Arizona Department of Agriculture

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The ADA would like to highlight these projects as success stories.

Introduction

On October 19, 2007, the Arizona Department of Agriculture (ADA) entered into a cooperative agreement with the United States Department of Agriculture (USDA), Agricultural Marketing Service (AMS) in the amount of $266,580.88 in combined FY06 and FY07 Specialty Crop Block Grant Program funds to fund twelve projects specifically designed to increase the consumption and enhance the competitiveness of Arizona Specialty Crops. Projects within the Arizona State Plan included three education projects, one marketing project, and eight research projects and were one to three years in duration. The expiration of the grant period was September 30, 2010.

Arizona Specialty Crop Guide

This project was completed on September 30, 2010

Project Summary

The goal of the Arizona Specialty Crop Guide project was to produce a reference guide for consumers to educate them on where our food comes from and the benefits reaped from buying Arizona grown produce.

Project Approach

From September 2007 through August 2008, the Arizona Department of Agriculture (ADA), Agricultural Consultation and Training (ACT) Intern, under the supervision of the Grant Coordinator, researched and compiled information on Arizona Farmers‟ Markets and U-Pick Farms, specialty crop programs offered by various organizations in the state, and educational and career opportunities in Arizona agriculture. The draft guide was distributed to several stakeholders and Department leaders for comment. After a thorough editing period, the layout and formatting was done by Esser Design, a graphic design company which is on Arizona state contract. Five thousand copies of the Arizona Specialty Crop Guide were printed and spiral bound. A bound copy of the guide was sent to AMS with the 2008 annual report and an electronic copy is attached to this report as **Appendix A**. The Arizona Specialty Crop Guide can also be viewed on the ADA website at: http://www.azda.gov/Main/Specialty_Crop_Guide.pdf.

The guides have been distributed at multiple venues and by various entities throughout the state of Arizona including: the Arizona Department of Agriculture lobby, Flagstaff Public Library, Kingman Branch Library, Casa Grande Public Library, Joe D. Valdez Main Library, Fountain Hills Branch Library, Copper Queen Library, Tubac Community Library, Yuma Lettuce Days, Legislative Ag Day, Southwest Ag Summit, Maricopa County Cooperative Extension, Pima County Cooperative Extension, Southwest Horticulture Annual Day of Education, Natural Resource Conservation District Annual Meeting, Arizona Farm Bureau Federation, and Maricopa County Farm Bureau Annual Meeting.

Goals and Outcomes Achieved

1. With the initial printing and distribution of the Arizona Specialty Crop Guide, ADA expects to reach approximately 2.5 consumers per reference guide distributed.

   All 5,000 Specialty Crop Reference Guides have been distributed. Based on this number, it is estimated that approximately 12,500 consumers have been reached through the distribution of the guide.

2. A link to ADA"s website will be included in the reference guide with a request for guide recipients to complete an online survey to assist ADA in determining the usefulness of the guide. Survey questions will be designed to determine the change in attitudes, awareness, and consumption of Arizona specialty crops resulting from information obtained in the guide. To encourage participation in the survey, consumers will be entered into a drawing to win an Arizona Grown tote bag.

   One-hundred percent of those individuals who voluntarily took the survey reported that information in the Arizona Specialty increased their awareness or knowledge of Arizona Specialty Crops. The respondents reported that the Farmers" Market listing, the Harvest Schedule, and the U-Pick Farms listing were the most useful sections of the guide. Thirty-three percent of the respondents said that they had changed their shopping habits or consumption practices since reading the Arizona Specialty Crop Guide. The most common change for respondents was that they now try to make more "locally grown" purchases. Sixty percent of respondents report having shared information from the Arizona Specialty Crop Guide with 1-3 people and 7% report having shared information with four or more people.

Beneficiaries

The Arizona Specialty Crop Reference Guide has reached approximately 12,500 Arizona consumers (based on average readership per copy of 2.5) through distribution at county libraries, cooperative extension offices and various agricultural venues throughout the state. Arizona consumers have benefitted with an increased knowledge and awareness of Arizona specialty crops.

Lessons Learned

The initial plan for distribution of the Arizona Specialty Crop Guide included distribution at county fairs throughout the state. When the program coordinator began contacting each county fair, ADA was informed that in order to distribute the guides, an ADA staff member would be required to man a booth each day during all operating hours of each fair. This proved to be a challenge due to budget constraints, staffing limitations and the limited number of guides available. It was realized that based on the projected attendance of the county fairs, the supply of guides would likely be exhausted days before the first county fair ended. An alternate plan was devised and after making calls to librarians throughout the state, guides were mailed to public libraries in Arizona counties. The guides were distributed free to the public by each library. The response was favorable, with one library even requesting a second shipment.

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Additional Information

Based on the enthusiastic response of stakeholders and the public, an update of the Arizona Specialty Crop Guide is currently underway. A second printing of the guide will be paid for with 2010 SCBGP-FB funds.

Local Food, Healthy Communities Video

This project was completed on September 30, 2010

Project Summary

The Community Food Bank Community Food Security Center (CFSC) educates advocates and provides support for increased production and consumption of Arizona grown and sold fresh fruits and vegetables in Southern Arizona. The CFSC requested and received $10,250 for the "Local Food, Healthy Communities" video project.

Access to locally grown fresh fruits and vegetables are essential to ensure the short and long term physical and economic health of Southern Arizonans**.** This project will produce bilingual (English and Spanish) education and promotion videos that will increase consumption of fruits and vegetables grown and sold in Southern Arizona. The videos will be used as a part of a "buy local campaign" of the CFSC and many other partners to promote local produce, educate consumers about our local food system, and promote the nutritional health and community benefits of eating local fruits and vegetables.

Project Approach

The goal of the "Local Food, Healthy Communities Video Project" is to increase consumption of fruits and vegetables grown and sold in Southern Arizona by making and distributing an educational marketing video that raises awareness of the personal health and community benefits of eating fresh fruits and vegetables.

The project was carried out by Community Food Resource Center (CFRC) staff, who collaborated with local farmers, market managers and local food enthusiasts in designing a script, and by a local video company who created the video in English with Spanish subtitles.

The video was distributed through a variety of outlets in Tucson, including the Community Food Bank (CFB) website, YouTube, local theaters, educational events and local food organizers who present the videos to their community groups.

The educational potential was further enhanced by a Peace Corps Fellow who worked at the CFB to develop a supplemental handout including discussion questions and up-to-date information on farmers" market locations in Tucson.

The CFB Farmers‟ Market Outreach Coordinator is currently coordinating with the Manager of Community Nutrition Programs for Pima County Health Department (gatekeeper for distribution to Tucson-area Women, Infants and Children (WIC) offices) to provide the videos to WIC caseworkers as part of educational presentations to WIC participants.

Goals and Outcomes Achieved

1. Video company facilitated meetings with the Community Food Security Center (CFSC) staff to determine videos‟ content
2. Video company made a creative brief of what the videos will include
3. CFSC staff, writer and video company draft script with input from local specialty crop producers and sellers
4. Baseline data collection at area farmers‟ markets, CSAs and other local market venues
5. CFSC staff and writer edited script
6. CFSC staff and video company schedule filming at local farms, and farmers‟ markets (restaurants and stores were not filmed, Tucson CSA was filmed)
7. Video company filmed at designated sites; edited and completed videos
8. Videos – 1. Producer/Grower and 2. Seller completed with Spanish subtitles in June 2009
9. Education staff change affecting distribution of video
10. Video on Community Food Bank website and YouTube
11. Video screened at The Loft Cinema (a Tucson non-profit theatre) on July 17, 2009 - approximately 1,000 people attended local food event
12. Additional to work plan – Congressional Hunger Fellow developed promotion materials and contacted potential locations for viewing; "Food is Good" CD
13. Additional to work plan – Farmers‟ Market Manager and Peace Corps Fellow coordinating research on "Measureable outcomes"
14. Additional to work plan – Peace Corps Fellow developed supplemental handout featuring activities to accompany viewing of video, along with up-to-date information on southern Arizona farmers‟ market locations and hours
15. Video distributed: 60 DVDs and supplemental handouts given to community stakeholders (from three counties in southeastern Arizona) participating in "Healthy Food, Healthy Future" conference (organized in partnership with World Hunger Year) on February 16-17, 2010; 1 DVD given to Manager of Community Nutrition Programs for Pima County Health Department (gatekeeper for distribution to Tucson-area WIC offices)
16. Coordination of DVD use with Pima County Health Department - Tucson-area WIC office waiting rooms evaluated as sites for looped playback of the video. None of the three WIC offices utilized a TV/DVD player in its waiting room. Use of DVDs in nutrition education classes for WIC clients is a more viable option at present.
17. Additional agencies and organizations with potential interest in utilizing the DVD or featuring video on websites have been located and will be contacted.
18. Additional to work plan – A Farmers‟ Market Outreach Coordinator has been hired. This full-time employee will utilize the DVD and other resources to make farmers‟ markets more accessible to low-income communities and will strengthen outreach efforts to WIC Cash Value Voucher, FMNP Coupon, and Food Stamp recipients.

19. Farmers‟ Market Outreach Coordinator has been invited to provide educational presentations to WIC staff and is incorporating use of DVD, along with instructions for WIC caseworkers on how to use DVD during meetings with WIC participants, into educational presentation.

	Santa Cruz River Farmers' Market (SCRFM) *Numbers reflect only the amount sold by CFB Farm and Garden and does not include other vendors**	**Community Food Bank Farmers' Market (CFBFM)** *Numbers reflect only the amount sold by CFB Farm and Garden and does not include other vendors***	**Marana Farm Stand (MFS)** *The MFS includes only CFB produce.*
Sales			
Jan thru June 2008	$10,553.16	$17,426.35	Not applicable – Stand began July 2008
July thru Dec 2008	$18,899.63	$24,669.46	$5,526.24
Jan thru June 2009	$20,786.02	$13,303.97	$7,591.01
July thru Dec 2009	$18,429.68	$16,812.81	$3,956.19
Jan thru June 2010	$21,799.38	$8,135.32	$6,113.41
July thru Oct 2010	$17,075.30	$21,850.83	$5,866.84
Market Attendance (weekly)			
Jan thru June 2008	70	75	NA
July thru Dec 2008	150 (SCRFM closed in Dec)	150	40
Jan thru June 2009	175	100	50
July thru Dec 2009	250 (SCRFM closed in Dec)	200	40
Jan thru June 2010	300	200	60
July thru Oct 2010	350	290	75
Seasonal AZFMNP Redemption at all CFB Markets			
Jan thru Dec 2008	AZFMNP vouchers redeemed at all CFB Farmers‟ Markets: $26,970	AZFMNP redemption rate at all CFB markets: WIC: 43% Senior: 61%	
Jan thru Dec 2009	AZFMNP vouchers redeemed at all CFB Farmers‟ Markets: $24,015	AZFMNP redemption rate at all CFB markets: WIC: 29% Senior: 90%	
Jan thru Oct 2010 (Numbers reflect AZFMNP vouchers cashed thru 11/11/10. Total unavailable until 12/15/10).	AZFMNP vouchers redeemed at all CFB sponsored farmers‟ markets thru November 11, 2010: $24,612	AZFMNP redemption rates 2010 thru 11/11/10: WIC: 34.69% Senior: 60.94%	

* In 2008: 4 AZFMNP approved growers at SCRFM, not including CFB produce
In 2009: 10 AZFMNP approved growers at SCRFM, not including CFB produce
In 2010: 13 AZFMNP approved growers at SCRFM, not including CFB produce

** In 2008: only CFB produce was AZFMNP approved
In 2009: 2 approved growers at CFB Farmers‟ Market, not including CFB produce
In 2010: 4 approved growers at CFB Farmers‟ Market, not including CFB produce

1. Increase in Attendance by August 2010

Average Attendance per Market

	Jan-Dec 2008	Jan-Aug 2010	% Increase
Santa Cruz River Farmers‟ Market	110	325	195%
CFB Farmers‟ Market	112	245	118%
Marana Farm Stand (began in July 2008)	40	67	67%

2. Farm Sales at Markets by August 2010

Average Market Sales of Community Food Bank Farm Produce

	Jan-Dec 2008	Jan-Aug 2010	% Increase
Santa Cruz River Farmers‟ Market	$29,452.79	$38,874.68	32%
CFB Farmers‟ Market	$42,095.81	$29,986.15	29% (decrease)*
Marana Farm Stand (began in July 2008)	$5,526.74	$11,980.25	117%

* The decrease in sales of Community Food Bank produce is not reflective of the CFB market‟s failure, but of the fact that more vendors were added to share the burden. In 2008, the CFB Farm produce supplied the entire market, whereas by 2010, 4 additional vendors became regular participants. Their sales were not tracked, but each vendor consistently sold-out throughout the season.

3. AZFMNP redemption by August 2010

Percentage of AZFMNP Sales at CFB Farmers‟ Markets

	Jan-Dec 2008	Jan-Aug 2010	% Increase
Santa Cruz River Farmers‟ Market	37%	50%	13%
CFB Farmers‟ Market	65%	83%	18%
Marana Farm Stand (began in July 2008)	15%	31%	16%

Beneficiaries

The beneficiaries of this project included women and seniors who received Arizona Farmers" Market Nutrition Program (AZFMNP) vouchers, who will benefit from viewing more detailed information about farmers" markets through the video.

Other beneficiaries included local farmers who saw their sales increase at all aforementioned Community Food Bank Farmers" Markets, due in part to an increase in usage of AZFMNP vouchers and a general increase in market attendance (see data under "Goals and Outcomes Achieved"). Though the numbers in the data reflect only the increase of sales of CFB produce, all markets grew sufficiently to sustain the addition of numerous local growers.

Lessons Learned

One of the challenges in meeting the goals of this grant has been a series of staff changes. With the addition of a full-time Farmers" Market Outreach Coordinator, who will focus specifically on increasing participation of WIC and food stamp recipients, we can incorporate the DVDs in a comprehensive educational plan. The Farmers" Market Outreach Coordinator began work in September 2010.

Another lesson we"ve learned is that there are a host of reasons why WIC participants are unable or choose not to redeem their AZFMNP vouchers. Starting in June 2010, the CFB Farmers" Market Manager and Peace Corps Fellow coordinated a research project on what factors contribute to WIC participants" decision to redeem their AZFMNP vouchers. The study revealed obstacles such as location and convenience of CFB farmers" markets, lack of access to transportation and the idea that healthy food is a luxury rather than necessity. The Community Food Resource Center is addressing some of these issues by adding a new farmers" market on Tucson"s south side and developing a mobile market system, which will provide opportunities for WIC participants to use their vouchers in areas that were not previously served by CFB farmers" markets.

Despite prior challenges, the Community Food Resource Center now has a useful educational tool which we"re utilizing in a variety of venues: from community events, to our Youth Farm Apprentice Curriculum to WIC and Supplemental Nutrition Assistance Program (SNAP) offices.

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Additional Information

All CFB Farmers" Markets increased enough to absorb numerous small, Arizona growers. Sales at each market have been sufficient to establish the additional growers as regular attendees of each market.

Arizona School Gardens

This project was completed on September 30, 2010

Project Summary

Through the establishment of thirty school gardens throughout Arizona, Western Growers Charitable Foundation (WGCF) assisted educators in receiving nutrition education curricula, and encourage hundreds of students to develop gardening and life skills, and improved attitudes toward fruits and vegetables.

Project Approach

These activities were completed in the second quarter of the project, before any of the cycles began and laid a foundation and outline for the three cycles:

- Western Growers Foundation (WGF) made contacts with Arizona Ag Literacy, University of Arizona Cooperative Extension of Maricopa County (UACE), and Arizona Department of Education (ADE) to gather information to create Marketing Plan.
- The timing of the yearly training was worked out with Monica Pastor of UACE.
- The application for the project was developed and posted online.

The activities performed for each of the three cycles were the same and as follows:

- Solicit applications from schools.
    - WGF met with the UACE, Arizona Ag Literacy, ADA and the Western Growers" Phoenix office to spread word about the program and solicit applications
- Collect and review applications
    - We received 126 applications total
        - The interest in this project was greater than our garden program in previous years, especially in 2010 when we received 72 applications
    - 10 schools were selected to participate in the program each cycle, for a total of 30
- Notify applicants of acceptance or refusal
    - Email notification was sent to both declined and approved applications.
    - In Cycles 2 and 3 an agreement was sent to recipients to collect summer contact information, and an explanation of expectations that was to be signed by both parties

- Compile Resources for schools
    - John Deere Water provided 30 drip irrigation kits
    - AZ Specialty Crop Lessons book from UACE (printed courtesy of Western Growers)
    - Other educational resources, flyers and lessons provided by UACE
- Teacher trainings conducted by the UACE in Phoenix each July.
    - 88 educators attended the U of A training
        - 2008- 30 educators trained
        - 2009- 26 educators trained
        - 2010- 32 educators trained
    - School teams received the funding, irrigation kit and educational resources only upon completion of the training workshop.

- Survey sent out to teachers at 6 month and 1 year mark.
    - These were sent via email to the main contact at each participating school

The UACE of Maricopa County, with the help of Arizona Ag Literacy and the Master Gardeners, provided a day long training workshop to a team of educators from each school in each cycle. These activities were overseen by Monica Pastor of UACE. Schools received hands-on lessons and educational resources including a workbook of AZ specialty crop lessons (printed courtesy of Western Growers).

UACE received $7,500 over three years for their training services. This paid for supplies, educational materials, and logistics for the training.

John Deere Water (formerly T-Systems International) provided irrigation kits for the 30 schools in the program free of charge.

Goals and Outcomes Achieved

Western Growers Foundation solicited applications for schools interested in being involved in the project. We received 126 applications. Each application was reviewed and scored against a set of criteria. Schools were selected and notified at the end of the school year in each of the three cycles. This led to the creation or renovation of 30 school gardens to be used for nutrition education across Arizona.

Professional development was provided by Ag in the Classroom and the UACE of Maricopa County in July of each project year. Teams of educators from each school received a full day of garden education training as well as lesson plans and ideas and the AZ Specialty Crop Lessons book, drip irrigation kit and $1250 to be used on garden equipment and supplies. The schools teams consisted of teachers, administrators, garden coordinators, key volunteers, and facilities personnel. In total, 30 teams made up of 88 educators were trained.

Each school was directed to give a pre-test to at least 30 students participating in the project. The test included self reporting on fruit and vegetable consumption, snacking behaviors and purchasing as well as basic nutrition knowledge. The schools were also directed to give the same test to the same set of students at the close of the school year or garden project. The quiz was developed by Western Growers Foundation and based on the self reporting fruit and vegetable consumption surveys used by the Network for a Healthy California and several teachers involved with Western Growers. We received 629 responses from 19 schools. A copy of the sample quiz is included with this report as **Appendix B**. Please note that not all students answered each question.

Schools self reported on what subjects, in addition to nutrition, were taught with the garden as well as on the number of students involved. Several schools made this a school-wide activity with the entire enrollment participating. Other schools focused on a grade level or number of classes. 15,401 students were involved in this project. All 30 schools used the garden for additional subjects.

We hope that the outcomes of this project are long term and result in a positive change in the attitudes and consumption of fruits and vegetables in young students. The information gathered in the quizzes indicate an improvement in nutritional knowledge, understanding that healthy foods are important, as well as both preference for specialty crop snacks and in students requests to parents to purchase fruits and vegetables.

Established Goals	**Actual Accomplishments**
1. 30 Arizona school gardens will be created and sustained during the three-year project period ending 2010.	A total of 30 gardens were created and/or sustained during this project period. 19 new gardens were created through this project. 11 gardens were expanded or renovated for use. 1 garden is no longer in use as the school was closed.
2. 90 school educators will receive Ag in the Classroom training as well as support to build gardens in their respective schools.	88 educators received training from our partner, Ag in the Class. In year two of the project, several teachers from several schools were taken ill and only 26 educators were able to attend. In year three, one school sent four educators. Each school has at least one educator attend the training workshop. This target was not met. Four teachers fell sick and couldn't be replaced in time for the 2009 training.
3. 100% of the students in the program will receive nutrition education through a structured garden-based program.	100% of the students in this project received nutrition education.
4. 75% of the students will be introduced to additional academic fields in the garden (e.g. science, math, literature, culinary arts, etc.)	100% of the students were introduced to at least one additional academic field in the garden. The most popular were science, math, language arts, and social studies. Some schools also used the garden for special needs, business skills and photography.
5. 50% of the students will have an increased understanding of the importance of proper nutrition on their health.	There was an average increase of 20% on the nutritional knowledge and health questions on the quiz. These students ranged from 1st to 12th grade. There were greater improvements in younger students than in High School students.

This project intended to achieve three primary, expected, measurable outcomes. Each outcome is outlined below.

1. Positive change in nutritional attitudes.
    a. More positive attitudes towards vegetables and fruits.
        i. How often do students ask parents to purchase fruits or vegetables?
            1. Pre-quiz results:
                a. 26% Never
                b. 44% Sometimes
                c. 30% Always
            2. Post-quiz results:
                a. 10% Never
                b. 50% Sometimes

c. 40% Always

3. As a result of the garden enhanced nutrition education project, there was a 10% increase in the number of students requesting fruits and vegetables from their parents. There was a 16% overall reduction in the number of students who never request fruits and vegetables.

b. More positive attitudes towards snacks of vegetables and fruits.

i. How often do you have a fruit or vegetable for snack after school?

1. Pre-quiz results:
   a. 25% Never
   b. 57% Sometimes
   c. 18% Always
2. Post-quiz results
   a. 12% Never
   b. 63% Sometimes
   c. 24% Always
3. As a result of the garden enhanced nutrition education project, 50% of the students who reported never eating fruit and vegetable snacks in the pre-quiz now report eating produce snacks either sometimes or always.

2. Positive change in nutritional behaviors.

a. Increased consumption of fruits.

i. Yesterday did you eat any fruits?

1. Pre-quiz results:
   a. 24% None
   b. 35% 1 serving
   c. 21% 2 servings
   d. 20% 3 or more servings
2. Post-quiz results
   a. 22% None
   b. 32% 1 serving
   c. 23% 2 servings
   d. 23% 3 or more servings
3. As a result of the garden enhanced nutrition education project, 3% more students eating three or more servings of fruit the previous day. This also shows a decrease of 2% in students who report not eating any servings of fruit the previous day.

b. Increased consumption of vegetables.

i. Yesterday did you eat any vegetables?

(Note: this question excluded fried vegetables and chips) ii

1. Pre-quiz results:
   a. 40% None
   b. 29% 1 serving
   c. 15% 2 servings
   d. 16% 3 or more servings

2. Post-quiz results
    a. 30% None
    b. 31% 1 serving
    c. 19% 2 servings
    d. 20% 3 or more servings
3. As a result of the garden enhanced nutrition education project, there is a decrease of 10% in students not eating any vegetable servings the previous day. There is also an increase of 4% in both students eating two and three or more servings of vegetables the previous day.

3. Increased awareness of fruits, vegetables, nutrition, and how these positively contribute to lifelong healthy lifestyles. This will be measured by cumulative counts of the following:
    a. UACE training for three educators/school
        i. In total 88 educators were trained by UACE
    b. Number of gardens established/improved
        i. In total, 30 school gardens were supported through this project.
            1. 19 new gardens were created through this project.
            2. 11 gardens were renovated. This includes gardens too small to serve the population or old gardens that had gone fallow or fallen into disrepair.
    c. Number of students and classes using the gardens (including number of schools in low income neighborhoods)
        i. 15,401 students at 30 schools were benefitted by this project and participated in the school garden.
        ii. 17 of the 30 schools have populations where 50% or more students are eligible for free or reduced price lunch through the Federal School Lunch Program.
    d. Number of students receiving nutrition education.
        i. 100%, or 15,401, of the students in this project received nutrition education.
        ii. There was a 20% increase in the nutrition education scores on the quiz.
    e. Number of students introduced to additional academic fields utilizing the garden.
        i. 100%, or 15,401, of the students in this project received instruction in additional academic fields.
            1. These additional fields included: science, language arts, math, social studies, environmental science, the arts, business, life skills and special needs classes.
    f. Number of students with an increased understanding of the importance of proper nutrition on their health.
        i. How important is it to eat healthy foods?
            1. Pre-quiz results:
                a. 11% not important
                b. 26% important
                c. 63% very important.

2. Post-quiz results
    a. 2% not important
    b. 20% important
    c. 78% very important
3. There is an increase in 15% of students who consider a healthy diet "very important" to them.

Beneficiaries

Thirty schools throughout Arizona directly benefitted from this project. 57% of the schools in this project are low income schools, meaning 50% or more of the school"s students are eligible for Free or Reduced Price Lunch through the Federal School Lunch Program.

Eighty eight educators (including teachers, administrators, school garden coordinators, and community volunteers) from 30 schools received professional development on the topic of school gardens and how to use gardens and specialty crops as educational tools for nutrition lessons and other academic fields. The teams of educators from each school received a full day of professional development and educational resources to take back and share with colleagues.

The current and future students at each school site are also beneficiaries of the project, which provided schools with the means to install a fruit and vegetable gardens used to enhance instruction. 15,401 students were directly involved in this project and benefitted from the garden at their school. All but one of the gardens continues to thrive and be used for nutrition, math, science and agriculture instruction.

The following are impacts on beneficiaries of the project. These numbers were retrieved through self reporting on consumption and attitudes and a quiz of nutrition beliefs and facts.

- 10% increase in the number of students eating at least1 serving of vegetables per day
- 12% increase in the number of students having a fruit or vegetable snack after school
- 15% increase in students who think that a healthy diet is very important
- 16% increase in students asking parents to purchase fruit and vegetables
- 20% average increase of students" scores on nutrition/health quiz questions
- 24% increase in students who can name the 5 food groups

Lessons Learned

Positive Results

This project revealed the large number of Arizona schools interested in garden enhanced nutrition programs. Before WGF began this project, there was little interest from Arizona schools in our garden programs. The outreach mechanisms (through the ADE and Ag Literacy) proved effective tools for reaching interested schools. The increased interest may also be attributed to the growing interest and spotlight nationwide on school gardens.

The post-project quiz revealed a 24% increase in students able to name the 5 food groups correctly. This increase was evident at both the elementary and high school levels.

Negative Results

We set a target of a 50% increase in nutrition quiz scores. We achieved a 20% increase in nutrition test scores. Though we fell short of our initial target, a 20% increase over the baseline scores does show real improvement in nutritional knowledge. This will provide us with better benchmark and baseline data for future projects and will improve our future target setting.

Though we provided both a sample quiz, an instruction sheet explaining the quiz and its purpose, and multiple reminders via email, more intense one on one outreach to teachers and schools is needed to ensure that the pre-and post- quizzes are completed in a timely manner and in the proper way.

One garden is no longer in operation as a result of the school closing.

These lessons have informed our new project that involves teacher dependent student assessment and we are already seeing better outcomes.

Conclusion

Garden enhanced nutrition education projects do have an impact on students‟ consumption of, attitude about, and knowledge of fruits and vegetables. Each question on the post-project quiz showed improvement (between 5% and 25%) over the pre-project quiz.

The UACE training and the lesson plans on Arizona specialty crops facilitated the use of the garden for teachers. The training and educational resources were key in integrating the garden into the academics of the school. The gardens can be used for virtually any subject from business to social studies to photography. Most schools spent the funds on garden supplies (soil, lumber, seed, hose, and tools) as opposed to educational materials.

Provide unexpected outcomes or results that were an effect of implementing this project.

Teacher retirement and layoff turned out to be an obstacle in this project. When following up with schools who had not yet returned the pre and post quiz results, we often heard that the teacher had been laid off or took early retirement and in her absence the quizzes could not be located. One school was even closed completely and we could not get in touch with anyone from the former school.

We collected more than 600 each of the pre and post quizzes, so there were enough samples to collect data- but each school was not represented.

Schools and teachers were reminded about the pre and post tests via emails periodically throughout the year. Some schools neglected this activity because of teacher turnover, the age (and poor literacy skills) of the students, and despite the reminders- some simply forgot.

Make it a requirement of the grant that if a teacher leaves the school/project, a new teacher must become the contact person, WGF must be notified and an amendment to the agreement must be signed with the school to alter the expectations or re-confirm the deliverables.

Reasons for non completed pre and post test, as reported by schools:

- School was permanently closed
- Teacher retired and/or changed schools and the quizzes are no longer available
- Teacher is no longer at the school and didn‟t inform new teacher about quiz requirements
- Teachers decided students were too young to complete the quiz

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Additional Information

Through this project, 15,401 Arizona students were introduced to growing, harvesting and eating Arizona specialty crops.

Based on the self reporting of students involved in the project, there has been an increased consumption of vegetables as well as an increase in students requesting that their parents purchase fresh fruits and vegetables at the grocery store.

10% increase in vegetable consumption.

15% increase in the number of students who sometimes or always ask their parents to buy fruits and vegetables at the grocery store.

12% increase in the number of students who choose fruits or vegetable as an after school snack.

Rachael Ray Show:
http://www.rachaelrayshow.com/show/segments/view/teaching-kids-grow/
The above link goes to a segment on the Rachel Ray show about one of the school gardens that participated in the project in Cycle 1. Molly Reed, the teacher, does not mention Western Growers Foundation or the Block Grant Program, but it gives a good picture of how gardens are used.

Attached, please find:

- Spotlight write-ups – **Appendix C**
  Spotlight is a biweekly industry newsletter that is sent from Western Growers to all of its members, employees and other industry members who sign up.
- Western Grower and Shipper articles – **Appendix D**
  Western Grower and Shipper is Western Growers‟ monthly magazine and is sent to all WG members.
- Press Releases – **Appendix E**
  Available press releases are attached.
- Photographs – **Appendix F**

Economic Impact Survey of the Arizona Nursery Industry

This project was completed on March 31, 2009

Project Summary

Agriculture production is vitally important to the state of Arizona. To support that statement, you must be able to adequately measure the size and scope of its impact. The federal statistics program that USDA-NASS administers each year does not include the Arizona horticultural production industry. Arizona NASS Director Steve Manhaimer states, "The federal statistics program does not cover nursery and horticulture statistics adequately." The Arizona Nursery Association was awarded $11,800 to complete an updated Economic Impact Survey of the Arizona Nursery Industry.

Project Approach

This project conducted full market research on the entire nursery crop industry. All results were compiled and formulated into a report by the USDA – National Agricultural Statistics Service Arizona Field Office. See **Appendix G**. The results of this report were summarized and drafted into an outreach brochure. See **Appendix H**. The Arizona Nursery Association printed 1,575 brochures for distribution, and posted an electronic copy at www.azna.org for easy accessibility. 300 brochures were sent to members of the Arizona Nursery Association, 200 brochures were sent to members of the Arizona Landscape Contractors Association, and 50 brochures were distributed at the Desert Horticulture conference in Tucson on May 15, 2009. These brochures continue to be distributed to interested parties.

Goals and Outcomes Achieved

Expected Measurable Outcomes:

1. The funding of this grant will enable the Arizona Nursery Association to quantify the growth of the industry between 2002 and 2007. The results will include information on employment, payroll, wages, and sales. In addition, an estimate will be made of the economic contribution of the Green Industry to the Arizona economy and state government revenue.

   By completing the survey with NASS and printing the accompanying brochure, the Arizona Nursery Association was able to quantify the growth of the industry between 2002 and 2007, including information on employment, payroll, wages and sales. This information allowed the Arizona Nursery Association to provide an estimate of the economic contribution of the Green Industry to the Arizona economy and state government.

2. 2,000 copies of an up to date, professional brochure will be distributed to nursery industry members as well as the association, to accurately depict the size, scope and impact of the industry.

   The Arizona Nursery Association printed 1,575 up-to-date brochures and has distributed 1050 to members and conference attendees. They will continue to distribute the brochure at conferences and trade shows over the next few years. Interested parties can also access the brochure electronically 24 hours a day via the web at www.azna.org.

3. The Arizona nursery industry will have an updated set of figures to give to the National Agricultural Statistics Service to use in support of including the nursery industry in their future surveys. The nursery industry will use this as an opportunity to again go back to USDA for funding of a national nursery industry survey.

   The Arizona Nursery Association was able to provide Steve Manheimer, the chairman of NASS in Arizona, with an updated set of figures. While he appreciates the size and scope of the industry, he does not see including the industry in future surveys as something that will be occurring in the near future. He indicated that the nursery industry could be stated as the 4th largest crop in Arizona; as long as it is accompanied by an asterisk explaining the surveys were not completed in the same manner. The Arizona Nursery Association will continue to work with the USDA to develop accurate surveys of the industry.

Beneficiaries

The entire nursery industry, members of the Arizona Nursery Association and members of the Arizona Landscape Contractors benefited from the completion of the economic impact survey. The quantitative data obtained by the survey including value of the industry, and number of employees provided by the industry have affected the potential impact of the entire Arizona industry already and we assume, it will continue to affect it in the future.

Lessons Learned

Since most of the project was outsourced to NASS, the project didn‟t have much staff interaction for positives and negatives. The NASS staff was extremely competent and worked well within the timelines.

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Additional Information

Right now, we cannot specifically cite an instance where ornamental plants were actually purchased as a result of this project. We can, though, document its use at the legislature to defend plant services programs within the Department of Agriculture. We can also document usage by nurseries when speaking with their banks and creditors over the past year. Without the survey figures in this project, there would not be specific numbers to provide to these businesses.

Management of Powdery Mildew in Melons

This project was completed on June 30, 2009

Project Summary

Powdery mildew on melons, caused by the fungus Podoshaera xanthii, is an important disease on cantaloupe, watermelon and other melons in Arizona. Significant yield losses can occur when environmental factors favor disease development. Management of this disease is heavily reliant on fungicides. Growers have noticed that the effectiveness of the primary fungicides used to manage powdery mildew has declined significantly after a few years of widespread use. Yearly fungicide field trials conducted by the PI on this project, Dr. Michael Matheron, also document these losses in efficacy, ranging from 30 to 60%, compared to when the chemistries were initially registered for use on melons. Continued loss in effectiveness of fungicides will lead to sharply increased levels of uncontrollable powdery mildew.

Project Approach

This University of Arizona research project was designed to test and develop strategies to stop or prevent the erosion of efficacy of the critical chemical tools that growers have to combat powdery mildew. Powdery mildew on melons, caused by the fungus *Podosphaera xanthii*, is a devestating disease on cantaloupe, watermelon and other melon crops in Arizona that can lead to significant yield losses when disease is severe. Management of this disease is heavily reliant on fungicides. Growers have noticed that several of the primary fungicides used to manage powdery mildew have become less effective after a few years of widespread use. Yearly fungicide field trials have documented these losses in efficacy as well. The goal of this research study is to evaluate the disease control efficiency of various fungicide treatment sequences, utilizing products with different modes of action that are registered for use on melon crops. The expected results will be 1) identification of treatment sequences providing the best levels of disease control and 2) minimization of the continued loss in effectiveness of these products by using these treatment programs that incorporate fungicides with different modes of action. Other potential benefits from this study will be determination of the inherent efficacy of each tested fungicide as well as identification of effective treatment programs which are least costly to the grower. Finally, it may be possible to identify effective treatment programs that contain one or more biopesticides, which would give growers the option of incorporating biopesticides into their powdery mildew treatment programs, reduce usage of conventional fungicides, and still achieve a high level of disease control.

The data was acquired from two field trials conducted in the spring and early summer of 2008 and 2009 at The University of Arizona Yuma Agricultural Center. Cantaloupe plants were grown in the field, subjected to various treatment sequences of conventional and biofungicide products, followed by rating of the final severity of powdery mildew using a disease evaluation scale. A high level of disease developed on untreated cantaloupe plants by the time they reached maturity and were rated for disease severity.

Among the single fungicides applied consecutively throughout the treatment period, Microthiol Disperss, Procure and Quintec reduced the severity of disease on both the top and bottom surfaces of leaves by an average amount of at least 98% compared to untreated plants. Of these

products, Microthiol Disperss would be of limited use, as the wettable sulfur active ingredient is generally phytotoxic to melon leaves when temperatures exceed 90 to 95EF. These temperatures are often met or exceeded when powdery mildew develops on melons in Arizona. The degree of disease control provided by the other materials applied consecutively throughout the trial, including Quadris, Topsin M, Serenade MAX, Kaligreen and Sovran, ranged from 30 to 80%. For effective resistance management, single fungicides can not be applied throughout the life of the crop to manage powdery mildew.

The primary purpose of this study was to evaluate the effectiveness of different alternation sequences among fungicides with different modes of action on the control of powdery mildew on melons. All tested treatment sequences where initial application of the highly effective products Quintec or Procure was alternated with any of the other tested products resulted in a minimum of 90% disease control. This degree of disease control at crop maturity would be highly acceptable to melon growers. Several of these alternation treatment programs contained fungicides that did not perform well when applied alone throughout the growing season; however, when incorporated into a treatment program, they can provide different modes of action to combat the development of resistance management and not compromise the final level of disease control achieved.

Due to the late onset of powdery mildew, there were no significant differences in the yield of marketable melons among treatments at the time of disease rating. The level of disease control provided by consecutive application of Kaligreen or Serenade throughout the treatment period would not have been sufficient to prevent significant yield loss soon after the final disease ratings were recorded, as the low level of disease suppression provided by these materials would be expected to result in rapid loss of a significant portion of living leaves, due to the high temperatures and low humidity in late June when this crop would have been harvested.

The ability to include less inherently effective fungicides, such as Quadris, Topsin M, Serenade MAX, Kaligreen and Sovran, into treatment programs for powdery mildew on melons provides benefits to growers beyond preserving the effectiveness of fungicides through resistance management. Firstly, some of these products may be less expensive than the highly effective products, such as Quintec and Procure, so that alternation programs including Quadris, Topsin M, Serenade MAX, Kaligreen or Sovran could cost less than alternation programs including only Quintec and Procure. Also, the effective control of powdery mildew obtained from treatment sequences alternating an effective product such as Quintec or Procure with biopesticides such as Kaligreen or Serenade MAX demonstrates that these softer chemistries can be used without sacrificing disease control.

Goals and Outcomes Achieved

Expected Measurable Outcomes:

1. Reach and educate approximately 1,000 stakeholders through distribution of extension fact sheets.

    Instead of developing a University of Arizona Cooperative Extension fact sheet, a paper will be published in a refereed journal, either the online journal “Plant Health Progress” within the Plant Management Network or the journal “Plant

Disease", which will present the findings from the 2008 or 2009 studies. In addition to state clientele, publication in either of these journals will reach a much broader national and international audience compared to publication as a state fact sheet. Planned preparation of this paper is in 2011, with publication in 2012.

2. Reach and educate approximately 2,000 stakeholders through oral presentations at workshops and extension meetings.

   The results of the 2008 study have been presented as oral presentations at the following workshops and extension meetings:

   - 2008 CAPCA Conference, Anaheim, California, October, 2008. 85 Pest control advisors and other stakeholders attended this presentation.
   - Western Disease Conference, Portland, Oregon, January, 2009. 13 stakeholders attended this presentation.
   - Desert Agricultural Conference, Casa Grande, Arizona, May, 2009. 50 Pest control advisors and other stakeholders attended this presentation.

   The results from the combined 2008 and 2009 studies have been presented as oral presentations at the following workshops and meetings in 2010.

   - IR-4 Western Region meeting, Yuma, Arizona, March, 2010. 19 agricultural stakeholders from western states attended this presentation.
   - Desert Agricultural Conference, Casa Grande, Arizona, May, 2010. 30 Pest control advisors and other stakeholders attended this presentation.
   - Annual Meeting of the American Phytopathological Society, Charlotte, North Carolina, August, 2010. Poster presentation of results from the two field trials. Approximately 1,500 people attended the meeting. The actual number of people that read the poster is unknown.
   - Progressive Farmers meeting, Blythe, California, October, 2010. 19 growers and other agricultural clientele attended.
   - The 21st Annual Desert Crops Workshop, Imperial, California, November, 2010. 80 pest control advisors, growers, and other clientele attended.

3. Reach at least 500 stakeholders through results posted on the University of Arizona Cooperative Extension Vegetables web page.

   To quickly disseminate information to growers, Pest Control Advisors, and other interested clientele, data from these trials were published in the "Arizona Vegetable IPM Updates" newsletter. This newsletter is an online communication from the University of Arizona Vegetable IPM team. Currently, approximately 350 individual clientele subscribe to this newsletter. Also, the Arizona Vegetable IPM Updates are made available through the trade publication "Western Farm Press."

   To rapidly reach a much broader national and international audience in addition to clientele in Arizona, the results of the 2008 and 2009 trials were published as "Plant Disease Management Reports," an online publication within the Plant Disease Management Network. It is unknown how many people have or will access these two published reports; however, they are available to a worldwide audience at the Plant Disease Management Network website.

Beneficiaries

The groups that benefit from completion of this project include melon growers, fungicide manufacturers, handlers and applicators, and consumers. Melon growers benefit by knowing how various fungicides can be used to maximize control of powdery mildew on their crop. Fungicide manufacturers benefit because the use of disease treatment programs using alternation among products with different modes of action will significantly increase product longevity in the marketplace by preserving disease management efficacy through resistance management.

Growers, fungicide handlers and applicators, and consumers will benefit from knowing that the biopesticides Kaligreen and Serenade MAX can be used in management programs without sacrificing an effective level of disease control.

Melon growers that must contend with powdery mildew now know that they can achieve a high level of disease control (minimum of 90% at crop maturity in these trials) by alternating an inherently effective fungicide, such as Quintec or Procure, with one or more of the less inherently effective products such as Quadris, Topsin M, Serenade MAX, Kaligreen and Sovran. Given the relative prices of all products tested in a geographical area, it is possible that growers can pick and choose among available disease control products to achieve excellent control of powdery mildew at a minimum economic cost. Minimizing disease management costs will help increase the competitiveness of Arizona melon growers.

Lessons Learned

The unexpected outcome of this study was the fact that products less effective in controlling powdery mildew by themselves could be incorporated into treatment programs in alternation with highly effective fungicides and result in the achievement of a high level of disease control.

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Additional Information

As stated earlier, the data from this study can save melon growers money when powdery mildew must be managed by showing that many different alternation sequences among several different products provide excellent control of this disease; thus allowing growers to choose among tested materials according to cost, and in so doing minimize treatment expenses. Also, growers have the option of including biopesticides in disease management programs, which could result in increased demand for their melons in the marketplace. Minimizing powdery mildew treatment costs and potentially increasing demand by using less conventional fungicides will enhance the competitiveness of Arizona melon growers and could result in increased consumption of Arizona grown melons in particular and Arizona specialty crops in general.

Cucurbit Yellow Stunting Disorder Virus Research

This project was completed on September 30, 2009

Project Summary

Cucurbit yellow stunting disorder virus (CYSDV), a whitefly (*Bemisia tabaci*)-transmitted crinivirus from the Mediterranean, emerged in 2006 in the Sonoran Desert and has resulted in over $25 million in losses to the U.S. fall melon crop alone affecting >45,000 acres in California and Arizona. In addition to reducing melon yields, the fruits harvested from infected plants experienced 2-4% decreased sugar content making them unmarketable (M. Russell, Melon Producer; Chair, CA Melon Res. Board/AZ Task Force member; pers. comm.; and J. LeBoeuf, Res. Coordinator, CA Melon Res. Board, pers. comm.). By the fall 2007 season CYSDV was identified in all four melon-producing counties in Arizona (Brown & Nolte, unpubl) at an estimated loss of $18 million that year. In California, the CYSDV affected region spans Niland to Holtville (N & S Imperial Valley) and in Arizona from Wellton to central Yuma County, La Paz, Maricopa, and Pinal counties. In 2008, the 22,000 acres of melons grown in central AZ had an expected worth of $550,000 for the spring-summer crops alone.

In vegetable crops, the uninformed and/or failed management of weed hosts that harbor virus-vector complexes compromise disease management, and lead to crop failures of a regional magnitude. A multi-state (and region-wide) effort was seen to be imperative to abate emerging and introduced plant viruses, and local as well as exotic whitefly vectors.

Fig. 1. Yuma melon field early September 2006. Note the chlorotic rows where virus infection initiated and then spread to infect entire fields (courtesy, Dr. MikeMatheron, Yuma Co. Plant Pathologist).

Project Approach

This project undertook the first step in „knowing who" and „where" the enemy is by putting into place a sensitive, rapid turn-around molecular assay for CYSDV detection. Two complementary assays were developed. Samples were collected by producer/PCA-county agent teams based on information provided through an Extension Bulletin (prepared by Nolte and Brown) and educational presentations at Vegetable Meetings (routine and emergency). Samples were sent to the laboratory in Tucson and results of the detection assays were rapidly conveyed through a conduit involving the „UA diagnostic lab result that was communicated direct to the respective county agent" and from the „county agent to PCA/producer" in order to expedite and streamline communications to all melon producing areas of the state. Follow-up samples were provided by all involved to gradually expand knowledge of the rapidly growing distribution of the virus. By the end of our study in 2007, CYSDV had been found in a total of four counties in southern and south-Central Arizona and two in CA.

Goals and Outcomes Achieved

Expected Measurable Outcomes:

1. Work through the AZ Task Force to provide a grower education program in cooperation with the California melon research board and Arizona melon producers to familiarize approximately 50 growers with the virus and its epidemiology and establish practices that will minimize disease impact.

   Research updates have been provided routinely 2-3 times a year. The Brown lab participated in vegetable producers task force meetings and education workshops and gave the following presentations or contributed data to them. The combined efforts of K. Nolte (varieties, relationship between symptoms and losses; J. Palumbo (row covers, insecticide efficacy trials), and J.K. Brown (diagnostics, epidemiology) have produced new and useful information relevant to virus management.

   Laboratory-based studies have focused on the more prevalent alternate hosts in the region that are of concern as CYSDV reservoirs. We have been examining transmission from melon to these hosts as well as transmission from these hosts to melon. This is time consuming work and will continue through 2010. Some data generated to date suggests that although alfalfa has been confirmed as a host of CYSDV in the field, it may be a relatively poor host (although results are not yet definitive). Plant species identified as confirmed and/or possible hosts include: various malvaceous (3 *Malva* spp.; alkali mallow) and other weeds: morning glory, *Physalis wrightii*, velvetleaf, silverleaf nightshade; cultivated hosts: alfalfa, canteloupe, honeydew, cassaba, cucumber, watermelon, bean, lettuce, Hibiscus, and papaya. In certain species CYSDV was detected both by RT-PCR and qPCR, while in others (mostly asymptomatic) virus was only detected by qPCR. All suspect hosts are being confirmed in whitefly tests in follow-on projects.

   a. The AZ Task Force met on Feb 11, 2008, and Mar 5, 2008 in Yuma, and again at the end of the spring season harvest (mid-July) to assess the situation prior to fall planting. As a result of the Yuma meetings a voluntary host-free period was agreed upon for Arizona as July 5 – August 5, 2008. The Task Force did not meet formally during 2009 but members attended the Research Update meetings held at the Yuma Country Extension office.
   b. The California Task Force met at the annual Melon Board meeting in January 2008 and 2009 to review the status of research progress, including CYSDV projects. Weed hosts identified in AZ and CA were highlighted (Presentation by R.L. Gilbertson, 2008; Presentation by W. Wintermantel, 2009). Collaborative effort by UC-Davis (Gilbertson, Natwick), USDA-Salinas (Wintermantel), U-Arizona (Brown, Taylor).
   c. The Brown lab provided diagnostics testing information to County Agents and other university Researchers (Matheron, Palumbo, Olsen-Pl Pathol-Extension) in Arizona.
   d. See **Appendix I** for a sampling of web-posted information.

2. Reach approximately 100 growers, researchers, and industry professionals through the distribution of extension fact sheets.

   Nolte, K. and Brown, J.K. 2007. CYSDV Bulletin for Arizona. Yuma County Extension Office, Yuma, AZ. The CYSDV fact sheet was prepared and distributed in Yuma (K. Nolte) and Maricopa counties (E. Taylor) at producers meetings.

   Combating CYSDV in Arizona. In S. McGinley [ed.], Science and Education 2009 Impacts, A College of Agriculture and Life Sciences Report to CSREES, The University of Arizona, Tucson, AZ. URL: cals.arizona.edu/impacts/1_5.html
   A number of newspaper articles were published in Yuma newspapers, Farm Press, Tucson Citizen, etc. (see list above).

3. Reach 200 growers, researchers, and industry professionals through presentations at workshops and extension meetings.

   Producer Education Meetings
   Arizona:
   -CYSDV Task Force Update: The Exotic *Cucurbit yellow stunting disorder virus*-what we know and don't know. Yuma, AZ. April 11, 2007.
   -Plant Viruses of Vegetables/Vegetable Seedlings & National Plant Diagnostics Network. In-Service Training-Cooperative Extension. Tucons, AZ. May 17, 2007 (U. Schuck, Organizer).
   -The new threat of *Cucurbit yellow stunt disorder virus* to Arizona and the region. Desert Agriculture Conference, Casa Grande, AZ. May 10, 2007 (AZ Crop Protection Association, Organizers).
   -Cucurbit yellow stunting disorder virus and whitefly vector distribution in Arizona and Sonora. CYSDV Workshop, Yuma. July 25, 2007 (K. Nolte, Organizer).
   -CYSDV Workshop-Status of the disease and epidemiology update. Yuma Extension Center Auditorium. Yuma, AZ, February 11, 2008. Organizer, Dr. Kurt Nolte.
   -Pre-fall Vegetable Meeting, Yuma County August 26, 2009. CYSDV related talks in Yuma were presented by Kurt Nolte, John Palumbo, and Judith Brown.
   -Maricopa Co (Vegetable Meeting, Maricopa Co Ext Office Meeting Hall, July 16, 2009. Presentation by Judith Brown (included data from the Brown and Taylor labs).

   California:
   -Epidemiology and Management of CYSDV. Annual Winter Workshop, Holtville, CA. November 4, 2008. Presented by Judith Brown (Host, Eric Natwick).
   -Annual Winter Vegetable Workshop, Holtville Nov 2009. Presented by Bill Wintermantel (USDA Salinas). Data provided by R. Gilbertson, J.K. Brown, and W. Wintermantel.

   Mexico:
   -*Cucurbit yellow stunting disorder virus*-A region wide pandemic. Workshop, Sonora Producers and Harris Moran Seed, Hermosillo, Sonora. December 18, 2007. Presentations by Judith Brown (U-Arizona) and Cosme Guerrero (UNISON).

4. It is anticipated that 10-30 growers or homeowners per year will bring samples in for CYSDV testing.

   -The Brown lab at the University of Arizona tested 80 cucurbit and other cultivated plant and weed samples for CYSDV and reported results to the individuals or County agents (Nolte, Taylor).
   -The Brown lab at the University of Arizona tested 159 cucurbit and weed samples (sent from homeowners or collected nearby homes and in and near melon, alfalfa, and other fields in Yuma (Palumbo, Nolte) and Maricopa/Pinal counties (Taylor).

   Scientific-Professional Presentations:
   Nolte, K., Palumbo, J., Brown, J.K., Tellez, M., and Bealmer, S. 2008. Integrating GIS in the epidemiology and management of the Cucurbit yellow stunt disorder virus (CYSDV). The Horticulture Society of America, National Meeting, 2008 (Abstract; Oral Presentation).
   Wintermantel, W.M., Brown, J.K., and Gilbertson, R.L. 2007. Widespread emergence of *Cucurbit yellow stunting disorder virus* (CYSDV) in the southwestern desert melon production region of the United States and Mexico. APS meeting San Diego, CA July 28-August 1, 2007 (Oral Presentation).

   Scientific Publications:
   Papayiannis, L.C., S. Hunter, S.C., Iacofides, T., and Brown, J.K. 2009. Detection of *Cucurbit yellow stunting disorder virus* in cucurbit leaves using sap extracts and real-time TaqMan® reverse transcription (RT) polymerase chain reaction (PCR). J. Phytopathol **doi10.1111/j.1439-0434.2009.01647.x.**
   Papayiannis, L.C., Brown, J.K, Seraphides, N.A., Hadjistylli, Ioannou, M.N., and Katis, N.I. 2008. A real time PCR assay to differentiate the B and Q biotypes of the *Bemisia tabaci* complex and application to determine their prevalence in cultivated and weed species on Cyprus. Bull Entomol. Res. On-line: **doi:10.1017/S0007485308006603**.

Project Goals:

1. Develop, optimize, and implement a real-time, quantitative PCR assay for CYDSV detection in cultivated and wild plant species.

   We developed and optimized a specific assay for CYSDV using real-time (quantitative) PCR (qPCR).
2. Develop technology for sample collection and elution to provide a method that surpasses presently available approaches.

   We developed a crude extraction method usable for symptomatic cultivated plants. We had inconsistent results with storing extracts on membranes. While the rapid extraction procedure is more cost-effective and takes less time than our previous extraction method, using the crude extract with some weedy species yielded false negatives.
3. Implement this virus-specific diagnostic assay to identify CYSDV in cultivated and wild plant hosts.

We ran a total of 294 assays from September 12, 2007 to September 30, 2008. Of these, 174 samples tested positive for CYSDV. The majority (164 or 94%) of the positive samples were from crop species. We tested a total of 10 crop species and over 26 weedy species.

4. Report results of the analysis with great accuracy and speed.

   Turnaround time was based on grower needs and results were reported shortly after the samples were received during planting, early season, and initial harvests in order to aid in management decisions. Later season samples were processed as they fit into the regular laboratory sequence (order of receipt) unless the lab was notified that it was urgent. When the information was needed to inform plow-down decisions, results were available in less than 24 hours.

5. Use the results to map the distribution and spread of the virus throughout the production seasons (w/ K. Nolte).

   Whitefly incidence maps are appended to this report in the "Arizona Pest Management Center IPM Project Final Report" in Appendix E.

6. Provide a pilot study and assay development template for other diagnostic capacity.

   Subsequent to developing the CYSDV qPCR assay, our lab has developed an assay for tomato chlorotic dwarf viroid, a recently emerged greenhouse disease in Arizona. Our experience with the CYSDV assay reduced the time to develop the new assay.

Beneficiaries

The information gained in this study has helped both the scientists and producers understand more about the epidemiology of CYSDV and the threat that it poses to melon production in Arizona. Indeed in the first year following the introduction of CYSDV it became clear that the virus had established in native or naturalized uncultivated plants in southern Arizona and so it was indeed important to identify relevant virus reservoirs. In addition to the wild hosts the cultivated crops also serve as reservoirs of the virus for subsequent melon plantings. This lead to improved management practices that consisted of earlier than usual insecticide applications (just as whitefly adults began to appear in fields) to reduce initial infection and thereby disease incidence in young plants, which are more susceptible to damage than older plants that become infected. Secondly, producers cooperated to eliminate infected fields as soon as the harvest was completed to reduce spread to newly planted fields. We will continue to study the distribution of the virus, which has now spread to four Arizona counties, and has been identified using qPCR in a number of native weed species. Validation of these initial identifications is underway using RT-PCR followed by cloning of the products and sequencing. In addition, the project will study the importance of wild hosts found positive in laboratory assays with respect to whitefly feeding and reproduction preferences on those hosts, to learn which weeds may be favored as whitefly hosts (feeding, reproduction or both), carry a high virus titer, and serve as optimal virus sources for dispersing whiteflies. Of particular importance are weed hosts that do not exhibit symptoms of virus infection, since field managers may not control those weeds and further endanger their and others crops.

Lessons Learned

Things that worked well:

- Development of the qPCR method was a huge timesaver as we have cut our diagnostic time in less than half.
- In some cases, crude extraction method worked well.
- qPCR technology worked very well and is now being adapted to other plant virus and viroid threats for Arizona.

Things that did not work well:

- Crude extracts on asymptomatic plants. Crude extracts on non-commercial crops.
- We have not developed the FTA card technology. For asymptomatic plants we need to use RNA extractions.
- Room-temperature storage for extracted plant sap.

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Additional Information

Initial monitoring confirmed the presence of CYSDV in cucurbit fields in four AZ counties during 2006-2007. This information helped stakeholders make knowledge-based decisions for management, including the removal of plants immediately upon harvest, and to initiate a volunteer early planting date observance (mid-Aug) toward a host-free period. Initially many producers/PCAs, and county agents were unable to distinguish between nutrient deficiency, toxicity of pesticides/herbicides, and virus infection. The development and implementation of the laboratory CYDSV detection assay was essential for corroborating virus prevalence and distribution, and for initiation of other outreach and research efforts to learn more about the viral pathogen and how to manage it.

The follow-up monitoring of fields in Yuma, La Paz, Maricopa, and Pinal counties showed that by 2007 all four counties had infected fields, indicating that CYSDV had survived through the first and second winters and that the virus would likely be a persistent problem in cucurbit production. In addition, several non-cucurbit hosts were identified indicating that the virus had a broader than expected host range and therefore, follow-up studies were needed to ascertain the over-seasoning reservoirs of CYSDV in southern and Central Arizona. This knowledge was useful to producers by enabling them to select melon varieties that were damaged to a lesser extent and therefore when combined with early-season whitefly vector control, plants produced more marketable fruit. These activities enabled the initial clarification of disease cycle by seasonal monitoring of melon crops in southern and south-central counties. Efforts were aimed at monitoring of cultivated and weedy hosts to determine whether CYSDV could overwinter in AZ (06-07), and/or if the virus possibly instead would be reintroduced from external sources (CA, Mexico) the following spring or summer. These studies were accomplished by assaying using

qPCR as the initial detection assay, followed by RT-PCR and cloning/sequencing from representative positive plants to corroborate qPCR results.

Several previously unrecognized over-seasoning hosts and possible reservoirs were identified in the deserts of central and southern Arizona. Some of these may possibly be relevant natural hosts of CYSDV and targets for removal if they are found to serve as reservoirs for annual outbreaks. The long-term goal is to foster knowledge-based cultural management by selective removal of specified weeds and planting proximity to known cultivated hosts in season-to-season crop rotations.

Refereed and other publications resulting from the project:

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Spring Harvested Lettuce Tipburn Resistance Research

This project was completed on September 30, 2010

Project Summary

Tipburn is a calcium deficiency related physiological defect causing necrotic or "burned" areas on leaf margins that affects spring harvested lettuce in Arizona (Jenni and Hayes, 2010). Tipburn occurs on all lettuce types, typically on inner leaves within the head where the damage is not easily observed until the head is used by consumers or processors. Lettuce growers and packing companies experience severe economic damage when tipburn occurs. Some packing companies reject entire fields when tipburn incidence exceeds 5%, and lettuce processed into salad requires even higher stringencies. Supplemental Ca fertilization in not effective at reducing tipburn (Hartz et al., 2007), and planting resistance cultivars is best approach to managing this disorder. Lettuce exhibits genetic variation for tipburn resistance, and successful breeding of resistant cultivars (reduced incidence of the disorder) has been demonstrated (Ryder and Waycott, 1998). Tipburn resistant cultivars were developed for specific use in coastal California, and include „Salinas", „Tiber", and several derivatives released by private seed companies. However, breeding for reduced incidence of tipburn is among the most difficult of breeding objectives. Continued progress in improving resistance has been slow, particularly in the romaine market type. A substantial cause of this are unpredictable genotype x environment (GE) interactions, and in some cases low amounts of genetic variation for tipburn resistance (Jenni and Hayes, 2010). In extreme cases, tipburn may not occur at all even in the most susceptible lines, and any opportunity for selection is lost. Plant morphology, particularly head closure, firmness, and plant vigor may also condition reduced incidence of tipburn (Barta and Tibbitts, 1986; Jenni and Hayes, 2010), but these characters may not be compatible with the desired market type. An improved understanding of the inheritance of tipburn resistance may improve breeding success. This includes elucidating the number and strength of quantitative trait loci (QTL), regions in the lettuce genome harboring genes for these traits, for tipburn resistance and plant morphology. Implicit in this goal is to improve our understanding of the relationships between QTL for tipburn resistance, plant morphology, and their interactions with environments. These goals were accomplished in this research by evaluating the segregation of tipburn resistance in recombinant inbred line (RIL) populations of lettuce segregating for tipburn resistance.

Project Approach

Field experiments and classic quantitative genetics analysis. Three RIL populations previously developed and with genetic maps (Table 1) were evaluated for tipburn incidence as well as morphological variables (head weight, core height, head closure, and head firmness) that may influence tipburn incidence. A fourth RIL population (Pacific x La Brillante) was proposed for these experiments. However, analysis of leaf and seed color indicated that this population had aberrant segregation, and was abandoned for this reason. For the remaining populations, plant culture and assessment of tipburn incidence (proportion symptomatic plants) used the methods of Jenni and Hayes (2010). Each RIL population was planted in Yuma, AZ field experiments using a randomized complete block design with three replications and evaluated for two years. Planting dates were in mid-December, resulting in evaluation dates of late March or early April. Core height and head weight were measured on two plants per plot per RIL in centimeters (cm) and grams (g) respectively. Head closure was assessed on a scale of 1 (open) to 9 (closed), while

head firmness was measured on a scale of 1 (soft) to 5 (hard). Head closure and head firmness were rated on a per plot basis. The amount of variation for these characters within each RIL population was different between the populations, but essentially normally distributed in all cases. Heritability (H^2), a ratio of genetic variation to non-genetic variation (environmental and interactions), was calculated for each RIL population on a per plot basis for tipburn incidence, core height, head closure, head weight, and head maturity according to the methods of Fehr (1991). Heritability estimates for tipburn were low (Salinas 88 x La Brillante: H^2=0.23; Salinas x Valmaine: H^2=0.23; Saladin x Iceberg: H^2=0.14), and indicate that selection for reduced tipburn incidence is relatively less effective, compared to the other traits with higher H^2. For example, H^2 estimates for core height were 0.47 (Salinas x Valmaine), 0.54 (Salinas 88 x La Brillante), and 0.71 (Saladin x Iceberg). Breeders can increase the amount of testing prior to selection, in the form of more replication and testing in more environments, to increase selection success. However, this approach is likely to lengthen the time needed to development new cultivars with improved tipburn resistance.

Genetic correlations were calculated using a macro described by Holland (2006) in SAS v. 9.1. Head closure was significantly and positively correlated (increased closure corresponding to increase tipburn incidence) with tipburn incidence in Salinas x Valmaine (0.84) and Salinas 88 x La Brillante (0.66). Core height was significantly and positively correlated with tipburn incidence in Salinas x Valmaine (0.66), while head weight (0.86) and head maturity (0.67) were significantly and positively correlated with tipburn incidence in Saladin x Iceberg. The remaining correlations were not significant. The results indicate that specific morphological characters can condition low tipburn incidence, and, the relationships between tipburn incidence and plant morphology can be population dependent. Unfortunately, the direction of these correlations may inhibit successful breeding of new tipburn resistant cultivars, as low tipburn incidence was correlated with RIL possessing open heads (less closure), light weight heads, late maturity, or tall cores. These specific morphological characters are considered undesirable in most new cultivars. Head closure, head weight (or plant vigor), and maturity were previously associated with tipburn (reviewed in Jenni and Hayes, 2010). A relationship between core height and tipburn has not been previously reported in the literature. These findings emphasize the need to select for reduced tipburn incidence by assessing only the plants possessing the specific morphology desired by the breeder.

SSR marker development and genetic map development of Salinas 88 x La Brillante. Genetic maps of RIL populations represent the order of genetic loci or genes of a specific cross. These maps are constructed from the segregation of molecular markers, and genetic maps are needed to determine the location of QTL for traits such as tipburn resistance. A map of single nucleotide polymorphism (SNP) molecular markers was developed by UC-Davis for the Salinas 88 x La Brillante population as part of research on resistance to *Verticillium dahliae*. We sought to add additional markers to improve the density of markers on this genetic map, which should improve our ability to detect QTL. Work was conducted to identify simple sequence repeat (SSR) markers that could be used for this purpose. We developed over 60 EST-SSR markers, and placed them on a genetic map of an interspecific cross to determine the distribution of markers in the lettuce genome. Markers developed in our laboratory were distributed on all 9 linkage groups (LGs). The largest number of markers was found on LG 6 (16 markers), while the lowest number

was detected on LG 1 (7 markers). This indicates random distribution of the markers (Goodness of Fit test p = 0.58). The EST-SSR markers have higher transfer rate to wild species related to lettuce (*Lactuca serriola*, *L. saligna*, and *L. virosa*) and are easy to score. In addition we have developed over 150 anonymous SSR from non-coding genomic regions through library-enrichment protocol. While our results show that SSR markers developed in our laboratory cover all linkage groups and can be used for mapping quantitative trait loci, we did not have time to determine the location of SSR markers for the Salinas 88 x La Brillante population. However, locations of the markers are likely similar to those observed on the population developed from an intespecific cross. The private company KeyGene provided data on 220 co-dominant amplified fragment length polymorphism (AFLP) markers using 13 primer combinations for the Salinas 88 x La Brillante populations. The AFLP and SNP markers were merged into a single genetic map using the software Joinmap version 2.0 (Stam, 1993), and subsequently used for QTL analysis.

Quantitative trait loci analysis. An introduction to the concepts of QTL mapping are discussed in Collard et al. (2005). Quantitative trait loci are the location of a gene or genes controlling a specific character (i.e. tipburn incidence measured in percent, head weight measured in grams). The location of the QTL is known relative to molecular markers on a genetic map, and the distance between QTL and molecular markers is reported in centimorgans (cM). The strength of a QTL can be summarized in an R^2 estimate, which is the percentage of total variation explained by the QTL. Larger R^2 values correspond to QTL with stronger effects. Additionally, QTL may have interactions with the crop production environment, due things such as differences in soil or weather between years or locations. The interactions are primarily recognized as an inability to detect a QTL in one or more year or location in a multi-year and multi-location experiment. Analysis to detect QTL was conducted for the Salinas x Valmaine population using the software MapManager QTX (Manly et al., 2001) and using the software QGene v. 4.3.6(Joehanes and Nelson, 2008) for Salinas 88 x La Brillante using standard approaches. Significance thresholds ($P < 0.01$ and $P < 0.05$) were determined using permutation analysis (1000 permutations). The genetic map for Saladin x Iceberg was not made available by HRI by the time of this report, and so no analysis could be conducted. Analysis of the Salinas x Valmaine population indicates that tipburn resistance is likely associated with differences in plant morphology, and was consistent with the genetic correlations found for this population. Four significant QTL on chromosomes 2, 4, and 7 were detected in the Salinas x Valmaine population, with R^2 values (the percentage of variation explained by the QTL) ranging from 12% to 19%. These R^2 values indicate that these QTL have low to moderate effects on tipburn resistance. QTL x environment interactions were present, as only two QTL were detected in both testing years. All QTL for reduced tipburn incidence (better resistance) were inherited from the romaine parent Valmaine. Eleven QTL for plant morphology were detected, six of these are closely located (1 to 2 cM) or have the same location (0 cM) as the QTL for tipburn resistance. The results indicate that tipburn resistance, head closure, core height, and maturity are conditioned by the same genes, or genes that are closely linked on the same chromosome.

Two QTL for tipburn incidence on chromosomes 1 and 4 were detected in Salinas 88 x La Brillante. For both QTL reduced tipburn incidence was inherited from Salinas 88, and only the QTL located on chromosome 1 was detected in both years of testing. The R^2 were 23% (2008) and 35% (2009) for the QTL on chromosome 1. The R^2 for the QTL on chromosome 4 was

15%. QTL for morphological characters were either located on different chromosome, or, were greater than 15 cM away from the tipburn incidence QTL. The QTL discovered in Salinas 88 x La Brillante may indicate the location of genes controlling a plants inherent ability to resistant tipburn, independent of plant morphology, and would be more useful in lettuce breeding for this reason.

Conclusion. This research was the most detailed examination of tipburn resistance in lettuce, among those that have been publically reported. In its totality, the results indicate that breeding for tipburn resistance is complicated by low heritability and interaction between QTL and environments. Additional, genes for tipburn resistance may be genetically linked with genes for plant morphology, or they may be the same genes. Trait relationships and correlations can be population dependent.

The cultivars Salinas and Salinas 88 likely differ by only a single recessive gene ($mo1^2$) that conditions resistance to *Lettuce mosaic virus*, and are expected to have posses the same genes for resistance to tipburn. Therefore, it was unexpected to detect QTL for tipburn resistance inherited from Salinas 88 in the Salinas 88 x La Brillante population, but not the Salinas x Valmaine population. This may be due to irregular segregation in the Salinas x Valmaine population. Alternatively, Salinas and Valmaine may share the same alleles at these QTL. However, Valmaine is generally regarded as more susceptible to tipburn than Salinas (Jenni and Hayes, 2010), and would indicate that the genes conferring this difference remain unknown.

Current breeding procedures for tipburn resistance in the USDA breeding program follow the approach of Ryder and Waycott (1998). Synthesizing the data here with the information reported in Jenni and Hayes (2010), several modifications can be made to improve breeding success. Single seed descent (SSD), as described in Fehr (1991), can be used to develop populations of inbred lines, eliminating the inefficiency of single plant selection in segregating generations. If possible, plants with undesired morphology conditioned by highly heritable traits (core height, head closure) can be applied during the inbreeding phase. Molecular markers, when available, could be use to select for desirable QTL during SSD. Assuming four QTL for resistance, as determined in the Salinas x Valmaine population, breeders should aim to develop populations of greater than 50 inbred lines to insure development of at least one line with all resistance QTL. Assessment of inbred lines should be conducted in as many environments as feasible, prior to applying strong selection pressure for reduced tipburn incidence. Two tipburn nurseries are available to the USDA that regularly result in tipburn symptoms, a mid-December planting in Yuma, AZ and a March/April planting at a select location in Salinas, CA (Jenni and Hayes, 2010). These nurseries can be used in tandem to collect data from two environments prior to selection, and seed can be reliably produced from the Salinas, CA location for use in the next selection cycle.

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Dr. Richard Michelmore‟s research program at the University of California at Davis (UC-Davis) developed and provided seeds of the Salinas x Valmaine population. UC-Davis also conducted SNP marker analysis and constructed genetic maps using the SNP markers for the Salinas x Valmaine and Salinas 88 x La Brillante population. Genetic maps for these populations were constructed as part of independent research projects. Seeds of the Saladin x Iceberg population were provided by Dr. Paul Hand with The Horticulture Research Institute, Warwick, UK. The private company KeyGene provided AFLP marker data for Salinas 88 x La Brillante in exchange for seeds of the population. This project was supported by the efforts of numerous technicians and students. These include: Mr. Jose Orozco, Mr. Dov Pechenick, Ms. Lisa Lai, Mrs. Amy Atallah, Ms Amy Folk, Mr. Mario Estrada, Ms. Elisha Garcia, Mr. Adan Romero, and Mr. Stevie Hall.

Goals and Outcomes Achieved

1. Field experiments were conducted over three years to collect data on tipburn incidence and plant morphology.
2. Molecular markers were developed to improve genetic maps of lettuce.
3. Classic quantitative genetics and QTL analysis was conducted to determine the inheritance of tipburn resistance in lettuce.
4. Conferences were attended throughout the research time period to disseminate the project findings.
5. Breeding lines were selected for characterization and eventual release to industry.

A separate goal of this research was to select individual recombinant inbred lines with improved tipburn resistance for potential release to the lettuce industry. This was possible using the Salinas x Valmaine population, and 13 romaine type lines were selected and characterized in three December planted replicated field experiments in Yuma, AZ. In these experiments, these RIL were not significantly different than Valmaine for any morphological character or yield (percent marketable heads) (Table 2). The head type of most of these RILs is commercially acceptable (Figure 1). Only three RIL had a significantly lower percentage of tipburn compared to Valmaine, although all RIL were numerically better than Valmaine. The performance of these selected RIL is consistent with the genetic analysis of the Salinas x Valmaine RIL population, as they represent a compromise between low tipburn incidence and acceptable head closure, core height, head weight, and firmness or maturity. Unreplicated field experiments are in progress to determine the breadth adaption for each selected RIL, which is needed to successfully release this germplasm. Field trials already completed indicate that RIL-27 and RIL-231 may be adapted to earlier November planting dates in Yuma, AZ; RIL-27, RIL-54, and RIL-260 are resistant to the soil borne viral disease Dieback; RIL-44 has potential for lettuce drop resistance; RIL-27 and RIL-231 have sufficient shelf-life of minimally processed salad to make them suitable for use in the salad market. Release of superior performing RIL may occur as early as 2012.

We have identified a large effect QTL from Salinas 88 conditioning reduced tipburn incidence in the Salinas 88 x La Brillante population. Development of a molecular marker for this QTL is still in progress. Additionally, this information will published in detail in peer reviewed journals. We are in the process of combing our results with an international group also working on tipburn resistance for eventual publication. We believe that the publication with combined data will have broader readership, increasing the impact of the research completed in this project. As this effort depends on scientist in diverse institutions, we do not have a time frame for eventual publication.

The stated goal of this research was: To develop lettuce cultivars with tipburn resistance and adaptation to spring production in Arizona. The approach is to develop molecular markers for MAS (tools), determine the inheritance of tipburn resistance (information), and select improved lines from test populations (germplasm). We have completed all of these except development of molecular markers for marker assisted selection. This aspect of the work in still in progress.

1. We have identified six QTL for tipburn resistance in two populations.
2. Thirteen breeding lines were selected for potential release to the lettuce industry
3. Research results were disseminated at the following conferences.
   California Lettuce Research Board, Coalinga, CA, March 11, 2008
   California Lettuce Research Board, Seaside, CA, October 14, 2008
   California Lettuce Research Board, Coalinga, CA, March 17, 2009
   Pre-Season Lettuce Workshop, Yuma, AZ, August 26, 2009
   California Leafy Greens Research Program, Seaside, CA, October 10, 2009
   South West Ag Summit, Yuma, AZ, March 1, 2010
   California Leafy Greens Research Program, Coalinga, CA, March 16, 2010

Beneficiaries

Lettuce is the most valuable specialty crop grown in Arizona, grossing as much as 500 million dollars annually. It is expected that the inheritance information we developed will increase the efficiency of tipburn resistance breeding, and increase the number of cultivars released with improved tipburn resistance. These benefits will continue to accrue so long as tipburn resistant cultivars are needed in Arizona. Calcium deficiency disorders occur in numerous crops, the data developed in this project may aid research on other crops grown in Arizona. Beneficiaries of our research will include growers, seed companies, packing companies, public research institutions, and companies that support these groups.

Precise monetary impacts are difficult to estimate. However, a single released USDA breeding lines may be used by up to 400 growers on up to 10,000 acres resulting in seed sales (through private seed companies) of approximately 3 billion seeds.

Lessons Learned

Analysis of data from the available populations was highly successful in this research. A negative aspect was the inability to obtain a genetic map and molecular marker scores for the Saladin x Iceberg population. The inability to obtain this information was out the USDA control, and it is not clear what could have been differently to obtain the information.

We determined that core height can influence the incidence of tipburn, this was previously unknown in the literature. We have discovered what we believe is the first QTL for tipburn resistance in lettuce that is not associated with plant morphology. The 2009 field experiment of the Salinas 88 x La Brillante population was harvested and shipped back to Salinas, CA for assessment of shelf-life of minimally processed lettuce. Preliminary results indicate that one large QTL control shelf-life in the population; this research is being continued.

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Additional Information

Tipburn can occur in Arizona on lettuce harvested in the spring, when lettuce prices typically peak. Our research seeks to increase the quality and availability of lettuce harvested during this time frame. Additionally, currently available cultivars are not produced for harvest during mid to late April, due to the likely occurrence of tipburn. Development of tipburn resistant cultivars that can be harvested in April could increase the market share of lettuce grown in Yuma, AZ. Improved breeding methods using the results from this research make the development of these cultivars more likely.

Table 1. Recombinant inbred line populations for identification of tipburn resistance quantitative trait loci and characteristics of their genetic maps.

				Genetic Map		
Population	Cross type[1]	Developer[2]	Number of lines	Number of molecular markers	Number of linkage groups	Total length (cM)
F_8 - Valmaine x Salinas[3]	Int - romaine x Res – iceberg	UC-Davis	150	76	12	438
F_7 - Salinas x La Brillante[4]	Res-iceberg x Sus-Batavia	USDA, Salinas	95	329	13	1043
F_8 - Salinadin x Iceberg[2]	Res-iceberg x Sus-Batavia	HRI, UK	94	NA	NA	NA
F_7 - Pacific x La Brillante[4]	Res-iceberg x Sus-Batavia	USDA, Salinas	95	NA	NA	NA

1/ Res = tipburn resistant; Sus = tipburn susceptible; Int = intermediate tipburn resistance
2/ HRI = Horticultural Research Institute, Warwick, UK; UC-Davis = University of California, Davis, CA, USDA = United Stated Department of Agriculture, Salinas, CA
NA = not applicable; cM = centimorgans

Table 2. Head weight, core height, head height, percent marketable, percentage of heads with tipburn, head maturity, and head closure type in the commercial romaine cultivars Valmaine and 13 recombinant inbred lines from Salinas x Valmaine tested in December plant replicated field experiments in Yuma, AZ.

Line	Weight	Core	Height	Percent Marketable	Proportion Tipburn	Head Maturity	Head Closure
Units	grams	cm	cm	%	%	1= immature 3 = over mature	
RIL-107	680.9	6.3	25.7	39	13	1.8	Open
RIL-159	697.1	7.5	29.2	36	0 V	1.8	Semi-Closed
RIL-174	595.8	8.2	28.9	31	0 V	2.0	Semi-Closed
RIL-231	569.3	9.3	30.9	50	20	1.7	Semi-Closed
RIL-260	646.9	6.5	27.7	46	27	2.0	Semi-Closed
RIL-27	649.1	9.3	33.4	65	27	2.0	Semi-Closed
RIL-291	627.9	6.8	29.3	50	3	2.2	Open
RIL-298	636.9	6.0	25.4	47	33	2.5	Closed
RIL-304	654.0	8.7	27.7	54	7	2.2	Semi-Closed
RIL-321	806.8	8.1	30.8	61	7	2.5	Semi-Closed
RIL-44	659.9	8.8	29.3	53	10	2.3	Open
RIL-54	693.6	8.8	28.8	41	0 V	2.7	Semi-Closed
RIL-61	820.7	6.9	28.9	52	23	2.5	Semi-Closed
Valmaine	703.2	6.7	29.6	48	47	2.8	Semi-Closed

V = significantly different than Valmaine

Figure 1. Representative heads from RIL-27 and RIL-231 (Salinas x Valmaine) from a Yuma, AZ November planted field experiment.

Quality and Microbial Risk Assessment of Iceberg and Romaine Lettuce as Influenced by Irrigation System

This project was completed on December 31, 2008

Project Summary

Recent outbreaks associated with leafy greens consumption have had serious negative impacts within the different groups (growers, processors, shippers, retailers) of the leafy green industry. As a result several guidelines have already been suggested and/or adopted in an effort to minimize risk of contaminated leafy products reaching the market. The changes suggested (e.g. by third party audits, retailers, restaurant associations and in the metrics of the California Marketing Agreement) to the general GAPs (Good Agricultural Practices) have not, however, considered intrinsic conditions encountered in the different crop production areas. We hypothesize those environmental conditions in the low southwest desert result in lower risk of contaminated lettuce than in other regions. Despite this, it is of particular concern that most Arizona vegetable growers use surface water which makes the proposed water quality standards eventually difficult to achieve during certain periods. This project will continue recent work examining the effect of irrigation system and schedule on microbial quality of lettuce, quantify the risk levels associated with the different water management programs, and determine the surviving ability of E. coli under the conditions prevalent in Arizona during winter. This research will compare economical return resulting from various practices, corresponding to different risk levels.

Project Approach

This project accomplished all goals set in the initial proposal. With funding from another source, the project hopes to answer other questions opened during this project. For example, it would be useful to approximate the risk of survival of *E. coli* O157:H7 in the field (by testing it side by side with the non-pathogenic strain used in this project). Also it is important to emphasize the amount of water that is present on the surface of leaves at the moment of inoculation through irrigation.

This project surpassed the goals that were established. Those goals were:

Goal 1: Demonstrate the effectiveness of drip, sprinkler and furrow irrigation schemes in determining final postharvest quality.
Goal 2: Estimate the uptake and survival rate of E. coli by romaine and head lettuce grown in Yuma as influenced by the irrigation system.
Goal 3: Compare cost/benefit ratio associated with irrigation systems examined in this project.

Ultimate Goal: To develop a clear and thorough understanding of the pros and cons of using each of the three irrigation system for production of lettuce in Yuma. The project aims to provide Arizona leafy green growers with a practical scheme, showing the effect of irrigation systems on yield, quality and microbial risk of Romaine and Iceberg lettuce.

An emphasis was placed on goal 2 and the ultimate goal, in the process of conducting this project, when it was observed that other work was being done targeting goal 1 and 3 (data not shown). The ultimate Goal and Goal 1 became especially important when it was learned (through on-going feedback from the industry) that growers were in urgent need of learning about the fate of pathogens under Arizona weather conditions. This was assessed using the three different irrigation systems.

Results confirm the enhanced risk of *E. coli* contamination when using overhead sprinkler irrigation, but also revealed the importance of an early irrigation termination for both spray and furrow irrigation. The latter, because a higher survival of *E. coli* in soil that was furrow irrigated was observed. The survival period of *E. coli* was longer in colder months. However, lab work with actual pathogens showed no significant difference in survival rate regardless of the irrigation system used. Clearly, a key conclusion in this project is that more stringent monitoring and food safety controls should be emphasized during the last few days before harvest.

This study is one of few works done in actual commercial fields, which enhances the impact of the findings for the industry and consumers.

Goals and Outcomes Achieved

The results from this project will impact the relationships between growers, national producers, processors, buyers and retailers.

1. Reach and educate 40 growers through oral presentations at workshops and extension meetings and one-to-one telephone conversations (incoming calls from growers).
2. Reach and educate 12,000 stakeholders per month through U of A Cooperative Extension Vegetables webpage postings. Seven thousand stakeholders will be reached through postings on the Western Vegetable Quality webpage at http://ag.arizona.edu/crops//vegetables/quality/index.html. The industry will partially rely on project results to establish guidelines to improve quality of the product reaching the retailers. Thus, influencing the decision of just one of the three major salad processors will result in an impact of approximately 40% of the 100 growers that supply lettuce for processing.
3. Findings will be published in the Arizona Vegetable Report, an annual bound publication that is distributed to growers, PCAs, CCAs, and extension personnel. Two thousand stakeholders will be reached through this distribution which is published each fall.

This project had the following achievements:

1. Results from this project were disseminated among growers and shippers of Arizona and California (at least 100) through two presentations done at the AZ Leafy Green Marketing Agreement Meeting and at the annual meeting of the California Leafy Green Research Board. Expansion of the information from that point has taken place through different groups such as the Western Growers Association and Yuma Vegetables both which have gotten copies of results obtained from my program including from this project.
2. Our results have also being posted in other forums such as the web site of the California Leafy Green Research Board and were disseminated by the University of Georgia, Department of Food Science.

3. The Arizona Vegetable Report has not being published since the project ended as the editor position is currently vacant. I expect this to be solved sometime in the near future.
4. The websites mentioned continue receiving similar volume of visitors, and although those have not been updated, thanks to the information that is already there I have been contacted on multiple occasions regarding information in this website. We hope to update this website soon when a person at the U of AZ gets in charge of it. Additional funding has been obtained to update on-line information in the next three years.
5. The findings of this results have also been disseminated beyond our region through columns/interviews in trade magazines such as The Packer and Fresh Americas through which more than 5,000 readers have been reached, all related to the produce industry
6. Our results have more concretely helped the industry establish guidelines. For example, knowing the survival of E. coli in the field when transmitted by water that gets in contact with the leaf tissue has prompted several companies to develop more stringent guidelines for crops that are sprinkled irrigated. We anticipate seeing an increase amount of growers placing more attention on these particular crops.

Beneficiaries

This research has benefited the leafy green industry in Arizona and the nation. Results from this proposal are fundamental to keep the vegetable industry growing as they indicate different risks associated with the irrigation system options available in the region. Knowing how biological contaminants survive under different conditions can allow growers to take the appropriate actions to avoid catastrophic events. For example, an outbreak associated with the consumption of their products. In 2006, an outbreak connected to spinach resulted in a decline in consumption by 30% even today.

Lessons Learned

Awareness of the impact of contaminated water and how irrigation systems can effect contamination is important for the growth of the leafy green industry in Yuma County. Work done on this project raised so much interest that the findings were requested to be presented several times in Arizona and California (where currently a similar project is being done in the Salinas Valley).

Since the results in this project are being disseminated in different forums, it is clear that an impact has occurred beyond Arizona limits. It is anticipated that more of this will occur after a couple of articles have been published in scientific journals.

The industry may now partially rely on the results to establish guidelines to improve quality of the product reaching retailers. These results have been presented to two key players in the industry (including the Sub-technical committee of the Arizona Leafy Green Marketing Agreement, which essentially controls food safety standards in the state"s industry). The on-going interest of the local industry prompted the focus in this project to be on aspects related to contamination risks, which resulted in several other projects beyond the scope of work presented here.

In this project, the goals related to produce safety were accomplished. At one point the decision had to be made whether the project should emphasize the produce safety goals for more

conclusive results. Enough information was compiled for all the goals, however, given the budget obtained and the time in this project, the reporting was limited to the findings on produce safety. For example, more product was sampled for the bacteria survival analysis, work on the effect of water potential was conducted, and a pattern of survival of bacteria in the soil vs time of the year was determined. For a one year project, the amount of data generated is substantial, and clearly, some of the data collected can still be used for further analysis.

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Additional Information

Assuring safety of leafy greens is fundamental for the competitiveness of Arizona leafy green crops. There has never been an outbreak associated with Arizona leafy greens, and through projects like this the industry now knows how to reduce possibilities in the future. Understanding why Arizona has been kept away from outbreaks is essential to keep this industry growing. See **Appendix J** for more information in table format.

Heavy Metal Risk Assessment in Arizona Fruits and Vegetables

This project was completed on September 30, 2008

Project Summary

Inorganic contaminants, such as heavy metals are of concern in edible fresh fruits and vegetables. The Colorado River is contaminated with low levels of potentially toxic elements, including uranium (U), lead (Pb), cadmium (Cd) and arsenic (As) and is used for irrigation of specialty food crops in the lower Colorado River (LCRR) region of Arizona and California. Renewed emphasis on alternative energy sources has revived interest in U mining on the Colorado Plateau, where over 1,000 new mine claims have recently been filed. In addition, Cd and U are commonly found in phosphate (P) fertilizers. Leafy vegetables require large applications of P fertilizer for optimal yield and quality, and have a propensity to accumulate heavy metals. Accumulation of these metal elements into food crops is a health concern as potential carcinogens or causal agents of human organ dysfunction. Recently, the European Union (EU) has recommended maximum levels (MLs) of Pb and Cd and other nations will likely implement similar restrictions. The objective of this project was to survey edible fruits and vegetables produced in the LCRR for potential accumulation of heavy metals. Accumulations of metals were generally higher in edible leafy vegetables, such as lettuce and spinach, compared to fruiting crops such as citrus, tomatoes, and dates. However, with the exception of spinach, most products sampled were below EU MLs for Pb and Cd. Uranium was also found at low levels in most food crops tested. The CARES (Cumulative and Aggregate Risk Evaluation System) model was used to derive an estimate of the 2-day average uranium intakes. The data shows that fruits and juices would be the primary sources of U exposure for children but leafy vegetables would be the primary source for adults. However, regardless of the food source, U exposures were less than 1% the more conservative reference dose established by the WHO for all age and gender

groups. Overall, the health risks from heavy metals in specialty crops produced in the LCRR are negligible.

Project Approach

Methods

Vegetable and fruit crops irrigated with Colorado River water were collected throughout the LCRR. Produce samples brought into the laboratory were diced, mixed thoroughly, and after freezing a sub-sample, they were freeze dried. The samples were ground and stored in vials for digestion. The samples were digested using nitric acid and peroxide and were analyzed for U using ICP/MS as described above.

Exposure estimates are made using the CARES (Cumulative and Aggregate Risk Evaluation System) model which combines the probability distributions of food intakes and residue concentrations, e.g., using Monte Carlo methods (NRC, 1993). Data from the U.S. Department of Agriculture‟s (USDA) continuing Survey of Food Intakes by Individuals (CSFII) from 1994 through 1996 and the 1998 Supplemental Children‟s Survey data (USDA, 2000) were used to estimate consumption. The model also includes recipe algorithms.

Results and Discussion

The proportions of various food crops consumed in the United States that are produced in the LCRR vary by crop (Table 2). For many cool season crops such as lettuce, broccoli, cauliflower, and carrots, over 90% of what is consumed in the U.S during the winter period is produced in the LCRR and total U.S. production on an annual basis ranged from 18 to 46%. More modest production of selected warm season vegetables (melons (*Cucumis melo*), peppers (*Capsicum annuum*) sweet corn (*Zea mays*) and water melons (*Citrullus lanatus*)) takes place during fall and spring production seasons but these are less than 15% total U.S. production. Of the citrus crops, the LCRR provides less than 1% of the orange (*Citrus sinensis*), approximately 3% of grapefruit (*Citrus paradise*), but over 30% of the lemon (*Citrus limon*) crops consumed in the United States. For dates (*Phoenix sylvestris*) there are almost 3000 ha in the LCRR which is essentially 100% of the U.S. production.

The ranges and means of heavy metals present in the crops tested are shown in Tables 3 through 6. Accumulations of metals were generally higher in edible leafy vegetables, such as lettuce and spinach, compared to fruiting crops such as citrus, tomatoes, and dates. Overall, levels of Pb and Cd were well below the EU MLs (Table 1) for most crops. One notable exception was spinach, where a large number of samples exceeded the EU ML of Cd of 200 ug/kg fw. Similarly, Durum wheat produced in the LCRR has values frequently exceeding EU MLs. The Durum wheat industry has addressed the issue through the development of low Cd transfer wheat cultivars.
Another way to assess potential risk is to consider hypothetical exposure relative to established reference dosages. Mean and 90 percentile estimates of lettuce consumption have been reported at 46 and 137 g per day for adult males (Smiciklas-Wright, 2002). From these values we can estimate dosages of Pb, Cd, As, and U and compare them to the established oral reference dosage (RfD) (Table 1). From the data (Table 7) we can see that mean exposures for all lettuce types is usually less than 1% the RfD for Pb and below 10% the RfD for Cd and As. Mean exposure from spinach to Pb, Cd, and As were a little over 1%, 10%, and 10%, respectively. For, both Cd and As, research is needed to evaluate potential aggregate exposures to food and drinking water.

However, it should be noted that for both Cd and As, total levels are not always a good indication of that bioavailable.

Most risk assessments for Cd are partially based on extrapolations from toxicological evidence from rice consuming populations affected with Cd induced renal proximal tubular dysfunction (Kobayashi 1978; Cai et al., 1995; Kobayashi et al., 2002). However, these estimates ignore differences in metal antagonist among various food sources and differences in the nutritional status of different populations (Chaney et al., 2004). For example, rice is low in zinc (Zn), iron (Fe), and calcium (Ca). High concentrations of one or more of these elements reduce the rate of Cd absorption in to the bodies of test animals and humans (Flannagan et al., 1978; Fox, 1988; Reeves and Chaney, 2002; Reeves and Chaney, 2004). Little consideration has been given to nutritional factors affecting the bioavailability of Cd (Chaney et al., 2004). In one study where durum wheat was fed to laboratory rats with a Zn adequate diet, it was found that less than 1.3% of the Cd in the durum grain was absorbed by the animals body (House et al., 2003). Similarly, not all the As in food is available to gastronomical adsorption by the body. For example seafood, which typically contains much higher As concentration than foods of terrestrial origin (Jelinek and Corneliussen, 1977) contains most arsenic as methylated rather than inorganic compounds (Phillips, 1994; Yost et al., 1998). It appears inorganic As is not formed upon the ingestion of the more complex methylated compounds (Buchet et al., 1994, 1996). A market basket survey conducted by Schoof et al., (1999) found that the highest total arsenic concentrations were found in seafood (160-2360 ug/kg), followed by rice (303 ug/kg), chicken (86 ug/kg), grape juice (58 ug/kg), and beef (52 ug/g). The highest inorganic arsenic concentrations were found in raw rice (74 ug/kg), followed by flour (11 ug/kg), grape juices (9 ug/kg), and cooked spinach (6 ug/kg). In fruits and vegetables, inorganic organic constituents were around 50 percent, while in grains, sugars, and oils it compromises only about one quarter of the total arsenic. Lower concentrations of inorganic arsenic were seen in meat, poultry, fish, and eggs. More work is needed to evaluate bioavailability of these potentially problematic metals.

The concentrations of total uranium in lettuce produced in the fields of the lower Colorado River region range from 0.1 to 13.5 µg /kg fw (Table 3). Concentrations were generally higher in the harvested portion of leaf lettuce types as compared to iceberg.

Estimated adult male dosages ranged from 0.0002 to 0.003 µg /kg bw-day. The WHO has established a reference (RfD) dose of 0.6 µg /kg bw-day for uranium. Generally, uranium intake from all crops produced in the LCRR would be less than 1% the RfD.

Goals and Outcomes Achieved

The overall objective of this project was to assess the heavy metal contents of fruit and vegetable crops produced in Arizona and assess potential health risks. The field and laboratory research component of this project is complete. The data has been presented at numerous workshops and grower meetings and has been well received. At present we estimate we have reached over 1,000 individuals through oral presentations. Oral presentations will continue at opportune field days and grower workshops. Although we have provided handouts at meetings, the final extension fact sheet is being coordinated with the development of the web page and peer review input from the reviewers of the scientific publications. Currently the web page delivery system for stakeholders is being developed, as well as scientific publications resulting from the research.

At present there has been insufficient time to evaluate the full impact of this program. The data will continue to serve the desired objectives well into the future, and will continually be referred on to determine the impact of this project.

Beneficiaries

The beneficiaries include producers and consumers of Arizona fruits and vegetables. The data from this project provides a resource by which producers can assure marketers that their product is safe. This database will also serve to assure consumers that Arizona fruit and vegetables are safe.

Lessons Learned

In the future web development needs to be completed before the research component is complete.

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Additional Information

The EU has established maximum allowable levels of certain heavy metals in all food crops, including fresh fruits and vegetables. Other nations will likely follow their lead. We have data to insure that most Arizona fruits and vegetables are well below these threshold levels of concern. Thus, these data will serve to make Arizona fruits and vegetables more competitive in domestic and global markets. See **Appendix K** for more information in table form.

Biocontrol Strategy Development for Lettuce Drop Disease Management

This project was completed on June 30, 2009

Project Summary

Lettuce drop caused by two related fungi, *Sclerotinia sclerotiorum* and *S. minor*, is one of the most important fungal diseases affecting lettuce production in Arizona. As such, considerable effort is directed towards disease management and yield loss prevention. Current management strategies rely heavily on chemical applications with moderate success. Novel strategies are needed to 1) provide improved disease suppression, 2) supplement current chemical strategies to prolong their efficiencies, and 3) reduce environmental impacts. Biocontrol is one such strategy**.** Of the biocontrol organisms tested against *Sclerotinia*, *Coniothyrium minitans* is promising and has consistently performed well against *S. sclerotiorum.* In contrast, *C. minitans* has not performing well against *S. minor* at standard application rates. However, results from recent trials revealed that very high application rates of Contans completely prevented disease development caused by *S. minor*. The application rate used in that study was 5X the recommended rate. Therefore, this proposed study aims to optimize the application rate and timing of Contans in the development of effective, yet economical biocontrol of lettuce drop caused by *S. minor*. In addition, factor(s) that diffused from *Sclerotinia* that attract and initiate

C. minitans response will also be identified to better understand biocontrol activity of *C. minitans.*

Project Approach

The main goal of this project was to develop an effective biocontrol strategy for the control of lettuce drop disease caused by *Sclerotinia minor*. The specific objectives were:

1. Optimize the application rate of the biocontol product Contans™ (*Coniothyrium minitans*) to effectively control lettuce drop disease caused by *S. minor* in lettuce production field.
2. Characterize the diffusible stimulating factor (s) from sclerotia of *Sclerotinia* spp. that may elicit *Coniothyrium minitans* response.

Objective 1. A field trial was set up and initiated as described in the project proposal during the 1st quarter of the project (Nov 07). During January, a third application of biocontrol products and chemical fungicide was applied to specific treatment as per described protocol. As with the first and second applications of the biocontrol product, irrigation was performed immediately afterwards to insure maximum survival of biological products in the field. Irrigation and fertilization was continued as needed and consistent with standard cultural practices for lettuce in the Yuma area until the completion of the trial (harvest) that was conducted on 4/7/08. At harvest, all healthy heads were recorded for all treatment plots. Analysis of variance of plot data was conducted to determine significant effects of select treatments on disease incidence.
A second trial was conducted during the winter of 2008-09 as a repeat of the 2007-08 trial to confirm findings and subject data to more robust statistical analysis. These combined data are presented in **Figure 1**.

Objective 2. Exudates were obtained from live *Sclerotinia* sclerotia by soaking sclerotia in sterilized water (1g/10 ml of water) for 1 hr and filtering through 0.2um filter. Collected exudates were separated into polar and non-polar portions by ethyl acetate fractionation. The aqueous phase containing polar compounds was collected in sterilized tubes and subjected to a preliminary assessment of stimulation activity using a spore germination stimulation assay. A suspension of *Coniothyrium minitans* spores (the biocontrol agent) were mixed with equal volume of fractionated polar compounds in cavity glass slides and incubated at 20°C for 48 hrs. The percent spore germination was calculated by counting the number of germinated spores in 100 spores on three different slide preparations using a compound microscope (**Table 1**). Thus, the percent of spore germination was the average of 300 spores. Spores mixed with water served as a control.

In addition, the soils were collected from the lettuce production fields and tested, if there is any stimulatory compounds present naturally in soil for *C. minitans* spore germination. Twenty grams of soil was added in 15 ml of sterilized water and mixed well. The extracts were collected in sterilized tubes and stored at 5°C. The spore germination experiment was carried out as mentioned above.

Objective 3:
In addition to the fractionation experiment, another experiment was initiated simultaneously to address the role of lectin in induction of pathogenicity genes in *Coniothyrium minitans* during

the parasitism on sclerotia of *Sclerotinia* spp. It has been shown that *C. minitans* successfully parasitizes the sclerotia of ascomycota fungi (*Sclerotinia* spp., and *Botrytis*) but not the sclerotia of basidiomycota fungi (*Rhizoctonia* sp) under laboratory condition. The reason for the ineffectiveness of *C. minitans* against sclerotia of basidiomycota is not known. However, recently it has been shown that fungi belonging to fungal family Sclerotineacea (e.g., *Sclerotinia* spp. and *Botrytis* sp) possess a novel type of lectin with no known homology with any other fungal lectin. Lectins are proteins with sugar binding affinity and play an important role parasitism in other mycoparasitic interactions such as *Trichoderma (a well known biocontrol agent)* pathogenicity on *Rhizoctonia solani* (pathogen) through recognition of and adhesion to their carbohydrate receptors. Thus, it can be hypothesized that difference in lectins present in these two phyla of fungi is the reason for effectiveness of *C. mintians* on Ascomycota fungi (*Sclerotinia*) but not on Basidiomycota fungi.

The Graduate Research Associate (PhD student), Ravi Periasamy was recruited 1st quarter to perform most activities related to this project. Two undergraduate students assisted Mr. Periasamy in the execution of the field trials during the 2nd quarter of the project. All personnel were active in the project the entire funding period.

Goals and Outcomes Achieved

Objective 1. Results revealed significant increases of disease in control plots as disease inoculum levels increased from 3.69 g to 14.5 g (19% disease vs 52% disease, respectively). At low inoculum rates, there were no significant differences between 6, 8, or 10 lbs Contans/acre, and all controlled disease nearly 100%. At medium inoculum levels, there were no significant differences in disease incidence between 6, 8, and 10 lbs/acre of Contans, with 6 lbs rate performing best. At high inoculum levels, there was no significant difference between 6 and 8 lbs rates, but the 10 lbs rate performing significantly better. There were no significant differences between disease incidence in the biocontrol plots and the plots in which the fungicide Endura was used. 4 lbs/acre of Contans resulted in significantly less control than that at higher rates and results were no different than the untreated controls. Thus, results reveal that 6 lbs/acres Contans was just as effective as 10 lbs/acre at medium inoculum levels, and significantly more effective than 4 lbs/acre. These findings are very promising and suggest that much lower rates of the biocontrol product can be used than previously thought for disease control as effective as standard chemical fungicides.

Fig. 1.

Yuma

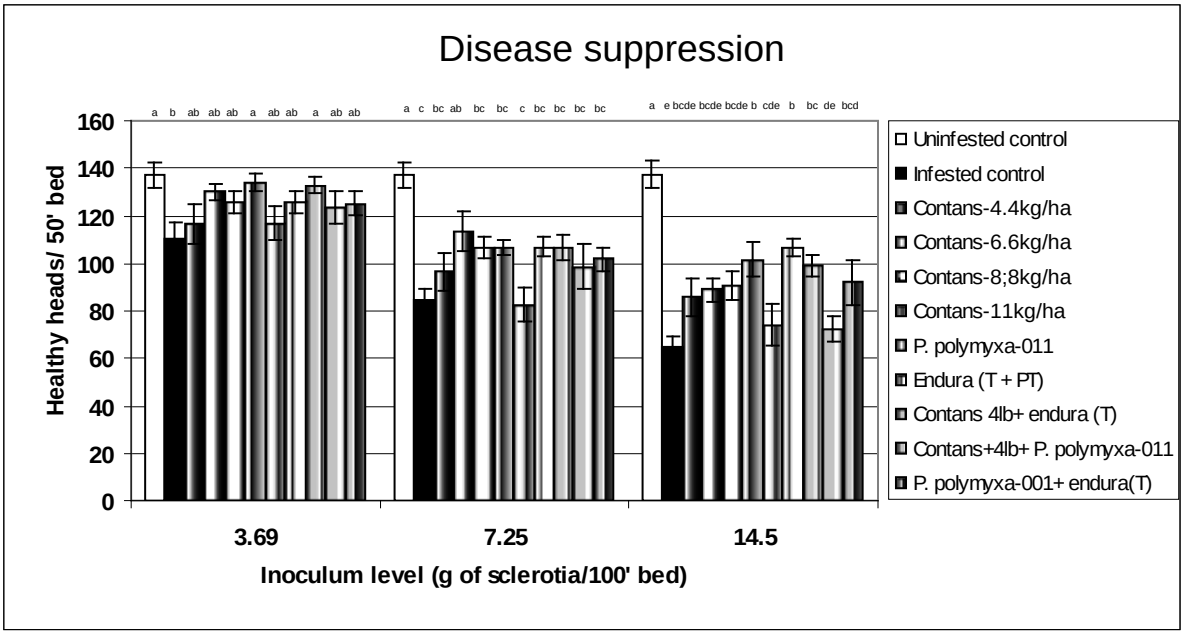


Fig. 3

Objective 2.

In comparing data from inhibition assay using native sclerotial exudates (unfractionated) and the polar fractions, results revealed that the polar compounds from the sclerotial exudates possessed nearly the same stimulatory potential as did the native exudates. There were no statistically significant differences between exudates from *S. minor* or *S. sclerotiorum* in their capacity to stimulate C. minitans spore germination. Thus, the reason for the effectiveness of biocontrol fungus against *S. sclerotiorum* and ineffectiveness against *S. minor* is likely not due to the differences in quality of sclerotial exudates of this two *Sclerotinia* spp., but may be due to the differences in exudates quantity. Interestingly, soil fractions did not induce spore germination which indicates that germination of *C. minitans* spores mainly depends on the nutrients available from hosts of the fungus, for example, exudes from sclerotia of *Sclerotinia* spp.

To determine the stimulatory properties of non-polar compounds from sclerotia, the same experiment was initiated with little modification. As the non-polar compounds cannot dissolve in water, both polar and non-polar compounds from sclerotia of *Sclerotinia* were collected by soaking sclerotia in sterilized water mixed with ethyl acetate (1g/10 ml of water mixed with ethyl acetate) for 1 hr and filtering through 0.2um filter. These exudates were separated further into polar and non-polar portions by ethyl acetate fractionation. The non-polar fractions were collected in ethyl acetate, were dried and collected in DMSO. Testing of stimulatory activity of these non-polar compounds is currently running and will be completed over the next few weeks.

Table 1.

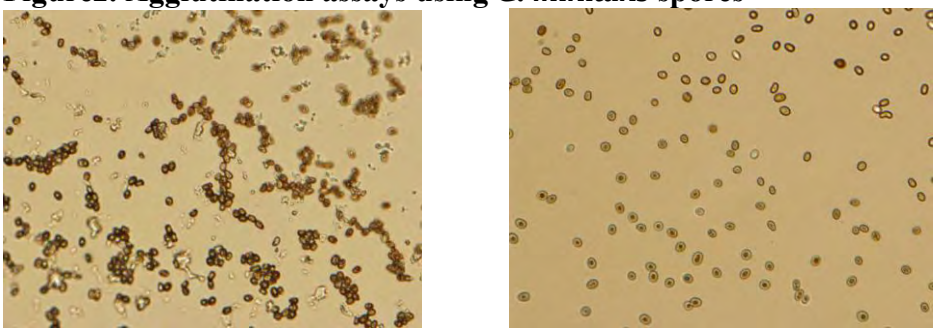
Percent of spore germination*					
Crude exudates		**Polar fraction**		**Soil extract**	**Control (Water)**
S. sclerotiorum	*S. minor*	*S. sclerotiorum*	*S. minor*		
91	95	80	86	0	0

* Values are the average of three replications

Objective 3.

Spore agglutination studies and inhibition assays were successfully carried out to determine the lectin-binding properties of *C. minitans* and the possible role of lectin during the pathogen-biocontrol interaction (Fig. 2). In agglutination studies, *C. minitans* spores were mixed with known quantities of a variety of lectins to determine if sugar-lectin binding would occur resulting in agglutination of spores into masses. Initially, commercially available plant lectins were utilized for this assay. Results from this assay revealed that *C. minitans* spores surface possess sugars specific to a number of lectins used in this study and induced agglutination. However, the incubation times required for agglutination varies with different lectins. Concanavalin A induced agglutination in an hour of incubation which is faster than the other lectins. Both soybean agglutinin and wheat germ agglutinin required 6 hrs of incubation to induce agglutination. However, the agglutination was observed only after 24 hrs of incubation with horse gram lectin.

Figure2. Agglutination assays using *C. minitans* spores



With lectin **without lectin**

There was no agglutination observed in control where spores are incubated with PBS (Table 2). Further agglutination studies using crude extracts from *Sclerotinia* sclerotia also resulted in agglutination, revealing that *Coniothyrium* can bind to lectins in fungal sclerotia. Further studies are underway to obtain highly purified lectins from sclerotia to definitively prove that it is unique sclerotia lectins that are responsible for the observed agglutination of *C. minitans* spores. Interestingly, lectin isolated from jack bean (ConA) inhibited *C. minitans* spore germination significantly suggesting that there may be additional outcomes resulting from spore-lectin interactions. Together, these results revealed that there are clearly interactions between lectins and surface sugar moities of the biocontrol fungi Coniothyrium, and these interactions during the parasitism may be positive (binding of biocontrol agent and host) or even negative (inhibition of germination of biocontrol agent).

Spore germination assay showed that sclerotial exudates of both *S. sclerotiorum* and *S. minor* induced spore germination in 48 hrs of incubation and the percent spore germination was 87 and 96 % for *S. sclerotiorum* and *S. minor*, respectively. However, the percent spore germination with both sclerotial exudates of Sclerotinia spp., significantly decreased in the presence of Concanavalin A and it was 2.1 and 3.1 % with sclerotial exudates of *S. sclerotiorum* and *S. minor,* respectively. The percent spore germination with either of the *Sclerotinia* exudates decreased with the presence of either, SSA, WGA, or horse gram lectin. Spores mixed with either lectin or PBS alone did not germinate (Table 3 and 4).

Table 2. Agglutination efficiency of *Coniothyrium minitans* spores with different lectins

Lectins	Time required for agglutination (hrs)
Concanavalin A	**1**
Soybean agglutinin	**6**
Wheat germ agglutinin	**6**
Horse gram lectin	**24**
PBS (control)	**No agglutination**

Table 3. Percent spore germination of *C. minitans* in sclerotial exudates of *Sclerotinia sclerotiorum* in the presence and absence of lectins

Treatments	Percent spore germinationA*
Spores + sclerotial exudates + ConA	**21c**
Spores + sclerotial exudates + SSA	**72.1ab**
Spores + sclerotial exudates + Horse gram	**87a**
Spores + sclerotial exudates + Coral tree	**69b**
Positive control	
Spores + SS exudates	**87a**
Spores + lectins	**0**
Spores + PBS	**0**

*** Average of three replications and two repetitions, ConA-Concanavalin A, SSA-soybean agglutinin, WGA-wheat germ agglutinin**
Columns with different letters are significantly different according to Tukey test (P<0.05) based on the F test in analysis of variance

Table 4. Percent spore germination of *C. minitans* in sclerotial exudates of *Sclerotinia minor* in the presence and absence of lectins

Treatments	Percent spore germination*
Spores + sclerotial exudates + ConA	**3.1b**
Spores + sclerotial exudates + SSA	**93.2a**
Spores + sclerotial exudates + Horse gram	**94a**
Spores + sclerotial exudates + Coral tree	**97a**
control	
Spores + SM exudates	**96a**
Spores + lectins	**0**
Spores + PBS	**0**

Expected Measurable Outcomes:
Measurable goals for outreach include 1) outreach to 500 researchers, industry professionals, and growers through results posted on extension website, 2) outreach to 500 researchers, industry professionals, and growers through distribution of extension fact sheets, and 3) outreach to 100 researchers, industry professionals, and growers at the annual Southwest Ag Summit. Regarding goal 1), the website "Lettuce Disease Management In Arizona" has been created (http://cals.arizona.edu/plp/sclerotinia/index.htm), password protection (user = sclerotinia, password = online). Public posting of the website was slated for November 2009, but has been delayed because of industry input requesting a more user friendly interface for website navigation. We are currently in the process of redesigning the navigation buttons and this should be complete by early 2011. Our measurable outreach of reaching 500 researchers, industry professional, and growers will easily be exceeded once the site is posted. Regarding goal 2), a comprehensive data fact sheet has been developed specifically focused on disease management of lettuce drop and is ready for distribution. A limited number of these have been printed and are available for distribution. However, following discussion with industry representatives it has been decided that the most optimal means for dissemination of this fact sheet is through a downloadable version on the Lettuce Disease Management In Arizona website. A button directing the downloading of this fact sheet has been added to the website slated for release in January. Again, following posting of the website, the measured goal of reaching 500 clients with our fact sheet will easily be exceeded with a downloadable vs. printed fact sheet. Regarding goal 3), despite requests to be included in the Southwest Ag Summit, the agendas are dictated and filled according to the priorities established by the planning committee. As such, other critical issues in cultivar breeding, cultural practices, and food safety issues have recently risen to a higher immediate priority for the lettuce industry and are included in the limited agenda of the Summit. However, Summit organizers repeatedly assured me that the concern over lettuce drop has not abated and they plan to include a session on the management of this disease in either of the next two planned summits. They have assured me I will be contacted once this inclusion has been finalized.

Beneficiaries

This research will directly translate into improved disease management strategies, which, if enacted, could potentially result in increased productivity for lettuce producers in Arizona and an overall increased competitiveness of the winter lettuce industry in southern Arizona. More broadly, this research will advance agriculture in desert areas, and elucidate at least one mechanism by which many biocontrol strategies fail upon moving laboratory findings to field applications.

Lessons Learned

A no-cost extension was requested by the grantee and approved by ADA on November 13, 2008. The new expiration date for this project was June 30, 2009. Below is an excerpt from the grantee"s request for the no-cost extension.

Aspects of the exudates fractionation are challenging and require additional time for completion.

Timetable:
The proposed project will begin in November 2007 and will continue for one year plus 8 months. The field trials will begin with lettuce planting in mid-November and continue until early March 2008 or until crop maturity. Following disease assessment and harvest for head weight, data analysis will be conducted and continue for 1-2 months. The experiments to characterize exudates from sclerotia will begin in August 2008 and will be completed in about 7 months. During this period, the exudates from both *Sclerotinia* spp will be collected and fractionated by HPLC. Then these fractions will be tested individually and in combination for the stimulatory effect on mycelial growth under laboratory conditions. The compound(s) that specifically present in both *Sclerotinia* spp and stimulate the *C. minitans* will be identified at the end of these experiments and will be further characterized by chemical analyses. Data analysis and comparative studies will be conducted over a two month period and be completed by April 2009. Manuscript preparation for both studies will be conducted during May and June 2009.

The execution of this project provided additional training for undergraduate and graduate students in field trial design and setup in desert production areas. Moreover, these trials provided exceptional opportunities for in depth training in the use of a number of statistical analysis programs currently available for field trial applications.

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Additional Information

The research conducted over the course of this project has resulted in a more comprehensive understanding of both the etiology and the epidemiology of lettuce drop in desert agroecosystems. This enhanced understanding will directly translate into improved disease management strategies, which, if enacted, could potentially result in increased productivity for lettuce producers and an overall increased competitiveness of the winter lettuce industry of southern Arizona and southwest desert agriculture. Dissemination of information resulting from this research will be published in the premier plant pathology journal, Plant Disease, under the manuscript title **"Efficacy of *Coniothyrium minitans* on lettuce drop caused by *Sclerotinia minor* in desert agroecosystem",** currently in review for publication. Online presentation of research findings are posted on the website "Lettuce Disease Management In Arizona" (http://cals.arizona.edu/plp/sclerotinia/index.htm). The website is posted but is currently password protected while the final edits of each webpage are being completed.

Environmental Factors' Effects on Nutritional Content and Post Harvest Quality of Leafy Greens

This project was completed on December 31, 2008

Project Summary

Seasonal high temperatures, intense sunlight, selenium rich soils, and saline irrigation waters characterize the aridic Southwest"s vegetable production region. Climate, soil and water effect

the production of natural plant products in crops. Preliminary field trials with specialty leafy vegetables suggest that greater accumulation of specific NPPs, total phenolics and vitamin C, are a direct result of the Southwest‟s agronomic factors such as salinity level in the water and sunlight incidence. Improvement in green color with high salinity in the water and increased accumulation of phenolics was previously observed, but with limited yields in some cases. Problems encountered in preliminary trials have been the control over environmental stressors, limiting the ability to isolate the effects of specific conditions. In this study, researchers will introduce controlled environment agriculture (CEA) systems into their research approach to impose specific levels of salinity and selenium on selected crops in the nutrient solution, permitting assessment of resultant changes in total phenolics and vitamin C, and permit researchers to quantify a secondary hypothesis of the research, that crops that have high levels of NPPs have a longer post harvest shelf-life. Data generated will provide baseline nutritional values for these specialty crops to compare to continuing field trials.

Project Approach

This study evaluated changes in harvest and postharvest leafy vegetable nutritional value in response to nutrient solutions of increasing salinity. Nutritional values were defined by the antioxidants vitamin C and polyphenolics, as determined by the 2,6-Dichloroindolphenol titrimetric and the Folin-Ciocalteu methods respectively. Four leafy vegetables (*Diplotaxis tenuifolia* (L.) DC cv. Sylvetta*, Eruca sativa* (P. Mill.) Thellung cv. Astro *Spinacia oleracea* cv. Bordeaux F1, and *Lepidium sativum* L. cv. Presto) were grown with five salinity levels from 1.5 to 9.5 dS m-1 electrical conductivity (EC), using a re-circulating ebb and flow irrigation system. Data for all species collectively evaluated from Trial II revealed a significant increase in harvest phenolics in the EC-9.5 treatment (mean 88.32 mg 100g-1 fresh weight) compared to the control (mean 74.68 mg 100g-1 FW). Eight-day postharvest total phenolics were significantly greater in the EC-3.5 treatment for Trial I and II (mean 103.57 and 116.11 mg 100g-1 FW respectively). At harvest vitamin C values in Trial I decreased significantly in the EC-5.5 treatment (mean 71.35 mg 100g-1 FW) compared to the control (mean 106.78 mg 100g-1 FW). Eight-days postharvest vitamin C values in Trial I were significantly highest in the EC-3.5 treatment (mean 86.97 mg 100g-1 FW) compared to the EC-9.5 treatment (mean 66.64 mg 100g-1 FW). The highest total phenolic and vitamin C content at harvest was exhibited by *E. sativa* and *D. tenuifolia* respectively. Our results offer no definitive support of increasing or decreasing antioxidants in response to increasing salinity or significant declines in yield; they do support the efficacy of saline irrigation water in a recycling system.

A review of the total phenolic changes for all species in response to salinity treatments reveals declines in Trial I and significant increases in Trial II. Phenolic changes in *Eruca*, *Spinacia* and *Lepidium* in response to salinity treatments mirror the trend for all species evaluated collectively. Similar results occurred with *Diplotaxis* with the exception of a decline in postharvest phenolics in Trial II. Less ambiguous is the response of vitamin C to salinity treatments, with significant harvest and postharvest declines as salinity increases in Trial I and II, for all species collectively and individually, with the exception of the Trial II *Eruca* harvest data. Only *Lepidium* data revealed significant positive correlations between salinity treatments and vitamin C. No correlations were found between total phenolics and vitamin C. Harvest data for both trials reveal nonsignificant declines in yields between the control (EC-1.5) and the highest salinity treatment (EC-9.5). However a significant difference between the treatments is apparent when

dry weight to fresh weight ratios are compared. Herein lies an interesting statistically significant trend where the highest salinity treatments are characterized by a larger dry to fresh weight ratio (DFR). When viewed with the statistically significant decline in photosynthetic rates from low salinity treatment (LST) to high salinity treatment (HST) one cannot help but consider the implications of lower photosynthetic rates (i.e., lower carbon capture) with a higher DFR. A putative answer is suggested when one views the decline in the fresh to dry weight ratio (FDW), where the lowest salinity treatments are characterized by the higher ratio values.

In summary, the results suggest that while the influence of salinity on antioxidants in Crucifers may be unique to a specific species or cultivar, they do support the premise that moderate salinity levels do not compromise the quantities of the polyphenols, vitamin C, and yields. While the focus of the research was not concerned with the utility of a re-circulating ebb and flow irrigation system as a viable production system for leafy greens, research does demonstrate the efficacy of recycling a nutrient solution with a loss in quality. A system that limits water use, in arid lands agricultural regions where irrigation water is an increasingly limited resource, compromised by salinity, suggests value.

Goals and Outcomes Achieved

The findings from this work were presented at an International Society of Horticultural Science conference held in Tucson, AZ in October 2008. Three manuscripts were submitted to the scientific community which are currently in revision. Parts of these results were also presented at different seminars given by Dr. Jorge Fonseca at The University of Arizona – Department of Plant Sciences (January, 2009). Dr. Fonseca was invited to present at Clemson University – Department of Horticulture (February 2009), in Costa Rica (July, 2009) and in Brazil (September, 2009). More presentations are anticipated at local and at regional settings during the coming year as results are published in the journal articles. A number of figures and tables have been prepared that can be uploaded in a public website in the near future.
The project initially projected reaching a number of stakeholders through different means of dissemination. However, the funding for this project was only partial and essentially covered the research portion to fund a Ph.D. student. With more funding, which has been requested through other funding sources, the project will fund a technician who will be updating a website (Vegetable Quality website) which has taken an average of 7,000 visits in the recent years. At this point stakeholders have been approached, and especially industry members and extensionists, essentially through the presentations that were described above.

A clear outcome of this research became evident through the impact that this research had at the Controlled Environment Agriculture Center. The irrigation system implemented (with recirculation of nutrient solution/saline water) during this project has brought attention to other research with other crops that are currently being planned at the University of Arizona. It is anticipated that more data will be generated using this technique which will be available for the industry to compete more efficiently.

Although most of the research conducted in this project involved a hydroponic system, the long-term impact is in conventional farming. This is because the effects of environmental factors are somewhat similar and this allows more understanding on how certain changes can affect specialty crop fields.

The data that has been targeted is presented further below in this report. The project achieved the modified goals which were set according to budget. Enough data has been compiled to demonstrate the viability of producing leafy greens for nutrient content under high saline solution (in recirculation). We believe it is important to further address the impact of selenium additions in the production of specialty crops.

The following were the goals established assuming that the full budget that was requested. The goals were adjusted according to the budget. An explanation of the modified scope of the goals is provided below.

Goal 1: Assess changes in the levels of total phenolics and vitamin C in selected specialty leafy vegetables in response to irrigation solutions of known salinity, measured by electrical conductivity (EC), with and without added selenium. This was accomplished with the exception of the assessment of the effect of selenium.

Goal 2: Determine a nutrient solution EC level that results in the maximum increase in two antioxidants with known nutritional value, without a measurable yield decline. This was accomplished.

Goal 3: Evaluate the effects of selenium treatments on total phenolics and vitamin C. This was not included in the project due to budget reduction.

Goal 4: Determine the relationship between total phenolics and vitamin C content to post-harvest shelf life. This was partially accomplished, because the data is not conclusive to determine whether those nutrients are correlated to shelf life.

In summary, this project observed the influence of salinity on antioxidants in Crucifers is unique to a specific species or cultivar (which was somewhat unexpected). Moreover the results support the premise that moderate salinity levels do not compromise the quantities of the polyphenols and vitamin C. The research also demonstrates the potential value of recycling a nutrient solution or use of saline irrigation water in an environment where water in limited or compromised.

Beneficiaries

This project benefits the leafy green growers in the Yuma area. Additionally, the results will be useful for the community of small growers in the southwest that are growing vegetables hydroponically.

1. If high saline water is what is available, this research showed that it is possible to use it, which may reduce substantial expenditure that could have targeted a decrease to the amount of salt in water.
2. The system utilized here also allowed savings (10-20%) in nutrient solution for subsequent crops.
3. Although difficult to estimate, this work also contributes knowledge to add value to products that may be sold by nutritional quality.

Lessons Learned

This project has been part of the dissertation work of the Ph.D. student, Jeff Muir Hamilton. As such it has been fundamental in the formation of a future agriculture leader. The short-term outcome was to demonstrate that salt stress, similar to what is found in some production areas in Arizona, does not compromise the nutritional quality and shelf life of Arizona leafy greens. This

information was missing in the industry. Moreover, this research has shown that nutritional quality can be associated to visual quality if regulated stress is produced in the field. This is information of special importance for leafy green processors. This adds to other research that has been conducted which has attracted the attention of food processors. It is anticipated that the project will edit a book on pre-harvest concepts for food technologist to feed information to those that source raw produce for value-added products.

In the course of implementing this work it was discovered that recycling a nutrient solution or use of saline irrigation water in an environment where water is limited or compromised can increase the nutritional quality of the crop.

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Nitrogen Application Rates and Tissue Level Data for Medjool Dates

This project was completed on September 30, 2010

Project Summary

Dates have been planted in the United States since the 1700"s, but there has been an industry in the Yuma area for only the last fifty years. This new industry is distinct in that it has been established with the Medjool cultivar rather than the Deglet Noor cultivar and is irrigated using low-volume irrigation rather than the traditional border flood method. Many of the trees are planted in sandy upland soil rather than in silty loam soil.

Project Approach

To generate data that will allow the Arizona date producer to be more efficient with their nitrogen applications while maintaining or improving yield, fruit size and fruit quality. The funding account for this project began on 12/5/07. We selected four experimental sites, with 100 trees, as follows:

1. Mesa Site #1 - Imperial Date Gardens Block (Near County 19th Street and Avenue B) 25 four-year-old trees on drip irrigation.
2. Mesa Site #2 - Imperial Date Gardens Block (Near County 19th Street and Avenue B) 25 eight-year-old trees on drip irrigation.
3. Valley Site #3 - Silverman 14 Block (Near County 12½ St. and Somerton Avenue) 25 eight-year-old trees on flood irrigation.
4. Valley Site #4 - Vandevoort Block (near County 10th Street and Somerton Avenue) 25 four-year-old trees on flood irrigation.

For each site, there are five single-tree treatments and five replications.

Goals and Outcomes Achieved

Expected Measurable Outcome:

Reach and educate 25 date producers on the optimal N application rates to that allow date producers to be more efficient with their N applications while maintaining or improving yield, fruit size and fruit quality.

Following the end of the quarter, leaves will be processed and analyzed for nutrient content. An additional growth measurement will be taken and final leaf and growth data will be analyzed. Results will be reported to local date growers.

Goals:

To determine the nitrogen requirements for Medjool date palms that will optimize tree yield and fruit quality. To correlate leaf tissue nitrogen levels to the nitrogen requirements and thus establish date palm tissue nutrient level thresholds.

During the first quarter, we had leaves analyzed that were collected during the final quarter of FY 2009 for determination of nutrient content. These leaves were sent to a laboratory (Ward Labs, Kearney, NE) for nutrient analysis. These results are summarized below:

	Leaf N concentration (%)	
N rate (Kg/tree)	Site 1	Site 3
0.20	1.634	1.930
0.53	1.582	1.998
0.93	1.566	1.924
1.47	1.520	1.944
2.27	1.543	1.936
	Site 2	Site 4
0.40	1.758	1.578
1.20	1.836	1.520
2.00	1.694	1.564
2.80	1.752	1.626
3.60	1.700	1.646

There was no clear relationship at that point between the leaf N concentrations and the amount of N applied. It is unclear if this is due to a lag time between the N applications and the appearance of N in the leaves, or due to improper sampling technique.

There was no yield collected in the first quarter, because in a few cases, fruiting arms were removed by the cooperator to enhance plant growth (a normal practice), and most of the young trees are not yet bearing.

Treatments for 2010 commenced in the second quarter, on 3/16/10, and terminated on 8/12/10. For the five-year-old trees, the 2010 treatments were 0.30, 0.86, 1.46, 2.14 and 2.94 kg per tree. This is an increase from the 0.2, 0.53, 0.93, 1.47 and 2.27 kg N per tree applied

in 2009. For the eight-year-old trees, the 2010 treatments are 0.4, 1.2, 2.0, 2.8 and 3.6 kg of N per tree applied annually, the same as last year. Treatments are split into seven applications, with applications every two weeks. Experimental design is randomized complete block.

Interim tree growth data was collected on 7/21, to see emerging trends, however final tree growth data was collected following cessation of treatments (10/28 and 29). Collection of leaves for analysis was from 9/9' through 9/15. Completion of these tasks completed our data collection goals for the project.

As a result, preparation of leaves for analysis, leaf analysis (Ward Labs, Kearney, NE), and analysis of leaf and growth data was delayed until past the end of the 4th quarter, and results will be reported in 2011.

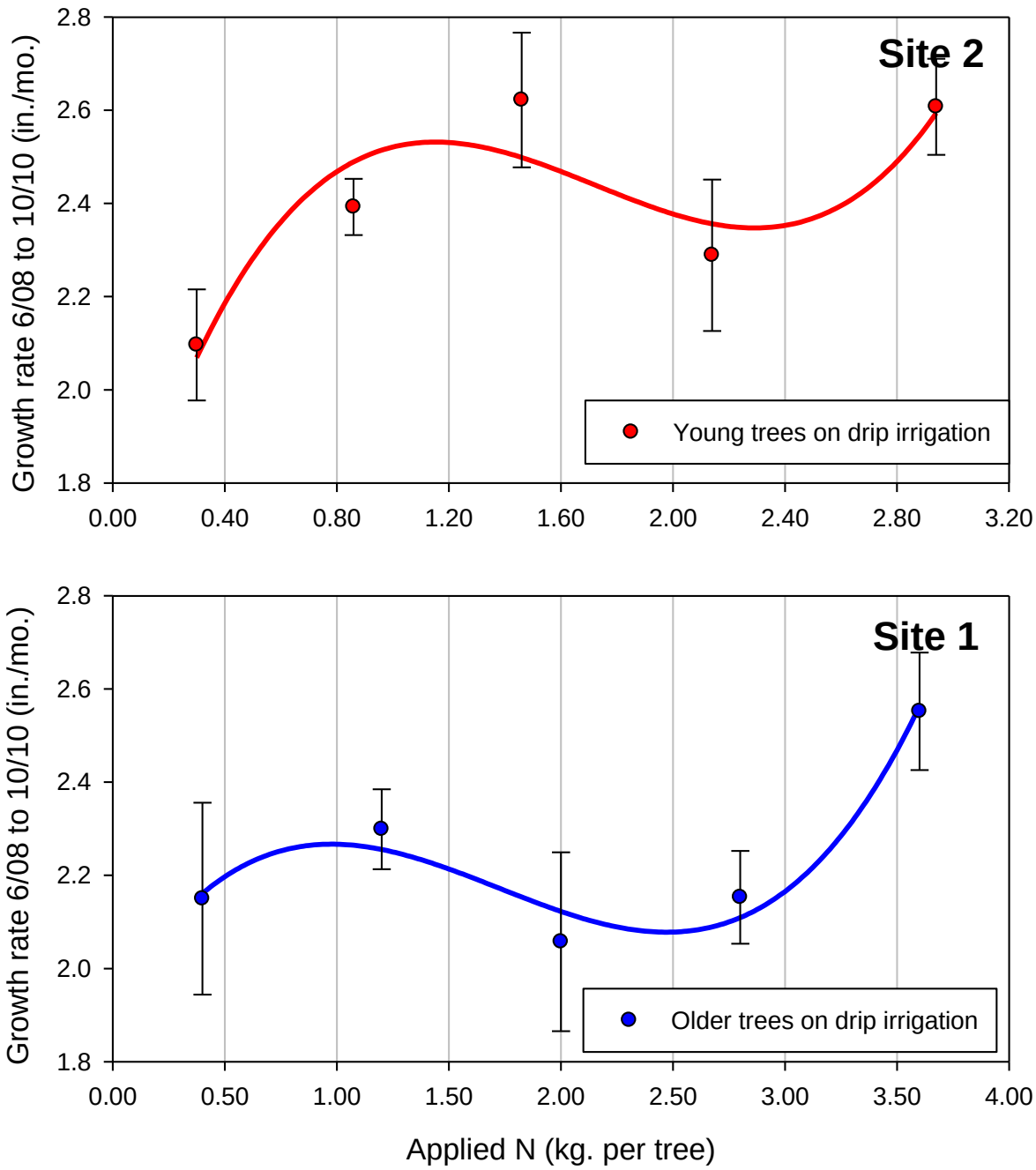
Our grower cooperators have continued with their irrigation and horticultural practices, thus keeping the date palms in good condition.

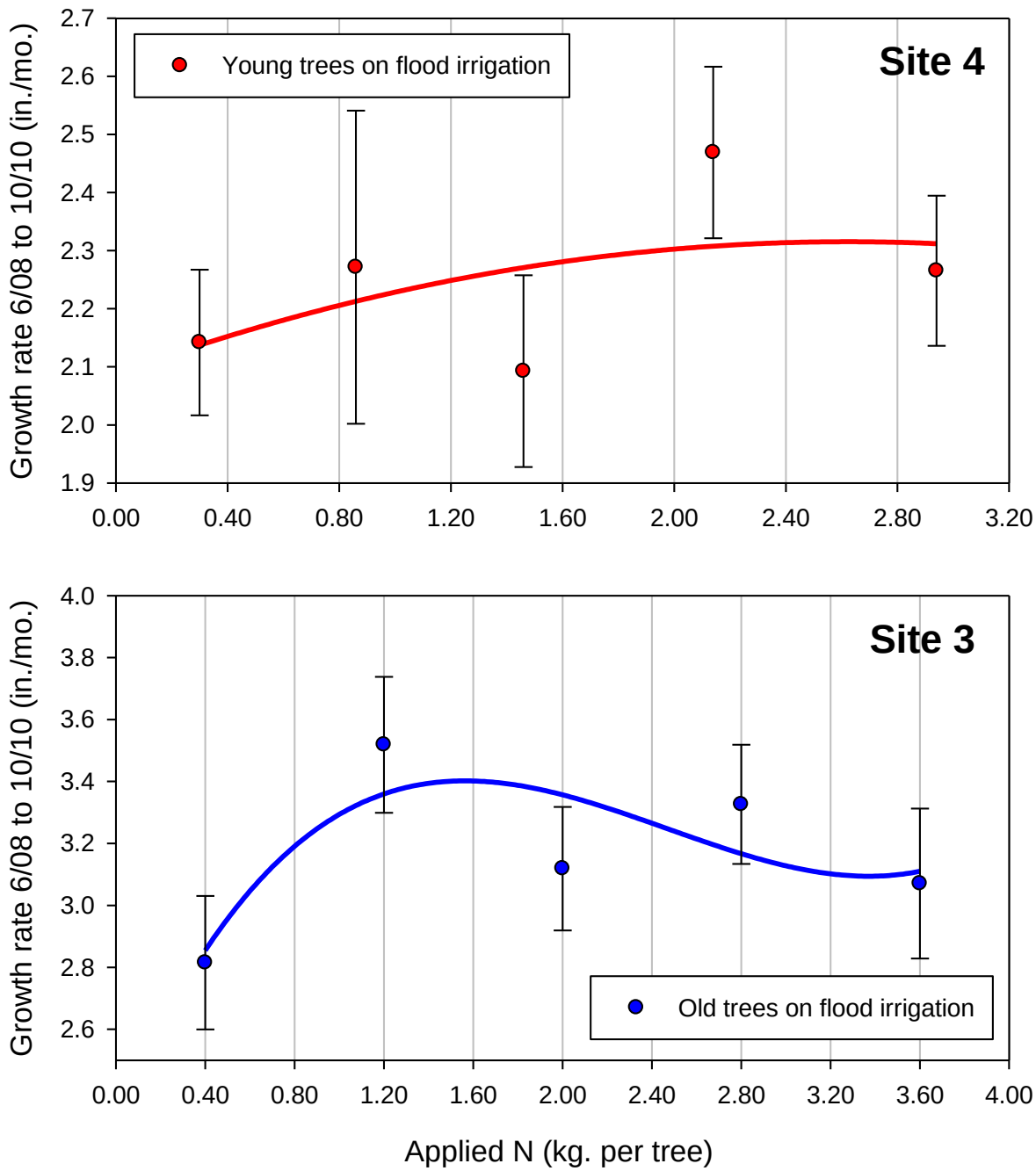
As a result, preparation of leaves for analysis, leaf analysis (Ward Labs, Kearney, NE), and analysis of leaf and growth data was delayed until past the end of the 4th quarter. Results are as follows:

	Leaf N concentration (%)	
N rate (Kg/tree)	Site 1 (older trees on drip)	Site 3 (older trees on flood)
0.40	**1.618±.021**	**1.704±.071**
1.20	**1.626±.046**	**1.686±.049**
2.00	**1.680±.034**	**1.686±.055**
2.80	**1.654±.042**	**1.730±.056**
3.20	**1.656±.054**	**1.724±.045**
	Site 2 (younger trees on drip)	Site 4 (younger trees on flood)
0.30	**1.708±.042**	**1.436±.046**
0.86	**1.650±.049**	**1.596±.011**
1.46	**1.736±.043**	**1.582±.051**
2.14	**1.700±.070**	**1.642±.046**
2.94	**1.668±.008**	**1.708±.032**

Applications of N have led to increased N concentrations in palm leaves. For trees on drip irrigation, applications of 2.00 kg. N led to the greatest N concentrations, while for trees on flood, any application rates greater than 0.4 kg/tree led to greatest N concentrations.

Results of our growth measurements are as follows:





Growth data suggests that for young trees on both flood and drip irrigation, 1 to 2 kg N per tree appears to lead to the greatest tree growth rate. For older trees on flood irrigation, 1 to 2 kg. N per tree appears to lead to the greatest growth rate, however for older trees on sandy soils using drip irrigation, as much as 3.5 kg. N per tree appears to lead to the greatest growth rate. This may be because N is applied much less efficiently on sandy soils than on the heavier soils that are commonly flooded.

Beneficiaries

Arizona date producers will be able to have more confidence that their N applications are meeting the needs of the plant, and leading to optimum yields and plant growth.

Lessons Learned

Reporting of leaf analysis results was delayed past the September 30th end of the quarter because once a fertilizer application has been applied, it is important to wait until the nutrients have been distributed throughout the plant, and can affect growth. This is the reason for the one month period between final fertilizer application (8/12) and leaf collection (9/9 through 9/15). Final growth measurement was delayed for this reason as well. We received the leaf analysis data from Ward Labs on 12/23/10. Due to the holidays, the data will not be analyzed until after the New Year.

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Appendix A
referenced from page 2

ARIZONA Specialty

CROP GUIDE

FARMERS' MARKETS · U-PICK FARMS
REGIONAL HARVEST SCHEDULES
AGRICULTURAL CAREERS & EDUCATION

ARIZONA DEPARTMENT OF AGRICULTURE

INTRODUCTION

Fruits, vegetables, tree nuts, dried fruits, and nursery crops make up the segment of agriculture defined by the United States Department of Agriculture (USDA) as "Specialty Crops". This Arizona Specialty Crop Guide was created and published using funds provided by USDA, Agricultural Marketing Service through the Specialty Crop Block Grant Program (SCBGP). The purpose of the SCBGP is to enhance the competitiveness and to promote the consumption of specialty crops.

This guide was designed to inform the public of the importance and availability of agriculture and to encourage Arizonans to purchase locally produced fruits, vegetables, nuts, and nursery crops. On the following pages you will find information on Farmers' Markets, U-Pick Farms, agriculture activities, and career and educational opportunities in agriculture. Read on to learn more about specialty crops which help to make up part of Arizona's $9.2 billion agriculture industry.

For more information about agriculture in Arizona, please visit us online at www.azda.gov

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LOCALLY GROWN PRODUCE

Food that is locally grown spends less time in the back of a truck; causing less damage to the food. When food is stored for long periods of time, the cells in the fruit begin to break down, causing wilting or bruising and the loss of nutrients.
The sugars in the food also turn to starch, which makes the food tougher, and not as flavorful (Sue Baic, British Dietetic Association, 2007).

PRESERVES OPEN LAND AND PREVENTS URBAN SPRAWL

Farms occupy large quantities of land, which keeps the soil fertile and water clean (not polluted with oil or trash). Some farmers plant "cover crops" which actually prevent erosion, restore nutrients in the soil, and trap emissions that contribute to global warming (Community Alliance with Family Farmers, 2001). When farms stay profitable, they don't have to sell their land to developers, thus preventing urban sprawl. This keeps Arizona beautiful and productive!

PROVIDES LOCAL ECONOMIC STABILITY

Less than 1% of the total American population earn their living by farming, and that number is dramatically decreasing. When farmers sell directly to consumers, they cut out the middleman and receive full retail value for their produce. This allows farmers to continue farming and providing a service to the community.

REDUCES AIR POLLUTION

Most crops trap harmful emissions from cars and manufacturing plants. Also, when you purchase locally grown foods, they do not have to be shipped as far to reach your local farmers market or food store. On average, food is shipped approximately 1,500 miles before reaching a supermarket (www.Sustainabletable.org). This requires approximately 300 gallons of fuel, (Peterbilt Motor Company, estimate, 2007) and thus emits harmful particles into the air. Buying local eliminates the need for companies to ship produce long distances.

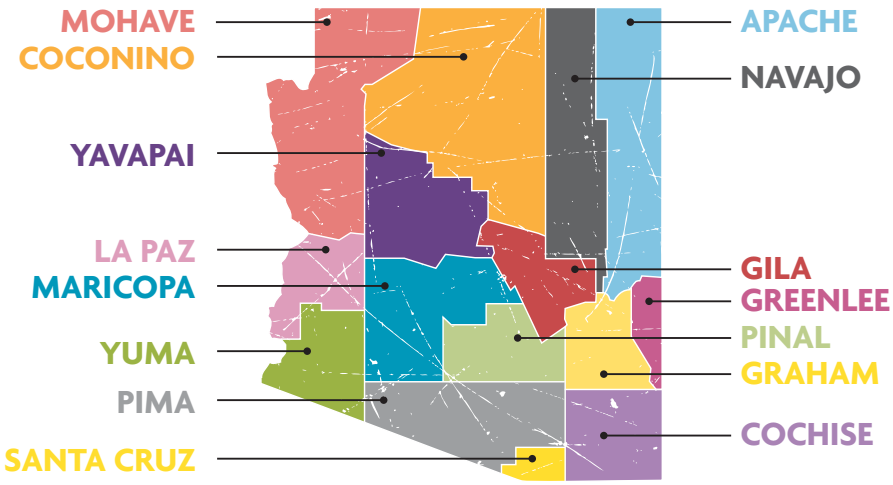
Buying local Arizona grown produce also helps prevent air pollution because foods are not artificially ripened. When foods have to be shipped from far away farms, they are picked before they are ripe to ensure the food will not spoil while it is being transported. Once it arrives to the destination, the food is gassed to make it aesthetically pleasing. Some are even preserved with artificial waxes (Community Alliance with Family Farmers, 2001).

FARMERS' MARKETS
By County

FRESH PRODUCE

JUST AROUND THE CORNER

ARIZONA FARMERS' MARKETS
BY COUNTY



MOHAVE COUNTY

KINGMAN MARKET
101 E. Beale St.
Kingman, AZ 86401
Phone: 928-753-3660
Hours: Memorial Day-Oct: Sundays 8am-11am
www.azfarmersmarkets.us

COCONINO COUNTY

FLAGSTAFF COMMUNITY MARKET
1414 North Rim Dr.
Flagstaff, AZ 86001
Phone: 928-774-7781
Hours: June-Oct. Sundays 8am-12pm
www.flagstaffmarket.com

TUBA CITY FARMERS' MARKET
100 Aspen Dr.
Tuba City, AZ 86045
Phone: 928-282-6886
Hours: Aug-Sept. Wednesdays 5:30pm-7:30pm
www.foodconnect.org

YAVAPAI COUNTY

CHINO VALLEY FARMERS' MARKET
901 S. US Hwy. 89
Chino Valley, AZ 86232
Phone: 928-713-1227
Hours: June-October Wednesdays 3pm-7pm
www.prescottfarmersmarket.org

COTTONWOOD FARMERS' MARKET AND JAMBOREE
187 E. Pima St.
Cottonwood, AZ 86326
Phone: 928-639-3200
Hours: July-September
Thursdays 5pm-dark
www.foodconnect.org

PRESCOTT FARMERS' MARKET
1100 E. Sheldon
Prescott, AZ 86301
Phone: 928-713-1227
Hours: May-October
Saturdays 7:30am-12pm
www.prescottfarmersmarket.org

PRESCOTT VALLEY FARMERS' MARKET
7221 E. Florentine Rd.
Prescott Valley, AZ 86314
Phone: 928-713-1227
Hours: July-October
Thursdays 4pm-8pm
www.prescottfarmersmarket.org

VERDE VALLEY FARMERS' MARKET
395 S. Main St.
Camp Verde, AZ 86322
Phone: 928-567-0535 x 136
Hours: Mid-June through Mid-October
Saturdays 8am-12pm
www.foodconnect.org

ARIZONA FARMERS' MARKETS
BY COUNTY

MARICOPA COUNTY

5TH AVENUE FARMERS' MARKET
4169 N. Craftsman Court
Old Town Scottsdale, AZ 85251
Phone: 623-848-1234
Hours: Mid-Nov - Mid-May
Saturdays 10am-2pm
www.arizonafarmersmarkets.com

AHWATUKEE FARMERS' MARKET
4700 E. Warner Rd.
Ahwatukee, AZ 85044
Phone: 623-848-1234
Hours: Oct-Apr, Sundays 9-1pm
May-Jun, Sundays 7am-11am
www.arizonafarmersmarkets.com

CAVE CREEK FARMERS' & CRAFTS MARKET
6900 E. Cave Creek Rd.
Cave Creek, AZ 85331
Phone: 480-585-8639
Hours: Year-round, Saturdays 9am-1pm
www.azfarmersmarkets.us

CAREFREE FARMERS' MARKET
100 Easy St.
Carefree, AZ 85377
Phone: 623-848-1234
Hours: Oct-Jun, Fridays 9am-1pm
www.arizonafarmersmarkets.com

CHANDLER FARMERS' MARKET
Dr. A.J. Chandler Park
3 S. Arizona Ave.
Chandler, AZ 85225
Phone: 480-782-3047
Hours: Year-round, Thursdays 3pm-6pm
www.azfarmersmarkets.us

COPPER CANYON GOLF CLUB
26577 W. Desert Vista Blvd.
Buckeye, AZ 85396
Hours: Nov-Apr, 1st Sat/month

DOWNTOWN PHOENIX PUBLIC MARKET
721 N. Central Ave.
Phoenix, AZ 85004
Phone: 602-253-6895
Hours: Year-round, Saturdays 8-1pm
Wednesdays 4pm-8pm
www.phoenixpublicmarket.com

ENCANTERRA
1035 E. Combs Rd.
Queen Creek, AZ 85240
Hours: Oct-May, 2nd Friday/month 10am-2pm

ESTRELLA LAKESIDE MARKET
10300. S. Estrella Parkway
Goodyear, AZ 85338
Phone: 480-585-8639
Hours: Oct-May, 3rd Saturday 10am-2pm
www.azfarmersmarkets.us

FOUNTAIN HILLS NOCTURNAL MARKET
16810 Avenue of the Fountains
Hours: Jan-Apr, 2pm-6am

EUROPEAN MARKET AT THE BORGATA
6166 N. Scottsdale Rd.
Scottsdale, AZ 85255
Phone: 480-585-8639
Hours: Jan-Apr, Fridays 3pm-8pm
www.azfarmersmarkets.us

FARMERS' MARKET AT THE OUTLETS OF ANTHEM
4250 W. Anthem Way
Phoenix, AZ 85086
Phone: 480-585-8639 or 623-465-9500
Hours: 1st Saturday each month, 10am-3pm
www.azfarmersmarkets.us
www.outletsanthem.com

KIVA CENTER COURTYARD
7121 E. 5th Ave.
Scottsdale, AZ, 85251
Hours: Oct-May, Thursdays 2:30pm-7pm
Sundays 10am-2pm

ARIZONA FARMERS' MARKETS
BY COUNTY

MARKET AT DC RANCH
20751 N. Pima Rd.
Scottsdale, AZ 85255
Phone: 480-502-2725
Hours: Oct-Apr, Saturdays 10am-2pm
www.beonmarketstreet.com

MESA COMMUNITY FARMERS' MARKET
263 N. Center St.
Mesa, AZ 85201
Phone: 623-848-1234
Hours: Year-round, Fridays 9am-12pm
www.arizonafarmersmarkets.com

MURPHY PARK
7010 N. 59th Ave.
Glendale, AZ 85301
Hours: Oct-May, Saturdays 9am-2pm

OLD TOWN SCOTTSDALE
1st St. and Brown Ave.
Scottsdale, AZ 85251
Hours: Nov-May, Saturdays 9am-2pm

PHOENIX CAMELBACK MARKET
3930 E. Camelback Rd.
Phoenix, AZ 85018
Phone: 602-224-0225
Hours: Sept-May, Saturdays 9am-1pm
www.vincentsoncamelback.com

ROADRUNNER PARK FARMERS' MARKET
3515 E Cactus Rd.
Phoenix, AZ 85032
Phone: 623-848-1234
Hours: May-Sep, Saturdays 7am-11am
Oct-Apr, Saturdays 8am-12pm
www.arizonafarmersmarkets.com

SURPRISE STADIUM
15850 N. Bullard Ave.
Surprise, AZ 85374
Hours: Oct 19-May, Sundays 10am-2pm

TOWN & COUNTRY FARMERS' MARKET
2021 E. Camelback Rd.
Phoenix, AZ 85016
Phone: 602-955-6850
Hours: Year-round, Wednesdays 10am-2pm
www.azfarmersmarkets.us

TRILOGY AT VISTANCIA
27980 N. Trilogy Blvd.
Peoria, AZ 85383
Hours: Sep-May, 4th Fri/month, 10am-2pm

WESTCOR'S SANTAN VILLAGE
Williams Field Rd./Loop 202
Gilbert, AZ 85295
Hours: Oct-May, 1st & 3rd Wed/month,
9:30am-2pm

WESTGATE CITY CENTER
6770 N. Sunrise Blvd.
Glendale, AZ 85305
Hours: Oct-May,
2nd Saturday/month 8am-12pm

YUMA COUNTY

MARKET IN CARVER PARK
385 S. 13th Ave.
Yuma, AZ 85364
Phone: 928-343-1243
Hours: May-Jun, Saturdays 7am-11pm
www.foodconnect.org

MARKET IN DOWNTOWN YUMA
Main St.
Yuma, AZ 85364
Phone: 928-343-1243
Hours: Dec-Mar, Tuesdays 10am-3pm
www.foodconnect.org
www.yumafoodbank.org/FarmersMarkets.htm

PIMA COUNTY

ARIVACA MARKET
16800 Arivaca Rd.
Arivaca, AZ 85601
Phone: 520-730-1324
Hours: June-Oct, Fridays 7am-9pm.
www.azfarmersmarkets.us
www.farmersmarketonline.com

CIVANO FARMERS' AND ARTISANS MARKET
5301 S. Houghton
Tucson, AZ 85747
Phone: 520-248-9218
Hours: Year-Round, Sundays 10am-2pm
www.azfarmersmarkets.us

COMMUNITY FOOD BANK FARMERS' MARKET
3003 S. Country Club Dr.
Tucson, AZ 85713
Phone: 520-622-0525
Hours: Year-round, Tuesdays 8am-12pm
www.communityfoodbank.org

DOWNTOWN FARMERS' MARKET
101 N. Stone Ave.
Tucson, AZ 85701
Phone: 520-326-7810
Hours: Year-round, Wednesdays 8am-1pm
www.azfarmersmarkets.us

EL PRESIDIO MERCADO
225 W. Alameda St.
Tucson, AZ 85701
Phone: 520-326-7810
Hours: Year-round, Fridays 10am-3pm
www.azfarmersmarkets.us

FARMERS' MARKET AT THE UNIVERSITY OF ARIZONA
1401 E. University Blvd.
Tucson, AZ 85721
Phone: 520-319-9868
Hours: Sept-Apr, Fridays 9am-1pm
www.ironwoodtreeexperience.org

MARANA FARM STAND AT HERITAGE RIVER PARK
S. of Tangerine Farms Rd. at Heritage Park Dr.
Marana, AZ 85658
Hours: Mar-Oct, Mondays 4pm-7pm
Nov-Apr, Mondays 3pm-6pm
www.communityfoodbank.org

ORO VALLEY FARMERS' MARKET
11000 N. La Canada
Tucson, AZ 85737
Phone: 520-918-9811
Hours: May-Oct, Saturdays 8am-12pm
Oct-May, Saturdays 9am-1pm
www.azfarmersmarkets.us

PLAZA PALOMINO FOOD FAIRE
2970 N. Swan
Tucson, AZ 85712
Hours: Year-round, Saturdays 10am-2pm
www.foodconnect.org

RINCON VALLEY FARMERS' MARKET
12500 E. Old Spanish Trail
Tucson, AZ 85747
Phone: 520-591-2276
Hours: May-Oct, Saturdays 8am-1pm
Oct-May, Saturdays 9am-2pm
www.rvfm.org

SANTA CRUZ RIVER FARMERS' MARKET
NE corner of Speedway & Riverview
between AZ School for the Deaf & Blind
and El Rio Neighborhood Center
Tucson, AZ 85745
Phone: 520-622-0525
Hours: Feb-Apr, Thursdays 3pm-6pm
May-Oct, Thursdays 4pm-7pm
www.communityfoodbank.org

TUCSON FARMERS' MARKET
4380 N. Campbell Ave.
Tucson, AZ 85718
Phone: 520-918-9811
Hours: May-Oct, Sundays 8am-12pm
Oct-April, Sundays 9am-1pm
www.azfarmersmarkets.us

ARIZONA FARMERS' MARKETS
BY COUNTY

SANTA CRUZ COUNTY

SONOITA GROWERS' MARKET
3428 Hwy. 83
Sonoita, AZ 85637
Phone: 520-455-9262
Hours: July-Sep, Saturdays 9am-12pm
www.foodconnect.org

TUBAC FARMERS' MARKET
40 Avenida Goya, Plaza de Anza
Tubac, AZ 85646
Phone: 520-319-9868
Hours: Oct-Apr, Thursdays 10am-2pm
May-Sept: one Thursday/month
www.ironwoodtreeexperience.org

APACHE COUNTY

CONCHO FARMERS' MARKET
Corner of Hwy 61 & 180A
Concho, AZ 85924
Phone: 928-337-2466
Hours: May-Oct, Saturdays 8am-12pm
www.conchofarmers.org

PINAL COUNTY

CASA GRANDE FARMERS' MARKET
13480 W. Jimmie Kerr Blvd.
Casa Grande, AZ 85222
Phone: 520-866-7313
Hours: March-Sept, Fridays 9am-12pm
www.azfarmersmarkets.us

FLORENCE FARMERS' MARKET
Main St.
Florence, AZ 85232
Phone: 520-868-4273
Hours: Nov-Mar, Saturdays 9am-12pm
www.azfarmersmarkets.us

GILA RIVER FARMERS' MARKET
Pima St. & Sacaton Rd.
Sacaton, AZ 85247
Hours: Mar-Sept, Wednesdays 8am-12pm
Phone: 520-562-3318 ext.225
www.azfarmersmarkets.us

ORACLE FARMERS' MARKET
1395 W. American Ave.
Oracle, AZ 85623
Phone: 520-896-9005
Hours: Year-round, Saturdays 9am-12pm
www.azfarmersmarkets.us

COCHISE COUNTY

BISBEE FARMERS' MARKET
Vista Park, Bisbee, AZ 85603
Phone: 520-227-5060
Hours: May-Oct, Saturdays 8am-12pm
www.foodconnect.org

ELFRIDA FARMERS' MARKET
10566 Hwy 191
Elfrida, AZ 85610
Phone: 520-642-2222
Hours: May-Nov, Fridays 2pm-6pm
www.localharvest.org

SIERRA VISTA FARMERS' MARKET
1658 Cottonwood Dr.
Sierra Vista, AZ 85635
Phone: 520-378-2973
Hours: Apr 26-Oct, Thursdays 2pm-6pm
Nov-Apr, 1st Thursday each month 12pm-4pm
www.sierravistamarket.com

GUIDE TO ARIZONA'S

FARMERS' MARKETS

Fresher Tastier

BY DAY OF THE WEEK

MOHAVE COCONINO YAVAPAI LA PAZ GREENLEE YUMA SANTA CRUZ

APACHE NAVAJO MARICOPA GILA PIMA PINAL GRAHAM COCHISE

	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
MOHAVE						**KINGMAN MARKET** 10 E. Beale St. Mem. Day-Oct, 8am-11am
COCONINO		**TUBA CITY** 1oo Aspen Dr. Aug-Sept, 5:30pm-7:30pm			**FLAGSTAFF** 1414 North Rim Dr. Jun-Oct, 8am-12pm	
YAVAPAI		**CHINO VALLEY** 901 S. Hwy 89 Jun-Oct, 3pm-7pm	**COTTONWOOD MARKET** 187 E. Pima St. Jul-Sept, 5pm-Dark **PRESCOTT VALLEY** 7221 E. Florentine Rd. Jul-Oct, 4pm-8pm		**PRESCOTT** 1100 E. Sheldon May-Oct, 7:30am-12pm **VERDE VALLEY** Main St. & Holloman Mid Jun-Mid Oct, 8am-12pm	
MARICOPA		**PHOENIX PUBLIC MARKET** 721 N. Central Ave. Year-Round, 4pm-8pm **TOWN & COUNTRY, PHX** 2021 E. Camelback Rd. Year-Round, 10pm-2pm **WESTCOR'S SANTAN VILLAGE** Williams Field Rd./Loop 202 Gilbert, AZ 85295 Hours: Oct-May, 1st & 3rd Wed/month, 9:30am-2pm	**CHANDLER FARMERS' MARKET** S. of Chandler Blvd. on AZ Ave. Hours: Year-Round, 3pm-6pm **FOUNTAIN HILLS NOCTURNAL** 16810 Ave Of The Fountains Jan-Apr, 2pm-6pm **KIVA CENTER COURTYARD** 7121 E. 5th Ave. Scottsdale, AZ, 85251 Hours: Oct-May, 2:30-7pm	**THE BORGATA SCOTTSDALE** 6166 N. Scottsdale Rd. Jan-Apr, 3pm-8pm **ENCANTERRA** 1035 E. Combs Rd. Queen Creek, AZ 85240 Oct-May, 2nd Fri/month, 10am-2pm **MESA COMMUNITY** 263 N. Center St. Year-Round, 8am-1pm **TOWN OF CAREFREE** 100 Easy St. Oct-Jun, 9am-1pm **TRILOGY AT VISTANCIA** 27980 N. Trilogy Blvd. Peoria, AZ 85383 Sep- May, 4th Fri/month, 10am-2pm	**5TH AVENUE, SCOTTSDALE** 4169 N. Craftsman Ct. Nov-May, 10am-2pm **CAVE CREEK** 6900 E. Cave Creek Rd. Oct-May, 9am-1pm (Closed Every 3rd Saturday) **COPPER CANYON GOLF CLUB** 26577 W. Desert Vista Blvd. Buckeye, AZ 85396 Nov-Apr, 1st Sat/month **DC RANCH, SCOTTSDALE** 20751 N. Pima Rd. Oct-Apr, 10am-2pm **ESTRELLA LAKESIDE** 10300 S. Estrella Pkwy Oct-May, 10am-2pm (Closed Every 3rd Saturday) **MURPHY PARK** 7010 N. 59th Ave. Glendale, AZ 85301 Hours: 9am-2pm **OLD TOWN SCOTTSDALE** 1st St. and Brown Ave. Nov-May, 9-2pm **PHOENIX CAMELBACK** 3930 E. Camelback Rd. Oct-May, 9am-1pm **PHOENIX PUBLIC MARKET** 721 N. Central Ave. Year-Round, 8am-1pm	**AHWATUKEE** 4700 E. Warner Rd. Year-Round, 9am-1pm **KIVA CENTER COURTYARD** 7121 E. 5th Ave. Scottsdale, AZ, 85251 Hours: Oct-May, 10am-2pm **SURPRISE STADIUM** 15850 N. Bullard Ave. Hours: Oct 19-May, 10am-2pm

	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY
MARICOPA					**ROADRUNNER PARK, PHX** 3515 E. Cactus Rd. May-Sept, 7-11am Oct-May, 9am-1pm **WESTGATE CITY CENTER** 6770 N. Sunrise Blvd. Glendale, AZ 85305 Oct-May, 2nd Sat/month, 8am-12pm	
YUMA	**DOWNTOWN YUMA** Main St. Dec-Mar, 10am-3pm				**CARVER PARK IN YUMA** 385 S. 13th Ave May-Jun, 3pm-7pm	
PIMA	**COMMUNITY FOOD BANK** 3003 S. Country Club Tucson, AZ Year-Round, 8am-12pm	**DOWNTOWN TUCSON** 101 N. Stone Ave. Year-Round, 8am-1pm	**SANTA CRUZ RIVER** 310 N. Commerce Park Feb-Apr, 3pm-6pm May-Oct, 4pm-7pm	**ARIVACA MARKET** 16800 Arivaca Rd. Jun-Oct, 7am-9pm **EL PRESIDIO MERCADO** 225 W. Alameda St. Year-Round, 10am-3pm **MARKET AT THE UofA** 1401 E. University Blvd. Sep-Apr, 9am-1pm	**ORO VALLEY** 11000 N. La Canada May-Oct, 8am-12pm, Oct-Apr, 9am-1pm **PLAZA PALOMINO FOOD FAIRE** 2970 N. Swan Tucson, AZ Year-Round, 10am-2pm **RINCON VALLEY** 12500 E. Old Spanish Trail May-Sept, 8am-12pm Oct-Apr, 9am-2pm	**CIVANO** 5301 S. Houghton Year-Round, 10am-2pm **TUCSON MARKET** 4380 N. Campbell Ave May-Oct, 8am-12pm Nov-Apr, 9am-1pm
SANTA CRUZ			**TUBAC** 40 Avenida Goya Oct-Apr, 10pm-2pm May-Sept, 1/Month		**SONOITA GROWERS MARKET** 3428 Hwy. 83 Jul-Sept, 9am-12pm	
APACHE					**CONCHO FARMERS' MARKETS** Corner of Hwy 61 & 180A May-Oct, 8am-12pm	
PINAL		**GILA RIVER** Pima St. & Sacaton Rd. Mar-Sept, 8am-12pm			**CASA GRANDE** 13480 W. Jimmie Kerr Mar-Sept, 9am-12pm **FLORENCE** Main St. Nov-Mar, 9am-12pm **ORACLE** 1395 W. American Ave Year-Round, 9am-12pm	
COCHISE			**SIERRA VISTA** 1658 Cottonwood Dr Apr-Oct, 2pm-6pm Nov-Apr, 12pm-4pm	**ELFRIDA** 10566 Highway 191 May-Nov, 2pm-6pm	**BISBEE** Vista Park May-Oct, 8am-12pm	

***CURRENTLY THE ONLY FARMERS' MARKET BEING HELD ON MONDAY IS THE MARANA FARM STAND IN PIMA COUNTY. (PLEASE SEE PG.8 FOR DETAILS)**

***MARKET DATES AND TIMES ARE SUBJECT TO CHANGE. CHECK WWW.AZFARMERSMARKETS.US FOR UPDATES.**

U-PICK FARMS
By County

FRESH PRODUCE

RIPE FOR THE PICKING

MARICOPA COUNTY

DATE CREEK RANCH AND ORCHARD
The ranch road is between mileposts 178 & 177, 6 miles NW of Congress Junction on Hwy 93, 22 miles NW of Wickenburg, AZ

928-321-0704, www.datecreekranch.com

Hours: July-October, weekends only: 7am-3pm

- FRUIT:
  Summer/Fall: apples (Golden & Red Delicious), peaches, pears
- MEAT:
  grass-fed beef

BOB WHITE FARMS
East of Cooper Road on Chandler Blvd.
Chandler, AZ 85225

480-988-2028

Hours: June-July, 6-11am daily

- VEGETABLES:
  Summer: corn, tomatoes, bell peppers, chiles, okra, black-eyed peas, string beans, squash, cucumbers
- FRUIT:
  Summer: melons

VERTUCCIO FARMS
Mesa, AZ 85212
480-650-6606

- VEGETABLES:
  Fall: Pumpkins
- FRUIT:
  Spring: Peaches

MOTHER NATURE'S FARM
1663 E. Baseline Rd.
Gilbert, AZ 85233

480-892-5874 www.mothernaturesfarm.com

Hours: Daily 9am-9pm

- VEGETABLES
  Fall: Pumpkins

SCHNEPF FARMS
24810 Rittenhouse Rd.
Queen Creek, AZ 85242

480-987-3100, www.schnepffarms.com

Hours: October-June, Wed-Sun: 7:30am-5pm

- VEGETABLES
  Fall: green beans, broccoli, cauliflower, pumpkins

  Winter/Spring: winter squash, beets, radishes, lettuce, spinach, zucchini, cucumbers, carrots, tomatoes (picked)
- FRUIT, OTHER:
  Fall: strawberries, sunflowers

  Winter/Spring: peaches, strawberries, Ana apples, plums, apricots

TOLMACHOFF FARMS
5726 N. 75th Ave.
Glendale, AZ 85303

623-386-1301, www.tolmachoff-Farms.com

Hours: October-July. Call ahead for times

- VEGETABLES
  Year-round: zucchini, tomatoes, cucumbers, black eyed peas, honey

  Spring/Summer: okra, squash, eggplant, yellow hot peppers.

  Not u-pick, but available: sweet corn

  Fall/Winter: pumpkins, gourds, sweet corn (u-pick), string beans, purple hull peas, yellow crook neck squash, carrots, beets, yams, greens: collard, mustard, turnips
- FRUIT
  Spring/Summer: not u-pick but available: watermelon, cantaloupe

PIMA COUNTY

AGUA LINDA FARMS

I-19 to Exit 42, take East Frontage Road South, Amado, AZ

520-398-3218, www.agualindafarm.net

Hours: March- October, Weekends 8am-3pm. (until 5pm in October)

- VEGETABLES
  Year-round: lettuce, cabbage, zucchini, squash, beans

  Winter/Spring: carrots, peas, Swiss Chard, Bok Choy, onions (not u-pick), arugula, spinach

  Summer/Fall: cucumbers, okra, basil, turnips, zinnias, pumpkins, gourds, tomatoes
- FRUIT, OTHER
  Summer/Fall: watermelon, sunflowers, honey, soaps
- MEAT
  grass fed beef

OUR GARDEN PRODUCE

16500 N. Stallion Rd., Catalina, AZ 85739
(10 miles North of Tucson)

www.ourgardencatalina.com

Hours: Wed-Sat: 9am-12pm (not u-pick)

- VEGETABLES
  Summer/Fall: tomatoes, peppers, sweet & hot turnips, zucchini, squash, beets, carrots, broccoli, cucumbers, lettuce, garlic, radicchio, radishes, green beans, okra, kale
- FRUIT, OTHER
  Year-round: eggs, honey, soaps

  Summer/Fall: pomegranates, melons, eggs

GILA

ARAVAIPA FARMS

89395 E. Aravaipa Rd.
Winkleman, AZ 85292

520-357-6901, www.aravaipafarms.com

Hours: vary by season

- FRUIT, OTHER
  Year-round: eggs

  Summer/Fall: Apricots (May), peaches, Asian pears

  Winter/Spring: Meyer lemons
- Aravaipa Farms Bed and Breakfast County Inn

COCHISE COUNTY

GRAYS GARDEN OF EAT'N
10501 Dove Song Lane
Hereford, AZ 85615

520-366-0606

Hours: Monday-Saturday 8am-Sundown

- VEGETABLES:
  Year-round: carrots, eggs, honey

  Winter/Spring: beets, broccoli, cabbage, cauliflower, Chinese greens, collards, kale, lettuce, mustard & salad greens, peas, radishes, spinach, Swiss chard, turnips

  Summer/Fall: cucumber, eggplant, garlic, green beans, green onion, hot peppers, okra, onions, potatoes, shallots, sweet corn, sweet peppers, tomatillos, tomatoes, squash, zucchini, pumpkins

- FRUIT, OTHER:
  Summer/Fall: apples, apricots, blackberries, melons, cantaloupes, grapes, peaches, pears, plums, watermelons, bread, soap, herbs, flowers, pecans

NARITA FARMS
6965 S. Narita Lane
Willcox, AZ 85643

520-384-4805

Hours: May-September, Daily: dawn to dusk

- VEGETABLES, OTHER
  Spring: peas

  Summer/Fall: beans, carrots, corn, onions, squash, eggplant, melons, peppers, tomatoes, brown eggs

- FRUIT
  Spring: strawberries

  Summer/Fall: melons

APPLE ANNIE'S ORCHARD, PUMPKINS AND PRODUCE
2081 W. Hardy Rd.
Willcox, AZ 85643

520-384-2084 and 520-384-4685
www.appleannies.com

Hours: June 29- October 31
Monday-Friday 9am-5pm

- VEGETABLES:
  Summer/Fall: summer & winter squash, tomatoes, sweet corn, onions, okra, pumpkins, green beans, gourds, eggplant, cucumbers, black eyed peas, chili peppers, bell pepper

- FRUIT, OTHER:
  Summer/Fall: apples (Fuji, Granny Smith, Red and Golden Delicious, McIntosh), peaches, pears, Asian pears, honeydew, watermelon, cantaloupe, flowers

- Festivals and Extravaganzas!

BROWNS ORCHARD
5774 N. Atwood Rd.
Willcox, AZ 85643
520-384-3671, www.youpickapples.com

Hours: August- November

- FRUIT:
  Fall: pears (Bartlett, Bosc, Starking Delicious, D'anjou), apples (Gala, Early Blaze, Red & Golden Delicious, Yellow Transparent, Gravenstein, Red Rome, Stayman Winesap, Winesap Commercial, Rome Beauty, Jonathan)

- MEAT
  grass fed lamb

- Press your own Cider!

ARIZONA

Harvest Schedule

FRESH PRODUCE

AVAILABLE YEAR-ROUND

ARIZONA HARVEST SCHEDULE

FRUIT OR HERB

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
ANISE	●	●	●									●
APPLE, FUJI									●	●		
APPLE, GALA								●	●			
APPLE, GOLDEN DELICIOUS								●	●	●		
APPLE, GRANNY SMITH									●	●	●	
APPLE, RED DELICIOUS								●	●	●		
APRICOTS					●	●						
CHERRIES						●						
DILL	●	●	●								●	●
DATES									●	●		
FIGS					●	●						
GRAPEFRUIT, RED BLUSH	●	●	●	●	●	●	●	●	●	●	●	●
GRAPEFRUIT, WHITE	●	●	●	●	●	●	●	●	●	●	●	●
GRAPES, BLACK BEAUTY						●	●					
GRAPES, CONCORD									●			
GRAPES, FLAME SEEDLESS						●	●					
GRAPES, PERLETTE					●	●	●					
GRAPES, THOMPSON SEEDLESS						●	●					
LEEKS	●	●	●								●	●
LEMONS	●	●	●					●	●	●	●	●
MELONS, CANARY	●	●	●	●	●	●	●	●	●	●	●	●
MELONS, CANTALOUPE					●	●	●	●	●	●	●	
MELONS, CASABA						●	●	●	●	●	●	
MELONS, CRENSHAW						●	●	●	●	●	●	
MELONS, HONEYDEW						●	●	●	●	●	●	
MELONS, ORANGE FLESH						●	●	●	●			
MELONS, SANTA CLAUS						●	●	●	●			
MELONS SHARLYN						●	●	●	●			
MELONS, SPECIALTY						●	●	●	●			
MELONS, WATERMELON					●	●	●	●	●	●	●	
ORANGES, BLOOD	●	●										●
ORANGES, MANDARIN	●	●	●									
ORANGES, NAVEL	●	●									●	●
ORANGES, SWEET	●	●	●								●	●
ORANGES, TEMPLE	●	●										●
ORANGES, VALENCIA		●	●	●	●	●	●					
PARSLEY	●	●	●	●						●	●	●
PEACHES					●	●		●				
TANGELOS, MINNEOLA	●	●									●	●
TANGELOS, ORLANDO	●	●									●	●
TANGERINES, ALGERIAN											●	●
TANGERINES, FAIRCHILD											●	●

● WINTER PRODUCE ● SUMMER PRODUCE

ARIZONA HARVEST SCHEDULE

VEGETABLE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
ARTICHOKES		●	●	●	●							
ASPARAGUS		●	●	●	●							
BEAN, FAVA		●	●	●								
BEAN, GREEN					●	●			●			
BEAN, PINTO							●	●	●	●		
BEETS	●	●	●								●	●
BOK CHOY	●	●	●								●	●
BROCCOLI	●	●	●							●	●	●
BROCCOLI, BABY	●	●	●								●	●
CABBAGE, GREEN	●	●	●	●	●	●	●	●	●	●	●	●
CABBAGE, RED	●	●	●	●	●						●	●
CARROTS	●	●	●	●	●	●	●	●	●	●	●	●
CAULIFLOWER	●	●	●	●							●	●
CAULIFLOWER, GREEN	●	●	●								●	●
CELERY	●	●	●								●	●
CILANTRO	●	●	●	●							●	●
CORN, SWEET					●	●	●	●	●	●	●	
DAIKON (JAPANESE RADISH)	●	●	●									
GREENS, BEET	●	●	●	●							●	●
GREENS, COLLARD	●	●	●	●							●	●
GREENS, MUSTARD	●	●	●	●							●	●
GREENS, TURNIP	●	●	●	●							●	●
KALE	●	●	●	●							●	●
KOHLRABI	●	●	●									●
LETTUCE, BUTTER/BOSTON	●	●	●								●	●
LETTUCE, ENDIVE	●	●	●								●	●
LETTUCE, ESCAROLE	●	●	●								●	●
LETTUCE, ICEBERG	●	●	●								●	●
LETTUCE, LEAF	●	●	●								●	●
LETTUCE, ROMAINE	●	●	●								●	●
LETTUCE, SPRING MIX	●	●	●	●							●	●
NAPA CABBAGE	●	●	●									●
ONIONS, SWEET (DRY)				●	●	●	●	●				
ONIONS, GREEN	●	●	●	●	●				●	●	●	●

● WINTER PRODUCE ● SUMMER PRODUCE

ARIZONA HARVEST SCHEDULE

VEGETABLE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
PARSNIPS					●	●						
PEPPERS, GREEN BELL							●	●	●	●		
PEPPERS, RED BELL							●	●	●	●		
PEPPERS, GREEN CHILI						●	●	●	●	●		
PEPPERS, RED CHILI								●	●	●	●	
POTATOES, RED				●	●	●	●					
POTATOES, RUSSET				●	●	●	●					
PUMPKIN									●	●		
RADICCHIO	●	●	●									●
RADISHES	●	●	●	●	●					●	●	●
RAPINI	●	●	●									●
SALAD SAVOY	●	●	●								●	●
SPINACH	●	●	●							●	●	●
SQUASH (SUMMER) CROOKNECK						●	●	●	●	●		
SQUASH (SUMMER) SCALLOPED						●	●	●	●	●		
SQUASH (SUMMER) STRAIGHTNECK						●	●	●	●	●		
SQUASH (SUMMER) ZUCCHINI						●	●	●	●	●		
SQUASH (WINTER) ACORN									●	●	●	
SQUASH (WINTER) BANANA									●	●	●	
SQUASH (WINTER) BUTTERNUT									●	●	●	
SQUASH (WINTER) GOLD ACORN									●	●	●	
SQUASH (WINTER) HUBBARD									●	●	●	
SQUASH (WINTER) KOBACHA									●	●	●	
SQUASH (WINTER) SPAGHETTI									●	●	●	
SQUASH (WINTER) TURBAN									●	●	●	
SWISS CHARD	●	●	●	●							●	●
TOMATOES	●	●	●	●	●	●	●	●	●	●	●	●
TURNIP	●	●	●	●							●	●

● WINTER PRODUCE ● SUMMER PRODUCE

The Farm to School program; a joint venture between the USDA and Department of Defense, "connects schools with local farms with the objectives of serving healthy meals in school cafeterias, improving student nutrition, providing health and nutrition education opportunities that will last a lifetime, and supporting local small farmers."

These healthy educational programs are further emphasized with farm visits, recycling and gardening programs. This program also provides a new market for farmers because they can provide a service to a larger segment of their community.

Farm to School programming is helping children learn to make healthy choices to prevent obesity, and aid in lifelong health. The Arizona Department of Education and Community Food Bank in Tucson, in conjunction with the WK Kellogg Foundation, are working hard to increase the number of participating schools. Currently, 13 schools are partnering with local farmers to bring students fresh, farm grown fruits, vegetables, meats, eggs, and honey. The Litchfield Elementary School District is a Farm to School Program supporter with seven elementary schools and three middle schools participating. Flagstaff High School participates in a Farm to School snack program.

FOR MORE INFORMATION:

Farm to School: www.farmtoschool.org, or 602-493-5231

www.foodconnect.org,

Litchfield Elementary School District: 623-935-6056

Community Food Bank at 520-622-0525.

The Arizona Farm Bureau established the "Fill Your Plate" program in December 2007 to help form a relationship between growers and the general public. The program provides chefs and the public with an opportunity to find and purchase locally grown food products. On the site www.azfb.org, simply click on the Fill Your Plate logo, seen above, to begin your search! Not only does this site offer a way to find Arizona's fruits and vegetables, but also hay, alpaca and lambs wool, a variety of meats including ostrich, pig, beef, and lamb, bath products, coffee, cactus, teas, candy, shrimp, wine and even wheat germ.

Once you begin your search on the Fill Your Plate site, you will find a detailed listing of each farmers market or farm where you can purchase your produce of choice. Produce information, contact information, directions and even some special events are listed by the grower. Recipes and a message board can also be found on this site. Check the page out frequently, as this program currently has more than 60 farmers and continues to expand.

FOR MORE INFORMATION:
www.fillyourplate.org

ARIZONA HAS MANY WAYS TO GET YOUNGSTERS INVOLVED IN AGRICULTURE. ARIZONA OFFERS CHAPTERS STATEWIDE FOR 4-H AND FFA.

WHAT'S IT ALL ABOUT?

4-H is an agricultural non-profit organization whose goal is to "provide educational opportunities for youth to become capable and contributing members of a global society." To support this mission they provide formal and non-formal community focused experimental learning, foster leadership and volunteering in youth and adults, and help develop skills that will benefit youth in life, projects, personal development, leadership and citizenship.

PROJECTS/OPPORTUNITIES

4-H has projects and activities ranging in subject from aeronautics, textiles, computer technologies, youth gardening, food preparation/nutrition, animal husbandry, photography, veterinary science, plant science, and many more! Arizona 4-H especially takes pride in their plant science programs, which operate in conjunction with the University of Arizona's Arboretum, the Boyce Thompson Arboretum, and elementary school classrooms all around the Phoenix-metro area. 4-H sponsors many activities that encourage members to interact with other chapters both state and nationwide. Some of the activities include:

- Arizona State Fair 4-H Horse Show at WestWorld in Scottsdale for members to show off their riding skills.
- National 4-H Congress in Atlanta, Georgia to allow members to meet with national sponsors.

FOR MORE INFORMATION:
Please visit: www.ag.arizona.edu/4-h/
or contact your county 4-H office at the number on pg. 27

COUNTY 4-H OFFICES

MOHAVE COUNTY
101 E. Beale St., Suite A
Kingman, AZ 86401
928-753-3788

COCONINO COUNTY
2304 N. 3rd St.
Flagstaff, AZ 86004
928-774-1868

YAVAPAI COUNTY
840 Rodeo Dr., Bldg C
Prescott, AZ, 86305
520-445-6590

LA PAZ COUNTY
2524 Mutahar
Parker, AZ 85344
928-669-9843

MARICOPA COUNTY
4341 E. Broadway Rd.
Phoenix, AZ, 85040
602-470-8086

YUMA COUNTY
2200 W. 28th St., Ste 102
Yuma, AZ 85364
928-726-3904

PIMA COUNTY
4210 N. Campbell
Tucson, AZ 85719
520-616-5161

SANTA CRUZ COUNTY
3241 N. Grand Ave, Suite 6
Nogales, AZ 85621
928-281-2994

APACHE COUNTY
845 W. 4th North
St. Johns, AZ 85936
520-458-8278 ext. 2141

NAVAJO COUNTY
100 E. Carter Dr.
Holbrook, AZ 86025
928-524-6271 or 928-524-4023

GILA COUNTY
107 W. Frontier Suite B
Payson, AZ 85541
928-474-4160

GREENLEE COUNTY
1684 Fairgrounds Rd.
Duncan, AZ 85534
928-359-2661 or 928-359-2305

PINAL COUNTY
820 E. Cottonwood, Bldg. B
Casa Grande, AZ 85222
520-856-3221

GRAHAM COUNTY
2100 S. Bowie
Soloman, AZ 85551
928-428-2611

COCHISE COUNTY
1140 N. Colombo
Sierra Vista, AZ 85635
520-458-8278 ext. 2141

NATIONAL FFA ORGANIZATION

WHAT'S IT ALL ABOUT?

FFA makes a positive difference in the lives of its students by developing their potential for premier leadership, personal growth and career success through agricultural education. The National FFA Organization is an integral, intra-curricular part of agricultural education. Initially organized in 1928 in Kansas City, Missouri, as Future Farmers of America, the official name of the organization was changed to the National FFA Organization to reflect the organization's evolution in response to expanded agricultural opportunities encompassing science, business and technology in addition to production farming.

FFA is focused on preparing its members with important life skills through career development events, which focus on various aspects of agriculture, from Livestock Evaluation to Floriculture to Agricultural Communications, as well as leadership skills, including Prepared Public Speaking and Parliamentary Procedure. Arizona Association FFA administers to the local chapters throughout the state.

PROJECTS/OPPORTUNITIES

Being involved in FFA allows its members many opportunities. Some of these benefits include hands-on training, leadership opportunities on the local, state and national levels, success in Career Development Events and scholarships.

SOME OF THE EVENTS SPONSORED BY FFA INCLUDE:

- Greenhand Conference, held at various locations, for 8th and 9th grade members to develop beginning leadership skills.
- Spring Conference at the University of Arizona, for members to participate in one of fifteen Career Development Events, including Job Interview, Forestry, Wildlife Management and Aquaculture.
- State FFA Camp in Heber, Arizona, a week-long leadership development event. Through various small group leadership activities and leadership workshops, students gain a deeper sense of their leadership ability while enjoying time with new and old friends from across Arizona.

FOR MORE INFORMATION: Please visit, www.azffa.org, or call 602-542-5564

YOUNG FARMER AND RANCHER PROGRAM

WHAT'S IT ALL ABOUT?

The Young Farmer and Rancher (YF&R) Program is a national program for people 18-35 years of age. The objective is to provide leadership opportunities to those who wish to join the Farm Bureau in expanding agriculture and its communities. Not only do they offer local programs in leadership, but also: legislative education, competitive events and networking.

FOR MORE INFORMATION:
www.azfb.org/programs/youngfarmers
or email yfr@azfb.org

PROJECTS/OPPORTUNITIES

The Young Farmer and Rancher Program is committed to giving their participants well-rounded knowledge of agriculture.

ANNUAL YF&R ACTIVITIES INCLUDE:

- Leadership Conference focusing on agricultural issues, leadership, tours, collegiate competition, and networking.
- National Conference at which members compete in agricultural contests in one of three categories:

  - Excellence in Leadership
  - Excellence in Agriculture
  - Achievement Award

- Competitions can award up to $1,200 for first prize on the state level, plus a paid trip to the National American Farm Bureau Conference.
- 5K run for Junior Achievement held at the Tempe Town Lake. YF&R members not only run, but they also provide troughs full of water bottles, and over 500 apples, oranges and bananas for runners to snack on.
- Governor's office visit. The YF&R members have a chance to meet with a senator, tour the Governor's office and have lunch with the Director of the Arizona Department of Agriculture.

UNIVERSITY OF ARIZONA

The University of Arizona is located in Tucson, Arizona, with a satellite campus in Sierra Vista. The College of Agriculture and Life Sciences offers the following agriculture programs:

- Agriculture and Bio-systems Engineering: utilizing biotechnology, biological sciences and physical sciences to create innovative solutions in irrigation, agricultural products, waste management, and water conservation.
- Agricultural Education: focuses on the integration, application and disbursement of knowledge about agriculture and applied sciences.
- Agriculture and Resource Economics: teaches students to analyze agriculture and resources from an economic perspective.
- Animal Science: focuses on the use of animals in agriculture.

FOR MORE INFORMATION: www.cals.arizona.edu or 520-621-7621

ARIZONA WESTERN COLLEGE

Nine campuses offering services to Yuma and La Paz counties in the following programs:

- Agriculture: focuses on animal industries, plant science, business management.
- Agriculture Business: teaches business analysis, management, budgeting, and finance.

FOR MORE INFORMATION: www.azwestern.edu or 928-317-6100

ARIZONA STATE UNIVERSITY

Arizona State University's Morrison School of Management and Agribusiness is located at the Polytechnic campus in Mesa and offers the following agricultural programs

- Food Science: prepares students to turn agricultural commodities into food products; taking a look at business and science.
- Food Marketing: an effective production-to-consumer program focusing on consumer markets and business practices.
- Agribusiness: a generalized program for students to learn everything from marketing, business, finance, and today's latest technologies.
- International Agribusiness: students learn international economics, commodity finance and training, as well as domestic skills.
- Agribusiness Finance: students learn risk factors that affect the agricultural market including environmental, biological, international trade policy; and how to use the tools of corporate management to fight these risk factors.

FOR MORE INFORMATION: www.poly.asu.edu/msma/ or 480-727-1585

MARICOPA COMMUNITY COLLEGES

With branches throughout Maricopa County, this college provides the following agricultural program at the Mesa campuses:

- Agribusiness: This two-year program emphasizes the technology of production and management. The program is designed to prepare individuals to become employed as owners, managers, supervisors, technicians, herdsmen, or farm hands in farming ranching, and dairying. The program also prepares the individuals for jobs with government agencies or other agencies involved with the technical phases of the Animal Science Industry.

FOR MORE INFORMATION: www.maricopa.edu or 480-731-8000

EASTERN ARIZONA COLLEGE

Campuses located in Thatcher and Safford offer:

- Agribusiness: focuses on general studies, and natural resource conservation.
- Agriculture: covers general studies but also technical writing and economics.

FOR MORE INFORMATION: www.eac.edu or 928-428-8257

YAVAPAI COLLEGE

With campuses in Prescott, Verde and Chino Valleys, and Sedona, this college offers a range of agricultural studies:

- Agriculture Education: prepares students to become a high school agriculture teacher with a focus on technology.
- Agriculture Technology management: offers a variety of specific topics including horticulture, equine science, sports and turf grass, aquaculture and horticulture.

FOR MORE INFORMATION: www2.yc.edu/ or 928-717-7727

CENTRAL ARIZONA COLLEGE

Central Arizona College services Pima County, offering a number of different levels of education, including 3 certificate programs and 2 Associate/transfer degrees. All programs are taught in a hands-on manner that prepares students for work in dairies, farms, business, real estate, biotechnology, etc:

- Agriculture: transfer degree to 4 year colleges.
- Agriculture General: Associates degree in Applied Sciences to prepare students for further education or working.
- Agriculture Business: certificate to prepare students for the workforce.
- Agriculture General: certificate for the workforce.
- Farm Business Management: certificate for the workforce.

FOR MORE INFORMATION: www.centralaz.edu or 520-494-5311

NORTHLAND PIONEER COLLEGE

Located in Apache county, with campuses in Show Low, Winslow, Holbrook and Snowflake, Northland Pioneer College offers certificates and degrees in:

- Agriculture-General: Associates degree. Classes include animal husbandry, diseases, forestry, landscape design and range management.
- Turf Grass Management: Associates Degree. Classes: soils, irrigation, wastewater treatment, horticulture.
- Agriculture-General: Certificate of applied science. Classes: soils, irrigation, wastewater treatment, horticulture.
- Range Management: Certificate of proficiency. Courses include ecology, range plants, and range management.
- Horticulture: Certificate of proficiency. Courses include soils, basic horticulture, and landscape construction. Program focus for a landscape or nursery aide.
- Animal Science: Certificate of proficiency. Courses include animal disease, industry, husbandry, breeding, and livestock judging.

FOR MORE INFORMATION: www.npc.edu

EDUCATION

Elementary schools, middle and high schools, and universities in Arizona all have agricultural education in one form or another. There are even specialists that travel from school to school to teach students of all ages about agriculture. In the state of Arizona, agri-science teachers are in high demand, and the position is very portable; meaning it can be put to use in every other state. To pursue an education and career in agriculture, contact a university or community college in your area.

IN THE FIELD

A few career opportunities in agriculture for those who love the outdoors, and want a hands-on ag career include: crop manager, farm manager, crop assistant, herdsman/breeding manager, pesticide technician, feedlot assistant, farm mechanic, food safety inspector, fertilizer/chemical applicator, soil scientist, air quality specialist, horticulturist, agriculture inspector, and livestock inspector.

AGRIBUSINESS

For those who want a more "tame" agriculture career, agribusiness is the perfect fit. Most of these opportunities include some type of sales and management. Grain manager, seed sale manager, certified appraiser, seed specialist, agronomist, GPS supervisor, animal nutritionist, animal health sales (dairy), ethanol plant manager, chemical engineer, grain merchandiser, and farm accounting/finance are all agribusiness careers.

While a few of these positions do not require higher education, some of these careers require a Bachelors degree. At various Arizona community colleges and universities, students learn the skills they need to pursue a career in agribusiness.

BIOTECHNOLOGY

If you like being inside, but don't want to sit behind a desk, biotechnology might be the job for you. Careers in biotechnology are mostly science based and are hands-on. A Bachelors Degree earned at the University of Arizona's College of Agriculture and BioSystems Engineering or Arizona State University's Ira Fulton School of Engineering (Bioengineering Department) can prepare students for any of these careers: agricultural science research technician, veterinary technician, microbiologist, veterinarian, genetic engineer, and bio-pesticide engineer.

THE ARIZONA CROP PROTECTION ASSOCIATION

The Arizona Crop Protection Association works to strengthen the crop protection industry by educating legislators and the public on the crop protection industry. They also hold events and present their members with continued education opportunities.

This scholarship is for full-time high school seniors or those currently pursuing a bachelors degree full-time at an Arizona University or College in agriculture, biological science, pest management, range management, golf course management, natural resource management, animal husbandry, or nutrition. Arizona students are preferred, but out-of-state students may also apply for this scholarship. The amount of funding awarded depends on funds available and number of applicants.

FOR MORE INFORMATION: www.azcropprotection.com/scholarship.html

THE YUMA COUNTY AGRICULTURE PRODUCERS SCHOLARSHIP

$500-2000 per academic year in funding. This scholarship is for full-time high school or beginning college students that are in a declared agriculture or agriculture related major. Science majors may also apply if there is an agricultural aspect of their program or career goals. For students to qualify, they must have at least a 2.5 grade point average (GPA.) This scholarship is issued based on merit, financial need or both.

FOR MORE INFORMATION: www.ag.arizona.edu/OAP/scholarships/YCAPS.doc

CALIFORNIA ASSOCIATION OF PEST CONTROL ADVISORS

California Association of Pest Control Advisors is a non-profit organization that was started in 1974 and is focused on upgrading "the qualifications of its members, and to provide technical information, encourage careful and skillful use of pest management practices." CAPCA consists of 16 chapters located from Oregon to New Mexico.

The CAPCA Scholarship is $3,000 of funding for students who are entering or returning to agriculture or horticulture college programs, and that would eventually like to have a career in pest management. Applicants must have at least a 2.5 GPA to qualify for funding.

FOR MORE INFORMATION: http://www.capca.com/general_information/

THE ARIZONA FARM BUREAU

The Arizona Farm Bureau offers annual scholarships through the County Farm Bureau offices to high school seniors and college students who are members, or whose parents are members, of the Farm Bureau. Applicants must have a 2.5 grade point average, but do not necessarily have to be agriculture majors. The individual county sets the major requirements for each scholarship.

FOR MORE INFORMATION:
http://www.azfb.org/whatis/index.cfm?fuseaction=county

THE ARIZONA NURSERY ASSOCIATION

The Arizona Nursery Association offers scholarships to Arizona residents who are employed in or have an interest in the nursery industry. Applicants must have above average academics or have at least 2 years of work experience to be considered for funding. The deadline to apply is April 15 of every year, and the scholarship funds range from $500-3000 each.

FOR MORE INFORMATION: http://www.azna.org/scholarships.htm

NOTES

ARIZONA DEPARTMENT OF AGRICULTURE
1688 West Adams Street
Phoenix, Arizona 85007
P 602-542-0137 Toll Free 800-294-0308
F 602-364-0830 www.azda.gov

1. Yesterday, did you eat any vegetables?

Vegetables are all cooked and uncooked vegetables; salads; and boiled, baked and mashed potatoes. ***Do not count French fries or chips.***

- o No, I didn't eat any vegetables yesterday.
- o Yes, I ate vegetables 1 time yesterday.
- o Yes, I ate vegetables 2 times yesterday.
- o Yes, I ate vegetables 3 or more times yesterday.

2. Yesterday, did you eat fruit?

- o No, I didn't eat any fruit yesterday.
- o Yes, I ate fruit 1 time yesterday.
- o Yes, I ate fruit 2 times yesterday.
- o Yes, I ate fruit 3 or more times yesterday.

3. Do you ever have any fruit or vegetables as a snack after school?

- o No
- o Sometimes
- o Always

4. Do you ask your parents to buy your favorite fruit or vegetable at the grocery store?

- o No
- o Sometimes
- o Always

5. How important is it for you to eat healthy foods?

- o Not important
- o Important
- o Very important

6. What is your favorite fruit?

7. What is your favorite vegetable?

8. How many fruits should you eat everyday?

9. How man vegetables should you eat everyday?

10. What are the 5 food groups?
    -
    -
    -
    -
    -

These can be changed to reflect messages you will be teaching this year:

11. We should eat carrots to help our:
    - Eyes
    - Hair
    - Teeth
    - Heart
12. We should eat oranges to help our:
    - Eyes
    - Immune System
    - Lungs
    - Skin

Now we want to know how much you like some foods.
(Please bubble in your answer)

Please note that you may, and are encouraged to, substitute fruits and vegetables that you will be growing in your garden this year.

How much do you like these fruits and vegetables?		I like this a lot	I like this a little	I do not like this	I don't know what this is
Artichokes…… …		O	O	O	O
Broccoli ….		O	O	O	O
Cantaloupe…….		O	O	O	O
Carrots.....		O	O	O	O
Lettuce ……		O	O	O	O
Spinach ……..		O	O	O	O
Strawberries…...		O	O	O	O
Watermelon…..		O	O	O	O

June 19, 2008

WGF REACHES OUT TO ARIZONA

Earlier this month, Western Growers Foundation announced the 2008 Arizona school garden grant and teacher training recipients.

Made possible in part by a Specialty Crop Competitiveness Block Grant from the Arizona Department of Agriculture, Western Growers Foundation is offering 10 Arizona schools a full day of teacher and parent training on garden education from the University of Arizona Cooperative Extension. These schools will also receive $1250 each to implement the skills they learn back at their own school gardens. Grant recipients will also receive a drip irrigation kit courtesy of T-Systems International.

List of grant recipients:
Sunburst Elementary, Glendale
William Jack Elementary, Glendale
Dystart Elementary, El Mirage
Faith North Montessori at Shaw, Phoenix
Sunrise Drive Elementary, Tucson
Borton Primary Magnet School, Tucson
Mendoza Elementary, Mesa
Desert Palms Elementary, Glendale
Foothills Elementary, Phoenix
Arlington Elementary, Arlington

For more information, contact WGF's Briana Lewis (blewis@wga.com) at (949) 885-2259.

# # #

July 16, 2009

WESTERN GROWERS FOUNDATION IMPACTS ARIZONA TEACHERS, STUDENTS

Yesterday, Western Growers Foundation (WGF) provided the tools and resources necessary for ten school gardens to take root in Arizona.

WGF is providing $45,000.00 over three years for 30 Arizona teachers annually to attend a continuing education workshop hosted by the University of Arizona Cooperative Extension in Maricopa County. This program is made possible in part by an Arizona Specialty Crop Block Grant.

This year's workshop, the second of three, was held yesterday in Phoenix.

The University of Arizona Cooperative Extension provides the workshop, which is taught by University of Arizona faculty and Master Gardener volunteers. Schools are selected by WGF, following the May 1 application deadline, to participate in the day-long workshop. WGF also provides $1,250.00 and an irrigation kit for each school to kick off its garden.

"We are thrilled to once again be partnering with the University of Arizona Cooperative Extension to provide tools and skills for Arizona teachers who are eager to start their own school gardens," said Western Growers Foundation Administrator Briana Lewis. "Western Growers Foundation is committed to helping Arizona's students reconnect with their food source and establish healthy eating habits and an active lifestyle. This workshop and the accompanying resources will go a long way toward constructing sustainable learning centers young Arizonans will enjoy for many years in to the future."

For more information, contact WGF's Briana Lewis (blewis@wga.com) at (949) 885-2259.

# # #

July 29, 2010

WGF AWARDS MORE THAN $12,000 TO AZ SCHOOLS

Yesterday, Western Growers Foundation (WGF) provided the tools and resources necessary for ten school gardens to take root in Arizona.

Grants of $1,250 were awarded for a school garden, as well as a one day professional development workshop for three teachers from each school. The training is provided by the University of Arizona Cooperative Extension in Phoenix.

"Western Growers Foundation is committed to helping Arizona's students reconnect with their food source and establish healthy eating habits and an active lifestyle," said Western Growers Foundation Administrator Briana Lewis. "This workshop and the accompanying resources will go a long way toward constructing sustainable learning centers young Arizonans will enjoy for many years in to the future."

The ten Arizona schools include: Ajo Elementary in Ajo, Basha High School in Chandler, Kyrene de las Brisas in Chandler, Pinon Elementary in Pinon, Puente de Hozho Elementary in Flagstaff, Sahuaro High School in Tucson, Tavan Elementary in Phoenix, Tucson High School in Tucson, Wildcat Charter School in Tucson, and Wright Elementary in Tucson.

This is the final year of a three year project, funded in part by The Arizona Department of Agriculture, Agricultural Consultation and Training, using Specialty Crop Block Grant funds provided by USDA, Agricultural Marketing Service.

For more information, contact WGF's Briana Lewis (blewis@wga.com) at (949) 885-2259.

WG Foundation Funds More Schools To Spread the Word

More California and Arizona school children will have access to healthy snacks, nutrition education and information about where their food comes from thanks to the Western Growers Foundation (WGF).

In July, the foundation awarded $15,000 in school garden grants, educator resources and drip irrigation kits (courtesy of John Deere Water) to 10 California garden education programs. Additionally it awarded $1,250 and a one day training program for three teachers to each of 10 Arizona schools.

WGF awards funds in Arizona and California through several distinct garden grant programs. This round of California grants was made possible through funding provided by the Monsanto Fund. The Arizona School Garden and Teacher Training program is funded, in part, through the USDA Specialty Crop Block Grant Program, through the Arizona Department of Agriculture. For this second round of funding in 2010, WGF awarded grants to both after schools programs and schools, as a way to reach an even broader group of children throughout the state.

"We are committed to raising a garden in every school throughout California and Arizona," said WGF Administrator Briana Lewis. "We found, however, that there are many dedicated organizations and eager children participating in after school programs where a garden would provide life-long benefits."

WGF AWARDED GRANTS IN CALIFORNIA TO:

Boys and Girls Club of North San Mateo County South San Francisco
Fort Bragg Middle School, Fort Bragg
Horace Mann Elementary School, Oakland
Marie Curie Elementary School, San Diego
Melrose Math, Science and Technology Magnet Elementary School, Los Angeles
New City Public Schools, Long Beach
Raymond Cree Middle School, Palm Springs
San Jose State University & Notre Dame High School, San Jose
Smart Moves Education and Enrichment Program, Oakland
Tule Elk Park Child Development Center, San Francisco

IN ARIZONA, THE GRANTS WERE AWARDED TO:

Ajo Elementary, Ajo
Basha High School, Chandler
Kyrene de las Brisas Elementary, Chandler
Pinon Elementary School (PUSD), Pinon
Puente de Hozho Elementary, Flagstaff
Sahuaro High School, Tucson
Tavan Elementary School, Phoenix
Tucson High Magnet School, Tucson
Wildcat Charter School, Tucson
Wright Elementary, Tucson

WGF provides financial support to garden enhanced nutrition education programs. These programs serve to connect students to the source of their food and to encourage the increased consumption of fruits and vegetables. This is one remedy to the epidemic of childhood obesity. Current research provides strong evidence that garden-enhanced education increases academic achievement, improves test scores, and increases children's consumption of and preference for fruits and vegetables. These gardens become outdoor classrooms where teachers enrich the curriculum in more than a dozen subjects with hands-on, real world learning.

Western Growers members created WGF to give back to the residents of California and Arizona who have contributed to their success over the years.

The simple, space saving greenhouse at Horace Mann Elementary (a new grant recipient) where students start their seeds before transplanting them into the raised beds.

WG FOUNDATION

Bringing Farming to Life for Arizona Students

By Paul Simonds

From coast to coast food groups, agricultural organizations, locavores, and others are attempting to reconnect consumers with where their food comes from. Through the years, people have lost touch with the fact that the food they enjoy daily somehow, someway originated on a farm. There is an absolute disconnect with who is providing the food.

Who is, better yet, what is a farmer? Recently several classes of third-grade students had the opportunity to meet a couple farmers in Arizona – they now have a pretty good idea of who is providing their food and where it is coming from.

With temperatures hovering above 100 degrees and students already back to school, Western Growers Foundation (WGF) Administrator Briana Lewis stood before a class of third grade students at Cerritos Elementary in Phoenix recently to deliver a $1,250 check, so that the children there could continue to maintain their already-thriving school garden. Lewis engaged in a little give and take with the kids – asking what their favorite vegetable was, or what was their favorite activity in the garden. As her brief dialogue came to an end, she informed the eager pupils that she had brought along a friend – a real-life farmer.

All of a sudden the 30 or so students began to clamor. They gasped, looked around, whispered in excitement to themselves … who and where was this farmer? They didn't see any elderly men in overalls armed with a pitch fork. They didn't see anyone manning a plow. Stationed around the five rows of seats before the garden were a handful of adults – school administrators, volunteers, parents and teachers – most of whom these kids recognized. There was one unfamiliar face – one gentleman who walked forward to join Ms. Lewis at the front of the class.

Dressed in shorts, a flowered shirt, dark sunglasses and a baseball cap to guard against the scorching sun, Western Growers Director and past Chairman of the Board Will Rousseau, Rousseau Farming Company, Tolleson, Ariz., stepped forward and with a smile stretched across his face, said, "I am probably not what you were expecting, am I?"

In that moment the children were silent. They were in awe. They had never met a farmer before, and Rousseau was not what farmers look like in their history books. Rousseau began to paint a verbal picture of what life is like on a farm. He talked about his family farming in the Phoenix area since the late 1800s. He talked about how baby carrots are processed and how watermelons are produced without seeds. As Rousseau spoke, a veil was slowly being lifted – these kids were starting to understand what farming was all about and where their

Will Rousseau fields questions from a third grade class at Cerritos Elementary in Phoenix, Ariz.

food comes from. After speaking for just a few minutes, Rousseau opened it up to questions. The kids wanted to know how many different fruits and vegetables he had grown, the size of his farm, what vegetable he liked most and even questioned him on his age. Before he left, the former WG chairman of the board toured the school's garden and answered questions from the school's volunteers. He even made sure each child walked away with a bag of baby carrots.

"We feel so fortunate to not only have been given this fabulous grant, but also have the pleasure of having Mr. Rousseau give a presentation to our students. We all learned so much from him being here and we are already using the lessons and advice he gave us when harvesting our watermelons," said Sloane Espey, Cerritos Elementary School's garden volunteer.

Through its school garden program, WGF has been reconnecting children with where their food comes from for seven years. To date, the Foundation has had a hand in more than 415 gardens in Arizona and California. Students from 20 more Arizona schools will watch their school gardens flourish this fall thanks to WGF, which partnered with the Arizona Department of Agriculture, Agricultural Consultation and Training and, for the third year in a row, the University of Arizona Cooperative Extension in Phoenix. Throughout the summer, the partnering organizations provided funding, training and resources for these schools to plant or renovate gardens.

▲ *Will Rousseau talks with lead garden volunteer Sloane Espey about how to better care for and harvest watermelons.*

Following the event at Cerritos Elementary, Lewis visited four more schools in the Phoenix area and then headed south to visit four more schools in Tucson. Each school is at a different stage of development in terms of their garden program. Some schools like Hollinger Elementary are well on their way, with a garden program that dates back 16 years. Others, like Anna Henry Elementary, have a team of willing teachers, eager parent volunteers, and a supportive district ready to get their garden growing but have not had the funding to get started. WGF's grant dollars will allow them to do just that.

Though it's not feasible to have a local farmer accompany Lewis to each school she visits, she was flanked by Western Growers member Brent Harrison, Al Harrison Co. Distributors, Nogales, Ariz., when she visited Sunrise Drive Elementary School in Tucson. These students also had never met a farmer. They had no idea what went into getting a watermelon from the field to their lunch boxes, that is until they had heard from Harrison. There was a familiar buzz when Lewis announced she had a farmer with her, and after talking about everything from personal size and seedless watermelons to how the watermelon queen is crowned, Harrison's celebrity grew ten-fold when the third graders found out he had brought seedless watermelon cubes and watermelon activity books to share with them.

▼ *Brent Harrison speaks to third graders at Sunrise Drive Elementary about growing, harvesting, and selecting watermelons in Tucson, Ariz.*

"We are so thankful to the Western Growers members like Will and Brent who volunteer their time to share their knowledge with our partner schools," said Lewis. "Nothing makes the connection to where your food comes from quite like having a real farmer explain the process. Their involvement makes agriculture real for these students."

Lewis also received a tour of the school's joint use garden from three students. Each of these students' families had adopted plots in the community section of the garden. The garden at Sunrise Drive serves as an outdoor classroom not only for the school's students, but the surrounding community as well. The garden has many plots that are available to the community. Community Gardens of Tucson provides educational sessions in the garden once a month.

To support the Foundation, or to express interest in participating in a school event, please contact the Foundation at wgf@wga.com.

FOR IMMEDIATE RELEASE
CONTACT: Paul Simonds, Mgr. Communications
(949) 885-2257/ PSimonds@wga.com
Or
Wendy Fink-Weber, Dir. Communications
(949) 885-2256 / WFWeber@wga.com

WESTERN GROWERS FOUNDATION IMPACTS ARIZONA TEACHERS, STUDENTS

IRVINE (July 14, 2009) – Tomorrow, Western Growers Foundation (WGF) will be providing the tools and resources necessary for ten school gardens to take root in the Grand Canyon State.

WGF, made possible through contributions from the Arizona Department of Agriculture, is providing $45,000.00 over three years for 30 Arizona teachers annually to attend a continuing education workshop hosted by the University of Arizona Cooperative Extension in Maricopa County. The workshop is scheduled from 9 a.m. to 4 p.m. tomorrow, July 15, at the University of AZ Cooperative Extension, Maricopa County at 4341 E. Broadway in Phoenix.
"Many schools and teachers want to have gardens in their school but may not have the necessary knowledge and expertise," said Monica Pastor, University of Arizona Cooperative Extension, Maricopa County director. "Gardens are an ideal way to take science, math, nutrition and language arts lessons and give them a real world application."

The University of Arizona Cooperative Extension hosts the workshop, which is taught by University of Arizona faculty and Master Gardener volunteers. Schools are selected by WGF, following the May 1 application deadline, to participate in the day-long workshop. WGF is also providing $1,250.00 and an irrigation kit for each school to kick off its garden.

"We are thrilled to once again be partnering with the University of Arizona Cooperative Extension to provide tools and skills for Arizona teachers who are eager to start gardens at their schools," said Western Growers Foundation Administrator Briana Lewis. "Western Growers Foundation is committed to helping Arizona's students reconnect with their food source and establish healthy eating habits and an active lifestyle. This workshop and the accompanying resources will go a long way toward constructing sustainable learning centers young Arizonans will enjoy for many years in to the future."

This year, WGF awarded grants to 10 Arizona schools, including: Mountain View Elementary School in Waddell, Mesa View Elementary in Chile, Arts Academy of Mesa in Mesa, Pinnacle Presbyterian Preschool in Scottsdale, Liberty Elementary School in Tucson, Connolly Middle School in Tempe, Collier Elementary in Avondale, Manzanita Elementary in Phoenix, Estes Elementary in Marana, Faith North Montessori in Phoenix and Navajo Elementary School in Scottsdale.

Western Growers Foundation is a 501(c)(3) public charity that supports innovative nutrition education projects and programs to create healthy individuals and communities. These projects include online consumer education through Producepedia.com, school-age outreach with the School Garden Program, and efforts that increase access to fresh fruits, vegetables and nuts. Visit Western Growers Foundation at http://www.wga.com/wgf for more information.

Western Growers is an agricultural trade association whose nearly 3,000 members from Arizona and California grow, pack and ship ninety percent of the fresh fruits, nuts and vegetables grown in California and seventy five percent of those commodities in Arizona. This totals about half of the nation's fresh produce.

# # #

FOR IMMEDIATE RELEASE

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20 ARIZONA SCHOOLS PRIMED TO RAISE SCHOOL GARDENS

IRVINE (August 5, 2010) - Students at 20 Arizona schools will watch their school gardens flourish, as they head back to school this month, thanks to Western Growers Foundation (WGF) who partnered with the Arizona Department of Agriculture (ADA), Agricultural Consultation and Training and, for the third year in a row, the University of Arizona Cooperative Extension (UACE) in Phoenix. Throughout the summer, the partnering organizations provided funding, tools and resources for these schools to raise or renovate gardens.

On Tuesday, WGF announced it had awarded $1,250 and a garden bed kit for 10 Arizona schools. ADA and Agricultural Consultation and Training assisted with this round of funding, using Specialty Crop Block Grant funds provided by the U.S. Department of Agriculture (USDA). Most of these schools are preparing to either plant a school garden for the first time or are in the process of renovating older gardens.

"It's really exciting that so many schools in Arizona are taking an interest in school gardens," said WGF Administrator Briana Lewis. "WGF has funded more than 415 school gardens through the years in Arizona and California. This summer we have really taken great strides toward reaching our dream of seeing a garden take root in every Arizona and California school."

Last week, WGF awarded ten Grand Canyon State schools with a $1,250 garden grant and a day-long professional development workshop for three teachers from each school. This program was funded, in part, by ADA, Agricultural Consultation and Training. UACE staff and Master Gardeners facilitated the day-long school garden training, giving Arizona teachers guidance, fresh ideas and resources to use in their school garden programs.

"We are focused on ensuring that the teachers and administrators who share our passion for school gardens have the knowledge and expertise needed to raise-up a successful outdoor classroom," said Monica Pastor, University of Arizona Cooperative Extension, Maricopa County director. "We believe that gardens are an ideal way to take science, math, nutrition and language arts lessons and give them a real world application."

Western Growers Foundation is a 501(c)(3) public charity that supports innovative nutrition education projects and programs to create healthy individuals and communities. These projects include online consumer education through Producepedia.com, school-age outreach with the School Garden Program, and efforts that increase access to fresh fruits, vegetables and nuts. Visit Western Growers Foundation at http://www.wga.com/wgf for more information.

# # #

Borton Primary Magnet School

Estes Elementary

Foothills Elementary, Phoenix

William Jack Elementary, Glendale

Sunrise Drive Elementary, Tucson

Faith North Montessori, Phoenix

Appendix G
referenced from page 17

ECONOMIC CONTRIBUTIONS OF ARIZONA'S GREEN INDUSTRY -- 2007

Compiled by:
Arizona Field office
USDA - National Agricultural Statistics Service

Submitted to:
Arizona Nursery Association
Arizona Landscape Contractors Association

October 2008

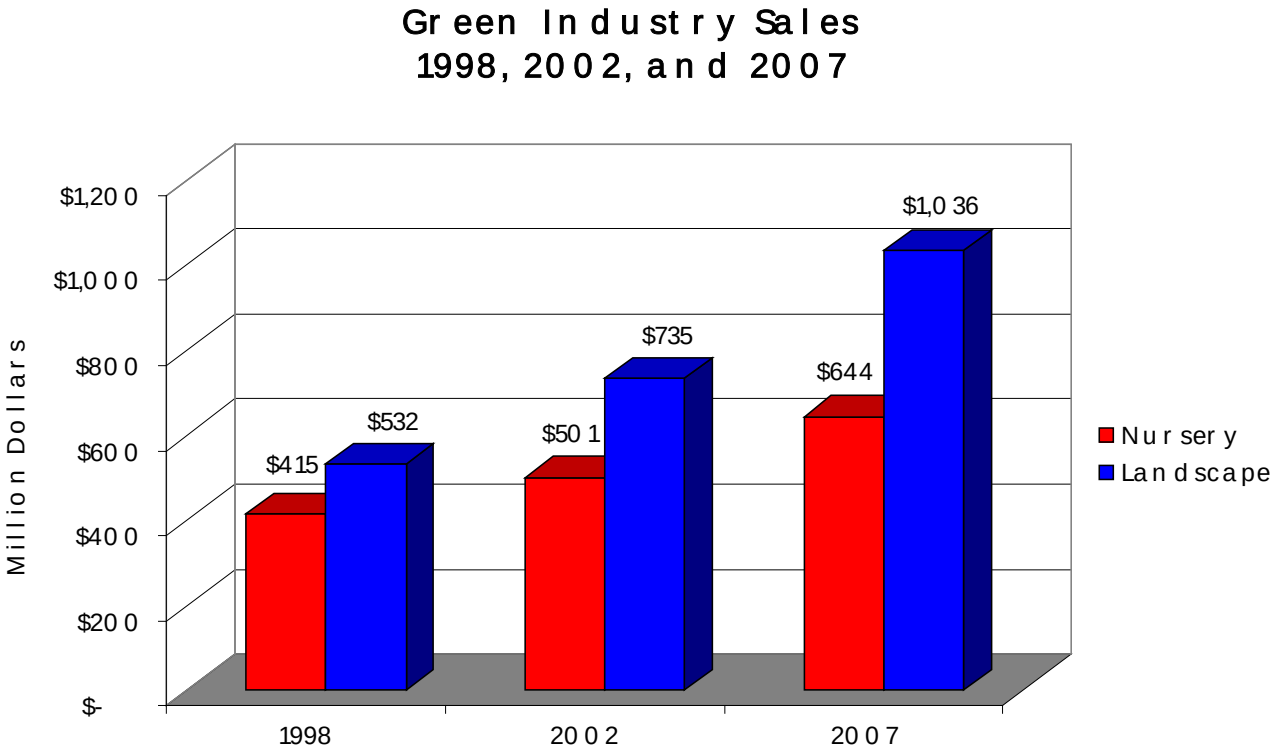
Arizona's green Industry – 2007
A Billion Dollar Industry

Sales continued to rise between 2002 and 2007 by an impressive 36 percent. Since 1998, sales from the nursery and landscape Services sector have grown by more than $700 million. Nursery sales totaled $644 million in 2007. Landscape service firms had sales of $1,036 million.

Green Industry Total Sales

Sector	1998	2002	2007	2007 As % of 2002
	Million Dollars			*Percent*
Nursery	**415**	**501**	**644**	**29**
Landscape Services	**532**	**735**	**1,036**	**41**
Total Green Industry	**947**	**1,236**	**1,680**	**36**

Green Industry Sales: $1.68 Billion

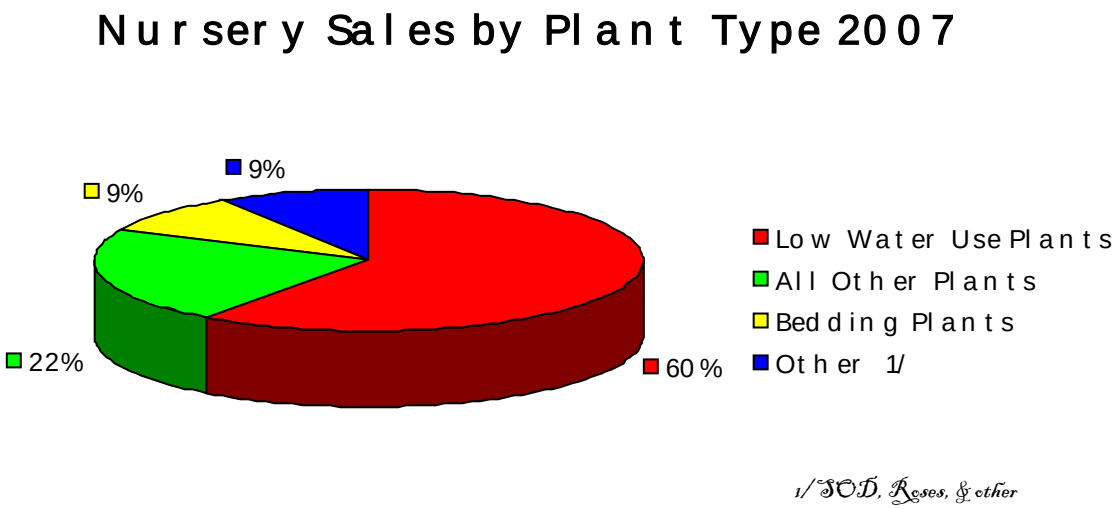


Total Nursery Sales: $644 Million

Low Water Use Plant Sales: $386 Million

Bedding and all other plant types: $258 million

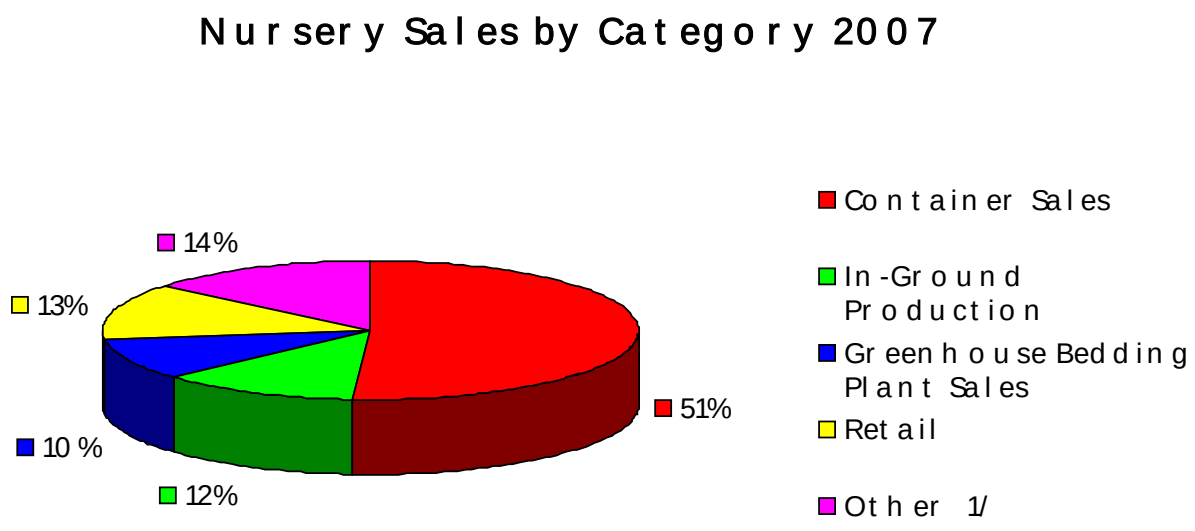
Sales of low water use plants continued to increase and accounted for 60 percent of all sales. Sales of other types of plants totaled 22 percent.



1/ SOD, Roses, & other

Total Nursery Sales: $644 Million Container Plant Sales: $328 million
All other sales: $316 million

Container Sales accounted for 51 percent of all nursery plant sales in 2007. sales of greenhouse bedding plants and in-ground production accounted for an additional 22 percent.



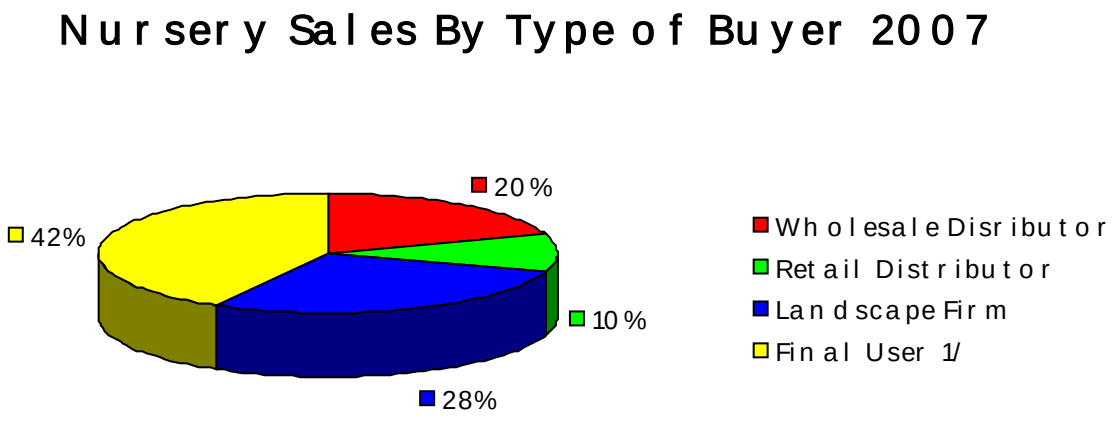
1/ Sod, Rewholesale, salvage & other

Total Nursery Sales: $644 Million

Sales To retail & Landscape Firms: $451 Million

All other buyers: $193 million

Retail Distributors, Retail Establishments and Landscape Service Firms accounted for 70 percent of the Nursery Production purchased in 2007.

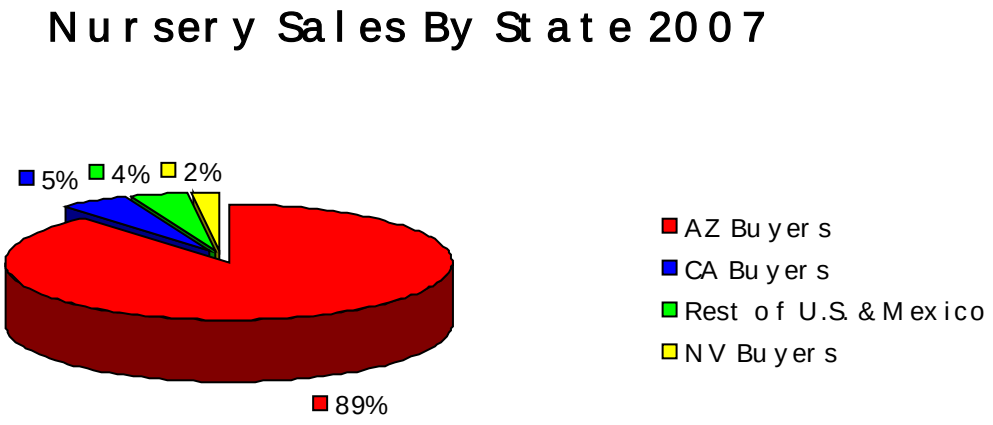


1/ Generally a retail customer

Total Nursery Sales: $644 Million

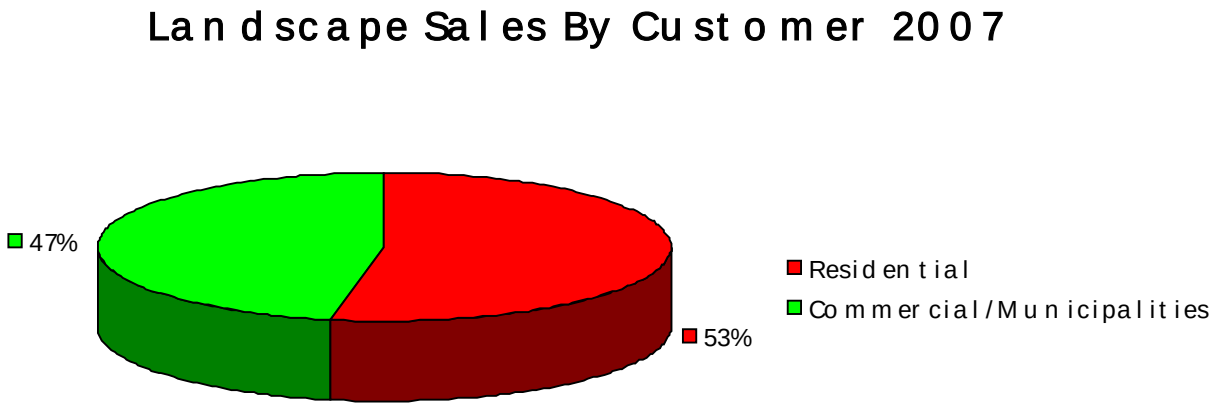
Nursery Sales to Arizona buyers: $573 million
sales to Nevada and California buyers: $39 million

Eighty-nine percent of all nursery sales in 2007 involved Arizona buyers. The second largest market for Arizona nursery production was California.



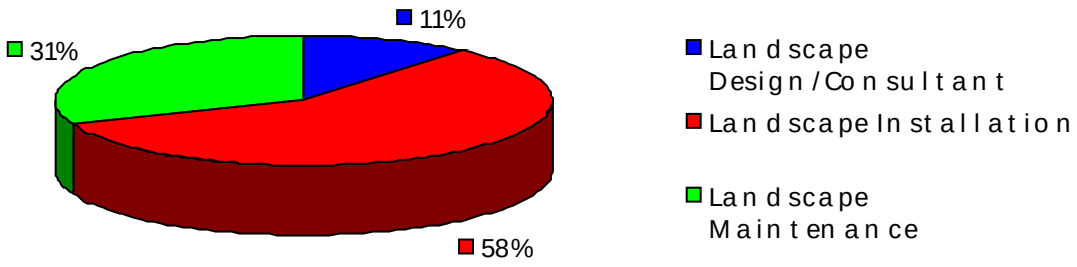
Landscape service firm sales:
$1.036 billion

Gross revenues from landscape service firms were split fairly evenly between residential customers and commercial/municipalities. Fifty-three percent of all sales were to residential customers.



TOTAL LANDSAPE SERVICE FIRM SALES: $1.036 BILLION

Landscape service installation sales: $601 million
Landscape service maintenance sales: $321 million
LANDSCAPE DESIGN SALES: $114 MILLION



Landscape Service Firms:

Total Gross sales by activity and type of customer - 2007

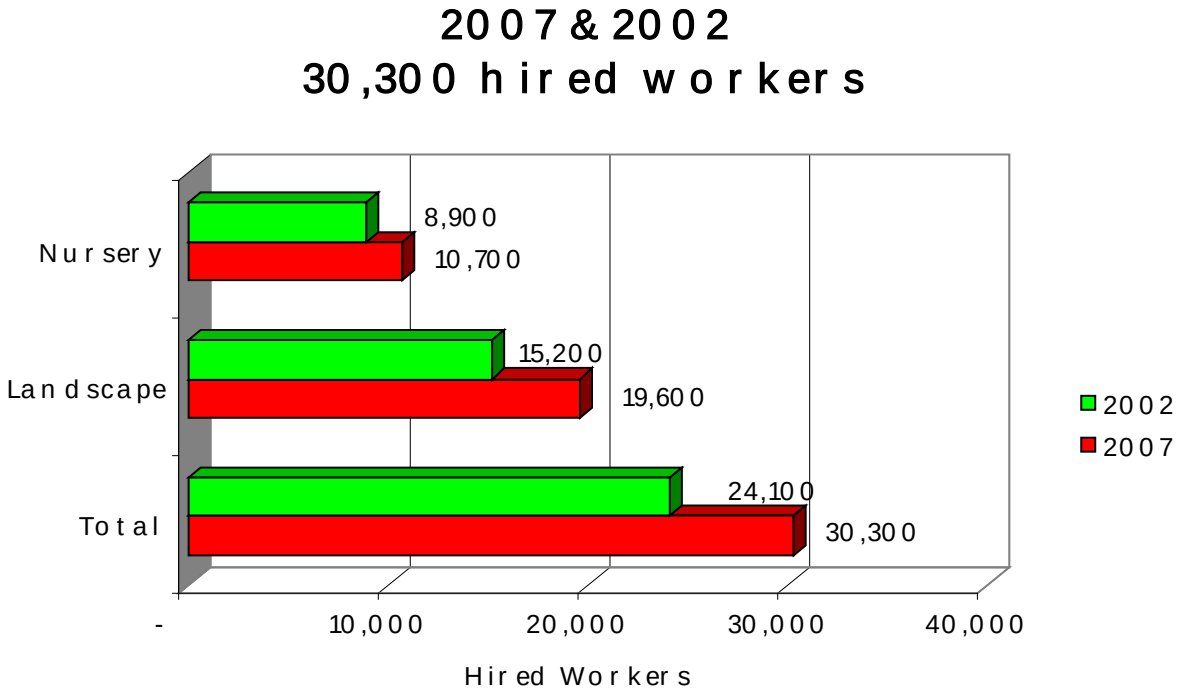
Activity	Type of customer		
	Residential	Commercial	Public
	Million Dollars		
Landscape design/consulting	66	38	10
Landscape installation	234	336	30
Landscape maintenance	116	193	13
total	416	567	53

Arizona's green Industry employment

The green industry provided direct employment to 30,300 hired workers in 2007, an increase of 26 percent since 2002. Since 1998, more than 10,000 workers have been added to the industry.

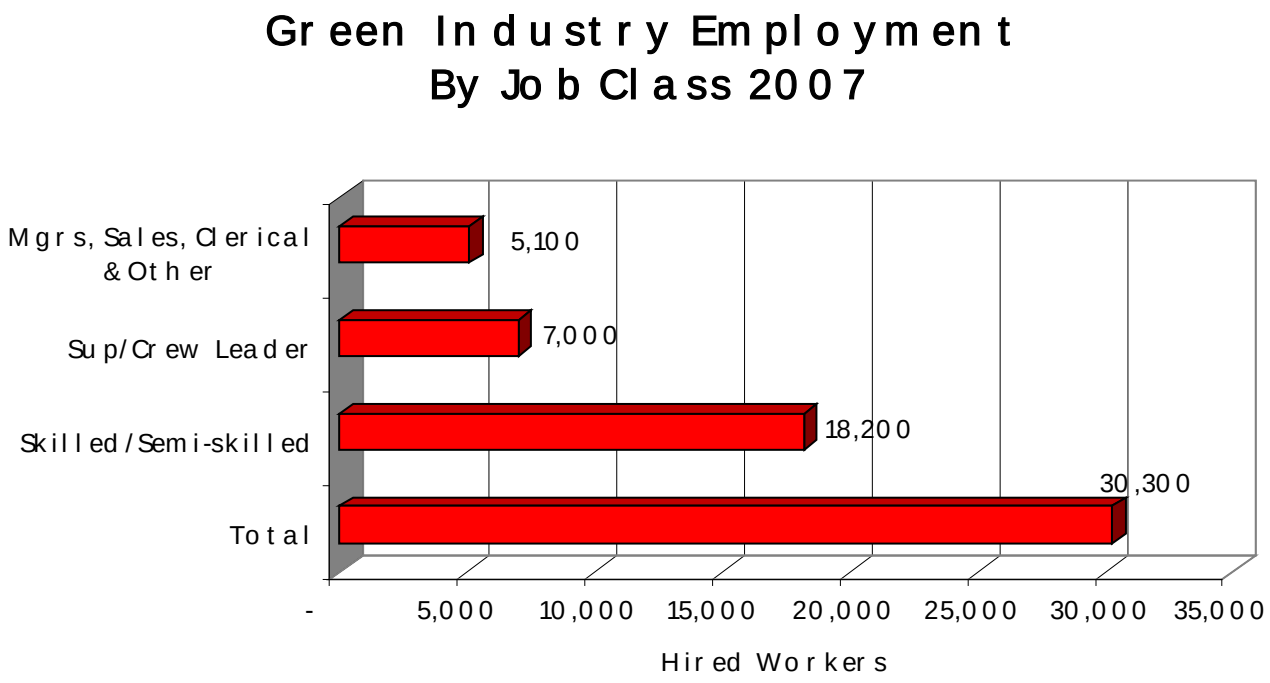
Green industry employment				
Sector	**1998**	**2002**	**2007**	**2007 as %of 2002**
		Hired workers		***Percent***
Nursery	**8,827**	**8,900**	**10,700**	**20**
Landscape services	**10,618**	**15,200**	**19,600**	**29**
Total green industry	**19,445**	**24,100**	**30,300**	**26**

Green industry employment:



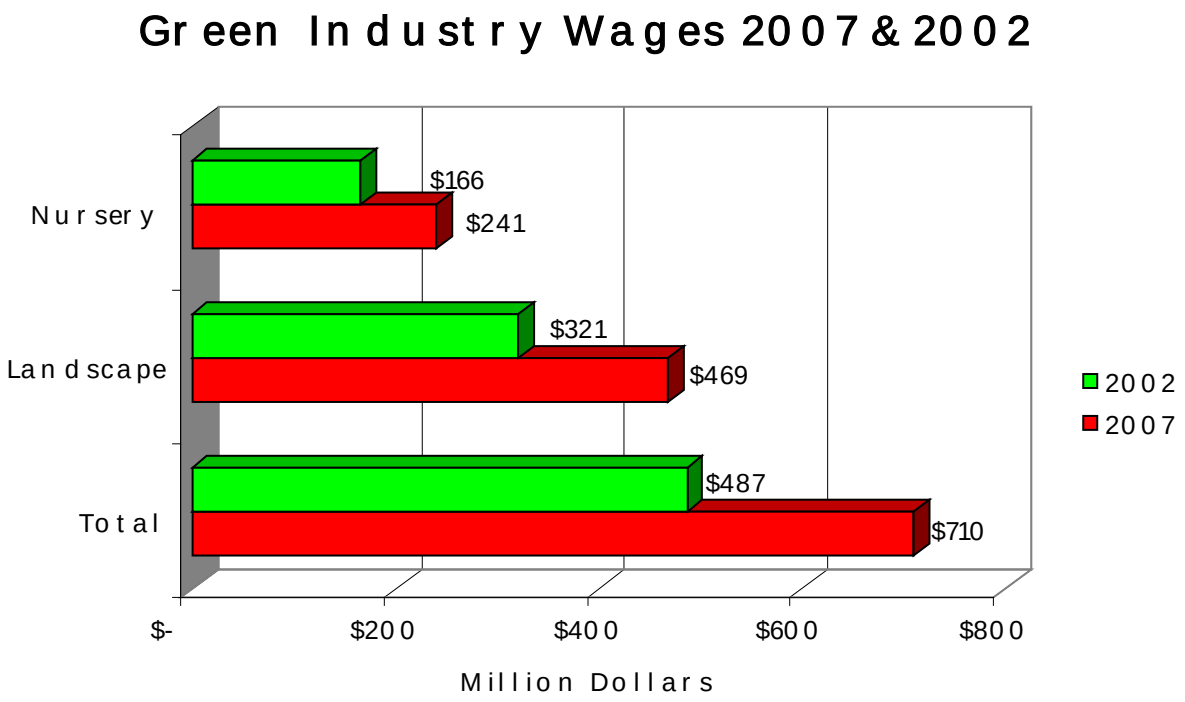
Green Industry Employment

Eighty- three percent of all green industry workers were classified as skilled or semi-skilled workers in 2007. Supervisors/crew leaders accounted for 23 percent of the total. Other workers totaled 17 percent.



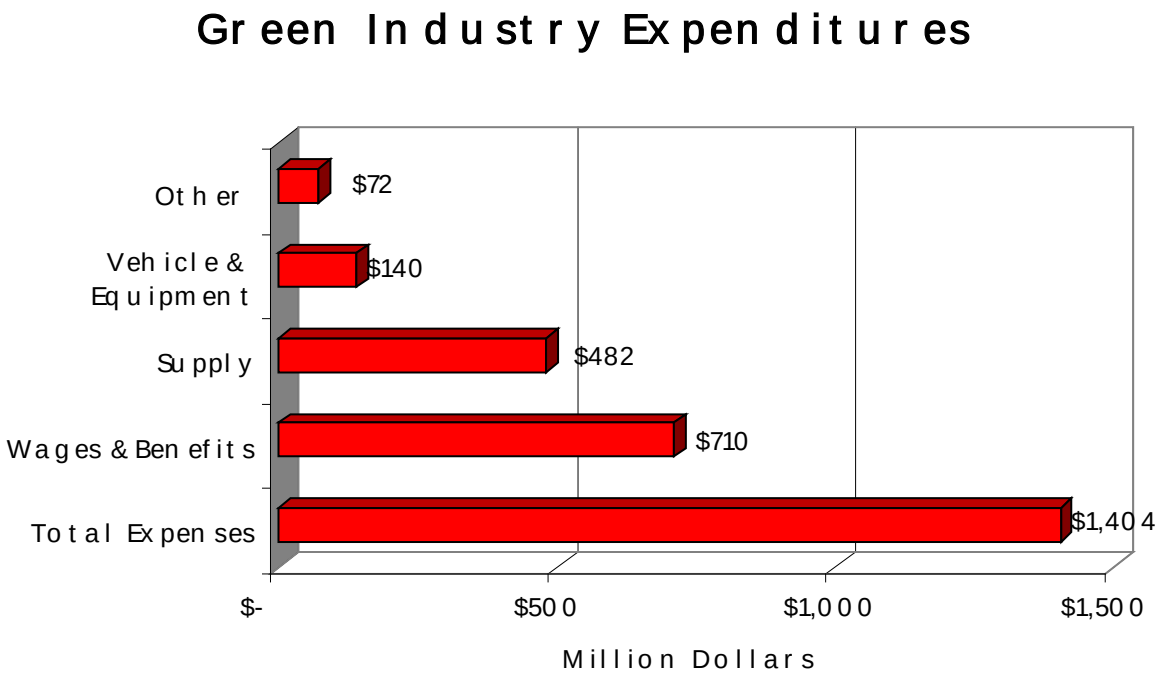
Green industry wages: $710 Million

The green industry continues to make a huge contribution to arizona's economy. Direct wages paid to green industry hired workers totaled $710 million in 2007, up 46 percent since 2002. The average salary received by green industry workers rose by 16 percent over that same period.



Green industry expenditures: $1.404 billion

The green industry spent more than $1.4 billion dollars on wages, supplies, vehicles and equipment, and other business expenses. Expenditures totaling more than a billion dollars make the green industry one of the most important agricultural sectors.



Green industry expenditures

Expense item	Total
	millions
Wages and benefits	**710**
Plant materials	300
Rock and soil amendments	54
Container and greenhouse supplies	43
Fertilizer and chemicals	17
Irrigation and other supply expenses	69
Total supply expenses	**482**
Vehicle lease/purchase	60
Fuel, motor oil, and all other vehicle or equipment expenses	80
Total vehicle and equipment expenses	**140**
All other business expenses	**72**
Total expenses (all categories)	**1,404**

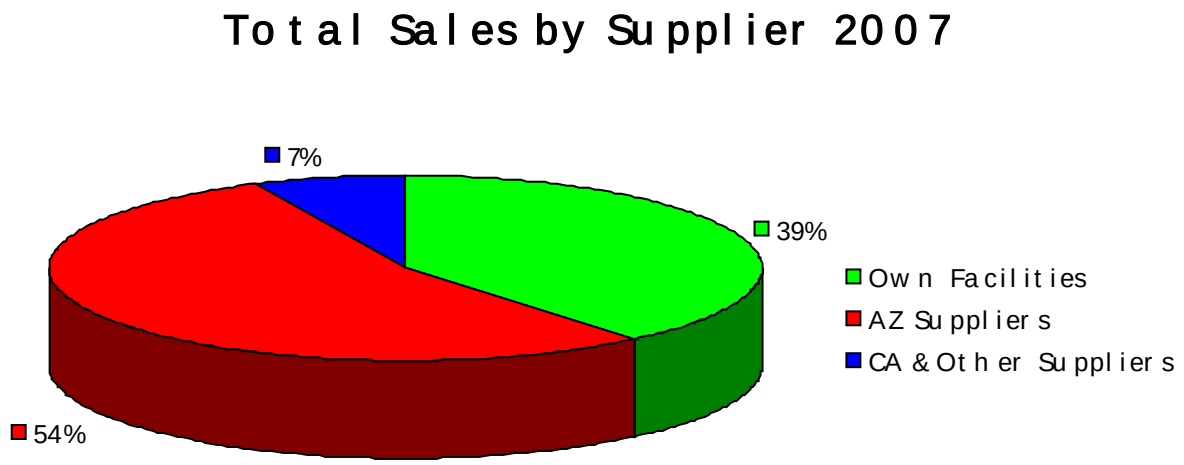
Total green industry expenses
1998, 2002, and 2007

Expense item	1998	2002	2007	2007 as % of 2002
		Million dollars		*percent*
wages and benefits	307	487	710	46
supply	225	359	482	34
vehicle and equipment	60	106	140	32
all other	33	58	72	24
Total expenses (all categories)	625	1,010	1,404	39

Other Statistics

Total Green Industry Sales by supplier

More than one-half of all green industry sales of plants and planting materials came from Arizona suppliers. Thirty-nine percent came from their own fields, Nurseries, or greenhouses.



Hourly wage average and annual salary by type of worker - 2007

Worker type	Hourly wage	Annual salary
	Dollars	
Laborer – nursery	8.86	17,963
Laborer – landscape	9.81	22,410
Field supervisor – landscape	13.34	49,935
Crew leader – landscape	14.58	33,448
Sales reps – nursery & landscape	18.63	74,200
Bookkeepers – nursery & landscape	13.79	39,793
Office managers – nursery & landscape	23.04	59,708

Ranking of the factors that affect the ability of a green industry establishment to expand in Arizona - 2007

Factors limiting ability to expand				
Factor	Least Effect 1	Somewhat effected 2	Most Effected 3	Not effected
	Percent			
Water supply	33	32	18	17
Hourly labor availability	12	26	50	12
Ability to hire managers	26	19	41	14
Land availability	52	17	11	20
Competition	32	45	12	11
Government regulations	18	34	36	12
Market demand	18	38	37	7
Availability of capital	30	35	25	10

Number of nursery or landscape service locations – 2007

Item	Number
Number of locations in Arizona	900
Total number of locations – all states	1,000

Number of acres in production, Arizona – 2007

Total acres	11,200

Percent of gross sales earned from business conducted in Arizona - 2007

Gross sales in Arizona	98%
Gross sales in other states	2%

Percent of green industry establishments By business structure – 2007 and 2002

	2007	2002
Sole proprietorship	19%	23%
Partnership	2%	- - -
Corporation	55%	64%
Llc	24%	11%
other	- - -	2%

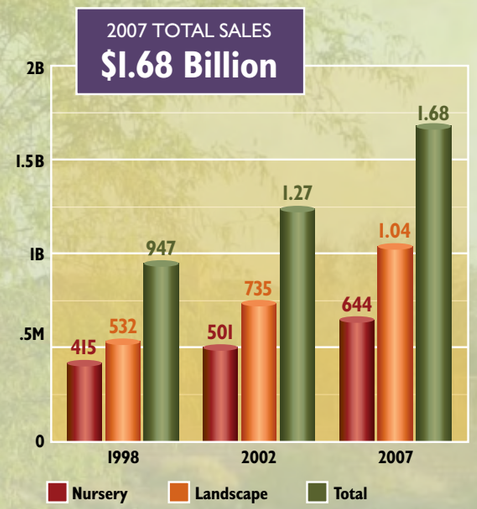
Percent of green industry establishments by year started – 2002 and 2007

	30+ years	30-21 years	20-10 years	Less than 10 years	Percent est. in last 20 yrs.
Year Company established					
2002	12%	26%	27%	35%	62%
2007	17%	25%	28%	30%	58%
Year Company Established In Arizona					
2002	12%	25%	26%	37%	63%
2007	15%	25%	26%	34%	60%

Percent of green industry Establishment by city where headquarters is located - 2007

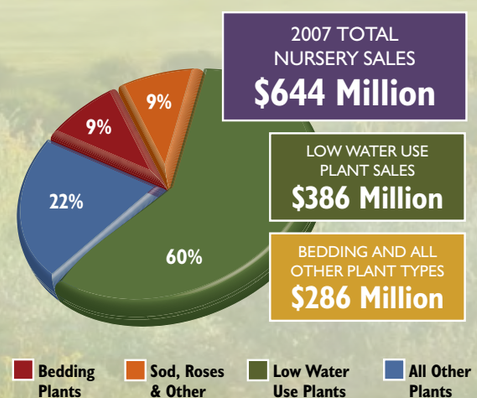
Headquarter city	Percent
Phoenix	29
Tucson	19
Scottsdale	6
Mesa	4
Yuma	3
Cave Creek	2
Chandler	2
Dewey	2
Florence	2
Glendale	2
Litchfield Park	2
Prescott	2
Sun City	2
Tempe	2
Waddell	2
Other	19
total	100

Green industry sales totaled $1.68 billion with an impressive 36 percent rise since 2002.



GREEN INDUSTRY TOTAL SALES

Sales continued to rise between 2002 and 2007 by an impressive 36 percent. Since 1998, sales from the nursery and landscape services sector have grown by more than $700 million. Nursery sales totaled $644 million in 2007 with an increase of 29 percent. Landscape service firms had sales of $1.04 billion with an astounding increase of 41percent.



NURSERY SALES BY PLANT TYPE

Sales of low water use plants continued to increase and accounted for 60 percent of all sales. Sales of other types of plants totaled 22 percent.

COMPILED BY

Arizona NASS
1400 Independence Ave., SW
Washington, DC 20250
www.nass.usda.gov/az

ISSUED BY

Arizona Nursery Association
1430 W. Broadway, Suite
Tempe, Arizona 85282
info@azna.org

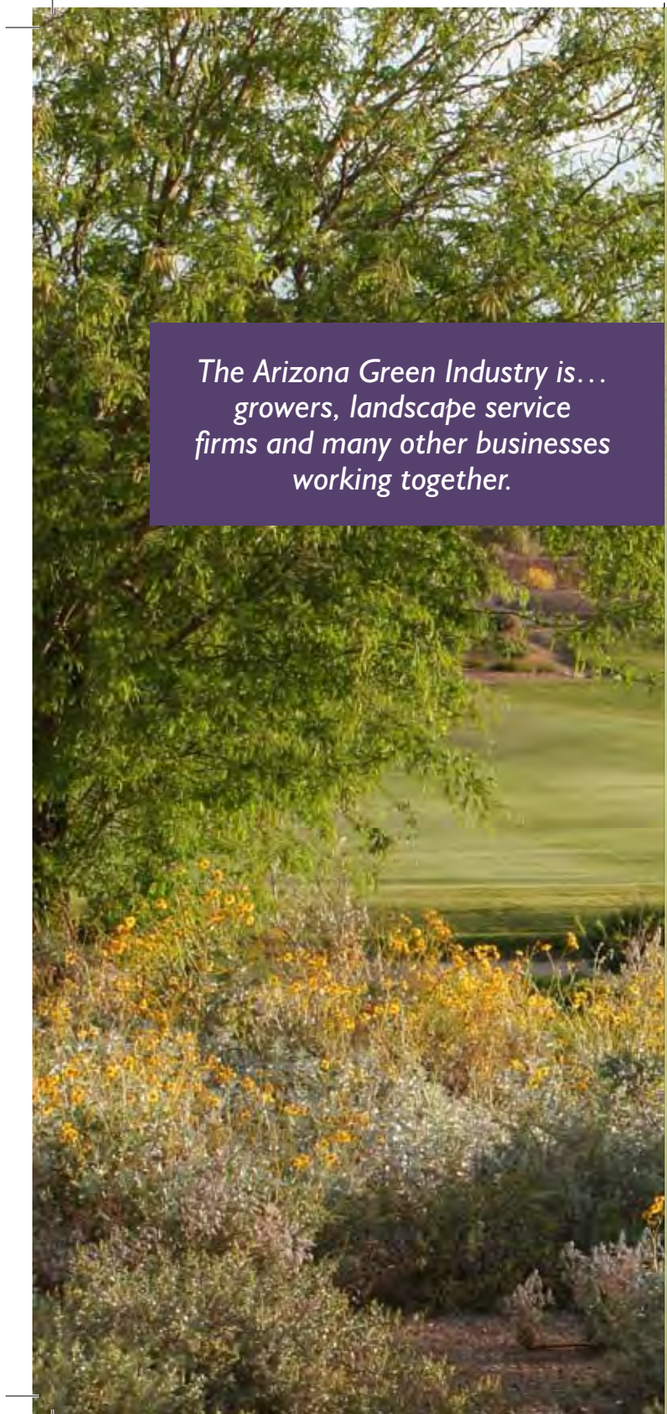
Arizona Landscape Contractors Association
5425 E. Bell Road, Ste. 105
Scottsdale, AZ 85254
judy@azlca.com

THE ECONOMIC IMPACT OF Arizona's Green Industry

2007 INDUSTRY REPORT

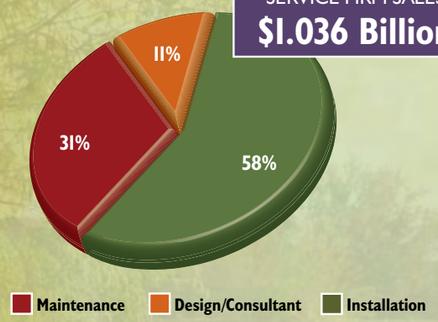
Photography courtesy of Bart Worthington

File Name: ANA_IndustryReport07_01.indd Overall Size: 15" x 8.5" Folded Size (4 panels) 3.8" x 8.5" Designer: Olive Street Productions 480-518-0396



The Arizona Green Industry is… growers, landscape service firms and many other businesses working together.

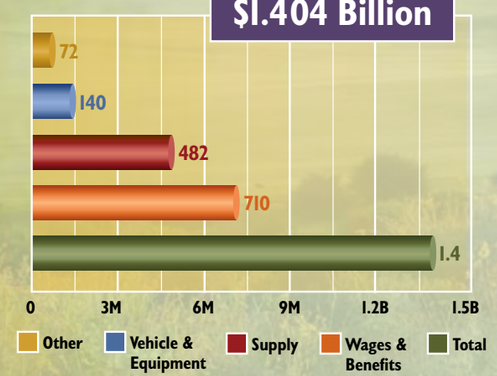
2007 TOTAL LANDSCAPE SERVICE FIRM SALES
$1.036 Billion



LANDSCAPE SALES BY CATEGORY

Landscape Service Installation Sales: $601 Million
Landscape Service Maintenance Sales: $321 Million
Landscape Design Sales: $114 Million

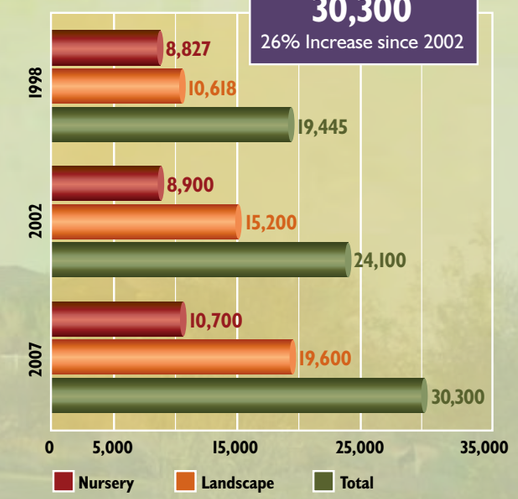
2007 TOTAL EXPENSES
$1.404 Billion



GREEN INDUSTRY EXPENDITURES

The green industry spent more than $1.4 billion dollars on wages, supplies, vehicles and equipment, and other business expenses. Expenditures totaling more than a billion dollars make the green industry one of the most important agricultural sectors.

2007 EMPLOYMENT
30,300
26% Increase since 2002



GREEN INDUSTRY EMPLOYMENT

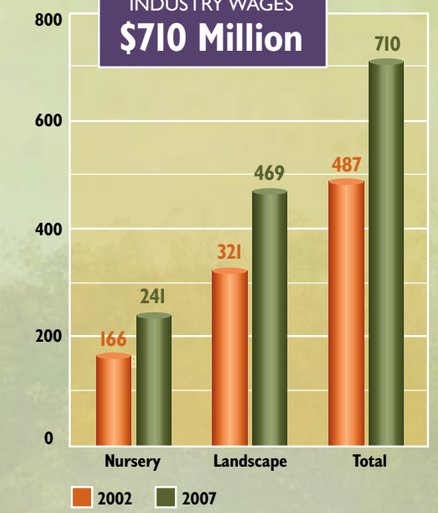
The green industry provided direct employment to 30,300 hired workers in 2007, an increase of 26 percent since 2002. Since 1998, more than 10,000 workers have been added to the industry.

2007 EMPLOYMENT
30,300

EMPLOYMENT BY JOB CLASS

Eighty- three percent of all green industry workers were classified as skilled or semi-skilled workers in 2007. Supervisors/crew leaders accounted for 23 percent of the total. Other workers totaled 17 percent.

2007 GREEN INDUSTRY WAGES
$710 Million



GREEN INDUSTRY WAGES

The green industry continues to make a huge contribution to arizona's economy. Direct wages paid to green industry hired workers totaled $710 million in 2007, up 46 percent since 2002. The average salary received by green industry workers rose by 16 percent over that same period.

NURSERY	HOURLY WAGE	ANNUAL SALARY
Laborer	8.86	17,963
Sales Reps	18.63	74,200
Bookkeepers	13.79	39,793
Office Managers	23.04	59,708

LANDSCAPE	HOURLY WAGE	ANNUAL SALARY
Laborer	9.81	22,410
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Crew leader	14.58	33,448
Sales reps	18.63	74,200
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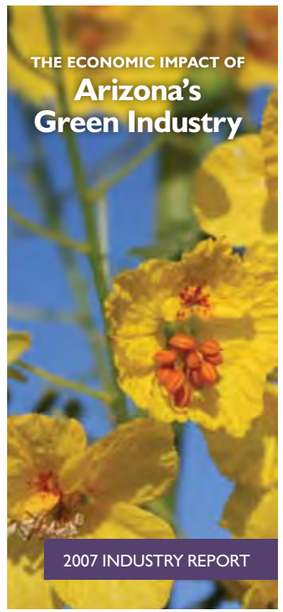
Office managers	23.04	59,708

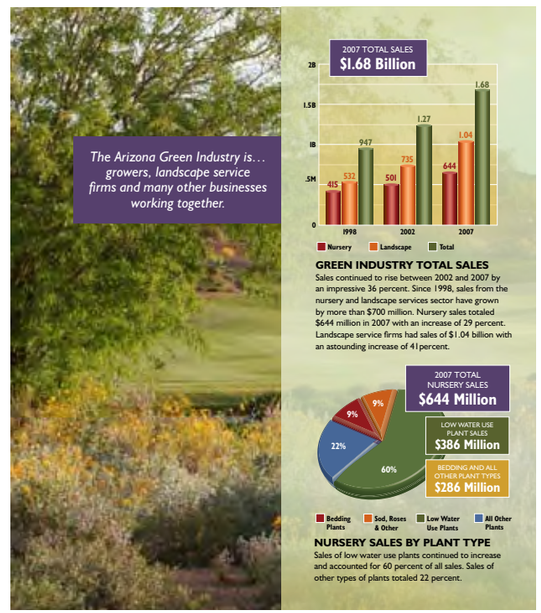
AVERAGE WAGE & SALARY

File Name: ANA_IndustryReport07_01.indd Overall Size: 15" x 8.5" Folded Size (4 panels) 3.8" x 8.5" Designer: Olive Street Productions 480-518-0396



Cover

Back Cover



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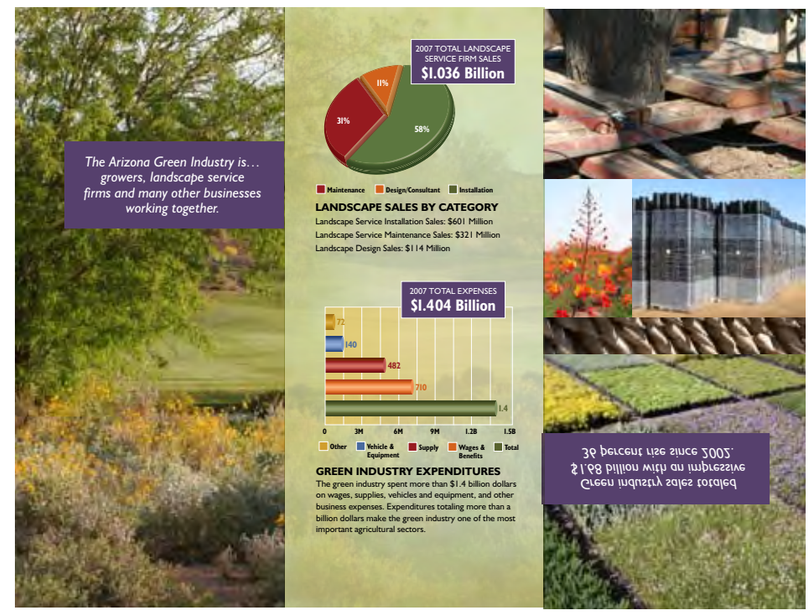
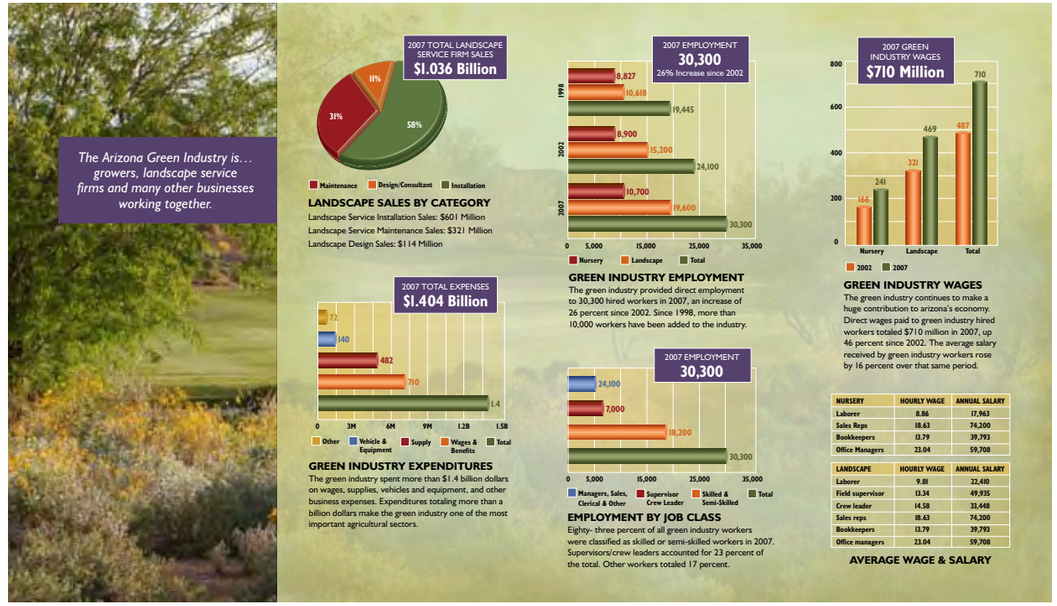


2nd fold



fully open

[PDF] Project Title: Field Monitoring of the **Cucurbit Yellow Stunting ...**File Format: PDF/Adobe Acrobat - Quick View
Kurt Nolte (**Extension** Agent, **Yuma County**, mapping of **virus** and **... Cucurbit Yellow Stunting Disorder Virus** (CYSDV) is a white-fly (Bemisia **...**

ag.arizona.edu/apmc/reports/Taylor_propopoal.pdf - Similar
UC IPM: UC Management Guidelines for **Cucurbit Yellow Stunting ...**Symptoms of **Cucurbit yellow stunting disorder virus** infection can be confused with **...** it was high in fall-planted melons in the Imperial and **Yuma** Valleys in both years. **...** T. A. Turini, UC Cooperative **Extension**, Imperial **County ...**www.ipm.ucdavis.edu/PMG/r116100211.html - Cached - Similar
Yuma County melon growers plan another CYSDV host-free period**Yuma County**, Ariz. melon growers are planning a voluntary host-free **...** help reduce the movement of **cucurbit yellow stunting disorder virus** (CYSDV) **...** Kurt Nolte, director, University of Arizona (UA) **Yuma County** Cooperative **Extension**, **..**westernfarmpress.com/mag/farming_**yuma_county**_melon/
Proactive efforts under way to minimize CYSDV losses in fall **...**The menace is the **cucurbit yellow stunting disorder virus** (CYSDV) that infects **... Yuma County** Cooperative **Extension** agent Kurt Nolte and Yuma Agricultural westernfarmpress.com/mag/farming_proactive_efforts_minimize/ - Cached
ANR IMPACT - **Cucurbit yellow stunting disorder**: A new disease in **...**In the fall of 2006, **cucurbit yellow stunting disorder** symptoms were found in **...** The **virus** was identified in melons and squash grown in Imperial **County**, **...** the University of Arizona Cooperative **Extension** to hold meetings in the **Yuma ..**ucanr.org/delivers/impactview.cfm?impactnum=60
A New Expanded Host Range of <italic>**Cucurbit yellow stunting ...**by WM Wintermantel - 2009 - Related articles - All 15 versions host range of **Cucurbit yellow stunting disorder virus** includes three **... Yuma County**, AZ, that were confirmed to be infected with CYSDV using primers to **...**apsjournals.apsnet.org/doi/abs/10.1094/PDIS-93-7-0685
Strategies to Fight a Whitefly-borne Melon **Virus** - 2009 report**Yuma County** melon producers suffered crop losses of 60 percent or more to the whitefly-transmitted **Cucurbit yellow stunting disorder virus** (CYSDV) when it **...** Yuma Agricultural Center (YAC), **Yuma County** Cooperative **Extension** and local **..**cals.arizona.edu/impacts/2009/2_2.html
Virus striking melon plants in **Yuma County**, Sonora The **virus** - **cucurbit yellow stunting disorder virus**, or CYSDV - first appeared in **Yuma** in **...** agriculture agent with the **Yuma County** Cooperative **Extension**. **...**www.tucsoncitizen.com/daily/local/45844.php
Article: To contain **virus**, farmers, gardners being asked to **...**The **cucurbit yellow stunting disorder virus** (CYSDV) has emerged as a new and **...** an agriculture agent with the **Yuma County** Cooperative **Extension**. **...** www.highbeam.com/doc/1G1-164611708.html
SeedQuest - Central information website for the global seed industry**Cucurbit yellow stunting disorder virus** (CYSDV) strikes melons in **Yuma County**, Arizona **...** agriculture agent with the **Yuma County** Cooperative **Extension**. www.seedquest.com/News/releases/2007/april/19050.htm
Success Through Efficient Management - GrowingDr. John Palumbo, UA research scientist and **extension** specialist, notes that a new **virus** transmitted by whiteflies, **cucurbit yellow stunting disorder virus**, is currently a major concern in **Yuma County**, but did not affect spring melons. **...**www.growingmagazine.com/article.php?id=4009
Growing**Cucurbit yellow stunting disorder virus** (CYSDV) is transmitted by the whitefly **...** and Dr. Kurt Nolte, **Yuma County Extension** director, are working to help **...**www.growingmagazine.com/article.php?id=3997
[PDF] Fighting a Melon **Virus** in **Yuma County** YFile Format: PDF/Adobe Acrobat - View as HTML
Cucurbit yellow stunting disorder virus (CYSDV) when it first appeared in 2006. **...** Agricultural Center (YAC), **Yuma County** Cooperative **Extension** ag.arizona.edu/pubs/general/resrpt2008/article7.pdf

[PDF] Effects of timing infection by **Cucurbit yellow stunting disorder** **...**File Format: PDF
Location where work will be performed: Westside Research and **Extension** Center **...** Thomas A. Turini, Vegetable Crops Farm Advisor, Fresno **County** **....** melons in **Yuma** (July 10), we were unable to evaluate CYSDV incidence beyond this **....** Emergence of **Cucurbit yellow stunting disorder virus** (CYSDV) in the desert **...**www.cmrb.org/uploads/files/20080923134044.pdf
[PDF] Imperial **County** Imperial **County** Agricultural BriefsFile Format: PDF/Adobe Acrobat - View as HTML
Cucurbit yellow stunting disorder virus (CYSDV) genus Crinivirus. **.....** Nolte, Area Agriculture Associate Agent, UA Cooperative **Extension**, **Yuma County**; **...**
ceimperial.ucdavis.edu/newsletterfiles/Ag_Briefs12757.pdf

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2008 ESA Annual Meeting, November 16-19, 2008: IPM Strategies for **.....** incidence of **cucurbit yellow stunting disorder virus** in southwestern Arizona **...** Stacey Bealmear , **Yuma County** Cooperative **Extension**, The University of Arizona esa.confex.com/esa/2008/webprogram/Paper36344.html
Tracking a Whitefly-Transmitted **Cucurbit Virus** in Melons | UANews.orgJun 24, 2009 **...** The whitefly-transmitted **Cucurbit yellow stunting disorder virus**, or CYSDV, **...** research faculty and **extension** specialists from the UA in **Yuma**, Maricopa, **...** to growers through our on-site **county** agents and researchers. **...**uanews.org/node/26168
[PDF] 2008 University of Arizona Combined Research and **Extension** Annual **...**File Format: PDF/Adobe Acrobat - Quick View
Yuma County melon producers suffered crop losses of 60 percent or more to the whitefly-transmitted **Cucurbit yellow stunting disorder virus** (CYSDV) when it **...**
www.reeis.usda.gov/.../2008-University-of-Arizona-Combined-Research-and -**Extension**-Annual-Report-of-Accomplishments-and-Results.pdf

Fresh from the Field - Agri-Bytes July 2009 - Fresh from the Field **...**If you should trap adult moths, contact your local **county** **Extension** agent, **...** The whitefly-transmitted **cucurbit yellow stunting disorder virus** was first **...** In the **Yuma**, Ariz., area, John Palumbo, a University of Arizona research
www.citrusandvegetable.com/Newsletter/.../tabid/.../Default.aspx?... – Cached

Table 1: Survival of E. coli ATCC 25253 introduced to a romaine lettuce field through different irrigation systems during early season (January, 2008) in Yuma, Arizona.

Irrigation Method	Source	Day 1	Day 7	Day 14
Sprinkler	Soil	160[b]	<10	20[a]
Drip	Soil	<10	<10	<10
Furrow	Soil	10[a]	136.6667	<10
Sprinkler Inside Cont	Leaves (Internal)	70[a]	<10	.
Sprinkler Outside	Leaves (External)	2033333	<10	.
Sprinkler Inside	Lettuce (Internal)	240666.7	<10	.
Drip	Leaves	<10	<10	.
Furrow	Leaves	<10	<10	.

[a] One positive sample, [b] Two positive samples. Inoculation of water and irrigation was done on day one 4 hours prior to microbial analysis.

Table 2: Survival of E. coli ATCC 25253 introduced to an iceberg lettuce field through different irrigation systems during early season (January, 2008) in Yuma, Arizona.

Irrigation Method	Source	Day 1	Day 7	Day 15
Sprinkler	Soil	3000[a]	20[a]	<10
Drip	Soil	146.6667	90[a]	<10
Furrow	Soil	1033.333	476.6667	20[a]
Sprinkler Outside	Lettuce	21925[b]	<10	.
Sprinkler Inside	Lettuce	170	<10	.
Drip	Lettuce	<10	<10	.
Furrow	Lettuce	<10	<10	.

[b] Two positive samples. Inoculation of water and irrigation was done on day one, 4 hours prior to microbial analysis.

Table 3: Survival of E. coli ATCC 25253 introduced to a romaine lettuce field through different irrigation systems during late season (March, 2008) in Yuma, Arizona.

Irrigation Method	Source	Day 1	Day 3	Day 10
Drip Control	Soil	<10	<10	<10
Furrow Control	Soil	<10	<10	<10
Sprinkler	Soil	670	50b	<10
Drip	Soil	470	186.6667	<10
Furrow	Soil	840	3133.333	10a
Sprinkler Ins Control	Lettuce	<10	<10	<10
Furrow Control	Lettuce	<10	<10	<10
Sprinkler Outside	Lettuce	250000	96966.67	10a
Sprinkler Inside	Lettuce	1686.667	506.6667	<10
Drip	Lettuce	<10	<10	<10
Furrow	Lettuce	<10	<10	<10

Table 4. Survival of *E. coli* ATCC 25253 introduced to an iceberg lettuce field through different irrigation systems during late season (March, 2008) in Yuma, Arizona.

Irrigation Method	Source	Day 1	Day 3	Day 10	Day 15
Drip Control	Soil	<10	<10	30a	<10
Furrow Control	Soil	<10	<10	10a	<10
Sprinkler	Soil	1293.333	<10	<10	<10
Drip	Soil	413.3333	<10	<10	<10
Furrow	Soil	3700	2076.667	20a	<10
Sprinkler Ins Control	Lettuce (Internal leaves)	<10	<10	10a	<10
Sprinkler Outside	Lettuce	1600a	580	<10	<10
Sprinkler Inside	Lettuce	<10	20a	<10	<10
Furrow Control	Lettuce	<10	<10	50a	<10
Drip	Lettuce	20b	<10	40a	<10
Furrow	Lettuce	<10	820a	50a	<10

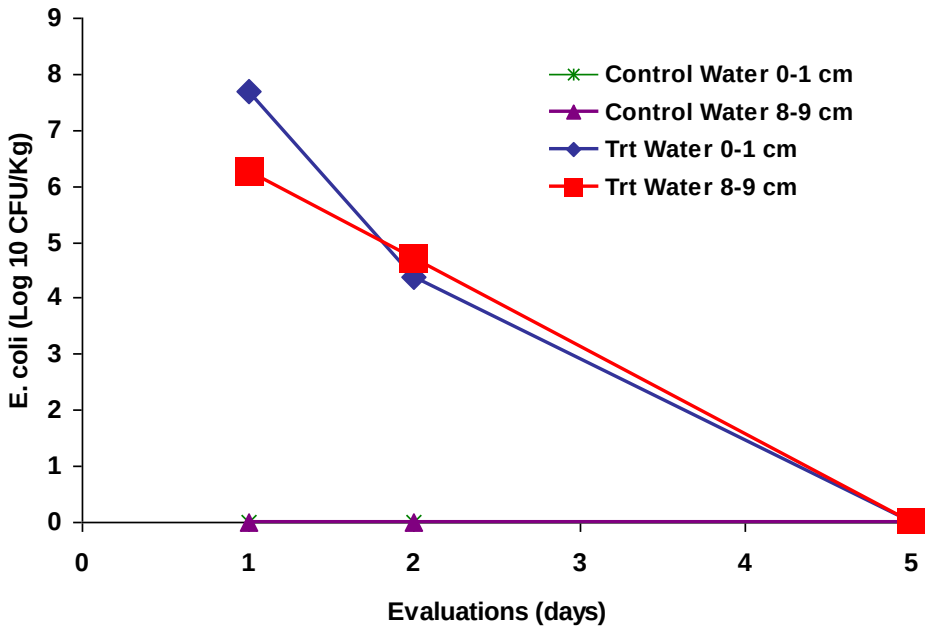

Figure 1: Survival of *E. coli* in drenched soil at two different depths – Trial 1.

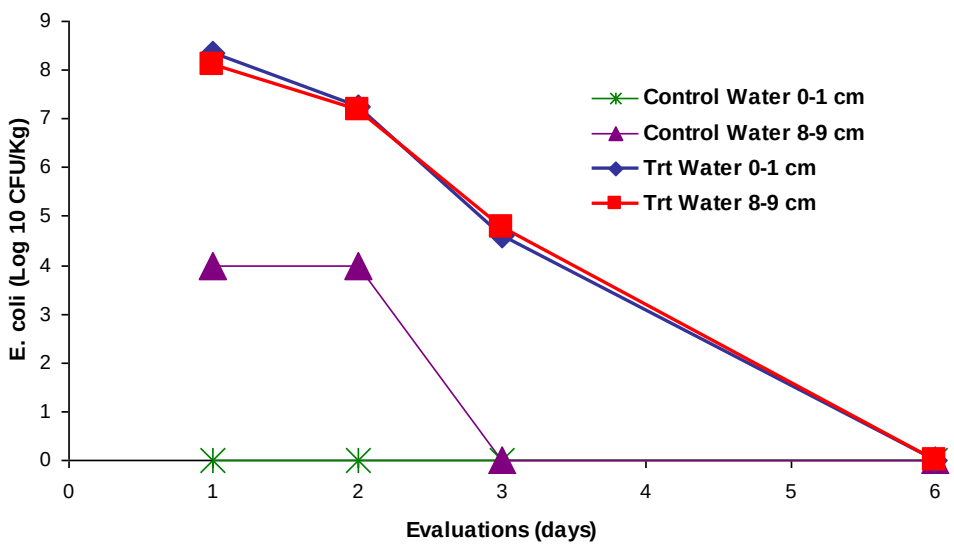

Figure 2: Survival of *E. coli* in drenched soil at two different depths – Trial 2

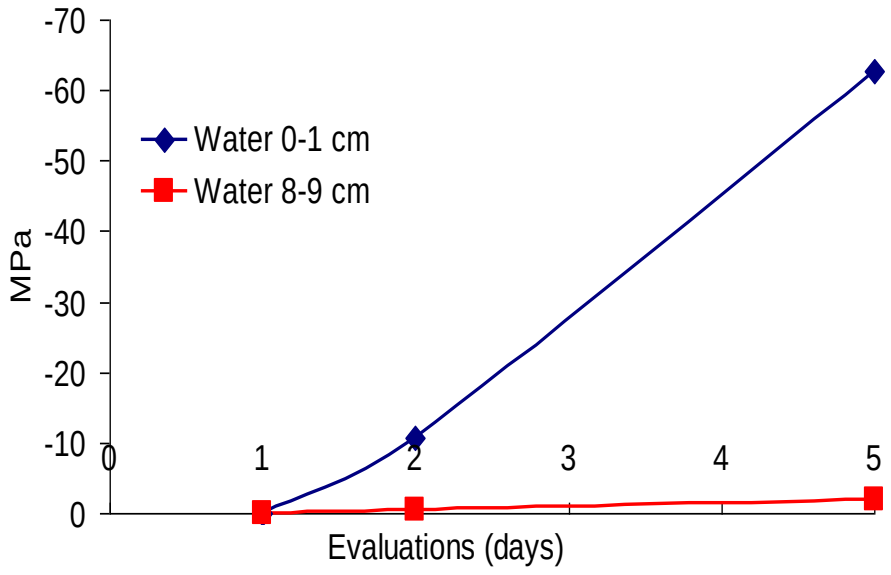

Figure 3: Water potential of the soil in Trial 1.

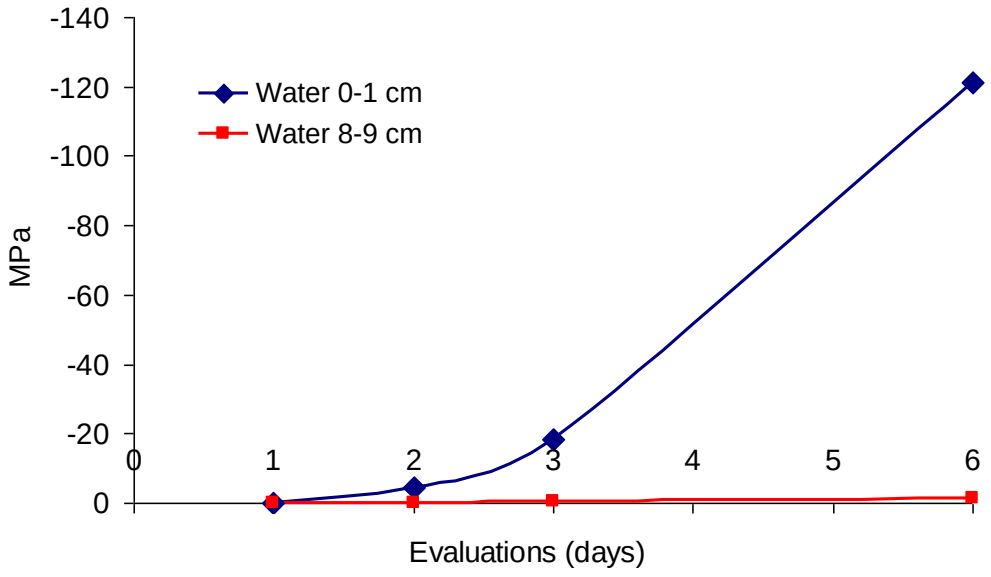

Figure 4: Water potential in the soil in the Trial 2.

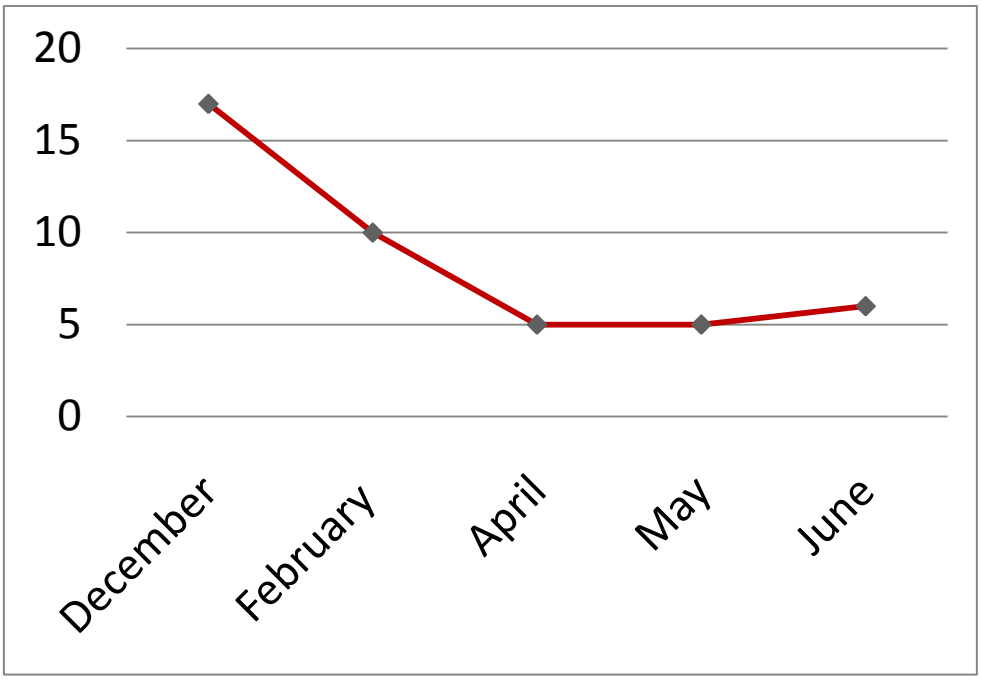

Figure 5: Approximate longest time (days) generic E. coli was observed in a Yuma valley field depending on the time of the year, after furrow irrigation with contaminated water.

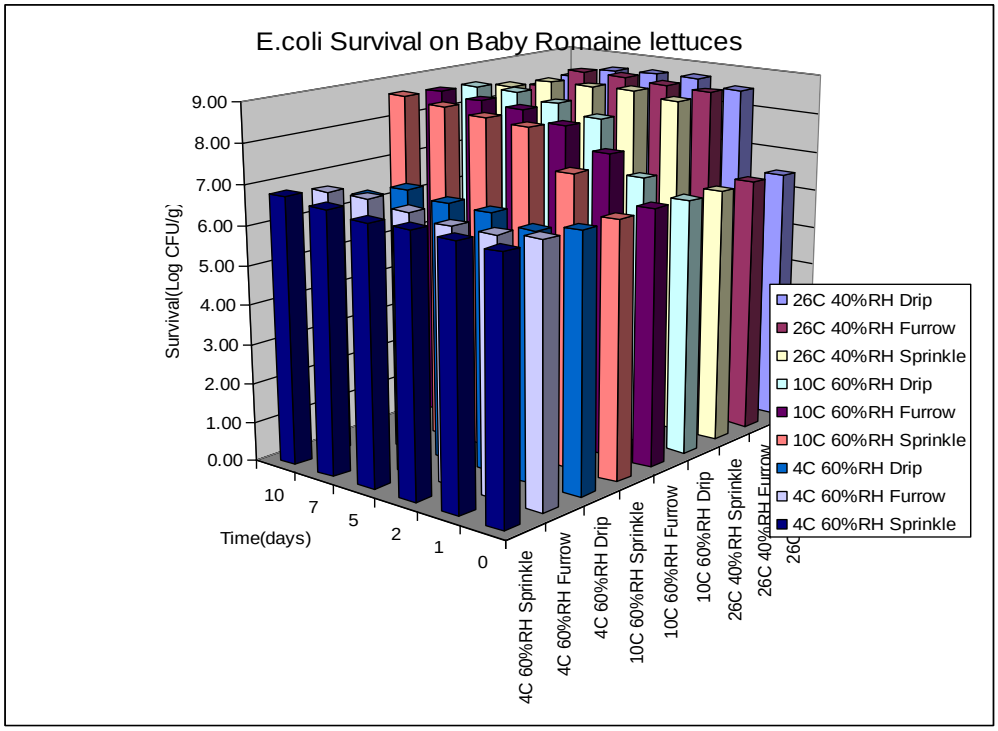

Figure 6: *E. coli* O157:H7 survival on young romaine lettuce subjected to different irrigation systems and to different postharvest storage conditions.

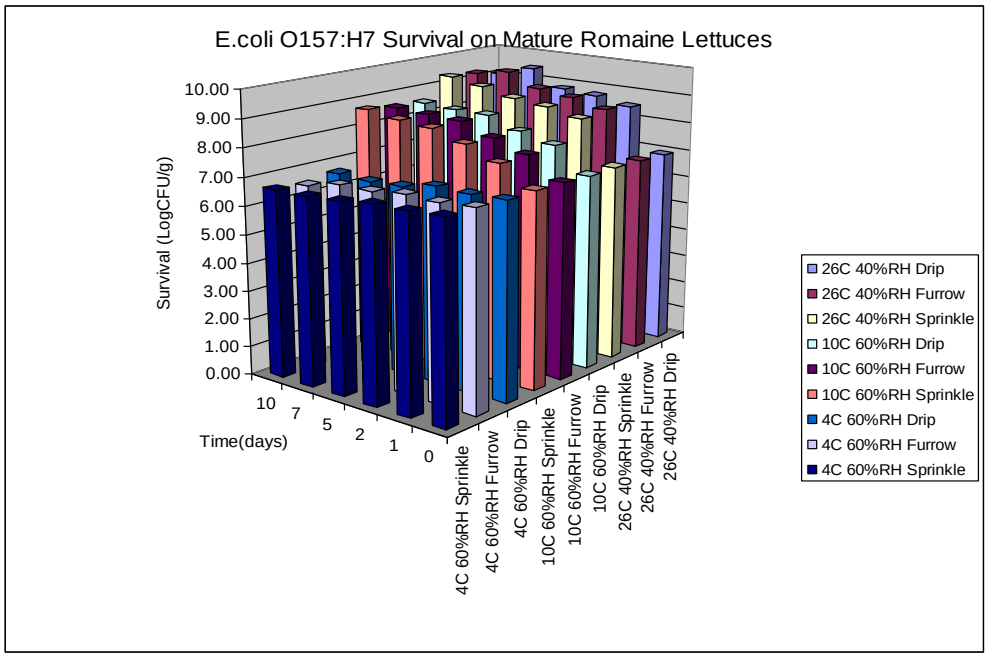

Figure 7: *E. coli* O157:H7 survival on adult romaine lettuce subjected to different irrigation systems and to different postharvest storage conditions.

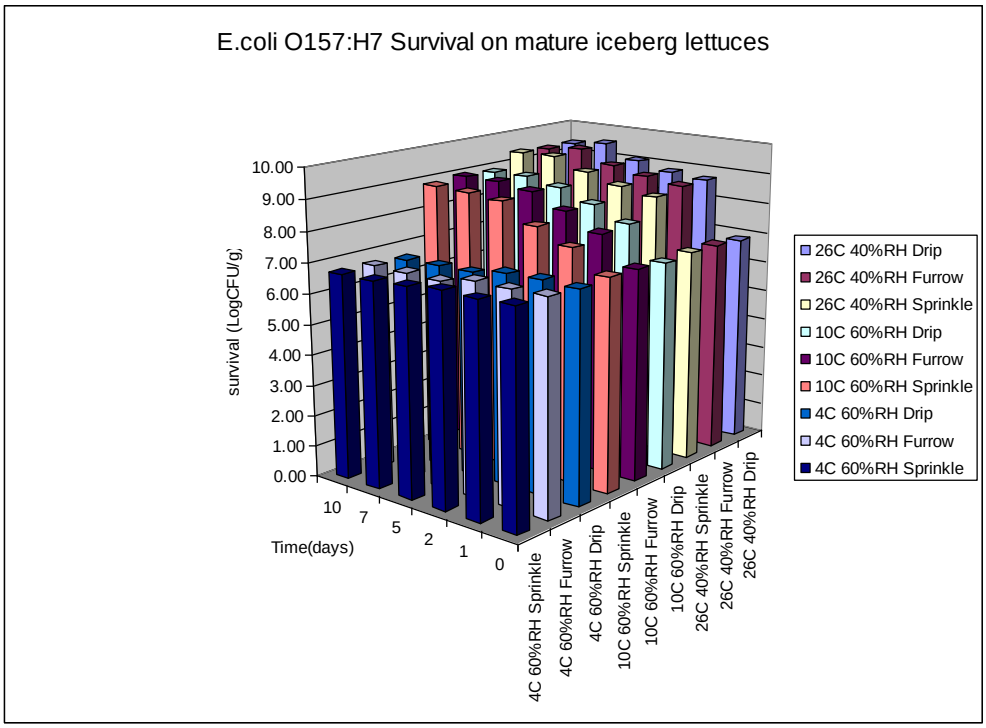

Figure 8: *E. coli* O157:H7 survival on mature iceberg lettuce subjected to different irrigation systems and to different postharvest storage conditions.

Table 1. Existing oral reference doses (RfD) established by the World Health Organization (WHO) and the United States Environmental Protection Agency (EPA) and maximum levels (MLs) enforced by the European Union (EU).

Metal	Oral RfD (µg/kg bw- day)		
	WHO	EPA	
Arsenic		0.3	
Cadmium	1	1	
Lead	7		
Uranium	0.6	3	
EU MLs (µg/kg fw)			
	Root Vegetable	Leafy Vegetable	Fruit
Cadmium	100	200	50
Lead	100	300	100

Table 2. Crops included in the assessment, area of production in Lower Colorado River region (LCRR), and percentage of total U.S. crop

Crop	Area of production in LCRR hectares (ha)	LCRR as a percentage of total U.S. crop (%)
Broccoli (*Brassica oleracea italica*)	9516	18.0
Cabbage (*Brassica oleracea capitata*)	1042	4.6
Carrots (*Daucus carota sativus*)	7227	28.0
Cauliflower (*Brassica oleracea botrytis*)	3,519	25.6
Celery (*Apium graveolens*)	553	4.3
Dates (*Phoenix sylvestris*)	2,925	100
Grapefruit (*Citrus Paradise*)	1,010	3.1
Grape (*Vitis vinifera*)	3,485	7.4
Lemon (*Citrus limon*)	7,085	32.1
Lettuce Head (*Lactuca sativa*)	25,669	32.9
Lettuce Leaf (*Lactuca sativa*)	21,252	45.8
Melon (*Cucumis melo*)	5,887	15.2
Onion (*Allium cepa*)	4,033	5.4
Orange (*Citrus sinensis*)	2,905	0.5
Pepper (*Capsicum annuum*)	1,804	10.6
Spinach (*Spinacia oleracea*)	2,951	15.2
Squash (*Cucurbita* sp)	79	0.3
Sweet corn (*Zea mays*)	3,376	5.4
Tomato (*Lycopersicon esculentum*)	137	0.03
Watermelon (*Citrullus lanatus*)	1,564	4.7

Table 3. Lead (Pb) contents of vegetable and fruit crops produced in the LCRR

Crop	n	Lead (µg/kg fw) Range	Mean
Broccoli (*Brassica oleracea italica*)	20	nd-56.1	4.8
Cabbage (*Brassica oleracea capitata*)	20	nd-11.5	1.7
Carrots (*Daucus carota sativus*)	19	nd-13.4	4.1
Cauliflower (*Brassica oleracea botrytis*)	20	nd-6.5	1.0
Celery (*Apium graveolens*)	16	nd-41.5	7.4
Dates (*Phoenix sylvestris*)	17	nd-183.5	25.3
Grapefruit (*Citrus Paradise*)	10	7.6-49.2	20.1
Grape (*Vitis vinifera*)	16	nd-118.9	42.9
Lemon (*Citrus limon*)	26	nd-21.1	3.8
Lettuce Head (*Lactuca sativa*)	24	1.0-68.7	10.4
Lettuce Romaine (*Lactuca sativa*)	24	4.9-48.5	13.4
Lettuce green leaf (*Lactuca sativa*)	24	13.1-81.7	33.9
Lettuce red leaf (*Lactuca sativa*)	24	20.9-119.8	41.7
Lettuce Boston (*Lactuca sativa*)	24	7.4-40.0	24.7
Melon (*Cucumis melo*)	20	0.7-15.9	5.8
Onion (*Allium cepa*)	17	nd-84.5	12.9
Orange (*Citrus sinensis*)	21	nd-73.7	19.0
Pepper (*Capsicum annuum*)	16	nd-23.6	9.1
Spinach (*Spinacia oleracea*)	30	2.0-393.1	93.8
Squash (*Cucurbita* sp)	4	nd-5.0	1.9
Sweet corn (*Zea mays*)	20	nd-86.4	24.2
Tomato (*Lycopersicon esculentum*)	11	nd-26.9	9.8
Watermelon (*Citrullus lanatus*)	21	nd-34.3	6.6

Non-detect concentrations were assigned a value equal to method detection limit/2 for calculation of mean, n = number of samples

Table 4. Cadmium (Cd) contents of vegetable and fruit crops produced in the LCRR

Crop	n	Cadmium (µg/kg fw) Range	Mean
Broccoli (*Brassica oleracea italica*)	20	7.6-62.1	17.1
Cabbage (*Brassica oleracea capitata*)	20	3.8-26.6	9.4
Carrots (*Daucus carota sativus*)	19	6.2-52.5	23.2
Cauliflower (*Brassica oleracea botrytis*)	20	4.5-20.7	11.7
Celery (*Apium graveolens*)	17	13.0-99.2	42.0
Dates (*Phoenix sylvestris*)	17	nd-26.7	7.9
Grapefruit (*Citrus Paradise*)	10	nd-2.9	0.6
Grape (*Vitis vinifera*)	16	nd-26.2	4.9
Lemon (*Citrus limon*)	26	nd-4.6	0.9
Lettuce Head (*Lactuca sativa*)	24	19.7-86.1	47.4
Lettuce Romaine (*Lactuca sativa*)	24	23.7-128.2	71.7
Lettuce green leaf (*Lactuca sativa*)	24	63.0-173.7	87.5
Lettuce red leaf (*Lactuca sativa*)	24	68.3-238.6	117.2
Lettuce Boston (*Lactuca sativa*)	24	49.4-139.8	89.5
Melon (*Cucumis melo*)	20	9.4-25.4	15.4
Onion (*Allium cepa*)	17	8.7-56.3	23.5
Orange (*Citrus sinensis*)	21	nd-3.5	0.6
Pepper (*Capsicum annuum*)	16	8.3-69.0	22.8
Spinach (*Spinacia oleracea*)	30	48.9-445.3	173.3
Squash (*Cucurbita* sp)	4	1.2-8.9	3.8
Sweet corn (*Zea mays*)	20	1.4-35.8	13.1
Tomato (*Lycopersicon esculentum*)	11	15.0-26.8	21.1
Watermelon (*Citrullus lanatus*)	21	nd-8.8	3.6

Non-detect concentrations were assigned a value equal to method detection limit/2 for calculation of mean, n = number of samples

Table 5. Arsenic (As) contents of vegetable and fruit crops produced in the LCRR

Crop	n	Arsenic (µg/kg fw) Range	Mean
Broccoli (*Brassica oleracea italica*)	20	nd-14.4	5.2
Cabbage (*Brassica oleracea capitata*)	20	nd-4.1	1.7
Carrots (*Daucus carota sativus*)	19	2.7-12.4	7.0
Cauliflower (*Brassica oleracea botrytis*)	20	nd-6.7	1.5
Celery (*Apium graveolens*)	17	nd-63.4	10.5
Dates (*Phoenix sylvestris*)	17	7.0-26.4	15.3
Grapefruit (*Citrus Paradise*)	10	nd	nd
Grape (*Vitis vinifera*)	16	10.7-190.3	47.7
Lemon (*Citrus limon*)	26	nd-2.4	1.0
Lettuce Head (*Lactuca sativa*)	48	2.4-57.5	12.9
Lettuce Romaine (*Lactuca sativa*)	24	2.9-33.9	13.6
Lettuce green leaf (*Lactuca sativa*)	24	12.0-78.9	41.7
Lettuce red leaf (*Lactuca sativa*)	24	11.3-101.0	39.3
Lettuce Boston (*Lactuca sativa*)	24	9.7-73.1	33.3
Melon (*Cucumis melo*)	20	3.0-30.2	11.2
Onion (*Allium cepa*)	17	nd-30.5	9.7
Orange (*Citrus sinensis*)	21	nd-3.5	0.6
Pepper (*Capsicum annuum*)	16	nd-2.7	0.5
Spinach (*Spinacia oleracea*)	30	0.2-180.7	38.2
Squash (*Cucurbita* sp)	4	2.5-7.6	5.7
Sweet corn (*Zea mays*)	20	nd-14.1	5.3
Tomato (*Lycopersicon esculentum*)	11	nd-3.8	0.4
Watermelon (*Citrullus lanatus*)	21	nd-10.5	2.9

Non-detect concentrations were assigned a value equal to method detection limit/2 for calculation of mean, n = number of samples

Table 6. Uranium (U) contents of vegetable and fruit crops produced in the LCRR

Crop	n	Uranium (µg/kg fw) Range	Mean
Broccoli (*Brassica oleracea italica*)	20	0.31-1.34	0.65
Cabbage (*Brassica oleracea capitata*)	20	0.14-0.98	0.34
Carrots (*Daucus carota sativus*)	19	nd-3.46	1.47
Cauliflower (*Brassica oleracea botrytis*)	20	0.13-1.14	0.37
Celery (*Apium graveolens*)	17	0.18-10.69	1.49
Dates (*Phoenix sylvestris*)	17	nd	nd
Eggplant (*Solanum melongena*)	3	0.02-0.56	0.20
Grapefruit (*Citrus Paradise*)	10	nd-0.47	0.16
Grape (*Vitis vinifera*)	16	nd-10.48	1.65
Green beans (*Phaseolus vulgaris*)	2	0.14-1.78	0.96
Lemon (*Citrus limon*)	26	nd-0.55	0.10
Lettuce Head (*Lactuca sativa*)	24	0.12-1.87	0.39
Lettuce Romaine (*Lactuca sativa*)	24	0.23-2.25	1.09
Lettuce Green leaf	24	0.90-11.0	4.2
Lettuce Red leaf	24	1.5-13.5	5.0
Lettuce Boston	24	0.56-7.6	4.0
Melon (*Cucumis melo*)	20	nd-1.22	0.39
Onion (*Allium cepa*)	17	nd-2.37	0.79
Orange (*Citrus sinensis*)	21	nd-0.81	0.22
Pepper (*Capsicum annuum*)	16	0.02-1.45	0.30
Spinach (*Spinacia oleracea*)	30	3.3-44.8	9.8
Squash (*Cucurbita* sp)	4	0.08-0.26	0.17
Sweet corn (*Zea mays*)	20	nd-7.96	0.61
Tomato (*Lycopersicon esculentum*)	11	nd-0.43	0.09
Watermelon (*Citrullus lanatus*)	21	nd-1.50	0.10

Non-detect concentrations were assigned a value equal to method detection limit/2. n = number of samples

Table 7. Estimated adult male metal exposures through leafy vegetables

	Concentration	Expose	Adult Male Dosage
Metal	µg/kg fw	µg/day	µg/kg bw-day
Iceberg Lettuce			
Pb	10.4	0.48 (1.42)	0.007 (0.021)
Cd	47.4	2.18 (6.50)	0.031 (0.093)
As	12.9	0.59 (1.77)	0.008 (0.025)
U	0.39	0.02 (0.05)	0.0003 (0.0008)
Romaine lettuce			
Pb	13.4	0.62 (1.84)	0.009 (0.026)
Cd	71.7	3.30 (9.82)	0.047 (0.140)
As	13.6	0.62 (1.86)	0.009 (0.027)
U	1.1	0.050 (0.149)	0.0007 (0.0021)
Green leaf lettuce			
Pb	33.9	1.56 (4.64)	0.022 (0.066)
Cd	87.5	4.02 (11.99)	0.057 (0.172)
As	41.7	1.92 (5.71)	0.027 (0.082)
U	4.2	0.191 (0.569)	0.003 (0.008)
Red leaf lettuce			
Pb	41.8	1.92 (5.72)	0.027 (0.081)
Cd	117.2	5.39 (16.06)	0077 (0.229)
As	39.3	1.81 (5.38)	0.026 (0.077)
U	5.0	0.232 (0.690)	0.003 (0.010)
Spinach			
Pb	93.8	5.25 (12.85)	0.075 (0.184)
Cd	173.3	9.71 (23.75)	0.139 (0.339)
As	38.1	2.14 (5.23)	0.031 (0.075)
U	9.8	0.549 (1.34)	0.008 (0.019)

1Based on mean and 90th%tile lettuce consumption of 46 and 137 g.
2Values in parenthesis represent 90th percentile values.

Table 8. Percentage of uranium dose for selected population subgroups from the top nine sources of dose for the total US population

Edible Crop	Total US Population	Children 1-2 Yr	Adults >50 Yr
Lettuce	22.7	5.0	27.5
Spinach	14.4	12.8	16.7
Carrots	11.7	15.8	10.8
Orange Products	11.5	17.8	9.0
Grape Products	8.2	18.1	5.8
Onions	6.4	4.3	5.9
Snap Beans	5.0	8.2	4.0
Sweet Corn	4.4	6.1	3.1
Celery	3.9	2.8	4.0
Broccoli	3.1	2.9	3.7

Table 9. Chronic aggregate exposure to U for all food crops produced in the LCRR for selected subpopulations

Population Subgroup	U exposure (µg/kg bw-day)
US Total	0.0030
Infants	0.0036
Children 1-2 Yr	0.0048
Children 3-5 Yr	0.0040
Females 13-49	0.0029
All Adults>50 Yr	0.0030

The EPA reference dose (RfD) is 3 ug/kg bw-day and the WHO RfD is 0.6 ug/kg bw-day.