex spissa*)	Sedge	Advanced
Seaside daisy (*Erigeron* 'Wayne Roderick')	Low-growing herbaceous perennial	Eliminated: froze in winter 2005

Selecting candidate plants

The starting point for this endeavor was the UC Davis Arboretum "All-Stars" program. Over the years, arboretum staff have taken note of plants that thrived in their Central Valley location on limited water, and developed All-Stars plant lists to help visitors identify plants that would be suitable for their own Central Valley gardens. All-Stars species must meet several criteria: (1) thriving over a number of years in the hot, interior valley location of the UC Davis Arboretum under a low watering regimen (generally twice a month) after establishment, (2) looking attractive during at least three seasons, (3) resisting pests and diseases and (4) optimally, though optionally, attracting or fostering beneficial wildlife such as bees and other beneficial insects, and birds. Some of these 50 plants could be found in any garden center, a few were available from small retail nurseries, and some were only available at arboretum plant sales.

From the All-Stars list as well as a list of an additional 50 potential All-Stars, we chose 10 species for the first low-water-tolerance field trial (table 1). These 10 species were selected for a variety of potential landscape uses and plant forms, including: ground covers (creeping sage [*Salvia sonomensis*] and California beach aster [*Lessingia filaginifolia*]); herbaceous perennials (serpentine columbine [*Aquilegia eximia*], Seaside daisy 'Wayne Roderick' [*Erigeron* 'Wayne Roderick'], coast gum plant [*Grindelia*

Ten UC Davis Arboretum All-Star species were evaluated for water usage, survival and growth. Five were advanced to the next trial stage (those shown plus eyelash grass) for testing by UC Master Gardeners.

stricta] and rosy coral bells [*Heuchera rosada*]); woody perennials (California lilac 'Valley violet' [*Ceanothus maritimus*] and Apache plume [*Fallugia paradoxa*]); and ornamental grasses (blue grama grass [*Bouteloua gracilis*] and San Diego sedge [*Carex spissa*]).

These 10 species are naturally found in a variety of ecosystems such as coastal woodlands and prairies, Sierra grasslands and dry hillsides. Some of these first selections for the trials were propagated by arboretum or university staff, and some were purchased from specialty native nurseries. Although all of these species had performed well in the arboretum, it should be noted that much of the arboretum has rich, sandy-loam soil and mature trees that provide windbreaks and shade in some places during portions of the day. In contrast, our irrigation trials were conducted in an unprotected open field with a somewhat heavy, clay-loam soil that is more typical of most Central Valley gardens, thereby providing a more rigorous test of the species' wind, sun, temperature and water tolerances.

Low water-use trials

A field was prepared to test 240 plants (24 of each species) on a UC Davis research farm in USDA Zone 9 (*Sunset* Zone 14). Plants were placed 2 yards apart along rows that were 2 yards apart, with 20 plants per row in each of 12 rows. This allowed the simultaneous testing of six individual plants on each of four different water treatments for each of the 10 species. The rows were covered with 3 to 4 inches of bark mulch, and two 2-gallon-per-hour drippers were buried beneath the mulch in the root zone of each plant.

The plants were placed according to a randomized complete block pattern in three blocks throughout the field. Each row was furnished with four water lines to deliver one of the water treatments to each plant after they were established. It is important that even drought-tolerant plants be given supplemental water until well-established, because the development of an adequate root system is a key component of drought-tolerance (Padilla and Pugnaire 2007). The 10 species were planted in fall 2004, and frost-killed specimens of creeping sage were replaced in spring 2005. All plants were irrigated regularly during summer 2005 to allow the root systems to establish adequately. Likewise, the plants were also watered during long, rain-free periods in the winter of 2005 to 2006.

Experimental irrigation treatments were carried out during the 2006 growing season. The four irrigation levels were based on percentages of reference evapotranspiration (ETo) as described in Water Use Classification of Landscape Species III (WUCOLS)

TABLE 2. Irrigation frequencies for native plant trial, based on reference evapotranspiration (ETo) water-use percentages

% ETo of treatment	Irrigation frequency during 2006 growing season
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80	13–18
60	16–23
40	26–34
20	58 (twice during the season)

(Costello et al. 2000). ETo was defined as the amount of water evaporated from a 4- to 7-inch-tall, cool-season grass in open field conditions. WUCOLS classifies landscape plants according to how much water they need compared to cool-season turfgrass, which is high water-use and needs 80% of ETo to look green and healthy in the summer growing season.

In our trial, we used the following percentages of ETo: 20% (low), 40% (low-medium), 60% (high-medium) and 80% (high). We wanted to assess not only if these plants were truly drought-tolerant, but also if they could survive under garden conditions where they might be combined with higher water-use species or adjacent to a high water-use lawn.

The average water-holding capacity of the soil was determined from soil samples collected at field capacity (the amount of water held in the soil after excess moisture from complete saturation is allowed to drain, usually after 24 to 72 hours) along a transect across the field. Irrigation was measured to replace half of the soil's water-holding capacity in the root zone of each treatment to a depth of 1.5 feet. Since some of the moisture in the soil is held too tightly to soil particles for plant uptake, plant water stress is usually avoided by providing an irrigation when 50% of field capacity has been depleted. This amounted to 21.2 gallons of water per plant delivered over a period of approximately 5.25 hours. We used ETo values calculated by the California Irrigation Management Information System (CIMIS), which comprises data collection stations in various locations throughout the state that measure precipitation, relative humidity, solar radiation, temperature and wind speed. The California Department of Water Resources provides values daily for ETo online for the public (www.cimis.water.ca.gov). During the May to October 2006 irrigated growing season, the Davis CIMIS station was accessed daily via the Internet, and the ETo values were placed into a water budget worksheet to calculate the four percentages of accumulated water deficit. From this data, the subsequent need for irrigation in any one of the water-use treatments could be determined.

In brief, all the plants received the same amount of water at each irrigation, but how often they received it was determined by their water-use percentage of ETo treatment (table 2). This low water-tolerance screening is somewhat unique to the needs of a California introduction program, since most states do not deal with complete drought from May to November each year.

Assessing plant performance

A plant growth index can be used to quantify the comparative growth of plants under different conditions. During the budgeted deficit irrigation beginning in June 2006, plant height and width measurements were taken monthly and used to calculate an average growth index for each species at each water level, using the following formula:

$$\frac{h + [(l+w)/2]}{2}$$

(Irmak et al. 2004). Height (h) was measured from the ground to the tallest leaf, and length (l) and width (w) were measured at right angles along the row (in a north-south direction) and across the row (in an east-west direction), respectively, using the outermost leaf in each direction.

From these measurements, a relative growth index was calculated for each species at each irrigation level on each measurement date using the following formula: current mean growth index divided by original mean growth index. General appearance, flowering and the presence or lack of pest problems were also noted for each treatment throughout the growing season. This information was used to help determine if a plant was worthy of moving into the next stage of the trial: testing in county demonstration gardens throughout California. Appearance alone did not eliminate a plant from advancement, such as in the case of shade-loving plants that were grown in the full sun.

UC Master Gardeners from around California, including Janet Cangemi (left) and Madeleine Mitchell of Fresno County, are now growing the native plants that were advanced in the trial and collecting data on their performance.

Survival of trial species

After the first summer of regular irrigation followed by wintering over in open field conditions, four species had suffered 50% or greater mortality, leaving six species in sufficient numbers to collect data (table 1). The species that did not survive the first year were coast gum plant, California beach aster, seaside daisy and creeping sage. The species that did survive were Apache plume, California lilac 'Valley Violet', serpentine columbine, rosy coral bells, eyelash grass and San Diego sedge.

The first three species that did not survive are native to warm coastal areas, as reflected by their common names. Although they had grown well in the UC Davis Arboretum for years, the unmitigated summer heat and cooler winter temperatures of our field-trial site proved too inhospitable for them. The fourth species that did not survive, creeping sage, was bitten back by frost in winter 2005 and did not transplant well into the clay-loam field soil in spring. However, the few creeping sage plants that did survive spread up to 9 feet in two directions across bare paths where the soil did not stay moist. It is native to well-drained slopes and is probably a good choice for restoration in its native range in the coastal and Sierra foothills, but was not deemed a good selection for most Central Valley gardens with space restrictions and heavier soils.

Growth and appearance

Apache plume. One of the six species that survived in the UC Davis open field, Apache plume, did not advance to the next stage of zone garden trials. It is a woody shrub with small, dissected leaves and a profusion of pink staminate flowers that lend it a fuzzy appearance when in bloom. While the September 2006 plant growth index was higher with moderate levels of irrigation than with either low or high levels (2.3 versus 1.8, respectively), this difference was statistically insignificant (fig. 1A). This species bloomed heavily over a long period of time, and showed no signs of disease or pest damage. However, Apache plume also had some undesirable characteristics. Large branches tended to flop over, yielding an untidy, open habit as the season progressed, and the abundant seeds self-sowed rather freely in dry paths and mulched beds.

California lilac 'Valley Violet'. The second woody shrub was a UC Davis Arboretum selection of California lilac that has become our banner species, 'Valley Violet'. This California lilac performed beautifully at any watering level, which was unexpected since so many other species of this genus will not tolerate summer water. It should be noted that July 2006 was exceptionally hot, even for Davis (19 days above 95°F, 10 days between 100°F and 110°F+), and yet the lilac's appearance was unaffected even at the lowest level of summer water. Steady increases in relative plant growth index over the season from 1.15 to 1.45 were observed for all irrigation levels, with no significant difference between the treatments (fig. 1B). In the spring, this plant bloomed in profusion from the base of its branches to the tips and was unbothered by pests or disease. This California lilac, with its yearlong deep-green color and staggering spring floral display, was eagerly accepted by all the demonstration gardens involved in the next phase of the trial.

Serpentine columbine and rosy coral bells. Two of our herbaceous species, serpentine columbine and rosy coral bells, are naturally found in shady woodland locations. Consequently, they all showed a loss in plant growth index at all irrigation levels during the hottest part of the growing season in our exposed site, with values between 0.7 and 0.9 (figs. 2A and 2B). However, there were no statistically significant differences between the irrigation treatments, leading us to conclude that during the hottest months, protection from the sun was more critical to the success of these species than the availability of water. Interestingly, under the highest watering regimen, two of the six columbines died by the end of July and two more died by the end of August, possibly showing an intolerance of wet soil during the hot season. However, the remaining two columbines were already beginning to recover by September when tempera-

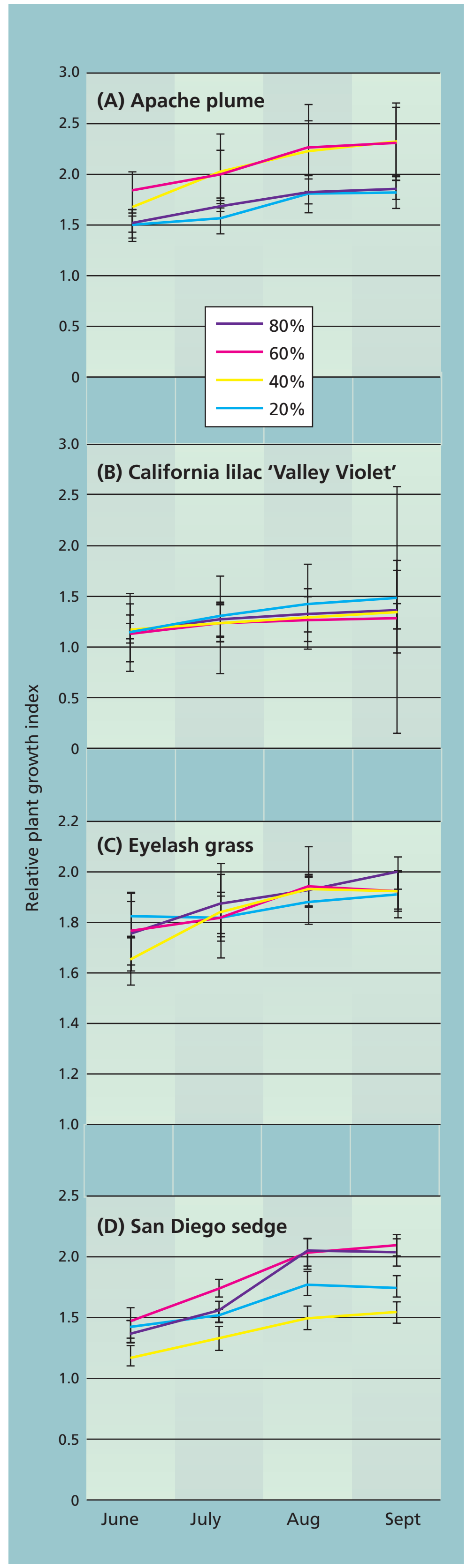

Fig. 1. Relative summer plant growth index for (A) Apache plume, (B) California lilac, (C) eyelash grass and (D) San Diego sedge. Bars represent 1 standard error.

tures began to drop, and all irrigation levels for both of these woodland herbaceous species showed dramatic recovery by the following June.

Noteworthy in both species was the prolific flower display, far beyond what was observable with specimens in shady locations in the nearby Arboretum during the same year. While both the coral bells and columbine leaves showed signs of sunburn and necrosis during the summer, their flowering seemed to benefit from the availability of light during the winter and spring months. Both were attractive to bees and syrphid flies, but were unbothered by pests or diseases. So, even though our test site's exposure was damaging to foliage, their mere survival under these conditions, combined with their spring beauty and attraction of beneficial insects, caused us to advance them to the next phase of the trial with a recommendation for planting sites with at least afternoon shade during the summer. Plants suited to dry shade are sorely lacking in the nursery trade, making serpentine columbine and rosy coral bells good introduction candidates.

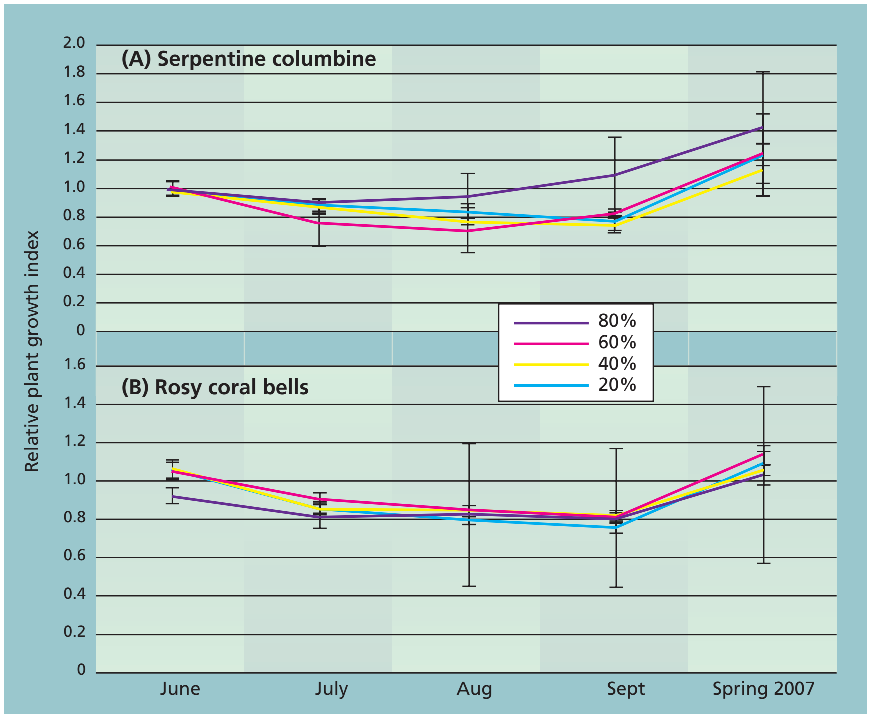

Fig. 2. Relative summer growth index and spring recovery for (A) serpentine columbine and (B) rosy coral bells. Bars represent 1 standard error.

Eyelash grass. Also called blue grama grass, eyelash grass is a bunch-type grass with a wide native range in prairies throughout North America. The amount of water it received in our trial made no significant difference in the amount of summer growth, with a September relative plant growth index of 1.9 to 2.0 (fig. 1C). Regardless of the amount of water, this species maintained a neat, fountain-form habit desirable for an ornamental grass, and had no pest or disease problems. For these reasons, we advanced eyelash grass to the zone garden trials.

San Diego sedge. San Diego sedge showed an unexpected toughness and drought tolerance for a plant that grows along streams in the wild. It sent up handsome flower spikes that matured to an attractive, buff-colored seed head held above sword-shaped leaves. None of these seeds has been observed to self-sow in the field, making it unlikely to be invasive in dry areas. At all irrigation levels, the plants showed consistent, positive changes in plant growth indices until the end of August, when growth leveled off, presumably in favor of seed production (fig. 1D).

San Diego sedge plants irrigated at the two lowest water levels (low and low-medium) did show slightly lower relative growth indices as the season progressed, with those given the second lowest water level (low-medium) inexplicably displaying the lowest relative plant growth index. However, the only statistically significant differences were between the low-medium and high-medium treatments in September (1.5 and 2.1, respectively). Plants at all irrigation levels became more attractive as the season progressed, and they were pest-free and disease-free. There was no consistent pattern to which watering level the plants preferred, making San Diego sedge a good candidate for a strong structural element in a variety of garden situations.

Zone garden trials

The key to the next stage of this endeavor was the Master Gardener Program, which is coordinated by UC Cooperative Extension. Because these programs are located in most counties throughout the state, they are uniquely situated to grow and collect data on the plants that are advanced from the first phase of the trials. Many counties have demonstration gardens, which make perfect sites for both data collection and exposure to the public.

The counties (and cities) currently participating in the second phase of the native plant trials are Shasta (Redding), Placer/Nevada (Grass Valley), Alameda (Livermore), Santa Clara (Palo Alto), Mariposa (Mariposa), Fresno (Fresno) and San Diego (Pt. Loma and Fallbrook) (fig. 3). The sites include coastal, inland valley and low mountain gardens, but all are within the boundaries of the climate zones recognized as "Mediterranean." As plants became available beginning in fall 2006 through fall 2007, each site was provided with six plants each of several prospective species advanced from the irrigation trial.

Master Gardeners in these areas have planted, tended and collected data on the plants provided. They are taking monthly measurements using the same protocol as the plant growth index used in the field trial. Soil types have been noted, irrigation frequency is being tracked and any unusual weather events noted. In addition, each garden is supplied with data sheets that allow them to rate each plant on a scale of 1 to 5 (poor to excellent) each month in five categories: foliage, flowering, pest resistance, disease resistance and overall vigor. Table 3 and figure 4 provide examples of the first year's compiled observations for rosy coral bells.

Over the course of the next few years, these data and observations will be cumulatively compiled across sites to determine if each plant has wide adaptability and appeal. Here especially, the Master Gardeners' experience will be invaluable. They will be able to render an opinion on a plant's garden-worthiness, as well as the response of the public to it over the course of its life in their garden. A plant thought interesting to an enthusiast may be completely unappealing to the average gardener, and might well prove unmarketable except at plant sales. That is not the plant we are looking for.

On the other hand, if a plant performs well and has wide appeal, we can create demand from an educated gardening public for these environmentally friendly introductions before they are even in the retail outlets. In addition, the wide range of demonstration garden situations will give us a more comprehensive set of cultural recommendations for growers, landscapers and home gardeners. Some of the Master Gardener groups have already begun sharing information on the program and its plants through garden signage, newsletters and local radio programs.

Propagation and production

In most regions of the country, propagation and production development is the purview of the commercial wholesale nursery industry. In Georgia, growers are invited to the university-managed test gardens each year to take cuttings of plants they are interested in and are encouraged to use their expertise to propagate and produce them (Armitage and Green 2001). In Arkansas, the nursery industry actually provides the university with the initial plants for their introduction trials, and the university provides them with the results (Lindstrom et al. 2001).

In our case, we are trying to persuade both the commercial industry and the public to use environmentally responsible, low-input plants with which they may be unfamiliar. Because of this, some of the initial propagation hurdles may have to be cleared by university and extension research. The highly successful Texas Coordinated Educational and Marketing Assistance Program (CEMAP) is a good model for cooperation between the university and the ornamental horticulture industry (Mackay et al. 2001). If a plant passes the various climate zone trials but is difficult to propagate, university and extension researchers tackle the problem until the best method is discovered. Graduate researchers at UC Davis and arboretum staff are continuing propagation research on our plants. Additionally, a commercial master propagator is currently working on protocols for several species, contributing the expertise of one who understands the requirements of mass production.

Fig. 3. Locations of Master Gardener demonstration gardens participating in the second phase of native plant trials.

TABLE 3. Rosy coral bells average annual ratings by Master Gardeners, fall 2006–fall 2007 (scale of 1–5, poor to excellent)

County (*Sunset* Zone)	Alameda (14)	Fresno (8)	Mariposa (7-central)	Nevada/ Placer (7-north)	San Diego 1 (24)	San Diego 2 (23)	Santa Clara (17)	Average
Foliage	3.6	4.3	4.4	4.8	4.6	2.9	4.5	4.1
Flowering	3.5	3.8	4.7	4.2	4.5	2.9	3.3	3.8
Pest resistance	4.9	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Disease resistance	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Overall vigor	3.3	4.2	4.7	5.0	4.8	2.7	4.7	4.2
Average	4.0	4.5	4.7	4.8	4.8	3.7	4.5	4.4

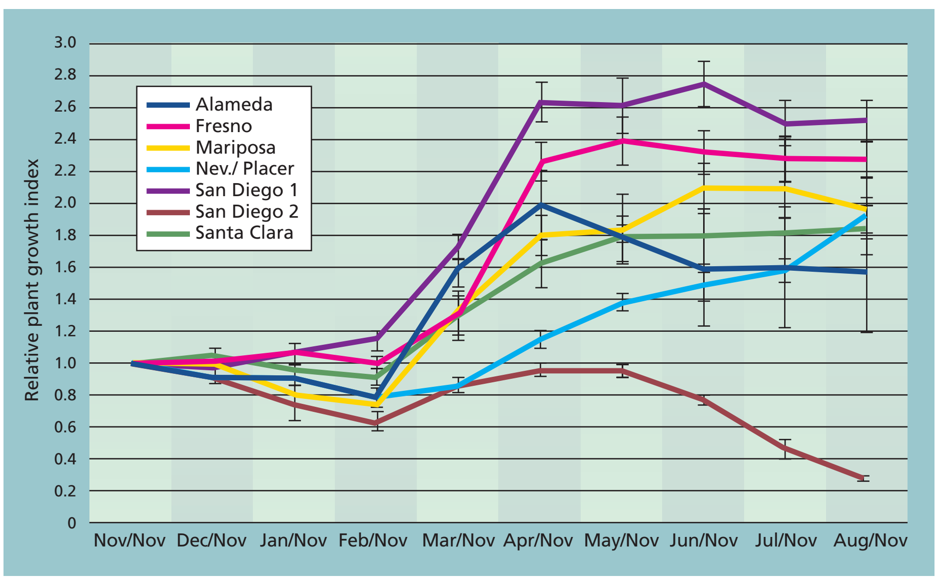

Fig. 4. Relative plant growth index for rosy coral bells in seven demonstration gardens, fall 2006–fall 2007. Bars represent 1 standard error.

Meeting market demand

Once a plant is ready for marketing, production schedules will be worked out to ensure sufficient supply to meet the expected demand at introduction. The National Arboretum has a regional cooperative program whereby growers and universities in seven southeastern plant-hardiness zones evaluate and increase the stock of plants slated for introduction (Dunwell et al. 2001). To ensure that these new plants are carefully screened, the National Arboretum controls their release through Material Transfer Agreements and centralized data analysis. After that, all the parties with an interest are involved in all aspects of testing and production, especially stock increase. In this way they can be assured of supply to meet the demand once a release date is announced (Pooler 2001).

In the hope of implementing at least part of the National Arboretum's model, the California Center for Urban Horticulture and its director Dave Fujino are currently acting as coordinators for the program's coalition, which comprises the UC Davis Arboretum, UCCE researchers, the previously mentioned commercial master propagator, several wholesale growers, a distributor and a horticultural marketing expert, all of whom have generously donated their time and resources. With the help of all parties, the first set of UC Davis Arboretum All-Stars is expected to be released in fall 2009.

Looking ahead

In the future, we hope to broaden the coalition of cooperating entities to include other botanical gardens, California Native Plant Society members, other university and junior college faculty with expertise in this area, and more members of the nursery and landscape industry with an interest in growing, selling and planting low-input plants. This model is based on several successful program examples such as those in Texas and Oklahoma, where candidates for field trials are put forth at annual meetings of large advisory committees composed of members from academia, extension services, botanical gardens and arboreta, professional landscape and nursery associations, and individual industry representatives. In these states, this group analyzes the results of the trials as well, and decides which plants are actually worthy of introduction (Anella et al. 2001; Mackay et al. 2001). Their goal, like ours, is to identify and promote plants that do well with minimal inputs throughout most of the state. In this way, all the parties who benefit from the trials and subsequent introductions can be included in the process from start to finish.

California consumers are increasingly aware of the need for environmentally sustainable horticultural practices. A large part of this sustainability is the use of plants requiring no chemical inputs and less water, mitigating the chemical load in watersheds and the waste of our precious water. The UC system — with its associated Cooperative Extension, Master Gardeners and California Center for Urban Horticulture — is ideally suited to establish and coordinate a cooperative effort with the nursery and landscape industries to introduce California native and other low-input plants to this new generation of consumers. Though this program is in its infancy, it holds great promise for fulfilling its goals of providing both producers and consumers with a large variety of beautiful plant materials, with greatly reduced negative impacts to the urban environment, for years to come.

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References

Anella LB, Schnelle MA, Maronek DM. 2001. Oklahoma proven: A plant evaluation and marketing program. HortTechnol 11(3):381–4.

Armitage AM, Green M. 2001. The university trial garden as a tool for evaluating and introducing new plant materials. HortTechnol 11(3):368–72.

Bailey HC, Deanovic L, Reyes E, et al. 2000. Diazinon and chlorpyrifos in urban waterways in Northern California, USA. Env Toxicol Chem 19:82–7.

Brenzel KN. 2007. *Sunset Western Garden Book* (8th ed.). Menlo Park, CA: Sunset Pub. 768 p.

[CalEPA] California Environmental Protection Agency. 2007. State Water Resources Control Board. Water Quality. Irrigated Agricultural Waivers Program. www.waterboards.ca.gov/agwaivers/index.html.

Costello LR, Matheney NP, Clark JR. 2000. A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California. The Landscape Coefficient Method and Water Use Classification of Landscape Species. UC Cooperative Extension and California Department of Water Resources. www.owue.water.ca.gov/docs/wucols00.pdf.

Dunwell WC, Fare D, Arnold MA, et al. 2001. Plant evaluation program for nursery crops and landscape systems by the Southern Extension and Research Activities/Information Exchange Group-27. HortTechnol 11(3):373–5.

Hanak E, Davis M. 2006. Lawns and water demand in California. Cal Econ Pol 2(2):1–24. Public Policy Institute of California, San Francisco, CA.

Irmak S, Haman DZ, Irmak A, et al. 2004. Measurement and analyses of growth and stress parameters of *Viburnum odoratissimum* grown in a multi-pot box system. HortScience 39(6):1445–55.

Lindstrom JT, Robbins JA, Klingaman GL, et al. 2001. The University of Arkansas Plant Evaluation Program. HortTechnol 11(3):362–4.

Mackay WA, George SW, Davis TD, et al. 2001. Texas Superstar and the Coordinated Educational and Marketing Assistance Program (CEMAP): How we operate. HortTechnol 11(3):389–91.

Padilla FM, Pugnaire FI. 2007. Rooting depth and soil moisture control Mediterranean woody seedling survival during drought. Functional Ecol 21(3):489–95.

Pooler MR. 2001. Plant breeding at the US National Arboretum: Selection, evaluation and release of new cultivars. HortTechnol 11(3):365–7

[USNA] US National Arboretum. 2006. Web Version of the USDA Plant Hardiness Zone Map. USDA Misc Pub No 1475, 1990. www.usna.usda.gov/Hardzone/index.html.

Weston DP, Holmes RW, You J, Lydy JJ. 2005. Aquatic toxicity due to residential use of pyrethroid insecticides. Env Sci Technol 39(24):9778–84.

Wilen CA, Robinson G, Osborn S. 2001. Survey of residential pesticide use in an urbanized area of Southern California. HortScience 36(3):613.