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The January 2007 Freeze – Effects of Cold on Plants in DELEP's Fields

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The winter of 2007 brought cold temperatures to southern Arizona, with a major freeze event occurring on January 14 and 15, 2007 in Tucson. In terms of minimum temperatures, duration, and effects on cultivated and native plants, this was the most severe freeze that the Tucson area has experienced since December 1978. Temperatures fell to 20° F at the University of Arizona campus and in some of the coldest parts of the Tucson area, dropped into the single digits.

DELEP's Tucson fields are ideal locations to evaluate plants for cold tolerance. The Campus Agricultural Center (CAC) fields are located adjacent to Rillito River and the West Campus Agricultural Center (WCAC) field is situated along the Santa Cruz River. These are low-lying areas that are subject to substantial cold air drainage at and temperatures frequently drop below freezing at night during the winter months. Temperature records during the January freeze indicate a minimum low of 18° F at the CAC and 20° F at the WCAC. Temperature readings are from Arizona Meteorological Network (AZMET) recording

stations. The actual temperatures experienced by plants in DELEP's field sites were probably lower as the fields are located closer to the dry river channels where cold air collects, than are the weather stations.

DELEP's Yuma field site, located at the Yuma Mesa Agricultural Center, was selected as a site for frost sensitive species. Since the first plantings in Yuma in 1991, minor freeze damage was noted only once. This January, a low temperature reading of 23° F was recorded at this site.

Conditions during the winter of 2006-2007 were ideal for evaluating plant response to low temperatures. Abundant rainfall the previous summer had helped alleviate the drought stress that many of the older plantings had experienced due to reduced irrigation. A period of dry weather in October was followed by moderate rainfall in November and December, accompanied by gradual cooling as autumn progressed. Several light freezes had occurred earlier in the winter and the plants were dormant and hardened off by January. The earlier freezes had produced only superficial damage on sensitive species in the Tucson fields.

As indicated in articles in previous issues of *Aridus* (August 2004, August 1997) that discussed the effects of freezing on plants, cold tolerance is difficult to quantify due to many interacting factors. As in previous years, this freeze produced

some surprises. Some plants that had survived previous freezes with little or no damage were more severely affected this winter, while other plants that have sustained significant damage in the past showed relatively little damage. Some of this might be accounted for by the degree of maturity of the plants or state of dormancy, but some of the observed effects are not readily explainable. Differences in the degree of damage between individual plants of the same accession were also observed, but this was not as pronounced as in previous years.

This report summarizes the effects of the January 2007 freeze on cultivated legumes growing in DELEP's field evaluation sites. Precise information on minimum temperatures in the individual fields is not available, however, these observations can provide a general idea of cold tolerance in many of these plants. For more extensive information on the long-term performance of plants in DELEP's fields, please visit the website at: <http://cals.arizona.edu/desertlegumeprogram>

Notes: Damage to foliage is indicated only for those plants that typically remain evergreen through the winter. All plants are established, perennial woody or suffrutescent taxa. For plants that were damaged, the number of plants at each field site is indicated in parentheses.

No freeze damage was evident on the following taxa:

Acacia acuminata CAC/WCAC
Acacia aneura CAC/WCAC
Acacia atramentaria WCAC
Acacia berlandieri CAC
Acacia brachystachya CAC/WCAC
Acacia caffra Yuma
Acacia catechu Yuma
Acacia caven WCAC
Acacia constricta CAC
Acacia coulteri Yuma
Acacia craspedocarpa CAC
Acacia deanii CAC
Acacia erioloba WCAC
Acacia greggii CAC/WCAC
Acacia haematoxylon CAC
Acacia harpophylla WCAC
Acacia modesta Yuma
Acacia neovernicosa CAC
Acacia nilotica Yuma
Acacia obtecta CAC
Acacia occidentalis CAC/WCAC
Acacia oswaldii CAC
Acacia papyrocarpa WCAC
Acacia prainii WCAC
Acacia rigidula CAC/WCAC
Acacia rivalis WCAC
Acacia roemeriana CAC
Acacia schaffneri CAC/WCAC
Acacia schottii CAC
Acacia senegal var. *leiorachis* Yuma
Acacia senegal var. *rostrata* Yuma
Acacia sieberiana var. *woodii* Yuma
Acacia victoriae WCAC
Acacia willardiana Yuma
Acacia wrightii CAC/WCAC
Albizia lebbeck Yuma
Amorpha fruticosa CAC
Caesalpinia gilliesii CAC
Caesalpinia paraguariensis CAC/
 Yuma
Caesalpinia sessilifolia CAC
Cercis chingii CAC
Colutea istria CAC
Dalea pulchra CAC
Eysenhardtia texana CAC
Faidherbia albida Yuma
Geoffroea decorticans CAC

Gleditsia caspica CAC
Gleditsia triacanthos WCAC
Gymnocladus dioicus CAC
Halimodendron halodendron
 WCAC
Havardia mexicana CAC
Havardia sonora Yuma
Leucaena greggii CAC/WCAC
Leucaena retusa CAC
Mimosa aculeaticarpa var.
biuncifera CAC
Mimosa emoryana CAC
Mimosa ephedroides CAC
Mimosa farinosa CAC
Mimosa grahamii CAC
Parkinsonia florida subsp. *florida*
 CAC/WCAC
Parkinsonia microphylla WCAC
Parkinsonia texana var. *macra*
 CAC/WCAC
Parkinsonia texana var. *texana*
 CAC/WCAC
Parkinsonia x 'Desert Museum' CAC
Pithecellobium unguis-cati Yuma
Prosopidastrum globosum CAC
Prosopis affinis Yuma
Prosopis chilensis WCAC
Prosopis flexuosa WCAC
Prosopis glandulosa var.
glandulosa WCAC
Prosopis glandulosa var.
torreyana CAC/WCAC
Prosopis laevigata CAC/WCAC
Prosopis nigra CAC
Prosopis pubescens CAC/WCAC
Prosopis reptans var. *cinerascens*
 CAC
Prosopis velutina CAC/WCAC
Psoralea spinosus CAC/Yuma
Robinia pseudoacacia CAC
Senna aphylla CAC
Senna artemisioides subsp.
zygophylla CAC
Senna wislizeni CAC
Sophora secundiflora CAC

Freeze damage was observed on the following taxa:

Acacia adsurgens CAC (1): This plant was killed with stems to 3" thick frozen.
Acacia ampliceps CAC (1): All stems froze back to 6' to the base (to 1" thick). This plant freezes to the base at this site most years.
Acacia amythethophylla Yuma (4): Most stems were frozen to 3" thick with new growth emerging mainly from the trunks.
Acacia angustissima var. *angustissima* CAC (10): Variable damage with stems killed back 1'-6' from the tips.
Acacia angustissima var. *suffrutescens* CAC (6): Most stems froze back 1'-3' from the tips.
Acacia aroma CAC (2)/WCAC (2): No damage was evident on the WCAC plants. Many stems froze back 3"-6" from the tips on plants at the colder CAC site.
Acacia ashbyae WCAC (2): 60% of the foliage was killed and some stems froze back 1'-2'.
Acacia borleae CAC (2): Some stems froze back only 2"-10".
Acacia brachybotrya CAC (1): 40% of the foliage was killed with individual stems losing all phyllodes. No stem damage.
Acacia brandegeana WCAC (2)/Yuma (2): Yuma plants were undamaged. Stems froze back 1"-3" on the WCAC plants.
Acacia brevispica CAC (2): Stems froze back 5' to the base (to 0.25" thick). The plants are recovering.
Acacia cambagei WCAC (2): The smaller plant (1.5' tall) froze to the base and is recovering. The larger plant (3' tall) lost 25% of its foliage but had no stem damage.
Acacia cana CAC (1): only 10% of the foliage was killed.

- Acacia citrinoviridis* CAC (2): Both plants (same accession) froze to the base (stems to 5" thick) and are recovering. In previous winters one of these plants regularly froze while the other exhibited little or no damage.
- Acacia coriacea* CAC (2): All stems froze back 4'-6' to the base. The plants are recovering.
- Acacia crassifolia* CAC (1): All foliage was killed and stems froze back 1' from the tips.
- Acacia difformis* CAC (2): Minor damage to phyllode tips only.
- Acacia ehrenbergiana* WCAC (1): Froze to base with stems to 0.25" thick killed. The plant is recovering.
- Acacia farnesiana* CAC (1)/WCAC (2): No damage to WCAC plants. Stems of CAC plant froze back 1'-3' (to 0.5" thick).
- Acacia fasciculifera* CAC (2)/WCAC (2): All stems froze to the base (to 1" thick). All plants are recovering.
- Acacia fleckii* WCAC (1)/Yuma (3): The Yuma plants were undamaged. Stems of WCAC plant froze back 1"-6".
- Acacia furcatispina* CAC (3): Some stems froze back to 9" from tips.
- Acacia galpinii* CAC (2)/Yuma (2): The Yuma plants were undamaged. Stems on the CAC plants froze back 6' from the tips (to 2" thick).
- Acacia gerrardii* subsp. *negevensis* CAC (3)/WCAC (2): Some stems froze back to 1' from the tips on plants at both sites. Other stems appear undamaged.
- Acacia grandicornuta* CAC (1): All stems froze to the base (to 1" thick). The plant is recovering.
- Acacia grasbyi* WCAC (1): The foliage was killed and stems froze back to 1' from the tips.
- Acacia harveyi* CAC (1): 95% of the foliage was killed and the plant subsequently died (stems to 3" thick).
- Acacia hebeclada* subsp. *hebeclada* CAC (3)/WCAC (2): Most stems on all plants froze back 1"-9".
- Acacia hereroensis* CAC (2): Most stems froze back 1'-3' from the tips on outer portions of the plant.
- Acacia jennerae* CAC (2), WCAC (2): WCAC plants were undamaged. CAC plants had 50% of the foliage frozen and many root suckers were killed. This is the first time that any freeze damage has been noted on this species.
- Acacia karroo* WCAC (2)/Yuma (1): The Yuma plant was undamaged. Stems of CAC plants froze back to 1' from tips (to 0.5" thick).
- Acacia kempeana* CAC (3): Minor damage to some phyllode tips only.
- Acacia kirkii* WCAC (2): Most stems froze back 1'-6' from the tips.
- Acacia leurderitzii* var. *leurderitzii* Yuma (2): Most outer stems froze to 0.5" thick.
- Acacia mellifera* subsp. *detinens* CAC (1)/WCAC (1): No damage to WCAC plant. Some stems of CAC plant froze back 1"-3".
- Acacia microcarpa* CAC (1): 90% of the foliage was killed and some stems froze back 1"-6" from the tips.
- Acacia millefolia* CAC (7): Variable damage with many stems frozen 1'-4' from tips (to 1.5" thick).
- Acacia montana* CAC (1): This plant was killed with stems to 2.5" thick frozen.
- Acacia nebrownii* CAC (3)/Yuma (2): The Yuma plants had only minor damage to some stem tips. The CAC plants froze to the base with stems to 2" thick killed and are recovering.
- Acacia notabilis* CAC (3): 2 plants of one accession were undamaged. The single plant of a second accession had 90% of the foliage killed and lost all but one stem.
- Acacia nysophylla* CAC (2): 1 plant had only 10% of its foliage damaged.
- Acacia patagiata* CAC (3): 1 plant was undamaged. 1 plant had 75% of the foliage killed. 1 plant apparently died with stems to 1" thick frozen. These plants are from the same accession.
- Acacia pendula* CAC (1)/WCAC (2): The WCAC plants were undamaged. CAC plant had extensive damage to foliage and some stem tips.
- Acacia permixta* CAC (2): All stems froze back 6'-8' (to 2" thick), to within 2' to 4' of the base.
- Acacia polyacantha* Yuma (2): Many stems froze to 2" thick though some smaller stems appear undamaged.
- Acacia pruinocarpa* CAC (3)/WCAC (2): WCAC plants suffered 10-25% foliage killed only. CAC plants suffered severe damage with stems killed to near the base (to 2" thick).
- Acacia pyrifolia* WCAC (2): Stems killed back to 4' to near base (to 0.5" thick).
- Acacia quornensis* CAC (2): Both plants froze to the base (stems to 1" thick). One plant died and the other is recovering.
- Acacia redolens* CAC (4): 2 plants of one accession had no damage while 2 plants of a second accession had 10% of the foliage killed and a few stems frozen back to 1' from the tips.
- Acacia reficiens* WCAC (1): Most stems froze back 3"-6".
- Acacia rehmanniana* WCAC (2): Some stems froze back 1'-6' from the tips (to 2" thick), other stems with only minor tip damage.
- Acacia salicina* CAC (2)/WCAC (2): WCAC plants were undamaged. CAC plants had all foliage killed and stems froze back 1'-3' from the tips. The plants at CAC and WCAC are of different accessions.
- Acacia stenophylla* CAC (1)/WCAC (2): WCAC plants were undamaged. The CAC plant was

killed (stem 3" thick). It had suffered severe damage in previous freezes. The plants at CAC and WCAC are of different accessions.

Acacia tetragonophylla CAC (3): 2 plants of one accession had 80% of the foliage frozen and stems killed back 2"-24" from the tips. A single plant of a second accession was killed to the base (stems to 5" thick) and is slowly recovering.

Acacia villosa CAC (2): All stems froze to the base (to 1" thick). The plants are recovering.

Acacia viscidula CAC (3): Minor damage to some phyllodes only.

Acacia xanthophloea Yuma (4): Most stems to 2" thick appear to have frozen.

Albizia amara subsp.

sericocephala Yuma (2): Stems froze to 1.25" thick.

Albizia anithelmentica Yuma (3): Stems froze back to 2' from tips (to 0.5" thick).

Albizia brevifolia Yuma (5): Most stems suffered only minor damage to the tips (to 0.25" thick).

Albizia forbesii Yuma (1): Stems froze back to 0.5" thick.

Albizia sinaloensis CAC (2)/Yuma (4): Freeze damage on the Yuma plants was not determined as they have suffered major die-back in recent years for undetermined reasons. The CAC plants froze to the base (stems to 1" thick) and are recovering.

Anadananthera colubrina WCAC (2)/Yuma (2): WCAC plants froze to the base (to 2" thick stems) and are recovering. Stems on the Yuma plants froze back to 0.5" thick.

Atelea cubensis Yuma (4): Foliage was killed with variable damage to stems which froze back to 9" from the tips.

Bauhinia forficata WCAC (2): Stems froze back to base (to 0.75" thick). The plants are recovering.

Bauhinia lunarioides CAC (5): 4 of the plants were undamaged. 1 plant appears to have frozen to the base (stems to 0.25" thick) but is recovering.

Bauhinia macranthera CAC (2): Stems froze back only 1"-3" from tips.

Bolusanthus speciosus CAC (1)/WCAC (1)/Yuma (6): The Yuma plants suffered only minor damage to the foliage. The WCAC plant had all foliage killed and some stems froze back to 5' from tips (to 0.5" thick) while other stems had only tip damage. The CAC plant froze to the base (stems 1.5" thick) and is recovering.

Brongniartia alamosana CAC (1)/Yuma (4): The Yuma plants had most outer stems frozen to 0.5" thick. The CAC plant froze back 4.5' to the base. The plant is recovering. It freezes to the base most winters at this cold site.

Brongniartia minutifolia CAC (1): Some stems froze to the base (to 1" thick) and other stems froze back only to 6" from tips.

Caesalpinia cacalaco CAC (1)/Yuma (3): The Yuma plants suffered minor stem tip damage only. The CAC plant froze to the base (stems to 1" thick) and is recovering.

Caesalpinia mexicana CAC (10): Variable damage on all plants with some stems frozen to 1.5" thick and other stems with minor damage.

Caesalpinia palmeri CAC (5)/Yuma (1): The Yuma plant was undamaged. 4 of the CAC plants had stems freeze back 1"-6" from the tips. 1 CAC plant had all stems killed to near the base (to 2" thick) but is recovering.

Caesalpinia platyloba Yuma (4): Stems froze back to 2' from the tips.

Caesalpinia pulcherrima CAC (5): All stems typically freeze to the base each winter.

Caesalpinia pumila Yuma (3): Most twigs appear to have frozen back to 1' from the tips.

Calliandra californica CAC (7): Most but not all stems froze back 3'-5' to the base.

Calliandra eriophylla CAC (6): Some stems froze back to 1' from tips.

Colophospermum mopane Yuma (3): 2 of the trees appear undamaged while the third has most stems frozen back to 16" from the tips.

Coursetia axilaris CAC (1): Minor damage to stem tips only.

Coursetia glandulosa CAC (4): Stems froze back to the base (to 9' long and 0.5" thick). The plants are recovering.

Dalbergia melanoxydon Yuma (1): Most stems appear to have frozen back to the main trunk.

Ebenopsis ebano CAC (2): The foliage was killed and many stems froze back 1'-2' from the tips.

Erythrina flabelliformis CAC (2): All stems froze to the base. One plant is recovering and the other appears to have died.

Eysenhardtia orthocarpa CAC (6): Variable damage with some stems frozen back to 2' from the tips.

Haematoxylum brasiletto Yuma (4): Minor damage to some stem tips only.

Havardia pallens CAC (4)/WCAC (2): Most stems of all plants froze back 1"-12" from the tips with plants at CAC suffering more damage than WCAC plants.

Leucaena leucocephala WCAC (2): All plants froze to the base (stems to 1" thick).

Leucaena pulverulenta CAC (1)/WCAC (2)/Yuma (2): The Yuma plants were undamaged. The WCAC plants froze to the base (stems to 1.5" thick) and are recovering. Stems to 3" thick froze on the 20' tall CAC plant.

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Staff and Volunteers in Action

Recently, DELEP has lost three long-time volunteers. Plant materials expert and local horticulture icon Warren Jones died at home on April 7th. Jones incorporated years of international plant science research into sharing his passion for arid-land plant studies. His work resulted in the introduction of many landscape specimens to southern Arizona since the 1970's. Jones served on DELEP's Advisory Board and provided years of indispensable guidance to the collections committee and gardens development at Boyce Thompson Arboretum. Dr. William Robert Kneebone was an Emeritus faculty member of UA College of Agriculture and Life Sciences and was one of the Desert Legume Program's original volunteers. He passed away gently, on April 20th. Kneebone also served two terms on the DELEP Advisory Board in the 1990's and the early years of the 2000's. He was an academic advisor to both Matt Johnson and me, when we were students at the UA. In March, volunteer Ted Hollander passed away, unexpectedly. Hollander and his wife, Laura, have been DELEP volunteers since 1992. We extend condolences to their families and express our appreciation for their individual contributions to the continued success of DELEP.

During the past winter I was reminded that our attempts toward increasing seed numbers of non-perennial legumes can be hit or miss. Several below-freezing temperature events thwarted our attempt to increase seed numbers of *Lupinus*

mutabilis. Our goal was to grow approximately 200 plants of this crop species. Shortly after the germination of about 60 seedlings in early December, several damaging frost events occurred.

Sadly, repeated frost throughout that month and in January 2007

dashed our hopes for this seed-increase attempt (10°-18°F in the Tucson valley, between January 13th and 15th).

Five species of *Astragalus*, two species of *Lotus*, and *Dalea mollis* were planted in other beds, in that field. My optimism for the emergence of these species was high, but by

early March no emergence was noted. Viability testing of these seed collections revealed that more than 80% of the seeds had live embryos. We watched and waited, but by late March we gave up our hopes for this field.

Fall 2007 sessions are tentatively scheduled for: September 12, October 10, November 14, and December 12. Feel free to contact me for more information: kcoppola@ag.arizona.edu

Editor's Note:

Due to circumstances beyond DELEP's control the April 2007 issue of *Aridus* was not published. MN



Lonchocarpa capassa (left) and *Colophospermum mopane* in Yuma field, March 2007. KC

Lonchocarpus capassa Yuma (6): Most leaves were damaged or killed and the tips of many stems appear frozen.

Lonchocarpus hermannii Yuma (6): Minor damage to foliage only.

Lysiloma candidum Yuma (3): Minor damage to some stem tips only.

Lysiloma divaricatum Yuma (4): Some stems froze back to 2" from the tips.

Lysiloma watsonii CAC (4)/WCAC (2): Most stems of WCAC plants froze to the base (to 2" thick) though a few had only tip damage. The CAC plants suffered severe damage with stems variably frozen to 1"-2.5" thick.

Mimosa asperata CAC (3): All stems froze to the base (to 1" thick) with vigorous recovery.

Mimosa distachya var. *laxiflora* CAC (3): The outer stems froze back to 6' from the tips (to 1" thick).

Mimosa dysocarpa CAC (7): Variable damage with some stems frozen to near the base (to 1.5" thick).

Mimosa malacophylla CAC (2): All the vine-like stems froze to the base. The plants are recovering.

Mimosa palmeri Yuma (3): Minor damage to stem tips only.

Olneya tesota CAC (1)/WCAC (2): WCAC plants were undamaged.

Leaves of the CAC plant froze and some stems froze back 1"-4" from tips.

Parkinsonia africana WCAC (1): Only the outer 1" of the stem tips were killed.

Parkinsonia praecox subsp. *praecox* CAC (2)/WCAC (2): Some stems froze back only 1" from the tips.

Peltophorum africanum CAC(3)/Yuma(4): The Yuma plants suffered damage to the outer foliage with some stems killed back to 1' from the tips. The foliage was killed on the CAC plants. 1 plant at CAC had stems frozen back to 1' from the tips while 2

others had stems freeze back to 6' from the tips (to 2" thick).

Peltophorum dubium Yuma (3): Stems were killed to 1" thick.

Piscidia mollis CAC (1): Froze back to the main stems (3.5" thick).

Pithecellobium dulce Yuma (1): The foliage was frozen and many stems were killed to at least 2" thick.

Schotia afra var. *angustifolia* WCAC (1): Some damage to foliage only.

Schotia brachypetala WCAC (1): Small plant 1' tall froze to base and is recovering.

Senna artemisioides subsp. x *artemisioides* CAC (4): 1 plant froze to near the base and is recovering. 3 plants of another accession had 90% of the foliage killed with many stems frozen back 1'-2'.

Senna artemisioides subsp. *filifolia* CAC (5): 5% of the foliage was killed with a few stems frozen back to 2' from the tips.

Senna artemisioides subsp. *hamersleyensis* CAC (1): All stems froze back to the base. The plant is recovering.

Senna artemisioides subsp. *petiolaris* CAC (5): All foliage was killed and most stems froze to near the base (0.5"-1" thick). The plants are recovering.

Senna artemisioides subsp. x *sturtii* CAC (2): Both plants were killed with stems to 3" thick frozen.

Senna atomaria Yuma (1): Some stems were killed to 0.5" thick.

Senna costata CAC (3): All stems freeze to the base in most winters.

Senna hirsuta var. *glaberrima* CAC (2): All stems freeze to the base each winter.

Senna lindheimeriana CAC (6): All stems freeze to the base each winter.

Senna marilandica CAC (1): Stems froze back 3' to base. The plant is recovering.

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Senna pallida CAC (7): Stems typically freeze to the base each winter but 2 plants were killed.

Senna polyantha CAC (2): Most twigs froze back only 1"-3" from the tips.

Sophora tomentosa Yuma (1): The foliage was killed and some stems froze to 0.5" thick.

Sutherlandia frutescens CAC (1): This plant was killed. No previous freeze damage has been observed on this short-lived species.

Tephrosia leiocarpa CAC (3): All stems freeze to the base each winter.

Zapoteca formosa var. *schottii* CAC (5): Most stems froze back 3'-5' to the base but some stems appear undamaged.

References

Johnson, M.B. 2004. Effects of the December 2003 freeze on plants in DELEP's fields. *Aridus* 16(2):1-7.

Johnson, M.B. 1997. Cold tolerance of legumes – effects of the December 1996 freeze on DELEP's Tucson fields. *Aridus* 9(3):1-4, 8.



Acacia polyantha in Yuma field in March, 2007. (KC)



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.

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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.

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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.



Frost damage in Yuma field, March 2007. KC

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