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Survival and Performance of Cultivated Perennial Legume Species in Arizona

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In May 1989, the Desert Legume Program began trial plantings of legumes in field plots located at the University of Arizona Campus Agricultural Center (CAC field 6), in Tucson. The initial purpose of these trials was to evaluate various taxa for their adaptability to the local climate. An additional goal was seed-increase to augment DELEP's seed bank. As the field trials continued, the plants also served as a source of plant material for several research projects primarily involving screening for bioactive compounds with pharmaceutical applications. Those plants that performed well and had an attractive growth form, foliage or flowers were also evaluated for their potential as landscape plants. A dozen trees and shrub species have made their way into the Arizona landscape nursery trade following field evaluations at DELEP. In 1991, a site for frost-sensitive woody legumes was established at the Yuma Mesa Agricultural Center, in Yuma, AZ. In 1997 a field for woody shrubs, suffrutescent perennials and some herbaceous perennial species was planted at a second location at the CAC (field 3) and in 1998 a field for trees was put in at the West Campus Agricultural Cen-

ter (WCAC). Together, the Tucson fields comprise approximately 3.5 acres and the Yuma fields add an additional 4 acres. Over 500 taxa of legumes have been planted among these fields in the past 14 years. Plantings have continued through 2004 with additional plants ready for installation in 2005.

With few exceptions, the plants used in these field trials have been propagated at DELEP's CAC facilities. In most cases, the plants are planted out from 1-gallon or 2-gallon containers, with some plants grown on to 5-gallon size prior to planting. Depending on planting location and eventual mature size, between 2 and 10 plants of each accession are propagated. Most planting has taken place during the spring and summer months to optimize establishment and growth prior to winter. Newly planted specimens are protected with poultry netting to exclude rabbits. This is removed when the plants are larger. Flood irrigation in the CAC fields is provided on an as-needed basis with the irrigation schedule adjusted to reflect the age of the plantings, season, and rainfall. In 2004, we began retrofitting the original CAC field (field 6) with a drip irrigation system. The WCAC field was provided with drip irrigation from the outset. The Yuma fields have been flood-irrigated once every three weeks in the summer months and once

every six weeks in the winter following an initial establishment period for the early plantings. Manual and chemical weed control is performed as needed. Larger woody species are pruned when young to encourage development of an arborescent form and to facilitate weed control beneath them. Otherwise, pruning is performed mainly to remove portions of plants that have been damaged by storms or freezing temperatures.

The soil at the different fields varies considerably. The CAC fields are located in the floodplain of Rillito Creek and the WCAC field is on the floodplain of the Santa Cruz River. The soil in field 6 at the CAC is sandy clay while field 3 has a heavier clay soil. At the WCAC field the soil is backfill of unknown origin. It has a lower clay content than the CAC fields. The pH at the Tucson field sites is slightly alkaline. The Yuma fields are located on an area of stabilized sand. Both the CAC and WCAC fields are located in areas subjected to cold air drainage and experience regular freezing temperatures in winter. In some years, overnight temperatures fall below 20° F (-6.6° C). These fields provide excellent locations in which to evaluate cold tolerance in tropical and subtropical legume species.

As expected, freezing temperatures accounted for the greatest number of plants that failed to survive. Many

plants died during their first winter and some of these might have survived had they been larger. The particularly cold freeze of December 1996, when temperatures in CAC field 6 fell to 15° F (-9.4° C) killed a number of plants that had survived previous winters with relatively minor damage. In some cases, sensitivity to freezing temperatures was observed to vary between individual plants within a single accession.

The second largest cause of mortality seems to be field conditions. Many Australian taxa that occur naturally in areas with acidic, sandy soils quickly declined and died when planted in the alkaline clay soil at the CAC fields. This was most noticeable during the hot, humid summer months. Others persisted for a year or two but grew little if any, developed chlorosis, and frequently exhibited considerable stem die-back before expiring. It was not determined which soil conditions resulted in the deaths of these plants or if pathogens may have been a contributing factor. Several species that had been planted in CAC field 3 had done well until the summer of 1999 when a combination of over 6 in (150 mm) of rain during July and a broken water main resulted in that field being inundated with standing water for a period of four weeks. The plants most affected by the waterlogged condition of the field were from regions with dry summers or from higher elevation dry regions. The majority of the species in the field showed little or no ill effects from this event.

Predation by rabbits and gophers accounted for the loss of a number of plants in CAC field 6 and the Yuma fields. Rabbits were primarily a problem with young/small plants, however, gophers appear to have caused fatal damage to several large shrubs and

at least one tree. Damage by chewing or sucking insects caused little apparent damage, and this was confined to certain species.

The course of these field trials has undoubtedly exceeded the life span for a number of suffrutescent taxa and even some woody species. Many Australian acacias are reported to live only 5 to 10 years. A number of plants died for reasons that were not determined. Some plants simply disappeared without a trace within their first months in the fields. Some small plants may have been accidentally destroyed during weed removal. Others may have been killed by herbivores or pathogens.

People have been moving plants from one location to another for thousands of years. This has greatly accelerated in the past century with the advent of modern transportation systems. In some cases, plants that have been introduced into environments beyond their natural distribution have escaped from cultivation and become serious pests, causing economic and environmental damage. Most exotic plant species do not exhibit invasive tendencies or at worst become garden weeds. Still, the possibility does exist for an introduced plant to escape and become a significant problem.

DELEP is keenly aware of its responsibility to avoid introducing plants that could become ecosystem weeds. To date, 56 taxa of legumes have been observed to reproduce from seeds in DELEP's field plots. It must be kept in mind that these fields are artificial environments that provide optimum conditions for germination and growth. The soil is regularly disturbed during weed control operations and ample moisture is present at intervals during the growing season. Arid environments present dif-

ficult challenges for the establishment of woody plants outside of riparian habitats as evidenced by the lack of infestations of exotic woody species in upland areas of the Sonoran Desert surrounding cities and towns with their abundance of cultivated non-native trees and shrubs.

Vigilance is essential, however, particularly with plants that are not native to southwestern North America. Of the 45 taxa of legumes observed to reproduce from seeds in the Tucson field sites, 17 are native to Arizona and 7 others are native to areas of the Sonoran Desert outside of Arizona. Only 10 taxa that reproduced in the original Tucson field site (CAC field 6) are native to areas outside of North America and of these, 5 subsequently died out. Five volunteer taxa have survived in the fields: *Caesalpinia gilliesii* is widely cultivated across the southwestern U.S. and often becomes feral around settlements. *Senna artemisioides* subsp. *filifolia* and *Senna artemisioides* subsp. *petiolaris* are widely grown as landscape plants in desert areas of southern and central Arizona. These Australian natives have been observed to establish occasionally along roads or in desert areas adjacent to landscapes where they are cultivated. *Senna aphylla* is represented by a single plant that volunteered adjacent to a parent plant in CAC field 6. *Mimosa farinosa* presents some concern as hundreds of seedlings have volunteered in the field where the parent plants are growing. Since irrigation has been reduced, new seedlings have been few, however these are being removed and this species will not be made available for horticulture. Only 2 legume taxa not native to the immediate vicinity of the CAC fields, *Senna hirsuta* var.

glaberrima and *Senna lindheimeriana*, have been observed to germinate outside of the irrigated areas of the Tucson fields. Both of these are native to areas of eastern Pima County at a slightly higher elevation.

Interestingly, none of the Australian acacias except for *Acacia stenophylla* have been observed to reproduce from seeds in DELEP's fields,

though many have profuse seed production. Two plants of *Acacia stenophylla* became established in CAC field 3 following extensive flooding in that field during the summer of 1999. In habitat, they are found along seasonally flooded watercourses and seasonal swamps, though they perform quite well in desert landscapes.

Several taxa have been observed to produce root-suckers under cultivation in DELEP's fields. These include *Acacia ampliceps*, *Acacia jennerae*, *Acacia salicina*, *Geoffroea decorticans* and *Prosopis reptans* var. *cinerascens*.

Legume Taxa Observed to Reproduce from Seeds in DELEP Field Evaluation Sites

Occurrence: F – Frequent, more than 20 plants
 O – Occasional, 5-20 plants
 R – Rare, less than 5 plants

Taxonomic Name	Occurrence
<i>Acacia angustissima</i> var. <i>angustissima</i> (Tucson)	O
<i>Acacia farnesiana</i> (Tucson)	R
<i>Acacia furcatispina</i> (Tucson)	R
<i>Acacia millefolia</i> (Tucson)	R
<i>Acacia modesta</i> (Yuma)	O
<i>Acacia neovernicosa</i> (Tucson)	R
<i>Acacia nilotica</i> (Yuma)	R
<i>Acacia roemeriana</i> (Tucson)	O
<i>Acacia stenophylla</i> (Tucson)	R
<i>Acacia villosa</i> (Tucson)	R
<i>Brongniartia alamosana</i> (Yuma)	O
<i>Caesalpinia gilliesii</i> (Tucson)	O
<i>Caesalpinia mexicana</i> (Tucson)	R
<i>Caesalpinia platyloba</i> (Yuma)	R
<i>Calliandra californica</i> (Tucson)	R
<i>Calliandra eriophylla</i> (Tucson)	R
<i>Dalea pulchra</i> (Tucson)	O
<i>Eysenhardtia orthocarpa</i> (Tucson)	O
<i>Eysenhardtia texana</i> (Tucson)	O
<i>Indigofera sphaerocarpa</i> (Tucson)	R
<i>Indigofera suffruticosa</i> (Tucson)	O
<i>Haematoxylum brasiletto</i> (Yuma)	O
<i>Havardia mexicana</i> (Tucson)	R
<i>Leucaena leucocephala</i> (Yuma)	F
<i>Lonchocarpus capassa</i> (Yuma)	R
<i>Lysiloma candidum</i> (Yuma)	O
<i>Macroptilium atropurpureum</i> (Tucson)	O
<i>Mimosa asperata</i> (Tucson)	R
<i>Mimosa dysocarpa</i> (Tucson)	R

<i>Mimosa emoryana</i> (Tucson)	F
<i>Mimosa ephedroides</i> (Tucson)	R
<i>Mimosa farinosa</i> (Tucson)	F
<i>Mimosa palmeri</i> (Yuma)	R
<i>Parkinsonia aculeata</i> (Tucson)	R
<i>Parkinsonia florida</i> subsp. <i>florida</i> (Tucson)	O
<i>Pithecellobium dulce</i> (Yuma)	F
<i>Prosopis glandulosa</i> var. <i>torreyana</i> (Yuma)	O
<i>Prosopis pubescens</i> (Tucson)	F
<i>Prosopis reptans</i> var. <i>cinerascens</i> (Tucson)	R
<i>Prosopis velutina</i> (Tucson)	O
<i>Rhynchosia texana</i> (Tucson)	O
<i>Senna aphylla</i> (Tucson)	R
<i>Senna artemisioides</i> subsp. <i>xartemisioides</i> (Tucson)	F
<i>Senna artemisioides</i> subsp. <i>filifolia</i> (Tucson)	F
<i>Senna artemisioides</i> subsp. <i>petiolaris</i> (Tucson)	O
<i>Senna artemisioides</i> subsp. <i>xsturtii</i> (Tucson)	F
<i>Senna confinis</i> (Tucson)	F
<i>Senna covesii</i> (Tucson)	F
<i>Senna durangensis</i> (Tucson)	O
<i>Senna hirsuta</i> var. <i>glaberrima</i> (Tucson)	F
<i>Senna lindheimeriana</i> (Tucson)	F
<i>Senna occidentalis</i> (Tucson)	O
<i>Senna pleurocarpa</i> var. <i>pleurocarpa</i> (Tucson)	R
<i>Senna roemeriana</i> (Tucson)	F
<i>Sutherlandia frutescens</i> (Tucson)	O
<i>Tephrosia purpurea</i> (Tucson)	F

The frequency of evaluations varied from yearly to once every several years depending on the field and the length of time since the field was originally planted. Information recorded for plant specimens growing in the field plots included survival, freeze damage and other problems, height or size, general health and appearance, and flowering/fruitletting. Accessions located in different fields have separate entries.

I extend my sincere appreciation to DELEP horticulturist Ken Coppola and the many volunteers, part-time groundkeepers and University of

Arizona student employees who have helped to propagate, plant and care for the plant specimens in this field study. I am grateful also to the personnel of the University of Arizona Campus Agricultural Center and West Campus Agricultural Center, in Tucson, and the Yuma Mesa Agricultural Center for preparing the fields, and for performing vital maintenance including irrigation, disking and mowing, removal of pruned material and gopher control.

The full text of the individual plant evaluations will be available as an email attachment. Interested parties may

contact DELEP by phone, post or by email at: mjohnson@ag.arizona.edu

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Staff and Volunteers in Action

Weather in Tucson turned dramatically cooler during late October, as is the norm. I began moving our frost-sensitive plants into the greenhouse to “overwinter”, on October 27th. We are using a much smaller greenhouse this winter, as we have fewer plants that fall into the “sensitive” category than we did in previous years. Few plants will remain in our shadehouses during the winter. Groups that will stay there include the unidentified *Lupinus* propagations, *Astragalus*, *Dalea*, and *Lotus* species. Several of the *Lupinus* that we grew for identification purposes last year were identified and I have repropagated accessions that either did not germinate or flower, in that first attempt. Hardy but weedy *Desmodium* “to be determined” and *Prosopis* species for the Boyce Thompson Arboretum will also remain in the shadehouses.

Some specimens being grown for identification are from seed collected in milder climate areas of Texas, and the southwestern United States. These are likely too frost-tender for Tucson, but perhaps suitable for eventual planting in our Yuma fields. After Matt has identified an accession, he determines whether that plant is appropriate for DELEP’s nursery.

New specimens already represented in the living collection but grown from a different seed accession might still be planted for seed increase, allowing us to broaden the genetic diversity in our seed bank.

Our Tucson volunteers are usually enthusiastic about adopting our propagation “leftovers” which are not needed for seed increase.

It was a sad day in October, when volunteer Betty Galamba called to inform us that Emily Johnson had died. Emily’s work here began in 1994 and included working with Ramona Johnson (no relation to Emily), Betty, and Janet Gray on the Donor Relations project. Emily was an enthusiastic, sweet, and generous part of our great team of volunteers. Although health problems prevented her regular attendance of meetings during the past few years, she will be missed by all of us who knew her. We send our sincere condolences, to Emily Johnson’s family and friends.

Matt is planning his winter trip to our Yuma fields during early December. Former DELEP employee Jamie Wahl has been caring for those specimens, on an occasional basis, this year. Thank you, Jamie and all Yuma volunteers. Thanks, also, to Wayne MacGowan, Chris Marshall, and Karl May, who have provided weekend labor in the greenhouse and shadehouses during the past year.

Dates for the spring 2005 volunteer sessions will be held on January 12th, February 9th, March 9th, April 13th, and May 11th. Please call me at 520-318-7047, to learn more about participation as a DELEP volunteer, both in Tucson and elsewhere. **KC**

Emily Johnson

DELEP Seed Identification Project

The DELEP seed bank includes nearly 3400 individual accessions of seeds. This represents 1344 identified species (1428 taxa including subspecies and varieties) in 218 genera. While most of the accessions were identified at the time of collection or received from other sources with identification, about 300 accessions were inadequately identified. For some, the genus is known while for others even this is lacking. Some of the 300 seed accessions were collected by DELEP personnel while others were provided by volunteers and other individuals. It is not always possible to identify an unfamiliar plant at the time a seed collection is made, particularly if flowers are absent, as the identification keys used in most floristic and taxonomic treatments are based at least in part on floral characters. These seed collections were processed and placed into frozen storage, with those accessions lacking identification to the generic level having a designated storage container labeled TBD (To Be Determined). The unidentified accessions represent potentially valuable additions to the seed bank and some contain significant numbers of seeds, but without identification they remain an untapped resource.

Two years ago, DELEP began a project to identify these accessions. An attempt was made to propagate at least one plant of each accession for purposes of identification. This initial effort produced plants from 170 accessions. The identity of some plants became

readily apparent as they grew, as examples of those species are represented in DELEP's field plantings. For a number of plants of wild origin with information on the collection location, it was possible to identify them from regional floras or monographs once they flowered. To date, 45 accessions have been identified to the species level and the genus has been determined for 7 additional accessions. The accessions identified in this project include three new taxa to the seed collection: *Astragalus prorifer* (1 accession from the Baja California peninsula, Mexico), *Indigofera miniata* var. *miniata* (2 accessions from the 1990 Texas collecting trip) and *Phaseolus angustissimus*, (1 accession from Santa Cruz County, Arizona and 1 accession from the 1996 Texas trip). Some accessions are of legumes that are commonly grown in hot climates around the world including *Albizia lebbbeck* (4 accessions) and *Leucaena leucocephala* (4 accessions). These species are already represented in DELEP's seed bank by several accessions, but the newly identified accessions add diversity to the collections of these plants. Other accessions that have been identified provided additional collections for plants for which we had previously had only a single accession. Some of the plants grown for this project are yielding quantities of seeds for the seed bank and others will be planted out to grow them to larger size for future identification.

This project is ongoing. We are repropagating some of the her-

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baceous accessions that previously died without flowering and will be making new attempts to grow the accessions that have not previously germinated. With some plants it may be practical to make pressed herbarium specimens and send these to specialists at other institutions for identification. The most challenging accessions will be those collected from cultivated plants in distant locales and those for which we lack any information on their origin. Some of these accessions will likely remain undetermined but we intend to continue efforts to identify as many of them as possible. **MBJ**

This seed identification project was made possible by the generous support of the Wallace Research Foundation.

Tree
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Opportunities for Participation

DELEP's bulletin Aridus, is published three times annually to stimulate interest in desert legumes, to inform our readers of DELEP's activities, and to encourage support for DELEP's programs. Manuscripts related to legumes are welcome and should be mailed to the editor for review. Subscriptions are complimentary and are available by contacting the DELEP office. Aridus is published by The University of Arizona on behalf of The Desert Legume Program.

Financial support for DELEP comes from contracts, grants and contributions from private industries, government agencies and individuals.

To Contribute: Send a check, payable to U of A Foundation/ DELEP, or call the DELEP Office concerning a pledge, a restricted gift, or estate planning.

The Desert Legume Program
2120 E. Allen Road
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Dedicated volunteer work is an integral component of DELEP. Our volunteers come from many backgrounds and work on a variety of projects including wild seed collecting, seed processing, organization of special events, and office work.

To Volunteer: Or just to explore the possibilities, telephone our office (520) 318-7047) or drop us a note or email: kcoppola@ag.arizona.edu.



Acacia brachystachya (KC)

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