2008
Specialty Crop Block Grant Program (SCBGP)
FINAL REPORT
REVISED

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Final Performance Report

Project Title

Expand Specialty Crop Education & Outreach for School Age Children and the Public in the Sierra Nevada Region

Project Summary

The purpose of this project is to expand and enhance the ability to educate school children, teachers, and the public about the importance of local agriculture in their lives. Building on Ag in the Classroom's (AITC) existing high quality programs can increase their effectiveness in the region.

Project Approach

Each of the program development efforts were designed to increase public awareness of the role that agriculture plays in our lives. Without that understanding, the agricultural way of life is put at risk of not being recognized as the source of food, fiber, and shelter that agriculture provides. As less than 1% of Californians today have first-hand experience with the farm or ranch, it is imperative that the public is informed and educated as to how food we rely upon is raised. By "training the trainers", the number of students who can be reached through educational programs is increased. Agricultural education provides a learning experience for all participants, utilizing existing skills and knowledge, engaging individuals interactively, and creating an opportunity for a team experience.

Specialty crops are the basis for the small family farms in the Sierra Foothill region. As students, teachers, and the public are educated about the benefits of agriculture and they experience agriculture first-hand, an appreciation for the agricultural industry is created. Recognition of the agricultural community's stewardship of the land, the open space and wildlife habitat values, and the farming practices that provide sustainability will allow small family operations to remain viable. Sustainability for the local economies is based upon the existence of hundreds of small farms, ranches, and wineries providing a direct marketing business model that makes up the fabric of the foothill community, with economic multipliers that benefit all service sectors in the area. Education and outreach is the key to sustaining or expanding the marketplace, which is a hedge against future encroachment on agricultural lands.

To expand existing programs, AITC developed the following: 1) a website portal for local agriculture and educators; 2) a summer teacher training institute; and, 3) a pilot "farm-to-school" program. Each task resulted in increased opportunities for agricultural education and outreach.

The website portal provided a communication tool that had previously been unavailable. The website was utilized to promote AITC's activities and programs, to conduct surveys, and to enroll participants in Farm Day and the *Teacher Ag Summer Institute*.

Expanding the opportunity for teacher education to the neighboring foothill counties broadened the program's reach in the foothills while equipping teachers with relevant knowledge and hands-on lessons about the role of agriculture in the region. Continued outreach to the minority and economically disadvantaged communities in eastern El Dorado County, from Placerville to South Lake Tahoe, ensured program availability to these students.

Goals and Measurable Outcomes Achieved

The development of the website portal was completed with the initial launch in January 2010, with additional content and capability added since then. A consultant was retained to develop the logo and website design. Using the criteria established in the proposal, the logo design was completed and the initial website portal design was posted for evaluation and review. Educators and other team members in the community evaluated the content and design components providing feedback to the design team and suggestions that were then incorporated. The website has been utilized to announce upcoming activities, to register and enroll *TASI*, Farm Day, and event participants, and to conduct surveys. It has created a presence for Ag in the Classroom in the agricultural and educational communities and is fast becoming an important resource.

The development of a teacher training institute culminated in June 2011 with the first *Teacher Ag Summer Institute (TASI)*. The institute included comprehensive hands-on learning for eleven teachers. Pre- and post-evaluations revealed that the participants gained a 53% improvement in understanding of local agricultural issues. Participants later attended a *"Back to the Farm"* session where they shared the resource materials that they developed based on the lessons that they learned at the institute. A report documented the experience of planning and conducting the institute as well as the lessons learned (report is attached). Resource materials have now been compiled into the first "Teacher Resource Guide" that will be made available to future teachers participating in the *TASI* experience (report is attached). Each institute will conclude with teacher-developed resource materials that will then be made available to future alumni of the institute.

One of the tasks was to improve two existing programs and createonea new program. The first existing program, *Art in the Orchard*, had the goal of adding two new exhibits to its next program, which was conducted in September 2009. As submitted in the grant proposal, Ag in the Classroom added two new exhibits to the program: 1) a petting zoo of local farm animals; and, 2) a display of local wine grapes. Visitors had the opportunity to have personal contact with farm animals. They were also able to touch and sample local wine grape varietals that were ripe for harvest. In addition, all food that was prepared was locally grown and a tent card described the food and where it was grown, expanding the learning to the harvest table that was enjoyed by all.

The second existing program, *Farm Day*, had the goal of improving the pre-training that is provided to participating classroom teachers and to expand the participation by 10%. In March 2010, the teacher training was expanded to include two teachers who were experienced "Farm Day veterans" who brought lesson plans that teachers could incorporate into their classrooms to expand student learning through pre-teaching. The following year, May 2011, saw the participation of over 1,100 students at the annual Farm Day, an increase of 23% over the 2008 figures included in the grant proposal.

The development of a "Farm to School" program was also completed in 2010. The program conducted four field trips for Camino School students to nearby Rainbow Orchards. A template was developed with the expectation that other schools and venues could adapt the program to meet their own local interests and needs. The program was named *"Fields of Learning"* to encourage flexibility in applying the template to a variety of commodities. The project manager designed evaluation criteria for students and teachers to determine understanding gained as a result of the program. A final report captured task data, lesson concepts, and described a "template" format (report is attached). Discussions are ongoing with other local schools that want to develop their own *"Fields of Learning"* programs. It is hoped that the program will continue to expand and high quality resources will be developed to support curriculum areas that address other specialty crop operations.

Financial Feasibility

Project leaders and grant consultants worked efficiently within aggressive schedules, maximizing the assistance of volunteers and other in-kind contributions to accomplish the goals of the grant. The experienced team leaders were able to mange project costs while performing on time.

Community partners volunteered in record numbers. There has historically been great support for the Farm Day event but expanding the opportunities to volunteer on the steering committee, on "*Fields of Learning*," and with the *Teacher Ag Summer Institute* expanded our pool of interested volunteers, who exhibited excitement about the new programs. The in-kind contribution from the community was expected to be about 86% of the grant value but our expectations were exceeded with a contribution of 108.9% in- kind contributions compared to grant funding.

Additional Assessment

With the website portal, the project coordinator learned that in order to be useful to the target community, agricultural and educational community input was needed as to their needs. The portal was tailored to be informative and useful for the intended audience and project leaders.

With the *Teacher Ag Summer Institute,* it was learned that the scheduled sessions were so ambitious and full of activities that more time was needed for the teachers to discuss the topics and reflect on what they learned. By incorporating more take-home resources, this project could be effective in providing information while maximizing the time spent at the institute. By creating the *"Back to the Farm"* session as part of the institute experience, the teachers were encouraged to work away from the institute and bring back the result after several weeks of thought. The teachers also enjoyed the opportunity to network with one another and develop relationships that extended beyond the scheduled institute dates, gaining even more resources once they returned to their school. Another discovery was made that the agriculturists who participated were impressed with the insightful questions asked by the teachers that showed they were really interested in learning about the industry. They are ready to volunteer again.

With the *"Fields of Learning"* program, it was found that there is a real interest in this type of program. The pilot program occurred in a community that already had strong relationships between the farmers and the school. Creating the curriculum proved challenging as the program was developed from the idea of expanding the school garden and hands-on learning beyond the boundaries of the school. While an enthusiastic volunteer team can work locally to build farm/school partnerships that allow year round learning, it was evident that there is a need to help volunteers organize, to establish a program that meets state standards, and to provide resources to those teacher/volunteer teams.

Additional Information

Events:
Steering Committee Meetings: Mar 15, 2010, Jun 16, 2010, Mar 22, 2011, Nov 10, 2011
Steering Committee & Community Receptions: Nov 9, 2010 & Jun 22, 2011
Farm Day – enhanced teacher training: Mar 2010 and Mar 2011
Fields of Learning, field trips: Fall 2009, Winter 2010, Spring 2010, and late Summer 2010
Teacher Ag Summer Institute: June 20 – 23, 2011, *Back to the Farm* session July 14, 2011

Publications:
Report: *"Fields of Learning": A Model School/Farm Partnership Program*, October 31, 2010
Report: *Teacher's Agricultural Summer Institute (TASI)*, October 31, 2011

Press Releases:
Ag in the Classroom Awarded California Department of Food and Agriculture Grant, March 22, 2010
Ag in the Classroom Launches New Website, June 30, 2010
Ag in the Classroom Showcases Model School/Farm Program, November 8, 2010
Teacher's Ag Summer Institute Available to Local Educators, January 11, 2011
Teacher's Agricultural Summer Institute Welcomes Local Educators, June 20, 2011

Presentations:
El Dorado County Board of Supervisors, December 7, 2010 and December 6, 2011
El Dorado County Ag Roundtable, April 23, 2010
CDFA Federal Funds Management Office Grant Performance & Compliance Visit with Robin Espana, September 28, 2011

Websites/Media:
El Dorado County Ag in the Classroom: website portal – www.agintheclass-edc.org
El Dorado County Ag in the Classroom DVD, 2010

Photo Gallery:
Photos of *"Fields of Learning"* may be found in the Report dated October 2010 and photos of *Farm Day* and *Teacher Ag Summer Institute* may be found in the Report dated October 2011.

Fields of Learning

Farm Day

Teacher Ag Summer Institute

Funding Expended to Date
Grant Award Amount $119,785.00
Invoiced to Date $109,732.19
Remaining Grant Balance $10,052.81
(The remaining grant balance was reallocated.)

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Final Performance Report

Project Title
Technical Assistance to Small-Acreage Farmers on the California Central Coast

Project Summary
According to the 2002 Census of Agriculture, 61 percent of farms in Santa Barbara County are 49 acres or less, with a median of 28 acres. In order for the specialty crop industry to remain vital, a certain number of growers are necessary to retain agricultural infrastructure and support services, such as fertilizer and irrigation technology retailers. As such, small growers are an important part of the health of the sector as a whole. Maintaining a critical volume of growers is essential to the long-term viability of regional and statewide specialty crop production. Collectively, small-acreage growers play a vital role in California specialty crop production.

Small-acreage specialty crop growers are facing unprecedented pressures from increasing input prices, regulations, phytosanitary demands, market consolidation, and nonagricultural development. The growers targeted by this project are those who have minimal agronomic training or access to agricultural education opportunities due to language barriers.

Cachuma Resource Conservation District (CRCD) recognized the need for training that is culturally appropriate, timely, and effective. The purpose of the project was to improve the long-term competitive position of small-acreage specialty crop growers by providing bilingual technical outreach and education on farm best management practices for water, soil, nutrients, and pesticides. The project goal was to enable these growers to address the challenges facing them to become sustainable specialty crop producers. The project targeted growers in Santa Barbara County but can be extended throughout California.

Project Approach
The overall goal of the project was to improve the long-term competitive position of small-acreage (50 acres or less) specialty crop growers by providing bilingual technical outreach and education on agricultural Best Management Practices (BMPs) for water, soil, nutrients, and pesticides. Proven technologies and BMPs have been transferred through workshops, field demonstration sites, and individual consultations and follow-up visits. The technical assistance provided includes BMPs for: irrigation management, soil and nutrient management, integrated pest management, and information management through recordkeeping and organization.

Over the course of the project, technical assistance was provided on the following topics: soil and nutrient management (soil sampling, soil analysis, soil mapping, salinity, soil nitrate quick test, erosion control, soil pH); irrigation management (irrigation design, irrigation evaluation to test distribution uniformity, leaching requirement, irrigation water pH, assessing soil moisture by feel); integrated pest management (plant pathology, plant selection and establishment for improved vigor, scouting and monitoring, beneficial insect releases, pest host identification); risk management via agricultural diversification; recordkeeping; and regulatory compliance.

CRCD attributes the success of the project to the professional caliber of its technical team, project timeliness, and high demand for CRCD's services as provided by the Specialty Crop Block Grant (SCBG) program.

Deliverables

Project deliverables for the 2.5 year project implementation period:

Tasks	Expected Deliverables	Achieved Deliverables
1. Provide farm management training to 35 small-scale growers	1. 35 growers equipped o make improved technical decisions	1. 72 growers equipped to make improved technical decisions on irrigation management, soil and nutrient management, IPM, and information management.
2. Carry out 2 workshops per year	2. 100 growers total to attended 5 workshops	2. 392 attendees (196 total target grower attendees) attended 15 bilingual workshops. Provided interpretation at 1 workshop hosted by University of California Cooperative Extension for approximately 55 growers and 1 workshop hosted by the Central Coast Agricultural Water Coalition for 3 growers.
3. Establish 2 demonstration projects per year	5 field trials used as demonstration sites	3. 6 field trials completed.

As a component of Task 1, several program participants have received individual assistance and technical training. Measurable outcomes included:

- CRCD assisted the local United States Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS) office in executing 22 Environmental Quality Incentives Program (EQIP) contracts for Socially Disadvantaged Growers. EQIP provides additional financial resources to certain growers targeted by this project. The growers received technical assistance from CRCD. Growers receive cost-share payments from NRCS for implementing Irrigation Water Management and Nutrient Management Practices upon successful completion of the EQIP contracts.
- CRCD demonstrated the release of beneficial insects and provided scouting and monitoring support as a part of an IPM program on 11 farms.
- Growers who received training on using the soil nitrate quick test (SNQT) were very pleased with the results. The SNQT allows growers to determine the current levels of soil nitrate and decide whether to apply nitrogen fertilizer. Growers consistently reported that the SNQT is a very good tool, helped to minimize the use of nitrogen fertilizer, saved them money, and are using the test on a regular basis. The SNQT was demonstrated to growers at several workshops and on an individual basis when requested during field visits. Many growers estimated midseason nitrogen fertilizer savings of 20 to 30 percent due to the use of the Soil Nitrate Quick Test (SNQT). Furthermore, one grower reported water savings of up to 50 percent due to improved soil moisture monitoring and management techniques, including recordkeeping, disseminated through the project.

Task 2. List of Workshops and Timeline:

	Workshop	Date	Number of Attendees
1	Production of Strawberries and Other Vegetables on the Central Coast	6/10/09	26
2	Important Items to Consider when Purchasing Strawberry Transplants for this Season	7/9/09	41
3	Strawberry Production in Santa Maria: Field Trial	8/27/09	33
4	Strawberry Field Day: Nitrogen Management Tools	9/9/09	21
5	USDA Assistance Programs Project Kickoff	10/30/09	15
6	Erosion Control: Preparing for Winter Rains	11/18/09	13
7	Lygus Monitoring and Experience with Strawberry Cutback in August for Harvest in November and December	11/19/09	13
8	IPM for Two-Spotted Spider Mite in Strawberries	12/2/09	19
9	Recordkeeping and Organization: How to Use Records to Earn More for Your Business	1/13/10	21
10	Soil Nitrate Quick Test Demonstration	1/27/10	17
11	Technical Resources and Regulatory Updates	4/13/10	3
12	Irrigation and Nutrient Management Meeting	4/22/10	48
13	Irrigation Management in Strawberries	5/11/10	67
14	Alternative Market Opportunities: How to Establish a Cooperative Business	7/8/11	10
15	Preparing the Field for the New Season	8/25/11	8

Task 3. Field trial demonstration sites, in cooperation with UC and CSC:

Trial	Area of Research	Trial Summary
Strawberry Cutback, Summer/ Fall 2009	Soil Fertility and Nutrient Management	The purpose of the trial is to determine the optimal cutback date and midseason fertilizer application rate for conventional cutback strawberries. A total of 3 cutback dates and 2 different rates of midseason fertilizer injections were studied for 1 strawberry variety. A total of 24 plots were tested. Differences in marketable yield of conventional strawberries were compared. Results were inconclusive due to pest pressure.
Organic Strawberry Irrigation, 2009	Irrigation Water Management	The trial looked at cutting back irrigation applications (reducing duration of irrigation events compared to grower standard) in organic strawberries. There were three treatments. It was determined that irrigation duration could be reduced by 20% without significant yield reduction.

Biochar as a Soil Amendment, 2009-2010	Soil Fertility and Nutrient Management	The purpose of the trial was to investigate the potential of a new biological soil amendment, biochar. Beneficial effects of this soil amendment have been hypothesized to include increasing soil organic material, preventing nitrate leaching, and sequestering carbon in soils. A total of 5 different rates of biochar material incorporation was tested on a total of 20 plots. Differences in marketable yield of conventional strawberries was compared. Biochar was not found to be effective in this trial.
Fertilizer Management for Conventional Strawberries, 2009-2010	Soil Fertility and Nutrient Management	The purpose of the trial was to determine the optimal amount of preplant compost and nitrogen fertilizer along with midseason nitrogen fertilizer applications for organic strawberries. A total of 2 strawberry varieties were studied, along with 3 different rates of pre-plant compost application and 2 different rates of midseason fertilizer injections. A total of 60 plots were tested. Differences in marketable yield of organic strawberries was compared in order to make fertilizer recommendations.
Fertilizer Management for Organic Strawberries, 2009-2010	Soil Fertility and Nutrient Management	The purpose of the trial is to determine the optimal amount of pre-plant compost and nitrogen fertilizer along with midseason nitrogen fertilizer applications for organic strawberries. A total of 2 strawberry varieties were studied, along with 3 different rates of pre-plant compost application and 2 different rates of midseason fertilizer injections. A total of 60 plots were tested. Differences in marketable yield of organic strawberries was compared in order to make fertilizer recommendations.
Fertilizer Management for Strawberries, 2010-2011	Soil Fertility and Nutrient Management	This trial explores optimum nutrient ratios for strawberries. The trial was completed in December of 2011. Results will be provided at the UC workshop in Santa Maria in May 2012.

'Technical Assistance to Small-Acreage Growers on the California Central Coast' owes much of its success to generous program partners for technical expertise and a desire to help socially disadvantaged small-acreage growers. Assistance in workshop delivery from University of California, Natural Resources Conservation Service (NRCS), California Strawberry Commission, Farm Service Agency, and others has allowed the project to be financially feasible.

The project has benefited greatly from the involvement and technical expertise of individuals from the following organizations: University of California, American Farmland Trust, Ag Water Quality Alliance (AWQA), Central Coast Water Quality Preservation Inc., Central Coast Ag Water Quality Coalition, California Department of Pesticide Regulation, City of Santa Maria, National Resources Conservation Service (NRCS), and Farm Service Agency.

Additional Assessment
At least 124 individual target growers have benefited through workshops and/or individual technical assistance. This represents a minimum total of 1,893 acres with an average of 27 acres and a median of 20 acres; the actual total acres impacted are estimated to be approximately 3,000 acres.

72 target growers have received individual technical assistance. Total attendance at workshops organized by the project equals 196 target growers (some growers attended more than one workshop and some of the 392 total attendees/267 total grower project workshop attendees were not project target growers).

All workshops had English and/or Spanish interpretation to increase accessibility. Post- workshop surveys contain extremely positive feedback. For example, a post-workshop survey showed that all respondents found the information presented "very useful" and were "somewhat likely" to "very likely" to make changes to their operation's transplant purchasing, pest management, and nutrient (fertilizer) management practices. At the August workshop on "Preparing the Field for the New Season," anonymous survey results indicated that 8 of 8 respondents stated the information presented in the workshop was *"very useful."* 7 of 8 respondents will *"probably"* or *"absolutely"* make changes to their field layout and 6 of 8 will *"probably"* or *"absolutely"* make changes to their irrigation system design. When questioned about expected changes to fertilizer practices based on information presented in the workshop, out of 8 respondents, 1 respondent anticipated applying 300 less pounds of preplant per acre, 2 respondents anticipated applying 200 less pounds of preplant per acre, 1 respondent anticipated applying 100 less pounds of preplant per acre. These potential fertilizer savings could result in positive impacts for the grower's overall competitiveness, financial viability, and the environment.

The project beneficiaries produce at least one or more of the following specialty crops: strawberries (most common), apples, artichokes, avocados, beets, blackberries, blueberries, broccoli, brussel sprouts, cabbage, calabaza, carrots, cherimoya, chilies, cilantro, fava beans, green beans, green onions, grapes, leeks, lemons, lettuce, mandarins, nectarines, peaches, radish, raspberries, spinach, squash, sweet peas, tangerines, tomatoes, tomatillos.

Additional Information: Event flyers are attached along with pictures from the workshops.

Financial Feasibility
Grant Award Amount $119,785.00
Invoiced to Date $119,785.00
Remaining Grant Balance $0

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Final Performance Report

Project Title
Eco-Friendly System/Technology for Lye-Peeling of Tomatoes

Project Summary
Tomato processing plants use sodium hydroxide to peel tomatoes and discharge wastewater with high salinity. Research efforts are urgently needed to develop technical solutions to reduce discharge of high salinity wastewater from tomato processing plants.

This project aimed at developing an eco-friendly tomato lye peeling system that will significantly reduce the discharge of wastewater containing high salt load from tomato processing plants. Reduction of fresh water use to cut down wastewater discharge is becoming an economic necessity. The salinity in wastewater will impact the future of food processing in California. According to Hewitt et al. (2008), "if salinity increases at the current rate until 2030, the direct annual costs will be very substantial at $539 million a year. Additional indirect costs to the Central Valley are $682 million and $259 million to the State. In total, the economic impact by 2030 if left unchecked could be $941 million a year. Furthermore, there is $145 million per year of non-market costs. In terms of job losses, the increase in salinity by 2030 could cost the regional economy 29,000 jobs." Development of an eco-friendly tomato peeling system will comply with the state and federal pollution control regulations while reducing wastewater disposal cost. This in turn will improve the profitability and overall economic viability of the tomato processing industry in California.

Project Approach
The task/activities undertaken to achieve the goal and objectives of this project are summarized below:

1. Data collection on a commercial lye peeling operation:
   Data was collected at the Del Monte Foods (Hanford, California) tomato processing plant on process throughput, process parameters (lye concentration, temperature, residence time, conveyor speed), process water demand (fresh water use), wastewater discharge (volume, average EC and pH values, and other wastewater characteristics), product characteristics (yield loss and surface pH), lye recirculation system and solids utilization/disposal methods.

2. Determination of the geometrical configurations of the eco-friendly system:
   The geometrical configuration was determined and a fluid spray system was designed that removed the peel of the lye treated tomatoes with no water. However, the current commercial tomato conveying systems during peeling were not compatible with the peel removal system. Laboratory trials were conducted to determine a compatible tomato conveying system, a number of designs were examined, and a roller conveyor acquired from a local conveyor manufacturing company. Modifications were made to the rollers to improve the rolling effectiveness of the tomatoes which is necessary for complete peeling.

3. Tomato peeling experiment with the eco-friendly systems:
   The tomato varieties experimented with are used for commercial processing and were supplied by

Del Monte of Hanford, CA. Data collected during tomato peeling were: variety, initial surface pH, percent yield loss, percent residual peel remaining on tomatoes, and final surface pH. Numerous batches of tomatoes belonging to different varieties were peeled with the new eco- friendly system.

The surface pH before and after peeling was in the ranges of 4.53-4.70 and 7.22-10.85, respectively. The yield loss during peeling was in the range of 10.49-21.69, and percent peel remaining after peeling was in 0.90-8.62. Future plans include modification of the roller surface to improve the percent peel remaining after peeling, and a citric acid rinse or bath to neutralize residual caustic on the tomato surface.

4. Modification of the roller conveyor for effective tomato peeling:
A new design was discussed with the supplier of the roller conveyor for modifying the roller surface to improve the percent peel remaining after peeling and to incorporate a discharge outlet to effectively capture the peel and liquid discharge stream, if any, for analysis. These modifications were carried out by the supplier of the existing roller conveyor. The surface of each roller was coated with a material to increase friction between roller surface and tomato skin. The gap between each pair of rollers was also reduced. An outlet for discharge of separated peels and liquid stream, if any, was placed below the rollers where the fluid spray system removes the peel from tomatoes.

5. Tomato peeling experiments with the modified roller conveyor:
Tomatoes were peeled with the improved roller conveyor utilizing 15% caustic solution. Yield loss ranged from 13.66-17.39%, while percent peel remaining after peeling substantially reduced and was in the range of 0.67-1.34%. The surface pH before and after peeling was in the ranges of 4.37-4.39 and 11.72-11.79, respectively.

6. Restoration of original tomato surface pH after peeling:
The surface pH after peeling (11.72-11.79) is not acceptable from food safety considerations and needed to be restored to its original value (4.37-4.39). Two sets of systems examined to achieve this were:
   a) Spraying of peeled tomatoes with 3%, 4% and 5% (w/w) citric acid solutions for -5 seconds. The acid/tomato (g/g) ratio needed for restoration of original tomato surface pH was found to be minimum (0.02) with 4% citric acid.
   b) Dipping of peeled tomatoes in 4% (w/w) citric acid solution for 1, 2 and 3 seconds. The average surface pH after citric acid dip was 4.35 and the ideal citric acid dip time interval observed was 2 seconds. The dipping of peeled tomatoes in citric acid solutions produced better results in restoring the original tomato surface pH because of 100% surface contact with citric acid solution thereby neutralizing the residual lye.

7. Tomato peeling experiments with larger batch size:
The modified roller conveyor was used for this study. The tomato batch size was increased in order to move towards a commercial prototype. Each batch of tomatoes (from the same lot, dump, and day) was split into three separate groups weighing 2.5 kg or 1.5kg (1.5kg groups were used beginning 8/11/11). Both the surface area of the batch and the surface pH were measured before the batch went through the peeling process. The peeling process encompassed a 50 second caustic bath (at 199° F) dip, a run through the air- knife peeler, removal of all left-over skin by hand, then a three second 4% citric acid solution to bring the pH back to normal levels.

The surface pH before and after peeling was in the ranges of 4.32-4.60 and 8.97-11.06,

respectively. The citric acid dip after peeling restored the surface pH in the range of 3.94-4.56. The yield loss after peeling, depending on tomato variety, was in the range of 11.03-20.08. The percentage of peel remaining after air-peeling was in the range of 1.9-6.2%.

Experiments with large tomato batches provided information that needs to be addressed for a commercial system. In some instances, the tomatoes remained unpeeled. This was due to a combination of factors such as yellow shoulders, inadequate rotation of the tomato as it passed beneath the wind jet nozzles. Scars and yellow spots were harder to peel. Tomatoes with yellow shoulders (sun burnt, dried and wrinkled skin) were harder to peel than tomatoes without yellow shoulders. The ends of tomatoes did not come in direct contact with the wind jets. As a result, peel remained intact on the ends. However, we hypothesize that a short pass across a pincher bed, available in commercial plants should remove the majority of those remaining peels.

The air-knife peeling system is very close to meeting the USDA's requirement of 1 square inch of peel per lb of tomatoes. The results showed a range of 0.94-1.65 for the majority of the trials performed. Two slits were created with a razor on opposite sides of the tomatoes and the amount of remaining peel decreased slightly with no impact on the yield loss.

Obstacles such as intact peel, dried skin, yellow shoulders, and peel build-up at ends all contributed to the level of remaining peel. The incorporation of a pincher bed would greatly reduce the amount of remaining peel and will bring the peel removal below USDA's requirement.

Del Monte Foods, Hanford, California, is the industrial partner and they provided all technical information on the current commercial process. Visits to the Hanford plant took place several times during the design phase and the company provided full access to the plant to observe the current commercial process. The company also provided all the tomatoes needed for experimentation during the project life.

Goals and Measurable Outcomes Achieved

The overall goal was to develop an eco-friendly system/ technology for significantly reducing fresh water use and wastewater discharge during lye peeling of tomatoes. The specific objectives of the proposed study are to determine a) the geometrical configurations of the system, and b) peel removing fluid characteristics.

The proposed goal and objectives were achieved. The activities listed in the previous section were performed, and the geometrical configuration of the system and peel removing fluid characteristics were determined. Tomatoes were peeled with air and no water was needed. The pilot-scale system works well and the air-knife peeling system is very close to meeting the USDA's requirement of 1 square inch of peel per lb of tomatoes. The results showed a range of 0.94-1.65 for the majority of the trials and information was gathered for the next phase of development.

The tomato processing industry in California and the U.S. is the beneficiary of the project outcome. There are sixteen California League of Food Processors (CLFP) member tomato processors in California, which handle 93% of industry tonnage (CLFP, 2008). The development of this eco-friendly technology will reduce the need for new regulation and will diminish wastewater disposal issues, significantly reduce treatment costs, and improve the profitability and overall economic viability of the tomato processing industry in California.

Additional Assessment

With large batch sizes the roller conveyor should have a mechanism to tear the peel and initiate the peeling process. With longer processing time, lye builds up on the rollers and slippage occurs, preventing the tomatoes from rotating. The air knives are then unable to reach the bottom due to the slippage. To prevent slippage from the accumulation of lye, the belt was washed in-between trials. Slippage was not a concern with a properly clean roller conveyer. However, washing the roller conveyer during peeling is not a feasible option as it defeats the purpose of the air knives. To resolve the slippage concern, a new roller surface needs to be developed. The roller will need a more aggressive surface to generate the friction necessary to ensure full rotation of the tomatoes as they pass underneath the air knives. In addition, peel build-up at two ends of peeled tomatoes was observed with some commercial varieties. The incorporation of a pincher bed, shorter than currently utilized in the commercial peeling process, would eliminate this problem.

Funding Expended to Date

Grant Award Amount $119,120.00
Invoiced to Date $118,268.26
Remaining Grant Balance $851.74
(The remaining grant balance was reallocated.)

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Final Performance Report

Project Title
Impacts of Kaolin Clay Spray on Pistachio Leaves to Reduce Evapotranspiration, Insecticide Usage, and Energy Consumption Through Water Pumping

Project Summary
In California, fruits and nuts make up a large portion of the state's irrigated acreage. Problematically, the areas in which these crops are grown (particularly south of the Delta) are increasingly short of water. Farmers and water districts are interested in techniques to reduce the amount of water used to irrigate crops not only in order to conserve that water, but because runoff from fields impacts in-stream water quality and quantity.

All plants require a certain quantity of water for evapotranspiration (ET), which accounts for the water both used by the plant and discharged into the atmosphere. The amount of water required for ET varies by crop type. The Irrigation Training and Research Center (ITRC) at Cal Poly State University, San Luis Obispo, conducted this research primarily to examine the possibility of using kaolin clay sprays to economically reduce ET, as well as maintain or improve crop quality, quantity, and reduce insect pressure. Previous research on the kaolin clay sprays only focused on crop quality and insect pressure.

In an effort to conserve water while maintaining or improving quality and quantity from pistachio trees an inert kaolin clay product, trademarked Surround™, was applied to large blocks of pistachio trees over two growing seasons. The Surround was applied multiple times each year at specific times during the growth stage to determine if Surround had any impact on ET, nut quality, yield, or insect damage.

The specific goals of this study were to:
1. Verify if the application of a common tree fruit insect pest inhibitor (Surround™) could reduce crop ET on pistachios.
2. Monitor yield and quality between treated and untreated pistachio trees.
3. Document secondary benefits such as reduced insecticide spraying and reduced irrigation pumping (which impacts California energy consumption and peak electric loads).
4. Publicize significant results through farm publications, ITRC web pages, and electronic correspondence with water conservation coordinators in California irrigation districts.

Project Approach
A 390-acre orchard near Lost Hills, California, was selected for this study. Factors that were considered during site selection included:
- The entire orchard is irrigated as one set (reducing the effects of varying irrigation on different sets)
- The tree vigor was fairly uniform across the orchard
- The trees were near maturity
- The orchard would provide results on a large scale (not just for individual trees)
- Eight uniform blocks could be easily marked and harvested
- The grower was interested in the study

Working in conjunction with the grower, NovaSource, the University of California Cooperative Extension, and Paramount Farming Company, ITRC generated a plan to examine eight large adjacent blocks (about 36 acres in size the first year and 9 acres in size the second year). Four of the blocks were treated three times each with Surround and four of the blocks remained untreated as control blocks. The initial selection of the orchard examined standard aerial and satellite photos for relatively uniform growth/age.

Using historical Landsat satellite images and a technology called SEBAL (Surface Energy Balance Algorithm for Land), which is very effective at estimating ET rates of large areas, the field was documented to have very similar ET rates in each of the eight blocks.

In addition to the SEBAL analysis the following data was also collected and analyzed as part of this research study:

- Soil samples were taken to verify and map soil types across the orchard.
- Soil moisture equipment was installed to monitor soil moisture depletion in each of the treated and control blocks.
- A pressure chamber (leaf bomb) was used to determine the stem water potential in each block on a weekly basis during the growing season.
- The treated and control blocks were harvested individually to determine any yield differences.
- Nut samples were gathered from each block for quality analysis.
- Insect traps were used to identify Naval Orange Worm (NOW) populations in each of the blocks.
- Small blocks of trees were intentionally under-irrigated by replacing the standard 1 gph emitters with 0.5 gph emitters. This provided information about the level of protection that Surround might have on pistachio trees in an extreme condition.
- A pressure switch was installed to determine the actual hours of run time and water applied.

The potential net benefit of this research was hypothesized to be less crop ET, possibly with higher yields because less energy would be used by the trees to repair damage. This means more energy is available to be stored in the fruit, to build healthy roots, and to encourage growth. For permanent crops, such as pistachios, this might result in a more vigorous, healthier tree in the year after the Surround treatment.

Goals and Measurable Outcomes Achieved

Surround was applied to the treated plots twice in 2009. The first application was on May 21st and the second application was on June 10-11th.

Each application consisted of a six percent concentration applied at 2.5 miles per hour. The application rate was 150 gallons of solution per acre. At a six percent concentration, roughly 75 pounds of Surround was applied per acre after both applications. For the second application, the sprayer traveled down a tree row in the opposite direction to ensure uniform coverage over the entire tree.

The orchard was harvested from September 14-18, 2009. During that time, the yield from each large 36-acre block was loaded into marked trucks. For each load, the net field weights of commercial trucks and the standard quality turnout data from the processor were referenced back to the plot from

which it originated. Paramount Farms provided the weights of each truck as well as the quality data from a 20-pound sample that is pulled from the truck when it is unloaded.

During the second year of the study, there were three applications of Surround. The first application on May 28th used 50 pounds per acre of Surround in 150 gallons of water per acre at approximately 2.5 mph. The Surround solution was applied so that the mixture just began to drip from the tree leaves.

After the first application of Surround, a number of observations were made, including:

- The uniformity of the application (Leaves within the tree were not coated, and leaves near the top were not as well coated)
- The effectiveness of the application

Because preliminary results from the first year did not indicate any potential water savings, yield differences, or quality differences, the decision was made to coat the trees exceptionally well the second year to provide this trial with the best potential for success. Then, if Surround did demonstrate the projected outcomes of this study, the proper amounts could be determined in future studies.

To address the observations from the first application, Surround was applied twice at 50 pounds per acre in 150 gallons of water per acre, but at a speed of 2 mph. The second and third Surround applications were on June 29 and August 18, 2010, respectively. The end result was complete coverage of the treated trees.

In 2010, the blocks were harvested from September 25 through October 1, 2010. The harvest was completed in the same manner as it was in 2009. It was evident during the harvest that the trees were in an "on" year. In addition, the number of male trees in each of the blocks was counted to determine yield per acre of female trees. This information was collected because the blocks were in a slightly different pattern compared to the first year of the study.

Estimating the ET from large blocks covered in Surround using a satellite based program like SEBAL is not possible with current methods because the Surround changes the reflectance which impacts the outputted ET values. SEBAL estimated that the plots treated with Surround had ET rates approximately 1-2 mm/day lower than the non-treated control blocks. However, ground based data demonstrated that there was actually very little difference.

Statistical analysis demonstrates that Surround does not significantly provide any water savings, yield, or quality benefits for pistachio trees in a slight under-irrigated condition or an extreme deficit irrigated condition. However, the weather in 2009 and 2010 played a large role in the data that was collected as part of this study. For example, 2010 was an exceptional production year (likely because of a mild summer) that may only occur once every 25 years. It is not believed that this impacted the results of the study, but it should be noted.

Statistical comparisons for soil moisture, stem water potential, and insect damage were not completed because the data, when plotted in a graphical form, showed minimal difference when averaged and compared by treatment and application depth (irrigation level). For this reason, statistical comparisons were deemed unnecessary for the purposes of this study. However, data was collected in each of the replications for each treatment for each year of the study, so statistical comparisons could have been completed if the graphical data would have demonstrated larger and more uniform differences.

Some of the results have been presented at various workshops and meetings to growers and researchers. See the following tables for workshops and meetings that occurred in 2010.

2010 Meetings Organized (Classes/Short Courses/Demonstrations/Field Days/Other**)**

Dates	Event / Presentation	Role	Location	No.
4/8	Kern Irrigation Workshop: Irrigation scheduling in permanent crops- process, planning, programs and pressure bomb / Irrigation scheduling essentials	Organized, Presented	Bakersfield	54

2010 Educational Extension Presentations (including oral presentations and posters)

Dates	Event / Presentation	Role	Location	No.
1/13	2010 Annual statewide pistachio day / Effect of SURROUND on water relations, yield and nut quality	Invited	Visalia	280
1/14	CA Pistachio Research Board project presentation day / Large-scale utilization of saline groundwater for development and irrigation of pistachios inter-planted with cotton, Effect of pre-plant tillage on pistachio development under drip irrigation	Invited	Kearney Ag Center	35
2/1-2	CA Irrigation Institute 48th Annual Conference – California's water supply running on empty: thinking outside the tank / Changing water demands of almonds	Invited, Co-organized, Moderated	Sacramento	88
2/10	2010 World Ag Expo / Irrigation management in a water short year	Invited	Tulare	40
5/10	Pistachio damage from frost/salinity interaction / review current knowledge of pistachio salt tolerance, diagnose field problems	Invited	Kern	20
6/25	Kern County Farm and Irrigation Tour for Australian Farmers	Organized	Kern	27
8/10-11	Sustainable Agricultural Partnerships 2010 / On-farm irrigation practice and new technology: separating myth from reality	Invited	San Francisco	110

In addition to the workshops listed above, a journal article is being submitted to the HortScience Journal: http://hortsci.ashspublications.org/

A complete technical report is attached.

Financial Feasibility

California Department of Food & Agriculture: $119,785.00

Cost Matching:

California State University/Agriculture Research Initiative: $108,275.00

TKI NovaSource – In-kind contribution $29,800.00
(23,000 lbs. of Surround, application costs and irrigation modifications)

Funding Expended to Date

Grant Award Amount $119,785.00
Invoiced to Date $119,785.00
Remaining Grant Balance $0

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Final Performance Report

Project Title
Sampling Protocol for *E. coli* in the Irrigation Water Canals of Imperial Valley, California

Project Summary
The purpose of this proposal is to develop a cost effective sampling protocol for generic *E. coli* in irrigation water, validate the sampling protocol through established analytical and statistical methods, and develop irrigation water quality management information and training to fruit and vegetable industry personnel. The results of this project will contribute to a better understanding of trends in microbiological irrigation water quality, narrowing the national and existing gap in the knowledge pertaining to the lack of suitable pathogenic *E. coli* indicator and irrigation water standard.

Project Approach
The Food and Drug Administration (FDA) has implicated irrigation water as possible source of the 2006 *E. coli* and the 2008 *Salmonella* contamination of fresh produce. The Imperial Irrigation District is located in the largest irrigation canal system in the U.S and home to one of the largest agricultural producing areas. These predominantly open and unlined canals are subject to risks from concentrated animal feeding operations (CAFO), manure stock piles, sheep grazing, storm water, tailwater return systems, and other contamination sources.

A team of scientists from the University of California, Riverside (UCR) and Davis (UCD) campuses, and Western Growers looked at developing a risk-based sampling protocol for generic (commensal) *E. coli* in the irrigation canals, correlated to targeted testing for enterohemorrhagic *E. coli* O157:H7 and *Salmonella*, and validating that protocol using statistical analysis. This project addresses the need to develop a standardized water sampling and analysis program that advances science-based water quality criteria for irrigation source water used in California, the creation and delivery of extension training materials, and data-based guidance tools for decision making. In order to accomplish this project's goals; the following revised and approved work plan was followed.

Task 1: Sampling Strategy
1) Complete literature review including previous water data collected by growers and by Imperial Irrigation District in 2007/2008
2) Quantify canal conveyance network, locations of spatial risk sites, and sampling location and frequency.
3) Develop statistical modeling design for the assessment and validation of *E. coli* sampling and produce a report documenting all sampling and modeling techniques
4) Laboratory preparation: purchasing of equipment and supplies for *E. coli* sampling and analysis; proficiency training for enumeration and verification methods.

Task 2: Sample Analysis and Validation
1) Sample, analyze and monitor targeted area
2) Perform statistical assessment of sampled *E. coli* data
3) Validate the sampling protocol through random and duplicate sample analysis

Task 3: Extension and Education
1) Perform final statistical analysis of generic *E. coli* and *E. coli* 0:157:H7 data
2) Compile and analyze results
3) Conduct outreach to inform growers about this project results
4) Publish results in local extension publication and/or regional trade journals

Rationale and Significance:
Personnel from UCR conducted a literature review and study to identify useful modeling strategies and methodologies that could be utilized in determining the number and location of sampling sites and the frequency of sampling necessary to generate statistically relevant and defensible information for this study.

A suitable location within the Imperial Irrigation District service area was selected based on modeling needs and project design including the spatial locations of known risk sites, effective sampling locations and a frequency for sampling and project duration were established. A conveyance network sampling strategy was developed to monitor for levels of Generic *E. coli* in the IID Ash Canal System. The network sampling strategy was composed of 24 canal sampling sites strategically located at farm gates, sub-canal headings, and upstream and downstream from previously identified risk factors. Personnel from UCD and Imperial County Cooperative Extension collaborated to secure sampling and analytical supplies and training was conducted to ensure proficiency and integrity of sampling, enumeration and verification.

Weekly sampling and testing was performed in an effort to validate the strategy from Sep 2009 – March 2010. Water samples for generic *E. coli* were collected on a weekly basis, with six of the 24 locations sampled at randomly selected rotating duplication sites each week. Water samples for pathogens were taken at 5 locations each week beginning Nov 9 and continuing throughout the project.

Over 2600 data points were collected for analysis including:
- ✓ Generic *E. coli* sampling
- ✓ Random duplication of generic *E. coli* samples
- ✓ Water Temperature, TDS, PH, and Turbidity sampling
- ✓ Pathogen sampling

Statistical analyses were performed on the measurements collected through this sampling strategy to quantify:
- ✓ Microbial patterns throughout the system
- ✓ The degree of down-stream spatial loading
- ✓ Contribution from specific risk source factors
- ✓ Validate the conveyance network sampling strategy
- ✓ Evaluate if generic *E. coli* density is predictive of pathogen presence.

Several significant hypotheses were explored and tested utilizing the baseline data collected and the UCR modeling methodology. Specific hypotheses included:

1. Are the average levels different across different sample locations, and if so, do the sites located immediately beyond known risk sources consistently exhibit higher average?
2. Do the area-wide levels change over time, and if so, does this pattern correspond to any meaningful physical process?
3. If the month effects exist on the levels, do the month effects change across locations?

Goals and Measurable Outcomes Achieved

Although the final results of this study indicate that more work may be necessary to develop a sampling protocol that is predictive and statistically reliable for a water conveyance system serving multiple growers, a better understanding of trends in microbiological irrigation water quality was achieved during the project. The general tasks of 1) developing a sampling strategy, 2) conducting sample analysis and validation; and, 3) performing extension and validation activities were completed.

Measurable Outcomes and Due Dates:
The work plan was carried out in three discrete tasks as follows:

Task 1: Sampling Strategy. - A detailed literature review of relevant statistical sampling and modeling methodology was conducted to examine and assess the potential for adapting river/stream network sampling protocols to the current network conveyance project. A statistical modeling design for the assessment and validation of *E. coli* samples was developed along specific parameters. *Completed August 2010*

Task 2: Sample Analysis and Validation. - An intermediate statistical assessment was performed of sampled *E-coli* data (collected through December 2009) in order to make corrections or adaptations to proposed data modeling approach as well as to guide the ongoing sampling program (from January through March 2010). *Completed August 2010*

Task 3: Extension and Validation. - A final statistical analysis of generic *E. coli* and *E. coli* 0157 was performed. The results were compiled and analyzed. The findings of this study were shared and discussed with growers in the Imperial Valley Region. *Completed March 2011*

The detailed final report for this project is included as an appendix to the Annual Report.

Funding Expended to Date

Grant Award Amount $95,828.00
Invoiced to Date $66,329.71
Remaining Grant Balance $29,498.29

CDFA will request approval from USDA at a later date to amend the State Plan to reallocate the remaining grant balance.

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Final Performance Report

Project Title
Supporting the USDA Fresh Fruit and Vegetable Program in California Schools

Project Summary
The long-term goals of this project are to 1) increase children's consumption of fresh fruits and vegetables on school campuses by delivering a piloted training and technical assistance program to improve the schools' use of the United States Department of Agriculture's (USDA) Fresh Fruit and Vegetable Program (FFVP) funds in procuring and offering quality seasonal produce; and 2) reinforce children's interest in consuming fresh fruits and vegetables by guiding school personnel in how to provide experiential educational opportunities in school gardens and with farmers at local farms.

Concern over children's health has increased in the last decade and health issues among children are becoming critical. School-age children now eat less than the recommended amount of fruits and vegetables and continue to show increases in diet-related health problems[1]. Since children eat a significant portion of their diet at school, the USDA began to address this issue by establishing the FFVP. This allows qualifying schools to purchase additional fresh fruits and vegetables to serve as snacks. To realize FFVP's full potential, the school personnel implementing it need professional training and technical assistance. Our project team was partially funded through a 2008-2010 USDA Team Nutrition Training Grant (TN) to develop, pilot, assess, and begin roll-out of ***Fresh Fruits and Vegetables: A Centerpiece for a Healthy School Environment*** **(FFVCHSE).** This training provides 1) skill-building in regional procurement and menu planning with seasonal produce; 2) techniques for handling, serving, and promoting fresh fruits and vegetables; and 3) tools for increasing students' awareness and consumption of fresh fruits and vegetables through experiential nutrition and garden-based education.

This Specialty Crop Block Grant project complemented and leveraged the USDA project. Project partners collaborated on specific project tasks, which were the following:

1) Design, develop, and provide FFVCHSE Trainers' workshop

2) Design and develop Fall 2009 FFVCHSE workshops

3) Provide 8 Spring/Summer FFVCHSE trainings in 2010

4) Provide 3 Fall/Winter FFVCHSE trainings in 2010-11

5) Provide 3 Spring Summer FFVCHSE trainings in 2011

6) Evaluate and report on success of FFVCHSE trainings

The goals were to 1) provide an essential Train-the-Trainers workshop to build understanding of content and improve delivery of FFVCHSE statewide, 2) complete FFVCHSE training for

[1] **Adams, M.A. et al**. Salad bars and fruit and vegetable consumption in elementary schools: a plate waste study. *J. Am Dietetic Assn. 2002. 102:S40 – S51.;* **American Academy of Pediatrics.** Policy statement: prevention of pediatric overweight and obesity. *Pediatrics.* 2003. 112: 424 – 430.

approximately 270 schools who would otherwise receive only the first half; and 3) provide FFVCHSE to approximately 100 additional schools during 2010-2011 school year.

Project Approach

From Fall 2009 to June 2011, the project team delivered a total of 15 Specialty Crop Block Grant Program (SCBGP)-funded FFVCHSE workshops in Northern, Southern and Central California.

- This represents 806 school personnel who received the full FFVCHSE training.
- Estimating a conservative 350 students per school, over 280,000 students could be impacted by these trainings.

The SCBGP-funded trainings were complemented by an additional 13 trainings delivered to approximately 650 attendees between Spring 2010 and Spring 2011. These were funded by the USDA Team Nutrition Training Grant and administered collaboratively by the project team and California Department of Education (CDE) Nutrition Services Division. [See Attachment A for details on dates/locations of workshops and numbers of attendees]

FFVCHSE trainings brought together a broad spectrum of participants: school food service directors and their staff; nutrition educators; pre- and after-school program staff; school teachers, principals and administrators; school garden educators and volunteers; local farmers and produce brokers.

The project team also delivered a 2.5 day Train-the-Trainers to professionals with expertise the content areas covered by FFVCHSE. These included food service directors, UC Extension and other governmental representatives, nonprofit program managers, regional leaders in the Farm to School movement, chefs and representatives from CDE. Nineteen professionals received training at the initial meeting, with an additional six professionals subsequently trained. All trained professionals have extended the content of this program in their own regions or local educational contexts in some significant way.

Workshop evaluations were consistently high. The overall average evaluation from all 15 workshops across the state was 4.52 out of 5.0. Individual workshops ranged from 4/2 to 4.8. [See Attachments B for averages.] A sample of comments on what participants found was most useful are as follows:

- Hands-on demonstration was very informative, visual demo was very well demonstrated
- Great to go through the lesson to understand how to train youth (not just explaining, but <u>doing</u>)
- Great networking, too!
- Gave me ideas of how to incorporate lessons and involve students and teachers in healthy eating
- The trainings provided steps on setting up a garden program, what is working at places that have already started the program, valuable resources and handouts that are readily accessible and ready to use, don't have to go back and re-create info / materials
- Ways to get resources and improve nutrition and nutrition education to our students
- Great resources, wonderful people. Thanks!

For each set of workshops, team members met to review previous evaluations and modify the presentation to ensure that content was as current and relevant as possible to the various regions in which the workshops were presented. The landscape of issues and programs around healthful school food is changing rapidly, and the team has been diligent about keeping up to date on national and state developments. It has been gratifying to follow the increased support for children's health from agriculture and health organizations such as the SCBG Program and USDA.

Goals and Measurable Outcomes Achieved

The goal of the project was to deliver "Fresh Fruit and Vegetables: Centerpiece for a Healthy School Environment" trainings to at least 550 people in the 14 workshops across the state. The project team in fact delivered to over 800 participants in 15 workshops. In addition, a total of 25 professionals were trained who extended the trainings in various ways in their local regions.

Workshop content included a range of topics relevant to developing and supporting healthy eating choices by children in a school environment, and ideally in their lives outside of school. In the Fall/Winter series, workshops covered topics such as National updates (policy and program updates); wellness policies; cooking and serving to kids; nutrition and garden education, and farm to school. Spring/Summer workshops covered more nutrition education, seasonality and how to incorporate seasonal produce into school meals, connecting garden-enhanced nutrition education to the academic standards, composing and recycling at schools, and promoting fresh fruits and vegetables to students.

In addition to highly successful trainings, at least three major projects have been developed and funded as a result of the FFVCHSE work: "Building Successful Farm to School Models," a project funded by CDFA; "A School-Based Approach to Reducing Childhood Obesity by Promoting Healthy Behaviors and Supporting Regional Agriculture," funded by University of California Ag and Natural Resources; and a continuation of FFVCHSE trainings with Life Lab Science Program at University of California, Santa Cruz as the lead agency.

Additional Assessment

Broad take-home lessons learned from this project have been the following:

- School professionals are enthusiastic and ready to make significant and positive changes in school food systems in order to improve children's health and diet. However, there are challenges to overcome in order to do this. Interactive meetings such as these provide a positive platform for trouble-shooting and problem-solving between and amongst trainers and participants.
- While challenging, conducting workshops that address a *wide* audience of adult professionals who are all involved in developing and maintaining healthy school environments, is valuable because of the opportunities for crossing barriers within our school system institutions.
- Developing a statewide team of knowledgeable trainers who can deliver consistent content across our state but tailor each workshop regionally is an efficient and effective way to reach a wide audience and create regional networks.

Over time, the statewide trainer team who develop and deliver this content has gained invaluable expertise through the rich opportunity they have to interact with professionals across the state and then periodically bring that experience back to trainer team gatherings for reflection and development.

Funding Expended to Date

Grant Award Amount: $119,785.00
Invoiced: $114,286.85
Remaining Grant Balance: $5,498.15
(The remaining grant balance was reallocated.)

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Final Performance Report

Project Title
Integration of a robotic cultivation system into California vegetable crop production systems

Project Summary
A robotic cultivator was evaluated to determine if it can be used to increase the efficiency of vegetable production by removing weeds from between lettuce and tomato plants in the row. Additionally, this machine was tested to determine if it can be used to thin direct-seeded lettuce and tomato to desired stands. Hand weeding is a significant expense for vegetable growers and currently the only way to remove weeds from within the crop row is with expensive hand weeding or with selective herbicides. The Tillett rotating cultivator, a robotic cultivator sold commercially in England, can remove weeds from the crop row. Direct-seeded crops are generally planted at high stands and then thinned by hand to desired stands at a cost of $80 to $150/acre. Production costs can be reduced if hand thinning the crops can be reduced or eliminated. The purpose of this project was to test the rotating cultivator in typical California vegetable production systems and determine if it is effective at crop thinning, removing weeds, and reducing time of hand thinning and weeding in lettuce and tomato.

Project Approach
The rotating cultivator and a standard vegetable cultivator were compared for weed removal effectiveness, relative times of hand weeding and crop thinning, as well as crop yields. Field studies were conducted with both cultivators in bok choi, lettuce and tomato during 2009 and 2010. Results were presented to growers and pest control professionals at field day demonstrations and in oral presentations at extension meetings. A formal scientific presentation of results was made at the Weed Science Society of America meeting in February 2011.

Goals and Measurable Outcomes Achieved
1. Determine if the rotating cultivator affects crop yield and increases labor use efficiency for crop thinning, weed removal, and hand weeding in lettuce and tomato.
2. Determine if the rotating cultivator reduces labor and production costs in lettuce and tomato.
3. Demonstrate the new cultivation system developed by this project to growers and allied industry, and work with growers to integrate this precision cultivation system into their production scheme.

The project is completed and all three of the above objectives were met. In 2009 and 2010 weed control and hand weeding times were measured in both lettuce and tomato. The rotating cultivator was also tested for crop thinning in lettuce and tomato. Attempts to thin direct-seeded tomato with the rotating cultivator were not successful. The rotating cultivator was able to cultivate transplanted tomato. The results indicate that the rotating cultivator can increase the efficiency of labor use for hand weeding and lettuce thinning, but did not always increase net returns. The rotating cultivator was demonstrated to many growers and the project collaborator reports that some of these machines have been purchased by California vegetable growers on the central coast and in the Central Valley.

Field trials were conducted in 2009 and 2010 at several key vegetable production districts in coastal and central California locations (Table 1).

Table 1. Crop, cultivar, location, planting dates, cultivation dates, hand weeding and harvest dates for lettuce, and tomato cultivator evaluations at Salinas, Gonzalez, Castroville, Santa Maria and Five Points, CA.

Crop	Cultivar	Location	Planting	Cultivation	Weeding	Harvest
2009 experiments:						
Head Lettuce (Seeded)	Corona	Salinas	5/20/09	6/18/09	7/6/09	7/29/09
Head Lettuce (Transplant)	Corona	Salinas	7/23/09	8/6/09	8/6/09 8/20/09	9/22/09
Tomato (Transplant)	Shady Lady	Salinas	6/24/09	7/9/09	7/14/09 7/29/09	9/23/10
Bok Choi (Transplant)	Joy Choy	Santa Maria	9/10/09	9/24/09	10/7/09	11/17/09
Romaine Lettuce	Unknown	Gonzalez	5/20/09	6/17/09	6/25/09	7/22/09
2010 experiments:						
Head Lettuce (Seeded)	Hallmark W	Salinas	6/23/10	7/21/10	8/6/10	8/31/10
Head Lettuce (Seeded)	Hallmark W	Salinas	8/24/10	9/16/10	---	11/10/10
Head Lettuce (Transplant)	Hallmark W	Salinas	9/3/10	9/21/10	9/27/10	10/28/10
Tomato (Transplant)	Shady Lady	Salinas	6/18/10	7/9/10	7/12/10 8/6/10	9/30/10
Tomato (Transplant)	H-2401	Five Points	5/11/10	6/3/10	6/17/10	9/17/10
Head Lettuce (Seeded)	Steamboat	Castroville	5/20/10	6/16/10	6/25/10	7/22/10

Results were presented to stakeholders at extension meetings and field day demonstrations listed in Table 2. Results were also presented at continuing education events such as the California Weed Science Society annual meetings and at the Weed Science Society of America annual meeting (a scientific meeting).

Table 2. Delivery of results from this project was made at extension meetings, field days and at a scientific meeting.

Event date	Sponsor	Location	Description
Nov. 3, 2009	Univ. California	Salinas, CA	Extension meeting
Jan. 12, 2010	CA Weed Sci. Soc.	Visalia, CA	Continuing education
July 15, 2010	Univ. California, Davis	Davis, CA	Field demonstration
July 20, 2010	Univ. California	Salinas, CA	Field demonstration

Nov. 9, 2010	Univ. California	Salinas, CA	Extension meeting
Jan. 20, 2011	CA Weed Sci. Soc.	Monterey, CA	Continuing education
Feb. 8, 2011	Weed Sci. Soc. Amer.	Portland, OR	Scientific meeting

Financial Feasibility

The funding level was adequate to perform the project tasks by University of California personnel. However, the equipment dealer from Solex in Dixon, CA made considerable contribution to this study in terms of personnel time and equipment use at no cost to the project. This work would not have been possible without the in-kind contributions of Solex.

Additional Assessment

Generally the rotating cultivator removed more weeds than the standard cultivator resulting in lower weeding times (Table 3). In transplanted lettuce the rotating cultivator did not reduce yields.

Table 3. Effect of cultivator type and pronamide rate on weed control, hand weeding time and marketable lettuce yield in transplanted head lettuce.

Cultivator type	Pronamide rate (lb ai/A)	Weed Control (%)	Weeding time (hr/Ac)	Marketable Heads (Tons/Ac)
Rotating	1.2	95.0 a	5.4 b	11.1
Standard	1.2	65.6 b	6.0 a	11.6
Rotating	0	95.4 a	5.4 b	10.0
Standard	0	76.5 b	6.2 a	10.2
LSD (P=0.05)		24.1	0.5	3.0
Treatment Prob (F)		0.0086	0.0150	0.5561

Economic analysis was performed on the results and partial budgets were developed which included the costs of labor inputs and income from the crop yields (Tables 4, 5, 6 and 7). The rotating cultivator appears to reduce the stand of seeded lettuce more than the standard cultivator. Sometimes the rotating cultivator knives pass too close to a lettuce plant causing damage to the plant. This cultivator damage results in reduced lettuce yields and lower net returns in the rotating cultivator compared to the standard cultivator regardless of herbicide treatment (Tables 4, 5). For transplanted lettuce the higher returns were for the lettuce treated with herbicide and weeded with the rotating cultivator compared to lettuce treated with herbicide and weeded with the standard cultivator (Table 6). For transplanted tomato without herbicide the net returns for the rotating cultivator were $208 higher than the standard cultivator (Table 7). It appears that the rotating cultivator worked best in transplanted lettuce and tomato where it removed most weeds, but did not damage the crop. In direct-seeded lettuce and direct-seeded tomato the rotating cultivator slightly damaged the crop and was not accurate enough to do the precision thinning required.

Table 4. Production costs and net returns for direct-seeded head lettuce in 2009 using the rotating and standard cultivators.

Treatment	Yield† (crtns/ac)	Gross Returns‡ ($/ac)	Production Costs ($/ac)	Net Returns§ ($/ac)
Rotating cultivator, plus Herbicide	943	10,467	445	10,022
Standard cultivator, plus Herbicide	1,068	11,855	549	11,306
Rotating cultivator, no Herbicide	783	8,691	336	8,355
Standard cultivator, no Herbicide	1,011	11,222	416	10,806

† Yield is in 42-lb cartons per acre.

‡ Gross returns = experimental yield in cartons per acre x $11.10 per carton (2009 price per carton for wrapped head lettuce for Monterey County).

§ Net returns above production costs (gross returns – production costs).

Table 5. Production costs and net returns for direct-seeded head lettuce in 2010 using the rotating and standard cultivators.

Treatment	Yield† (crtns/ac)	Gross Returns‡ ($/ac)	Production Costs ($/ac)	Net Returns§ ($/ac)
Rotating cultivator, plus Herbicide	601	7,633	424	7,209
Standard cultivator, plus Herbicide	700	8,890	398	8,492
Rotating cultivator, no Herbicide	635	8,065	260	7,805
Standard cultivator, no Herbicide	727	9,233	285	8,948

† Yield is in 42-lb cartons per acre.

‡ Gross returns = experimental yield in cartons per acre x $12.70 per carton (estimated USDA-AMS 2010 price per carton for wrapped head lettuce for Salinas – Watsonville; 2010 Monterey County Crop Report is not yet available).

§ Net returns above production costs (gross returns – production costs).

Table 6. Production costs and net returns for transplanted head lettuce using the rotating and standard cultivators.

Treatment	Yield† (crtns/ac)	Gross Returns‡ ($/ac)	Production Costs ($/ac)	Net Returns§ ($/ac)
Rotating cultivator, plus Herbicide	897	11,392	337	11,055
Standard cultivator, plus Herbicide	824	10,465	275	10,190
Rotating cultivator, no Herbicide	814	10,338	139	10,199
Standard cultivator, no Herbicide	872	11,074	128	10,946

† Yield is in 42-lb cartons per acre.

‡ Gross returns = experimental yield in cartons per acre x $12.70 per carton (estimated USDA-AMS 2010 price per carton for wrapped head lettuce for Salinas-Watsonville (Monterey County Crop Report is not yet available).

§ Net returns above production costs (gross returns – production costs).

Table 7. Production costs and net returns for transplanted tomatoes using the rotating and standard cultivators.

Treatment	Yield† (tons/ac)	Gross Returns‡ ($/ac)	Production Costs ($/ac)	Net Returns§ ($/ac)
Rotating cultivator, plus Herbicide	16.9	1,403	323	1,080
Standard cultivator, plus Herbicide	16.5	1,370	291	1,079
Rotating cultivator, no Herbicide	16.8	1,394	415	979
Standard cultivator, no Herbicide	15.8	1,311	540	771

† Yield is in tons per acre.

‡ Gross returns = experimental yield in tons per acre x $83 per ton (estimated 2010 price per ton for California processing tomatoes using 2009 Fresno County Crop Report price).

§ Net returns above production costs (gross returns – production costs).

The photo below is a test of thinning lettuce on a commercial field near Salinas CA in May 2009.

The photo below demonstrates cultivation in transplanted lettuce near Salinas, CA in July 2009.

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Final Performance Report

Project Title
Enhancing Identification of Agromyzid Leaf-Miners Threatening California's Specialty Crops

Project Summary
The purpose of the proposed research was to increase understanding of flies in the plant-feeding family Agromyzidae (leaf-miner flies), known for their leaf-mining habits, and of particular importance to California's specialty crops. Because the species is extremely diverse, has a very wide host range, and is very poorly known and unevenly studied, a more comprehensive understanding of California's fauna, and of the many invasive species likely to be introduced into the State, is a primary goal. The project seeks to facilitate rapid and accurate identification of specimens and plant damage by producing publicly available tools to differentiate native and already introduced species from alien invasives that potentially threaten California agriculture, and to more comprehensively document their host ranges, distributions, and leaf-mining strategies that cause the damage to crop plants. The project goals were to:

1. Create comprehensive resources to aid in the diagnostics and identification of native and introduced species and of invasive species encountered at borders, ports, nurseries, and in detection surveys;

2. Increase the understanding of host-ranges for California's native and introduced fauna, as well as the host-ranges for the invasive species of potential agricultural significance;

3. Further document the distributions of California's native fauna, and that of invasive species of potential agricultural significance.

4. Documenting leaf mine types was not achieved due to the lack of sufficient reared material from which to identify and categorize patterns of leaf mine type associated with particular species.

Project Approach
The publications from this project provide data that are unavailable elsewhere, including full lists of hosts for the genera revised, a comprehensive view of their distributions within the state, full descriptions and illustrations for all species, and most importantly resources for making authoritative identifications of the species. Species of this family have been notoriously difficult to identify due to poorly worked-out taxonomy in the past. But for several of the largest and most commonly encountered genera in California, this problem has been solved by comprehensive revisions with excellent resources for identification. When the electronic products are deployed (interactive identification keys, factsheets), this resource will become even more important, as it synthesizes the information from the publications, and provides more photographic documentation in an easy to use format for professionals and non-professionals to access the information online. The publications and electronic products are discussed in the "Results and Conclusions" section, and listed in the "Additional Information" section.

Goals and Measurable Outcomes Achieved
Hand-collected and reared specimens from throughout the state have supplemented thousands of historical specimens gathered from all major institutions housing Californian collections, including the

California Academy of Sciences, San Francisco (CASC), the Canadian National Collection of Insects, Ottawa, Ontario, Canada (CNC), the California Department of Food and Agriculture (CDFA), Sacramento (CSCA), the Essig Museum of Entomology, University of California, Berkeley (EMEC), the Santa Barbara Museum of Natural History (SBMN), the Bohart Museum of Entomology, University of California, Davis (UCD), the Los Angeles County Museum (LACM) and the United Stated National Museum of Natural History, Washington, D.C. (USNM). All relevant type specimens necessary for understanding species limits were examined and photographed, and facilitated understanding of the definitions for each California species, including finding new species. From this understanding, specimens collected and from the various institutions above were used in revisionary work for publication (i.e., describing the morphology, photographing and illustrating important characteristics, developing keys for identification, verifying and adding new host records, expanding known distributional ranges, etc.), and for development of web-based interactive identification keys and factsheets for individual species. Interactive identification keys are developed using Lucid 3.5 software, scoring characters into a matrix (species: character). Factsheets are developed using Fact Sheet Fusion version 1.0.25 software, writing pages with text and figures for deployment as web pages or as stand-along informational sheets. Factsheets are also deployed through the Lucid keys as a final display following identification of specimen.

All outcomes were geared towards developing a greater understanding of California's native and previously-introduced agromyzid fauna, as well as pest species known to be potentially invasive for California's numerous agricultural commodities. Specifically:

1. Development of publicly web-accessible interactive identification keys, richly illustrated with images of critical diagnostic features from external morphology and internal genitalic morphology. The measurable outcome will be the launching of these keys via the CDFA website, which will greatly enhance the ability to accurately identify agromyzid leaf-miners in California. The Lucid key is a single package resource that is coupled with the factsheets in #2. As such, deployment will occur when the resource is finished, before the end of 2012. Most of the photographs are finished, descriptions for many species are done, and the resource is in development. The postdoctoral scientist continues to work on the goals of this project via another funding source. Example screenshots are attached. The Lucid key, along with the resources below, will be deployed by the end of the year and will be accessible at http://www.cdfa.ca.gov/plant/ppd/keys.html, under the "Insects and other Arthropods" tab.

2. Development of web-accessible resources (i.e., websites, factsheets) that will give background information, including distributional and faunistic data, images of leaf-mine types, analyses of host ranges, discussions of potential damage, etc. Factsheets will be deployed as they are completed, before the end of 2012. Example screenshots are attached. These resources, along with the Lucid key above, will be deployed by the end of the year and will be accessible at http://www.cdfa.ca.gov/plant/ppd/keys.html, under the "Insects and other Arthropods" tab.

3. Publication of articles in scientific journals revising certain groups of agromyzids, describing new species and putting the relevant data into the peer-reviewed scientific literature. Three articles were published in 2011, and three articles are very near submission (will be published in 2012). The three articles that will be published by the end of the year are entitled "In addition, 2 presentations at scientific meetings were made. The publications and presentations are attached.

4. The fourth goal of documenting leaf mine types was not achieved due to the lack of sufficient reared material from which to identify and categorize patterns of leaf mine type associated with particular species.

Financial Feasibility

The original time frame was two years for this project. The original postdoctoral scientist left the position after six months. The new postdoctoral scientist continued through the remainder of the grant period for a total of 16 months. The amount of funding provided as match was adequate, with CDFA providing microscopy and camera equipment, work space and technical help, general supplies related to this kind of work, and in-state travel with other CDFA scientists.

Additional Assessment

As one of the most diverse, commonly-encountered and agriculturally significant groups of leaf-mining flies, it was determined to first revise *Liriomyza* in a series of genus-level treatments examining those Agromyzidae most damaging to California's specialty crops, including food and ornamental plants. The genus *Liriomyza* was revised and published in 2011, with 63 species found to occur in the state, representing approximately 75% of all known North American species diversity. Of these, 12 were described as new to science, and several represented important new state records. A number of new host and rearing records were also gathered, particularly on ornamental and vegetable crops, significantly expanding the known host range of many species. The complete host ranges for the most important agricultural pests in *Liriomyza* has been developed, with numerous new records. All species are accompanied by full descriptions, illustrations, host records and an identification key to easily facilitate identifications by experts and non-experts alike. Two of the other largest genera for California, *Melanagromyza* and *Ophiomyia* are also being similarly revised. For *Melanagromyza*, 27 species occur in the state (including one new record for the US), which represents approximately 75% of all US species, and 40% of all known North American species. Three of these species are new to science, and several represent new state records, and numerous new host records significantly expanding the known host range of many species. For the rest of the USA for *Melanagromyza*, there are at least six new species, 10 new distributional records, and several new host plant records. For *Ophiomyia*, 28 species occur in the state (including one new record for the US), which represents approximately 80% of known North American species. Three known North American species are new to science, and there are several new state records and host range extensions. For the large genus *Phytomyza*, the section known as "holly leafminers" (*Phytomyza ilicis*-group) was revised, which is mainly an eastern North American group including 11 species. But significantly, one species was recorded as accidentally introduced into California, and another (a European species) was recorded as accidentally introduced into the Pacific Northwest. For the other genera in California, each contains less than 20 species, with most actually containing five species or less.

For the electronic products (interactive Lucid keys, factsheets), their deployment will occur in 2012. The Lucid key to all California genera is complete. Scoring characters for the Lucid keys to species within each genus is finished for about half the species, photographs are finished for nearly all species, factsheets are finished for 77 species, and factsheets are in progress for most species. To illustrate the state of photographs taken and factsheets developed, the following table lists the numbers of species completed in each genus:

Subfamily	Genus	Subgenus	Species	Photos	Factsheets
Agromyzinae	*Agromyza*	-	18	11	

	Hexomyza	-	4	1	
	Japanagromyza	-	1	1	
	Melanagromyza	-	27	27	27
	Ophiomyia	-	30	25	25
Phytomyzinae	*Amauromyza*	*Annimyzella*	1	1	
		Cephalomyza	11	2	
	Calycomyza	-	13	12	
	Cerodontha	*Butomomyza*	3	1	
		Cerodontha	1	1	
		Dizygomyza	6	1	
		Icteromyza	5	2	
		Poemyza	5	3	
		Phytagromyza	1	0	
	Galiomyza	-	1	0	
	Haplopeodes	-	2	2	
	Liriomyza	-	63	25	25
	Metopomyza	-	3	2	
	Nemorimyza	-	1	1	
	Paraphytomyza	-	4	2	
	Phytobia	-	5	2	
	Phytoliriomyza	-	11	9	
	Phytomyza	-	70	42	
	Pseudonapomyza	-	1	1	

Additional Information:
Following are the Publications and Presentations that resulted from this project. On the additional pages are screenshots of Lucid Identification Tool pages, Fact Sheet Fusion development pages, and a couple of slides from the presentations listed below.

Publications:

Lonsdale, O. 2011. The *Liriomyza* (Agromyzidae: Schizophora: Diptera) of California. *Zootaxa* 2850: 1-123.

Lonsdale, O. & Scheffer, S.J. 2011. Revision of the Holly leaf-miners in the Nearctic (*Phytomyza*: Agromyzidae). *Annals of the Entomological Society of America* 104(6): 1183-1206.

Scheffer, S.J. & Lonsdale, O. 2011.*Phytomyza omlandi* spec. nov.— the first species of Agromyzidae (Diptera: Schizophora) reared from the family Gelsemiaceae (Asteridae). *Proceedings of the Entomological Society of Washington* 113(1):42-49.

Shi, L. & Gaimari, S.D. [near submission, anticipate submission to *Zootaxa* and publication by the end of 2012]. A revision of the genus *Ophiomyia* from California.

Shi, L. & Gaimari, S.D. [near submission, anticipate submission to *Zootaxa* and publication by the by the end of 2012]. The *Melanagromyza* of California, with descriptions of three new species (Diptera: Agromyzidae).

Shi, L. & Gaimari, S.D. [near submission, anticipate submission to *Zootaxa* and publication by the by the end of 2012]. Three new species of the genus of *Ophiomyia* from the southern United States and northern Mexico.

Oral presentations:

Shi, L. & Gaimari, S.D. 2011. Enhancing identification of the genus *Melanagromyza* from California (Diptera: Agromyzidae). Annual Meeting, Entomological Society of America, Reno, NV; 15 November. [attended by approximately 75 people]

Shi, L. 2011. Enhancing identification of Californian agromyzids. California Department of Food & Agriculture, Plant Pest Diagnostics Center Seminar Series, Sacramento, CA; 15 December. [attended by approximately 30 people]

Funding Expended to Date

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(The remaining grant balance was reallocated.)

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Final Performance Report

Project Title
"California Grown" Retail campaign Northern and Southern California

Project Summary
The purpose of this project was to increase sales of and demand for California grown specialty crops. This goal was achieved by reaching out to California consumers at the point of purchase with a multi-tactic advertising campaign placed in Northern California Safeway and Southern California Albertsons stores. This project is valuable to the state's specialty crop industry because it delivered a reminder to seek out locally-grown specialty crops to time-starved consumers at the point of purchase resulting in an increase in sales.

Project Approach
To achieve the project goals a multi-tactic retail advertising campaign was implemented in Northern California Safeway and Southern California Albertsons stores including free standing inserts in area newspapers, in-store floor graphics and grocery cart advertisements. The marketing tactics were executed from July 2009 through September 2009. A consumer intercept survey was conducted during the promotional period to gauge the effectiveness of the promotion.

Goals and Measurable Outcomes Achieved
The goal at the beginning of the project was to show a 2 to 3% increase in category sales during the promotional period. Retail scanner data in various categories with a number of branded products that were easily identified as California grown were accessed. Three weeks of data including the weeks prior, during, and after the promotion were analyzed and the category sales increase expectations were exceeded. The following category sales increases were experienced during the weeks of the promotion:

- Wine category: A 5% increase was realized the first week of the promotion and built to a 12% sales increase by the end of the promotion period.
- Dried fruit category: A 2% increase was realized the first week of the promotion and built to a 12% increase by the end of the promotion.
- Produce category: A 5% increase was realized by the end of the promotion period.

Ninety-seven (97) consumer intercept surveys were conducted at both control and promotional stores to gauge the consumer awareness of the "California Grown" messages. Forty-four (44) surveys in Northern California and fifty-three (53) in Southern California. Demographics were not complied for the survey.

The goals of the consumer intercept surveys were to show a 10% increase in campaign awareness and for consumers to state an increase in purchases of California grown products compared to consumers at the control stores. The results from the survey below show the goals were met.

- 90% of total survey respondents indicated that buying agricultural products from California is an extremely or very good way to support the local economy. From previously collected data, a benchmark of 30% was established. The results from the study show that consumer attitudes have changed significantly regarding the importance of purchasing California grown products.

- When asked specifically about the current advertisement, 52% of the respondents at promotional stores indicated it was more likely to inspire them to seek out and purchase agricultural products from California as compared to only 49% at control stores.

- 58% of respondents indicated they have heard of or seen advertisements or publicity for the "California Grown" campaign.

The final measurable outcome was media reach. The tactics employed by this campaign reached consumers both in their homes and in-store. The newspaper free standing insert appeared in 94 newspapers in the state and reached a circulation of 11,732,000 in an area with 751 Safeway stores and 413 Albertsons stores. A total of 1,718 floor graphics and a total of 4,800 grocery cart advertisements were placed in Safeway and Albertsons stores. All of the measurable outcomes were achieved and exceeded by September 30, 2009.

Funding Expended to Date
Grant Award Amount $239,750.00
Invoiced to Date $239,750.00
Remaining Grant Balance $0

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Final Performance Report

Project Title
Development of a Web-Based Specialty Crop Nutrient Information Database (Phase I)

Project Summary
The California Department of Agriculture (CDFA), Fertilizer Research and Education Program (FREP), through industry-funded research over the past 22 years, has collected experimental field trial data that can help specialty crop growers in water and nutrient management measures to enhance environmental stewardship. The research has produced over 125 scientific technical reports whose conclusions offer tremendous value to specialty crop growers. However, the problem is that the plethora of valuable scientific data on nutrient and water efficiency/management has not been effectively distributed to specialty crop growers for implementations on fields.

There are four classical distribution methods of scientific information that have been adopted by FREP:

1) An annual FREP conference where the technical information is presented to growers and certified crop advisors (CCA). The objective is that CCAs will further distribute the scientific information to specialty crop growers/farmers.
2) FREP conference proceedings report distributed at the conference, public board meetings, and offered electronically via the FREP website.
3) Final technical research documents and abstracts posted online for reference.
4) Scientific journal articles published by the principal investigator of the FREP funding.

These classical methods rely primarily on CCAs to communicate this information to the grower/farmer, and can be classified as indirect methods of information distribution. There is significant demand for a database to provide growers with direct access to research results and recommendations, some of which can be classified as best management practices, which will allow specialty crop growers to effectively manage plant nutrients and water applications in California. Thus, the objective of this proposal is to develop the foundation (Phase I) to an important scientific web-based information distribution tool so that specialty crop growers will have easy access to FREP's 22 years of plant nutrient and water recommendations that can be quickly applied at the field level.

Specifically, Phase I entails developing an electronic template into which scientific data from the FREP technical reports can be added to facilitate the ability of specialty crop growers to search the database by crop, nutrient, and location.

Project Approach
Phase I is part of a larger four phase project to develop a web-based nutrient database to make the information contained in the final research reports easily available, comprehensible in a short period of time, and convenient to implement by individual specialty crop growers at the farm level. Completion of phase I is critical to moving forward to Phase II (user interface), Phase III (summarize all FREP scientific information into database's electronic template), and Phase IV (stakeholder feedback on database and user interface). Phase I supports a unique foundational aspect off the overall project, and included the identification of a comprehensive software platform to support the database, development of an electronic template into which scientific information can be added to support database search

capabilities, summarization of a select number of technical reports into an easy-to-comprehend numerical values for testing the electronic template, and addressing any unforeseen issues prior to initiating Phase II through IV.

This project is part of a larger effort, which upon completion will create a direct information pathway between the FREP data and the specialty crop growers that has not existed to date. Thus the beneficiaries of this work are the estimated 40,000 specialty crop growers in California. Consequently, the potential of nutrient and water quality BMP practices at the farm level for specialty crops are expected to increase. The economic impact of the database is expected to be significant in terms of nutrient reductions to grower fields while maintaining (and potentially) increasing crop yields, and a cost-effective method of delivering technical science data to specialty crop growers for easy access and implementation at the field level.

Goals:
The goal of phase 1 was to: 1. Develop an electronic template with established data entry fields for scientist to input information/data, 2. Evaluate potential software programs for developing the database, 3. Use Joint Application Design (JAD) principals, concepts, and strategies to determine the scope of work and user expectations, 4. Review and summarize selected FREP technical research reports, 5. Input the information into the electronic template for testing, and 6. Determine the limitations of the electronic template and address problems.

Goals and Measurable Outcomes Achieved
Measurable Outcomes and Due Dates:

The general tasks of this project was to 1) evaluate appropriate software programs for database development, 2) design electronic template, 3) develop and test electronic template 4) input summarized information into the electronic template and 5) finding solutions to limitations of the electronic template.

The work plan was carried out in four discrete tasks as follows:

Task 1:
Evaluate potential software programs for developing the database – a number of software programs were evaluated. The department has identified and defined specific standards for database development software. The standard requires internet/web interface usability along with several other performance and cost criteria. Three separate software programs were identified as appropriate for this database. They include Visual Studio for the development environment, Microsoft SQL server for the production environment, and ASP.NET (e.g., active server) for the web interface. These three software programs were used in combination to develop the template and complete phase 1 of the project. *Completed October 2011.*

Task 2:
The electronic template developed was carefully designed with adequate entry fields to be specific enough to capture all detailed scientific data in the technical reports yet broad enough so that the database can be applicable to all specialty crop growers/users. The electronic template consists of several data entry fields that refer to specific information found in the technical reports. The initial template contained 36 fields for data entry. The fields were expanded to 45 data entry fields after testing. A parent-child relationship format for data entry was adopted after initial findings that there might be multiple records (child) with different nutrient requirements for the same crop (parent).

Images of the electronic template, showing the data entry fields, can be found at the end of this performance report. *Completed November 2011.*

Task 3:
The programmer supervisor was responsible for developing the electronic template and moving it on for testing to a highly qualified Research Scientist. There were seven randomly selected FREP technical reports that were collected and summarized. Thus, a total of 315 (45 data entry fields x number of technical research projects = 315 data entry fields tested) fields were tested with input data from the seven FREP technical reports. The research scientist identified the lack of several important data entry fields upon initial testing. The programmer supervisor added nine additional data entry fields based on the initial test results. The summary of scientific information into the electronic template without losing important data from the final FREP technical reports provided by the principal investigators of the research has been recognized by the FREP program as a critical feature of the database. This task completed the testing component of the database as outlined in the project proposal. *Completed December 2011*.

Task 4:
Discuss data input template design and find solutions to problems. Issues were discussed and solutions were identified for Programmer Supervisor implementation at several Joint Application Design (JAD) sessions. Nine separate JAD meetings were held to discuss the database design, template, and input and testing of data entry fields. These nine JAD sessions and the topic of discussion are provided in the project proposal. These meetings were instrumental to ensuring there were adequate number of data entry fields in the template and the database was capable of delivering expected user requirements (e.g., internet accessibility).

Additional Assessment
Results and conclusions: Phase I of the database as outlined in the project proposal has been completed. The team successfully correctly estimated the time to jointly develop an electronic data entry database interface. The team was able to implement a template for technical scientific data entry. The time and cost estimated as outline in the project proposal was adequate to determine the appropriate fields and iterations to generate an agreed solution to the business database design. The team successfully produced the foundation (completion of phase I) to allow the overall project to move forward to phases II through IV.

Additional Information: Example screen shot of FREP search based on Crop type.

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USDA, AMS Agreement No:
Specialty Crop Agreement No. 12-25-B-0832

State of California
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Date Submitted:
May 1, 2012

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Specialty Crops Block Grant

Report

Teacher's Agricultural Summer Institute

Submitted to:

California Department of Food and Agriculture
1220 N Street, Sacramento, CA 95814

by

El Dorado County Ag in the Classroom
2460 Headington Road, Placerville, CA 95667

October 31, 2011

Teacher's Agricultural Summer Institute

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Appendix

"I would highly recommend that you continue this program for more teachers to find out about the importance of Ag all around us, and to help more teachers realize how crucial it is to be teaching about these concepts to our children."

-Toni Linde, 2nd grade teacher
Plymouth Elementary School

INTRODUCTION

For three nights and three days in June 2011, a band of teachers from the Sierra Foothill region immersed themselves in agriculture-based learning at the inaugural Teacher's Agricultural Summer Institute (TASI) in Coloma, California. Facing searing heat that reached the century mark each day, the teachers maintained an indefatigable enthusiasm that did not wane during educational activities, presentations, and field trips to local agricultural sites. Through the jam-packed ten-hour days, teachers showed a determination to gain as much information, resources, and ideas from the presenters, agriculture producers, and each other as possible.

For El Dorado County Ag in the Classroom, the inaugural institute broadened its outreach to teachers of all grade levels. TASI provided an opportunity to educate and inform teachers about the benefits of agriculture, the stewardship of agriculturists, the open space and habitat values and practices that ensure sustainability - along with the challenges local farms and ranches must address to remain viable. By reaching teachers with this critical information and perspective, the numbers of students that benefit from this knowledge is exponential.

"Although I consider myself knowledgeable about many areas of natural resources and agriculture, I was happy to learn there is much more "out there". During our institute, we experienced field studies in such diverse topics as alpacas, olive oil, organic wines, orchards and ag laws, cattle ranching, forestry, water, soil and forests...

The expert's knowledge of all the facets needed to succeed in their field was awe inspiring. (How little did I know!) Their knowledge was surpassed only by the passion for their important work...I feel like I received a teacher's booster shot and have recommitted to include more ag lessons in my classroom. "

-Rene Pecota, 4th grade teacher, Camino School

This report summarizes the planning, the execution, the outcomes, and the lessons learned from the first Teacher's Agricultural Summer Institute made possible under the Specialty Crop Block Grant awarded through the California Department of Food and Agriculture. This experience has shown EDCAITC that TASI is on the right track. All that we learned along the way and the feedback received from participants, presenters, agricultural hosts and partners have provided a strong foundation for growing teacher institutes in the future and expanding teacher training programs in Sierra foothills.

EL DORADO COUNTY AG IN THE CLASSROOM OVERVIEW

El Dorado County residents are very fortunate to have many diverse agricultural operations such as farms, orchards, timber lands, cattle ranches, vineyards, and olive groves, to name a few. The benefits from these operations are priceless - they fuel our economy, feed our families, and preserve our beautiful rural landscapes. But with fewer than 2% of Californians involved in agriculture, it is important that our children learn about the role agriculture has in our everyday lives - the food we eat, the clothes we wear, and the homes we live in.

El Dorado County Ag in the Classroom (EDCAITC), is a local, grassroots, charitable nonprofit organization that provides high quality agriculture-related educational programs, resources, and training to increase awareness and understanding of the importance of agriculture.

EDCAITC's mission is to promote an understanding and appreciation of how important and all-encompassing agriculture is in our daily lives.

We do this by providing quality educational resources and programs that:

- Connect students to hands-on agricultural experiences;
- Help students make informed decisions about their food choices and health;
- Promote an understanding of the sustainable production of food, fiber, and shelter;
- Highlight the significance of our local food supply and agricultural heritage.

For the EDCAITC organization, 2010 and 2011 have been landmark years. Through the Specialty Crop Block Grant awarded from the California Department of Food and Agriculture, EDCAITC has piloted *Fields of Learning*, a school-farm partnership education program in Camino, launched its new website to provide teachers and the community with quick access to ag-education resources, held its first *Teacher Summer Agricultural Institute,* and expanded teacher training for *Farm Day.*

Fields of Learning is a model program developed by EDCAITC that creates partnerships between local schools and agricultural producers. The successful *Fields of Learning* program between Camino School and Rainbow Orchards started its third year in fall 2011. During fall, winter, and spring, first grade students have participated in hands-on, learning activities in a "real world" setting during field trips to Rainbow Orchards. Another Fields of Learning partnership, between Gold Oak Elementary School and Goldbud Farm, is in its second year.

In 2010, Ag in the Classroom launched its new website: www.agintheclass-edc.org. The site is designed for local teachers, students, ag producers, and the general public to access current information about agriculture-related educational activities, programs, and events. The website has not only expanded communication with the education community and general public, it has increased our efficiency in program delivery.

In 2011, teachers, schools, and volunteers were able to sign-up for Farm Day through the website. Teachers applying for the Teacher's Agricultural Summer Institute used the online application via the website.

In May 2011, over 1,100 third grade students (almost 50% of all third grade students in El Dorado County) enjoyed a fun day of learning on a wide range of agricultural topics at the 10th Annual ***Farm Day***. Since 2002, nearly 7,000 students have attended this premier field trip hosted by EDCAITC at the El Dorado County Fairgrounds. Volunteer presenters brought agriculture alive to students through creative, interactive demonstrations and activities.

EDCAITC realized a long-held goal of providing teacher training by hosting their first Teacher's Agricultural Summer Institute (TASI) in June 2011. TASI has provided a powerful springboard for future Ag in the Classroom's teacher training programs in the future.

TASI PROGRAM

With the announcement of the inaugural Teacher's Agricultural Summer Institute in El Dorado County, teachers were invited to enter the world of local agriculture. In a specialty crop producing region populated with small agricultural operations, TASI provided an opportunity to share with teachers the many contributions of agriculture to the community, as well as the challenges and issues farmers and ranchers growing their products and bringing them to market. Through classroom style activities and hands-on experiences at orchards, farms, vineyards, forest lands, and working ranches, TASI participants gained a deeper understanding of the agricultural systems that sustain the health of people, the community, and the natural environment.

"I was fortunate enough to be a participant in the first Teachers' Ag Summer Institute this June... We were not only able to gain a wealth of information from the presenters and venues we visited, but we came home with two bags full of valuable teaching materials and resources. .. In addition to all of this, I felt personally challenged and sharpened as an educator from spending time with a quality group of committed teachers. Their collective expertise added significantly to the value of the experience."

- Rosilynn Sept, 5th grade teacher

The institute was designed by El Dorado County Ag in the Classroom (EDCAITC) and the University of California Cooperative Extension in partnership with the El Dorado County Office of Education, the Folsom Lake College El Dorado Center, El Dorado County Farm Bureau and local agricultural producers.

Within the context of sustainable agriculture and resource management, the TASI's three-day program was as diverse and varied as the agricultural landscape. TASI learning activities provided a basis for integrating agriculture in every day curriculum: language arts, science, math, and social sciences. The resources and activities presented were designed to meet California curriculum standards to ensure ease for incorporating topics and lessons into the classroom.

After completing the institute, each teacher created a lesson plan or class activity associated with topics discussed during TASI and presented to the entire group at the "Back to the Farm" gathering on July 14, 2011. Coming together at Folsom Lake College El Dorado Center, the teachers enthusiastically shared classroom activities and resources with their fellow educators. Copies of these educational activities, along with those provided during TASI, have been compiled into a resource booklet that will be available to teachers through the EDCAITC website and on disk.

TASI enrollment was available to K-12 teachers from public and private schools in Amador, El Dorado, and Placer counties. Announcements about TASI and the opportunity to apply were sent to the three county offices of education for pre-arranged dissemination. A press release was distributed and an article was printed in the largest newspaper in El Dorado County, The Mountain Democrat. On two occasions, the TASI coordinator spoke at El Dorado County Office of Education's scheduled meetings of school principals and provided TASI handouts for distribution at their schools. Program information and application timelines were prominently posted on EDCAITC's website. TASI was consistently promoted during the course of Ag in the Classroom programs and outreach activities.

The application process for TASI was easily accessible to teachers through EDCAITC's website: www.agintheclass-edc.org. Except for the one-time application fee of twenty-five dollars, there was no charge to attend the institute. Lodging, meals, transportation, educational materials and activities were all provided at no cost to the participating teachers.

Teachers who completed the institute and presented the classroom activity, both orally and in writing, at the follow-up "Back to the Farm" session, received a stipend of three hundred dollars.

EDCAITC reached its target enrollment of 10 to 15 participants for the pilot institute. Eleven teachers were accepted into the program from Amador and El Dorado Counties: six (6) teachers from grades K-4, four (4) teachers from grades 5-8; one (1) teacher from grades 9-12. Outreach efforts to Placer County teachers did not yield applicants in 2011. The TASI team is confident that with an enhanced targeted approach, Placer County will be represented at future institutes.

Originally envisioned to take place at the El Dorado Center of the Folsom Lake College, the TASI team evaluated local options and decided to locate the first Teacher's Agricultural Summer Institute at the EarthTrek campground on the American River in Coloma, California. There were several advantages to this location. Transportation to and from lodging to the college site would have taken valuable time from each day's schedule and incur additional expense. At one location, EarthTrek offered lodging (in tent cabins), meals, open air classroom space, and activity areas. Centrally located near orchards, ranches, and vineyards, EarthTrek provided a natural setting that kept teachers connected with the agricultural environment throughout the three day institute. The camp setting also enhanced the educational experience by providing time for post-dinner speakers, activities, and "campfire" opportunities for teachers to interact.

TASI began in late afternoon on a Monday, as teachers settled in at Earthtrek. At dinner, participants had time to get acquainted and afterwards, attended their first TASI session. After an overview of daily schedules for the week, participants engaged in their first educational activities. Each day of TASI had a combination of classroom, hands-on educational activities, and field trips to agricultural producers.

On Wednesday evening that week, El Dorado County Ag in the Classroom and its Specialty Crop Block Grant Steering Committee hosted a community reception in honor of ag education and the TASI participants. Attended by community leaders, agriculturalists, and EDCAITC supporters, the reception provided an opportunity celebrate the inaugural institute and to express appreciation to the teachers for their commitment to ag-related education.

The presenters, agricultural hosts, and TASI coordinator created a challenging, meaningful, and diverse mix of educational activities that was informative and thought-provoking. The teachers that formed TASI inaugural alumni group responded with keen interest, enthusiasm, and dedication. It is this first group of teachers that determined the success of the Teachers' Agricultural Summer Institute and fueled Ag in the Classroom's determination to expand its teacher training programs in the coming years.

TASI TOPICS, LESSON PLANS, AND ACTIVITIES

Sustainability and the long term viability of farms and ranches is especially critical in rural communities, including the Sierra foothills region. Most of El Dorado's agriculturalists meet the USDA criteria for small farmers. In this context, the value-added component of specialty crops contributes to the economic viability of agriculture operations in El Dorado County as well as its neighbors in Amador and Placer counties. This provided the backdrop for the agricultural education provided at the Teacher's Agricultural Summer Institute.

TASI topics and educational activities were based on the three tenants of sustainable agriculture: environmental stewardship, economic profitability, and social viability.

Within the context of local agriculture, a wide variety of topics were covered at TASI including:

Defining Agriculture:

- sustainable, local, conventional, organic.
- seasonal food crops; what grows when

Discovering local agriculture:

- local agricultural products; role of specialty crops
- crop statistics and economic impact
- role ag plays in quality of life

Natural Resources, Cycles, Ecosystems and Interdependence

- soil, water, sunlight, air
- agricultural conservation practices (soils, water)
- wildlife habitat

Pest Management

- Integrated pest management
- invasive species,
- beneficials, hedgerows

Land Use

- ordinances (ranch marketing, winery), ag districts
- conservation easements
- value of ecological services
- climate, soils, terrain – where to plant crops

Forestry

- timber production
- fuels management
- habitat values

Rangeland - Food and Fiber Production

- oak woodlands, water filtration
- grazing management
- milk, meat and more – full use of animal products
- fiber production

Production, Management, Business Operations, Marketing

- what to grow – how to decide?
- marketing – direct, wholesale, distribution infrastructure, farm stand, farmers markets.
- transporting and distribution
- value-added products

The TASI daily agenda was comprised of a mix of classroom demonstrations, activities, and agricultural site visits. In addition to handouts, each teacher received a thumb drive containing the educational resources and activities presented during the institute.

For Agricultural education to be effective, teachers must have resources to integrate agricultural instruction into their lesson plans that meet California state curriculum standards. The information provided must be science-based. Resources and activities presented were carefully selected for their quality, content, and ease of integration into the classroom.

TASI invited two organizations highly regarded for their educational materials and programs to provide presenters and materials at the institute. Project WET, a nonprofit organization dedicated to reaching children and teachers with water education, and Project Learning Tree, a program of the American Forest Foundation, provides teachers with training and materials on natural resources and environmental education. Project WET and Project Learning Tree presenters led teachers through several hands-on, investigative, easy-to-use activities. Each TASI participant received the 517 page Project WET Curriculum and Activity Guide containing multidisciplinary water-related activities for students in grades K-12, as well as Project Learning Tree's K-8 Environmental Education Activity Guide.

Other educational activities presented were developed and/or selected by EDCAITC's planning team, including the TASI coordinator, Wendy West, with University of California Cooperative Extension and several local teachers with extensive experience in agriculture-related education. The daily agenda, which lists each activity is shown on the next two pages.

Teacher's Ag Summer Institute Agenda

Monday, June 20, 2011	Activity
3:00 p.m. – 4:00 p.m.	Check-in and settle-in
4:00 p.m. – 6:00 p.m.	Introductions and Activities; Leader: Wendy West
	The Farm Web
	Caretakers All - Caretakers of Animals
	Land Plans - Food for Thought, Marin Version
	Food Miles: Growing Local Food Connections
6:00 p.m. - 7:00 p.m.	Dinner
7:00 p.m.	Free Time and Campfire
Tuesday, June 21, 2011	
7:00 a.m. - 8:00 a.m.	Breakfast and Pack Lunches
8:00 a.m. - 8:30 a.m.	Overview of the Day - Wendy West
8:30 a.m.	Depart for Field Trip (take lunches)
9:30 a.m. – 12:30 p.m.	Field Trip - Forest Management and Timber Production (South of Pollock Pines)
	J&R Logging and USFS - Harvest, Thinning and Fuels Reduction Project
	Sierra Pacific Industries - Timber Production Multi-stage Site
12:30 p.m.	Leave to return to EarthTrek Campground
1:30 p.m. - 5:30 p.m.	PLT and WET Activities and Book Walks (4.0 hrs.) Leaders: Susie Kocher and Brian Brown
	'Tree Factory' (PLT pg. 269)
	'Incredible Journey' (PWET pg. 161/PLT pg. 188)
	'Every Tree For Itself' (PLT pg. 117) / ' Forest For The Trees' (PLT pg. 291)
	'Just Passing Through' (PWET pg. 166)
	'Thirsty Plants' (PWET pg. 116)
	'Color Me A Watershed' (PWET pg. 223) or 'Sum of the Parts' (PWET pg. 267)
	'Wet Work Shuffle' (PWET pg. 360)
	'How Big Is Your Tree' (PLT pg. 284)
	Book Walk
5:30 p.m. - 6:00 p.m.	Break
6:00 p.m. – 7:00 p.m.	Dinner
7:00 p.m. – 8:00 p.m.	California Foundation for Ag in the Classroom - Stephanie Etcheverria
8:00 p.m.	Campfire
Wednesday, June 22, 2011	
7:00 a.m. - 8:00 a.m.	Breakfast and Pack Lunches
8:00 a.m. - 8:30 a.m.	Overview of the Day - Wendy West

8:30 a.m.	Depart for Field Trip (take lunches)
8:45 a.m. - 1:30 p.m.	Field Trip - Coloma and Apple Hill
	8:45 a.m. - 10:00 a.m. Bacchi Ranch - Chuck Bacchi and Bill Frost
	10:30 a.m. - 1:30 p.m. Rainbow Orchards - Christa Campbell and Tom Heflin
1:30 p.m.	Leave to Return to EarthTrek Campground
2:00 p.m. – 4:30 p.m.	Activities and Resources
	2:00 p.m. - 2:30 p.m. Diversity Game; Leader: Wendy West
	2:30 p.m. - 4:00 p.m. 'Shake Rattle and Roll', 'Soil Particle Game', Soil Analysis, Soil Sifting
	Leaders: Tobias Guatschi and Pat Stow
	4:00 p.m. - 4:30 p.m. Native American Plant Prints; Leader: Pat Stow
4:30 p.m. - 5:00 p.m.	Break
5:00 p.m.	Depart for Boeger Winery
5:30 p.m. - 7:30 p.m.	AITC Reception at Boeger Winery 5:30 p.m. - 7:30 p.m.
7:30 p.m.	Leave to return to EarthTrek Campground
8:00 p.m.	Campfire
Thursday, June 23, 2011	
7:00 a.m. - 8:00 a.m.	Breakfast and lunch prep
8:00 a.m. - 8:30 a.m.	Overview of the Day - Wendy West; Pat Stow - "Show and Tell" Activities
8:30 a.m. – 9:00 a.m.	Dairy Council of California - Lisa Larsen and Tracy Witmer
9:00 a.m. - 9:30 a.m.	'Get the Ground Water Picture' (PWET pg. 136) Leader: Tobias Gautschi
	'Pass the Jug' (PWET pg. 392) Leader: Pat Stow
9:30 a.m.	Depart for Field Trip
10:30 p.m. - 4:30 p.m.	Field Trip - South County and Coloma
	10:30 a.m. - 12:30 p.m. Fitzpatrick Winery - Brian and Dianna Fitzpatrick (plus eat lunch)
	1:00 p.m. - 2:00 p.m. Rancho Margarita Alpacas - Wayne and Jo Webb
	3:00 p.m. - 4:30 p.m. Mad Dog Mesa - Coloma
4:30 p.m.	Leave to return to EarthTrek Campground
5:00 p.m. - 5:30 p.m.	Closing Session and Post Assessment at EarthTrek

TASI FIELD TRIPS

A key component of the Teacher's Agricultural Summer Institute was providing hands-on experience at local agricultural sites. The daily field trips offered teachers direct contact with a wide array of agricultural producers. From apples to alpacas, from olive oil and to timber, the field trip hosts were informative, relatable, and thoughtful in their presentations and demonstrations. Each field trip host discussed their unique operation in context of sustainability. Casual in approach, teachers' questions were encouraged and welcomed throughout site visits.

"The opportunity to meet with and visit working ranches, orchards, vineyards, animal farms and logging operations helped me gain valuable insight into the challenges local businesses face to maintain sustainable operations."

-- Barbara Simpson, Pinewood Elementary School

The following is a description of the field trips taken during TASI.

Bacchi Ranch - Coloma

With deep roots and history in El Dorado County, Bacchi Ranch provided an overview of beef cattle production including federal grazing allotments and marketing cattle, evaluation of annual forage production and seasonal availability, and how invasive plants reduce production. Topics also included ranch diversification, considerations for the generation, and the value to the community of the ranch land through wildlife habitat, water filtration, and viewscapes.

Fitzpatrick Winery - Fair Play

Wine grapes comprised 17% of the 2010 agricultural production in El Dorado County. Teachers learned about organic grape production, including certification requirements, steps in producing the annual crop, pest management and soils and nutrient management.

Mad Dog Mesa (Olive Oil) - Coloma

This producer has over 3,200 olive trees and a variety of fruit trees. The hosts discussed the organic processes used for pest control and fertilizing their trees. The production of olive oil was explained along with methods used for direct marketing of their products.

"I LOVED THE VARIETY OF FIELD TRIPS AND ACTIVITIES THAT WE DID! I HOPE WE CAN DO THIS AGAIN AND AGAIN!"

-TEACHER PARTICIPANT

Rainbow Orchards - Camino (Apple Hill)

As a producer of apples, pears, peaches, and blueberries, a wide range of topics were discussed regarding fruit production and direct marketing; value-added products; land use and agricultural zoning and ordinances, the impact of the Williamson Act and the establishments of Ag Districts. Teachers planted pumpkin seedlings (seedlings grown by Camino School students; students harvested the pumpkins in the fall as part of the Fields of Learning Program) and learned to make "ice cream in a bag" - a favorite activity with students.

Rancho Margarita Alpacas - Somerset

An overview of breeding and the increasing alpaca fiber production in California and the nation was provided. The hosts pointed out that diverse production of specialty crops in the foothills is due in part to its diverse landscape: some lands have good, level soils for crops, other lands that are rocky, uneven and steep, are very suitable for grazing animals like alpacas. Teachers learned about processing the fiber (skirting, cleaning, carding, spinning) and marketing the finished product.

Sierra Pacific Industries and J&R Logging

In forest lands in the Sierra Mountains, representatives from Sierra Pacific Industries, J&R Logging, and the U.S. Forest Service, provided a comprehensive overview of timber harvest operations, equipment used, land management strategies, government regulations, marketable/non-marketable products, harvest plans, wildlife habitat planning, and community uses of lands. Teachers were able to see timber being readied and cut for transport.

BACK TO THE FARM

An important aspect of the Teacher's Agricultural Summer Institute was encouraging teachers to utilize the knowledge and resources they gained during the three day session. To that end, a "Back to the Farm" session was included as part of the institute. Each teacher was asked to create a lesson plan or class activity that they would present to the entire group on July 14, 2011 at the Folsom Lake College El Dorado Center.

Prior to the "Back to the Farm" gathering, the teachers submitted their activity plan on a template provided by TASI, along with supporting activity materials and resources. These plans were reviewed and a copy was made for each TASI participant. These lesson plans, along with others presented during the institute, have been compiled into a resource book that will be available to local teachers at no cost.

The classroom activities presented by teachers were varied and received with enthusiasm by the group.

Topic titles included: "Dirt Made My Lunch", "My Friends, the Trees", "Thank a Bee (for every third bite of food)", "Renewable or Not?, Sustainable or Not?", "Seed Sort", "Garden Based Activity to learn about Ph - acids and alkalis".

An example of a Lesson Plan & Activities template, "Berry Good," is shown on the next page. "Back to the Farm" completed lesson templates are included in the Appendix.

TASI EVALUATION

In creating and implementing the first Teacher's Agricultural Summer Institute, it was especially important to assess program effectiveness, efficiency, and quality of program delivery. Assessment provides essential information for development of programs and planning for future teacher training.

Through pre- and post-questionnaires and surveys of participating teachers, key information regarding TASI was gathered to:

1. determine if objectives were achieved.
2. determine quality of the program and effectiveness of individual components of the institute.
3. provide information for decision making regarding future programs.

1. Determine if desired outcomes were achieved.

The primary objective of TASI was:

- to increase teachers' understanding and knowledge about local agriculture so they will share that information with their students through classroom activities.

To ascertain if the primary objective was obtained, participating teachers were given a pre- and post-survey regarding their overall knowledge of agriculture-based educational resources and programs for use in their classrooms, as well as knowledge of basic topics like soil, water, conservation, and sustainability.

Results of the pre and post- TASI survey showed a 53% increase overall in the teachers knowledge, as shown on the Teachers Pre- and Post-Assessment Chart on the following page.

Teacher's Ag Summer Institute

Teachers Pre- and Post-Assessment

Overall result:

53% increase in knowledge about agricultural topics and resources.

Assessment Questions:

1a. I feel comfortable covering a range of agricultural aspects in my teaching. (Pre)
1b. I now have several useful ideas generated during the conference to help me feel comfortable covering a range of agricultural aspects in my teaching. (Post)
2. I am knowledgeable of the different resources and partners that can aid me in bringing agricultural curriculum into my classroom.
3. I have a variety of curricular resources that tie state standards to agricultural curriculum.
4. I have knowledge of soil issues.
5. I know how to evaluate soil for its agricultural potential/best use.
6. I have knowledge of water issues.
7. I have knowledge of forestry management and the issues related to it.
8. I understand the issues of conservation, sustainability and land management with regards to agriculture in our region.

Scale:

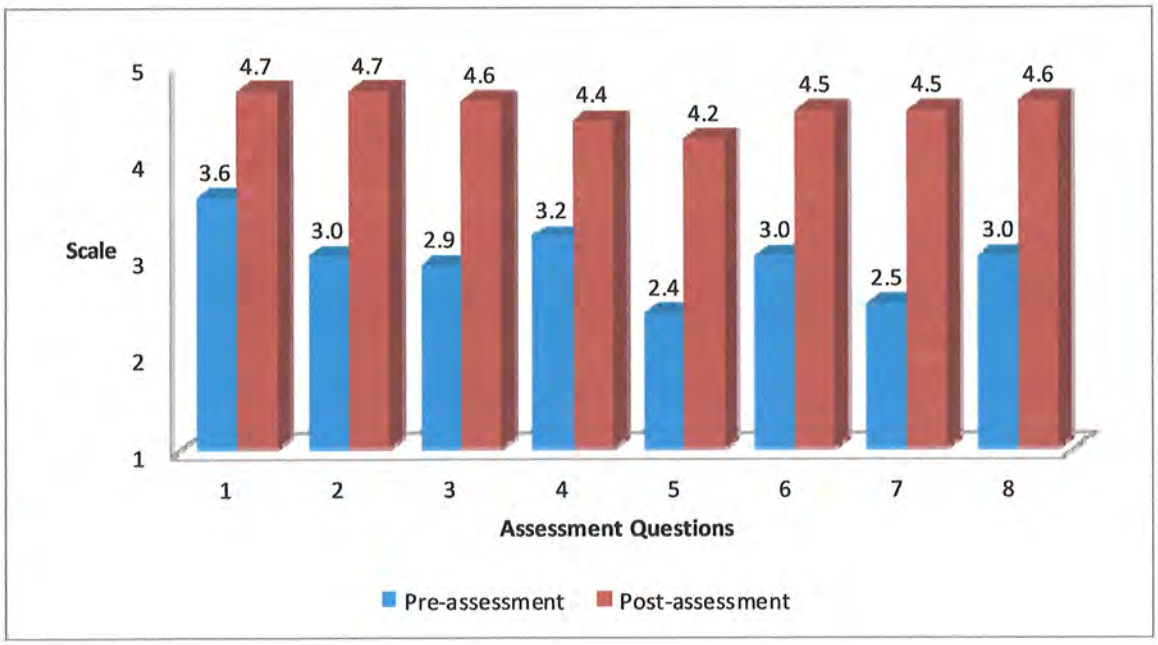
5 = Strongly Agree

4 = Agree

3 = Somewhat Agree

2 = Somewhat Disagree

1 = Disagree



2. Determine quality of program and effectiveness of individual components of the institute.

Teachers were asked to rate each individual educational activity and field site visit on a scale of 1 (poor) to 5 (excellent). The average rating for fourteen (14) of the seventeen (17) TASI educational modules exceeded 4.1 points. The remaining five (5) presentations averaged a 3.69 rating. The overall average rating for field trips to agricultural sites was 4.33. The evaluation results for each activity are shown in the following chart.

2011 Teacher's Ag Summer Institute

Teachers Evaluations*

Educational Activities and Field Trips to Agricultural Sites

Each activity rated on a scale of 1 - 5:

1 – Poor
2 – Not great
3 – OK
4 – Great
5 – Excellent

Monday, June 20, 2011	Avg. Score
The Farm Web	**3.80**
Land Plans: Food for Thought, Marin Version	**4.12**
Food Miles: Growing Local Food Connections	**3.83**

** 9 forms completed of 11 teachers attending*

Tuesday, June 21, 2011	Avg. Score
J&R Logging & US Forest Service (site visit)	4.50
Project Learning Tree and WET activities:	
Tree Factory	4.22
Incredible Journey	4.55
Every Tree For Itself	4.33
Just Passing Through	4.44
Thirsty Plants	4.33
Sum of the Parts	4.27
How Big is Your Tree	4.11
Book Walk	4.55
CA Foundation for Ag in the Classroom - speaker	3.44
Sierra Pacific Industries – timber production	3.77

Wednesday, June 22, 2011	Avg. Score
Bacchi Ranch field trip	4.33
Rainbow Orchards field trip	4.55
Diversity Game	4.33
Shake, Rattle & Roll, Soil Particle Game, Soil Analysis	4.22
Native American Plants Prints	4.44
AITC Reception at Boeger Winery	4.77

Thursday, June 23, 2011	Avg. Score
"Show and Tell" Activities	4.33
Dairy Council of California Presentation	3.66
"Get the Ground Water Picture"	4.44
Fitzpatrick Winery field trip	4.66
Rancho Margarita Alpacas field trip	4.55
Mad Dog Mesa (Olive Oil) field trip	4.33

In addition, participants were asked to provide comments and feedback (anonymously if they preferred) regarding their perspectives on the institute. The following are representative comments received:

PROJECT LEARNING TREE EVALUATION:

"Thanks, I am eager to use the materials and learn more."

"Love these Project Learning Tree activities!!! Thank you!"

"I'm eager to use the materials - thanks!"

THE BEST FEATURE OF THE WORKSHOPS?

... "participating in the activities so we know how to do them and how the kids will feel doing them too."

... "active ways to learn the ideas."

..."all the hands-on lessons and enthusiasm and knowledge of .... the facilitator."

3. Information for decision making regarding future teacher training programs.

Participating teachers were asked to respond to a post-TASI survey to provide input that would help planning future teacher institutes and training sessions.

There were five questions asked regarding:

Question	Response
1. Format of resources and materials provided	10 preferred thumb drive 3 preferred binder with hard copies
2. If future TASI did not include overnight night stays, which schedule would be recommended?	10 recommended 3 one-day sessions in consecutive days 1 recommended 3 non-consecutive days spread throughout the summer
3. How important is providing a stipend to participating teachers?	3 rated it very important 8 rated it somewhat important
4. Would you have attended TASI if the stipend has been:	$200 - 10 yes, 1 no $150 - 10 yes, 1 no $100 - 9 yes, 2 no $ 0 - 5 yes, 6 no
5. Ideas for marketing TASI to regional teachers in the future?	Written answers provided.

The input received through surveys and participant comments will provide critical information as planning begins for the next TASI. It will help Ag in the Classroom evaluate if the institute should continue in its current form or should it be modified to improve effectiveness and efficiency. The input from participating teachers together with feedback from presenters, field trip hosts, and volunteers will provide the foundation for planning the next Teacher's Agricultural Summer Institute.

It was important to EDCAITC that the Teacher's Agricultural Summer Institute provided a high quality program that exceeded participants' expectations. Planners were determined to provide informative, varied, and relevant educational activities, including field trips to local agricultural operations. It was also important to provide quality resources and materials that teachers could take with them and use in their classrooms.

Information obtained through the surveys, questionnaires, and personal input indicates that the inaugural Teachers Agricultural Summer Institute hit its mark. We learned that some program components can be replaced and some enhanced. The evaluation process continues as EDCAITC reviews the input received and uses the information to design an even better version of the Teacher's Agricultural Summer Institute.

> *"I loved the variety of "field trips" and activities that we did! I hope we can do this again and again!! Thank you for all of the amazing planning that went into all of this week!"*
>
> *- TASI participant*

CONCLUSIONS AND PLANS FOR THE FUTURE

Creating the Teacher's Agricultural Summer Institute was an important milestone in fulfilling El Dorado County Ag in the Classroom's mission to promote the understanding and appreciation of the importance of agriculture in our lives and in our community. TASI provided EDCAITC an exceptional opportunity to connect with teachers from all grade levels and expand our program's reach throughout the El Dorado County area of the Sierra region.

Through the daily experiences of the first Teacher's Agricultural Summer Institute, input from participating teachers, and the feedback from the presenters and our agricultural hosts, Ag in the Classroom has determined that TASI was an unqualified success. The enthusiastic response from the teachers and all those involved, helped create a synergy and bond not anticipated. The subject matter and resources were embraced by the attendees at a level we had hoped for but could not predict.

SEVERAL KEY LESSONS LEARNED THROUGH THE FIRST TASI EXPERIENCE WERE:

1. Teachers are eager to learn about agriculture through an institute such as TASI, as evidenced by the enthusiastic participation of TASI's first class. Our challenge in the future is to improve our outreach to encourage more teachers to apply and participate in future institutes.

2. Providing a wide variety of educational activities and field trips was received well and served teachers' interests. But we learned that the number of activities in the agenda was slightly over ambitious, occasionally causing time constraints. Time allotments and the number of activities will be adjusted in the future.

3. Participating teachers valued having time with their peers to share information and experiences. This was an indirect benefit of TASI. Future institutes will incorporate time for teachers to interact and learn from each other.

4. Local agriculturalists are enthusiastic and skilled presenters during field trips. The TASI program was strengthened by the support of local agricultural producers. Field trip hosts presented agricultural concepts and responded to teachers' questions clearly and effectively. Field trips to agricultural sites will remain a key component of future institutes and it is expected that this year's enthusiastic field trip hosts will assist in recruiting additional agricultural partners for TASI.

Ag in the Classroom's vision for the future is that agricultural-based teacher training reaches all schools throughout the El Dorado County region. By providing teachers with the information, tools, and resources to incorporate agricultural lessons in their classrooms, the number of students who benefit from this knowledge is ten-fold. As we inform teachers, and in turn, reach students, about the benefits and role of agriculture in our community, public awareness will increase. This heightened understanding will help local farms, ranches, and vineyards remain viable and strengthen the community and region. The first Teacher's Agricultural Summer Institute is a major step toward realizing this vision.

In the coming years, the Teacher's Agricultural Summer Institute will be the cornerstone of Ag in the Classroom's evolving teacher training program. EDCAITC is committed to developing and growing TASI into a highly recognized and respected annual institute for teachers in the Sierra region.

"Thanks for a great week. I had a wonderful time and made some great connections .... I would love to see this program both continue and expand. Let me know if I can be of any help in the future in that regard. "

- Angela Personeni, 7th & 8th Grade
Ione Junior High

APPENDIX

List of enclosed TASI documents:

1. Press Release - TASI Announcement January 2011
2. Press Release - TASI "Welcoming Educators" June 2011
3. TASI Outreach Announcement for Teachers
4. TASI Sponsors, Hosts, Leaders, and Donors List
5. Community Reception Invitation
6. "Back to the Farm" Teacher Lesson Plans
7. El Dorado County Ag in the Classroom Video (in report sleeve)

El Dorado Ag in the Classroom
2460 Headington Road
Placerville, CA 95667

IMMEDIATE RELEASE:
January 10, 2011

Teacher's Ag Summer Institute Available to Local Educators

Educators from Amador, El Dorado and Placer counties have a unique opportunity to connect with local agriculture by attending the Teacher's Ag Summer Institute June 20-23, 2011. The three-day workshop will bring together teachers with farmers, ranchers and other agricultural and natural resource specialists to gain a deeper understanding of the agricultural productions systems and how they sustain the health of people, society, and the natural environment.

"We are very excited to connect teachers---and ultimately local students---with agricultural production and the food we eat, the clothes we wear and the shelter provided by the roof on our homes", noted Wendy West, project coordinator. "Teachers will be able to share an expanded understanding of what agriculture brings to our local communities, while providing students with new opportunities to practice critical thinking skills in the classroom, utilizing resources and experiences provided at the teacher institute."

The Teacher's Ag Summer Institute (TASI) combines classroom-style instruction, learning stations, hands-on, in the field experiences and sample classroom activities to immerse participants in the vital world of agriculture. Breakout sessions for primary, secondary and high school educators will connect the topic of the day with resources and hands-on activities, tied to California state curriculum standards to ensure ease in incorporating topics and lessons into the classroom. Topics will include conservation and stewardship practices; land use and zoning issues; ecological services provided by crop, forest and rangelands; production, marketing and distribution systems; economic and business considerations and the historical context of agriculture in the region. Field activities will be conducted at working ranches, orchards, farms, forest lands and wineries located throughout El Dorado County. All meals, three nights lodging, transportation to the field sites and resource materials are included and free to teachers attending. A $25 participation fee is due at the time of acceptance to the program. Educators need little or no background in agriculture to attend the institute.

Teachers will prepare and present a lesson plan or class activity, developed from resources and experiences gleaned while attending TASI, at the "Back to the Farm" event on July 14, 2011. After completing the institute and presenting at the follow-up event, teachers will each receive a $300 stipend. Optional continuing education credits will also be available.

Funding for the Teacher's Ag Summer Institute has been provided by a Specialty Crop Block Grant awarded to the El Dorado County Ag in the Classroom (EDCAITC) by the California

Department of Food and Agriculture (CDFA) to expand specialty crop agricultural education and outreach programs in the Sierra foothills region. As a local, grassroots charitable nonprofit organization, EDCAITC offers educators, students, and the public opportunities to learn about agriculture in context of local farms, ranches, and forests.

Applications are available at: www.agintheclass-edc.org/teachersaginstitute.html and will be accepted until February 15, 2011. For more information contact Wendy West, project coordinator at 530-621-5533 or wkwest@ucdavis.edu.

CONTACT: Wendy West
wkwest@ucdavis.edu 530-621-5533

El Dorado Ag in the Classroom
2460 Headington Road
Placerville, CA 95667

IMMEDIATE RELEASE:
June 20, 2011

Teachers' Agricultural Summer Institute Welcomes Local Educators

Educators from El Dorado and Amador counties will have a unique opportunity to connect with local agriculture during the Teacher's Ag Summer Institute (TASI) June 20-23, 2011. The three-day workshop will bring teachers together with farmers, ranchers and other agricultural and natural resource specialists to gain a deeper understanding of the agricultural production systems and how they sustain the health of people, community, and the natural environment.

A project of the El Dorado County Ag in the Classroom, a local nonprofit organization, TASI will provide participating teachers with both classroom-style instruction and hands-on field experiences at working ranches, forest lands, orchards, farms, and wineries throughout El Dorado County.

"We are very excited to connect teachers---and ultimately local students---with the world of agricultural that contributes to the food we eat, the clothes we wear and the shelter provided by the roof on our homes", noted Wendy West, project coordinator. "Teachers will be able to share an expanded understanding of what agriculture brings to our local communities, providing students with new learning opportunities by utilizing resources and experiences provided at the teacher institute."

Agricultural topics presented will include conservation and stewardship practices; ecological services provided by crops, forest and rangelands; production, marketing and distribution systems; and economic and business considerations.

What:	**Teacher's Ag Summer Institute (TASI)**
When:	**Monday, June 20, 5:00 p.m.** **Opening Session** **Tuesday through Thursday, June 24** **8:30 a.m. to 5:00 p.m. daily**
Where:	**EarthTrek campground by the South Fork of the American River, Lotus/Coloma**

Visual/photo Opportunities:	**Class Activities at EarthTrek by the American River** **Field Visits to agricultural sites (see fact sheet attached)**

Teachers' Agricultural Summer Institute

Funding for the Teacher's Agricultural Summer Institute has been provided by a Specialty Crop Block Grant awarded to the El Dorado County Ag in the Classroom (EDCAITC) by the California Department of Food and Agriculture (CDFA) to expand specialty crop agricultural education and outreach programs in the Sierra foothills region.

Hosted by the El Dorado County Ag in the Classroom (EDCAITC), the Teachers' Agricultural Summer Institute is designed in partnership with the EDCAITC, University of California Cooperative Extension, El Dorado County Farm Bureau, and El Dorado County Office of Education.

El Dorado County Ag in the Classroom is a local, grassroots nonprofit organization that provides quality agricultural-based educational resources to teachers, students, and the public to increase awareness of the role of agriculture in our lives.

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CONTACT: Karen Owen, El Dorado County Ag in the Classroom
(916) 337-4021 kareno.grant@gmail.com

FACT SHEET

TEACHER'S AGRICULTURAL SUMMER INSTITUTE (TASI)

DATES:	JUNE 21 through JUNE 23, 2011 8:30 a.m. - 5:00 p.m. each day
ATTENDEES:	Teachers from El Dorado and Amador counties representing elementary, middle, and high schools.
JUNE 20, 2011	TASI Kick-off 5:00 p.m.
JUNE 21, 2011	Activities by Project Learning Tree and Project WET (Water Education for Teachers) at EarthTrek campground. (8:30 a.m.)
	Field trips to three forest land sites (Sierra Pacific Industries, U.S. Forest Service, J&R Logging 12:30 - 5:00 p.m.).
JUNE 22, 2011	Field trips to Bacchi Ranch, Rainbow Orchards. (8:30 a.m. to 1:30 p.m.)
	Classroom activities at EarthTrek campground. (2:00 p.m.)
	Community Reception, Boeger Winery (5:30 p.m. to 7:30 p.m.)
JUNE 23, 2011	Dairy Council of California presentation. (8:30 a.m.)
	Field Studies at Fitzpatrick Winery and Lodge (10:30 a.m.); Rancho Margarita Alpacas (1:30 p.m.) and Mad Dog Mesa (3:00 p.m.).

Teacher's Ag Summer Institute

Bring the wonders of local agriculture into your classroom!

June 20-23, 2011

Plus "Back to the Farm" – August 2, 2011

This program brings together teachers with farmers, ranchers and other agricultural and natural resource specialists to gain a deeper understanding of the food and agricultural systems that sustain the health of people, society, and the natural environment. Experiential activities set within the context of agriculture and resource management become the basis for integrating Ag with language arts, science, math and social sciences in the everyday curriculum.

The three-day Ag Institute will combine classroom-style instruction, learning stations, hands-on, in the field experiences and sample classroom activities to immerse participants in the vital world of agriculture. Break-out sessions for primary, secondary and high school educators will connect the topic of the day with resources and hands-on activities to take back to the classroom setting. Resources and activities will meet California state curriculum standards to ensure ease in incorporating topics and lessons into the classroom.

Each teacher will create a lesson plan or class activity, which they will present to the entire group at the "Back to the Farm" gathering on Tuesday, August 2, 2011 from 6:00 – 8:30 p.m. After completing the institute and presenting at the follow-up event, teachers will each receive a $300 stipend for attending and completing the institute. Optional continuing education credit will also be available to teachers.

Who Should Attend: Teachers (grades Kindergarten through High School) from the Sierra foothill region from Amador, El Dorado and Placer counties. Teachers need little or no background in agriculture to attend.

How Your Students Will Benefit: K-12 students in the Sierra Foothill Region are ultimately the audience for the knowledge and skills gained at the Ag Institute. Teachers will be able to share their new understanding of agricultural and natural resource management principles and concepts with their students by developing classroom curriculum that integrates conceptual

learning about agriculture's impact on our daily lives. Students will also practice critical thinking skills by exploring new topics and themes utilizing a wide variety of resources provided to teachers attending the sessions.

Topics: Environmental stewardship, conservation practices, land use, ecological services, production, marketing and distribution systems, economic and business considerations and historical context.

When: June 20-23, 2011; the institute will begin late afternoon on Monday, June 20th and conclude at 5:00 pm on Thursday, June 23rd. Teachers will also need to attend and present at the event on Tuesday, August 2, 2011 from 6:00 p.m. - 8:30 p.m.

Where: Lodging and workshop sessions will be held in Coloma, CA. Facilities include group tent cabins, outdoor dining and meeting areas, showers and restrooms --- all located on the banks of the South Fork of the American River. Field trips will be held at working ranches, orchards, farms and wineries in the Apple Hill, Coloma and southern El Dorado County areas.

Cost: All meals (Monday dinner through Thursday lunch), three nights lodging, transportation to the field sites and resource materials are included and FREE to teachers attending. A $25 participation fee is due at the time of registration.

Presented By: El Dorado County Ag in the Classroom (EDCAITC) and the University of California Cooperative Extension in partnership with the El Dorado County Office of Education, the Folsom Lake College El Dorado Center and local agricultural producers. Major funding for this project has been provided through a Specialty Crop Block Grant awarded by the California Department of Food and Agriculture to EDCAITC to expand its specialty crop agricultural education and outreach programs in the foothill region.

Additional information and application forms will be available online after December 1, 2010 at: http://ucanr.org/2011teacheragsummerinstitute. For more information contact the TASI Coordinator – Wendy West, UC Cooperative Extension 530-621-5533 wkwest@ucdavis.edu.

Teacher's Ag Summer Institute

Sponsors

Ag in the Classroom – El Dorado County
www.agintheclass-edc.org

El Dorado Community Foundation
www.eldoradocf.org

Funding Provided By

California Department of Food and Agriculture
http://www.cdfa.ca.gov

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California Foundation for Ag in the Classroom
www.cfaitc.org

Lisa Larsen
Tracy Witmer
Dairy Council of California
www.dairycouncilofca.org

Field Trip Hosts/Speakers

Robert D'Agostini, Jr.
J&R Logging
PO Box 1
Mt. Aukum, California 95656

Wayne and Jo Webb
Rancho Margarita Alpacas
www.ranchomargaritaalpacas.com

Christa and Tom Campbell
Rainbow Orchards
http://rainboworchards.info

Chuck Bacchi
Bacchi Ranch
http://bacchiranch.com

Rich Wade
Sierra Pacific Industries
www.spi-ind.com

Amy and Bob Day
Mad Dog Mesa Olive Oil
www.maddogmesa.com

Dianna and Brian Fitzpatrick
Fitzpatrick Winery and Lodge
www.fitzpatrickwinery.com

Boeger Winery
www.boegerwinery.com

El Dorado County Ag in the Classroom

invites you to attend a reception

Celebrating Agriculture and Education

and the

Teacher's Ag Summer Institute

Wednesday, June 22, 2011
5:30 - 7:30 p.m.
Boeger Winery
1709 Carson Road, Placerville

Sponsored by:

El Dorado Community Foundation

El Dorado County Ag in the Classroom

Reception will feature a sampling of local
foods and beverages.

Please RSVP by email: info@agintheclass-edc.org
or telephone: 530.622.7116

Lesson Plan & Activities 2011 Teacher's Ag Summer Institute

TITLE	AUTHOR
My Friends, the Trees (Mini-Unit)	**Toni Linde**
CONTENT AREA **Science, Math, Social Studies, Visual Arts, Lang. Arts**	DATE SUBMITTED **7-11-11**
GRADE **2nd (K-6th)**	DURATION: **Four 30-60 minutes sessions for the entire Mini-Unit**

1	**Standards Correlations Benchmarks**	**Life Science:** 2c. Organism characteristics are inherited from parents and influenced by the environment. 2e. Environmental stress affects development of plants. **English-Language Arts:** 2.2 2.3 2.4 2.5 2.7 2.8 **Social Studies:** 2.4
2	**Objectives**	*To help students understand the importance of trees in their environment and to help instill ownership of their actions to the survival of a tree and / or a forest of trees.*
3	**Resources and Materials**	**"Tag Along with Twig"** pamphlets from the Forest Foundation for each child; many different reference books on trees and leaves. **Arrangements with a local Fire Department to be a guest speaker. (See Day 4)** Tree cookies; green leaves and others from the ground (gathered WITH the children); grocery bags for Leaf Safari; Copies from PLT 76, 77, 78, 81; Copies from AIMS reference books for Leaf Safari and others. (attached)
4	**Teaching the Lesson (Lesson Sequence and Activities)**	**Day 1:** Each child will get their own Tree Cookie to learn the trees' layers and how to examine the health of their tree and count the rings for its age. Using magnifying glasses and / or a microscope adds to this lesson. Worksheets from PLT p.330 and 331 will be done together. Can also use AIMS worksheet p.44 for "Cookie Rubbing" and recording. Children will learn the "motions" of each tree layer and then act out a whole tree trunk with the teacher as the hartwood. (Homework --- "Twig" pamphlet, page 1 and 2.) **Day 2:** Discuss the other pages in the "Twig" pamphlet and do the last page about Different Forester Jobs together. Discuss PLT 77 Trees in Trouble -- talk about being a "Tree-tective" using PLT p. 335 worksheet as a guide. Divide up into teams and examine trees around the playground and any garden area for signs of trouble. After about 5-10 minutes, gather together to discuss results. (Homework --- Copy of worksheet to examine own trees around their house.)

Day 3: Signs of Fall --- "Leaf Safari"

(This works best after leaves start falling --- September / October)

Brainstorm first about signs of Fall. Then read a book or two about the changes that they may see around them in the Fall.
Set ground rules for Leaf Safari: Remind kids that we never pick leaves off of a tree for this activity. We ONLY get leaves from the ground, but want leaves that are not "crunchy" yet. They must also stay with their partner in our area.
Pick partners and give each set a grocery bag for their collection. Go to a yard area that has several different types of leaves and after 5 minutes, move to another area to do the same. Return to class and each child picks their favorite leaf to use for the AIMS worksheet p. 31. Can also do PLT worksheet p. 340, if time.

Day 4: "Living with Fire" PLT 81
Discuss common causes of fires and list which ones are caused by humans. Compare house fires to a forest fire, or a fire in the trees.
Teach about the "Fire Triangle" of heat, fuel, and oxygen and how the weather can make a difference in fires.

Arrange ahead of time: Have a fireman visit your classroom to discuss the importance of fire safety. Ask if the fireman can take the children outside to the playground to show just how fast different kinds of fuels ignite (in controlled containers) to demonstrate the dangers of improper forest care. (This obviously needs to be something the fireman prepares before coming to your class.)
Also, have the fireman show the proper way to put out a fire, including the use of a Fire Extinguisher at the end of this lesson.

Follow-up / added activities:
PLT 78 Visible Changes activity, Part B. Should do this outside together.
Need rubbing alcohol and jars to hold pieces of leaves and the alcohol to cover them. Also, pencils and cut-up strips of filter paper (paper towels usually work OK.) Follow directions PLT p. 338-339. This shows the chlorophyll and other colors in the leaves.

AIMS worksheet --- "How Do We Use Trees?" p. 45 Make a list of the ways.

Adopting a Class Tree and record changes for it throughout the year.

Leaf rubbings / Bark rubbings for a cover to a booklet about the class tree, etc.

Measuring your tree height --- try many different ways:
AIMS p. 25 + Clinometer construction page; p. 26 and worksheet p. 42.

7	**Assessment**	Teacher observation as lessons are presented. Assess throughout the year as you talk about trees in the different seasons and the activities happening around them.
8	**Notes and Reflections**	There are so many directions that you can go with these lessons and all can be adjusted to any grade level of at least K-6th.

Lesson Plan & Activities 2011 Teacher's Ag Summer Institute

TITLE **Thank a Bee (for every third bite of food)!**		AUTHOR **Renee Pecota**
CONTENT AREA **Science, Language Arts, Social Studies**		DATE SUBMITTED **7-11-11**
GRADE **4**	DURATION: **"Into" activity 1 hour (#1,2,3 below); I hour (#4,5,6 below)**	

1	**Standards Correlations Benchmarks** **Science:4LS3.C** **Language Arts: R2.6** **Social Studies: H-SS 4.14**	S: How do plants depend on animals? LA: Students distinguish between cause and effect. SS: How have California's landforms and water affected settlement?
2	**Objectives**	S: Students will show how flowering plants and vegetables rely on honeybees to pollinate them. LA: Students will create a cause/effect graph relating to the dwindling population on honeybees. SS: Students will identify regions of California where fertile soil and adequate water are the natural resources which are necessary for farming. Art: Students will develop a meal which reflects the importance of pollination in food choices. LA: Students will verbally share their meal.
3	**Resources and Materials**	"Flower Power, "The Bee Body", "Student Glossary" A map of California Understanding the role of Honey Bees Paper Plates, glue sticks, scissors (optional) Magazines or scraps of colored paper Overhead transparencies as needed for student visual learning <u>Other teacher resources included</u>
4	**Teaching the Lesson (Lesson Sequence and Activities)**	1. Think-pair-share <u>Topic:</u> Honey bees: why do we need them? Assess for prior knowledge about pollinators/pollinating (the focus is on flowering plants).

2. In groups, students complete "Flower Power" and "The Bee Body" using the student glossary as a resource for locating and labeling bee characteristics.
3. Using the map have students recall and locate the main agricultural areas of California. In addition, discuss if this is the only place to grow food. Have students give locations of other places bees are needed.

1. Use "Understanding the Role of Honeybees" to create cause/effect graph. Teacher uses an overhead copy, while students complete theirs individually. Should students have difficulty identifying reasons for honeybee decline, guide them using the teacher resource "What can we do to help save the bees?"
2. Create a meal. Using the art supplies students plan and make a meal consisting of foods which require pollination. **At least 1/3 of the meal must be foods which are pollinated by bees.** Grains such as wheat and corn do not require bee pollination, but are pollinated by wind. Dairy products from milk cows are a result of pollination as dairy cows eat alfalfa as a main diet source.

7	**Assessment**	Students will know prior to beginning the packet that neatness and correct and correct spelling are required. Assessment will include work in the packet and presentation of a meal which follows the guideline in #6 above.
8	**Notes and Reflections**	

Lesson Plan & Activities 2011 Teacher's Ag Summer Institute

TITLE **Bird Beak Buffet**	AUTHOR **Angela Personeni/ adapted from mysciencebox.com**
CONTENT AREA **Science**	DATE SUBMITTED **7/12/11**
GRADE **7th**	DURATION: **3-4 45min class periods**

1	**Standards Correlations Benchmarks**	7th Grade Life Science 3. Biological evolution accounts for the diversity of species developed through gradual processes over many generations. As a basis for understanding this concept: 1. Students know both genetic variation and environmental factors are causes of evolution and diversity of organisms. 7. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will: a. Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence. <u>Grade 9-12</u> 7. The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept: a. Students know why natural selection acts on the phenotype rather than the genotype of an organism. d. Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions. 8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept: a. Students know how natural selection determines the differential survival of groups of organisms. b. Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment.

2	**Objectives**	**Objectives** Can explain what natural selection is and the conditions necessary for it to occur. Can discuss changes in a population in the context of natural selection. Can use terms such as natural selection, evolution, and adaptation scientifically. Can organize data in a table and graph. Can graph changes in a population over time *Students understand the correlation between natural process of selection and human imposed processes of selection in breeding agricultural crops and livestock.*
3	**Resources and Materials**	**Materials** • 1 pound of red beans • 1 pound of black beans (of a similar size and shape as the other beans) • 1 pound of white beans (of a similar size and shape as the other beans) • 25 plastic forks • 25 plastic spoons • 25 plastic knives • 30 paper cups • 1 stopwatch • 1 whistle • broom and dustpan for cleanup • 1 copy of the Bird Beak student handout for each student • 3 copies of the Bird Beak data tables • 4 clipboards with a pencil/pen tied to each • Optional: masking tape or string to designate the borders of the feeding ground

4	**Teaching the Lesson** **(Lesson Sequence and Activities)**	**Lesson Plan** **Day 1 - Introduction** 1. Open class with a discussion of what human traits might help a person be more successful (Is it an advantage to be tall? Is it an advantage in America to be blond haired and blue eyed? How about in another country like Africa or Asia?) Leave the interpretation of "more successful" open and somewhat vague. If this seems to controversial for your group of students, then discuss variation in cat or dog traits and what might help a pet survive better (Is it an advantage for a cat to be shy? Is it an advantage for a dog to be friendly?). Lead students to discuss what traits help a corn plant or a beef cow be more successful and what is success for a corn plant or a beef cow. 2. Lead the discussion towards thinking about what "more successful" really means. Does that mean being more popular or making more money or more likely to live happily ever after? In scientific terms, what matters in the long run is whether you survive, find a mate, and reproduce, passing on your genes to the next generation. In agricultural terms it means to produce the most desirable food crop in the most resource efficient way. 3. Introduce the activity. Pass out the handout and describe the rules. 4. Check that students understand that all the birds are of the same species but have different beak traits. Similarly, all the beans are of the same species but have different color traits. 5. Check that students understand that the birds that eat the most food will have a baby with a similar beak and that the birds that eat the least will die. Similarly, surviving beans (those not eaten) will have one baby with the same color trait. 6. Finally discuss the data collection that occurs after each round. Each student is responsible for counting the number of each type of bean they eat and entering their data on the bird population data clipboards. Once all the bird population data has been gathered, then a volunteer from each group will report their data on the bean population data clipboard. 7. If data will also be collected in lab notebooks, have students copy or paste the data tables and graphs into their notebooks.

Day 2 – Bird Beak Buffet

1. Distribute a cup to each student. Next, give each student a plastic utensil.
2. Quickly go over the rules before heading out to the feeding ground. Make sure you bring clipboards, beans, a stopwatch, and a whistle.
3. Place the 4 data clipboards in different locations near the feeding ground.
4. Have students stand on the edge of the feeding ground. Sprinkle the mixed beans (100 of each type) into the feeding ground.
5. Blow the whistle and give students 20 seconds to "eat" as many beans as possible. Look out for students that cheat (have cups touching the ground, interfere with other students, etc.) and dump out the contents of their cups or eliminate them from the game. Blow the whistle again to signal the end of the year.
6. Each student should go to the clipboard for their beak type, count the number of beans of each type they ate, and enter that information in the data table.
7. Each group should calculate the grand total number of beans of each type that were eaten by their group (the bottom row of the table).
8. One volunteer from that group can bring that information to the bean population data clipboard and enter their groups' information. The volunteers can then help to complete the bean data table and count out the proper number of beans to add to the feeding ground.
9. While the volunteers are entering bean population data, the rest of the students should help to sort their beans by color and return them to the stockpiles.
10. Finally, have students line up by the total number of beans they ate. Have the 5 students that ate the fewest beans act out a grisly death. (Acting out the deaths helps students realize that they are actually dying and entering the game as a new bird with new traits, not just trading in one tool for another.) Confiscate their utensils. Give them new beaks that match the beaks of the 5 students that ate the most beans.
11. Have a student enter this information (the number of birds that died and number of babies born) on the bird population data clipboards.
12. Repeat steps 5-11 for each of the next 3 years of the game for a total of 4 rounds.
13. Collect the clipboards, cups and utensils. Sweep up any remaining beans.

Day 3 – Organize, graph and discuss data

1. Create data tables on the board (or make and overhead copy) similar to the ones on the second page of the Bird Beak Student handouts.
2. Use the information from the clipboards to fill in the summary table. Have students fill in their tables as well.
3. Have students graph the data for each population (red beans, white beans, black beans, fork-bills, spoon-bills, blade-bills) with years 1-5 on the x axis and the number of organisms at the start of a year on the y axis. The graphing may be done:
   - individually in their lab notebooks
   - groups of 3 can each graph one bird and one bean and compare graphs as a group
   - a group of students can create large poster sized graph for one of the populations to display around the room.
4. Discuss the graphs. Notice patterns such as one population going up while another goes down. See if the population is growing steadily or exponentially.
5. Discuss the reasons why one population did well while another did poorly. Is there a different scenario in which a different bird or bean would do best?
6. At this point it is possible to formally address some of the vocabulary.
   - Discuss natural selection – the process by which organisms with traits that best suit the environment are most likely to survive, reproduce, and pass on their genes to the next generation. In this activity, the bean that had the best camouflage and that was the hardest to catch survived, reproduced, and passed on their genes.
   - Discuss evolution – descent with modification, most often as the result of natural selection. In this activity, we started with the same number of beans of each type but ended up with the population skewed towards the beans with the best suited traits.
   - Discuss adaptation – a trait that is very well suited to a given environment that has, through natural selection, increased in the population over many generations. In this case, a particular color of bean could be considered an adaptation since it increased in the population through natural selection.
7. Describe Charles Darwin's adventures on the Beagle and how his observations (particularly of the finches on the Galapagos Islands) led him to propose the idea of natural selection.
8. Discuss how humans had been using selection processes in

		plant and animal breeding for agricultural purposes for hundreds of years prior to Darwin's theory. Lead class in a discussion of how diversity in crops or livestock benefits our environments, our sustainability and best utilizes resources. 9. Finally, return to the discussion you used to open this activity – what human traits might help someone be more successful – and revisit those issues in the light of what your students now know about natural selection and evolution. In particular, you can discuss whether and how natural selection has worked and is still working on the human species and compare this to how farmers and ranchers have used selection to benefit agricultural production.
7	**Assessment**	**Assessment** 1. Collect the students' graphs and responses to the conclusion questions. 2. Before the activity, have students write a short essay about "what is evolution and how does it work?" These may be collected to give you as the teacher a sense of what their initial understanding may be. After the activity and discussion, have students revise their essay to reflect what they now know about evolution. Have students reflect also on how similar selection processes have benefited humans in terms of agriculture production.
8	**Notes and Reflections**	

Lesson Plan & Activities 2011 Teacher's Ag Summer Institute

TITLE **Seed Sort**	AUTHOR **Barbara Simpson**
CONTENT AREA **Science and Mathematics**	DATE SUBMITTED **10/10/2011**
GRADE **Kindergarten**	DURATION: **30-90 depending on which activities you choose**

1	**Standards Correlations Benchmarks** **KLS 2.a 5** **K IE 4.a** **K Math sort**	Students know how to observe and describe similarities and differences in appearance and behavior of plants (and animals). Students use 5 senses to observe common objects. Students sort by size, color, or other characteristics. Students will understand the comparative vocabulary small, medium, and large
2	**Objectives**	*Students will be able to sort seeds and separate by small medium and large* *Students will understand the depth to plant seeds of various sizes.* *Students will learn where seeds come from and observe and/or gather seeds in natural environment if possible.*
3	**Resources and Materials**	Cups, potting soil, seeds from various plants and in several sizes. Notecard, glue and more seeds/beans for art extension. PLT activity 43 as a reference.
4	**Teaching the Lesson (Lesson Sequence and Activities)**	Review previously taught lessons on "Plants have seeds" from Scott Foresman Science Lesson 3 Unit B. and on "What is a seed?" PLT 43 Show seed samples. Discuss similarities and differences. Have students sort seeds with whatever method they choose. Then have them sort them by size. Talk about planting seeds and planting depths. Have each child pick one seed to plant, talk about the depth they will each plant theirs and plant them in clear cups. Follow up the next day with lesson on plant needs. **Outdoor Extension:** If weather cooperates and there is a suitable and safe place to do this, go on a search for seeds and collect them. Show where to find seeds and how various seeds are dispersed. PLT activity 43 **Art extension:** Create a mosaic or picture on a notecard with glue and seeds.
7	**Assessment**	Give students three seeds of different sizes and have them show you the small, medium and large ones. Have paper with the three planting cups and have students place their seeds to the right planting depth based on their sizes. See attached assessment page.
8	**Notes and Reflections**	Bring in a coconut and a Pinecone to talk about really big seeds.

Lesson Plan & Activities 2011 Teacher's Ag Summer Institute

TITLE **The Fire Triangle**	AUTHOR **Steve Simpson**
CONTENT AREA **Science**	DATE SUBMITTED **July 14, 2011**
GRADE **6**	DURATION: **One class period**

1	**Standards Correlations Benchmarks**	Science 6.3.0 Heat moves in a predictable flow from warmer objects to cooler objects until all the objects are at the same temperature. Science 6.3.b Students know that when fuel is consumed, most of the energy released becomes heat energy
2	**Objectives**	Students will be able to identify the three parts of the fire triangle. Students will be able to list two fuels that release heat when they are consumed. Students will be able to predict what happens when any component of the fire triangle is eliminated Students will explain the meaning of a calorie of heat
3	**Resources and Materials**	Hot Topics:Wildfires and You Pages 9-11, Lesson 1- From The Forest Foundation Candles, matches, peanuts, Test tube, thermometer, Cold metal or glass objects such as bottles, cans, coins, coffee cups, ice cubes, etc.
4	**Teaching the Lesson (Lesson Sequence and Activities)**	Play the friction challenge as a "grabber". In groups of 3, 2 students rub their hands together for 15 seconds to generate heat. They then grab the Third member's arm. The third member is the judge to determine which student generated the most heat through friction. Switch roles so that all students get to be competitors. Discuss what happened, what was created. Brainstorm other examples of when friction can create heat. Generate a collaborative list of preconceptions about heat: What do you know about heat?, how does heat move?, what are the three legs of the fire triangle?, What happens when one leg is removed? Sketch or display a picture of the fire triangle. Light the candle with the match. Have the students identify the correlation between the match, candle, and the air with the three legs of the fire triangle.

Place a glass upside down over the candle. As the flame goes out, ask which leg of the fire triangle was removed. Have a student place a hand near the surface of the glass and describe what is felt. Ask the class what happens to the energy being released by the burning fuel in the candle.

Place one Alka-Seltzer® tablet in a glass half filled with water. The bubbles are creating carbon dioxide and will fill the air space in the glass with CO2. Pour the invisible gas onto another candle until the flame is extinguished. Again ask which leg of the fire triangle was removed to cause the fire to be extinguished.

Brainstorm ideas and examples of ways to remove other legs of the fire triangle to extinguish fire. Think of firefighters and ways they put out house fires, vegetation fires, vehicle fires, etc.

Divide the class into two groups.

Group one Performs the "Heat Movement Challenge" In this challenge, they touch a cold object and hold it for thirty seconds. They then record their observations about heat movement in their journals, answering the following: What did you notice?, How does heat move?, Does heat continue to move after the cooler object is the same temperature as the warmer object?

Group two performs the "Peanut Fuel " demonstration. This will demonstrate what happens when fuel is consumed. Ask for definitions of a fuel and examples. Hypothesize what will happen when a lit match is placed under a peanut. Light the peanut and observe the results of what happens when a fuel is consumed. Discuss: What did you notice?, Was the hypothesis correct?, and What happens when fuel is consumed?

(an advanced version is to place one milliliter of water in a test tube above the peanut and measure with a thermometer the temperature increase. One calorie of heat will be transferred from the peanut to the water when one milliliter of water increases temperature by on degree centigrade)

Switch groups

Combine groups to process their observations of the three activities. What was used to create heat?, Which direction did heat move? Examine the earlier list of preconceptions to see which were accurate and which need to be refined.

Create a chart of what we have learned about heat.

7	**Assessment**	Students will pick an object in the class or at home that can be used as fuel in a fire. They will explain how heat could be transferred in that object. They will tell what "fuel" is being consumed. They will tell one way to put out that object on fire by removing one element of the fire triangle.
8	**Notes and Reflections**	Further lessons are titled Fire-How Does it Relate to You?, Fire in Our Communities-What Can WE Do?, and Fire Investigation and Experimentation www.calforestfoundation.org

Lesson Plan & Activities 2011 Teacher's Ag Summer Institute

TITLE **Seed Saving- Beets**	AUTHOR **Gretchen Smith**
CONTENT AREA **Science/ Math**	DATE SUBMITTED **7/12/2011**
GRADE **4th-**	DURATION: **After bolted plant, 2 hours**

1	**Standards Correlations Benchmarks** **Life Science**	California Content Standards Grade 4, Life Sciences 3.0, Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept: c. Students know many plants depend on animals for pollination and seed dispersal, and animals depend on plants for food and shelter.
2	**Objectives**	*Learn to reuse plants for future crop production*
3	**Resources and Materials**	Plants, wire screen, paper storage bags, colored pencils.
4	**Teaching the Lesson (Lesson Sequence and Activities)**	After planting seeds, watching and harvesting the product, allow some plants to bolt or bloom flowers. In this activity we use beets. Allow a plant or two to stay in the ground until it produces flowers. Once flowers are in bloom, hang in still dry area. After about a week, place a large plastic bag over the plant and shake to assist the seeds in falling off. You may also use your hands to rub off the seeds. Some may prefer using a screen to separate the seeds from blossoms and other material. Once you separate the seeds, have students count and package a specified amount. Students can see who can find the most seeds as a game. Package seeds in a paper storage container such as an envelope and plant

		next season. Label each envelope with type of seeds and directions. Have students illustrated the front of the envelope using colored pencils. Students will recall, journal, and illustrated what they have done from start to finish.
7	**Assessment**	**Facilitator will examine the seeds to see if in fact the product has been satisfactorily placed in envelope.** **Long Term- Students may replant for next season crop.**
8	**Notes and Reflections**	**This project can be done with many types of plants including lettuce and spinach type plants.** **Students enjoy being able to bring the product home to share with the family.** **One plant can produce hundreds of seeds. Some of the seeds will not be viable.**

Lesson Plan & Activities 2011 Teacher's Ag Summer Institute

TITLE **A Garden Based Activity using the Scientific Method to learn about Ph (acids vs alkalis)**	AUTHOR **Gail VonWald**
CONTENT AREA **Science**	DATE SUBMITTED **7/12/2011**
GRADE **K-10**	DURATION: **85 minutes**

1	**Standards Correlations Benchmarks**	Understandings about scientific inquiry Abilities necessary to do scientific inquiry Environmental quality Environmental hazards
2	**Objectives**	*Learn about ph – acid vs alkali* *Practice the scientific method* *Experiment with common foods and common cleaning ingredients* *Practice safety rules* *Create cotton art with acids & alkalis*
3	**Resources and Materials**	<u>Red Cabbage Indicator Solution</u> (for younger children & time saver this may be prepped ahead of time) 1-carefully slice the red cabbage into small pieces. 2-Put the pieces in the saucepan with enough water to cover them 3-Bring the water to a boil, turn off the heat, stir the cabbage mixture and leave it to cool for 30 minutes. 4-Pour the cabbage water through the sieve into the jar. The liquid in the jar is the cabbage indicator. Keep it in the refrigerator. <u>Acid & Alkali Experiment Ingredients</u> (put small amounts of each in a clear labeled cup) Apple Juice Lemon Juice Vinegar 7-Up Yogurt Water Milk Baking Soda Toothpaste Hydrogen peroxide Desk Spray Cleaner Stir sticks

4	**Teaching the Lesson** **(Lesson Sequence and Activities)**	Discuss what we know about acids in our environment; how chemicals affect our water supply, plants and animals…what do we know about acid rain, how acidic foods taste etc. Discuss the Scientific Process (used by scientists, gardeners, students, to discover and understand new information) - question, prediction, hypothesis, experiment, data, conclusion, communication Discuss a tool for measuring the ph scale. Demonstrate the ph scale; a way to measure the number of hydrogen ions in a solution. In a solution acids have less hydrogen ions (ph is a number below 7), alkali has more hydrogen ions (ph is a number above 7), (7 is a neutral solution) Use the above list of experiment ingredients and record a prediction about the ph of some common foods and cleaners. Explore a red cabbage (preferably fresh picked from the garden). What do we notice that is special about red cabbage? (It is an awesome color, different than many vegetables, how does it taste? (Sweet, crunchy) What can we use cabbage for? (Salads, coleslaw, for science experiments?) Record what you think will happen if cabbage indicator solution is added to each test ingredient. Add some cabbage indicator solution to each labeled cup and record your findings. Record your conclusion of how cabbage indicator solution changes color in an acidic or alkali solution.

		Create a cotton batik with acids & alkalis -Get a cotton square -Soak it in cabbage indicator solution for 5 min -Wring out the cotton square -Press it between paper towels to get out excess liquid -Place square on paper plate -Use squeeze bottles (lemon juice and baking soda) and place drops of solutions on the wet cotton square. -See what happens, discuss what types of solutions these bottles contain -Have some fun and continue decorating your cotton square -Let the cotton square absorb solutions for several minutes before quickly rinsing with cold water and let dry.
7	**Assessment**	Red cabbage contains a natural pigment that reacts with hydrogen ions. Red cabbage solution will change color in the presence of acids and bases. Discuss the benefits vs dangers of acids and alkalis Complete a lab report or record predictions, observations, data and conclusions in your science journal.
8	**Notes and Reflections**	**The Usborne Book of Science Experiments by Jane Bingham, was used as a** **resource for this lesson.** **Extend this lesson to explore the ph of soil.**

Teacher's Agricultural Summer Institute

Teacher's Activity and Resource Guide

Lesson Plans and Activities for the Classroom

Developed under a Specialty Crop Block Grant
from the California Department of Food and Agriculture

El Dorado County Ag in the Classroom
2460 Headington Road, Placerville, CA 95667

December 2011

Activity and Resource Guide for Teachers

El Dorado County Ag in the Classroom

- Berry Good Blueberries
  Grade 1
- Eat Your Plant Parts!
  Grades 2-6
- Thank a Bee for Every Third Bite of Food!
  Grade 4
- Renewable or Not? Sustainable or Not?
  Grades 4-6
- Diversity on the Farm
  Grades 4-8

December 2011

Berry Good

Levels:
Grade 1
Social Science
Math
Language Arts
Visual Arts

Materials:
Map of the United States

"Berry Magic" by Betty Hoffmon and Teri Sloat

"Blueberries for Sal" by Robert McCloskey

Blue stamp pad

Paper

Pencils or thin markers

Handout – "A Tremendous Mouthful!"

Paper bags

Index cards

Scissors

Markers or crayons

Glue

Paint sticks

Tape

Lima beans painted blue (to represent blueberries)

Handout – "Storing Blueberries" math mat

Objectives:

Students will develop an understanding of how groups of people or cultures use stories to explain natural occurrences around them. Students will develop an understanding of foods grown in their community. Students will use blueberry models in math, art and eating activities. Students will understand the influence of nutrition on health.

Background and History:

Native American Tradition:
For centuries, blueberries were gathered from the forests and the bogs by Native Americans and consumed fresh and also preserved. The Northeast Native American tribes revered blueberries and much folklore developed around them. The blossom end of each berry, the calyx, forms the shape of a perfect five-pointed star; the elders of the tribe would tell of how the Great Spirit sent "star berries" to relieve the children's hunger during a famine. Parts of the blueberry plant were also used as medicine. A tea made from the leaves of the plant was thought to be good for the blood. Blueberry juice was used to treat coughs. The juice also made an excellent dye for baskets and cloth. In food preparation, dried blueberries were added to stews, soups and meats. The dried berries were also crushed into a powder and rubbed into meat for flavor.

Blueberry Thanksgiving:
During the seventeenth century, settlers from England arrived in the New World to begin colonies. Immediately, they set about clearing the land and establishing farms so they could not rely solely on supplies from England. But the land and the climate were far different from what they left behind. Many early attempts at farming failed.

In the winter of 1620, the Pilgrims established a settlement at Plimoth (spelled Plymouth today). Many perished during the first few months, but those that survived went on to build homes and establish farms.

Their neighbors, the Wampanoag Indians taught the settlers new skills that helped them survive. They showed them how to plant corn and how to gather and use native plants to supplement their food supply. One important native crop was blueberries!! The colonists learned from Native Americans how to gather blueberries, dry them under the summer's sun and store them for the winter. In time, blueberries became an important food source and were preserved, and later canned. A beverage made with blueberries was an important staple for Civil War Soldiers.

(from http://www.childrenslit.com/childrenslit/th_blueberry_month.html)

"Storing Blueberries" handout available at:
http://www.scholastic.com/content/collateral_resources/pdf/b/Blueberries.pdf

The blueberries Sal and her mother picked were divided between canning for the winter, and feeding hungry tummies. In this activity children re-create their experience with math mats and blueberry counters to practice addition and subtraction skills.

Give each child a copy of the Storing Blueberries math mat (page 10 of handout). Each child will also need a handful of counters. The painted dried bean blueberries, used in "A Tremendous Mouthful" work well. Share a story problem based on the story—for example: "Little Sal's mom canned five blueberries, and Little Bear's mom stored four berries in her tummy!" As you share the story, use an overhead to model placement of the counters on the mat, placing five counters on the canning jar and four counters on the bear's tummy. Have children follow along using their own math mats. Then ask: "Who stored more? How many did they store all together? How many more berries did Little Sal's mom store than Little Bear's mom?" Write number sentences to go with each question (for example, 5 + 4 = 9) to show how many berries they stored all together.

Standards Correlations/Benchmarks:

Social Studies 1.5 (3)
Math 2.0 (2.5)
Listening 1.0 (1.1)
Language Arts/Reading Comprehension 2.0 (2.1)
Visual Arts 2.0 (2.4)

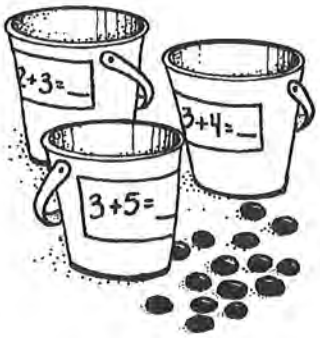
Assessment:
Check for understanding by having a class discussion sharing the responses to:
What do the stories "Blueberries for Sal" and "Magic Berry" have in common?
How are blueberries and apples the same?
Where do blueberries grow?
What other foods grow in this community?

Adapted from "Berry Good" lesson plan and activity designed by Rose French, Teacher's Ag Summer Institute 2011.

Tip

The small plastic baskets used for berries in most supermarkets work great for sorting activities and for use with activities such as Gone Blueberry Pickin'. Small pails are available from Oriental Trading Company (orientaltrading.com; 800-228-2269).

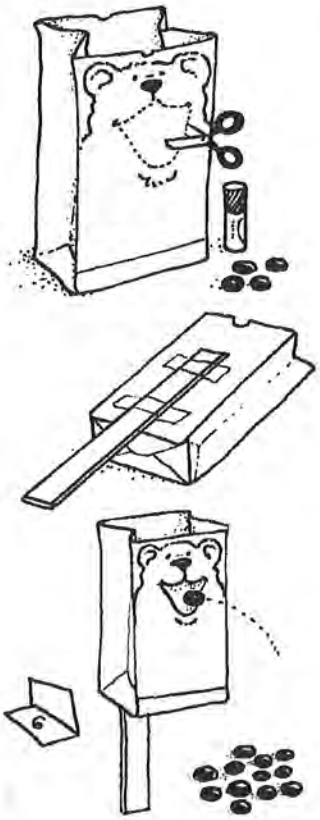
Gone Blueberry Pickin'



Invite students to go blueberry picking with this fun adding and counting activity that also works great as an independent math center activity. You will need several small pails (or baskets; see Tip, left) and dried beans painted blue to resemble blueberries. (Save the beans for use with other activities in this section.)

1. Label the front of each pail with a numeral (for younger children) or a number sentence such as 3 + 4 = ___ (for older children).
2. With students working in pairs, invite them to fill the pails with the correct number of blueberries, based on the numeral or number sentence. You might provide ten-frames for assistance with one-to-one correspondence and counting.

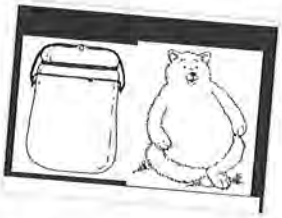
A Tremendous Mouthful!



Little Bear tastes a "tremendous mouthful" of blueberries from Little Sal's mother's pail. How much is a "tremendous mouthful"? Does it mean the same to everyone? In this activity, students experiment with "mouthfuls" as they estimate what a tremendous mouthful might mean to their math partner, and then find the difference between their estimate and their partner's.

1. Enlarge the bear pattern (page 10) and give each child a copy. Invite children to color and cut out their bear and glue it to the front of a brown paper lunch sack, positioning the bear pattern as shown (left). Help children cut out an opening for the mouth of the bear, cutting through both the pattern and the paper bag. Have children tape a ruler (or other handle) to the back of the puppet.
2. Have children pair up. Give each pair some blueberries from Gone Blueberry Pickin' (above).
3. Have partners take turns secretly choosing a number (from 1–10, or any set you choose) and writing it on a sheet of paper. This number represents the number of blueberries in a mouthful for Little Bear. The child who chose the number holds up his or her Little Bear puppet, and the other child places blueberries in the bear's mouth, trying to match the partner's number.
4. Children count the blueberries in the bag to determine the difference between that and the number on the paper.

Teaching Early Math Skills With Favorite Picture Books © 2007 by Constance J. Leuenberger, Scholastic Teaching Resources



Storing Blueberries

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3. Share new stories. Invite students to write number sentences to explain the berries on each math mat story.

"Kuplink, Kuplank, Kuplunk!"

As Little Sal picks berries, she drops them into her pail, "Kuplink, kuplank, kuplunk!" The sound of the berries hitting the bottom of the empty pail helps her count the berries. Students can strengthen their counting skills as well as their auditory discrimination skills with this berry-picking adventure.

1. Use colorful electrical tape to divide a cookie sheet into ten sections. Make two rows of five boxes each to create a ten-frame.
2. Turn the cookie sheet toward you, hiding it from children. Ask children to get ready to listen and count as you place "berries" (small magnets) in the "bucket." Place two or three magnets on the frame in order, one in the first box, one in the second, and so on. Invite children to listen to and count the sound of the magnets hitting the cookie sheet. Have students call out how many or hold up the number of fingers that match the number of magnets placed on the cookie sheet.
3. Show the cookie sheet to students, and have them count the magnets to check their responses. Repeat the activity for different numbers.

Book Links

For more literature that reinforces number sense and addition and subtraction skills, try these selections:

Counting Our Way to Maine
by Maggie Smith
(Orchard Books, 1995)

For more fun in the blueberry state, read this rollicking tale of a family's vacation to Maine, beginning with packing one baby and ending with catching 20 fireflies.

One Watermelon Seed
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While Max and Josephine plant and harvest their garden, they find many opportunities to count by ones and tens.

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This colorful book is filled with delicious opportunities to practice one-to-one correspondence and counting by fives.

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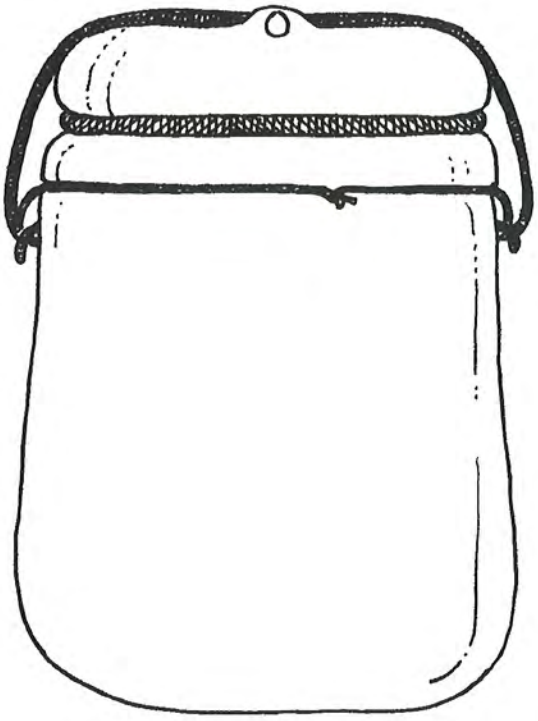

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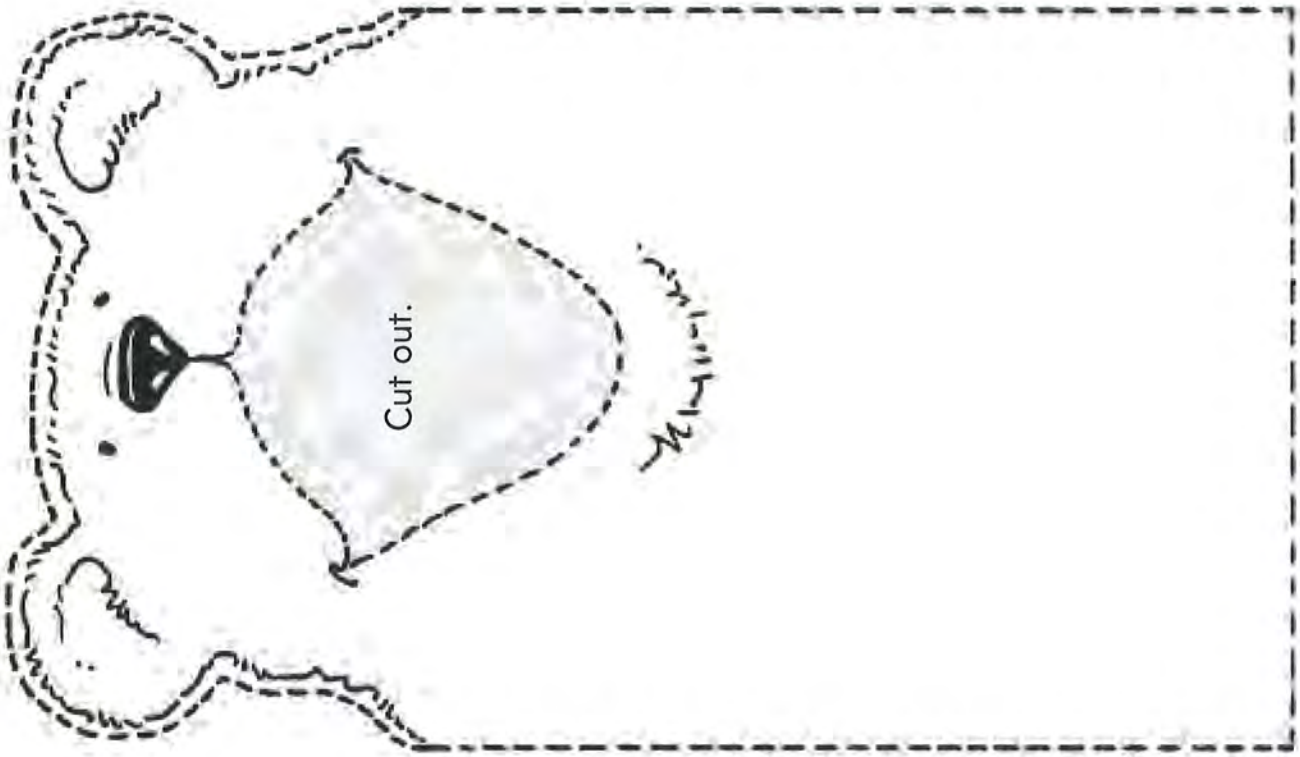

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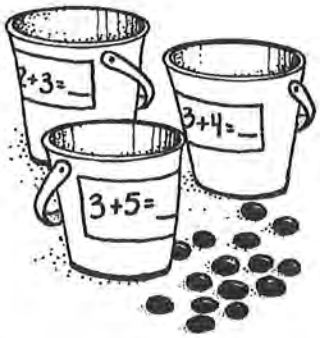

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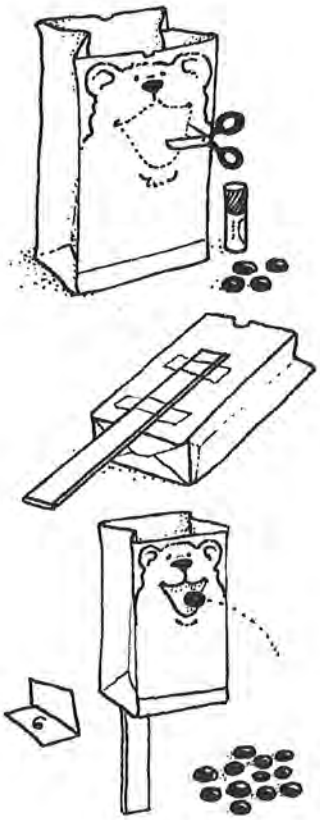

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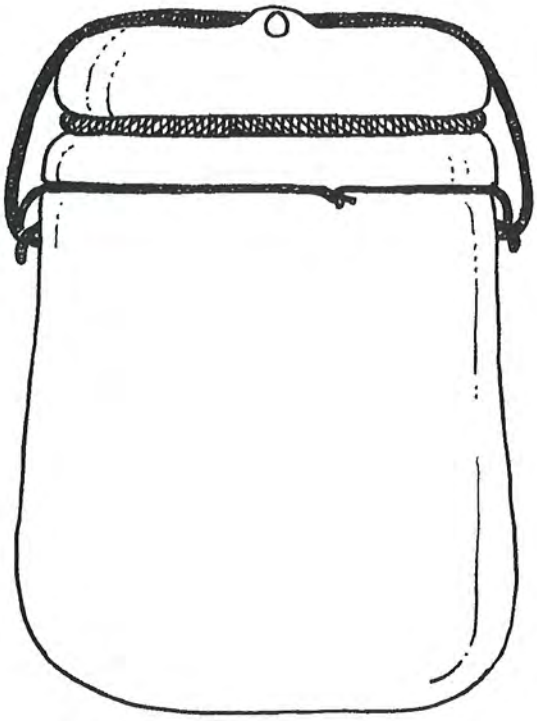
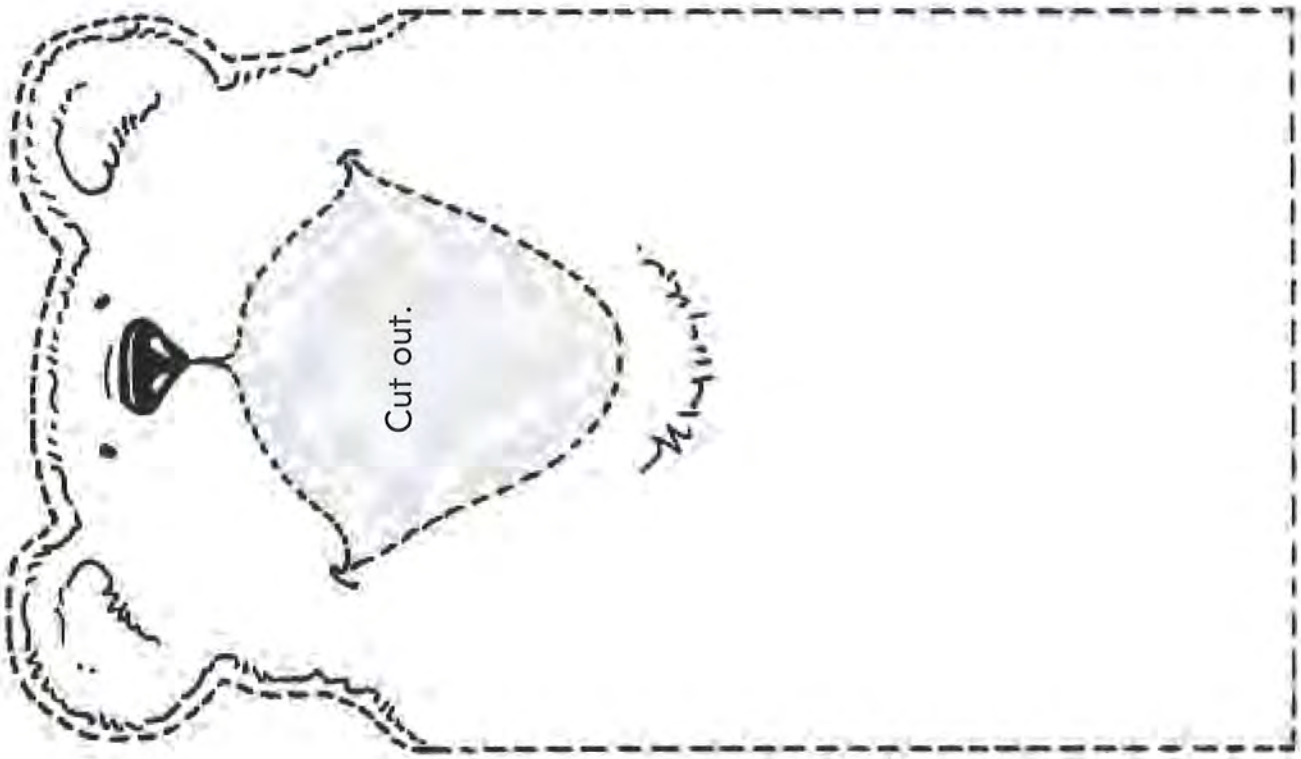
The concept of subtraction is reinforced as animals eat apples off a tree until the farmer is left with no apples.

Storing Blueberries



A Tremendous Mouthful!



Teaching Early Math Skills With Favorite Picture Books © 2007 by Constance J. Leuenberger, Scholastic Teaching Resources

Eat Your Plant Parts!

Grade Levels:
2-6

Materials:
Large paper sacks – 6

Stopwatch

Fresh fruit and vegetable photo cards; see resources to purchase cards or make you own from grocery advertisements

Cutting boards

Knives for chopping

Grater

Paper plates (optional)

Assorted vegetables and fruits, including large leaves

Salad dressing

Bowl(s) for salad dressing

Background:
Here is a list of plant parts and the food that we get from them. Note that some fruits and vegetables include more than one plant part.

Roots: carrots, turnips, rutabagas, beets, radish, parsnip, jicama, sprouts
Stems: celery, broccoli, bok choy, asparagus, cauliflower, rhubarb, sprouts, napoles (cactus), potato, yam, onion, garlic (these stems seem like roots, that they really are underground stems)
Leaves: lettuce, spinach, chard, bok choy, cabbage, greens, cilantro, parsley, basil,
Flowers: broccoli, cauliflower, squash flowers, nasturtium, asparagus, saffron
Fruits: squash, cucumber, tomato, green beans, grapes, apples, pears, olives
Seeds: nuts, beans, rice, wheat, oats, corn, peas, pomegranate, peanuts

Plant Part "Bag 'em" Game:

1. Label six large paper sacks: "Roots", "Stems", "Leaves", "Flowers", "Fruits", "Seeds". Place the bags in a row across the room from the students.
2. Divide the class into teams. First team: distribute a fruit and vegetable card to each team member. Have the students line up; start the stop watch; each student runs to the row of bags and places their card in the bag based on which plant part their fruit or vegetable represents. Record the time (in seconds) for the first team to complete the race.
3. Review each bag of cards and discuss; deduct 5 seconds for each incorrect card in a bag.
4. Continue with second, third, fourth, etc. team.
5. Tally results and proclaim the overall winner – healthy food prizes optional!
6. Discussion:
    a. Do some plants we eat go in more than one category? (e.g. broccoli has both stems and flowers that we eat; bok choy has both edible stems and leaves, etc.)

Finger Salads:
Set out tables, cutting boards and salad dressing dip bowl. Pre-harvest or purchase, wash, and grate a variety of "plant parts" vegetables and fruits. Students should sanitize or wash their hands. Each student should pick one large leaf (e.g. spinach, lettuce or chard) and hold it in the palm of their hand (or use a paper plate); add chopped or grated vegetables or fruits (e.g. carrots, beets, kohlrabi, summer squash, apples or other items in season); roll the leaf up. Dip once (and only once!) into salad dressing dip bowl. EAT UP and ENJOY! Optional: Repeat!

Discussion:

- What plant parts did you eat in your finger salad?
- How many plant parts could be in one food? For example, pizza has four plant part groups: fruit (tomato, olives), seeds (wheat), stem (garlic, onion) and leaves (oregano and basil).

Resources:
Fresh Fruit and Vegetable Photo Cards; California Department of Education; available to purchase at (search "cards" to jump to this publication): http://www.cde.ca.gov/re/pn/rc/documents/catalog2010.pdf#search=fresh%20fruit%20and%20vegetable%20cards&view=FitH&pagemode=none

Adapted from "Eat Your Plants" Nutrition Activity #3 – TWIGS and Finger Salads – UC Davis Children's Garden Program: http://www.cfaitc.org/conference/2009/pdf/handouts/fingersalads.pdf

Thank a Bee For Every Third Bite of Food!

Levels:
Grade 4
Science
Language Arts
Social Sciences

Materials:

"The Honey Bees Body" Handout

"Work Bees Do" Handout

"Flower Power" Handout

"The Bee Body" Handout

Student Glossary Handout

California Map

"Understanding the Role of the Honeybee" Handout

"What Can We Do to Help Save the Bees" Teacher Resource

Art supplies – paper, markers, glue

Objectives:

- Students will show how flowering plants and vegetables rely on honeybees to pollinate them.
- Students will create a cause/effect graph relating to the dwindling population on honeybees.
- Students will identify regions of California where fertile soil and adequate water are the natural resources which are necessary for farming.
- Students will develop a meal which reflects the importance of pollination in food choices.
- Students will verbally share their meal.

Activities:
Think-Pair-Share Topic: Honey bees: why do we need them?
Assess for prior knowledge about pollinators/pollinating with the focus on flowering plants.

Teacher reads "The Honey Bees Body" and "Work Bees Do" handouts.

In groups, students complete "Flower Power" and "The Bee Body" using the student glossary as a resource for locating and labeling bee characteristics.

Using the map have students recall and locate the main agricultural areas of California. In addition, discuss if this is the only place to grow food. Have students give locations of other places bees are needed.

Use "Understanding the Role of Honeybees" to create cause/effect graph. Teacher uses an overhead copy, while students complete theirs individually. Should students have difficulty identifying reasons for honeybee decline, guide them using the teacher resource "What can we do to help save the bees?".

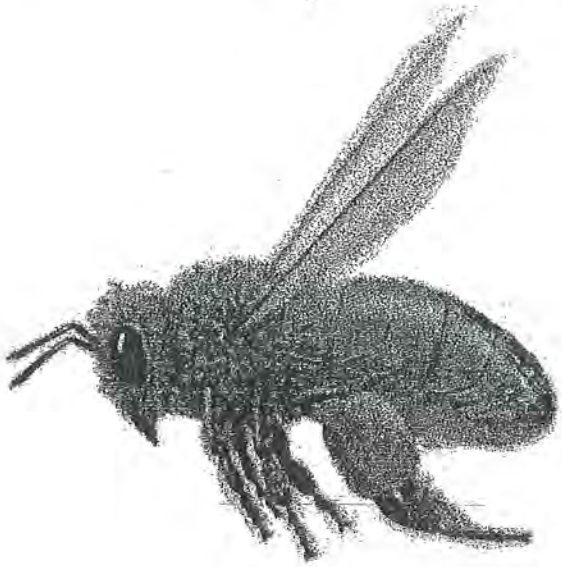
Create a meal. Using the art supplies students plan and make a meal consisting of foods which require pollination. **At least 1/3 of the meal must be foods which are pollinated by bees.** Examples: grains such as wheat and corn do not require bee pollination, but are instead pollinated by wind; dairy products from milk cows are a result of pollination as dairy cows eat alfalfa as a main diet source.

Standards Correlations/Benchmarks:
Science:4LS3.C; Language Arts: R2.6; Social Studies: H-SS 4.14

Assessment:
Students will know prior to beginning the packet that neatness and correct and correct spelling are required. Assessment will include verbal presentation of a meal which follows the guideline in described in "Create a Meal"

Adapted from "Thank a Bee" lesson plan and activity designed by Renee Pecota Teacher's Ag Summer Institute 2011.

The Honey Bees Body



A bee is an insect. Its body has three parts, head, thorax and abdomen.

The bees legs and wings are attached to the thorax.

There are two pairs of wings and six legs.

A bee has compound eyes but they do not see colours the same as we do. They do not see red.

A bee has two antenna which are sensitive to smell and touch.

The sting is found in the abdomen.

Bees have a long slender hairy tongue called a proboscis that acts as a straw so they can sip nectar, honey or water.

Bees have pollen baskets on their hind legs.

To help them with jobs in the hive bees have mandibles for cutting, grasping,or working with wax to construct the comb. They are also used for cleaning the hive, or for defending themselves.

Work Bees Do

Worker Bees.

The vast majority of adult honey bees in any colony are female worker bees. The jobs of the worker bees are:

tending and feeding young bees (larvae),

making honey, making royal jelly and beebread to feed larvae,

producing wax,

cooling the hive by fanning wings,

gathering and storing pollen, nectar and water,

guarding the hive,

building, cleaning and repairing the comb,

and feeding and taking care of the queen and drones.

The Queen Bee.

There is only one queen in a honey bee colony. She is slightly larger than a worker bee, with a longer abdomen. She does not have pollen baskets on her legs. It is her job to lay eggs. She can lay up to 2000 a day!

The Drones.

The drones could be called the couch potatoes of the insect world. While they wait for an opportunity to mate with a queen, they are fed and cared for by workers, and only occasionally fly out of the hive to test their wings. If no opportunity to mate arises by fall, the drones are ejected from the nest by the workers and left to fend for themselves.

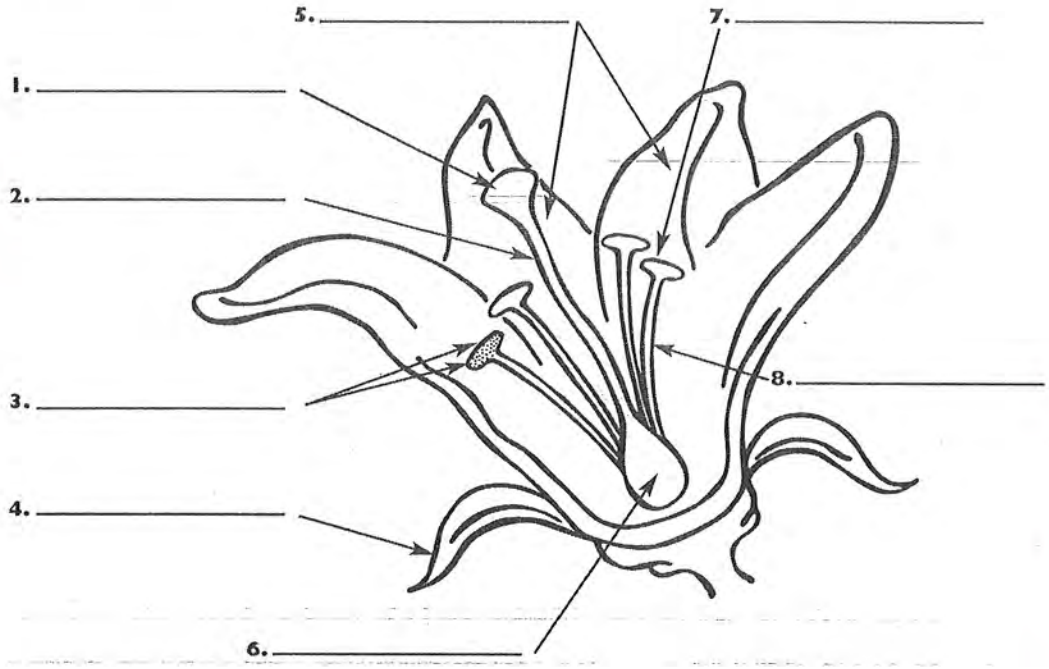
Activity 1

Name _____ Date _____

Flower Power

Flowers are beautiful and often fragrant to us, but for the plant, flowers serve a critical function. Flowers are how plants produce seeds to reproduce. In many cases, the flower contains both male and female parts. In order to reproduce, pollen, the male contribution, must somehow be transferred to the female part of the flower called the stigma.

Using the "Glossary of Flower Parts," label the parts of a flower.



Glossary of Flower Parts

Male Flower Parts (called the "stamen"):

Anther—the bright sac that produces and contains the pollen grains.

Filament—the stalk that supports the anther.

Pollen grains—the powdery particles that contain the male sex cell (gametes); also a nutritious, protein-rich food for bees.

Female Flower Parts (called the "pistil"):

Ovary—the base of the female portion of the flower containing the ovules that become seeds.

Stigma—sticky surface where the pollen lands and germinates.

Style—the narrow region of the pistil between the stigma and the ovary.

Other Flower Parts:

Petals—the colorful, thin structures that surround the sexual parts of the flower and not only attract pollinators but also protect the pistil and stamen.

Sepal—commonly green, leaflike structures that protect the bud prior to opening.

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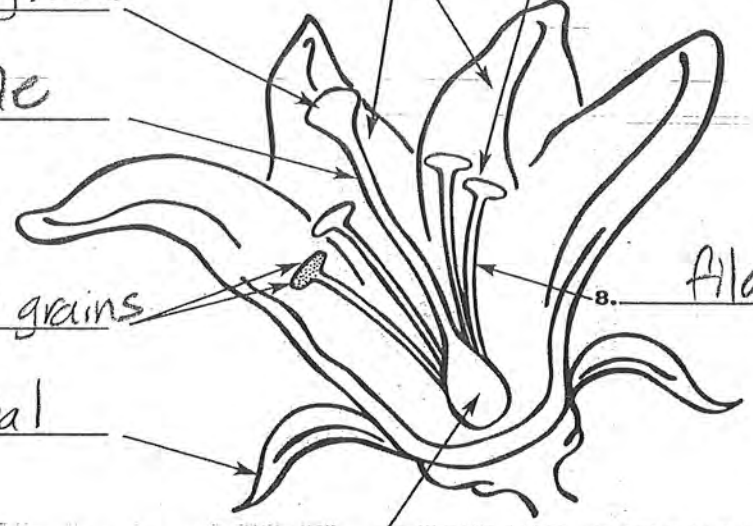

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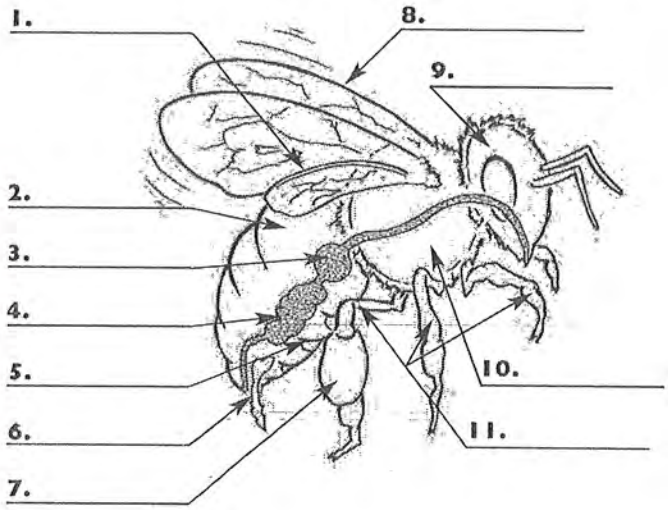
Activity 2

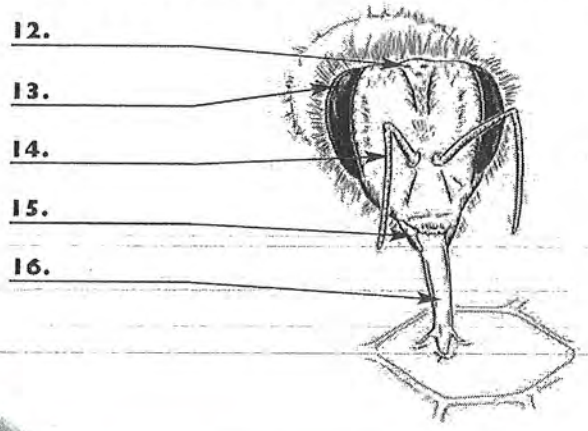
Name _____ Date _____

The Bee Body

Label the bee's body parts using words from the lists to the right.



- Abdomen
- Forewing
- Head
- Hind wing
- Honey sac
- Legs
- Midgut or ventriculus
- Pollen basket
- Stinger
- Thorax
- Wax gland



- Antenna
- Compound eye
- Mandible
- Ocellus
- Proboscis or tongue

Putting Bees on the Map: State Capitals

Capital cities are important places—they're usually where the state government is located, and where important laws and other decisions are made. Do you know the capitals of each state? Use the Get the Buzz on Honey Bees map to answer the questions below.

- Which two states rely on honey bees to pollinate sunflowers? _____
- What are the capitals of these states? _____
- In which two states do honey bees pollinate avocados? _____
- What are the capitals of these states? _____

Now make a list of every state with its capital city. How quickly can you memorize the list?

Student Glossary

Abdomen—the rear body region of a honey bee composed of nine segments and containing many organs including those for digestion, reproduction, and respiration.

Adult—a fully formed, mature honey bee.

Antenna(e)—the moveable, sensitive feelers on an insect's head which detect odor and movement.

Bee dances—a way honey bees communicate to find nectar sources.

Bee metamorphosis—the four stages of transformation in the life of a honey bee.

Beebread—a mixture of nectar and pollen.

Beeswax—substance secreted from glands located on the underside of the worker bee's abdomen.

Brood—the offspring produced by the colony (eggs and larvae).

Brood cells—cells that house developing bees.

Cell—a hexagonal wax chamber built of beeswax for brood rearing and storage of honey and pollen.

Cocoon—the silk chamber a larva spins around itself just prior to the pupal stage of development.

Colony—a group of honey bees living together.

Comb—a structure made up of hexagonal wax cells.

Compound eye—an eye made up of thousands of tiny lenses that allow a honey bee to see ultraviolet light, which is invisible to the human eye, as well as visible light (except red).

Dehydration—the removal of water from a substance.

Diameter—the length of a straight-line segment through the center of a sphere.

Drone—a male honey bee that is produced from an unfertilized egg.

Drone cell—a brood cell that is larger than the normal worker brood cells and in which the queen deposits drone eggs.

Egg—laid by a queen bee, this is the first stage in the life of a honey bee.

Exoskeleton—the hard outer covering which forms a bee's body.

Guard bees—the bees that guard the hive entrance.

Head—the forward body region of the honey bee's three sections that contains the compound eyes, simple eyes, antennae, mandibles, and proboscis.

Hexagon—a polygon having six sides and six angles.

Hive—a home to a colony of bees.

Hive scent—all the worker bees of a colony produce a scent that is characteristic of their colony and is recognized by all the members.

Honey sac—the stomach-like organ that is connected by a funnel shaped valve to the digestive tract. The nectar stored here will be unloaded into empty hive cells or passed on to house bees for food.

Honeycomb—six-sided wax cells in a beehive.

Larva—hatched from the egg the queen bee lays, the larva will pupate and eventually turn into an adult insect.

Legs—a honey bee has three pairs of segmented legs used not only for walking but also to dust off antennae, brush pollen out of the thousands of branched hairs that cover the body, and to store pollen.

Mandible—located on either side of the honey bee's head, these jaw-like structures are used to chew honey and pollen, and to knead wax.

Mate—to join together as male and female to produce young.

Midgut or ventriculus—the stomach section in the abdomen which digests food.

Nectar—a sweet liquid secreted by flowers of various plants.

Ocellus—simple eye with a thick lens that can sense changes in the brightness of daylight.

Pollen—the fine, powder-like material produced by flowering plants.

Pollen basket—an area on the hind legs of honey bees used to transport pollen.

Polygon—a closed figure bound by three or more sides.

Proboscis or tongue—a straw-like structure used for sucking nectar or honey.

Propolis—a resin-like material collected from trees by bees. Used to construct and seal parts in the beehive and protect the hive from the elements.

Pupa—the third stage in a bee's life, during which the larva's body changes to an adult.

Queen—a female bee that lays eggs.

Royal jelly—a milky, yellow syrup that is very high in protein, that young worker bees secrete from glands inside their heads and feed to larvae.

Scent gland—found at the tip of the abdomen of worker bees and produces a scent characteristic of that particular colony.

Stinger—found in a chamber at the end of the abdomen (in female honey bees only) and is used to defend against intruders.

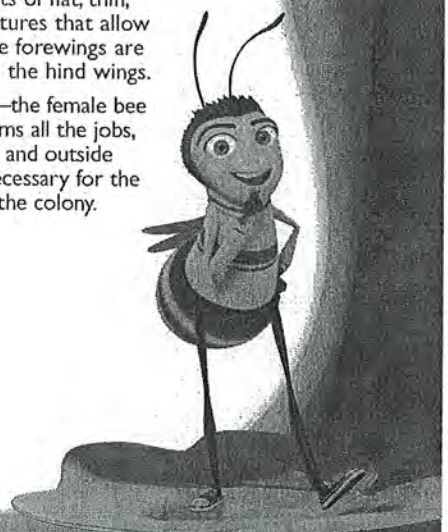
Thorax—the middle section of the honey bee's three sections that contains the flight muscles, the wings, and six legs.

Wax—the substance excreted from the glands located on the underside of a worker bee's abdomen.

Wax gland(s)—four pairs of glands that are specialized parts of the body wall. During the wax-forming period in the life of a worker, they become greatly thickened and take on a glandular structure.

Wing(s)—the honey bee's back has two sets of flat, thin, body structures that allow it to fly. The forewings are larger than the hind wings.

Worker—the female bee that performs all the jobs, both inside and outside the hive, necessary for the survival of the colony.



How to Understand the Role of the Honeybee
by Mrs. Pecota

Flowering vegetables and plants rely on honeybees to pollinate them. Without these pollinators the food supply of the world would dwindle. Colonies of honeybees are mysteriously being reduced in population and this has been happening for many decades. Why is this occuring?

CAUSES	EFFECT
	Honeybee colonies are disappearing.

What can we do to help?

What can we do to Help Save the Bees?

Although scientists have not yet pinpointed a single cause of the decline in bee populations they have agreed on one thing: there are things that can be done to help save the bees we have.

*Take a look at your yard. Does it tempt bees with flowering plants? Could you do more by adding a section of plants that appeal to bees? Could you limit the use of harmful pesticides?

* Leave bees and their hives in peace. Honeybees are not aggressive and will not sting you unless provoked. If you see a swarming hive, tell and adult and have them call the county agriculture department.

* Buy local honey to support farmers who keep bees.

Renewable or Not? Sustainable or Not?

Levels:
Grades 4-6

Materials:
Lesson A:
Bag of objects that could be used to quickly make a structure (e.g. paper tubes, blocks, books, etc.)

T-chart- handout

Resource cards - handout

Clues – handout

Large bowl

Popped popcorn

Slips of paper

Bag to hold slips of paper for drawing

Paper bags – 14 (lunch size)

Objectives:
1. Students will describe what a resource is and will be able to define and classify given resources as renewable or nonrenewable.
2. Students will participate in simulation activities that demonstrate the use of renewable and nonrenewable resources by society to assist in understanding factors that make a renewable resource sustainable.
3. Students will further consider and discuss sustainability by examining current forestry practices in California.

Background:
Resource: a source of supply that can be used as needed.
Resourceful: using what you have to get the job done
Natural resources: raw materials that we use in our physical world to meet our needs and wants (e.g. air, water, land, minerals, trees, animals, plants, etc.)
Renewable resources: resources that can be replenished through natural or human processes. For example, plants and animals can be used and consumed by humans, and can be grown again or replenished.
Nonrenewable resources: resources that exist in finite or limited amount (e.g. fossil fuels-oil, coal, natural gas, copper, gold, etc.)
Sustain: to keep up, prolong or supply necessary support.
Sustainability: in reference to renewable resources, it is using resources now to meet the needs of the present without compromising the ability of the future generations to meet their own needs with these resources.
Sustainable forestry practices: the harvesting and replanting of trees in such a way that there is a balance between society's demands for forest products and benefits, and the preservation of forest health and diversity.
Lesson Sequence and Activities:

Lesson A
Introduction:
1. Spill out a bag of random object on a desk and ask a student to quickly make any kind of structure with the material. Ask what resources were used to construct the creation? Follow up by having students to come up with a working definition for **"resource"** and write it on the board. As an extension, note that the student who built the structure was being **"resourceful".**
2. Next establish that resources are needed to make everything we need and use. These materials are called **natural resources**. Students should then generate a definition for this term, which can also be recorded.

Activity 1 "Charting the Differences"
1. Students will work in groups of three or four for this activity. Explain that resources can be put in two categories: **renewable** and **nonrenewable**. Make a T-chart on the board with these terms and pass out student work sheet with T-chart, resource cards, and clues to each group. Students will categorize each of the resources into one of these groups by placing the cards appropriately on the chart. Each group should begin by passing out the resource cards and clues to group members, then reading the clue cards to their group, and finally, using

the information to classify the resources by placing pictures correctly on the chart. If desired, a class poster of the chart can also be created with student cards.

2. Student teams should use the bits of information given to synthesize a definition for renewable and nonrenewable resources. Everyone on the team should understand each of the clues and agree with their team's definition.

3. As an extension, any group that finishes early may answer the question at the bottom the worksheet:

- Looking around the room and list as many items as you can that are made from renewable natural resources, and then make a separate list of all the items made from nonrenewable natural resources.

4. Groups should share their definitions, and a class definition should be generated or restated from student input.

5. As a wrap up, check for any confusion in categorizing resources from student T-charts and clarify. As time allows choose from the following wrap up questions:

- What advantages and disadvantages might there be for using renewable natural resources in place of nonrenewable ones?
- Are there any resources that would continue to be available no matter how much people use them? (possible answers: tide, wind, sunshine/solar, etc.)

Assessment

Have students write an answer to the first question from the wrap up.

Lesson B:

Introduction:

1. Show poster from previous activity of renewable and nonrenewable resources and ask students to restate the definition of each.

2. Ask students if there could be any way that a renewable natural resource might not be renewable. (Don't prompt students in answering this if they do not know. The activities to follow will demonstrate the answer.)

Activity 2 "Popcorn Generations and the Nonrenewable Resource"

1. Prepare the following:

- A large bowl of popcorn
- 14 slips of paper labeled as follows:
  - two with "1st Generation"
  - four with "2nd Generation"
  - eight with "3rd Generation"
- place the paper slips in a bag for students to draw from
- have 14 small bags for collecting popcorn

2. Have 14 students each draw a slip of paper from the sack and instruct them not to show it to anyone. Give each a lunch bag and explain that they will be part of the demonstration.

3. Bring out the bowl of popcorn and explain that it is going to represent the world's supply of a nonrenewable resource (reference the t-chart or class poster).

4. Ask the two 1st generation students to come up and instruct them to take as much of the popcorn as they want. When the first group has had their fill, invite the four 2nd generation students to go up and take as much of the popcorn as they want. Finally have the 3rd generation students come and take what they want.

5. Discuss with students what is happening to the world's popcorn supply. How much was left for each generation? Ask if any of the participating students thought about those who might be coming after them? How is what happened to the popcorn like what happens in the real world of natural resources?

Activity 3 "Popcorn the Renewable Resource"

1. Now put students in teams of four and give each group a small bowl with 16 piece of popcorn. Explain that this time the popcorn represents the team's supply of a renewable resource (reference the t-chart or class poster).

2. Explain the following "Rules of the Game":
   - Each student can take freely from his or her team's supply of popcorn.
   - At the end of the game each team member will get to eat all of the popcorn he or she has collected.
   - Each team member needs to take at least one piece per round to stay alive, or be **sustained.**
   - Each round will last one minute, and at the end of each round teams will receive half as many more pieces of popcorn as are left in the team's bowl.
   - Assign one scorekeeper on each team to record how many pieces each player takes and how many are left in the team bowl after each round.
3. Play 3 or 4 rounds. Stop after each round for students to record and to distribute popcorn where appropriate. Find out if there are any students who did not survive that round.
4. After the game determine which students had the most popcorn in their personal supply, and which teams had the most in their group supply.
5. Ask if there is a group that thinks they could keep their resource supply going forever the way the game was going.
6. Introduce the term **sustainability**.
   - **Sustain** means to keep up, prolong, or supply necessary support.
   - Ask if students can give examples of something that has been sustained or what it means to **sustain**. (Possible examples to help: to sustain their lead in the standings the team had to win the next three games; the runner was able to sustain her fast pace throughout the race; the sustain pedal on the piano keeps the notes playing on).
   - Ask students what they think **sustainability, or the ability to sustain** a natural resource, might mean.
7. Present the definition of **sustainability** or **sustainable yield**: Using a resource in a way that meets the needs of the present without compromising or limiting future generations having enough to meet their needs.
8. Referencing the popcorn game, discuss what they observed about what were some reasons the renewable resource was used up and what was required to make it last or make it sustainable.

Assessment:
Students should write a brief description of what happened in the second popcorn activity and end with one of the following statements:
- We managed our popcorn resource with sustainability because _____.
- We did not manage our popcorn resource with sustainability because _____.

Standards Correlation/Benchmarks:
Resources 6b Grade 6
Reading 1.2 Grades 4-6
Reading 1.3 Grade 4
Reading 2.3 Grades 4-5
Science 6a Grade 6

Adapted from "Renewable or Not? Sustainable or Not?" lesson plan and activity designed by Rosilynn Sept, Teacher's Ag Summer Institute 2011; and American Forest Foundation, Project Learning Tree: PreK-8 Environmental Education Activity Guide 2009.

Nonrenewable Resources	Renewable Resources

Looking around the room and list as many items as you can that are made from renewable natural resources, and then make a separate list of all the items made from nonrenewable natural resources.

Clue 1.

On Earth, there are only limited amounts of fossil fuels such as oil, coal, and natural gas. There are also only limited amounts of minerals such as iron, copper and phosphates. These resources either cannot be replaces by natural processes or require far too many years to replenish.

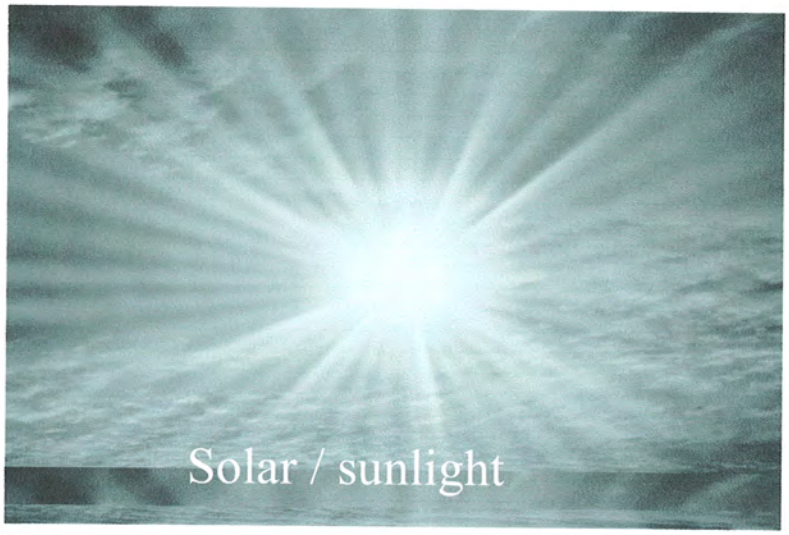
Clue 2.

Renewable natural resources include plants, animals, and water, when they are properly cared for. Minerals and fossil fuels such as coal and oil, are examples of nonrenewable natural resources.

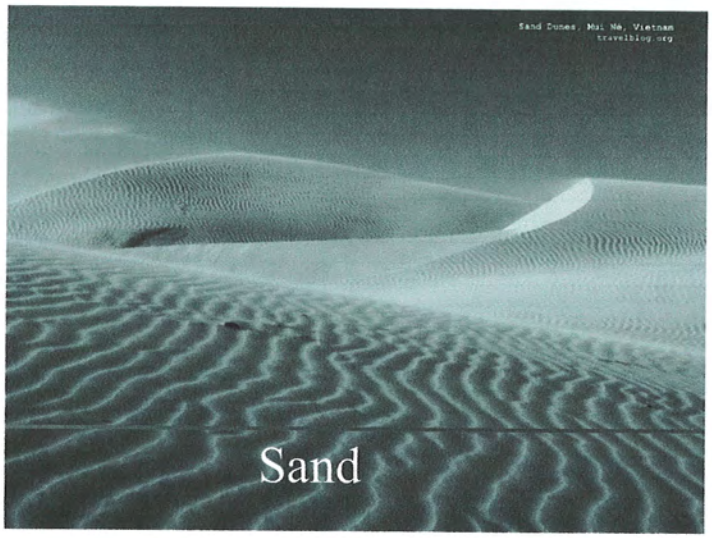
Clue 3.

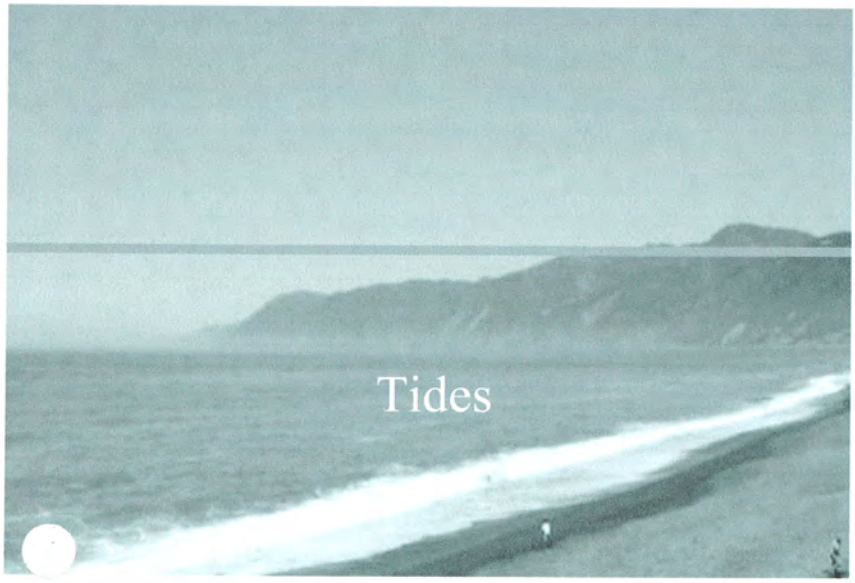
Trees, wildlife, water and many other natural resources are replaced by natural processes. Plants and animals can also be replenished by human activities. Water is continuously cycled and reused. Sunlight, wind, geothermal heat, tides, and flowing water are resources that are constantly being renewed or restored.

OIL


Solar / sunlight

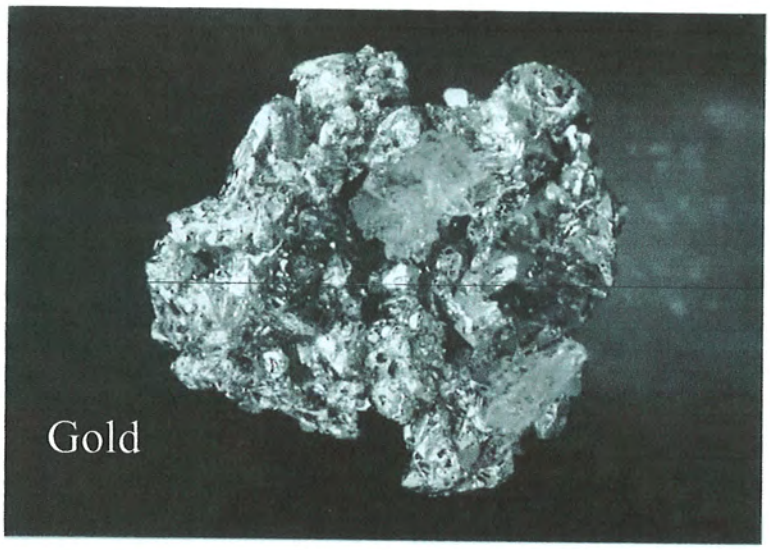
Corn


Sand Dunes, Mui Ne, Vietnam
travelblog.org
Sand


Tides

Wind

Geothermal / hot springs
Coal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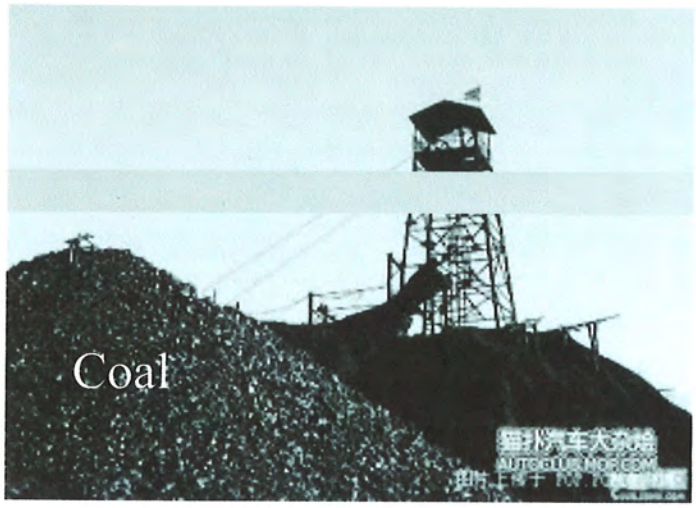
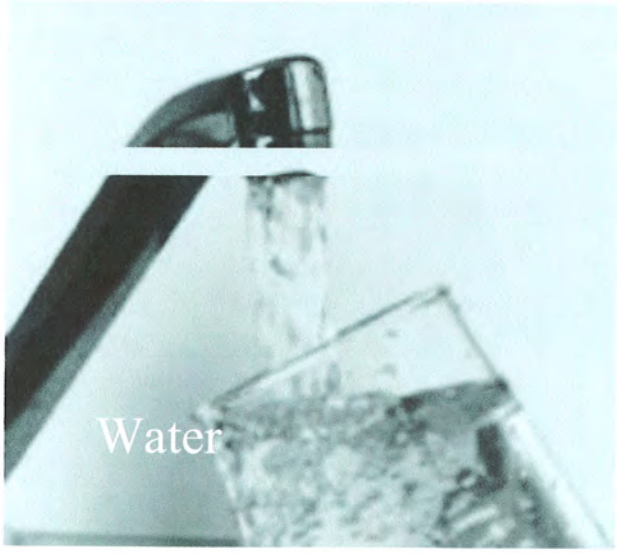

Coal

Forests


Water

LIGHT MEAT CHUNK STYLE
TUNA
IN WATER AND SALT

Diversity on the Farm

Levels:
Grades 4-8

Materials:
Apples - handout

Crayons, markers or colored pencils

Scissors

Hole punch

String or yarn

Background and History:
All living things have a different genetic makeup. These genetic differences can make some kinds of plants or livestock resistant to pests or disease while other kinds may not be. Diversity in genetic makeup allows some plants to survive under harsh environmental conditions, such as drought, poor soils, or frost, while other plants simply do not survive. Diversity in genetic makeup in livestock can make some animals less susceptible to disease or produce more milk than others.

Traditionally, farmers have selected for specific traits by collecting seeds from desirable plants and planting them or breeding livestock to reproduce desirable traits. Over thousands of years this has created highly managed crops and livestock adapted to its particular environment as well as the needs and preferences of farmers, ranchers and consumers.

Additionally, farmers plant a wide range of crops, ensuring that something will survive even if there were a natural disaster, such as insect infestations, during the year. The diversity of crops also provides families and consumers with a varied diet.

Biodiversity comes from the words "bio" meaning life and "diversity" meaning varied. There are three types of biodiversity that farmers and ranchers can consider when planning what crops or livestock to grow:

1. Biodiversity between difference kinds of crops or livestock, e.g. cattle, sheep, goats;
2. Biodiversity within a single kind of crop, e.g. Golden Delicious, Jonathan, Granny Smith apples;
3. Biodiversity within individual plants or animals, e.g. two Douglas fir trees growing side by side, with one tree producing more cones and seeds than the other each year.

Ask the students:
Can you think of examples of biodiversity in our local community?
Possible answers:
- a farmer producing lettuce, green beans and squash;
- a farmer producing tomatoes, cabbage and flowers to sell at a Farmers Market;
- a farmer growing different varieties of pumpkins (jack-o-lantern and pie pumpkins) or melons (cantaloupe, honeydew and watermelon);
- two grape vines growing beside each other, one producing larger bunches of grapes than the other;
- two Red Delicious apple trees growing side by side with one producing 25% more apples than the other.

What could happen on a farm that would make diversity important?
Possible answers:
- a disease could damage all the tomatoes on a farm, but the farmer would still have cabbage and flowers to harvest and sell at the market;
- a late frost in spring damaged all of the Golden Delicious apples but all of the Granny Smith apples were fine since they blossom later in the spring;
- the farmer saves seed from green beans that produced a large crop this year to plant next year to try to increase yield.

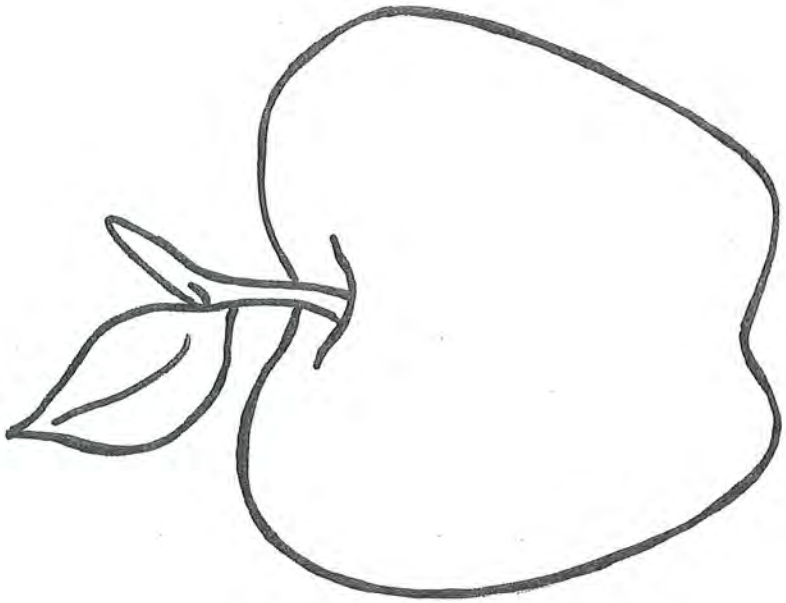
DIVERSITY GAME

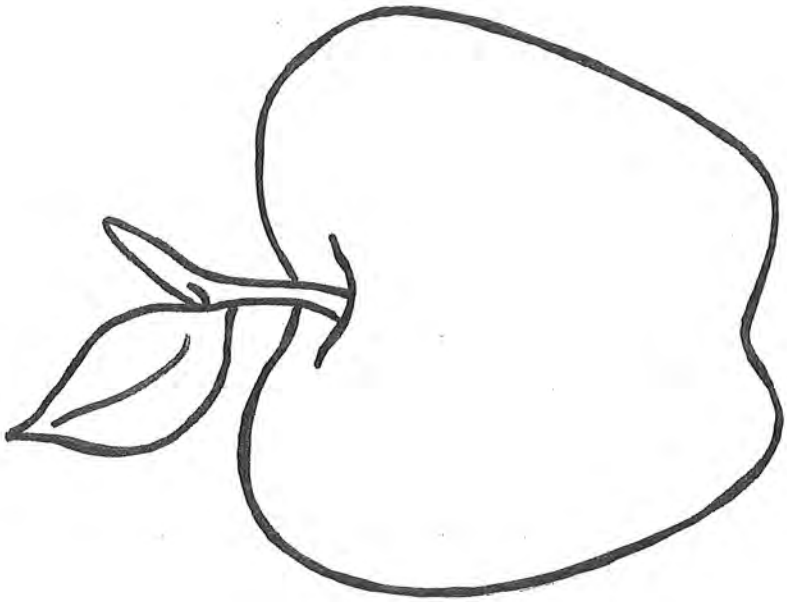
1. Make enough copies of the apple black line master so that each student has one.
2. Do this activity on a playing field or indoor area with space to walk around.
3. Have the students fold the apple handout in half along the dotted line.
4. Next, ask students to color the apple on one side, leaving the apple on other side plain.
5. Have students punch or poke a hole through the cutout at the top and loop a string through the hole. Ask them to tie the string so that the apple pictures can loop around their neck. Have them display the uncolored, plain side of the apple first.
6. Ask the students to close their eyes. Tell them that you will secretly choose one student to act as the apple "plague", a disease that can destroy apples. You will let the "plague" student know by tapping him or her on the shoulder.
7. Make a large circle in the field or indoor space. Have students move around in the circle. As they begin to circulate around the area, have students shake the hands of all of the other students. As the "plague" circulates, he or she will secretly tickle the palm of the other students using an index finger, indicating that the tickled student is out of the game.
8. At first the plague will have a large impact because the apples are all the same variety. After the class has played the game for a few minutes, stop and take a count of the number of students, or apples, that were attacked by the plague.
9. Start the game again, but this time have students flip apple pictures over to show the side they colored. Tell students that you will select one of them to be the plague again, but this time the plague is restricted to one color of apple. Secretly whisper the color to the student you select to play the plague. This time the plague can give the secret tickle signal only to students with that color of apple. Stop the game after a few minutes and count how many apples were attacked this time compared to last time.

Discussion:

- Was there a difference in the size of the two groups attacked by the plague?
- Why do you think there was a difference?
- Why would biodiversity be important to a farmer or rancher?

Adapted from "Maize" – Life Lab Science Program





Specialty Crops Block Grant

Report

Fields of Learning

A Model School/Farm Partnership Program

Submitted to:

California Department of Food and Agriculture
1220 N Street, Sacramento, CA 95814

by

El Dorado County Ag in the Classroom
2460 Headington Road, Placerville, CA 95667

October 31, 2010

FIELDS OF LEARNING

A Model for School/Farm Partnerships

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Appendix

FOREWARD

Joyce Joy, President
El Dorado County Ag in the Classroom

El Dorado County residents are very fortunate to have many diverse agricultural operations such as farms, orchards, timber lands, cattle ranches, and olive groves, to name a few. The benefits from these operations are priceless - they fuel our economy, feed our families, and preserve our beautiful rural landscapes. And it's this lifestyle, being connected to the land, that brings people to our county.

It is not only important that our children understand the role agriculture has in our everyday lives - the food we eat, the clothes we wear, and the homes we live in - but it's imperative that our children *want* to sustain and be connected to the land. Because they will be the stewards of our land in the future, we need them to be knowledgeable and passionate advocates for agriculture to ensure sustainability.

Fields of Learning is a model program developed by EDCAITC that creates partnerships between schools and agriculture producers. Students have the opportunity for hands-on learning in the "real world" setting of a farm or ranch – smelling the fruit, walking the fields, pruning the branches, turning apples to cider. At each visit, it amazes both grower and teachers how this process of witnessing and participating first hand brings out such a sense of discovery, wonder, and excitement in the students.

EDCAITC created this template to assist schools and agricultural producers to initiate their own Fields of Learning programs. This is the beginning of nurturing our future stewards' minds- starting them on a path to better understand and be passionate about the sources of our food, the role of agriculture in our community, and their connection to nature and the earth's bounty.

The Fields of Learning Pilot Project was made possible through a Specialty Crop Block Grant awarded to EDCAITC by the California Department of Food and Agriculture (CDFA). CDFA receives funding for this grant program from the U.S. Department of Agriculture. We appreciate CDFA's support for our efforts to expand education and outreach programs in the El Dorado County Region and increase educational opportunities for teachers, students, and the public.

Joyce

AG IN THE CLASSROOM OVERVIEW

El Dorado County Ag in the Classroom (EDCAITC) is a local, grassroots, charitable nonprofit organization that provides high quality agriculture-related educational resources, programs, and training to increase awareness and understanding of the importance of agriculture.

Agriculture is an essential part of our daily existence - from the food we eat, the clothes we wear, to the homes we live in. With less than 2% of Californians involved in agriculture, it is critical that our children learn where their food, fiber, and shelter come from. Ag in the Classroom provides resources and opportunities for children to gain an appreciation and understanding of agriculture's role in their lives. As students learn about soil, cultivation, food cycles, animals, nutrition, natural resources, and stewardship of the land, they begin to understand our connection to nature and its considerable bounty.

El Dorado County Ag in the Classroom offers educators, students, and the public a variety of educational opportunities through several programs: Farm Day, the Teacher's Agricultural Summer Institute (TASI) scheduled for June 2011 and Fields of Learning (FOL).

Since 2002, EDCAITC has hosted over 6,000 third grade students at its annual Farm Day at the El Dorado County Fairgrounds. Each May, over 40 volunteer presenters bring agriculture alive to hundreds of students through creative, interactive demonstrations and activities. Children learn about local produce, soil, worm composting, organic pest management, irrigation, bees, herbs, habitats, and resources that healthy forests provide. They participate in presentations on fiber from alpaca, llama, and sheep; working animals like horses and goats; and food animals like poultry and beef cattle. Students also learn about being good stewards of the land.

The Teacher's Agricultural Summer Institute brings together teachers with farmers, ranchers and other agricultural and natural resource specialists to gain a deeper understanding of the food and agricultural systems that sustain the health of people, society, and the natural environment. The three-day Ag Institute will combine classroom-style instruction, learning stations, hands-on in the field experiences to immerse participants in the vital world of agriculture. In turn, teachers will be able to share what they have learned about agricultural and natural resource management with their students.

Based on the Fields of Learning pilot project and creation of this template, EDCAITC looks forward to the development of new FOL school/farm partnerships in our region. Each future FOL partnership provides an opportunity to gain insight and knowledge that will help continuously refine and enhance the Fields of Learning model.

Additional information about agricultural-education resources, current events, and EDCAITC's programs are available on its new website: www.agintheclass-edc.org.

FIELDS OF LEARNING PROGRAM

Fields of Learning (FOL) is a cooperative project between agricultural producers and local schools. By matching classrooms and local ag producers, FOL establishes a vital link between education and agriculture in a way that allows students to apply classroom concepts through experiential learning while gaining an appreciation for agriculture's place in their community. FOL also enhances the relationships between educators, parents, students and the community, thereby strengthening the community as a whole.

While school field trips to farms are not uncommon, FOL provides a unique, comprehensive approach to its program. Fields of Learning incorporates both in-class learning activities and applied learning activities during seasonal field trips , while cultivating an ongoing relationship between school, agriculture and communities over the course of the school year.

Fields of Learning activities and educational resources are designed to be easily integrated agricultural-based instruction into teacher lesson plans while ensuring that they meet California state curriculum standards. Key elements of the program include:

- **Field trips**: multiple visits to partner farms or ranches highlight seasonal growing cycles.
- **In-class activities**: monthly agricultural educational activities complement field trip topics.
- **Standards:** learning activities and educational resources meet California state curriculum standards in multiple subject areas: science, math, language arts, visual arts, and history/social science.
- **Health & Nutrition**: studies show that as students learn about growing food and taste the foods they grow, they are more apt to appreciate healthy eating.
- **Duration:** program activities take place throughout the school year.
- **Assessment:** participate in pre- and post-testing to assess program effectiveness.

Key educational concepts students learn about include:

- The local food production cycle.
- The nutritional aspects of food produced locally.
- How agriculture contributes to their community.
- Using skills from the classroom in real world problem solving situations.
- Recognizing and identifying the necessity and influences of the four seasons in food production.

The Fields of Learning program is designed to be readily customized to meet the priorities, the environment, and resources of individual schools and agricultural partners. Each school's FOL team develops their individualized program plan, including setting goals, identifying standards-based learning activities for the classroom and field trips, and determining measures of success.

"Students are excited to travel away from school. Many are surprised to see what grows on a farm. They find out what animals can be found there. Children are led through the process of how apples, gourds, blueberries, pumpkins and peaches get from a farm to their table."

-Mrs. French, 1st grade teacher, Camino School

GETTING STARTED - PUTTING YOUR TEAM TOGETHER

Initiating a Fields of Learning program begins at the school level. Gaining the support of the school administration is essential, as is the commitment of teacher(s) to the program. A school garden program can be a natural springboard for an FOL program but school gardens are not essential to a successful program. When planning your first FOL program, it may be advantageous to focus on one grade level. The FOL model is designed around a partnership of one agricultural producer with one grade level at a school during a school year. This arrangement hopefully ensures that the time and resources committed by the ag partner are not overly burdensome and therefore, increases the likelihood of establishing an ongoing partnership. If an agricultural producer is willing to partner with more than one grade level, they must understand that it will increase the number of visits to their operation as well the time commitment on their part to the program.

It takes a core group of individuals to plan and carry out the program. The Fields of Learning team at a school is comprised of:

- School-based coordinator (school garden coordinator, parent, or community member).
- Agricultural producer, i.e. farmer, rancher etc.
- Teachers of classes participating in FOL
- Volunteers

Team member roles and responsibilities include:

FOL Coordinator

- Builds relationship with agricultural partner.
- Serves as link between school and ag partner.
- Works with FOL team to plan school year activities and schedule.
- Conducts and/or schedules in-class activities.
- Coordinates field visits to ag locations/may lead portions of field trip activities.
- Maintains program information, including program team contact info, activity sheets, copies of pre-and post evaluation materials.
- Keeps team informed of program schedule and meetings.

Agricultural Partner:

- Commits to a minimum of one school year
- Allows access to their ag operation for on-site visits from school classes
- Prepares for visits from schools and participate in field trips.
- Establishes ground rules for school "guests" on their property.
- Meets with coordinator, teachers, team members to plan field trip activities and tour routes.
- Considers visiting classrooms and speaking to classes prior to field trips.
- Prepared to commit time and resources to the project. The ag partner often donates not only time to the project but also product (such as fruit, juice, and baked goods) to be used for both classroom and field trip activities.

Teachers:

- Commit to a minimum of one school year.
- Determine agriculture-based lessons and activities to be used based on curriculum and academic content standards.
- Meet with the FOL team to plan field trip structure and activities.
- Coordinates transportation, parent participation, and lunch (if needed) for field trips.
- Brings necessary classroom materials on field trips.
- Handle student behavior during field trips.

Finding Agricultural Partners

While not always possible, there are advantages to seeking out agricultural enterprises in the vicinity of your school. When schools seek out local partners, they build a sense of community amongst students, parent and administrators. By connecting with a local farm or ranch through FOL, the agricultural enterprise becomes part of the day to day fabric of the life of the school and students. Transportation for field trips is simplified for teachers, students, and volunteers. Close proximity also increases the opportunity for the agricultural partner to visit the school.

More important than location is the agricultural partner's commitment to the FOL program with your school. The only limitation on the location of a willing ag partner is that travel time to and from the ag producer for field trips fits within the school day schedule. Schools may also seek agriculture partners according to their specific type of agricultural operations, i.e. farms that grow different crops, ranches, olive orchards etc. FOL programs with some ag operations may be of great educational benefit to higher grades than younger grades and vice versa.

Recommendations for agricultural producers interested in acting as partners can be found through these entities in your community:

- Talk with PTA/PTO members, teachers, and parents at your school.
- Contact your local Ag in the Classroom program.
- Contact your local Agricultural Commissioner.
- Contact your local Farm Bureau.
- Contact the FFA program in your area.
- Contact your local Cooperative Extension office. They specialize in educational programs and offer many resources, including 4-H, Master Gardeners, and Master Food Preservers.

Finding a Coordinator and Volunteers

The Fields of Learning Coordinator is the point person for all of your FOL-related activities during the year. The coordinator works cooperatively with teachers and volunteers to ensure that program activities run smoothly. It is recommended that the coordinator is knowledgeable about agriculture or gardening. School garden coordinators at schools that have gardens, can be a natural fit as the FOL coordinator. If the garden coordinator is unable to take on FOL duties, they may know of possible candidates for the FOL position.

Volunteers provide important support for the Fields of Learning program by helping with field trip on-site activities, assisting in the classroom, and being an ambassador for the program in the school and community. Volunteers (many will be parents) also play a key role in raising funds for FOL activities.

Recommendations for finding a coordinator and volunteers:

- Seek involvement of the school's Parent Teacher Organization (PTO).
- Ask teachers and school staff referrals.
- Talk with local FFA teachers. FFA students or former students may be interested in participating.
- Tap into high schools, community colleges and universities. Many schools have service learning/community service requirements for students and intern programs. They may be looking for opportunities for their students.
- Contact school garden coordinators, garden clubs, agricultural organizations, and the local Ag in the Classroom for potential candidates for the FOL coordinator position.

SCHOOL-BASED ACTIVITIES

Classroom Sessions

School-based activities are designed to introduce students to concepts they will encounter and use on their field trips. Introducing vocabulary words and linking concepts from science and social studies gives students a starting point on which to build and learn.

"Pre-teaching" is a way to get students thinking about where they are going and what they might encounter. Students can be asked to predict what they might see, hear, taste and do on the field trip. These predictions and expectations are great prompts for journal entries and optimize learning opportunities.

Classroom learning activities may include:

- Pre- or post-testing
- Creating a "KWL" chart (What do you Know? What do you Want to know? What did you Learn?) around a specific crop or field trip related topic (apples, pumpkins etc).
- Linking vocabulary from classroom to the field trip learning activities
- Using the food cycle diagram to identify current activities on the farm. A chart of the seasons can be used concurrently to make the link between seasons and food production.
- Students making journal entries to predict what they may see at the farm.

Classroom discussions can also lay the foundation for expectations with respect to student behavior and safety rules while on site.

- Emphasize: this is a working ag production site, and someone's home and business
- Present safety rules
- Review appropriate clothing/shoes for field trip
- Present overview of field trip. Field questions from students, as this can generate activities for the day and give students an idea/concept to work on while on the field trip.
- Give any special instructions for clothes and shoes. During the winter instruct students to wear an appropriate weight coat and shoes that will keep their feet warm and dry.

Reviewing in class what occurred on the field trip is useful for assessing what students learned and reinforcing key concepts and lessons. This gives you an idea if you met your students' expectations. Students can read their "before" journal entries and then read the journal entries made on the fields trip and compare the two.

Students will comment on their favorite activities, places visited, etc. This information is useful in helping the FOL team assess effectiveness of the field trip activities from the students' perspective.

Sample KWL Chart

Classroom activity before and after field trip*

What we **K**now	What we **W**ant to Know	What we **L**earned
Apples are red, yellow & green	Why is the skin different colors?	
The skin has vitamins	Why do apple have seeds?	
They have seeds	Why do apples have stems?	
Water makes them grow	How do apples grow?	
The seeds are in a star shape	How do the four seasons affect apples?	
The skin protects the apple	How do the seeds get inside?	
Apples grow on trees	Why do apple trees keep growing?	
The seeds are hard	Why do apples turn brown when sliced?	

*Sample chart from first grade class

FIELD TRIPS TO AG PARTNER'S FARM OR RANCH

Fields trips to the classroom's agricultural partner is an essential part of the Fields of Learning program. These on-site visits to a farm or ranch provide students with a wide range of experiential learning opportunities. The multiple visits to the ag producer's site over the course of the school year are scheduled to coincide with the seasons.

FOL field trips are designed to be instructional and include engaging students in field trip activities and demonstrations. They are considered hands-on instructional time, identical to instruction inside the classroom. Placed-based learning provides opportunity to tailor lessons to the specific agricultural operation, allowing the FOL team flexibility to maximize the effectiveness of the field trip with age appropriate activities.

Planning Field Trips

The FOL coordinator, teacher(s), and ag partner share in planning the activities on field trips. Basic components of the field trip include *a walking instructional tour, learning activities, and demonstrations.* Examples of field trip activities can be found in the Camino School/Rainbow Orchard pilot project section.

Walking Instructional Tour

- Prior to the field trip, have the coordinator and ag partner do a walkthrough of the tour, identifying stopping points for instruction and ensuring the tour meets time scheduled.
- Make sure terrain is accessible and will accommodate the group size.
- Make sure route makes efficient use of time.
- Follow same basic route each visit so students can see changes over time and seasons. Assess whether areas visited on the tour are accessible every season. If not, adjust plan in advance.
- Teacher(s), coordinator, and ag partner review information to be presented to students to ensure accuracy and alignment with classroom curriculum.

When planning field trips, make contingency plans for weather. Is there a barn or warehouse that can be used on a rainy day? Can you schedule an alternative "rain or snow" date?

Choose parent chaperones who will engage all of the students in their care with the activities at hand. It is worthwhile to let parent chaperones know that FOL field trips provide an "outdoor" classroom for students and that the day's activities are part of the students' school work.

"THROUGH FIELDS OF LEARNING, LOCAL STUDENTS HAVE THE OPPORTUNITY TO LEARN HANDS-ON THE LIFE CYCLE OF FRUIT AND VEGETABLE PRODUCTION IN THEIR OWN BACK YARD. BY DEVELOPING A CONNECTION WITH THE FARMER, THEY LEARN THE VALUE OF STEWARDSHIP OF THE LAND WHICH HAS THE POTENTIAL TO IMPACT THE FUTURE SEASONS OF THEIR LIVES."

CHRISTA CAMPBELL, RAINBOW ORCHARDS

Learning Activities

While visiting a farm or ranch, students participate in pre-planned learning activities that enhance and reinforce what they are learning about agriculture. The resources and physical layout of the farm will have direct bearing on the specific activities selected. If there is a suitable place for tables, a wide variety of hands-on activities can be planned.

Volunteers (usually parents) assist in leading learning activities. Instructions for each learning station are provided to the volunteers ahead of time like the following examples from the Camino School/Rainbow Orchards FOL program:

Peeling & Cutting Apples (Science, movement) 3 parents

Have students wash their hands with foam sanitizer. Line them up in front of the two peelers. Have each child peel an apple. They can keep the peels and eat them while they cut up their apple. Send them over to the table and put their apple on a plate. Use the plastic knife to cut apples into chunks and put into big plastic baggie. We will use the apples tomorrow to make apple sauce.

Apple Snap & Dancing (movement) 2 parents

Explain to students that their objective is to bite into their apple without the use of hands. Have students line up. Parents hold each end of the bamboo stick. Have students put their hands behind their backs. Say on your mark, go and have students begin. After 5 to 7 minutes, have students form a circle. Start CD and hold the same bamboo stick for the first limbo song. Students know movements for the chicken dance and Hokey Pokey.

The Little Red House (Language Arts, art) 2 parents

Pass out a red book along with a round tag circle. Have students use crayons to follow along page by page. When books are complete, please read students a story. You may choose to sing Round the Apple Tree.

Dissecting Apples & Labeling Apple Parts (Math and Science) teacher & parent

Students first follow along to complete the labeling of an apple. Next pair children and give each pair an apple that is cut in half. Pass out the recording sheet. Ask each pair to pull all the seeds out of the core. They may need to eat the apple to get to them. They record their findings on their half of the apple.

Demonstrations

Students' learning can be enhanced by on-site demonstrations of machinery, irrigation, pruning, planting, picking, crating etc. These demonstrations offer students practical lessons in the day to day operations of an agriculture producer. An example of a demonstration that includes student participation is showing how a picking bag works, how to pick fruit without damaging the tree and fruit, and how to empty the bag. A few students wear a picking bag and other students pick a fruit and place it in the bag. A winter demonstration can show students how a tree is pruned.

WHAT STUDENTS MAY SEE ON A FIELD TRIP TO AN APPLE ORCHARD:

	Fall	Winter	Spring	Late Summer
CLIMATE	Fall is when people come to the orchard for fruit, cider and baked goods.	Winter is when the trees are preparing to make fruit. Pruning takes place when the trees are resting.	Spring is when the trees flower and bees pollinate the flowers. Spring weather can be unpredictable. Seeds are planted for pumpkins, squash or other vegetables.	Summer is when apples, berries, pumpkins, squash and other fruit grow. Watering and weeding everything is the biggest chore.
HABITAT	Wildlife can be found in the orchard.	The orchard is a winter home to wildlife.	Wildlife visits the orchard during spring. Lots of bees are here.	Wildlife can help reduce some pests, and they can find water here.
TREES	Trees have leaves and ripe fruit.	Trees are bare - no leaves or fruit.	Trees flower and leaves start growing.	Leaves are full size. Fruit grows all summer.
FRUIT	Apples are ripe and harvested. Some sold fresh, some made into cider, some pies, donuts, apple sauce etc.	Apples are all harvested and refrigerated in the cold storage.	Tiny fruit can be seen on trees after pollination.	Fruit grows larger over the summer. Farmers check for ripeness in late summer.
WORKERS	Lots of people working-harvesting, making cider, baking pies, donuts, etc.	Workers prune the trees, rake and compost the prunings.	Workers thin the crop and help with weed and pest control.	Workers help with irrigation, weed, and pest control.
MARKET	Cold storage full of fruit boxes.	Apples are stored and sorted for use in the cider press and sale at farmers markets.	Small amount of apples left for cider and sale at farmers markets.	Apples gone. Berries starting to ripen.
BARN	Barn is busy - lots of people buying fruit, cider, donuts, pies, pumpkins, etc.	Barn is used to store picnic tables and other equipment.	Barn still used for storage.	Barn opened to sell berries, peaches and early apples. Workers prepare baked goods and make jams/jellies.

Follow-up discussions after field trips

Within a week or so of the field trip, seek the input from teachers and the ag producer regarding various aspects of the day. Some questions to ask are:

- Was the timetable workable? Were activities too long/too short?
- Were there enough chaperones/volunteers?
- Did learning activities go as planned?
- Was learning content effective? Was it grade level appropriate?
- Should some content be modified?
- Did each segment of the field trip run smoothly? What improvements can be made?
- Was the ag producer satisfied with the day's events?

Evaluating each field trip will help the FOL team identify what can be changed, enhanced, or eliminated in their continuous process to fine-tune and improve the program.

LINKING FIELD OF LEARNING WITH SCHOOL CURRICULUM

Agricultural-based education is directly applicable to a wide variety of lessons including science, history-social science, mathematics, English/language arts, health/nutrition, and visual arts. Through Fields of Learning, students have access to hands-on, experiential learning opportunities that can make topics such as science come alive and inspire curiosity, problem solving, and reasoning skills.

Subject areas in classroom lesson plans can be easily integrated into agricultural topics:

Science:

> life cycle of plants, what plants need to grow, what is the role of the sun, how plants reproduce, how soils differ, the role of soil in plant growth, soil erosion, how seasons affect plants and livestock, composting.

Mathematics:

> Math can become more relevant to students when concepts are applied to a real-life farm setting. Measurement, weight, volume, comparisons, fractions, and calculations can be readily used in context of farm based products and operations.

History-Social Science:

> Agriculture is an integral part of the history of our country and our world. Where we get our food, the cultural connections to what we eat, and food supply have significantly influenced our past and our present. The role of local agriculture and its place in the community can be explored - when was their ag partner's operation begun? What crops were first cultivated in our county and why? The Thanksgiving holiday also provides an opportunity to connect the role of food and history. Local pumpkins, squash, or apples can be used in classroom Thanksgiving activities. Other cultural experiences surrounding food can be explored, i.e. Native American agriculture and food preparation practices.

English-Language Arts:

> Reading and writing are classroom basics that easily relate to agricultural themes. FOL students keep journals, writing entries for each field trip. Other activities can include thank you letters to their FOL farmer, writing a farm-related story or poem, and studying new vocabulary words related to agriculture and their field trip experiences.

Visual and Performing Arts:

> Field trips and classroom activities can inspire students to create works of art, dance, and drama. FOL students often create paintings about their field trip experiences. They also make stamps from fruit and plant parts. Other ideas include painting a mural about farms or ranches in their community, or putting together a collage using seeds, leaves and other plant related material. Students can write and perform a farm inspired play, public service announcement, or poem.

Health and Nutrition:

> FOL provides a hands-on opportunity to acquaint students with healthful agricultural products and can even motivate students to try a fruit or vegetable that they have never eaten. Some learning activities include comparing nutritional values of specific crops, conducting "blindfolded" taste tests of vegetables or fruits, keeping student journals highlighting agricultural products eaten and describing any new produce tried, invite chefs/cooking programs to do cooking demonstrations for students/parents, prepare a class or school recipe book that features family or favorite recipes that use locally grown products.

There are many resources for agriculture-based education that is consistent with California school standards. A great source for classroom materials, resources, and ideas can be found at the California Foundation for Ag in the Classroom website at www.cfaitc.org. Many of their resources are available at no cost, including their 2009/10 Teacher Guide in paperback or CD. Another source for resources for educators is El Dorado County Ag in the Classroom's (EDCAITC) website at www.agintheclass-edc.org. EDCAITC's website lists helpful links on the Teacher's Resource page.

PILOT PROJECT: CAMINO SCHOOL/RAINBOW ORCHARDS

The pilot project for Fields of Learning (FOL) was conducted in the 2009-2010 school year by Camino Union Elementary School and Rainbow Orchards in Camino, California. Focusing on two first grade classes, the project encompassed the seasons of fall, winter, spring, and summer. The summer segment was held when the students returned to school as second graders in August 2010.

The project followed a basic format: at least one classroom session reserved to "pre-teach" concepts, vocabulary, and other related topics prior to each field trip, followed by the actual field trip and a follow-up classroom session. Pre-testing took place before the initial field trip for first graders in fall 2009. Post-testing took place before the field trip scheduled for fall 2010, when students were second graders.

Overall, the teachers and agricultural partner considered the pilot to be a very successful. Students were enthusiastic participants and showed an increase in understanding of the learning concepts presented. One striking lesson learned by the FOL team was the importance of being flexible in terms of schedule, learning activities, and subject content. Agriculture in the "real" world is affected by a variety of environmental factors, especially weather. The FOL pilot project team adjusted topics and activities in response to current conditions, especially weather and its affect on the farm. It presented a meaningful opportunity to introduce students to how uncertain and complex growing food can be.

"By participating in Fields of Learning, the producer becomes actively engaged in the education of local youth. This community service gives the farmer the opportunity to pass on to the younger generation the value of stewardship of the land and the importance of local food production."

Christa Campbell, Rainbow Orchards

Fall 2009

The fall field trip was longer in duration than winter and spring field trips because early fall is a very active time at the farm. This time of year offers many valuable opportunities to introduce basic concepts and engage students in learning activities and demonstrations. Since it is the students' first visit to the farm, more time was spent on basic orientation to the farm operation

Classroom session before field trip

- Pre-test administered
- KWL chart (What do you Know? What do you Want to know? What did you Learn?) was introduced with the central topic of apples. This is a direct link to classroom lessons students are working on over the course of 2-3 weeks.
- Students make journal entries to predict what they might see at the orchard.

First field trip - late September

As part of the project plan developed by the first grade teachers, FOL coordinator and ag producer, the following fall field trip schedule was set:

10:00 - 10:45 am	Group 1 Tour with FOL Coordinator/Ag Producer Group 2 Johnny Appleseed Activities stations (see appendix)
10:45 - 11:30 am	Group 2 Tour with FOL Coordinator/Ag Producer Group 1 Johnny Appleseed Activities stations
11:30 - 12:30	Lunch and Games
1:00 - 1:20 pm	Group 1 Story, Journaling Group 2 Tree Drawing/Labeling
1:20 - 1:45 pm	Group 1 Tree Drawing/Labeling Group 2 Story, Journaling
1:45 pm	Snack of apple cider donuts for students, teachers, and volunteers
2:15 pm	Depart for school

Walking Tour:

The route selected passed through the barn, on to the apple orchard where students selected a tree to "adopt", past the compost heap, between rows of apple trees and blueberry bushes, back to the barn for a trip through the cold storage and kitchen. The FOL coordinator and ag producer shared the narrating duties on the walk.

Information presented on the tour:

Barn: Apples come to the barn in huge bins. The barn is where cider is pressed. A brief explanation of cider-making (apples crushed and juice squeezed out, put into jugs and refrigerated, leftovers are called pulp). If cider-making is underway, students observe. Point out that Johnny Appleseed got his seeds from cider mills.

Apple orchard: Students select a tree to "adopt", tour leaders make sure the tree is easy to distinguish from other trees with branches low enough to pick some fruit without using a ladder. Students pick out "landmarks" so they can remember where their tree is located. Discuss the topic of orchards

as habitats for wildlife, since we see lots of goose droppings and tracks as well as deer tracks, jack rabbit footprints and assorted bird tracks.

Apple bin: Usually there is an apple bin in the orchard. Ask students to estimate how many apples fit in the bin and how much it would weigh when full. (Answers: about 2,000 apples weighing 1,000 pounds). Talk about how a huge box full of apples gets to the barn. Demonstrate picking technique with a picking bag, if available. Explain that they will be able to pick apples from their adopted tree next fall, when they are second graders, because that's how long it takes to grow an apple.

Fruit Trees: Stop at a tree and explain what each part of the tree is for and how it helps the tree live and grow. Key points: Leaves make food for the tree using sunshine, air, water and chlorophyll, the chemical in leaves that gives them their green color. The trunk and branches hold the tree upright and carry water and nutrients to all parts of the tree. The roots bring water and nutrients into the tree from the soil and hold the tree in the ground. The fruit makes seeds for new trees. The fruit tastes good and is good for you.

Compost heap: At the compost heap, students learn that the pulp from cider pressing is recycled into fertilizer. Allow students to touch the pulp, if this is workable. Touching is optional, but encouraged. Show students that all kinds of things go in compost-such as pulp, rotten fruit, prunings, etc.

Apples/blueberries: Walk between the apple trees and blueberry bushes. Discuss that farmers often grow more than one kind of crop, so they have something ready to harvest for as much of the year as possible. Point out the bird tape and discuss that pests need to be controlled so there are enough crops to bring to market.

Cold storage/kitchen: Before entering the cold storage, explain that apples can be kept for long periods of time at cold temperatures. Enter cold storage. Explain that the cold storage is colder than their refrigerator at home to keep apples fresher longer. Students were asked what the current calendar month is (September) and they recite the months of the year in order starting with September all the way to May. They are told that this is how long apples can be kept in cold storage and that apples kept this long are generally used for cider only. Counted the apple bins. In the kitchen, looked at the food products being prepared and explained how donuts are made.

Learning Activities

Learning activity "stations" are set up at picnic tables." Volunteers, usually parents, lead activities at each station. Specific details of learning activities are listed in the appendix.

Lunch is eaten outside at picnic tables. Games are used in place of recess time. Games like "Duck, Duck, Goose", the "Chicken Dance" and "The Hokey Pokey" are played. Children are not allowed unstructured free time - to keep them from wandering into an area that may be unsafe.

After lunch, students begin a journaling activity. While one group journals, the other listens to a story read by the teacher. The information from the walk through the orchard is put to use by making a "scientific" illustration of an apple tree. Students draw a tree, based on a drawing made by

the FOL coordinator. They then are taken through the process of labeling parts of the tree. Students are asked what each part is and what function it performs for the tree. After the illustration is complete they are asked to write a sentence to describe their tree.

When journaling and stories are completed, students return to the picnic tables for a final snack of apple donuts and fresh cider. After cleaned up, the bus arrives to return students to school.

Estimated time allowed for field trip: 3 ½ hours.

Classroom follow-up

Discussed the field trip by returning to the KWL chart. Students were asked if they were able to answer their questions, the "W" part of KWL, by going to the orchard. Reviewed each item in the "W" column and wrote the answer to that question. If there are unanswered questions, ask the class again and see if anyone has an answer. Do the necessary research in order to satisfy students' curiosity.

Any journaling that wasn't completed during the field trip can be taken up in the classroom, even if it is just a time to reflect on the experience.

Winter 2010

Classroom Sessions

- The concept of dormancy was introduced, along with the concept of pruning. Discussion began by asking if anyone has seen the crews of men pruning trees, perhaps while they are riding the bus to or from school. Depending on the timing of the field trip, some pruned branches are brought into classroom to force into blooming. This is linked to a garden project in progress which centers on forcing hyacinth bulbs.
- Create a new KWL chart addressing winter in the orchard.
- Students make predictions about what they will find in the orchard during the winter.

Second field trip - late February

When planning this field trip, three days are usually set to allow for change in schedule due to inclement weather. Camino, California is at 3,000 feet elevation in the Sierra Nevada foothills, and weather conditions can be highly unpredictable. Fortunately, the weather conditions were ideal for the winter field trip: a cold, clear day following a light snow.

Walking tour:

This field trip was shorter in duration than in the fall. Just as in the fall, the two classes followed separate tracks: one class went on the walking tour while the other class toured the barn area.

Class A goes to the adopted tree, barn, cold storage, bake shop; Class B goes to the orchard, compost heap, apples/blueberries and then to the adopted tree and then the classes switch. Exceptions are made for weather-related problems such as wet trails or damaged trees that make the route impassable.

Apple orchard: Asked students to find their adopted tree. The concept of dormancy was revisited. Reminded students that an apple tree needs lots of hours of cold temperature to make apples. Showed students the dormant leaf buds that were not visible when the tree had leaves and fruit in the fall. Looked for signs of animals in the orchard. We had a little snow on the ground, which makes spotting tracks easy. Students are asked to identify tracks.

Compost heap: The compost heap is bigger after harvesting and cider making are finished for the year. This is a good place to look for animal tracks, since animals come to feed off of the old fruit. It was explained that decomposing materials give off heat, and that the center of the compost heap is very warm and busy breaking down all the fruit.

Apples/Blueberries: Continued to look for animal tracks. Students were asked to notice any changes in the blueberry bushes as well as the apple trees in this part of the orchard.

Cold storage/bake shop: Entered the cold storage and counted the number of apple bins. Is it more or less than in the fall? Students saw that the bake shop is empty.

Barn: The barn is full of picnic tables and equipment. No apples are stored here in the winter. Cider is made less frequently, so the cider press may be inoperable. It is cold in the barn.

"Adopted" tree: Students watched a pruning demonstration by Farmer Tom. Farmer Tom tells the class why trees need pruning and how to choose which parts to prune.

Journaling: Returned to the barn where picnic tables are set up. Students then revisited the pruning lesson given by Farmer Tom. They are given a picture of a tree with letters A-G in places that pruning is necessary. FOL leader starts with letter A and takes students through "pruning" the tree by drawing a line where a cut should be made. Students are asked, "Why are we pruning this?"

The field trip ended with a cup of hot cider before boarding the bus back to school.

Classroom follow-up:

Revisited the KWL chart. Students worked on bringing any incomplete journals up to date. Class discussed students' predictions made prior to the field trip.

SPRING 2010

The original plan for spring included a water "play day" with water games supplied by the teachers to complement the topic of irrigation. Conditions proved too cold for the planned activities, so we changed our focus and activities to weather. A late hard frost had occurred a few weeks prior to the field trip, so we focused on the impact the frost had on the trees and crops.

So the students could harvest a crop in the fall, as second graders, a small plot at Rainbow Orchards was dedicated to the students for growing pumpkins, a crop normally grown on site for sale in the fall. Seedlings were started at school and raised in the FOL coordinator's greenhouse until they were ready to transplant.

Classroom Sessions

Session one: Students learn about growing seedlings for planting at Rainbow Orchards during their next field trip. Students plant seeds in pots with potting soil. The pots are taken to the school greenhouse for germination.

Session two:

- Make another KWL chart focusing on spring in the orchard.
- Discuss pollination and fruit set concepts
- Discuss effects of recent weather on orchard
- Ask students to predict what might be happening in the orchard during spring time.

Third field trip

When planning this field trip two dates are set, since weather is still unpredictable. Spring 2010 was unusually cold and wet. The field trip date was reset several times and the weather was still cold (55 degrees in the last week of May!). As a result, activities scheduled were changed so the students could move inside if it rained.

Again the group was split as in the winter with half going to cold storage/bake shop, barn and adopted tree. The other group toured the orchard, compost heap and apples/blueberries with a stop to plant the pumpkin seedlings.

Cold storage/Bake shop: Counted the apple bins again and compared it to fall and winter counts. The bake shop is quiet, since there are very few apples.

Barn: Students were shown how the barn is still used for storage to keep things dry.

Apple orchard: We deviated slightly from our usual route so we could see trees damaged by the freeze. Shriveled leaves and burned-looking branches were noted. Students were asked to predict how this will affect apple production. We looked at some very young fruit that has set in spite of the cold wet weather. Students were on the lookout for wildlife, as animals are moving about more in the slightly warmer weather.

Compost heap: The heap is very slow at decomposing because it has been cold. The wet weather has kept the heap very damp and the material is expected to break down quickly when the weather heats up.

Apples/blueberries: The apples are still very small due to cold weather. The blueberries are growing well. Up the hill, the students could see the peach trees that were severely damaged by the frost. The trees have very few leaves on them.

Pumpkins: We stopped at our small plot to plant our pumpkin seedlings. They have four leaves and should be safe from freezing. Each student helps plant a seedling. Rainbow orchards will care for them over the summer.

Activities: In lieu of water games, the students made ice cream in a bag. Students get to see how cold temperatures affect things and they get to eat the results of their labor.

After lunch, students returned to school.

Classroom Follow-up

Journaling: Journaling is done in class after the field trip due to the weather. Students write down the ice cream in a bag recipe (California State Grange recipe). Students predict how big their pumpkin might be in the fall.

KWL chart: Questions that are left on the KWL chart are answered and discussed.

FALL 2010

This is the final field trip and closely follows the format of the previous fall. Second grade students made scarecrows to decorate the lawn area at Rainbow Orchards for the fall season.

Classroom pre-teach

- Administer post-tests-the identical test presented in Fall 2009 and a second test asking students to make predictions about their pumpkins.

- Generate KWL chart, following the theme of pumpkins.
- Instruct students to bring supplies for making scarecrows, such as old dresses, hats pants, boots, shoes, shirts, gloves, etc. Remind them that their scarecrows will be on display all fall.

Fourth Field Trip

The final field trip is a review of the information presented to students as first graders and also went into more detail on specific concepts such as photosynthesis.

Timeline:

10:00 - 10:45 am	Group A: Orchard/Garden Walk Group B: Work on Scarecrows
10:45 - 11:30 am	Group A: Work on Scarecrows Group B: Orchard/Garden Walk
11:30 - 12:00 pm	Pick Apples - both groups
12:00 -12:30 pm	Lunch - both groups
12:30 - 1:00 pm	Games and bathroom breaks
1:00 - 1:15 pm	Group A: Apple Barn for pumpkin pick and cold storage Group B: Finish scarecrows; make a journal illustration of their scarecrow
1:15 - 1:30 pm	Group A: Apple Barn for pumpkin pick and cold storage Group B: Finish scarecrows; make a journal illustration of their scarecrow
1:30 pm	Donuts and apple cider for all
2:00 pm	Depart for school

Walking tour:

Apple orchard: Reviewed what each part of the tree does to help the tree survive. The concept of photosynthesis was introduced. Students were asked who remembered how many apples fit in a bin. Students were on the lookout for signs of wildlife. The Class identified their tree. We asked students to notice any difference between apples grown in 2010 and apples that were grown in 2009. They noticed that 2010 apples were more blemished and smaller. (Due to unusual weather).

Compost heap: The compost heap is smaller because the old fruit and pulp rotted over the summer. The compost is spread in the orchard to fertilize the soil. Students noticed lots of blemished pumpkins which resulted from the cool wet spring and abnormally mild summer.

Apples/blueberries: We could see the peach trees that froze in the spring were still alive but were weak because they lost too many leaves. They will be replaced with blackberries in the spring. The blueberries had been harvested and the plants were healthy.

Pumpkins: Stopped at the small plot where students planted pumpkins in the spring. The pumpkins were still green and very small. The FOL Coordinator explained that the mild summer with lower than normal temperatures was not good for growing pumpkins. Pumpkins need hot days to grow bigger and faster under these conditions. Since the pumpkins were not ready for picking. A class parent volunteered to pick up the ripened pumpkins and bring them to school later in the fall.

Picking apples: The trees adopted by the students in 2009 bore very little fruit, again due to the freeze in May. Students did pick apples for apple dolls from another tree that was small enough and bore plenty of fruit. When the students are in third grade, they will visit the orchard with parents to check on their adopted tree.

"WHENEVER I EAT AN APPLE I THINK OF THIS PLACE [RAINBOW ORCHARDS]"
1ST GRADE STUDENT, CAMINO SCHOOL

Barn & cold storage: In the cold storage area, students counted the apple bins and noticed there were far fewer than in 2009. They were able to connect that to the freeze in May ruining apples. The barn was much the same, baking goods for tourists and cooking donuts.

Picking pumpkins: Students picked a small "Oz" pumpkin to take home as a substitute for the pumpkins they planted. Students put their initials on the bottom of the pumpkin with a marker. Parents collect the pumpkins to load on the bus later.

Journaling: Students draw an illustration of their scarecrow that decorates Rainbow Orchards.

The day ended with an apple cider donut and cup of fresh cider.

Classroom follow-up activities:

- Completed KWL chart
- Compared the orchard condition to fall 2009
- Created "Thank You" cards for Rainbow Orchards

EVALUATION AND SUSTAINING YOUR PROGRAM

It is essential that you measure the impact that Fields of Learning has made on your students. During the planning process, identify goals for the FOL program and determine a method for evaluating your success. Create several measures that can be tracked through the year, such as pre- and post-testing. This data, along with feedback from teachers, ag producers, students, parents, and volunteers, will provide vital information to evaluate your program, build on its strengths, and make improvements where needed. It will also provide a strong basis for maintaining a sustainable program.

Communication is a key component in building and maintaining a strong program. Keeping the team (including your ag partner), school administration, parents, donors, supporters, and volunteers "in the loop" on program accomplishments and activities fosters a sense of connection with the program which strengthens its base of support.

While you are busy *doing,* it is important to keep track of program activities and progress. Maintain records of FOL activities with descriptions, dates, and photos. Maintain files of materials used on field trips and in classrooms as well as all program documents, including your master plan for the year's program, pre- and post evaluations, key communications, and list of volunteers. Record all donations and donors of funds and materials. When possible, log positive feedback you receive from students, parents, and community members. All this information will help as you share your accomplishments with numerous FOL stakeholders - school administration, teachers, ag partners, PTO, parents, students, volunteers, the community at large - and assist you in seeking support and funds needed to sustain your program.

There are a variety of ways to keep your stakeholders and the community informed about your program. A quarterly or biannual newsletter could be sent through mail or email, with a summary of activities, calendar of upcoming events, photos, and student comments. An annual report could be produced and distributed at a school-based events or mailed. Presentations at PTO/PTA meetings or other community gatherings provides the opportunity for individuals to ask questions and offer input. These efforts take time, so finding reliable volunteers to share the workload will help keep your communications on track. Whatever methods you choose to share your Fields of Learning story, maintaining a regular schedule will enhance your program's reputation and help expand your base of support.

APPENDIX

List of enclosed resources and learning activities:

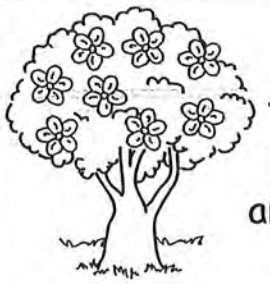
1. The Seasons of an Apple Tree (1st grade FOL pre- and post-test)
2. Planting Pumpkins - shape and color (1st/2nd grade pre- and post-test)
3. Look Inside An Apple
4. The Little Red House booklet
5. Dissecting Apples and Labeling Apple Parts (math & science)
6. 5 Red Apples (math)
7. Apple Snap and Dancing (movement)
8. Johnny Appleseed coloring book
9. Here's to Johnny Appleseed (song)

Name:_____ Date:_____

The Seasons of an Apple Tree

Draw a line from the picture to the right season.
Color the Picture.

The apples are green and growing.



The apple blossoms are starting to grow.

The apples are ready and can be picked.

The tree is bare and resting.

Winter

Summer

Spring

Fall

BONUS: Write sentences on the back of this sheet using the 4 words - Winter, Spring, Summer, and Fall.

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We planted pumpkin seedlings at Rainbow Orchards in May. Now it is September, and we are going to see our pumpkins. What do you expect to see when we arrive?

What color will my pumpkin be?

I think my pumpkin will be _____.

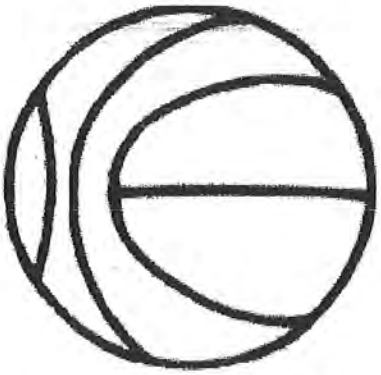
How big will my pumpkin be?

My pumpkin will be as big as a:

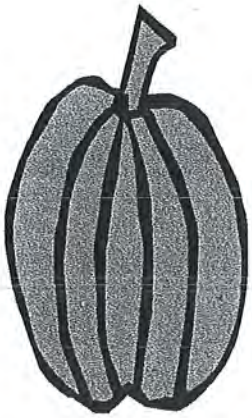
Baseball

Soccer ball

Basketball



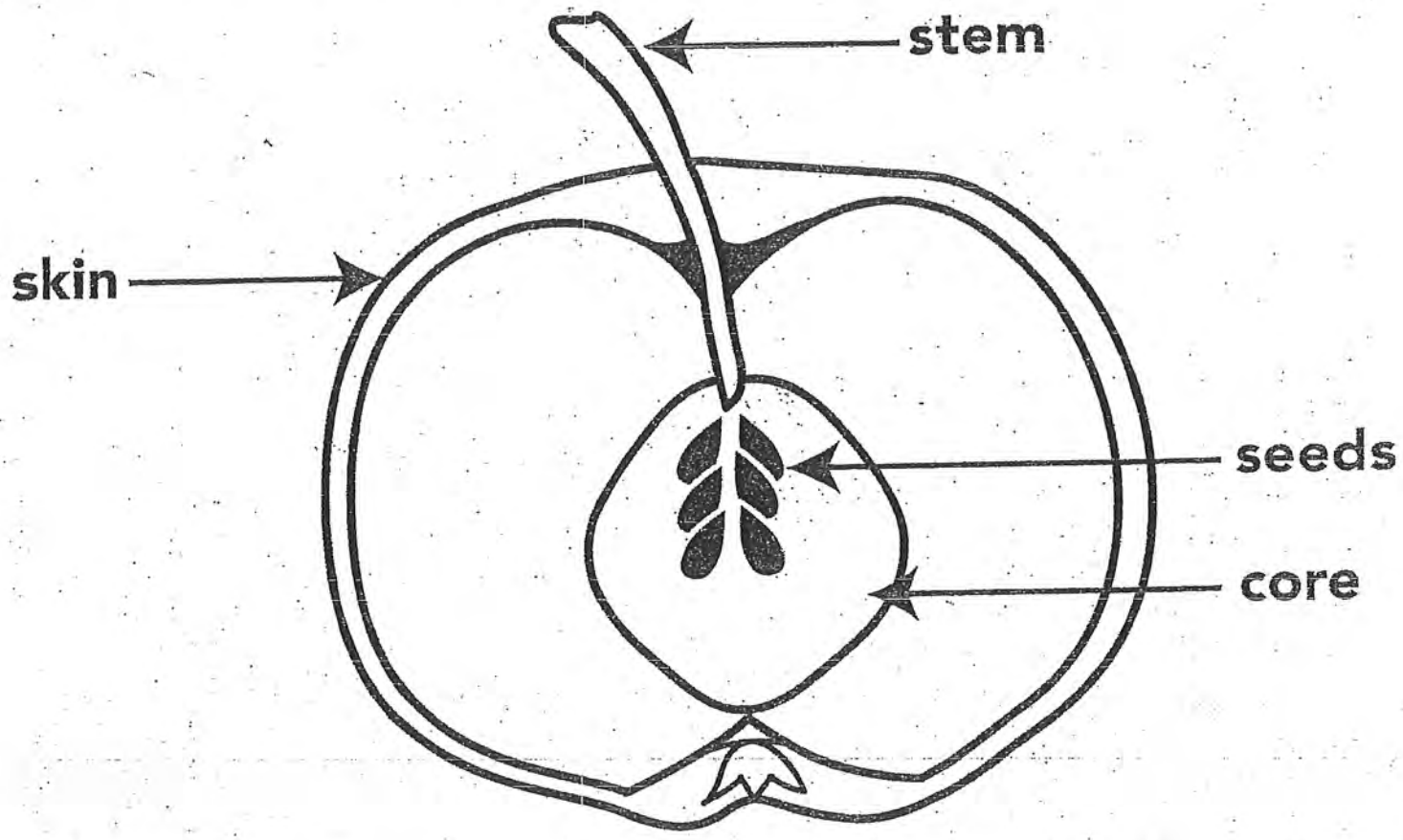
What shape will my pumpkin be?



Name: _____ Learn-Along Pa

Look Inside an Apple

Look at the diagram of the apple half. Then follow the directions below.



1. Put a ✔ on the stem.
2. Circle the seeds.
3. Write how many seeds are in the apple. _____
4. Color the core yellow.
5. Make an ✘ where you would like to bite the apple.

Now Try This! Apples can be red, yellow, or green. Which color apple do you like to eat? Color the skin of the apple above that color.

The Little Red House booklet (drawing and coloring activity)

Create half-page size stapled booklet with red paper cover for each student with the following pages:

Write "The Little Red House" on the cover.

On numbered pages, write the following at the bottom of the page:

1) What is round,

2) What is red,

3) has no windows,

4) has no door,

5) and a star inside?

6) An apple!

Student draw and color each page.

Dissecting Apples & Labeling Apple Parts (Math and Science)

First, students follow along to complete the labeling of an apple.

Next, pair up the children and give each pair an apple that is cut in half.

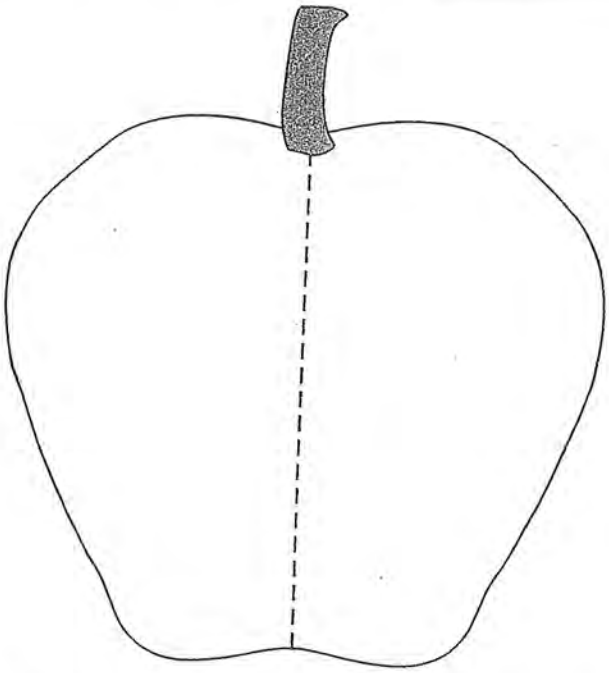
Pass out the recording sheet.

Ask each pair to pull all the seeds out of the core. (They may need to eat some the apple to get to the seeds).

Students record their findings on their half of the apple on the recording sheet.

Students complete math sheet, coming up with different combination of seeds.

Names _____ _____



Our apple has _____ seeds.

M1(2e)-MA-019c

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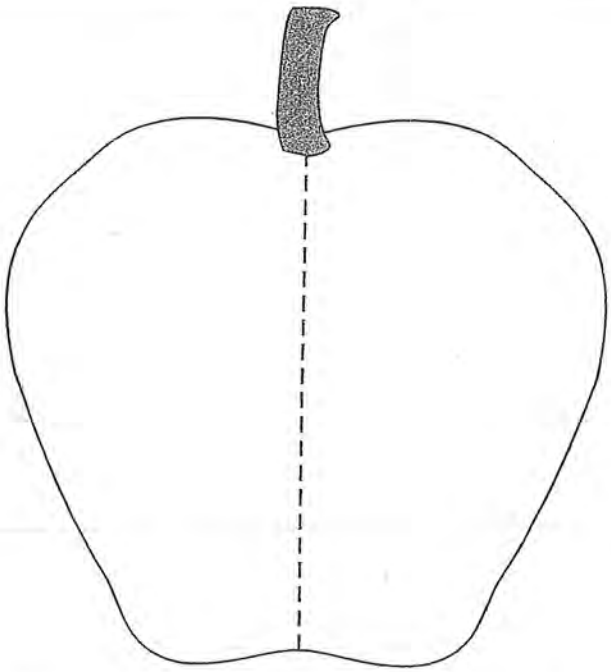
Names _____ _____



Our apple has _____ seeds.

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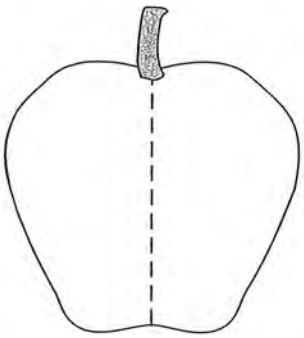
Name _____

Master 21

Math 1 *(for use with Lesson 21)*



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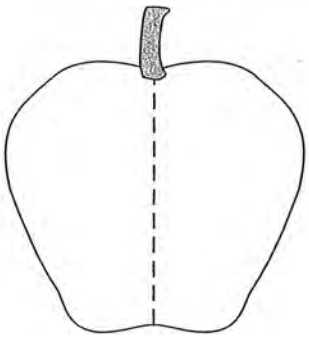

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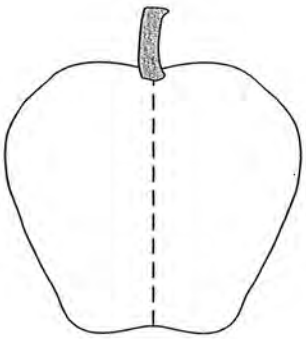

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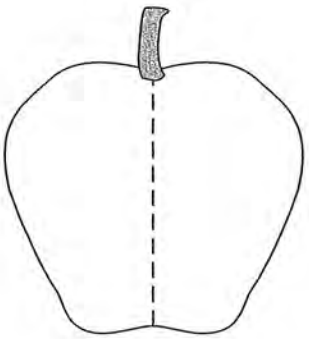

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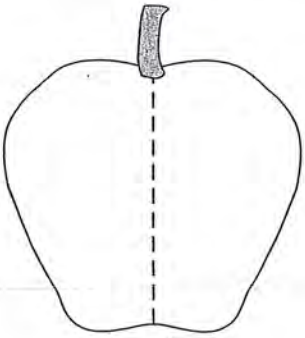

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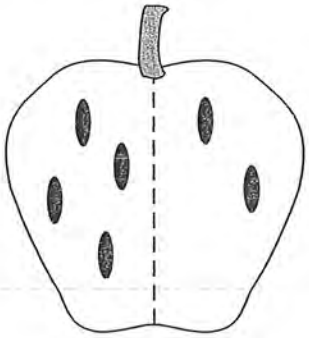

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5 Red Apples

5 red apples sweet to the core.
1 fell down and then there were four.

4 red apples sitting in a tree.
1 fell down and then there were three

3 red apples one for you, and you, and you.
1 fell down and then there were two.

2 red apples shining in the sun,
1 fell down and then there were one.

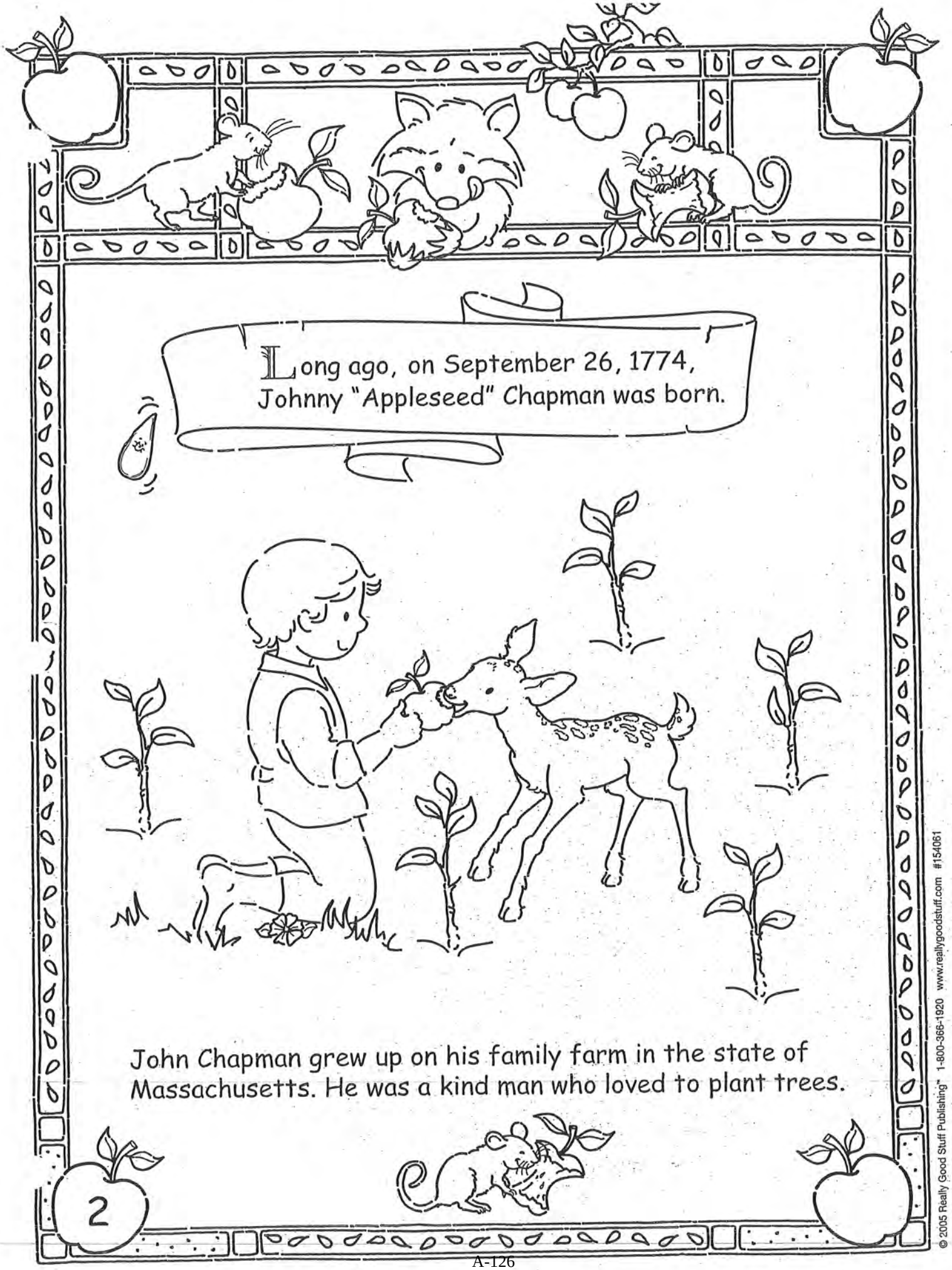
1 red apple left all alone
1 fell down and there were none. – Author Unknown

Apple Snap & Dancing (movement) 2 parents

Explain to students that their objective is to bite into their apple with out the use of hands. Have students line up. Parents hold each end of the bamboo stick. Have students put their hands behind their backs. Say on your mark, go and have students begin. After 5 to 7 minutes, have students form a circle. Start CD and hold the same bamboo stick for the first limbo song. Students know movements for the chicken dance and Hokey Pokey.

Apple Snap & Dancing (movement) 2 parents

Explain to students that their objective is to bite into their apple with out the use of hands. Have students line up. Parents hold each end of the bamboo stick. Have students put their hands behind their backs. Say on your mark, go and have students begin. After 5 to 7 minutes, have students form a circle. Start CD and hold the same bamboo stick for the first limbo song. Students know movements for the chicken dance and Hokey Pokey.



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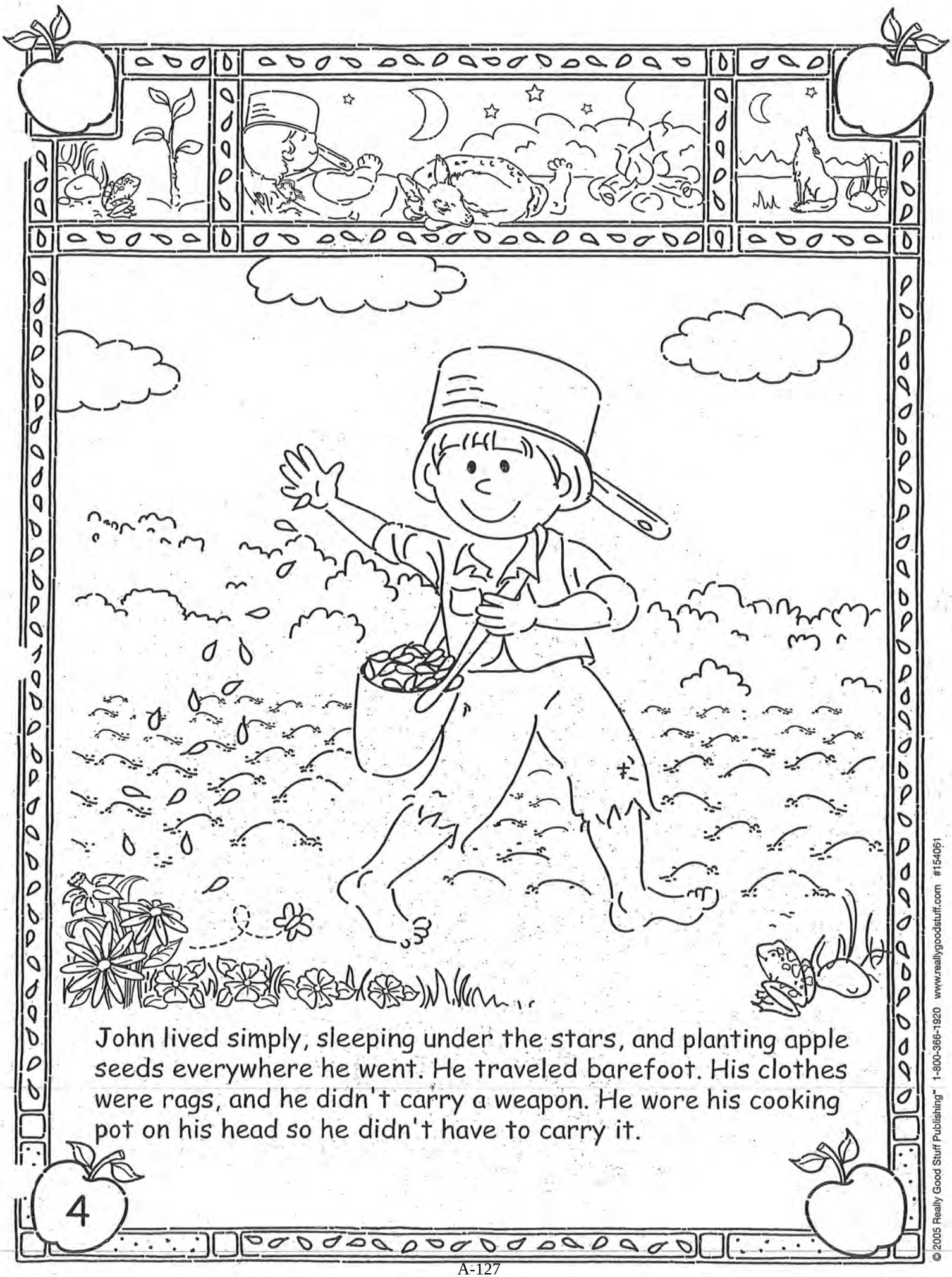

John lived simply, sleeping under the stars, and planting apple seeds everywhere he went. He traveled barefoot. His clothes were rags, and he didn't carry a weapon. He wore his cooking pot on his head so he didn't have to carry it.

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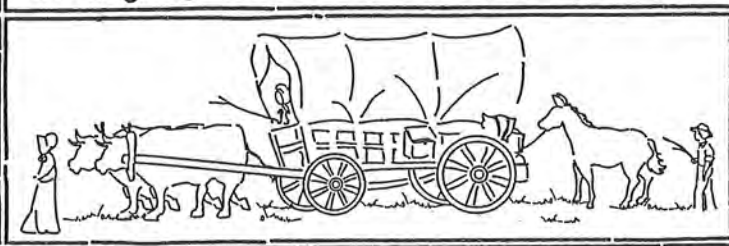

John liked to help people. He would stop and help pioneers build their homes. Sometimes, he would work on a farm.

He worked hard. All he asked for were meals and a place to sleep. People wanted him to settle down, but he always said he was happiest in the wilderness. Before he left, he would always plant some seeds. People started calling him "Johnny Appleseed."

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Today, children and adults remember Johnny Appleseed. We admire him for his love of nature, his peaceful way with animals, and his lifelong dedication to the spreading of apple trees across our great country.

We also thank him for Mom's delicious apple pie!

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Here's To
Johnny
Appleseed!

HERE COMES JOHNNY

HERE COMES JOHNNY APPLESEED
  APPLE SEEDS ARE ALL HE NEEDS
PLANTING ORCHARDS ON HIS WAY OUT WEST.

WEARS A POT UPON HIS HEAD
  BENEATH THE STARS HE MAKES HIS BED
FOLKS SAY JOHNNY'S APPLES ARE THE BEST!

(TUNE: PETER COTTONTAIL)

DRAW A PICTURE OF WHAT YOU THINK JOHNNY APPLESEED LIKED TO DO BEST. WRITE A SENTENCE.

Production of Strawberries & Other Vegetables on the Central Coast

Wednesday, June 10, 2009

8:00 AM – 12:00 PM
The Rancho Bowl
128 E. Donovan Road
Santa Maria, CA 93454

AGENDA

The presentations will be in Spanish or in English with Spanish translation.

8:00 - 8:20 **Welcome - Cachuma Resource Conservation District**
Adriana Morales, Field Biologist – Cachuma RCD

8:20 – 8:25 **Introduction of Surendra Dara – Strawberry & Vegetable Crops Farm Advisor for the University of California**
Mark Gaskell, Farm Advisor – UCCE Santa Maria

8:25 – 8:45 **Dealing with the Two Spotted Spider Mite in Strawberries**
Surendra Dara, Farm Advisor – UCCE Santa Maria

8:45 – 9:15 **Water Management for Central Coast Row Crops**
Mark Battany, Farm Advisor – UCCE San Luis Obispo

9:15 – 9:30 **Break**

9:30 – 10:00 **Farm Loans & Farm Programs – USDA - Farm Service Agency, Santa Maria**
Victor Manuel Hernandez, Farm Loan Specialist & Brenda Farias, County Executive Director

10:00- 10:30 **Summary of Strawberry Fertilization Practices**
Mark Gaskell, Farm Advisor– UCCE Santa Maria

10:30 – 11:15 **The Importance of Plant Nutrition in Strawberry Production**
Mark Bolda, Farm Advisor – UCCE Watsonville

11:15 – 11:45 **Strawberry Grower Panel: Efficient decision making.**
Mark Bolda, Farm Advisor – UCCE Watsonville

11:45 – 12:45 **Field Visit - Strawberry Fertility Field Trial**

This informational workshop is sponsored by Cachuma RCD, UCCE, & the USDA-Farm Service Agency, with funding from the, CA Department of Food & Agriculture, the CA Department of Water Resources, and the USDA-Farm Service Agency.

STRAWBERRY WORKSHOP:
IMPORTANT ITEMS TO CONSIDER WHEN PURCHASING STRAWBERRY TRANSPLANTS THIS SEASON

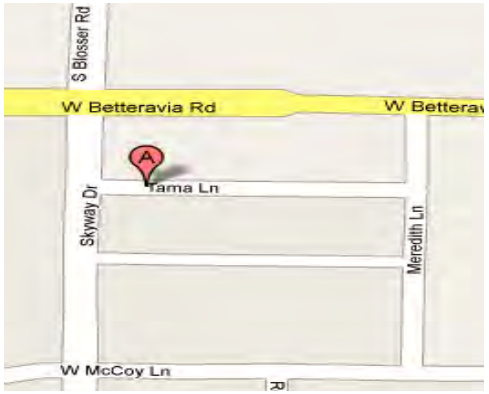
Presented by:
CURT GAINES – Plant Licensing Field Representative: UC Davis

When: Thursday, July 9, 2009, from 4:00 to 7:00 pm.

Where: 1141 Tama Lane. Santa Maria, CA.

How: Presentation in English with Spanish Translation Provided

Who: Workshop organized by Cachuma RCD (805)928-9269 ext 107



CALIFORNIA STRAWBERRY COMMISSION
A HEALTHY INDULGENCE

Cachuma ResourceConservation District

UC CE University of California Cooperative Extension

Workshop on
Strawberry Production in Santa Maria

Thursday, August 27, 2009

10:00 am to 2:00 pm

Presented in English with Spanish interpretation.

Morning Location:
Shephard Hall
Santa Maria Public Library
421 S. McClelland St.
Santa Maria, CA 93454

Afternoon Field Location:
Hwy 1 South, approximately 1.1 miles south of Black Rd. On left hand side across from Rancho Maria Golf Course. Enter green Powder River gate and park.

9:45 – 10:00 **Sign-In and Registration**

10:00 – 10:10 **Welcome**
Tom Lockhart, District Manager – Cachuma RCD

10:10 – 10:20 **USDA/NRCS/Environmental Quality Incentives Program (EQIP)**
Nikki Smith, Soil Conservationist – NRCS Santa Maria

10:20 – 10:30 **Cachuma RCD Mobile Irrigation Lab Services**
Kevin Peterson, Irrigation Specialist – Cachuma RCD

10:30 – 11:00 **Strawberry Nursery Basics - What you should ask your nursery representative and what you need to know concerning the plants that you purchase**
Curt Gaines, Plant Licensing Field Representative – UC Davis InnovationAccess - Technology Transfer Services

11:00 – 11:15 **Update on Lygus Monitoring Studies in the Santa Maria Area**
Surendra Dara, Farm Advisor, Strawberries and Vegetables – UCCE Santa Maria

11:15 – 11:45 **Preliminary Results from Field Trials with Irrigation and Nitrogen Management with Strawberries in Santa Maria**
Mark Gaskell, Farm Advisor– UCCE Santa Maria

11:45 – 12:15 **Relocate to Strawberry Field Site**

12:15 – 1:00 **Lunch Provided in the Field**

1:00 – 1:30 **Discussion of Field Trials**
Tom Lockhart, District Manager – Cachuma RCD

1:30 – 2:00 **What's New for Insect Control in Strawberries?**
Frank Zalom, Professor and Extension Agronomist – UC Davis, Dept. of Entomology

Cachuma Resource Conservation District

UC CE University of California Cooperative Extension

CALIFORNIA STRAWBERRY COMMISSION
A HEALTHY INDULGENCE

4 Irrigated Agriculture Waiver Education Credits have been approved: #0908927-036-NPI.
Please RSVP and address questions to Claire Wineman at (805) 928-9269x121 or claire.wineman@ca.nacdnet.net.
Funded by the California Strawberry Commission, CA-DWR, and CDFA's FREP and SCBG programs.

CACHUMA RCD

Please call Adriana Morales
Biologist/Resource Conservationist
Tel: (805) 928-9269 Ext.107
Cell: (805) 540-9951

DIA DE CAMPO EN CULTIVOS DE FRESA

MANEJO DEL NITROGENO

1. Después de rozar las plantas y para fresa de segundo año
2. Para antes de plantar fresas
3. Determinar la cantidad de fertilizantes de liberación controlada usado como pre-plant
4. En Enero del 2010 y después de plantar, como usar la prueba rápida de Nitrógeno (NQT) para inyecciones del CAN17
5. En irrigación – fertigación, como lavar la sal y mantener el fertilizante en el área de las raíces de las plantas

2 Sesiones Idénticas

Cuando: **Miércoles, Septiembre 9, 2009**

Sesión de la Mañana:

Lugar: El Campo de Sunrise al Este de Santa María. Mire un aviso de "Field Day" colocado sobre Telephone Rd. A ½ milla de Clark Ave. Tome un camino sin pavimentar que lo lleva hacia el Hwy 101.
De 10:00 am. a 12:00 medio día.

Sesión de la Tarde:

Lugar: El Campo de Jesús Hernández al Oeste de Santa Maria. Tome Main St West, tome Ray Rd a la izquierda, tome Sinton Rd a la izquierda y encontrara un aviso de "Field Day".
De 02:00 pm. a 04:00 pm.

CACHUMA RCD

Please call Adriana Morales
Biologist/Resource Conservationist
Tel: (805) 928-9269 Ext.107
Cell: (805) 540-9951

STRAWBERRY FIELD DAY

NITROGEN MANAGEMENT TOOLS

1. Cutback strawberries & second year berries
2. Before planting strawberries
3. Determining pre-plant fertilizer rates
4. For January 2010 after planting, how to use the Nitrate Quick Test (NQT) for CAN17 injections
5. For irrigation – fertigation, how to leach salts and keep fertilizers in the root zone.

2 Identical Sessions

When: **Wednesday, September 9, 2009**

Morning Session:

Where: Sunrise field East of Santa Maria. Look for "Field Day" sign on Telephone Rd. ½ mile North of Clark Ave. Take dirt road back towards Hwy 101.
From 10:00 am. to 12:00 noon.

Afternoon Session:

Where: Jesus Hernandez's field West Santa Maria. Take Main St West, take Ray Rd to the left & take Sinton Rd to the left and look for a "Field Day" sign.
From 02:00 pm. to 04:00 pm.

Cachuma Resource Conservation District

Por favor llame a Claire Wineman
Watershed Resource Manager
Tel: (805) 928-9269 Ext.121
Cell: (805) 540-9951

NRCS

TALLER SOBRE CONTROL DE EROSION EN CAMPOS DE AGRICULTURA: PREPARESE PARA LAS LLUVIAS DE INVIERNO

Cuando: El miércoles 18 de noviembre del 2009. de 10:00 am a 12:00 pm.

Donde: En Tanglewood, a la entrada del campo de Gabriel Contreras.

Direcciones: Tome la Betterravia Rd. al oeste, gire a la izquierda en Black Rd. y continúe hasta que observe el aviso de Tanglewood. Gire a la derecha cuando observe avisos de "Field Day" colocados sobre Black Rd.

Temas a Tratar:

1. Que es erosión y como se puede controlar
2. Como trabaja la erosión y como puede afectar la calidad del agua (demostración)
3. Como manejar las lluvias de invierno en esta estación de cultivo
4. Como manejar las lluvias de invierno para la siguiente estación de cultivo

Patrocinado por Cachuma RCD, USDA-NRCS, USDA-CSREES, y CDFA-SCBG

Experiencias con el Recorte de la Fresa en Agosto para la Cosecha en Noviembre y Diciembre Jueves, Noviembre 19, 2009

9:00 am a 11:00 am

Presentado en Español o Inglés con traducción al Español

Temas:

Variedades, Fertilizante, Riego, y Monitoreo de Lygus

Presentadores:

Mark Gaskell, Asesor Agrícola – UCCE Santa María

Surendra Dara, Asesor Agrícola, Fresas y Vegetales – UCCE Santa María

Lugar del Taller:

Siga los avisos colocados en la Telephone Rd y E Clark Ave.

Cachuma Resource Conservation District

UC CE University of California Cooperative Extension

Por favor dirija sus preguntas a:
Claire Wineman al oficina: (805) 928-9269 x121 o celulár: (805) 540-9951 o claire.wineman@ca.nacdnet.net
Patrocinado por CA-DWR, USDA-CSREES, CDFA-FREP y CDFA-SCBG

El Manejo de los Acaros (two-spotted mites)
en el Cultivo de la Fresa
miércoles, diciembre 2, 2009

9:00 am a 11:00 am

Presentado en Español o Inglés con traducción al Español

Temas:

Manejo integrado de plagas: prevención, inventario (scouting), monitoreo, tratamiento

Presentador:

Surendra Dara, Asesor Agrícola, Fresas y Vegetales – UCCE Santa María

Lugar del Taller:

Siga los avisos colocados en la Telephone Rd y E Clark Ave.

Cachuma Resource Conservation District

UC CE University of California Cooperative Extension

Por favor dirija sus preguntas a:
Claire Wineman al oficina: (805) 928-9269 x121 o celulár: (805) 540-9951 o claire.wineman@ca.nacdnet.net
Patrocinado por CA-DWR, USDA-CSREES, CDFA-FREP y CDFA-SCBG

Cachuma Resource Conservation District

FSA
FARM SERVICE AGENCY

TALLER DE ORGANIZACIÓN DE CUENTAS Y MANEJO DE DATOS: COMO MANEJAR INFORMACION DEL CAMPO PARA GANAR MAS

Cuándo: El miércoles 13 de enero del 2010 de 10:00 am a 12:00 pm.

Dónde: Sala de Conferencias
USDA Service Center
(Centro de Servicios del USDA)
920 E. Stowell Rd.
Santa Maria, CA 93454

Direcciones: El USDA Centro de Servicios está atrás del nuevo Trader Joe's (cerca de Costco) en el viejo edificio de Columbia Records.

Victor Hernandez del FSA presentará:

1. Por qué la organización de cuentas y el manejo de datos es importante
2. Cómo organizar los datos de gastos e ingresos
3. Cómo procesar los datos
4. Cómo utilizar la información de los datos para tomar decisiones mejores para su negocio

Patrocinado por Cachuma RCD, USDA-FSA, USDA-NRCS, USDA-CSREES, y CDFA-SCBG
Para más información o para inscribirse, llame a Claire Wineman al tel: (805) 928-9269 ext.121 o cell: (805) 540-9951

Cachuma Resource Conservation District

Prueba rápida del nitrato (NO_3^-) del suelo

Cuándo: El miércoles 27 de enero del 2010 de 3:00 pm a 5:00 pm.

Dónde: Sala de Conferencias
USDA Service Center
(Centro de Servicios del USDA)
920 E. Stowell Rd.
Santa Maria, CA 93454

Direcciones: El USDA Centro de Servicios está atrás del nuevo Trader Joe's (cerca de Costco) en el viejo edificio de Columbia Records.

Tom Lockhart del RCD presentará cómo se puede utilizar la prueba rápida del nitrato del suelo para planificar la aplicación de CAN-17.

Estaremos haciendo citas para visitas individuales en el campo.

No hay ningún compromiso, pero estaremos vendiendo el equipo para hacer la prueba. Si quiere comprar el equipo, un paquete completo vale $60. O el tubo para sacar el suelo vale $45 y el resto del equipo (los palitos, los químicos, y los tubos) valen $15.

Patrocinado por Cachuma RCD, USDA-NRCS, USDA-CSREES, y CDFA-SCBG
Para más información o para inscribirse, llame a Claire Wineman al tel: (805) 928-9269 ext.121 o cell: (805) 540-9951

The Central Coast Ag Water Quality Coalition
Presents . . .

Technical Resources and Regulatory Updates for Central Coast Ag

When: Tuesday, April 13, 9:30 am - 3:00 pm

Where: Bonipak/Betteravia Farms, Conference Room upstairs in Packing House
1850 W. Stowell Rd., Santa Maria

Attend the morning or the afternoon session, or both!

Session I - Technical Resources

9:15 Sign in

9:30 BMP Challenge Program -- Steve Shaffer, Consultant

9:50 Conservation planning with the NRCS -- Nikki Smith, USDA NRCS

10:00 Nitrate trends in city wells -- Shannon Sweeney, City of Santa Maria

10:20 Break

10:30 Assessing technical capacity in Central Coast agriculture -- Lisa Lurie, AWQA

10:50 TMDL update – Kay Mercer, CCAWQC

Session II - Pesticides and Water Quality

1:30 IPM for Central Coast Ag -- Dr. Surendra Dara, Santa Barbara Co. UCCE

1:50 DPR Surface Water Program Update -- Mark Pepple, CDPR

2:20 Chlorpyrifos formulations and water quality: field trial results -- Cressida Silvers, CCAWQC

2:30 Cooperative Monitoring results for pesticides -- Sarah Greene, CCWQP Inc.

Continuing Education Credits approved for
Ag Regulatory Program (Ag Waiver) and Certified Crop Advisors.

Spanish translation provided.

For more information, contact Cressida Silvers, Central Coast Ag Water Quality Coalition
cressidasb@yahoo.com or (805) 964-4342

Irrigation and Nutrient Management Meeting

Thursday, April 22, 2010

9:00 am to 11:45 am

SB County Board of Supervisor's Hearing Room
511 E. Lakeside Parkway
Santa Maria, CA 93454

Presented in English with Spanish interpretation.

8:45 – 9:00	**Sign-In**
9:00 – 9:30	**Nitrogen Management Studies: Field Scale Evaluations** Tim Hartz, Extension Vegetable Specialist, UC Davis
9:30 – 10:00	**Irrigation Management and Impact on Nitrate Leaching and Fertilizer Use Efficiency** Michael Cahn, Irrigation and Water Resources Farm Advisor, Monterey County
10:00 – 10:15	***Break***
10:15 – 10:45	**Practical Soil Nitrate Testing and Fertilizer Management** Richard Smith, Vegetable Crops and Weed Science Farm Advisor, Monterey County
10:45 – 11:15	**Polyacrylamide (PAM) Update: Formulations, Control of Chlorpyrifos in Runoff** Michael Cahn, Irrigation and Water Resources Farm Advisor, Monterey County
11:15 – 11:45	**Panel Q&A** Kevin Peterson, Mobile Lab Team Leader, Cachuma RCD Speakers

CEUs have been requested for the Ag Waiver Program and Certified Crop Advisors
For more information, contact Cressida Silvers, CCAWCQ, 964-4342

Cachuma Resource Conservation District

UC CE University of California Cooperative Extension

Central Coast Agricultural Water Quality Coalition

Also funded by the CDFA/SCBG and USDA/CSREES/OASDFR programs, and by a grant from the California Department of Conservation.

University of California Cooperative Extension
Agriculture & Natural Resources

624-A West Foster Road
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Phone: 805.934.6240
Fax: 805.934.6333

E-mail:
cesantabarbara@ucdavis.edu

Web site:
cesantabarbara.ucdavis.edu

Irrigation Management in Strawberries

Tuesday, 11 May 2010
Manzanita Berry Farms, 1891 West Main, Santa Maria, CA
Continuing Education Credits have been requested

9:00 Registration is free

9:30 Water use and salinity evaluation
Stuart Styles, Cal Poly, San Luis Obispo and Chuck Bates, John Deere

9:50 Strawberry plant performance during sprinkler and drip establishment
Oleg Daugovish, Strawberry and Vegetable Crop Advisor, UCCE, Ventura

10:20 Soil moisture sensors
Ben Faber, Farm Advisor, UCCE, Ventura

10: 40 Practical experiences of irrigation management
David Peck, Manzanita Berry Farms, Santa Maria

10:55 Proper irrigation for disease and pest management
Surendra Dara, Strawberry and Vegetable Crops Advisor, UCCE, Santa Maria

11:00 Use of PAM for sediment control in irrigation run-off
Michael Cahn, Irrigation and Water Resources Advisor, UCCE, Salinas

11:30 Field tour and lunch

To help us make sufficient arrangements, please respond to Surendra Dara by 30 April, 2010 at (805) 934-6240; 624 A West Foster Rd, Santa Maria, CA 93455. Email: skdara@ucdavis.edu

Spanish translation will be available.

Please call ahead for arrangements of special needs; every effort will be made to accommodate full participation. The University of California prohibits discrimination against or harassment of any person on the basis of race, color, national origin, religion, sex, physical or mental disability, medical condition (cancer-related or genetic characteristics), ancestry, marital status, age sexual orientation, citizenship, or status as a covered veteran (special disabled veteran, Vietnam-era veteran or any other veteran who served on active duty during a war or in a campaign or expedition for which a campaign badge has been authorized). University Policy is intended to be consistent with the provisions of applicable State and Federal laws. Inquiries regarding this policy may be addressed to the Affirmative Action Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th Floor, Oakland CA 94612 (510) 987-0097.

University of California, United States Department of Agriculture and Santa Barbara County Cooperating

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Fax: 805.934.6333

E-mail:
cesantabarbara@ucdavis.edu

Web site:
cesantabarbara.ucdavis.edu

University of California Cooperative Extension Agriculture & Natural Resources

Manejo de Riego en Fresas

Martes, 11 Mayo 2010
Manzanita Berry Farms, 1891 West Main, Santa Maria, CA
Se ha pedido créditos de educación continua

9:00 Inscripción gratis

9:30 Utilización de agua y evaluación de salinidad
Stuart Styles, Cal Poly, San Luis Obispo y Chuck Bates, John Deere

9:50 Comportamiento de plantas durante establecimiento con riego de aspersión y de goteo. *Oleg Daugovish, Strawberry and Vegetable Crop Advisor, UCCE, Ventura*

10:20 Sensores de humedad de suelo
Ben Faber, Farm Advisor, UCCE, Ventura

10: 40 Experiencias practicas de manejo de riego
David Peck, Manzanita Berry Farms, Santa Maria

10:55 Riego apropiado para el manejo de enfermedades y plagas
Surendra Dara, Strawberry and Vegetable Crops Advisor, UCCE, Santa Maria

11:00 El uso de poliacrlimida (PAM) para controlar el escurrimiento de sedimento
Michael Cahn, Irrigation and Water Resources Advisor, UCCE, Salinas

11:30 Tour del campo y almuerzo

Para que haya recursos suficiente, por favor responda a Surendra Dara antes del 30 de abril, 2010 en (805) 934-6240; West Foster Rd, Santa Maria, CA 93455. Email: skdara@ucdavis.edu

Créditos de educación continua serán pedidos. Por favor, llame con anticipación para necesidades especiales; Se hará el esfuerzo para acomodar participación completa.

Interpretación al Español será disponible.

La Universidad de California prohíbe la discriminación o el hostigamiento de cualquier persona. Esta prohibición abarca rezones de raza, color, origen nacional, religión, sexo, incapacidad física, mental, estado de salud (casos de cáncer o de características genéticas), ascendencia, estado civil, edad, orientación sexual, ciudadanía o condición de veterano (veterano con incapacidad específica, veterano de la era de Vietnam y cualquier veterano que haya estado en servicio activo en una guerra, campaña o expedición para la cual una insignia de campaña haya sido autorizada.). La política de al Universidad se propone concordar con las disposiciones de las leyes federales y estatales procedentes. Las preguntas sobre la política antidiscriminatoria de la Universidad pueden dirigirse a: Affirmative Action Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th Floor, Oakland CA 94612 (510) 987-0097.

University of California, United States Department of Agriculture and Santa Barbara County Cooperating

Cachuma Resource Conservation District

TALLER DE OPORTUNIDADES PARA MERCADOS ALTERNATIVOS: COMO ESTABLECER UN NEGOCIO COOPERATIVO

Cuándo: El jueves 8 de julio del 2010 de 2:00 pm a 3:30 pm.

Dónde: Sala de Conferencias
USDA Service Center
(Centro de Servicios del USDA)
920 E. Stowell Rd.
Santa Maria, CA 93454

Direcciones: El USDA Centro de Servicios está atrás del nuevo Trader Joe's (cerca de Costco) en el viejo edificio de Columbia Records.

Claire Wineman del Cachuma RCD presentará una presentación desarrollado por Deb Garrison sobre:

1. Conceptos claves de mercadeo
2. Ejemplos de mercados alternativos.
3. Ventajas y desventajas de establecer un negocio cooperativo.
4. Cómo establecer un negocio cooperativo.

Patrocinado por Cachuma RCD, USDA-CSREES, y CDFA-SCBG
Para más información o para inscribirse, llame a Claire Wineman al tel: (805) 928-9269 ext.121 o cell: (805) 540-9951

Adriana Morales training growers in Spanish on how to perform the Soil Nitrate Quick Test (SNQT).

Field portion of "Strawberry Production in Santa Maria" workshop at first demonstration site established.

Sign-in period for "Strawberry Production in Santa Maria" workshop.

Kevin Peterson, right, establishing second demonstration site and field trial with grower cooperator, left.

"Strawberry Field Day: Nitrogen Management Tools" Workshop at field trial demonstration site.

"Strawberry Field Day: Nitrogen Management Tools" Workshop at field trial demonstration site.

"CSREES/CDFA/EQIP Project Kickoff" Meeting.

Demonstration of runoff model at "Erosion Control: Preparing for Winter Rains" Workshop.

"IPM for Two-Spotted Spider Mite in Strawberries" Workshop at field trial demonstration site.

"IPM for Two-Spotted Spider Mite in Strawberries" Workshop at field trial demonstration site.

Providing simultaneous English-Spanish interpretation (note growers wearing headsets) for "Soilborne Pest Management in Strawberries" UCCE Workshop.

"Recordkeeping and Organization: How to Use Records to Earn More for Your Business" Workshop.

Establishing field trial demonstration site for biochar soil amendment for conventional strawberries.

Establishing field trial demonstration site for fertilizer application rates for organic strawberries.

"Irrigation Management in Strawberries" Workshop.

"Irrigation Management in Strawberries" Workshop.

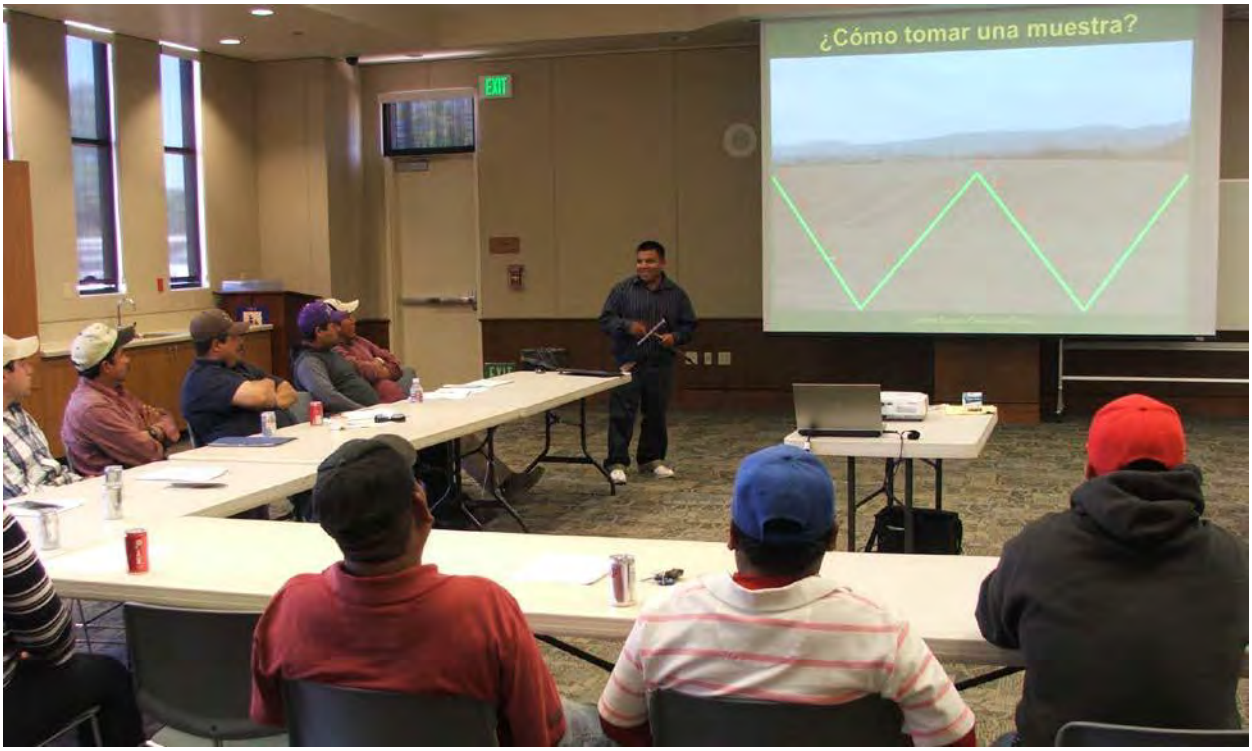
"Business Management for the New Season" Workshop, 7.19.11.

"Business Management for the New Season" Workshop. 7.19.11

"Business Management for the New Season" Workshop, 7.19.11.

"Preparing the Field for the New Season" Workshop, 8.25.11.

"Preparing the Field for the New Season" Workshop, 8.25.11.



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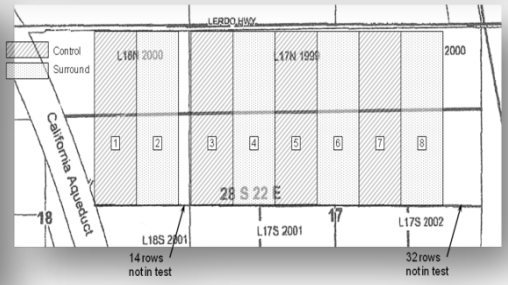
Effects of Surround™ on Pistachio Trees
Two-Year Study



February 2012

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Irrigation Training and Research Center
February 2012

EXECUTIVE SUMMARY

In California, fruits and nuts make up a large portion of the state's irrigated acreage. Problematically, the areas in which these crops are grown (particularly south of the Delta) are increasingly short of water. Farmers and water districts are interested in techniques to reduce the amount of water used to irrigate crops not only in order to conserve that water, but because runoff from fields impacts in-stream water quality and quantity.

All plants require a certain quantity of water for evapotranspiration (ET), which accounts for the water both used by the plant and discharged into the atmosphere. The amount of water required for ET varies by crop type. The Irrigation Training and Research Center (ITRC) at Cal Poly State University, San Luis Obispo, conducted this research primarily to examine the possibility of using kaolin clay sprays to economically reduce ET, as well as maintain or improve crop quality, quantity, and reduce insect pressure. Previous research on the kaolin clay sprays only focused on crop quality and insect pressure.

In an effort to conserve water while maintaining or improving quality and quantity from pistachio trees an inert kaolin clay product, trademarked Surround™, was applied to large blocks of pistachio trees over two growing seasons. The Surround was applied multiple times each year at specific times during the growth stage to determine if Surround had any impact on ET, nut quality, yield, or insect damage.

The specific goals of this study were to:

1. Verify if the application of a common tree fruit insect pest inhibitor (Surround™) could reduce crop ET on pistachios.
2. Monitor yield and quality between treated and untreated pistachio trees.
3. Document secondary benefits such as reduced insecticide spraying and reduced irrigation pumping (which impacts California energy consumption and peak electric loads).
4. Publicize significant results (if positive) through farm publications, ITRC web pages, and electronic correspondence with water conservation coordinators in California irrigation districts.

A 390-acre orchard near Lost Hills, California, was selected for this study. Factors that were considered during site selection included:

- The entire orchard is irrigated as one set (reducing the effects of varying irrigation on different sets)
- The tree vigor was fairly uniform across the orchard
- The trees were near maturity
- The orchard would provide results on a large scale (not just for individual trees)
- Eight uniform blocks could be easily marked and harvested
- The grower was interested in the study

Working in conjunction with the grower (Rod Stiefvater), NovaSource, the University of California Cooperative Extension, and Paramount Farming Company, ITRC generated a plan to examine eight large adjacent blocks (about 36 acres in size the first year and 9 acres in size the

second year). Four of the blocks were treated three times each with Surround and four of the blocks remained untreated as control blocks. The initial selection of the orchard examined standard aerial and satellite photos for relatively uniform growth/age.

Using historical Landsat satellite images and a technology called SEBAL (Surface Energy Balance Algorithm for Land), which is very effective at estimating ET rates of large areas, the field was documented to have very similar ET rates in each of the eight blocks.

In addition to the SEBAL analysis the following data was also collected and analyzed as part of this research study:

- Soil samples were taken to verify and map soil types across the orchard.
- Soil moisture equipment was installed to monitor soil moisture depletion in each of the treated and control blocks.
- A pressure chamber (leaf bomb) was used to determine the stem water potential in each block on a weekly basis during the growing season.
- The treated and control blocks were harvested individually to determine any yield differences.
- Nut samples were gathered from each block for quality analysis.
- Insect traps were used to identify Naval Orangeworm (NOW) populations in each of the blocks.
- Small blocks of trees were intentionally under-irrigated by replacing the standard 1 gph emitters with 0.5 gph emitters. This provided information about the level of protection that Surround might have on pistachio trees in an extreme condition.
- A pressure switch was installed to determine the actual hours of run time and water applied.

The potential net benefit of this research was hypothesized to be less crop ET, possibly with higher yields because less energy would be used by the trees to repair damage. This means more energy is available to be stored in the fruit, to build healthy roots, and to encourage growth. For permanent crops, such as pistachios, this might result in a more vigorous, healthier tree in the year after the Surround treatment.

The results from the first year of this study demonstrated that Surround had minimal to no impact on, or benefit for, pistachio trees with mild under-irrigation in a single growing season. Furthermore, the data analysis from the second year replicated the results from the first year of the study. The statistical analysis demonstrates that there is no significant difference between pistachio trees that were treated with Surround and pistachio trees that were untreated.

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INTRODUCTION

Nuts are a major crop on the western side of the San Joaquin Valley, where rainfall is minimal. However, irrigation supplies to these and other crops through the California Aqueduct and Delta-Mendota Canal are being drastically reduced. These reductions are leading to:

- Reductions in irrigated acres
- Increased groundwater pumping
- Increased water costs
- The removal of some permanent crops

The common solution for dealing with a lack of water is to fallow land and increase the amount of groundwater pumped on-farm. Fallowing is a simple technique that consists of intentionally not planting a seasonal crop so that permanent crops can be irrigated with the available water, from both surface flows and pumped ground water. However, this solution is becoming less practical as both surface irrigation supplies and the water table continue to decrease. To meet crop water demands for both permanent and seasonal crops, innovative techniques or products will play a critical role.

A product believed to have the potential to help offset reductions in irrigation supplies in the San Joaquin Valley was Surround™. Surround is inert kaolin clay that is directly applied to crops. When Surround is applied to a plant a white film is created that acts as a protective layer. This protective layer, in trials with other tree crops, has been documented to:

- Reduce sunburn on fruit
- Reduce pressure and crop damage from some insect pests
- Increase yield

Research in the area of sunburn and pest protection is widely available, but the effects of Surround on evapotranspiration (ET) and yield specifically for pistachio trees was unknown. This study looked at the possible benefits of using this white coating to reflect light from the plant surface. The assumption was that reflecting sunlight back into the sky could reduce the amount of heat in the orchard. This, in turn, might reduce ET (assuming adequate water is available) without adversely affecting yield, or potentially reduce stress (assuming there is insufficient water available), thereby improving yield.

Surround potentially has direct benefits on photosynthesis as well, by reducing heat and light extremes. A cooler plant uses less water for cooling through transpiration, and the open stomata may enhance CO_2/O_2 exchange. Likewise, water-stressed plants show reduced photosynthesis and can have increased damage, since the chloroplasts continue to absorb light.

The growth of pistachio trees and their yield (quantity and quality) are impacted by conditions in the year of harvest as well as from previous seasons. Therefore, the research was conducted over two growing seasons to obtain a complete picture of the effects of Surround on pistachio trees.

EXPERIMENTAL DESIGN

The Irrigation Training and Research Center (ITRC) at Cal Poly and the UC Davis Cooperative Extension selected a field typical of California pistachio production in the San Joaquin Valley. Significant positive impacts, if seen in this Surround trail, would have substantial benefits for pistachios and other nut crops in similar locations. This section outlines the location of the field trial and the design used to conduct the research.

Research Crop and Field Location

The crop selected for the focus of this research was pistachios. Pistachios thrive in areas with cool winters and long, hot summers. Although pistachio trees are drought resistant, tolerant of excessive summer temperatures, and somewhat salt tolerant, these conditions can reduce yield when water is limited.

Pistachio trees, by their nature, are alternate bearing. This means that for any given year, production might be up and then the following year production will be lower. In addition, the production is set by buds from the previous year. Therefore, it is possible that the Surround could actually impact the production the following year. To address the characteristics of the pistachio tree, the research was conducted for two growing seasons (2009-2010).

Pistachio fields on the west side of the San Joaquin Valley are particularly vulnerable to water shortages now and in the future, especially with reduced flows from the Delta. For these reasons, a pistachio orchard near Lost Hills, California, was selected to conduct this research.

The pistachio field is located on the south side of Lerdo Highway just to the east of the California Aqueduct.

Irrigation Adequacy

The original concept for the research was to find a field that was irrigated to provide "full ET," and then under-irrigate portions of the field that were sprayed with Surround. The thought was that using a combination of Surface Energy Balance Algorithm for Land (SEBAL) analysis, soil moisture monitoring, and stem water potentials, differences in crop ET between treated and non-treated plots could be determined. Furthermore, a detailed yield analysis would detect the impact on yields. The hypothesis was that if Surround was used, the ET could safely be reduced without having any negative impact on yield quality or quantity.

Published unstressed ET values for pistachios vary, depending upon the source. ITRC's published ET rates for pistachios in this area (www.itrc.org) are approximately 39 inches per year (Jan-Dec). Dr. David Goldhamer of University of California (2005) lists the seasonal ET for pistachios of 41 inches (Apr-Nov).

From an irrigation scheduling standpoint, the primary consideration is whether the irrigation system can meet the daily crop ET needs. This is important because in this particular field, with three emitters per tree, only about 25-35% of the soil volume is wet by the emitters. This small

percentage volume means there is very little or no soil moisture storage available to provide supplemental, stored water supply on hot days.

ITRC publishes a peak monthly ET rate for pistachios in this area of 8.8 inches, which gives an average daily ET of about 0.28 inches/day. The gross application rate of the irrigation system is 0.34 inches/day. Assuming an irrigation system distribution uniformity of 0.96 (described later), this allows for a NET application rate of about 0.32 inches/day, which is somewhat lower than the highest daily ET rates, but somewhat higher than the peak monthly ET rate of 0.28 inches/day.

In other words, this field's irrigation system was capable of just meeting the peak ET requirement if the trees were irrigated 24 hours/day, 7 days/week. However, because of a low water allocation from the irrigation district and the high expense of pumping supplemental groundwater, the field in fact was only irrigated about 6 days/week during July and August 2009. The result was a relatively uniform under-irrigation, of about 5%, across the field in 2009.

In 2010, the average summer temperatures were cooler than normal so the grower irrigated less frequently than he did in 2009. In 2009, an average depth of about 30 inches was applied to the field, while in 2010 an average depth of about 25 inches was applied. Therefore, using published ET for pistachios, the orchard was considerably under-irrigated. However, the difference in irrigation water applied each year does not correlate with the achieved yield (refer to the *Results* section of this report for details).

Because of the deficit irrigation, this particular research could therefore not be expected to document any water savings. However, this experimental design was capable of showing if Surround can reduce negative impacts that might otherwise occur if a field is under-irrigated.

Irrigation System and Distribution Uniformity (DU)

A major factor in selecting the test field was that the entire field was irrigated as one block using drip irrigation. This was ideal because it minimizes any potential error that could occur when there are multiple irrigation blocks, which basically equates to the same depth of water being applied to each tree during the growing season when a good irrigation system is used. It is impossible to ensure that all trees receive the same depth of water because irrigation systems are not perfect. To determine the uniformity of the drip system an evaluation was conducted.

The irrigation system distribution uniformity was measured to verify that irrigation water was being applied as evenly as possible across the field. $DU_{low\ quarter}$ is calculated as:

$$DU_{lq} = \frac{Average\ of\ low\ quarter\ Q\ values}{Average\ of\ all\ Q\ values}$$

where Q is equal to flow rate of individual emitters.

To understand the global DU, 18 locations in the field were randomly selected. The flow rates from six emitters were collected at each location for a total of 108 pressure compensating emitter

samples. In addition, pressures were taken at the ends of every hose. These values were complied to calculate the DU of the irrigation system.

> *The result of the DU evaluation was 0.96. This is considered excellent. A DU_{lq} of 1.0 is perfect, meaning every plant receives the same amount of water. Therefore, not only was the field ideal because it was irrigated as a single block, but was also ideal from an irrigation system uniformity standpoint.*

Field Variability

Ideally, the soil and tree vigor across entire field should be uniform. To examine the uniformity of the field's crop vigor the Normalized Difference Vegetation Index (NDVI) was used, which was calculated using a satellite image from 2008, the year prior to the first year of the study (see **Figure 1**).

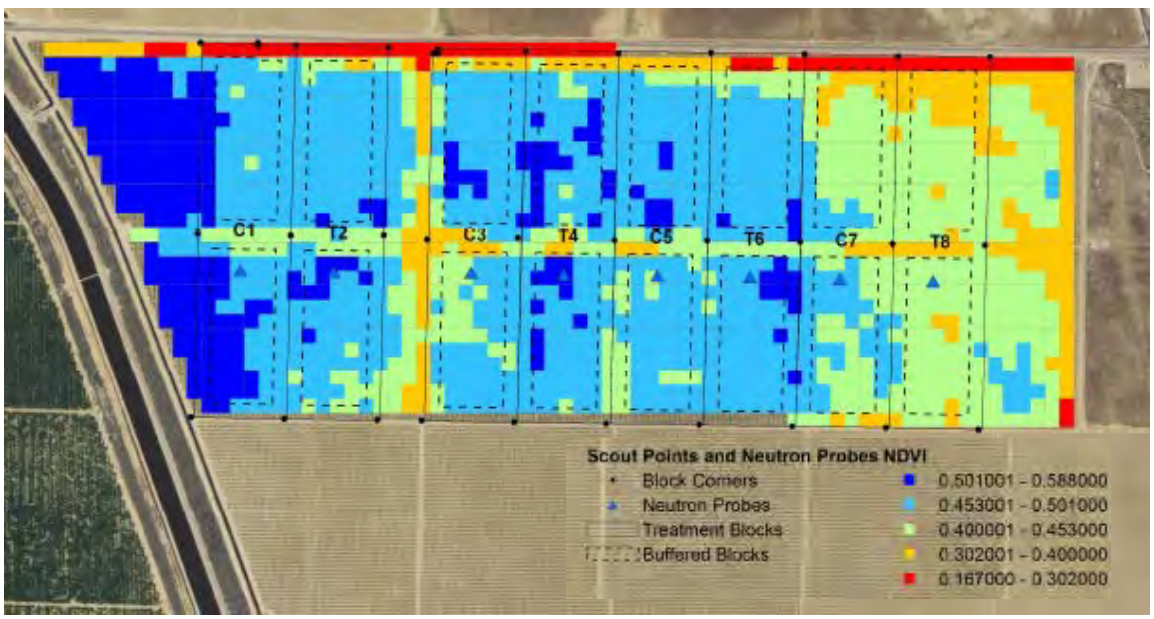


Figure 1. Variation in crop vigor or NDVI. Image from August 2, 2008. Developed by Davids Engineering, Inc.

Using the same image, the surface temperature of the field could be calculated as well. The surface temperature of the field had variations similar to the crop vigor (see **Figure 2**).

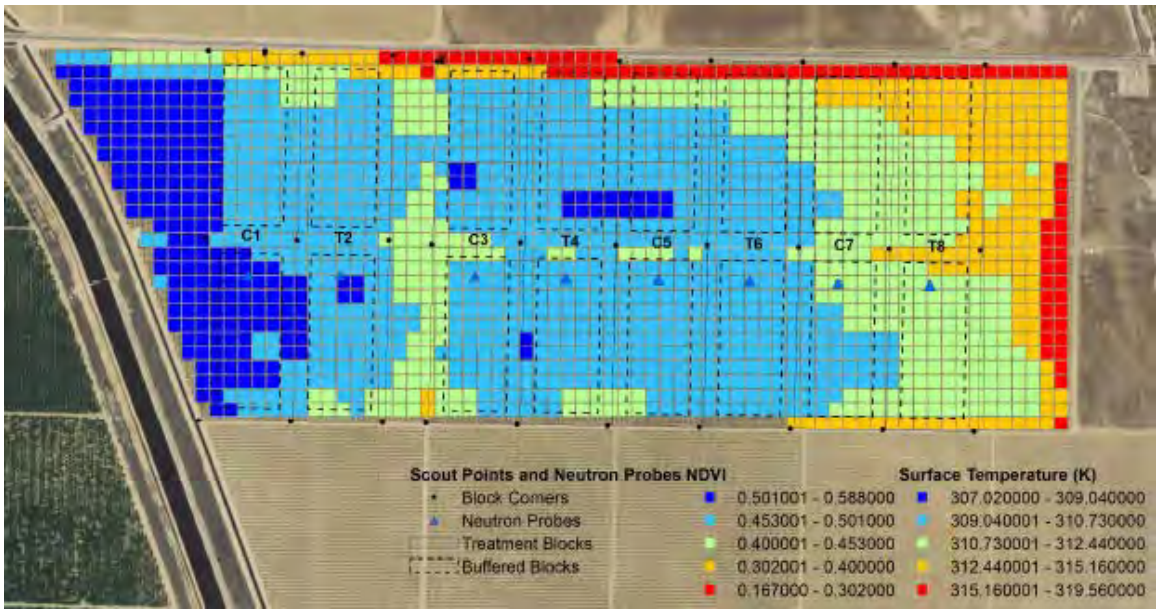


Figure 2. Variation in surface temperature (from left to right). Image from August 2, 2008. Developed by Davids Engineering, Inc.

The variations in vigor and surface temperatures are most likely due to a gradation of salinity across the field. Soil salinity levels are highest on the east side of the field (right-hand side of **Figures 1 & 2**). Due to the variability of both crop vigor and surface temperature, alternating the control and treated plots enabled the analysis to be completed as pairs (C1 to T2, C3 to T4, etc.), as well as on the whole.

Attachment A demonstrates the soil characteristics identified by the National Resource Conservation Service (NRCS) soil survey.

Soil variations and salinity variations are very common and uncontrollable. Therefore, to offset the variation, the eight large test plots were alternated between control and treatment blocks. While Blocks 7 and 8 had slightly lower NDVI and surface temperatures, they were still used as part of this study. The analysis on the right side of ***Figures 1 and 2*** *may have lower values because the trees from the middle of Block 8 to the right were planted a year later. However, these trees were deemed to be mature.*

Water Source

The field was supplied with two sources of water. During the 2009 growing season, approximately 514 acre-feet (AF) were from California Aqueduct water. That water has an EC_{iw} of approximately 0.67 dS/m. Approximately 459 AF were obtained from a well, with an EC_{iw} of approximately 3.5 dS/m. The total applied volume was approximately 973 AF. The total area of the field is about 390 acres.

During the 2010 growing season, both sources of water were used, but the EC_{iw} was not collected. In addition, only approximately 813 AF of water was applied to the 390-acre field.

The orchard was under-irrigated both years when compared to published ET values for pistachio trees. However, ideal weather conditions in 2010 led to a phenomenal production year – even with some deficit irrigation. Therefore, this research could not document any water savings, so the research focuses on yield, quality, and insect damage.

2009 Test Plot Layout

Previous Surround research has mostly been conducted in small, more controlled plots and environments. Because SEBAL was to be used for estimating reductions in ET for treated trees, large plots were needed so that multiple image pixels would be available for each treatment area. The large plots also offset any potential differences on a tree by tree basis because each large plot consisted of approximately 4800 trees.

For the first year of this study, eight large plots (each approximately 36 acres in size) were examined, four of which were treated with Surround and four of which were the non-treated control. A total of 288 acres was used for this study in 2009; 144 acres were treated and 144 acres were non-treated. The control and treated blocks alternated to overcome some field variability from left to right (see **Figure 3**). The saltiest area of the field (on the east end of the field) was not included.

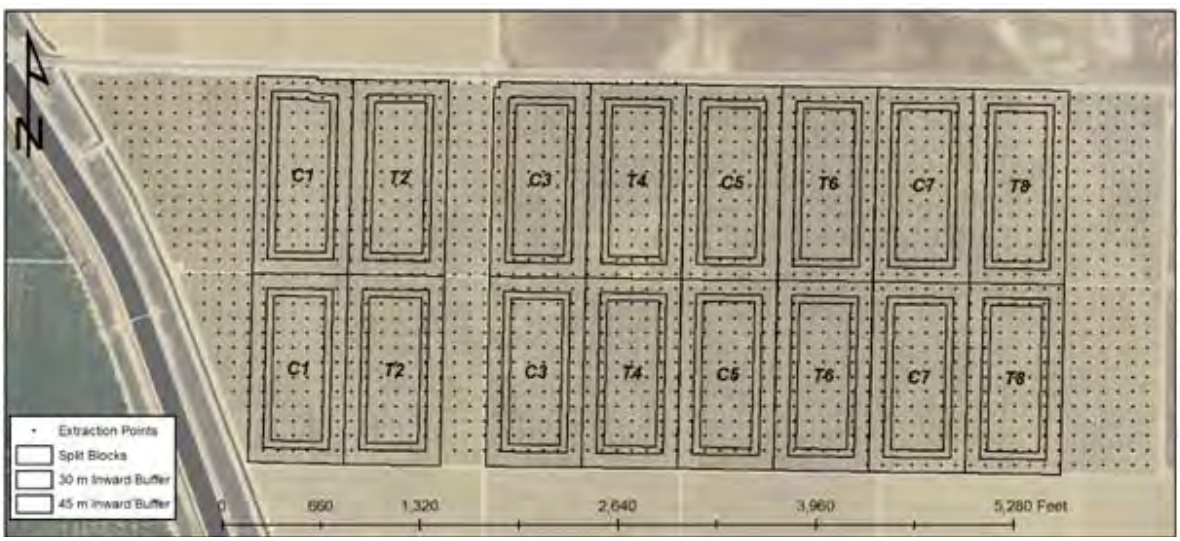


Figure 3. Eight test plots – four control and four treated with Surround™

Each of the large test plots in 2009 was 32 rows wide and 150 trees in length. The tree spacing was 20 feet between rows and 17 feet down a tree row.

<u>Sub-Plots for Extreme Water Stress</u>

In addition to the large 36 acre plots, one sub-plot was created within each large plot (for a total of eight sub-plots). Each sub-plot consisted of eight consecutive trees down a single row. The purpose for these sub-plots was to investigate differences between treated and non-treated trees with a serious water stress that was initiated near the beginning of the nut filling stage (early

July). At that time, the sub-plot trees received only half the water that was applied to the majority of the field.

Using the NDVI map (**Figure 1**), locations for each of the eight sub-plots were selected within each of the large plots by identifying trees with similar indexes for crop vigor. This method improves the analysis between sub-plots because the trees being compared begin with a similar NDVI. The following locations were identified for the sub-plots:

- C1 plot – Row 27, trees 4-11 from the south edge
- T2 plot – Row 12, trees 4-11 from the south edge
- C3 plot – Row 18, trees 4-11 from the south edge
- T4 plot – Row 9, trees 4-11 from the south edge
- C5 plot – Row 20, trees 4-11 from the south edge
- T6 plot – Row 16, trees 4-11 from the south edge
- C7 plot – Row 5, trees 4-11 from the south edge
- T8 plot – Row 2, trees 18-25 from the south edge

The sub-plots were located near the south edge of the field to simplify harvesting and monitoring. The rows are identified based on the large plots moving from the west towards the east. Once the sub-plot locations were selected, the trees were marked and the original Netafim on-line pressure compensating 1.0 gallon per hour (gph) emitters were replaced with Netafim on-line pressure compensating 0.5 gph emitters, which is a 50% reduction in applied water (**Figure 4**).

Figure 4. Replacing on-line 1.0 gph emitters (black) with 0.5 gph emitters (red) to increase stress during nut fill in the sub-plots.

The 50% reduction in applied water was not implemented for the entire season. This reduction began on July 10, 2009, which is just before critical nut filling in pistachio trees. Prior to this, irrigations were 100% of the water applied to the rest of the field. The original emitters were reinstalled after harvest.

2010 Test Plot Layout

Surround did not appear to provide conclusive water savings, yield, or pest management results in a slight under-irrigation condition during the first season. However, there was merit to continuing the study, in a somewhat revised format, for one more year because:

1. The extreme stress results from the small sub-plots were intriguing. It was not known if it was a fluke or if they could be replicated.
2. Trees often have yield impacts that do not show up until the second year.
3. There is increased concern about the Navel Orangeworm damage, and it was hoped that the second year of application would shed some better light on the impact of Surround on NOW.

For these reasons, the large treatment blocks were scaled down from 36 acres in 2009 to 9 acres in 2010 to minimize input costs. However, the small under-irrigated subplots were increased in size from 8 trees to 64 trees to determine if Surround does impact nut production in an extreme stress condition. See **Figure 5** for a map of the 2010 layout.

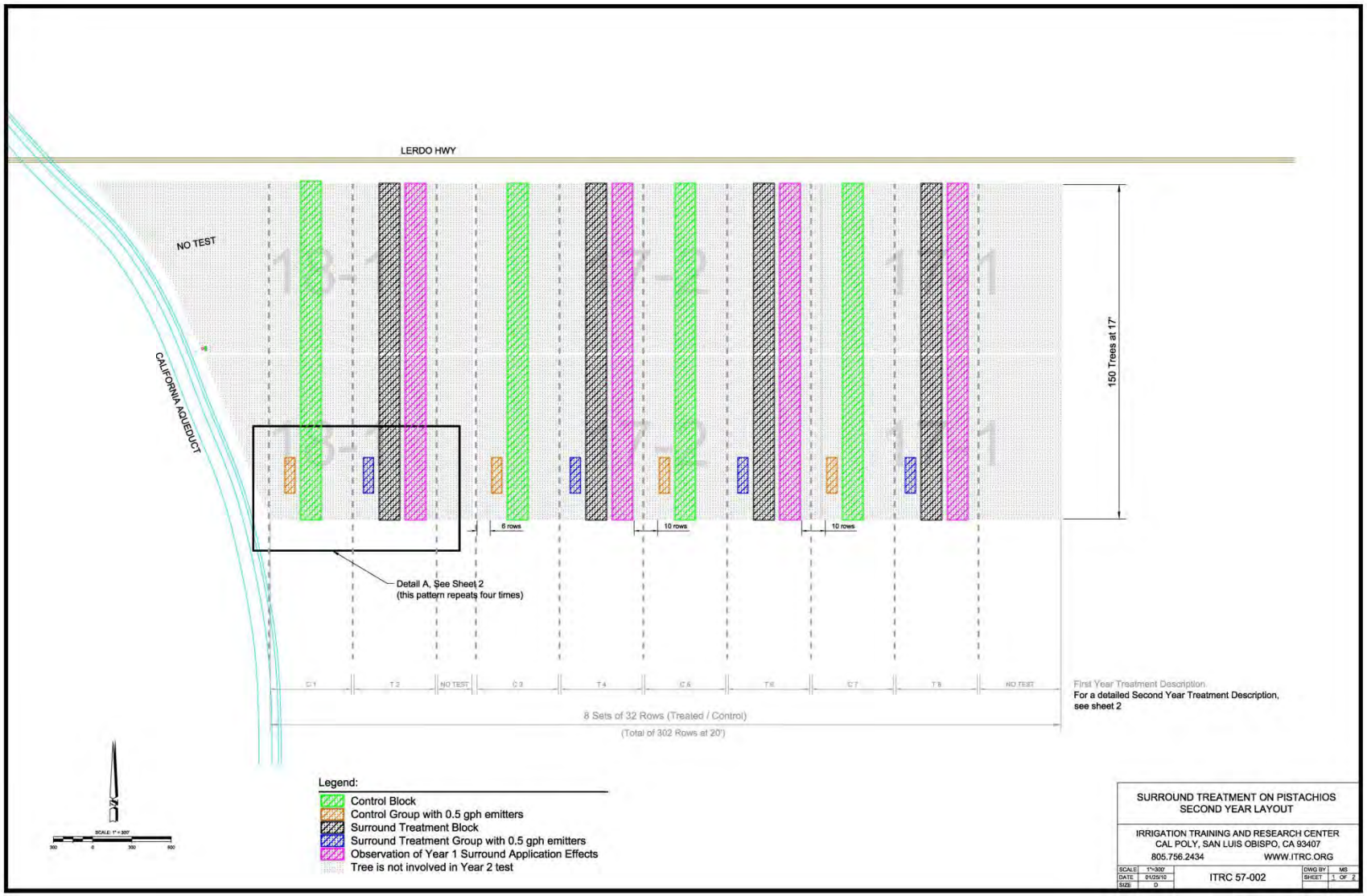


Figure 5. Test plots in 2010 – four control, four treated one year, four under-irrigated sub-plots, and four treated two years with Surround™

The second year of testing was composed of a pattern that repeated four times across the field by alternating between control and treatment blocks. This pattern is based on the Year 1 control/Surround treatments.

There were five different blocks of trees in the second year of testing (replicated 4 times). The descriptions below match the colored blocks shown above in **Figure 5**:

- *Control Block (green).* The control section remained in the same location. However, the size was reduced to 8 rows wide by the length of the orchard, to match the reduced size of the treated section. (Note: There was a 2-row gap between the small control plot with 0.5 gph emitters and the control block to prevent side effects from the reduced irrigation in the deficit irrigated control plot).
- *Small Control Plot with 0.5 gph Emitters (brown).* A group of trees in each control block, 4 rows wide and 16 trees long (for a total of 64 trees), received 50% of the flow that the rest of the orchard received. This portion of the test was expanded from Year 1 (which was only 8 total trees in each block). For the test, the inner 2 rows by 12 trees for a total of 24 trees were harvested.
- ***Surround Treatment Block (black)***. This block of trees was 8 rows wide by the length of the orchard, and received Surround in Year 2. These were trees that also received Surround in Year 1. (Note: There was a 2-row gap between the small Surround treatment plot with 0.5 gph emitters and the Surround treatment block to prevent side effects from the reduced irrigation in the deficit irrigated Surround treatment plot).
- *Surround Treatment Plot with 0.5 gph Emitters (blue).* In Year 1, this block of trees received Surround and normal irrigation. In Year 2, a group of tree in each treatment block, 4 rows wide and 16 trees long (for a total of 64 trees), was treated with Surround, but only received 50% of the irrigation that the rest of the orchard received. For the test, the inner 2 rows by 12 trees for a total of 24 trees were harvested.
- *Observation of Year 1 Surround Application Effects.* This block of trees was 8 rows wide by the length of the orchard. Surround was applied here in Year 1, but it was not applied in Year 2. This was compared to the control blocks and second year application of Surround.

Table 1 provides a description of each proposed test block and the corresponding location in the field. The location descriptions begin at the southwestern corner of the field and move east using the tree rows.

Table 1: Test plots/blocks for Year 2 Layout.

Year 1 Location	Year 2 Plan	Size	Location
Control Section	Control Group with 0.5 gph emitters	A group of 16 trees x 4 rows (total of 64 trees)	Starts at row 7 from the beginning of each Year 1 Control Section. Move 13 trees into the orchard to arrive at the Southwestern corner of group
	Control Block	8 rows wide by length of the orchard	Middle of each Year 1 Control Section
Treatment Section	Surround Treatment Group with 0.5 gph emitters	A group of 16 trees x 4 rows (total of 64 trees)	Starts at row 5 from the beginning of each Year 1 treated block. Move 13 trees into the orchard to arrive at the Southwestern corner.
	Surround Treatment Block	8 rows wide by the length of the orchard	Move to row 11 from the beginning of each Year 1 treated block to arrive at the Southwestern corner.
	Observation of Year 1 Surround Application Effects	8 rows wide by the length of the orchard	Move to row 21 rows from the beginning of each Year 1 treated block to arrive at the Southwestern corner.

Expansion of Water Stressed Sub-Plots

A detailed view of one of the replications is shown in **Figure 6**. The emitters in the small deficit irrigated plots (shown in orange and blue below) were replaced with 0.5 gph Netafim emitters on May 15, 2010. These trees were deficit irrigated at 50% of the rest of the orchard from that point through harvest. Because we observed interesting results from the first year of deficit irrigated trees (which were very few), the small plots were expanded to determine if Surround may help in an extreme stress condition.

A total of 64 trees in each of the control and treatment blocks were deficit irrigated in 2010. To prevent water from nearby trees from affecting the results, only the inner 24 trees were harvested for yield and quality analysis. This provided a two-tree buffer of under-irrigated trees around the test plot used for this study.

Figure 6. Large test plots in 2010 – four control, four treated one year and four treated two years with Surround™

RESEARCH METHODS

Measurements were taken throughout both growing seasons to quantify the following:

1. Historical Field Variations in Evapotranspiration (ET)

During the first year of the study, historical Landsat satellite images were processed using a technology called SEBAL, which is used to estimate evapotranspiration rates of large areas. Pixel by pixel, SEBAL (Surface Energy Balance Algorithm for Land) computes water consumption and biomass production in natural, urban and agricultural environments using 25 computational steps incorporated into 19 models. In contrast to other water consumption calculation methods, SEBAL uses spectral radiances recorded by satellite-based sensors, plus ordinary weather data, to solve for the energy balance from the Earth's surface. This method provides a good estimate of the actual ET, which includes the effects of water availability, crop vigor, management practices, and any other factors that can influence ET.

During the second year of the study another modeling program called METRIC (Mapping EvapoTranspiration at high Resolution with Internalized Calibration) was used to verify the ET of the entire field. The purpose for using this model was to verify that the control and treatment blocks started at a relative point to one another each year of the study. The Idaho Department of Water Resources (IDWR) in conjunction with University of Idaho's department of Agricultural and Biological Engineering (UI) worked to develop and apply this computer model. It uses Landsat satellite data to compute and map ET. ITRC believed this would be a good opportunity to help field-verify the model as well as verify the initial status of each test block.

The purpose of these historical examinations was to document ET rates over the entire test field comparing it to the previous year as well as the year following the two-year study.

2. Differences in ET between Treated and Untreated Plots

Although SEBAL is known to produce reasonable estimates of crop ET, the introduction of Surround changes the albedo (reflectance). If SEBAL estimates of ET could match in-field ET estimates (based on application, stress and soil moisture), SEBAL would give more extensive data on ET variation than one could obtain with field measurements.

The same is true for METRIC. However, if the model is impacted by the application of Surround, these models would only be used to verify initial field conditions, rather than to estimate the actual crop ET from the control and treatment blocks.

3. Differences in Tree Stem Water Potential and Soil Moisture

To determine the amount of stress in a particular block or trees, tree Stem Water Potential (SWP), using shaded bagged leaves, was measured bi-weekly and soil moisture data was measured once a week in each of the plots. Using a leaf bomb, SWPs were gathered from a given tree in the middle of each of the control, treatment, and deficit irrigated plots.

This analysis was used to determine any differences in crop stress between treated, untreated, and deficit irrigated plots. SWP does not quantify ET, but the values recorded at mid-day are an indication of maximum water stress in the tree and can help explain differences in yield and ET.

In addition to SWPs, access tubes for a neutron probe were installed in each plot to monitor the water available to the trees with time. Using the neutron probe, soil moisture data was collected on a weekly basis. This information was used to determine if Surround may keep the trees cooler which, in turn, may reduce the water consumed by the trees, leaving more moisture in the soil. Likewise, the soil moisture content could have potentially helped explain the yield results and/or SEBAL estimates.

Because the plots were adjusted the second year, the soil moisture and SWP locations were moved from the previous year to accommodate the new test plots.

4. Differences in Measured Yield Quantity and Quality

Yield was measured for each treated and non-treated plot individually as well as the small deficit irrigated sub-plots. Yields for pistachios trees are based on the total tonnage and the percentage of splits. Because the nut filling stage (from about July 1 until August 15) is very sensitive to moisture stress, it was anticipated that yields and quality may improve on the treated plots. Furthermore, the split percentage could potentially be improved.

In addition to sampling each of the large plots for quality and yield, during the second year, quality analysis samples were also collected from pistachio trees adjacent to each of the small deficit irrigated sub-plots to determine if Surround can maintain quality even with severe under-irrigation.

5. Pest Management

Secondary benefits which may be able to minimize inputs such as reduced insecticide spraying were also recorded. Using pheromone traps and collecting nut samples from several trees, this information was used to determine if Surround can reduce Navel Orangeworm (NOW) populations. The pheromone traps were placed in each of the test plots to track NOW infestations.

Application of Surround in 2009

Surround protects the plant by adhering to the plant's leaves. Therefore, the Surround was applied after foliage had developed, but before the critical nut filling stage. More than one application of Surround was necessary to ensure proper coverage each year. The applications of Surround were also aligned with the NOW flight patterns, in order to predict the NOW movement and apply the Surround prior to that date to detour them from laying eggs in the treatment blocks.

Surround was applied to the treated plots twice. The first application was on May 21st (**Figure 7**) and the second application was on June 10-11th (**Figure 8**).

Figure 7. First application of Surround on May 21, 2009.

Figure 8. Second application of Surround on June 10-11, 2009.

Each application consisted of a six percent concentration applied at 2.5 miles per hour. The application rate was 150 gallons of solution per acre. At a six percent concentration, roughly 75 pounds of Surround was applied per acre after both applications. For the second application, the sprayer traveled down a tree row in the opposite direction to ensure uniform coverage over the entire tree (**Figure 9**).

Figure 9. Application of Surround via large fan sprayers.

The original plan in 2009 was to apply Surround to the treated plots in three applications. However, because the first two applications were so effective, the third application was deemed unnecessary (**Figure 10**).

Figure 10. Excellent Surround coverage after two applications. Treated and non-treated plots are shown.

Application of Surround in 2010

During the second year of the study, three applications of Surround were applied. The first was applied on May 28th and applied 50 pounds per acre of Surround in 150 gallons of water per acre at approximately 2.5 mph. The Surround solution was applied so that the mixture just began to drip from the tree leaves (**Figure 11**).

Figure 11. First application dripping

After the first application was applied, a number of observations were made, including:

- The uniformity of the application (Leaves within the tree were not coated, and leaves near the top were not as well coated)
- The effectiveness of the application

Because preliminary results from the first year did not indicate any potential water savings, yield differences, or quality differences, the decision was made to coat the trees exceptionally well the second year to provide this trial with the best potential for success. Then, if Surround did demonstrate the projected outcomes of this study, the proper amounts could be determined in future studies.

To address the observations from the first application, two more applications of Surround were applied at 50 pounds per acre in 150 gallons of water per acre, but at a speed of 2 mph. The second application was on June 29th and the third application was on August 18th. The end result was complete coverage of the treated trees (**Figure 12**).

Figure 12. Trees after third application.

Collecting Soil Moisture and Leaf Water Potential Data

Class 125 two-inch diameter PVC pipe access tubes were installed 16 trees south of the middle road inside each of the test plots to a depth of nine feet. The tube provides access to soil moisture content using the neutron probe. The locations of the tubes are shown as blue triangles in the false color composite diagram illustrated in **Figure 13**.

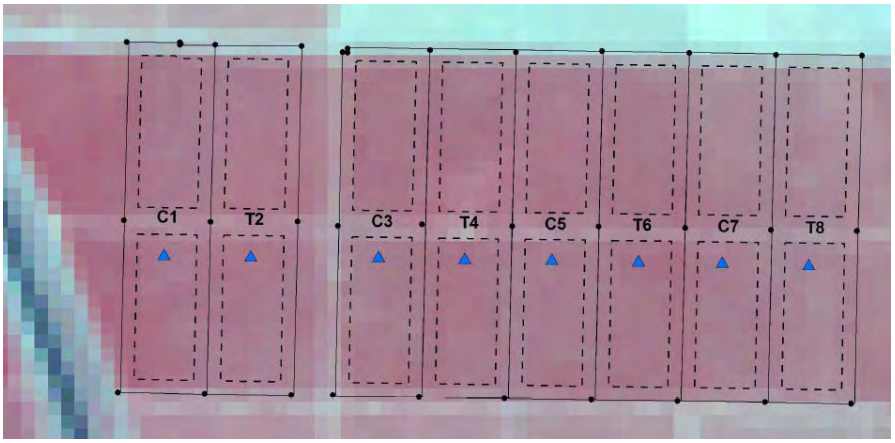


Figure 13. Locations of soil moisture access tubes (blue triangles) in 2009. Shown on a false color composite map using Landsat 7 imagery from August 2, 2008. Developed by Davids Engineering, Inc.

In 2010, more access tubes were installed. In addition to the locations shown in **Figure 13**, access tubes were also installed in each of the small deficit irrigated sub-plots. These measurements were used to determine if Surround might prevent the soil moisture in these small blocks from being consumed as quickly (**Figure 14**).

Figure 14. Neutron probe access tube

SWP was determined bi-weekly by wrapping a shaded leaf from the tree adjacent to neutron probe tubes in a foil bag about 30 to 90 minutes prior to sampling. The bagged leaf was cut from the branch between 12 and 3 PM and inserted into a Pressure Measurement Systems (PMS) pressure chamber, to determine tree SWP in bars of pressure. SWP from the eight sub-plots was also collected to determine if Surround had any impact on stressed pistachio trees. The soil water content was measured weekly and the SWP bi-weekly from April to October 2009 and from May to November in 2010.

Monitoring Water Applied

To verify the amount of water that was applied to the field during the growing season, residential flow meters were installed in-line in each block to monitor the volume of water applied to a given number of trees. In addition, in 2010, a pressure switch was installed in-line which recorded the number of hours the system had run (**Figure 15**). This information was compared to CIMIS to determine if the fields were irrigated at full ET.

Figure 15. Monitoring water applied

Collecting Yield Data

The orchard was harvested from September 14-18, 2009 (**Figure 16**). During that time, the yield from each large 36-acre block was loaded into marked trucks. For each load, the net field weights of commercial trucks and the standard quality turnout data from the processor were referenced back to the plot from which it originated. Paramount Farms provided the weights of each truck as well as the quality data from a 20-pound sample that is pulled from the truck when it is unloaded.

During the second year, the blocks were harvested from September 25 through October 1, 2010. The harvest was completed in the same manner as it was in 2009. It was evident during the harvest that the trees were in an "on" year. In addition, the number of male trees in each of the blocks was counted to determine yield per acre of female trees. This information was collected because the blocks were in a slightly different pattern compared to the first year (see **Figure 5**).

Figure 16. One of four harvesting units used to determine the yield from the pistachio plots

Harvesting the Small Deficit Irrigated Sub-Plots in 2009

The "50% reduced irrigation" sub-plots were made up of eight trees near the south edge of the field in 2009. Each large plot had one sub-plot nested within it. The inner six trees were sampled, leaving the end trees as a buffer to ensure that the harvest information was not influenced by trees receiving more than 50% of the applied water. The small deficit irrigated sub-plots were harvested by hand using poles and tarps because the grower did not want to slow the production harvesting (**Figure 17**). Only one row of eight trees was retrofitted with 0.5 gph emitters so that there were no adjacent "buffer rows" that also received reduced water. Thus, the test trees may have had the benefit of some higher level of available water across the row.

Figure 17. Sub-plots were hand harvested and weighed in the field.

Debris was removed from the weighed product (**Figure 18**). These sub-plot weights were not included in the large plot yields for simplification purposes. A 14- to 20-pound sub-sample was collected from each sub-plot and analyzed by the processor in exactly the same manner as the large production sub-samples from trucks to determine the quality of the product.

Figure 18. Removing debris from sub-plots and collecting samples for quality.

Harvesting the Small Deficit Irrigated Sub-Plots in 2010

The study was conducted for a second year largely because the preliminary results in the small deficit irrigated sub-plots in 2009 were intriguing. To determine if these results were accurate the sub-plots were expanded from a total of 8 trees to a total of 64 trees. In 2010, however, the trees were not harvested by hand, but mechanically harvested to remove the variability of hand harvesting.

The inner 24 trees of each small deficit irrigated block were marked with a ribbon and harvested prior to the entire row. These bins were weighed on site using a large trailer scale (**Figure 19**). The treated sub-plots were compared to untreated sub-plots to determine if Surround has positive impacts on yield or quality.

Figure 19. Harvesting under-irrigated subplots and weight the bins.

Monitoring Insect Pressure

The principal pest for pistachios is the Navel Orangeworm (NOW). NOW feed on the meat of the pistachio, causing discoloration and resulting in damaged product. A simple pheromone trap was deployed in each of the large plots to monitor NOW infestations (**Figure 20**).

Figure 20. Pheromone trap used as an indicator of NOW within a control test plot.

Nut samples were taken from each plot to verify actual damage because of NOW. Approximately 8,000 nuts were collected from each large plot in 2009 and approximately 20,000 nuts were collected from each plot in 2010. Each nut was individually evaluated to understand any benefits that Surround has on NOW populations.

No pesticides or other chemicals were applied with the aim at reducing NOW populations. Therefore, it is assumed that any reduction in NOW populations could be attributed to the application of Surround.

RESULTS

The results from the first year of this study demonstrated that Surround had minimal impact on, or benefit for, pistachio trees with mild under-irrigation in a single growing season. Furthermore, the data analysis from the second year replicated the results from the first year of the study. The statistical analysis demonstrates that there is no significant difference between pistachio trees that were treated with Surround and pistachio trees that were untreated.

Evapotranspiration

The original experimental design intended to use computations in SEBAL with an image from 2008 (**Figure 21**) as the benchmark and then track relative ET in the treated and control plots/blocks based on values obtained using SEBAL during the research period in 2009 (**Figure 22**). **Figure 22** shows that the SEBAL technique computes a significant reduction in ET on treated plots. However, this was not consistent with soil moisture depletion measurements, which showed equal water uptake throughout the field. It was concluded that SEBAL does not give valid ET estimates when there is a highly reflective substance such as Surround on the leaves. Therefore, SEBAL could not provide data that could be used for this study.

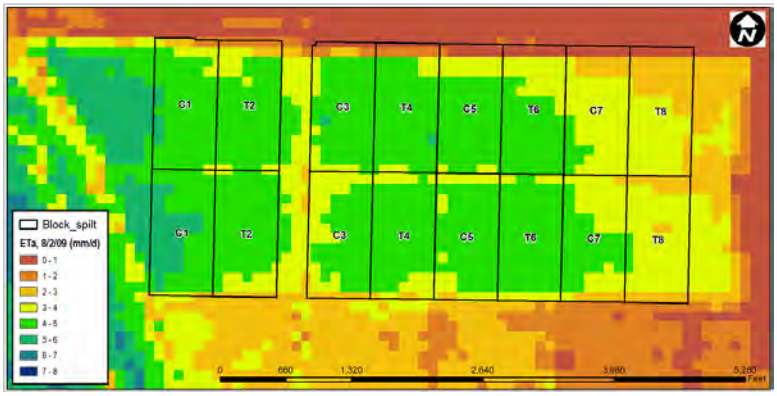


Figure 21. SEBAL image on August 2, 2008 before Application of Surround. Developed by Davids Engineering, Inc.

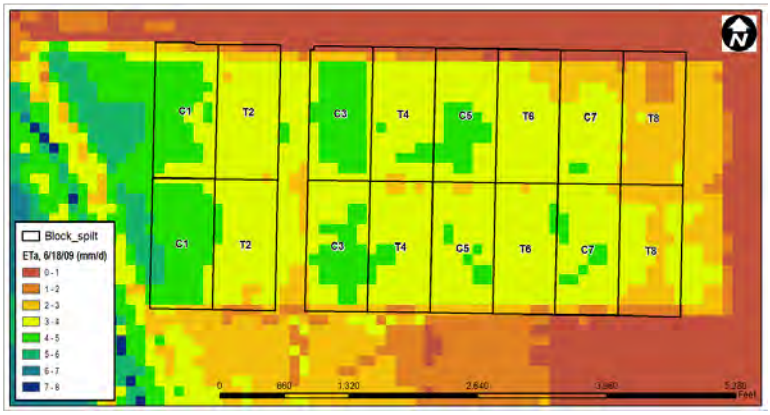


Figure 22. SEBAL image on June 18, 2009 after Application of Surround. Developed by Davids Engineering, Inc.

Large Plot Yield and Quality

Because SEBAL could not be used to determine if there are any water savings because of Surround, the focus of this study turned to yield and quality. Yields were considered because it was assumed that a potential reduction in crop stress may translate into an increase in yield. For this reason, yield data was collected from each of the large plots. Each load was tracked from the field to the processing plant. The yield results from both 2009 and 2010 are shown in **Table 2**.

The planting year did vary between blocks. However, all the trees were deemed mature for production purposes. The alternate bearing year did not hold true during this research study. A mild summer, in 2010, led to an exceptional production year for all growers in the San Joaquin Valley. Therefore, while it was believed that some trees where in an "on" year in 2009, they did even better in 2010.

Each treatment was replicated four times each year. However, the large treatment blocks were scaled down from 36 acres in 2009 to 9 acres in 2010 to minimize input costs. Furthermore, data was collected from four blocks that were only treated with Surround the first year of the study to determine if Surround had any lingering effects.

Table 2: Yield and quality results for large plots

								Lbs/acre						Quality (%)				
Year	Block	Planting Year	Alternate	Description	# Rows	# Male Rows	Acres	Split Inshell	Yield	Damage	Ed IS from CS	Light Stained	Blanks	Light Stained	Blanks	Split IS	Total Insect Damage	Total IS Wt
2009	C1	2000	off	Control	32	7	35.98	1976	2243	9	194	30	369	0.38%	4.77%	73.78%	0.12%	29.30%
2010	1	2000	on	Control	8	2	8.96	5217	6795	19	1452	148	475	0.76%	2.49%	69.94%	0.10%	35.08%
2009	T2	2000	off	Surround	32	6	36.06	2217	2441	24	134	54	531	0.60%	6.00%	71.70%	0.27%	27.62%
2010	2	2000	on	Surround (2 yrs)	8	2	8.90	4995	6726	20	1603	133	593	0.75%	2.91%	65.98%	0.10%	34.29%
2010	3	2000	on	Surround (1st yr only)	8	1	9.13	4678	5835	41	1109	124	415	0.75%	2.51%	71.97%	0.25%	35.35%
2009	C3	1999	on	Control	32	6	36.06	3176	3563	60	231	93	913	0.68%	6.78%	67.55%	0.45%	26.80%
2010	4	1999	on	Control	8	2	8.90	4758	5883	19	1010	316	379	1.92%	2.34%	74.37%	0.12%	36.50%
2009	T4	1999	on	Surround	32	7	35.83	3314	3764	49	337	122	961	0.88%	7.02%	67.19%	0.35%	27.43%
2010	5	1999	on	Surround (2 yrs)	8	2	8.90	5236	6783	25	1399	429	297	2.42%	1.67%	72.02%	0.14%	37.45%
2010	6	1999	on	Surround (1st yr only)	8	2	8.90	5363	6725	14	1257	232	306	1.27%	1.74%	74.94%	0.08%	37.43%
2009	C5	1999	on	Control	32	6	36.06	2932	3419	60	379	106	903	0.85%	7.25%	64.48%	0.48%	27.50%
2010	7	1999	on	Control	8	2	8.90	4782	6385	35	1520	486	321	2.79%	1.80%	69.26%	0.20%	36.56%
2009	T6	1999	on	Surround	32	6	36.06	2929	3380	51	326	130	875	1.09%	6.98%	65.99%	0.42%	27.76%
2010	8	1999	on	Surround (2 yrs)	8	2	8.90	5519	6764	43	1145	534	324	2.80%	1.78%	75.91%	0.23%	36.68%
2010	9	1999	on	Surround (1st yr only)	8	2	8.90	5231	6546	44	1214	467	379	2.47%	2.08%	73.53%	0.24%	35.84%
2009	C7	1999	on	Control	32	7	35.83	2876	3595	42	590	165	815	1.38%	6.65%	62.82%	0.34%	29.18%
2010	10	1999	on	Control	8	2	8.90	5018	6256	62	1108	612	212	3.73%	1.31%	76.13%	0.38%	38.36%
2009	T8	14 rows 1999, 18 rows 2000	split	Surround	32	6	36.06	2523	3076	60	445	131	806	1.19%	7.32%	62.49%	0.54%	27.80%
2010	11	4 rows 1999, 4 rows 2000	on	Surround (2 yrs)	8	2	8.90	5060	5952	41	815	327	307	2.03%	1.89%	79.53%	0.25%	36.68%
2010	12	2000	on	Surround (1st yr only)	8	2	8.90	4991	6172	51	1108	382	339	2.47%	2.28%	74.01%	0.31%	37.48%

Statistical Analysis of the Large Plot Yield Results

All statistical analyses were carried out using SAS/STAT software, Version [9.2] of the SAS System for Windows. An analysis of variance was used to compare Surround and control means for each response variable. Treatment and control plots were blocked within the field and block was considered a random factor for purposes of statistical modeling. Multiple comparisons were carried out using Tukey's method to control the family-wise error rate at 0.05.

Yield

In 2009, there was no significant difference ($p = 0.8301$) in the mean yields (lbs/acre) of Surround and control.

Table 3: 2009 mean yields (lbs/acre) for Surround and control.

Treatment	Mean(SE) lbs/acre
Surround	3165.3 (301.95)
Control	3204.9 (301.95)

In 2010, there were no significant differences ($p = 0.6424$) among the mean yields (lbs/acre) for plots treated with Surround in both years, plots treated with Surround in 2009 only, and control.

Table 4: 2010 mean yields (lbs/acre) for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) lbs/acre
Surround – 2 year application	6556.2 (126.06)
Surround – 1 year application	6319.6 (126.06)
Control	6330.1 (196.06)

Split Inshell Weight

In 2009, there was no significant difference ($p = 0.9673$) in the split inshell mean weights (lbs/acre) for Surround and control.

Table 5: 2009 split inshell mean weights (lbs/acre) for Surround and control.

Treatment	Mean(SE) lbs/acre
Surround	2745.7 (251.19) a
Control	2740.0 (251.19) a

In 2010, there were no significant differences ($p = 0.3908$) among the split inshell mean weights (lbs/acre) for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 6: 2010 split inshell mean weights (lbs/acre) for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) lbs/acre
Surround – 2 year application	5202.4 (126.67)
Surround – 1 year application	5065.4 (126.67)
Control	4943.6 (126.67)

Split Inshell (%)

In 2009, there was no significant difference (p = 0.6931) in the percentage split inshell means for Surround and control.

Table 7: 2009 percentage split inshell means for Surround and control.

Treatment	Mean(SE) %
Surround	6.68 (2.17)
Control	6.72 (2.17)

In 2010, there were no significant differences (p = 0.3908) among the percentage split inshell means for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 8: 2010 percentage split inshell means for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) %
Surround – 2 year application	7.34 (1.97)
Surround – 1 year application	7.36 (1.97)
Control	7.24 (1.97)

Light Stained

In 2009, there was no significant difference (p = 0.5237) in the light stained mean weights (lbs/acre) of for Surround and control.

Table 9: 2009 light stained mean weights (lbs/acre) for Surround and control.

Treatment	Mean(SE) lbs/acre
Surround	109.1 (23.60)
Control	98.4 (23.60)

In 2010, there were no significant differences (p = 0.4389) among the light stained mean weights (lbs/acre) for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 10: 2010 light stained mean weights (lbs/acre) for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) lbs/acre
Surround – 2 year application	355.7 (88.30)
Surround – 1 year application	301.1 (88.30)
Control	390.8 (88.30)

Light Stained (%)

In 2009, there was no significant difference (p = 0.3392) in the percentage light stained means for Surround and control.

Table 11: 2009 percentage light stained means for Surround and control.

Treatment	Mean(SE) %
Surround	0.94 (0.17)
Control	0.82 (0.17)

In 2010, there were no significant differences (p = 0.4389) among the light stained mean percentages for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 12: 2010 percentage light stained means for 2-year and 1-year applications of Surround and control.

Treatment	Mean(SE) %
Surround – 2 year application	2.00 (0.51)
Surround – 1 year application	1.74 (0.51)
Control	2.30 (0.51)

Edible Inshell from Closed Shell

In 2009, there was no significant difference (p = 0.5198) in the edible inshell from closed shell mean weights (lbs/acre) of Surround and control.

Table 13: 2009 edible inshell from closed shell mean weights (lbs/acre) for Surround and control.

Treatment	Mean(SE) lbs/acre
Surround	310.3 (78.24)
Control	348.3 (78.24)

In 2010, there were no significant differences (p = 0.8262) among the edible inshell from closed shell mean weights (lbs/acre) for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 14: 2010 edible inshell from closed shell mean weights (lbs/acre) for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) lbs/acre
Surround – 2 year application	1240.8 (123.96)
Surround – 1 year application	1171.9 (123.96)
Control	1272.4 (123.96)

Total Inshell Wt (%)

In 2009, there was no significant difference (p = 0.4136) in the percentage total inshell weight means of Surround and control.

Table 15: 2009 percentage total inshell weight means for Surround and control.

Treatment	Mean(SE) %
Surround	27.65 (0.44)
Control	28.20 (0.44)

In 2010, there were no significant differences (p = 0.7624) among the percentage total inshell weight means for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 16: 2010 percentage total inshell weight means for 2-year and 1-year applications of Surround and control.

Treatment	Mean(SE) %
Surround – 2 year application	36.27 (0.64)
Surround – 1 year application	36.52 (0.64)
Control	36.63 (0.64)

Blanks

In 2009, there was no significant difference (p = 0.3851) in the mean weight of blanks (lbs/acre) for Surround and control.

Table 17: 2009 blank mean weights (lbs/acre) for Surround and control.

Treatment	Mean(SE) lbs/acre
Surround	793.2 (112.46)
Control	749.9 (112.46)

In 2010, there were no significant differences (p = 0.7988) among the mean weights of blanks (lbs/acre) for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 18: 2010 blank mean weights (lbs/acre) for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) lbs/acre
Surround – 2 year application	380.2 (53.76)
Surround – 1 year application	359.8 (53.76)
Control	346.8 (53.76)

Blanks (%)

In 2009, there was no significant difference (p = 0.2369) in the percentage blanks means for Surround and control.

Table 19: 2009 percentage blanks means for Surround and control.

Treatment	Mean(SE) %
Surround	6.83 (0.44)
Control	6.36 (0.44)

In 2010, there were no significant differences (p = 0.8276)) among the percentage blanks means for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 20: 2010 percentage blanks means for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) %
Surround – 2 year application	2.06 (0.25)
Surround – 1 year application	2.15 (0.25)
Control	1.99 (0.25)

Damage

In 2009, there was no significant difference (p = 0.7051) in the mean damage (lbs/acre) for Surround and control.

Table 21: 2009 damage means (lbs/acre) for Surround and control.

Treatment	Mean(SE) lbs/acre
Surround	45.9 (10.15)
Control	42.7 (10.15)

In 2010, there were no significant differences (p = 0.7670) among the damage means (lbs/acre) for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 22: 2010 blank mean weights (lbs/acre) for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) lbs/acre
Surround – 2 year application	32.2 (8.25)
Surround – 1 year application	37.4 (8.25)
Control	33.9 (8.25)

Damage (%)

In 2009, there was no significant difference (p = 0.5609) in the percent damage means for Surround and control.

Table 23: 2009 percent damage means for Surround and control.

Treatment	Mean(SE) %
Surround	0.40 (0.07)
Control	0.35 (0.07)

In 2010, there were no significant differences (p = 0.7146) among the percent damage means for plots applied with Surround in both years, plots applied with Surround in 2009 only, and control.

Table 24: 2010 percent damage means for 2-year and 1-year applications of Surround, and control.

Treatment	Mean(SE) %
Surround – 2 year application	0.18 (0.05)
Surround – 1 year application	0.22 (0.05)
Control	0.20 (0.05)

For the full analysis, see **Attachment B**.

Small Deficit Irrigation Sub-Plot Yield and Quality

The small deficit irrigated sub-plots were also harvested to compare yields. In 2009, six of the sub-plot trees irrigated at 0.5 gph and six trees (irrigated at 100%) adjacent to and two tree rows east of the small sub-plots were hand-harvested for comparison purposes. The assumption was that trees with significantly higher stress may be able to yield more pistachios when treated with Surround.

In 2010, the deficit irrigation sub-plots were expanded to include 64 trees because the 2009 results indicated that there was a significant difference for deficit irrigated trees coated with Surround. Four of the sub-plots were treated with Surround and four of them were used as control blocks.

Table 25 demonstrates the average yield differences from the hand-harvested sub-plots by treatment in 2009 and the mechanically harvested sub-plots in 2010.

Table 25: Yield and quality results from the small deficit irrigated sub-plots

							Lbs/acre				Quality (%)			
Year	Block	Tag #	Planting Year	Description	# Trees	Irrigation	Split Inshell	Yield	Damage	Ed IS from CS	Light Stained	Split IS	Total Insect Damage	Total IS Wt
2009	C1	8849	2000	Control	6	1/2 gph	2380	2596	19	168	1.14%	76.55%	0.60%	26.17%
2009	C1	8850	2000	Control	6	1 gph	2666	2802	17	66	2.21%	81.58%	0.52%	27.65%
2010	C1	9506	2000	Control	24	1/2 gph	5470	8338	26	2761	0.62%	62.95%	0.30%	39.57%
2010	C1	9514	2000	Control	24	1 gph	5217	6796	19	1452	20.54%	50.03%	0.26%	35.08%
2009	T2	8851	2000	Surround	6	1/2 gph	2662	2818	35	130	2.14%	77.92%	1.02%	26.19%
2009	T2	8852	2000	Surround	6	1 gph	1980	2149	46	61	2.18%	70.35%	1.64%	21.65%
2010	T2	9507	2000	Surround	24	1/2 gph	2547	6226	0	3625	0.20%	40.65%	0.00%	43.02%
2010	T2	9515	2000	Surround	24	1 gph	4994	6724	20	1603	5.45%	69.86%	0.26%	34.29%
2009	C3	8853	1999	Control	5	1/2 gph	1895	2088	17	180	0.46%	61.80%	0.56%	20.69%
2009	C3	8854	1999	Control	5	1 gph	2375	2624	90	76	1.06%	57.22%	2.16%	16.47%
2010	C3	9508	1999	Control	22	1/2 gph	2042	4618	58	2480	0.00%	37.13%	1.06%	36.41%
2010	C3	9516	1999	Control	22	1 gph	4757	5882	19	1010	7.54%	74.39%	0.30%	36.50%
2009	T4	8855	1999	Surround	6	1/2 gph	3034	3385	27	203	0.92%	63.66%	0.56%	21.66%
2009	T4	8856	1999	Surround	6	1 gph	2736	2979	33	143	1.06%	63.69%	0.78%	17.99%
2010	T4	9509	1999	Surround	22	1/2 gph	2695	5351	10	2641	0.74%	41.46%	0.16%	36.26%
2010	T4	9517	1999	Surround	22	1 gph	5235	6782	25	1399	2.68%	82.26%	0.35%	37.45%
2009	C5	8855	1999	Control	6	1/2 gph	2862	3117	41	151	0.82%	71.55%	1.04%	24.74%
2009	C5	8856	1999	Control	6	1 gph	2276	2448	51	91	1.96%	72.90%	1.64%	25.43%
2010	C5	9510	1999	Control	22	1/2 gph	2503	5872	0	3309	0.00%	38.93%	0.00%	40.09%
2010	C5	9518	1999	Control	22	1 gph	4781	6384	35	1519	13.71%	66.08%	0.50%	36.56%
2009	T6	8855	1999	Surround	6	1/2 gph	3295	3584	21	198	0.26%	73.95%	0.48%	28.34%
2009	T6	8856	1999	Surround	6	1 gph	3158	3441	24	244	0.00%	74.72%	0.58%	5.77%
2010	T6	9511	1999	Surround	22	1/2 gph	2457	5255	0	2748	0.36%	43.14%	0.00%	40.14%
2010	T6	9519	1999	Surround	22	1 gph	5518	6762	43	1145	5.23%	73.31%	0.59%	36.68%
2009	C7	8855	1999	Control	6	1/2 gph	2621	3122	0	469	0.16%	66.35%	0.00%	26.78%
2009	C7	8856	1999	Control	6	1 gph	2720	2987	13	188	0.96%	75.93%	0.36%	27.35%
2010	C7	9512	1999	Control	24	1/2 gph	4019	6038	16	1957	0.84%	63.34%	0.26%	38.42%
2010	C7	9520	1999	Control	24	1 gph	5017	6255	62	1108	12.66%	73.07%	0.95%	38.36%
2009	T8	8855	1999	Surround	6	1/2 gph	3315	3763	14	416	0.62%	69.25%	0.30%	28.34%
2009	T8	8856	1999	Surround	6	1 gph	2681	3243	13	514	1.22%	68.65%	0.32%	27.24%
2010	T8	9513	1999	Surround	24	1/2 gph	4117	5352	16	1119	0.92%	70.49%	0.28%	36.34%
2010	T8	9521	1999	Surround	24	1 gph	5059	5951	41	815	1.72%	82.85%	0.64%	36.68%

The lightly shaded cells for split inshell, yield, damage, and edible inshell from closed shell are calculated from 1) actual quality analysis taken adjacent to the corresponding 0.5 gph sub-plots, and 2) yield data collected from the adjacent large plots.

The 2009 results in **Table 25** illustrate a significant difference for both the control 0.5 gph and the Surround 0.5 gph sub-plots compared to the adjacent 1.0 gph sub-plots. These results were intriguing, and were misleading because the sample size was small and the trees were hand harvested, leading to the error in analysis. The expanded sub-plots in 2010 did not support the results from 2009.

Statistical Analysis of the Small Deficit Irrigated Sub-Plots

All statistical analyses were carried out using SAS/STAT software, Version [9.2] of the SAS System for Windows. Comparisons of means for each treatment (Surround versus control), each irrigation level (1 gph versus 0.5 gph or depth applied), and each treatment by irrigation level were carried out using an analysis of variance for each response variable. Treatment and control plots were blocked within the field and block was considered a random factor for purposes of statistical modeling. Pairwise comparisons of treatment by irrigation combination means were adjusted using the Bonferroni method to control the Type I error rate at 0.05.

Yield

In 2009, there was no significant difference in treatment by irrigation level interaction ($p = 0.2680$), nor was there a significant difference ($p = 0.2368$) in the mean yields (lbs/acre) of the two irrigation levels when averaging over the treatment. There was, however, a significant difference ($p = 0.0328$) in the mean yields (lbs/acre) for Surround and control when averaging over (combining) the irrigation levels. This is believed to be a result of hand-harvesting the small subplots.

Table 26: 2009 mean yields (lbs/acre) for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround		3170.2 (183.28)
Control		2723.0 (183.28)
	1	2834.1 (183.28)
	0.5	3059.1 (183.28)

Table 27: 2009 mean yields (lbs/acre) for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround	0.5	3387.5 (222.14)
Surround	1	2952.8 (222.14)
Control	0.5	2730.7 (222.14)
Control	1	2715.3 (222.14)

In 2010, there was no significant difference in treatment by irrigation level interaction ($p = 0.3145$), nor were there significant differences in the mean yields (lbs/acre) of the two irrigation

levels (p = 0.2134) when averaging over the two treatments, or the two treatments (p = 0.6118) when averaging over the irrigation levels.

Table 28: 2010 mean yields (lbs/acre) for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround		6050.5 (301.76)
Control		6272.8 (301.76)
	1	6442.0 (301.76)
	0.5	5881.3 (301.76)

Table 29: 2010 mean yields (lbs/acre) for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround	1	6554.8 (426.75)
Control	1	6329.2 (426.75)
Control	0.5	6216.5 (426.75)
Surround	0.5	5546.1 (426.75)

Split Inshell Weight

In 2009, overall there was no significant difference in treatment by irrigation level interaction (p = 0.1589). There was no significant difference in the split inshell mean weights (lbs/acre) of the two irrigation levels (p = 0.2937) when averaging over treatments. However, when averaging over (combining) the irrigation levels, there was a significant difference in the split inshell mean weights (lbs/acre) for Surround and control (p = 0.0455). This is believed to be a result of hand-harvesting the small subplots.

Table 30: 2009 split inshell mean weights (lbs/acre) for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround		2857.6 (143.66)
Control		2474.4 (143.66)
	1	2573.9 (143.66)
	0.5	2758.1 (143.66)

Table 31: 2009 split inshell mean weights (lbs/acre) for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround	0.5	3076.5 (185.16)
Surround	1	2638.6 (185.16)
Control	1	2509.14 (185.16)
Control	0.5	2439.62 (185.16)

In 2010, overall there was no significant difference in treatment by irrigation level interaction (p = 0.3767). However, pairwise comparisons of the treatment by irrigation level means show some significant differences (see **Table 32**). When averaging over irrigation levels, there was not a

significant difference in the split inshell mean weights (lbs/acre) of Surround and control (p = 0.7438). There was, however, a significant difference in the split inshell mean weights (lbs/acre) for the irrigation levels (p = 0.0013) when averaging over (combining) the treatments.

Table 32: 2010 split inshell mean weights (lbs/acre) for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround		4077.5 (313.10)
Control		4225.63 (313.10)
	1	5072.1 (313.10)
	0.5	3231.1 (313.10)

Table 33: 2010 split inshell mean weights (lbs/acre) for each treatment by irrigation level combination.
Note: Means connected with the same letter are not significantly different at the 0.05 level.

Factor		Mean(SE)	
Treatment	Irrigation (gph)	lbs/acre	
Surround	1	5201.3 (442.78)	a
Control	1	4942.9 (442.78)	a
Control	0.5	3508.4 (442.78)	a b
Surround	0.5	2953.8 (442.78)	b

Split Inshell (%)

In 2009, overall there was no significant difference in treatment by irrigation level interaction (p = 0.2430). There was no significant difference in the split inshell percent means of the two irrigation levels (p = 0.7954) when averaging over (combining) treatments. When averaging over the irrigation levels, there was no significant difference in the split inshell percent means for Surround and control (p = 0.9127).

Table 34: 2009 split inshell percent means for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround		70.3 (3.35)
Control		70.5 (3.35)
	1	70.6 (3.35)
	0.5	70.1 (3.35)

Table 35: 2009 split inshell percent means for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Control	1	71.9 (3.61)
Surround	0.5	71.2 (3.61)
Surround	1	69.4 (3.61)
Control	0.5	69.1 (3.61)

In 2010, overall there was no significant difference in treatment by irrigation level interaction (p = 0.3097). However, pairwise comparisons of the treatment by irrigation level means show some significant differences (see **Table 36**). When averaging over irrigation levels, there was

not a significant difference in the split inshell percent means of Surround and control (p = 0.4463). There was, however, a significant difference in the split inshell percent means for the irrigation levels (p = 0.0037) when averaging over (combining) the treatments. This demonstrates that there were more split inshell nuts in the 1 gph subplots, as expected.

Table 36: 2010 split inshell percent means for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround		63.0 (4.28)
Control		58.2 (4.28)
	1	71.5 (4.28)
	0.5	49.8 (4.28)

Table 37: 2010 split inshell percent means for each treatment by irrigation level combination. Note: *Means connected with the same letter are not significantly different at the 0.05 level.*

Factor		Mean(SE)	
Treatment	Irrigation (gph)	%	
Surround	1	77.1 (6.05)	a
Control	1	65.9 (6.05)	a b
Control	0.5	50.6 (6.05)	a b
Surround	0.5	48.9 (6.05)	b

Edible Inshell from Closed Shell Weight

In 2009, there was no significant difference in treatment by irrigation level interaction (p = 0.0605), nor were there significant differences in the mean yields (lbs/acre) of the two irrigation levels (p = 0.0726) when averaging over treatments, or the two treatments (p = 0.0777) when averaging over (combining) the irrigation levels.

Table 38: 2009 edible inshell from CS mean weights (lbs/acre) for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround		238.8 (67.00)
Control		173.5 (67.00)
	1	172.85 (67.00)
	0.5	239.5 (67.00)

Table 39: 2009 edible inshell from CS mean weights (lbs/acre) for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Control	0.5	242.0 (70.90)
Surround	1	240.7 (70.90)
Surround	0.5	237.0 (70.90)
Control	1	105.1 (70.90)

In 2010, there was no significant difference in treatment by irrigation level interaction (p = 0.3767), nor was there a significant difference in the mean yields (lbs/acre) of Surround and

control (p = 0.7438) when averaging over irrigation levels. There was, however, a significant difference in the mean yields (lbs/acre) for the irrigation levels (p = 0.0013) when averaging over (combining) the treatment. This demonstrates that there are more closed shell nuts in the under-irrigated subplots, as expected.

Table 40: 2010 edible inshell from CS mean weights (lbs/acre) for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround		1887.0 (222.21)
Control		1949.5 (222.21)
	1	1256.4 (222.21)
	0.5	2580.1 (222.21)

Table 41: 2010 edible inshell from CS mean weights (lbs/acre) for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Control	0.5	2626.7 (314.26)
Surround	0.5	2533.4 (314.26)
Control	1	1272.2 (314.26)
Surround	1	1240.6 (314.26)

Total Inshell Weight (%)

In 2009, overall there was no significant difference in treatment by irrigation level interaction (p = 0.1506). There was no significant difference in the total inshell weight percent means of the two irrigation levels (p = 0.1187) when averaging over (combining) treatments. When averaging over the irrigation levels, there was no significant difference in the total inshell weight percent means for Surround and control (p = 0.3736).

Table 42: 2009 total inshell weight percent means for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround		22.2 (2.25)
Control		24.4 (2.25)
	1	21.2 (2.25)
	0.5	25.4 (2.25)

Table 43: 2009 total inshell weight percent means for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround	0.5	26.1 (2.83)
Control	0.5	24.6 (2.83)
Control	1	24.2 (2.83)
Surround	1	18.2 (2.83)

In 2010, overall there was no significant difference in treatment by irrigation level interaction (p = 0.7514). When averaging over irrigation levels, there was not a significant difference in the

total inshell weight percent means of Surround and control (p = 0.9873). There was, however, a significant difference in the total inshell weight percent means for the irrigation levels (p = 0.0431) when averaging over (combining) the treatments.

Table 44: 2010 total inshell weight percent means for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround		37.6 (0.73)
Control		37.6 (0.73)
	1	36.5 (0.73)
	0.5	38.8 (0.73)

Table 45: 2010 total inshell weight percent means for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround	0.5	38.9 (1.03)
Control	0.5	38.6 (1.03)
Control	1	36.6 (1.03)
Surround	1	36.3 (1.03)

Light Stained (%)

In 2009, overall there was no significant difference in treatment by irrigation level interaction (p = 0.1590). There was no significant difference in the light stained percent means of the two irrigation levels (p = 0.0699) when averaging over (combining) the treatments. When averaging over the irrigation levels, there was no significant difference in the light stained percent means for Surround and control (p = 0.8593).

Table 46: 2009 light stained percent means for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround		1.1 (0.31)
Control		1.1 (0.31)
	1	1.3 (0.31)
	0.5	0.8 (0.31)

Table 47: 2009 light stained percent means for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Control	1	1.5 (0.36)
Surround	1	1.1 (0.36)
Surround	0.5	1.0 (0.36)
Control	0.5	0.6 (0.36)

In 2010, overall there was a significant difference in treatment by irrigation level interaction (p = 0.0042). See **Table 48** for results of the pairwise comparisons of treatment by irrigation level means. When averaging over irrigation levels, there was a significant difference in the light

stained percent means of Surround and control (p = 0.0053). There was also a significant difference in the light stained percent means for the irrigation levels (p < 0.0001) when averaging over the treatments.

Table 48: 2010 light stained percent means for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround		2.2 (1.01)
Control		7.0 (1.01)
	1	8.7 (1.01)
	0.5	0.5 (1.01)

Table 49: 2010 light stained percent means for each treatment by irrigation level combination. Note: *Means connected with the same letter are not significantly different at the 0.05 level.*

Factor		Mean(SE)	
Treatment	Irrigation (gph)	%	
Control	1	13.6 (1.42)	
Surround	1	3.8 (1.42)	a
Surround	0.5	0.6 (1.42)	a
Control	0.5	0.4 (1.42)	a

Damage Weight

In 2009, there was no significant difference in treatment by irrigation level interaction (p = 0.3593), nor was there a significant difference (p = 0.1747) in the damage weight means (lbs/acre) of the two irrigation levels when averaging over (combining) the treatments, or the two treatments (p = 0.6675) when averaging over irrigation levels.

Table 50: 2009 damage weight means (lbs/acre) for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround		26.7 (8.32)
Control		31.0 (8.32)
	1	35.9 (8.32)
	0.5	21.8 (8.32)

Table 51: 2009 damage weight means (lbs/acre) for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Control	1	42.6 (10.72)
Surround	1	29.2 (10.72)
Surround	0.5	24.3 (10.72)
Control	0.5	19.3 (10.72)

In 2010, there was no significant difference in treatment by irrigation level interaction (p = 0.3535), nor were there significant differences in the damage weight means (lbs/acre) of the two

irrigation levels (p = 0.0733) when averaging over (combining) the treatments, or the two treatments (p = 0.2681) when averaging over the irrigation levels.

Table 52: 2010 damage weight means (lbs/acre) for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Surround		19.4 (6.16)
Control		29.6 (6.16)
	1	33.0 (6.16)
	0.5	15.9 (6.16)

Table 53: 2010 damage weight means (lbs/acre) for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	lbs/acre
Control	1	33.9 (8.72)
Surround	1	32.2 (8.72)
Control	0.5	25.2 (8.72)
Surround	0.5	6.7 (8.72)

Total Insect Damage Percentage

In 2009, overall there was no significant difference in treatment by irrigation level interaction (p = 0.4905). There was no significant difference in the total insect damage percent means of the two irrigation levels (p = 0.1381) when averaging over treatments. When averaging over the irrigation levels, there was no significant difference in the total insect damage percent means for Surround and control (p = 0.5864).

Table 54: 2009 total insect damage percent means for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround		0.7 (0.22)
Control		0.9 (0.22)
	1	1.0 (0.22)
	0.5	0.6 (0.22)

Table 55: 2009 total insect damage percent means for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Control	1	1.2 (0.3)
Surround	1	0.8 (0.3)
Surround	0.5	0.6 (0.3)
Control	0.5	0.5 (0.3)

In 2010, overall there was no significant difference in treatment by irrigation level interaction (p = 0.4157). When averaging over irrigation levels, there was not a significant difference in the total insect damage percent means of Surround and control (p = 0.2834). There was also not a

significant difference in the total insect damage percent means for the irrigation levels (p = 0.1620).

Table 56: 2010 total insect damage percent means for each treatment and irrigation level.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Surround		0.3 (0.11)
Control		0.5 (0.11)
	1	0.5 (0.11)
	0.5	0.3 (0.11)

Table 57: 2010 total insect damage percent means for each treatment by irrigation level combination.

Factor		Mean(SE)
Treatment	Irrigation (gph)	%
Control	1	0.5 (0.15)
Surround	1	0.5 (0.15)
Control	0.5	0.4 (0.15)
Surround	0.5	0.1 (0.15)

For full analysis see **Attachment C**.

Soil Moisture Content

A Campbell Pacific Nuclear Hydroprobe 503DR (neutron probe), using thermalized neutron backscatter, was used to estimate changes in soil water content. A soil water balance was then computed by combining this change in soil moisture content with the applied irrigation water. The water balance ET was less than the potential unstressed ET, and closely matched the SEBAL-predicted ET on the non-treated plots. The water balance ET was the same for treated and non-treated plots, indicating (as predicted) that with deficit irrigation there was no difference in ET.

Figure 23 illustrates that the total soil water content for the standard 1.0 gph emitter trees was about the same at the beginning and the end of the season at the six- to nine-foot depth, averaging less than 40% available water on this mix of soils, ranging from sandy loam to clay (see **Attachment A**). While more fluctuation occurred in the top five feet, which is expected, the difference between the treatment and the control is roughly the same, indicating that average water content differences were a function of slightly sandier soils at the neutron probe access sites for the Surround sites in the 0-5 foot depth and not a function of treatment.

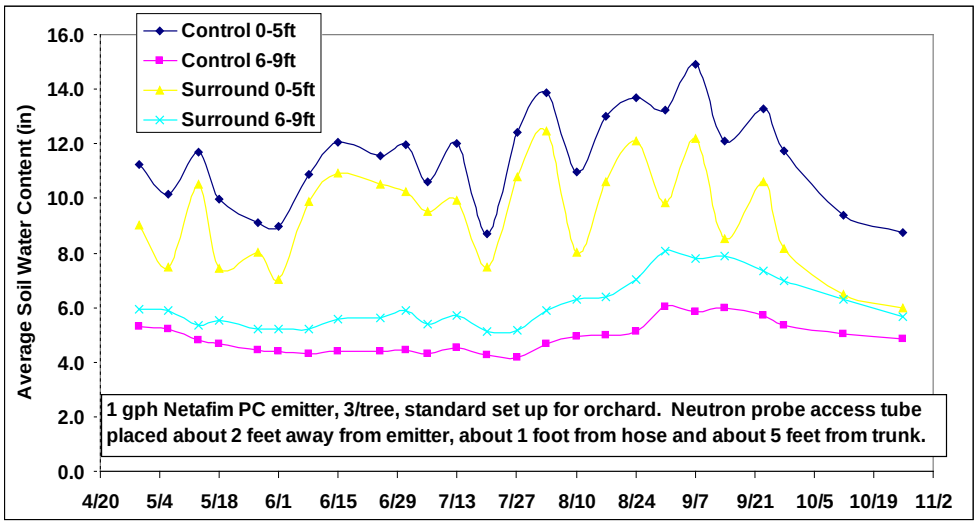


Figure 23. Soil moisture content from beginning to end of the 2009 growing season with full irrigation. Average totals by treatment for the 0-5 feet and 6-9 feet zone.

The results from the 2010 standard 1.0 gph emitters also indicates little variation between the control and treated blocks (**Figure 24**). For this reason, statistical analysis was not conducted on this data.

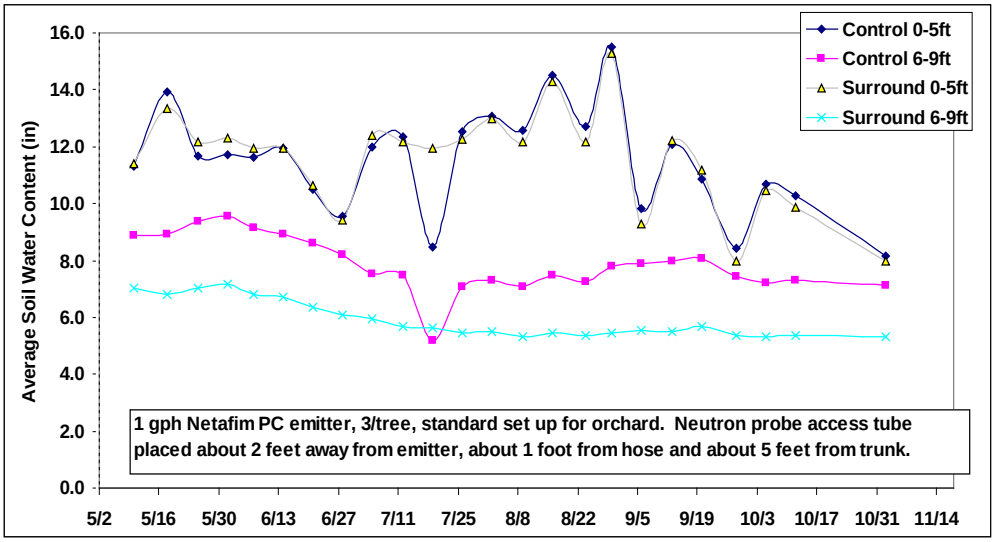


Figure 24. Soil moisture content from beginning to end of the 2010 growing season with full irrigation. Average totals by treatment for the 0-5 feet and 6-9 feet zone.

The soil moisture was also monitored in the small deficit irrigation sub-plots in 2010. The results from this data demonstrates that Surround may in fact preserve some soil moisture (**Figure 25**) in an extreme stress situation, but the SWP (**Figure 29**) demonstrates that the tree cannot take advantage of this difference. It is interesting to note that the separation between the Surround and control 0-5ft average trend lines begins to occur after the initial application on May 28th and widens after the second application on June 29th. The third application on August

18th does not appear to have much effect. This may indicate that the trees were completely coated after two applications.

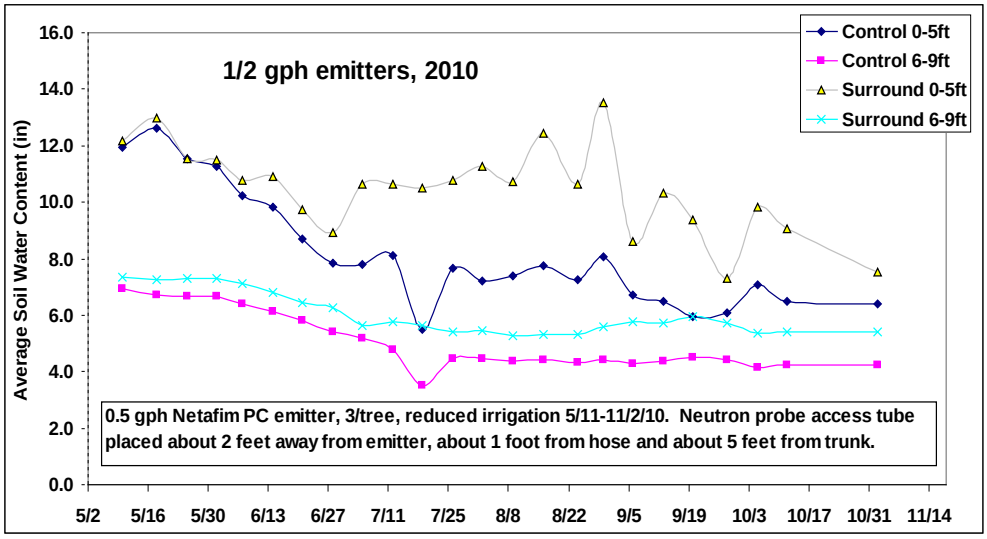


Figure 25. Soil moisture content from beginning to end of the 2010 growing season at 50% of the applied water. Average totals by treatment for the 0-5 feet and 6-9 feet zone.

Comparing Calculated ET

Using the change in collected soil moisture data and applied water over the same time period, weekly ET was calculated. Cumulative field ET is shown in **Figure 26 and 27**, comparing the control and treatment plots. The average water applied, via irrigation, was also computed for the entire field using the pressure switch and residential flow meters. The graph illustrates very minimal differences. These small differences could be attributed to variations in soil type or crop vigor near each of the soil sensor locations.

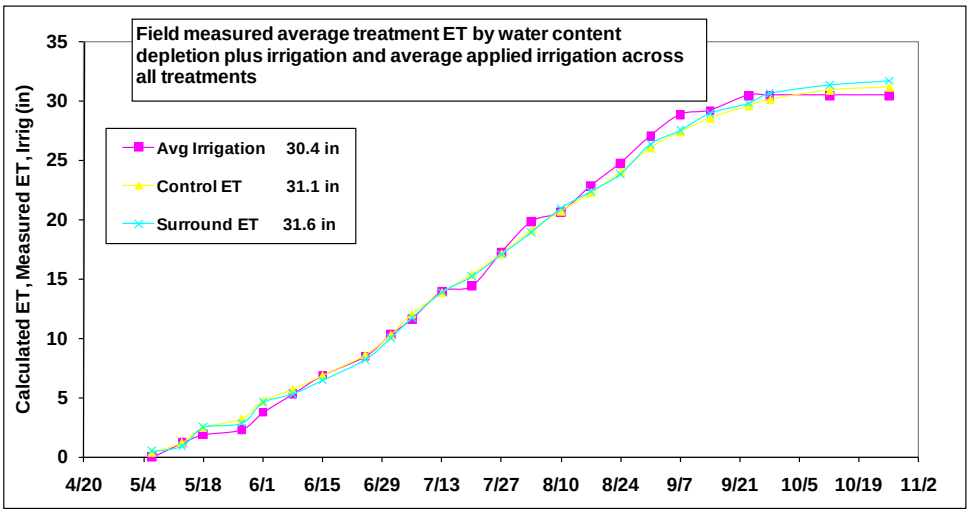


Figure 26. ET estimates for control and Surround plots as well as the average amount of water applied to the field in 2009.

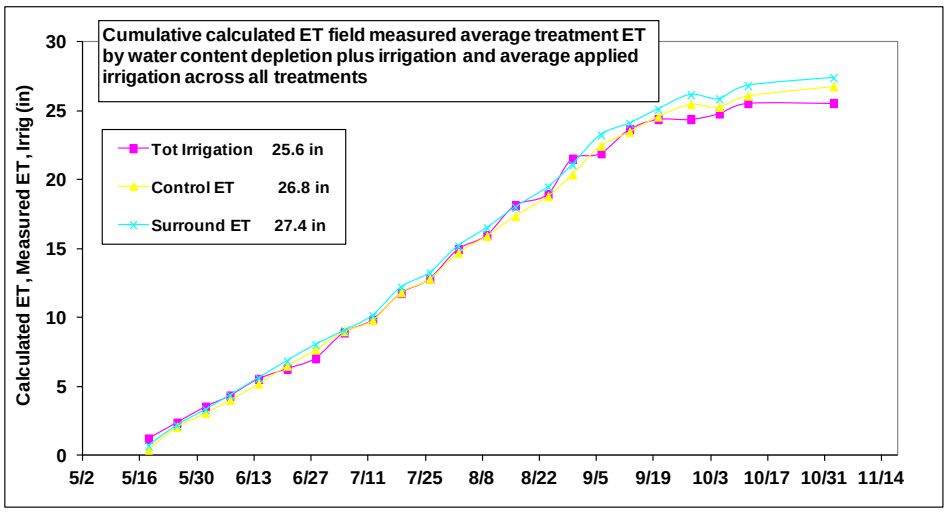


Figure 27. ET estimates for control and Surround plots as well as the average amount of water applied to the field in 2010.

Both **Figures 26 and 27** illustrate that virtually the same amount of water was utilized for ET, regardless of the treatment. This supports the idea that the Surround is impacting the estimates of ET calculated using SEBAL.

Stem Water Potential

SWP was collected by sampling a leaf near each of the neutron probe sites. Because the May-June stem water potential measurements showed only moderate levels of stress despite apparent deficit irrigation, eight tree sub-plots were created in each large plot. The sub-plots were irrigated at 50% of the large plots, changing the applied water rate from approximately 0.34 in/day to 0.17 in/day. This caused an additional -3 to -10 bars of stress compared to that experienced by the 1.0 gph emitters. This information was used to determine if Surround can reduce tree stress. **Figure 28** demonstrates that the 8 tree sub-plots were being under-irrigated. The differences between the control and Surround treatments for both the large plots and the sub-plots are shown.

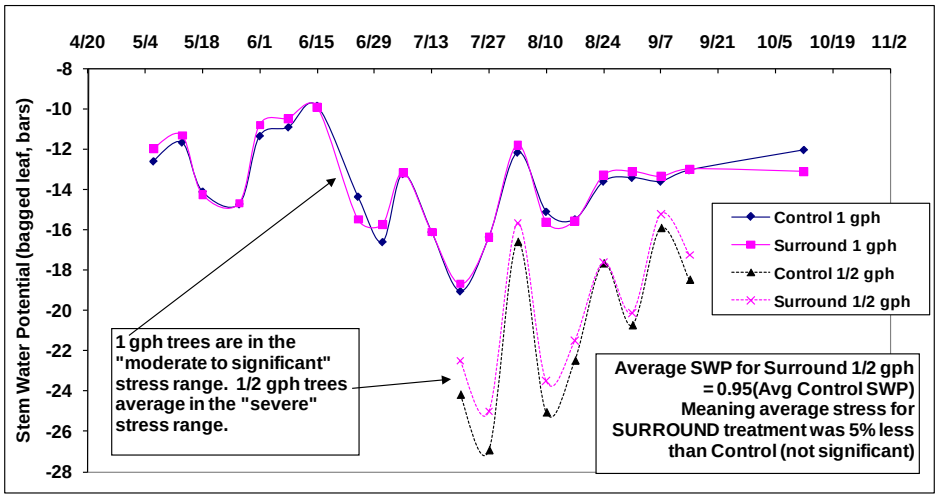


Figure 28. Comparison of leaf water potential for large plots (1.0 gph) and sub-plots (0.5 gph) in 2009. Surround subplot has only slightly less stress.

The expanded deficit irrigation sub-plots were tracked from June through October 2010. The results from the SWP readings are similar to the results observed in 2009 (**Figure 29**).

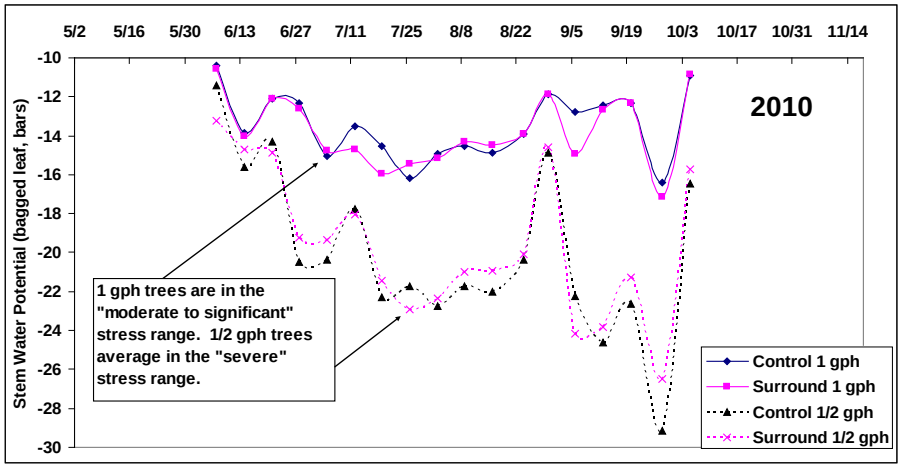


Figure 29. Comparison of leaf water potential for large plots (1.0 gph) and sub-plots (0.5 gph) in 2010.

The results of the stem water potential demonstrate no significant benefit for reducing stress of pistachio trees. Data from both years indicates that Surround does not reduce the stress of pistachio trees, whether it is fully irrigated or deficit irrigated.

Insect Pressure

A reduction in insect damage is widely considered a secondary benefit of Surround. Therefore, a simple pheromone trap was installed in each of the large plots to track the presence of NOW populations. The traps were checked once per week and the average number of male NOW in both the Surround and Control plots is shown in **Figure 30**.

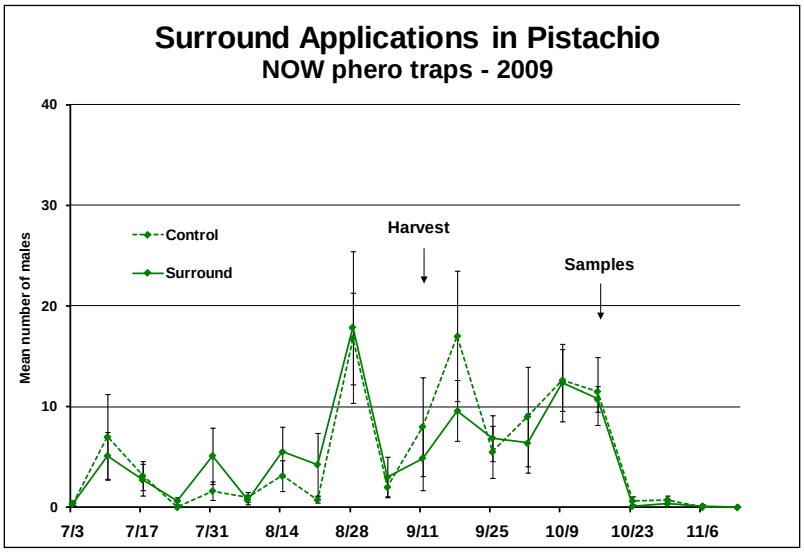


Figure 30. NOW population dynamics based on pheromone traps from July to November 2009. Average from Surround and control plots.

The results demonstrate little differences between the treated and the non-treated plots. Likewise, insect damage was very minimal during both years of this study. Therefore, a statistical analysis was deemed unnecessary for the purposes of this research study.

In 2010, NOW damage was calculated on the average for both the treated and control blocks. The results indicate that there was slightly less damage on average to the Surround treated blocks; however, it was not enough to warrant a statistical comparison (**Figure 31**).

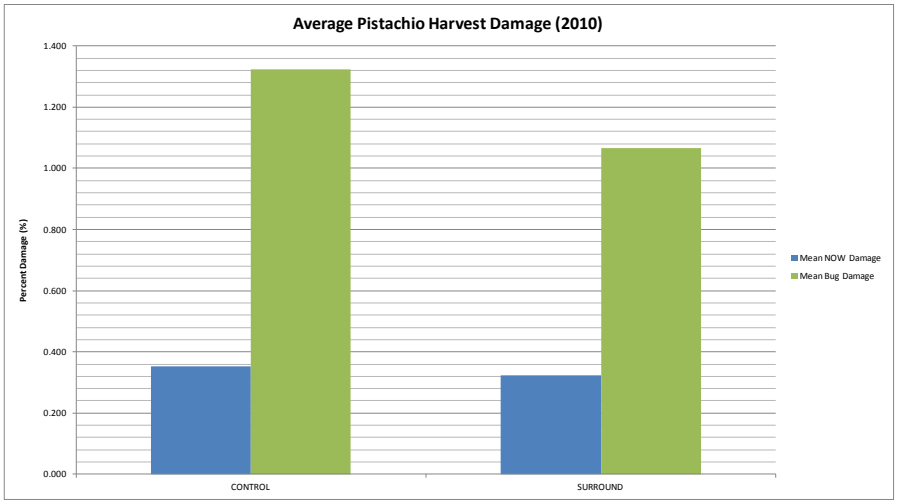


Figure 31. Average damage to the control and treatment blocks based on approximately 20,000 nut samples from each plot.

The average trapped male NOW populations were higher in 2010, but quality did not suffer. In fact, many growers stated that the NOW populations and damage caused by NOW were extremely low during both years of this study. For this reason, this research cannot conclude that Surround helps protect against insect damage.

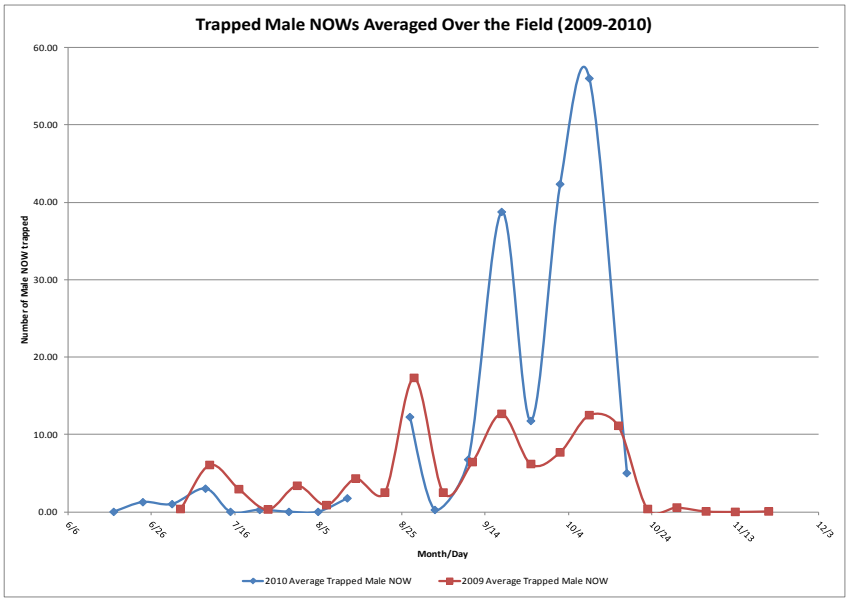


Figure 32. Male NOW trapped vs. time.

CONCLUSIONS AND DISCUSSION

The purpose of this research was to determine if an inert kaolin clay, trademarked Surround™, could have beneficial impacts on pistachio trees on the west side of the San Joaquin Valley by reducing stress under deficit irrigation and possibly decreasing the incidence of Navel Orangeworm and subsequent damage to the nut. These benefits could make Surround cost-effective; especially during water-short years.

The white film on leaves resulting from the application of Surround can skew remotely sensed satellite spectral estimates of ET such as those generated by SEBAL, making these techniques inaccurate when using this material. Large-scale plots treated with Surround were estimated by SEBAL to have 1-2 mm/day (about 25%) less ET than the non-treated control blocks. However, ground based data using applied water and soil moisture depletion demonstrated that there was virtually no difference over the season.

Surround does not provide any statistically significant water savings, yield, or quality benefits for pistachio trees for either a slight deficit-irrigated or 50% deficit irrigated condition. Pistachios can be a difficult crop to work with when evaluating yield impacts due to the extreme nature of the crop's "alternate bearing" tendencies. For example, 2010 yields were more than twice as great as 2009 (with perhaps even greater benefit in nut size due to a very mild summer). There was no treatment impact noted in either year and it is believed that only one biennial cycle was sufficient for the purposes of this study.

Soil moisture, stem water potential, and insect damage data was collected weekly from four replications to allow for statistical comparison. However, when it became obvious that the averages for these data were trending in a nearly identical fashion for both control and Surround treated trees a statistical analysis was deemed unnecessary.

Soil Salinity

The salinity of this field has been documented for several years. Each year the soil salinity increases. This problem is compounded because groundwater is used to supplement reductions in surface water. This increase in soil salinity may be limiting crop ET, impacting the yield results. A complete soil salinity map of the field was not completed as part of this study.

Alternate Bearing

Pistachios have alternate bearing years. That is, in a given year the yield will be significantly higher than the following year, and then the yield be significantly higher again the year after that. In this study, a majority of the trees were in a low bearing year during 2009. However, Plots 1, 2 and approximately half of Plot 8 were in the high bearing cycle in 2009. This could have potentially impacted the yield results. Extending the study for a second year may have reduced any impacts caused by the alternate bearing cycle, but 2010 was such a good production year that it was nearly impossible to determine if the bearing year impacted the results.

METRIC Modeling

To verify that both the Surround and the control blocks had a relative starting point a program called METRIC™ was used. Below is a summary of the results of the METRIC model calculations of ET (evapotranspiration) and NDVI (normalized difference vegetation index) for the Surround treated pistachio field in the May 2009, 2010, and 2011. For each of these years, METRIC was used to calculate the mean ET and NDVI for each of the eight test blocks. These results will be statistically analyzed to determine if there is any significant difference between the test blocks.

In addition, the model was run using an image in July 2010 so that the METRIC ET prediction could be compared to the depth applied to the field. Since the pistachio field was under-irrigated for the season, it was assumed that the water applied would go directly to ET. The two methods returned the same value: An average of 0.21 inches/day was applied to the field, and the METRIC model measured an average ET of 0.22 inches/day across the field.

METRIC Process

METRIC uses a combination of satellite imagery and ground-level weather data to create a raster image output of the ET for a particular day. Other METRIC outputs include the NDVI, surface temperature, and Kc values. The two major inputs to the METRIC model are a Landsat satellite image (**Figure 33**) and local weather station data. Traditional crop ET (ETc) calculations are done by multiplying the daily or hourly reference ET (ETo, for grass reference) by a crop coefficient, Kc. The ETo is calculated using local weather station data, and the Kc-value is obtained from historic studies of individual crops.

This is a widely used and refined method, but it has limitations. The Kc value is a potential value, and does not always reflect the conditions on the ground. In the field, ET varies with soil type, vegetation density, differences in crop development curves, irrigation uniformity, and many other factors. In contrast to this, the METRIC model calculates ET based on a surface energy balance from the short wave and thermal radiation information contained in the satellite image. This information is combined with weather station data such as precipitation, wind speed, maximum and minimum temperatures, and dew point temperature in order to calculate both a Kc value and a 24-hour ETc value for each pixel of the image. The goal of the METRIC model is to compute the actual ETc, rather than the potential ETc represented by traditional crop coefficient methods.

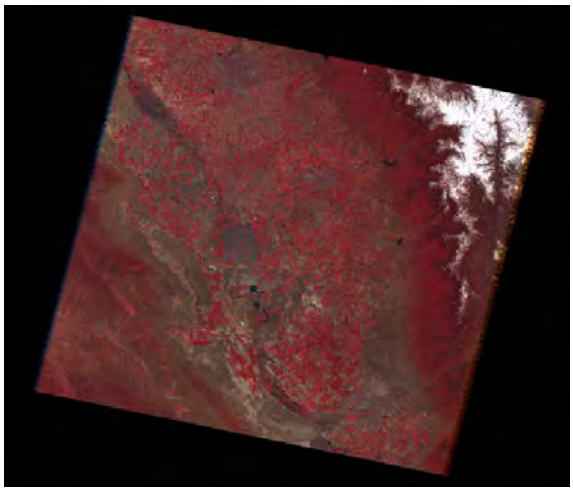


Figure 33. Landsat satellite image of the San Joaquin Valley (May 10, 2010).

The METRIC model contains three sub-models written in structured-text coding in ERDAS (a raster-based GIS application similar to ArcView) and three Excel workbooks that are used to turn the spectral image and weather station data into a final ET raster image. The final raster output for the model shows the ET across the field on a 30 meter by 30 meter resolution (refer to **Figure 34**). The resolution is a function of the original satellite image, which is 30 meters by 30 meters for every band except the thermal radiation. The thermal radiation band is 120 meters by 120 meters, and is sharpened using a separate model in order to bring it to the same resolution as the rest of the bands. This is an excellent resolution for most applications of METRIC, although there are some restrictions when it is applied to a small area, such as the pistachio field used in this study. The resolution means that there are several rows of trees within each pixel, so it is not possible to isolate groups of one or two rows to contrast treated and untreated areas. However, the "test blocks" used in the study consisted of a buffer area well within the resolution of the image.

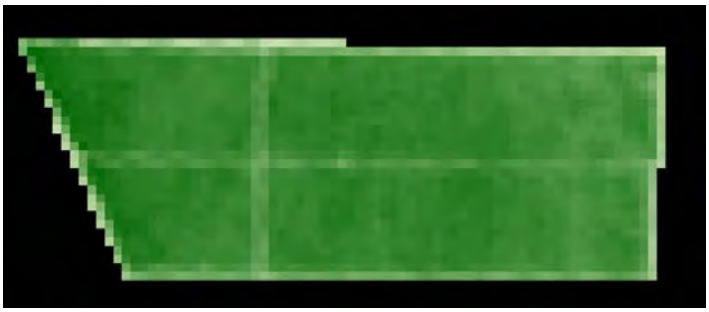


Figure 34. Final METRIC ET image (April 29, 2011).

In order to perform the statistical analysis, the METRIC output rasters were subdivided into eight "area of interests" corresponding to the boundaries of the eight test blocks (**Figure 35**). For the METRIC process, the outer rectangle encompassing both sub-blocks was used as the area of interest. The mean and standard deviation for both ET and NDVI were calculated in each of these eight blocks for 2009, 2010, and 2011. These results are the final work product of this process, and can be statistically analyzed to examine any differences between the blocks.

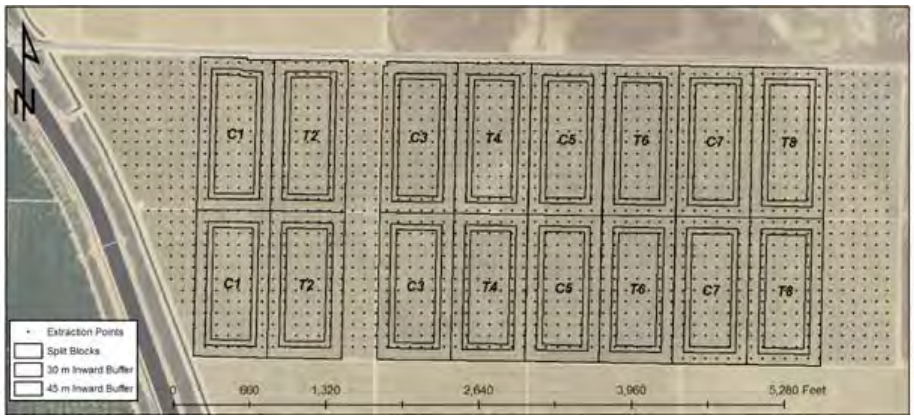


Figure 35. Test blocks 1-8.

Results: Variation in NDVI and ET between Blocks

Tables 58, 59, and **60** list the mean and standard deviation of the ET and NDVI for 2009, 2010, and 2011 (respectively) for each block in the field. F or 2009, the total average ET was 4.1 mm/day and the total average NDVI was 0.45. For 2010, the total average ET was 3.7 mm/day and the total average NDVI was 0.48. For 2011, the total average ET was 2.0 mm/day and the total average NDVI was 0.48.

Table 58: May 9, 2009: Evapotranspiration and NDVI by block.

Block	Average ET (mm/day)	ET Standard Deviation (mm/day)	Average NDVI	NDVI Standard Deviation
1	4.27	0.87	0.448	0.015
2	3.96	0.78	0.439	0.012
3	4.22	0.82	0.454	0.020
4	4.33	0.79	0.460	0.019
5	4.21	0.64	0.455	0.015
6	4.29	0.72	0.463	0.017
7	3.97	1.06	0.445	0.016
8	3.54	1.54	0.422	0.022

Table 59: May 12, 2010: Evapotranspiration and NDVI by block.

Block	Average ET (mm/day)	ET Standard Deviation (mm/day)	Average NDVI	NDVI Standard Deviation
1	4.23	0.88	0.448	0.015
2	3.88	0.87	0.483	0.030
3	3.86	0.97	0.496	0.044
4	3.88	0.91	0.501	0.045
5	3.76	1.04	0.496	0.039
6	3.80	1.00	0.505	0.045
7	3.42	1.61	0.478	0.031
8	2.95	2.19	0.447	0.016

Table 60: April 29, 2011: Evapotranspiration and NDVI by block.

Block	Average ET (mm/day)	ET Standard Deviation (mm/day)	Average NDVI	NDVI Standard Deviation
1	2.50	0.67	0.498	0.019
2	2.10	0.69	0.485	0.016
3	2.09	0.67	0.484	0.022
4	2.16	0.67	0.496	0.015
5	2.08	0.68	0.486	0.015
6	2.11	0.67	0.494	0.014
7	1.65	1.04	0.470	0.025
8	1.31	1.28	0.445	0.037

Statistical Analysis: NDVI and ET between Blocks

The statistical analysis from the METRIC modeling demonstrates that there is no significant difference between the treatment and control plots from year to year. All statistical analyses were carried out using SAS/STAT software, Version [9.2] of the SAS System for Windows. An analysis of variance was used to compare Surround and control mean NDVI for each year. Treatment and control plots were blocked within the field and block was considered a random factor for purposes of statistical modeling.

2009

In 2009, there was no significant difference (p = 0.5783) in the mean NDVI of Surround and control treated plots.

Table 61: 2009 mean NDVI for Surround and control.

Treatment	Mean(SE)
Surround	0.4460(0.0070)
Control	0.4505(0.0070)

2010

In 2010, there was no significant difference (p = 0.7621) in the mean NDVI of Surround and control treated plots.

Table 62: 2010 mean NDVI for Surround and control.

Treatment	Mean(SE)
Surround	0.4840(0.0123)
Control	0.4795(0.0123)

2011

In 2011, there was no significant difference (p = 0.6429) in the mean NDVI of Surround and control treated plots.

Table 63: 2011 mean NDVI for Surround and control.

Treatment	Mean(SE)
Surround	0.4800(0.0093)
Control	0.4845(0.0093)

Results: METRIC™ Accuracy

In addition to the three May images processed, an additional July 2010 image was processed to assess the accuracy of the METRIC ET prediction. Since the pistachio field was slightly under-irrigated for the season, it was assumed that any water applied would go directly to ET (and the soil moisture reservoir). The image date was selected based upon the following criteria:

- It needed to be during peak ET: July or August
- It needed to be a time when there was a fairly constant ETo
- It needed to be during an irrigation event; where the depth of irrigation water applied has been fairly constant for at least 4 proceeding days
- It needed to have a ratio of depth applied to ETo which was fairly constant during the irrigation event

The depth of irrigated water applied and ETo values were compared for June 10 – September 10, 2010, and an image date of July 31, 2010 was chosen (**Figure 36**).

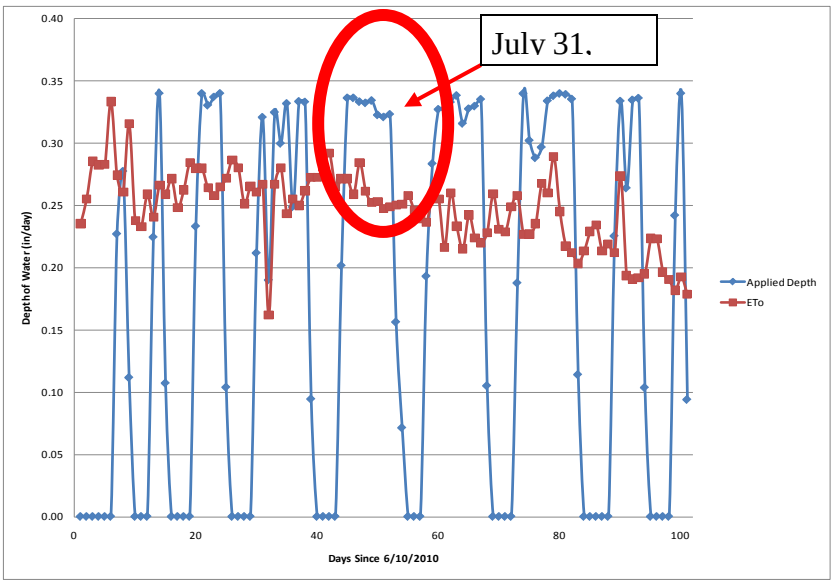


Figure 36. Image date selection based on ETo and applied depth of irrigation water.

The Landsat image used was taken on the last day of an irrigation event. The frequency of irrigation events during July 2010 was 14 days. An average of 0.32 inches/day of water was applied for nine days leading up to the image date. The average depth applied during the entire 14-day period, including both the nine "on" days and five "off" days, was **0.21 inches/day**.

After the METRIC model was run for the field on July 31, 2010, the average ET for entire field was calculated. This averaging excluded values below 4.0 mm/day in order to filter out the roads that run down the center of the field. The actual ET calculated for the field using METRIC on July 31, 2010 was **0.22 inches/day**.

The rate of ET predicted by the METRIC model is almost exactly the same as the applied depth of water, indicating that the results of the METRIC model are highly accurate when compared to the actual field conditions.

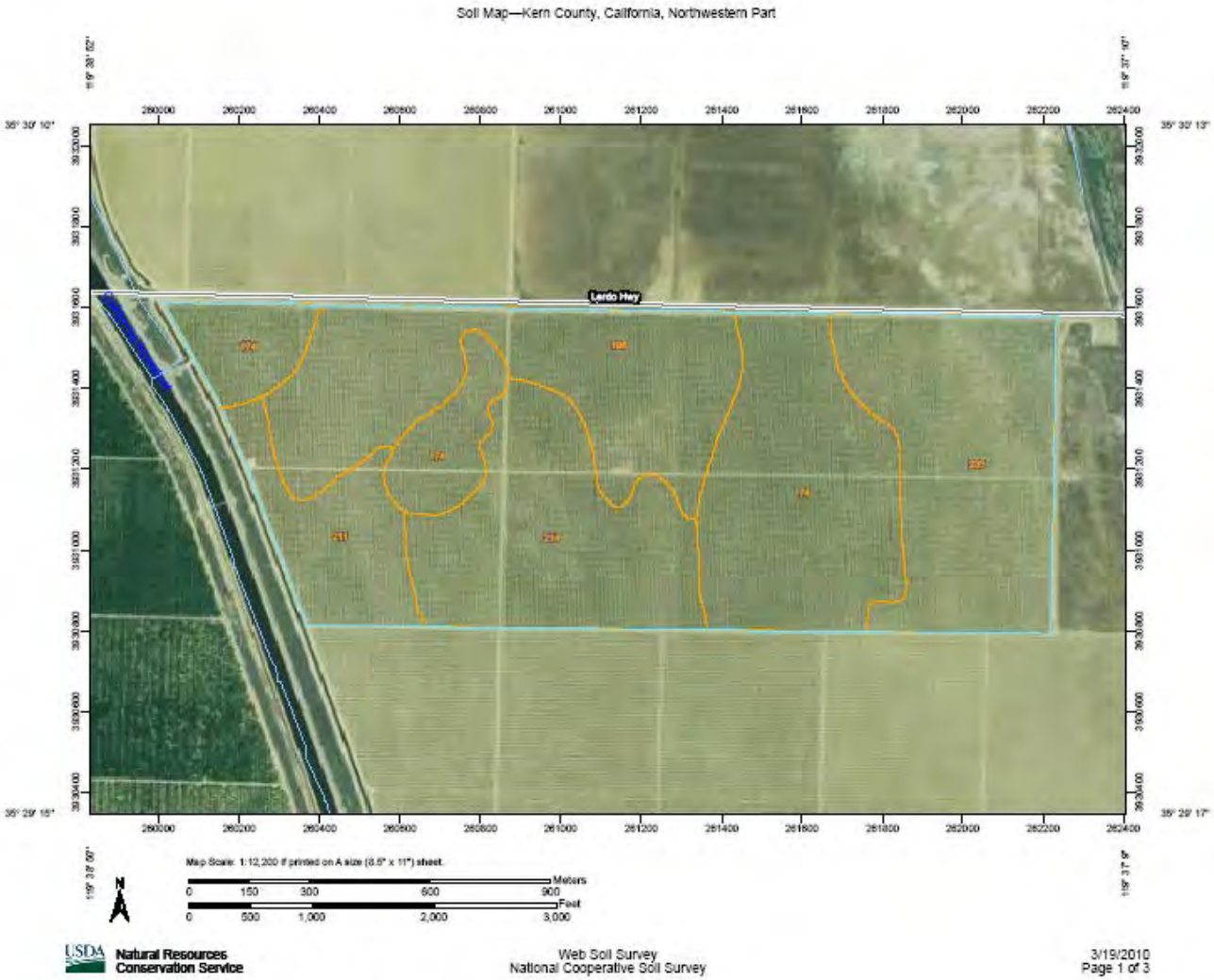
REFERENCES

Allen, R. G., M Tasumi, and R. Trezza. 2007. Satellite-based energy balance for mapping evapotranspiration with internalized calibration (METRIC) – Model. *Journal of Irrigation and Drainage Engineering* 133, no. 4: 380-394.

Goldhamer, D.A. 2005. Irrigation Management chapter of University of California Pistachio Production Manual (2005). Edited by L. Ferguson. pgs. 103.116. http://ucmanagedrought.ucdavis.edu/pistachios.cfm

Irrigation Training and Research Center (ITRC). California Polytechnic State Univ., San Luis Obispo, CA 93407. http://www.itrc.org/etdata/isdata/dmtypis15.pdf

ATTACHMENT A
SURROUND STUDY SOIL SURVEY MAP



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:12,200 if printed on A size (8.5" x 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Kern County, California, Northwestern Part
Survey Area Data: Version 5, Jul 22, 2008

Date(s) aerial images were photographed: 8/4/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Kern County, California, Northwestern Part (CA666)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
174	Kimberlina fine sandy loam, 0 to 2 percent slopes	113.1	28.7%
196	Milham sandy loam, 0 to 2 percent slopes	89.8	22.8%
211	Panoche clay loam, 0 to 2 percent slopes	32.8	8.3%
214	Panoche clay loam, saline-alkali, 0 to 2 percent slopes	73.5	18.7%
235	Twisselman clay, 0 to 2 percent slopes	84.7	21.5%
Totals for Area of Interest		**393.9**	**100.0%**

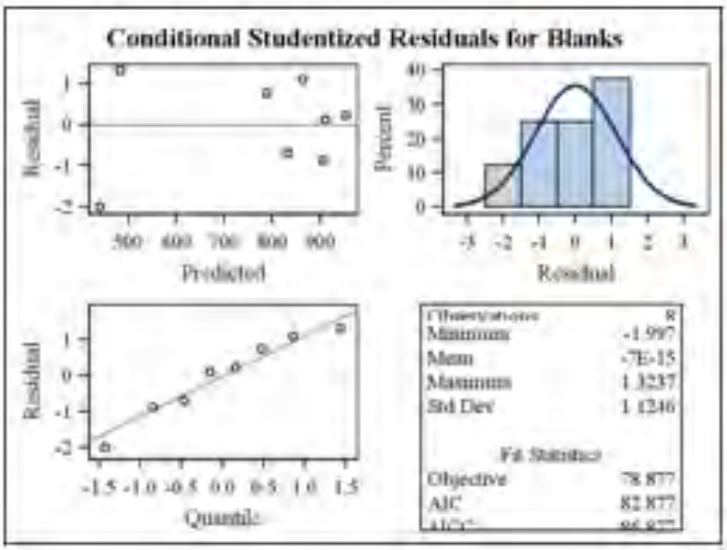
ATTACHMENT B
DATA – LARGE BLOCKS

Blanks: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	1.03	0.3851

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	749.86	112.46	3.22	6.67	0.0055
TRT	Surround	793.24	112.46	3.22	7.05	0.0046

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-43.3823	42.7694	3	-1.01	0.3851	Tukey-Kramer	0.3851

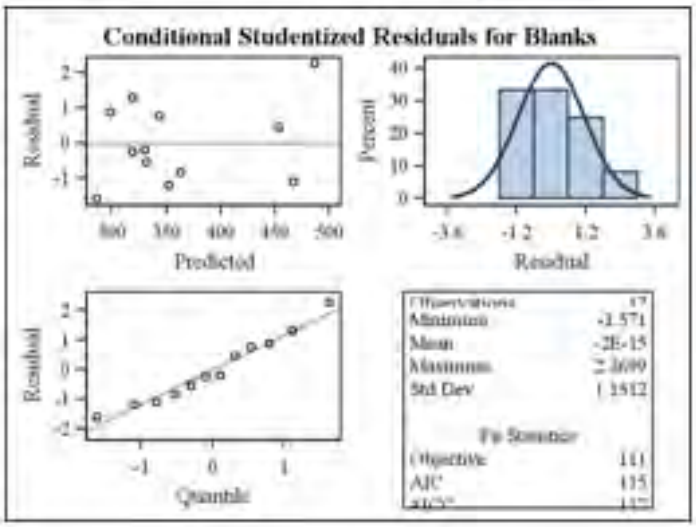


Blanks: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	0.23	0.7988

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	346.81	53.7636	5.37	6.45	0.0010
TRT	Surround	380.17	53.7636	5.37	7.07	0.0006
TRT	Surround_1	359.78	53.7636	5.37	6.69	0.0008

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-33.3576	49.2299	6	-0.68	0.5233	Tukey-Kramer	0.7845
TRT	Control	Surround_1	-12.9752	49.2299	6	-0.26	0.8009	Tukey-Kramer	0.9627
TRT	Surround	Surround_1	20.3823	49.2299	6	0.41	0.6932	Tukey-Kramer	0.9112

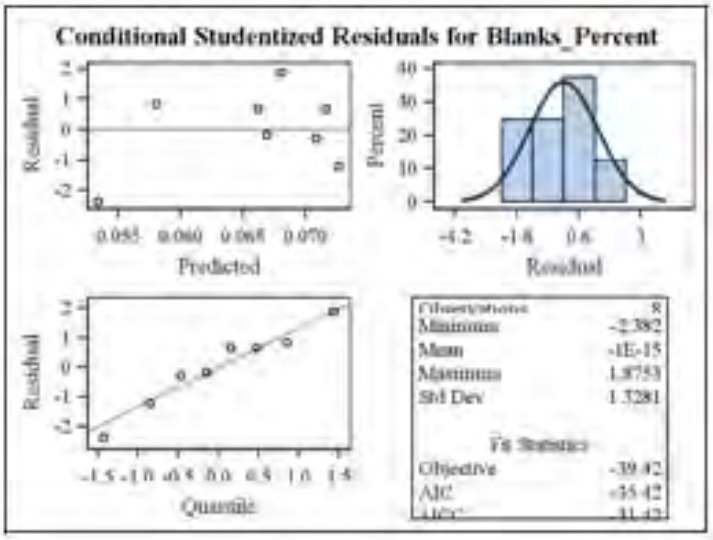


% Blanks: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	2.17	0.2369

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.06362	0.004370	3.89	14.56	0.0002
TRT	Surround	0.06830	0.004370	3.89	15.63	0.0001

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-0.00468	0.003176	3	-1.47	0.2369	Tukey-Kramer	0.2369

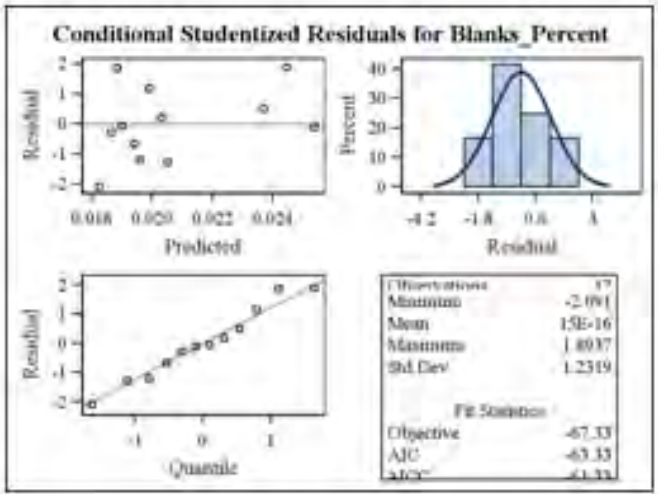


% Blanks: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	0.20	0.8276

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.01986	0.002457	6.76	8.08	0.0001
TRT	Surround	0.02061	0.002457	6.76	8.39	<0001
TRT	Surround_1	0.02152	0.002457	6.76	8.76	<0001

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-0.00075	0.002676	6	-0.28	0.7880	Tukey-Kramer	0.9577
TRT	Control	Surround_1	-0.00167	0.002676	6	-0.62	0.5556	Tukey-Kramer	0.8129
TRT	Surround	Surround_1	-0.00092	0.002676	6	-0.34	0.7434	Tukey-Kramer	0.9379

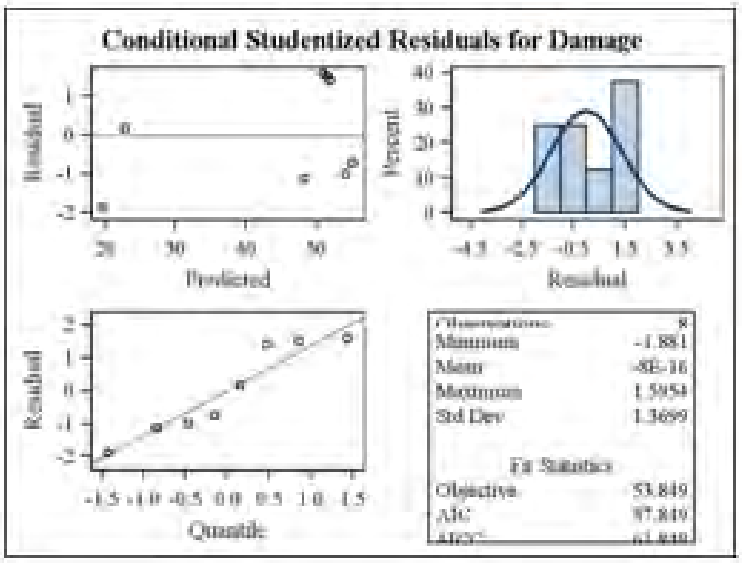


Damage: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	0.17	0.7051

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	42.7095	10.1489	4	4.21	0.0136
TRT	Surround	45.9461	10.1489	4	4.53	0.0106

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-3.2366	7.7722	3	-0.42	0.7051	Tukey-Kramer	0.7051

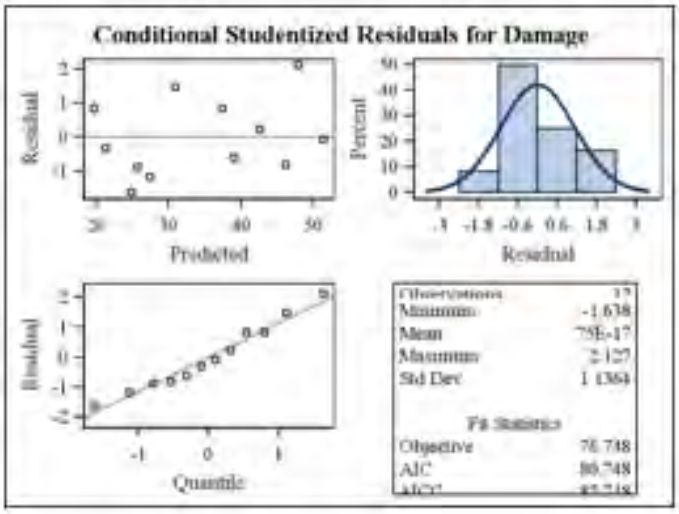


Damage: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	0.28	0.7670

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	33.9061	8.2518	5.07	4.11	0.0090
TRT	Surround	32.1980	8.2518	5.07	3.90	0.0111
TRT	Surround_1	37.4346	8.2518	5.07	4.54	0.0060

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	1.7081	7.1718	6	0.24	0.8197	Tukey-Kramer	0.9694
TRT	Control	Surround_1	-3.5286	7.1718	6	-0.49	0.6402	Tukey-Kramer	0.8777
TRT	Surround	Surround_1	-5.2367	7.1718	6	-0.73	0.4928	Tukey-Kramer	0.7557

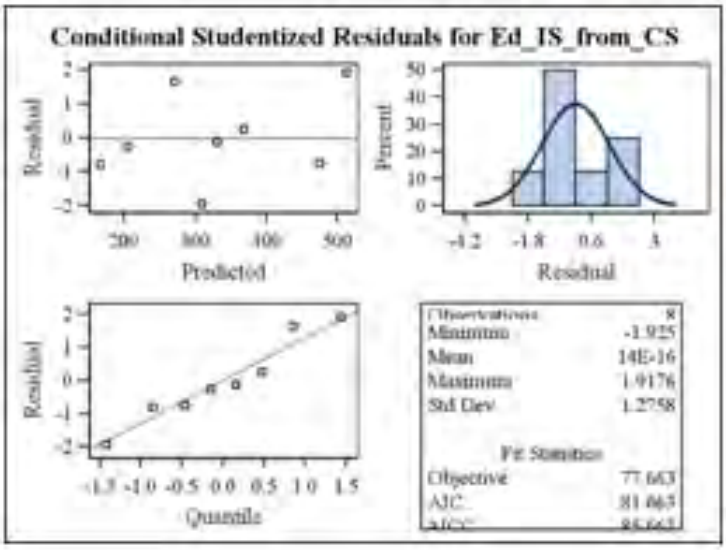


Edible Inshell from CS: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	0.53	0.5198

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	348.32	78.2432	3.74	4.45	0.0130
TRT	Surround	310.30	78.2432	3.74	3.97	0.0189

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	38.0216	52.3008	3	0.73	0.5198	Tukey-Kramer	0.5198

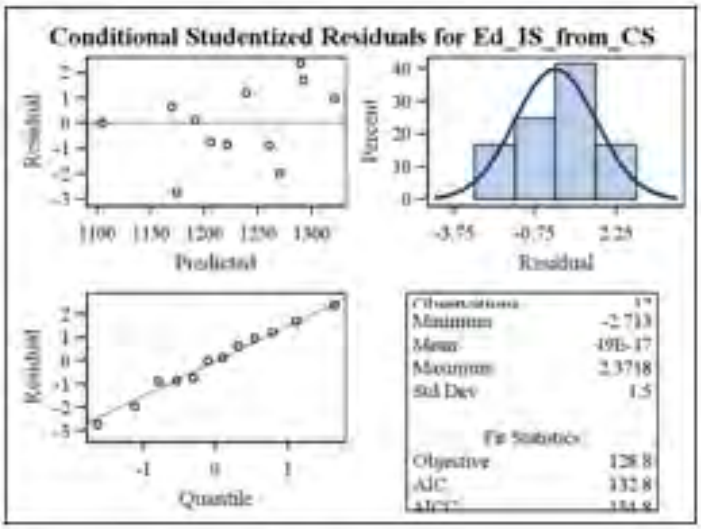


Edible Inshell from CS: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	0.20	0.8262

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	1272.36	123.96	8.71	10.26	<.0001
TRT	Surround	1240.83	123.96	8.71	10.01	<.0001
TRT	Surround_1	1171.89	123.96	8.71	9.45	<.0001

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	31.5330	163.68	6	0.19	0.8536	Tukey-Kramer	0.9798
TRT	Control	Surround_1	100.47	163.68	6	0.61	0.5619	Tukey-Kramer	0.8182
TRT	Surround	Surround_1	68.9382	163.68	6	0.42	0.6883	Tukey-Kramer	0.9083

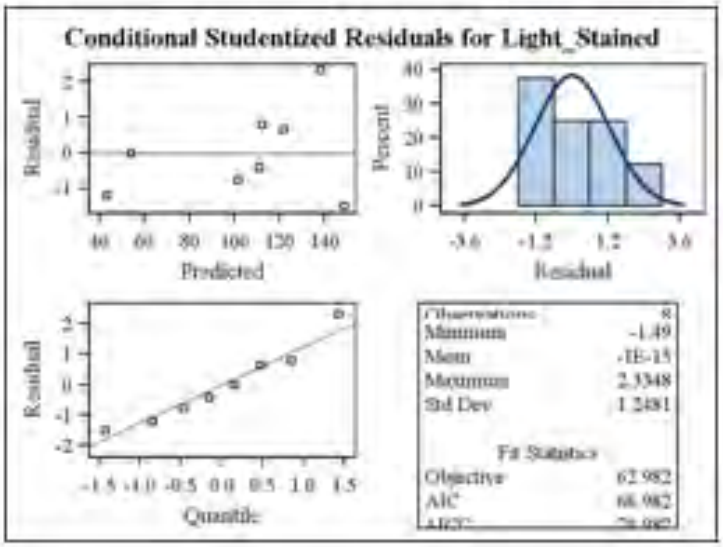


Light Stained: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	0.52	0.5237

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	98.3958	23.5956	3.66	4.17	0.0169
TRT	Surround	109.13	23.5956	3.66	4.63	0.0122

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-10.7360	14.9150	3	-0.72	0.5237	Tukey-Kramer	0.5237

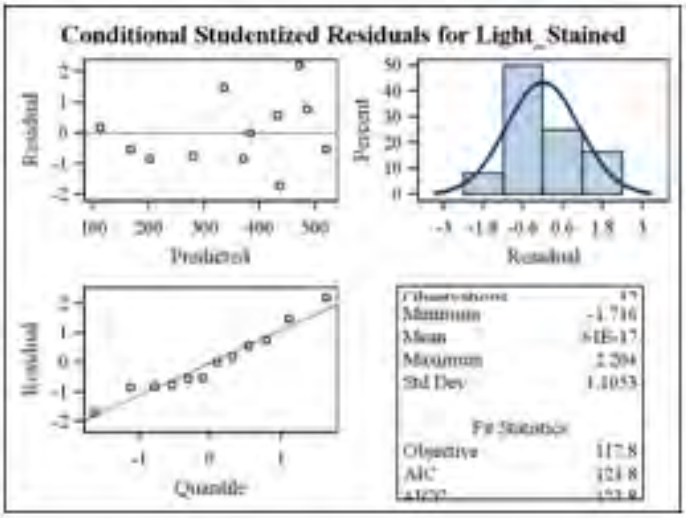


Light Stained: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	0.95	0.4389

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	390.77	88.2957	4.4	4.43	0.0092
TRT	Surround	355.74	88.2957	4.4	4.03	0.0130
TRT	Surround_1	301.06	88.2957	4.4	3.41	0.0233

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	35.0272	65.6860	6	0.53	0.6130	Tukey-Kramer	0.8584
TRT	Control	Surround_1	89.7085	65.6860	6	1.37	0.2210	Tukey-Kramer	0.4142
TRT	Surround	Surround_1	54.6813	65.6860	6	0.83	0.4370	Tukey-Kramer	0.6983

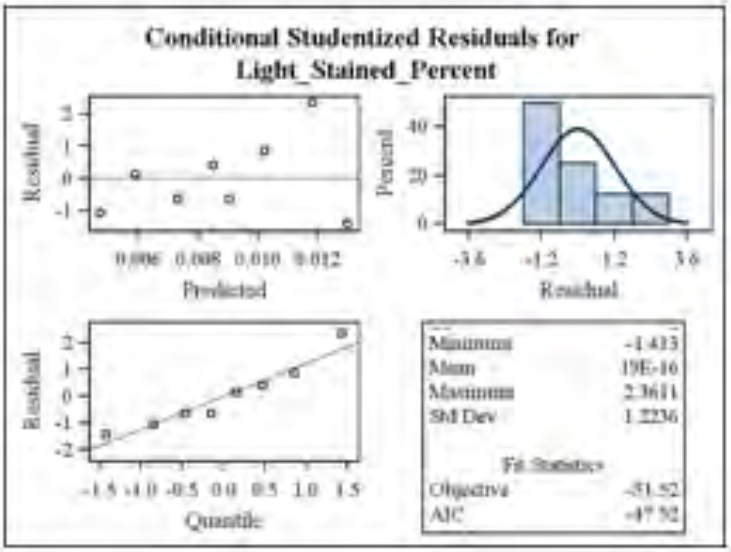


% Light Stained: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	1.29	0.3392

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.008231	0.001739	3.58	4.73	0.0119
TRT	Surround	0.009406	0.001739	3.58	5.41	0.0077

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-0.00118	0.001036	3	-1.13	0.3392	Tukey-Kramer	0.3392

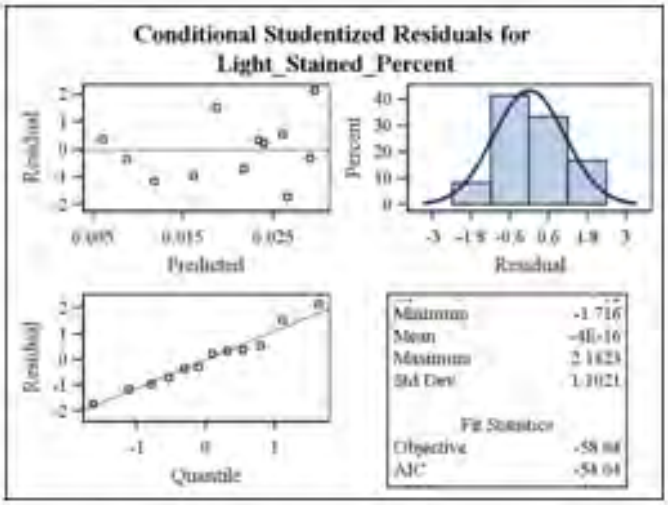


% Light Stained: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	1.14	0.3811

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.02299	0.005114	4.33	4.50	0.0091
TRT	Surround	0.02000	0.005114	4.33	3.91	0.0150
TRT	Surround_1	0.01737	0.005114	4.33	3.40	0.0242

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	0.002990	0.003724	6	0.80	0.4527	Tukey-Kramer	0.7151
TRT	Control	Surround_1	0.005613	0.003724	6	1.51	0.1824	Tukey-Kramer	0.3524
TRT	Surround	Surround_1	0.002624	0.003724	6	0.70	0.5075	Tukey-Kramer	0.7698

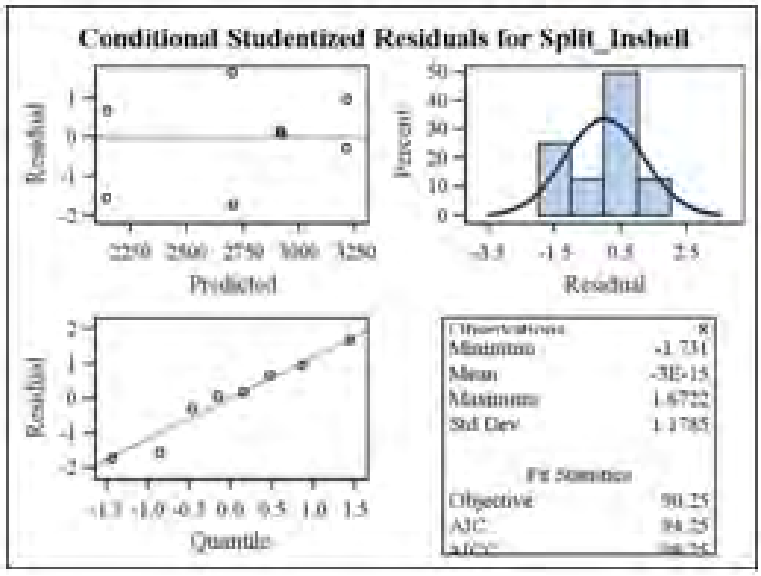


Split Inshell: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	0.00	0.9673

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	2739.96	251.19	3.42	10.91	0.0009
TRT	Surround	2745.72	251.19	3.42	10.93	0.0009

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-5.7636	129.49	3	-0.04	0.9673	Tukey-Kramer	0.9673

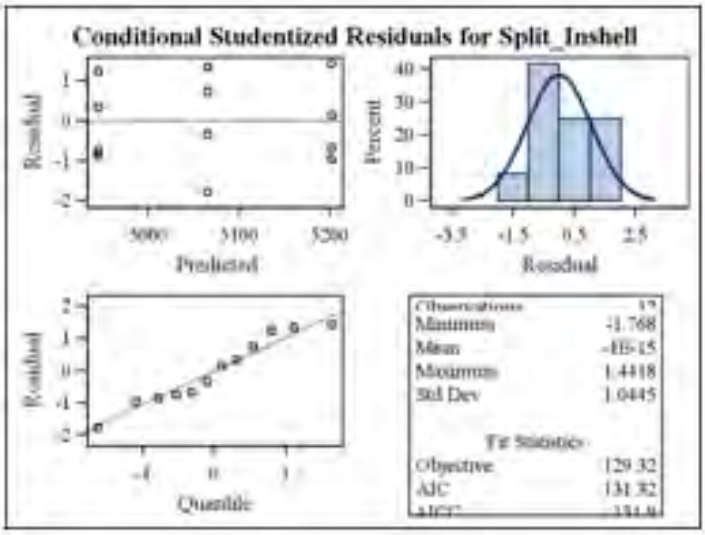


Split Inshell: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	9	1.04	0.3908

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	4943.58	126.67	9	39.03	<.0001
TRT	Surround	5202.39	126.67	9	41.07	<.0001
TRT	Surround_1	5065.56	126.67	9	39.99	<.0001

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-258.81	179.13	9	-1.44	0.1824	Tukey	0.3602
TRT	Control	Surround_1	-121.98	179.13	9	-0.68	0.5131	Tukey	0.7801
TRT	Surround	Surround_1	136.84	179.13	9	0.76	0.4645	Tukey	0.7332

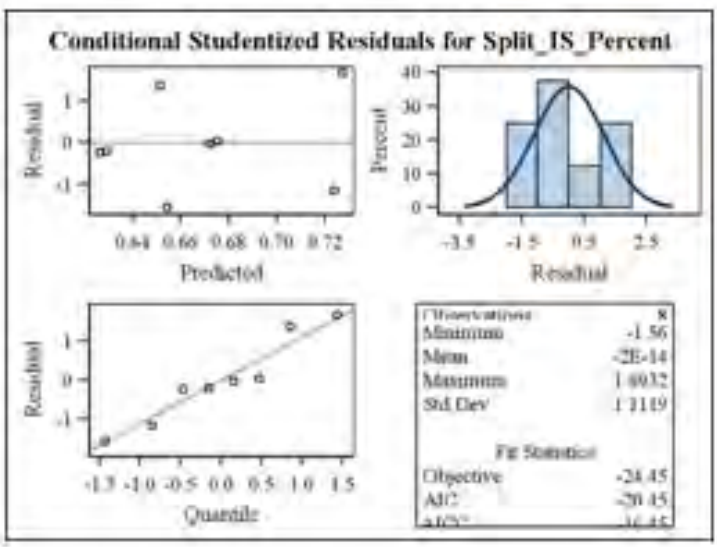


Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	0.19	0.6931

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.6716	0.02173	3.18	30.91	<.0001
TRT	Surround	0.6684	0.02173	3.18	30.76	<.0001

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	0.003182	0.007319	3	0.43	0.6931	Tukey-Kramer	0.6931

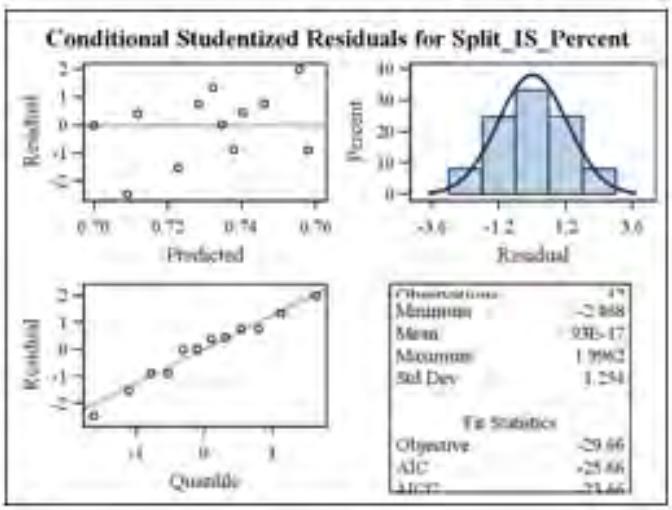


Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	0.16	0.8554

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.7243	0.01966	7.06	36.84	<.0001
TRT	Surround	0.7336	0.01966	7.06	37.31	<.0001
TRT	Surround_1	0.7361	0.01966	7.06	37.44	<.0001

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-0.00933	0.02206	6	-0.42	0.6870	Tukey-Kramer	0.9075
TRT	Control	Surround_1	-0.01186	0.02206	6	-0.54	0.6102	Tukey-Kramer	0.8563
TRT	Surround	Surround_1	-0.00253	0.02206	6	-0.11	0.9125	Tukey-Kramer	0.9928

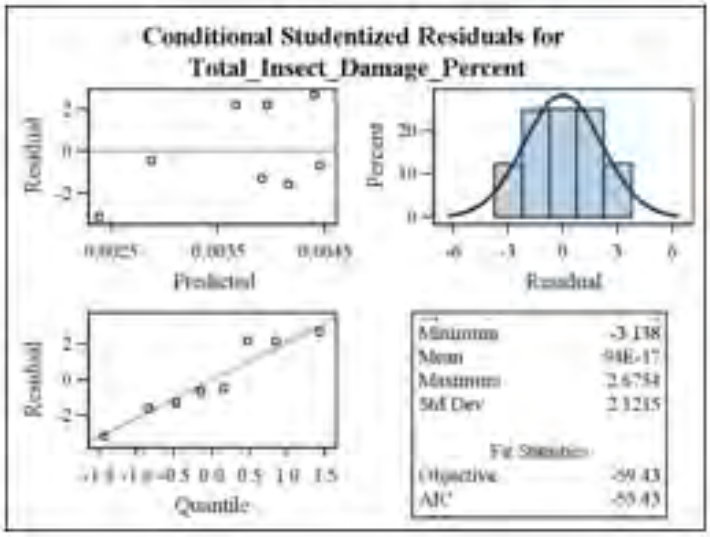


Total % Insect Damaged: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	0.43	0.5609

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.003476	0.000716	5.03	4.85	0.0046
TRT	Surround	0.003970	0.000716	5.03	5.54	0.0026

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-0.00049	0.000758	3	-0.65	0.5609	Tukey-Kramer	0.5609

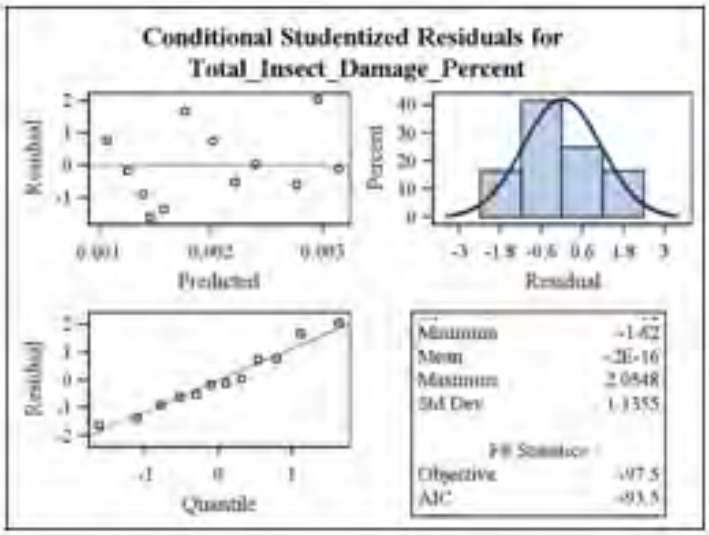


Total % Insect Damaged: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	0.36	0.7146

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.002000	0.000517	5.05	3.87	0.0115
TRT	Surround	0.001811	0.000517	5.05	3.51	0.0169
TRT	Surround_1	0.002189	0.000517	5.05	4.24	0.0080

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	0.000189	0.000447	6	0.42	0.6872	Tukey-Kramer	0.9077
TRT	Control	Surround_1	-0.00019	0.000447	6	-0.42	0.6887	Tukey-Kramer	0.9085
TRT	Surround	Surround_1	-0.00038	0.000447	6	-0.84	0.4314	Tukey-Kramer	0.6922



Total Inshell Weight %: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	0.90	0.4136

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.2820	0.004423	5.86	63.75	<.0001
TRT	Surround	0.2765	0.004423	5.86	62.52	<.0001

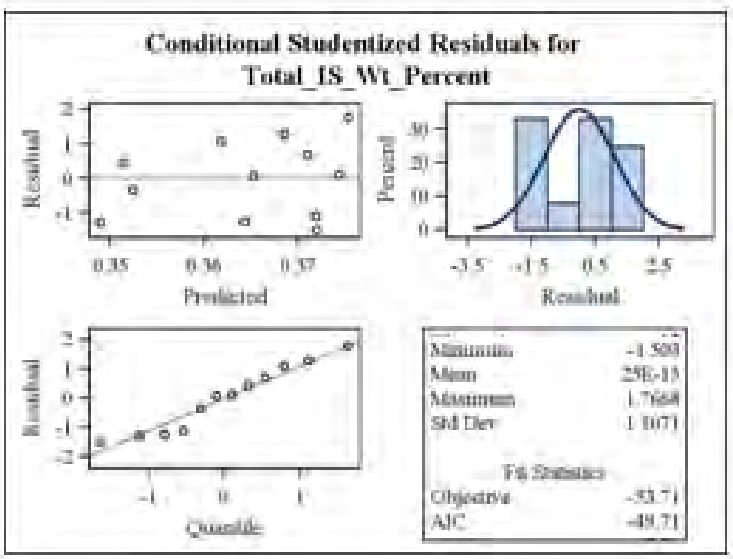
Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	0.005453	0.005760	3	0.95	0.4136	Tukey-Kramer	0.4136

Total Inshell Weight %: Year = 2010

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	6	0.28	0.7624

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	0.3663	0.006379	4.44	57.41	<.0001
TRT	Surround	0.3627	0.006379	4.44	56.86	<.0001
TRT	Surround_1	0.3652	0.006379	4.44	57.26	<.0001

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	0.003512	0.004800	6	0.73	0.4920	Tukey-Kramer	0.7550
TRT	Control	Surround_1	0.001004	0.004800	6	0.21	0.8412	Tukey-Kramer	0.9763
TRT	Surround	Surround_1	-0.00251	0.004800	6	-0.52	0.6201	Tukey-Kramer	0.8636

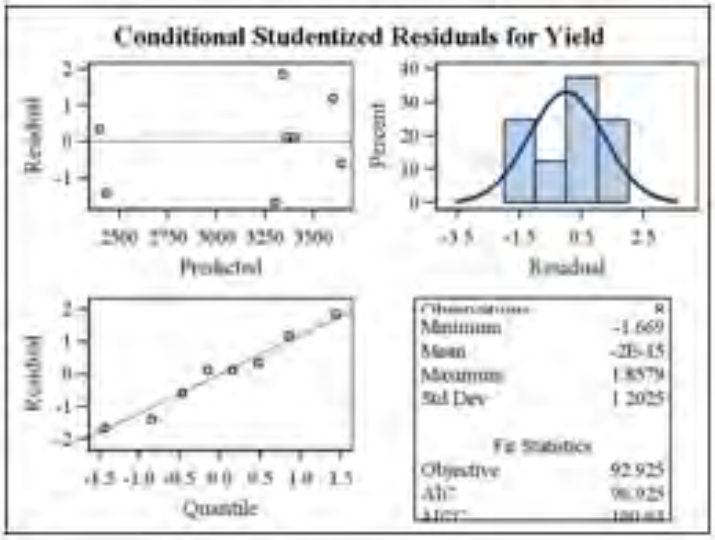


Yield: Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	3	0.05	0.8301

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	3204.89	301.95	3.51	10.61	0.0009
TRT	Surround	3165.28	301.95	3.51	10.48	0.0009

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	39.6098	169.35	3	0.23	0.8301	Tukey-Kramer	0.8301



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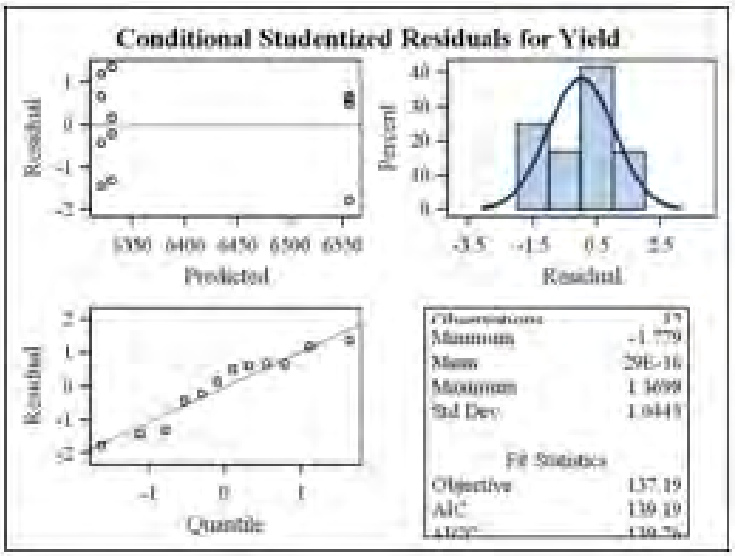
Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	2	9	0.47	0.6424

Least Squares Means						
Effect	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control	6330.10	196.06	9	32.29	<.0001
TRT	Surround	6556.22	196.06	9	33.44	<.0001
TRT	Surround_1	6319.56	196.06	9	32.23	<.0001

Differences of Least Squares Means									
Effect	TRT	TRT	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment	Adj P
TRT	Control	Surround	-226.13	277.27	9	-0.82	0.4358	Tukey	0.7033
TRT	Control	Surround_1	10.5394	277.27	9	0.04	0.9705	Tukey	0.9992
TRT	Surround	Surround_1	236.66	277.27	9	0.85	0.4155	Tukey	0.6811



ATTACHMENT C
DATA – SMALL BLOCKS

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Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	9	0.20	0.6675
Irrigation	1	9	2.17	0.1747
TRT*Irrigation	1	9	0.93	0.3593

Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control		30.9724	8.3192	6.19	3.72	0.0093
TRT	Surround		26.7241	8.3192	6.19	3.21	0.0175
Irrigation		1 gph	35.8964	8.3192	6.19	4.31	0.0047
Irrigation		1/2 gph	21.8001	8.3192	6.19	2.62	0.0384
TRT*Irrigation	Control	1 gph	42.6404	10.7222	10.7	3.98	0.0023
TRT*Irrigation	Control	1/2 gph	19.3044	10.7222	10.7	1.80	0.1001
TRT*Irrigation	Surround	1 gph	29.1524	10.7222	10.7	2.72	0.0205
TRT*Irrigation	Surround	1/2 gph	24.2958	10.7222	10.7	2.27	0.0453

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		4.2483	9.5662	9	0.44	0.6675	Bonferroni
Irrigation		1 gph		1/2 gph	14.0963	9.5662	9	1.47	0.1747	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	23.3360	13.5287	9	1.72	0.1186	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	13.4880	13.5287	9	1.00	0.3448	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	18.3446	13.5287	9	1.36	0.2081	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-9.8480	13.5287	9	-0.73	0.4852	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-4.9914	13.5287	9	-0.37	0.7207	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	4.8566	13.5287	9	0.36	0.7279	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.6675
Irrigation		1 gph		1/2 gph	0.1747
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.7118

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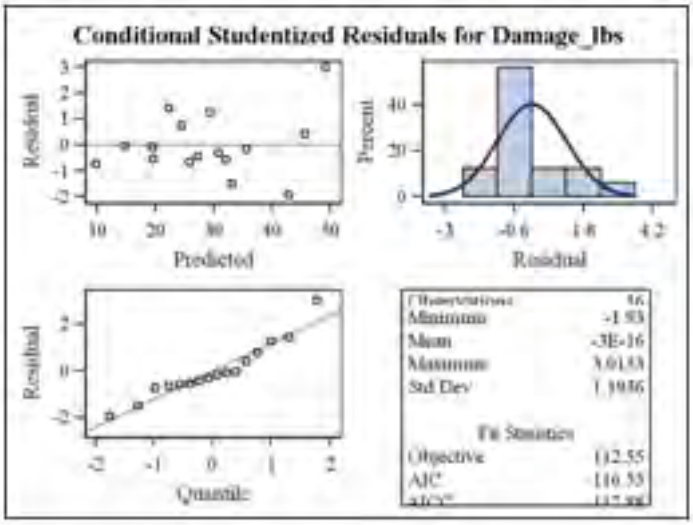
Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	1.0000



Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
TRT	1	12	1.35	0.2681
Irrigation	1	12	3.85	0.0733
TRT*Irrigation	1	12	0.93	0.3535

Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT	Control		29.5545	6.1624	12	4.80	0.0004
TRT	Surround		19.4333	6.1624	12	3.15	0.0083
Irrigation		1 gph	33.0455	6.1624	12	5.36	0.0002
Irrigation		1/2 gph	15.9423	6.1624	12	2.59	0.0238

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Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT*Irrigation	Control	1 gph	33.9000	8.7150	12	3.89	0.0021
TRT*Irrigation	Control	1/2 gph	25.2090	8.7150	12	2.89	0.0135
TRT*Irrigation	Surround	1 gph	32.1910	8.7150	12	3.69	0.0031
TRT*Irrigation	Surround	1/2 gph	6.6757	8.7150	12	0.77	0.4585

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		10.1212	8.7150	12	1.16	0.2681	Bonferroni
Irrigation		1 gph		1/2 gph	17.1032	8.7150	12	1.96	0.0733	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	8.6910	12.3248	12	0.71	0.4942	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.7090	12.3248	12	0.14	0.8920	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	27.2244	12.3248	12	2.21	0.0474	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-6.9820	12.3248	12	-0.57	0.5815	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	18.5333	12.3248	12	1.50	0.1585	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	25.5153	12.3248	12	2.07	0.0607	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.2681
Irrigation		1 gph		1/2 gph	0.0733
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.2842
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	0.9510
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.3640

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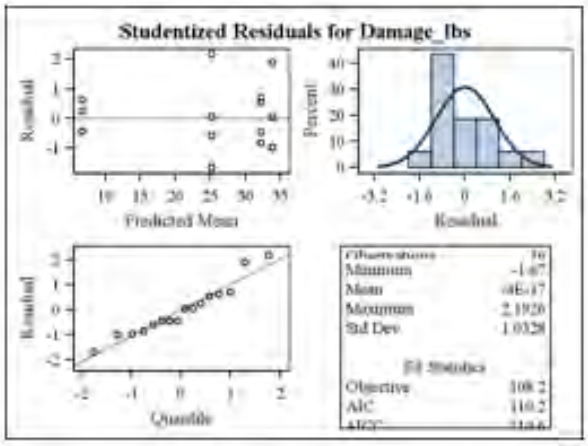

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Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	9	3.96	0.0777
Irrigation	1	9	4.13	0.0726
TRT*Irrigation	1	9	4.60	0.0605

Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control		173.54	67.0010	3.39	2.59	0.0716
TRT	Surround		238.81	67.0010	3.39	3.56	0.0309
Irrigation		1 gph	172.85	67.0010	3.39	2.58	0.0723
Irrigation		1/2 gph	239.50	67.0010	3.39	3.57	0.0307
TRT*Irrigation	Control	1 gph	105.05	70.8987	4.2	1.48	0.2092
TRT*Irrigation	Control	1/2 gph	242.03	70.8987	4.2	3.41	0.0249
TRT*Irrigation	Surround	1 gph	240.65	70.8987	4.2	3.39	0.0254
TRT*Irrigation	Surround	1/2 gph	236.98	70.8987	4.2	3.34	0.0267

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		-65.2773	32.7870	9	-1.99	0.0777	Bonferroni
Irrigation		1 gph		1/2 gph	-66.6552	32.7870	9	-2.03	0.0726	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	-136.98	46.3678	9	-2.95	0.0161	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	-135.61	46.3678	9	-2.92	0.0169	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	-131.93	46.3678	9	-2.85	0.0192	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.3779	46.3678	9	0.03	0.9769	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	5.0504	46.3678	9	0.11	0.9157	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	3.6725	46.3678	9	0.08	0.9386	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.0777
Irrigation		1 gph		1/2 gph	0.0726
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.0967

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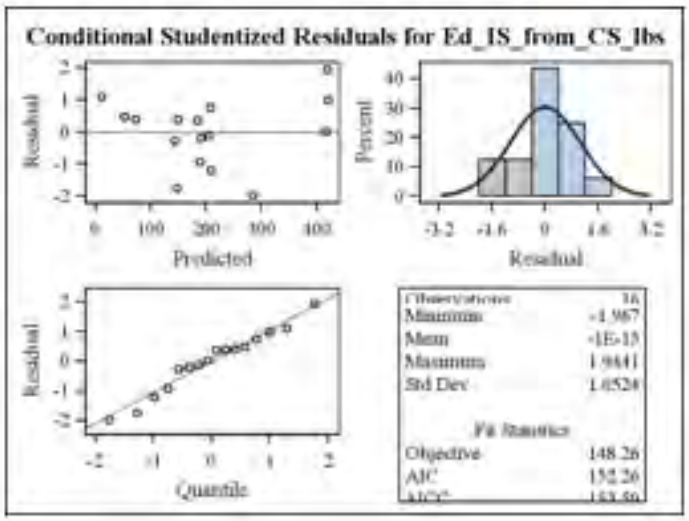
Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.1014
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.1154
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	1.0000



Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
TRT	1	12	0.04	0.8457
Irrigation	1	12	17.74	0.0012
TRT*Irrigation	1	12	0.01	0.9234

Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT	Control		1949.46	222.21	12	8.77	<0001
TRT	Surround		1886.97	222.21	12	8.49	<0001
Irrigation		1 gph	1256.37	222.21	12	5.65	0.0001
Irrigation		1/2 gph	2580.05	222.21	12	11.61	<0001

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Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT*Irrigation	Control	1 gph	1272.19	314.26	12	4.05	0.0016
TRT*Irrigation	Control	1/2 gph	2626.73	314.26	12	8.36	<.0001
TRT*Irrigation	Surround	1 gph	1240.56	314.26	12	3.95	0.0019
TRT*Irrigation	Surround	1/2 gph	2533.37	314.26	12	8.06	<.0001

Differences of Least Squares Means										
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Adjustment**
TRT	Control		Surround		62.4949	314.26	12	0.20	0.8457	Bonferroni
Irrigation		1 gph		1/2 gph	-1323.68	314.26	12	-4.21	0.0012	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	-1354.55	444.43	12	-3.05	0.0101	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	31.6256	444.43	12	0.07	0.9444	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	-1261.18	444.43	12	-2.84	0.0150	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1386.17	444.43	12	3.12	0.0089	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	93.3641	444.43	12	0.21	0.8371	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	-1292.81	444.43	12	-2.91	0.0131	Bonferroni

Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT	Control		Surround		0.8457
Irrigation		1 gph		1/2 gph	0.0012
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.0608
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.0897
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	0.0532
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.0786

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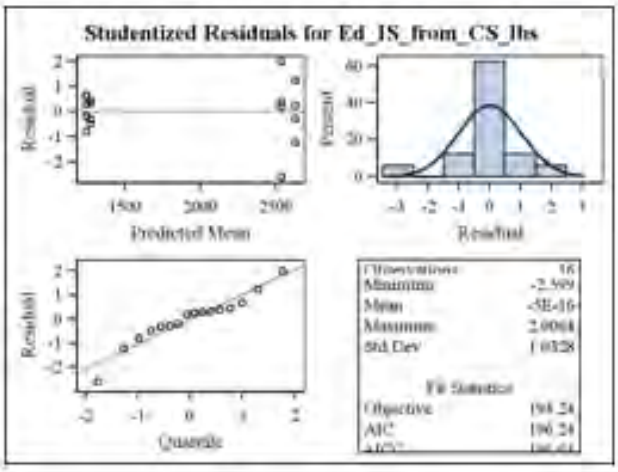

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Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	9	0.03	0.8593
Irrigation	1	9	4.23	0.0699
TRT*Irrigation	1	9	2.36	0.1590

Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control		0.01095	0.003097	4.25	3.54	0.0218
TRT	Surround		0.01050	0.003097	4.25	3.39	0.0251
Irrigation		1 gph	0.01331	0.003097	4.25	4.30	0.0111
Irrigation		1/2 gph	0.008138	0.003097	4.25	2.63	0.0549
TRT*Irrigation	Control	1 gph	0.01547	0.003572	6.81	4.33	0.0037
TRT*Irrigation	Control	1/2 gph	0.006436	0.003572	6.81	1.80	0.1157
TRT*Irrigation	Surround	1 gph	0.01115	0.003572	6.81	3.12	0.0174
TRT*Irrigation	Surround	1/2 gph	0.009841	0.003572	6.81	2.76	0.0291

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		0.000459	0.002516	9	0.18	0.8593	Bonferroni
Irrigation		1 gph		1/2 gph	0.005173	0.002516	9	2.06	0.0699	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.009037	0.003558	9	2.54	0.0317	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.004323	0.003558	9	1.21	0.2553	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.005633	0.003558	9	1.58	0.1479	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-0.00471	0.003558	9	-1.32	0.2178	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-0.00340	0.003558	9	-0.96	0.3637	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.001310	0.003558	9	0.37	0.7213	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.8593
Irrigation		1 gph		1/2 gph	0.0699
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.1903

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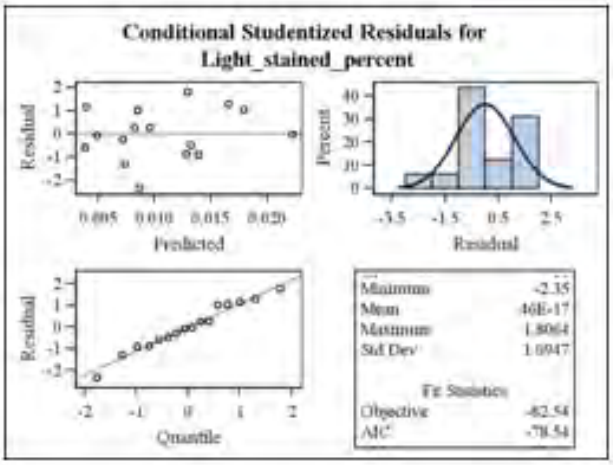
Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.8873
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	1.0000



Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
TRT	1	12	11.53	0.0053
Irrigation	1	12	33.52	<.0001
TRT*Irrigation	1	12	12.45	0.0042

Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT	Control		0.06989	0.01005	12	6.95	<.0001
TRT	Surround		0.02161	0.01005	12	2.15	0.0527
Irrigation		1 gph	0.08690	0.01005	12	8.64	<.0001
Irrigation		1/2 gph	0.004594	0.01005	12	0.46	0.6558

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Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT*Irrigation	Control	1 gph	0.1361	0.01422	12	9.58	<.0001
TRT*Irrigation	Control	1/2 gph	0.003647	0.01422	12	0.26	0.8019
TRT*Irrigation	Surround	1 gph	0.03768	0.01422	12	2.65	0.0212
TRT*Irrigation	Surround	1/2 gph	0.005541	0.01422	12	0.39	0.7035

Differences of Least Squares Means										
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Adjustment**
TRT	Control		Surround		0.04827	0.01422	12	3.40	0.0053	Bonferroni
Irrigation		1 gph		1/2 gph	0.08231	0.01422	12	5.79	<.0001	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.1325	0.02010	12	6.59	<.0001	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.09844	0.02010	12	4.90	0.0004	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.1306	0.02010	12	6.50	<.0001	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-0.03404	0.02010	12	-1.69	0.1163	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-0.00189	0.02010	12	-0.09	0.9265	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.03214	0.02010	12	1.60	0.1359	Bonferroni

Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT	Control		Surround		0.0053
Irrigation		1 gph		1/2 gph	<.0001
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.0002
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.0022
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.0002
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	0.6975
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.8153

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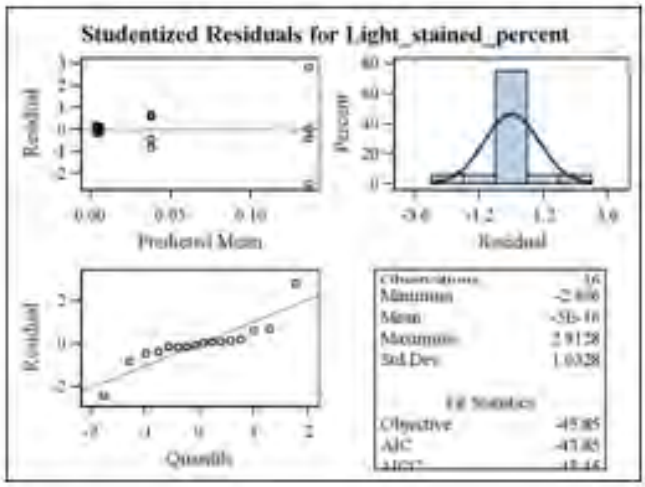

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Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	9	5.38	0.0455
Irrigation	1	9	1.24	0.2937
TRT*Irrigation	1	9	2.36	0.1589

Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control		2474.38	143.66	6.19	17.22	<.0001
TRT	Surround		2857.57	143.66	6.19	19.89	<.0001
Irrigation		1 gph	2573.87	143.66	6.19	17.92	<.0001
Irrigation		1/2 gph	2758.07	143.66	6.19	19.20	<.0001
TRT*Irrigation	Control	1 gph	2509.14	185.16	10.7	13.55	<.0001
TRT*Irrigation	Control	1/2 gph	2439.62	185.16	10.7	13.18	<.0001
TRT*Irrigation	Surround	1 gph	2638.60	185.16	10.7	14.25	<.0001
TRT*Irrigation	Surround	1/2 gph	3076.53	185.16	10.7	16.62	<.0001

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		-383.19	165.19	9	-2.32	0.0455	Bonferroni
Irrigation		1 gph		1/2 gph	-184.20	165.19	9	-1.12	0.2937	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	69.5244	233.62	9	0.30	0.7728	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	-129.46	233.62	9	-0.55	0.5930	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	-567.39	233.62	9	-2.43	0.0381	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-198.99	233.62	9	-0.85	0.4164	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-636.91	233.62	9	-2.73	0.0234	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	-437.93	233.62	9	-1.87	0.0936	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.0455
Irrigation		1 gph		1/2 gph	0.2937
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1.0000

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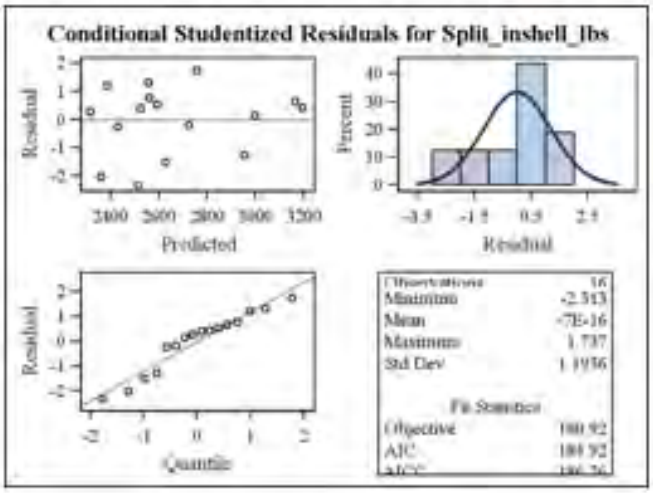
Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.2284
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	0.1402
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.5617



Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
TRT	1	12	0.11	0.7438
Irrigation	1	12	17.29	0.0013
TRT*Irrigation	1	12	0.84	0.3767

Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT	Control		4225.63	313.10	12	13.50	<.0001
TRT	Surround		4077.52	313.10	12	13.02	<.0001
Irrigation		1 gph	5072.06	313.10	12	16.20	<.0001
Irrigation		1/2 gph	3231.09	313.10	12	10.32	<.0001

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Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT*Irrigation	Control	1 gph	4942.86	442.78	12	11.16	<.0001
TRT*Irrigation	Control	1/2 gph	3508.40	442.78	12	7.92	<.0001
TRT*Irrigation	Surround	1 gph	5201.26	442.78	12	11.75	<.0001
TRT*Irrigation	Surround	1/2 gph	2953.78	442.78	12	6.67	<.0001

Differences of Least Squares Means										
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Adjustment**
TRT	Control		Surround		148.11	442.78	12	0.33	0.7438	Bonferroni
Irrigation		1 gph		1/2 gph	1840.97	442.78	12	4.16	0.0013	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1434.46	626.19	12	2.29	0.0409	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	-258.40	626.19	12	-0.41	0.6871	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	1989.09	626.19	12	3.18	0.0080	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-1692.86	626.19	12	-2.70	0.0192	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	554.62	626.19	12	0.89	0.3932	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	2247.49	626.19	12	3.59	0.0037	Bonferroni

Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT	Control		Surround		0.7438
Irrigation		1 gph		1/2 gph	0.0013
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.2452
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.0478
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	0.1151
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.0223

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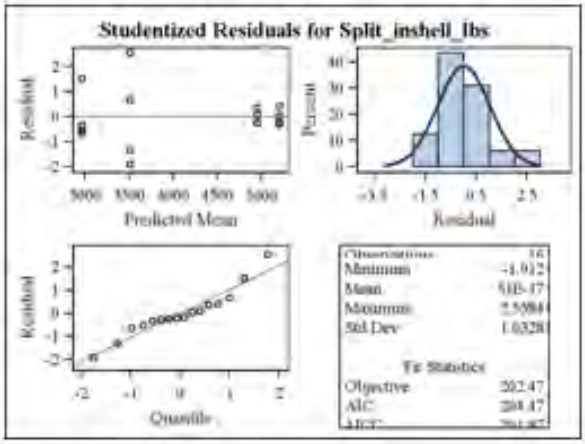

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Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	9	0.01	0.9127
Irrigation	1	9	0.07	0.7954
TRT*Irrigation	1	9	1.56	0.2430

Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control		0.7048	0.03354	3.52	21.02	<.0001
TRT	Surround		0.7027	0.03354	3.52	20.95	<.0001
Irrigation		1 gph	0.7063	0.03354	3.52	21.06	<.0001
Irrigation		1/2 gph	0.7013	0.03354	3.52	20.91	<.0001
TRT*Irrigation	Control	1 gph	0.7191	0.03607	4.62	19.94	<.0001
TRT*Irrigation	Control	1/2 gph	0.6906	0.03607	4.62	19.15	<.0001
TRT*Irrigation	Surround	1 gph	0.6935	0.03607	4.62	19.23	<.0001
TRT*Irrigation	Surround	1/2 gph	0.7119	0.03607	4.62	19.74	<.0001

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		0.002116	0.01876	9	0.11	0.9127	Bonferroni
Irrigation		1 gph		1/2 gph	0.005010	0.01876	9	0.27	0.7954	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.02845	0.02653	9	1.07	0.3114	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.02556	0.02653	9	0.96	0.3605	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.007126	0.02653	9	0.27	0.7943	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-0.00289	0.02653	9	-0.11	0.9155	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-0.02133	0.02653	9	-0.80	0.4422	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	-0.01843	0.02653	9	-0.69	0.5047	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.9127
Irrigation		1 gph		1/2 gph	0.7954
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1.0000

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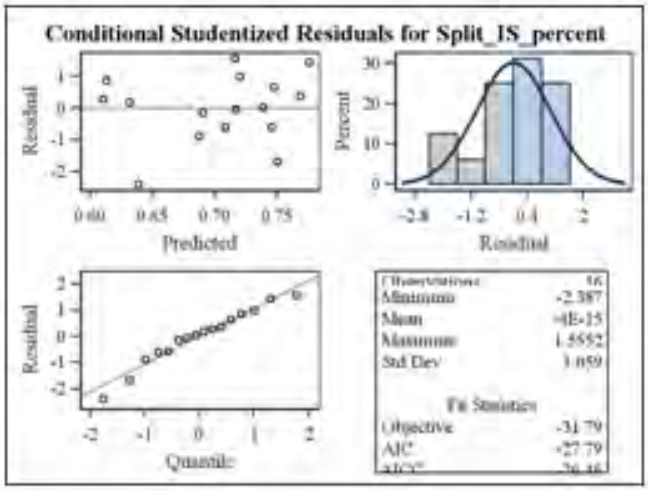
Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	1.0000



Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
TRT	1	12	0.62	0.4463
Irrigation	1	12	12.89	0.0037
TRT*Irrigation	1	12	1.13	0.3097

Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT	Control		0.5824	0.04278	12	13.61	<.0001
TRT	Surround		0.6300	0.04278	12	14.73	<.0001
Irrigation		1 gph	0.7148	0.04278	12	16.71	<.0001
Irrigation		1/2 gph	0.4976	0.04278	12	11.63	<.0001

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Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT*Irrigation	Control	1 gph	0.6589	0.06050	12	10.89	<.0001
TRT*Irrigation	Control	1/2 gph	0.5059	0.06050	12	8.36	<.0001
TRT*Irrigation	Surround	1 gph	0.7707	0.06050	12	12.74	<.0001
TRT*Irrigation	Surround	1/2 gph	0.4893	0.06050	12	8.09	<.0001

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		-0.04764	0.06050	12	-0.79	0.4463	Bonferroni
Irrigation		1 gph		1/2 gph	0.2172	0.06050	12	3.59	0.0037	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.1530	0.08556	12	1.79	0.0990	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	-0.1118	0.08556	12	-1.31	0.2158	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.1696	0.08556	12	1.98	0.0709	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-0.2648	0.08556	12	-3.10	0.0093	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	0.01654	0.08556	12	0.19	0.8500	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.2814	0.08556	12	3.29	0.0065	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.4463
Irrigation		1 gph		1/2 gph	0.0037
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.5938
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.4254
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	0.0556
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.0389

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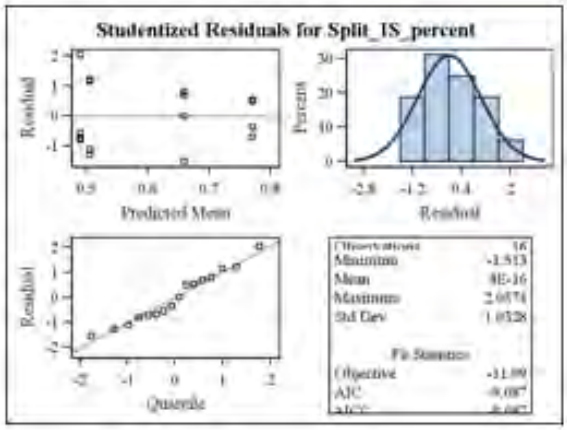

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Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	9	0.32	0.5864
Irrigation	1	9	2.65	0.1381
TRT*Irrigation	1	9	0.52	0.4905

Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control		0.008587	0.002238	6.46	3.84	0.0075
TRT	Surround		0.007095	0.002238	6.46	3.17	0.0175
Irrigation		1 gph	0.009992	0.002238	6.46	4.47	0.0036
Irrigation		1/2 gph	0.005690	0.002238	6.46	2.54	0.0412
TRT*Irrigation	Control	1 gph	0.01169	0.002916	11	4.01	0.0021
TRT*Irrigation	Control	1/2 gph	0.005485	0.002916	11	1.88	0.0868
TRT*Irrigation	Surround	1 gph	0.008296	0.002916	11	2.84	0.0160
TRT*Irrigation	Surround	1/2 gph	0.005894	0.002916	11	2.02	0.0684

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		0.001492	0.002644	9	0.56	0.5864	Bonferroni
Irrigation		1 gph		1/2 gph	0.004303	0.002644	9	1.63	0.1381	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.006204	0.003740	9	1.66	0.1315	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.003393	0.003740	9	0.91	0.3879	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.005795	0.003740	9	1.55	0.1556	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-0.00281	0.003740	9	-0.75	0.4715	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-0.00041	0.003740	9	-0.11	0.9154	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.002402	0.003740	9	0.64	0.5367	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.5864
Irrigation		1 gph		1/2 gph	0.1381
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.7891

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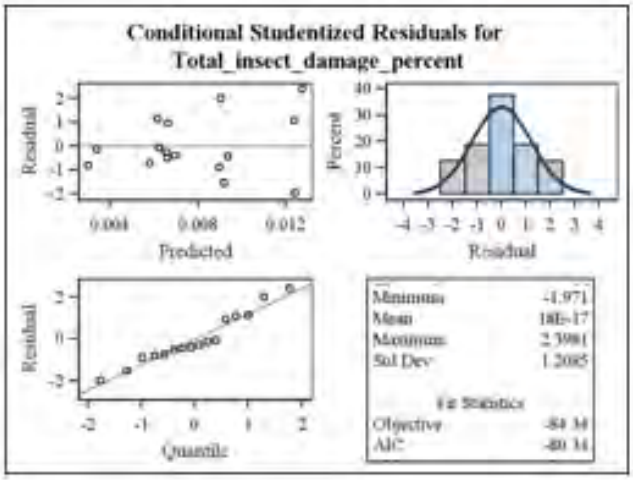
Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.9339
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	1.0000



Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
TRT	1	12	1.26	0.2834
Irrigation	1	12	2.22	0.1620
TRT*Irrigation	1	12	0.71	0.4157

Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT	Control		0.004536	0.001062	12	4.27	0.0011
TRT	Surround		0.002849	0.001062	12	2.68	0.0199
Irrigation		1 gph	0.004811	0.001062	12	4.53	0.0007
Irrigation		1/2 gph	0.002574	0.001062	12	2.42	0.0321

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Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT*Irrigation	Control	1 gph	0.005021	0.001502	12	3.34	0.0058
TRT*Irrigation	Control	1/2 gph	0.004050	0.001502	12	2.70	0.0194
TRT*Irrigation	Surround	1 gph	0.004601	0.001502	12	3.06	0.0098
TRT*Irrigation	Surround	1/2 gph	0.001098	0.001502	12	0.73	0.4787

Differences of Least Squares Means										
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Adjustment**
TRT	Control		Surround		0.001686	0.001502	12	1.12	0.2834	Bonferroni
Irrigation		1 gph		1/2 gph	0.002237	0.001502	12	1.49	0.1620	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	0.000971	0.002124	12	0.46	0.6555	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.000420	0.002124	12	0.20	0.8464	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.003923	0.002124	12	1.85	0.0895	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-0.00055	0.002124	12	-0.26	0.7996	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	0.002952	0.002124	12	1.39	0.1897	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.003503	0.002124	12	1.65	0.1249	Bonferroni

Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT	Control		Surround		0.2834
Irrigation		1 gph		1/2 gph	0.1620
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.5367
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.7495

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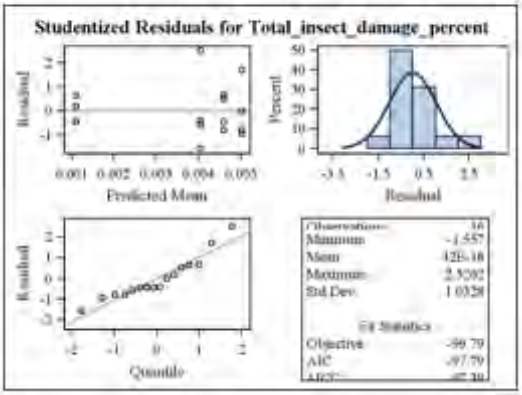

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Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	9	0.88	0.3736
Irrigation	1	9	2.97	0.1187
TRT*Irrigation	1	9	2.47	0.1506

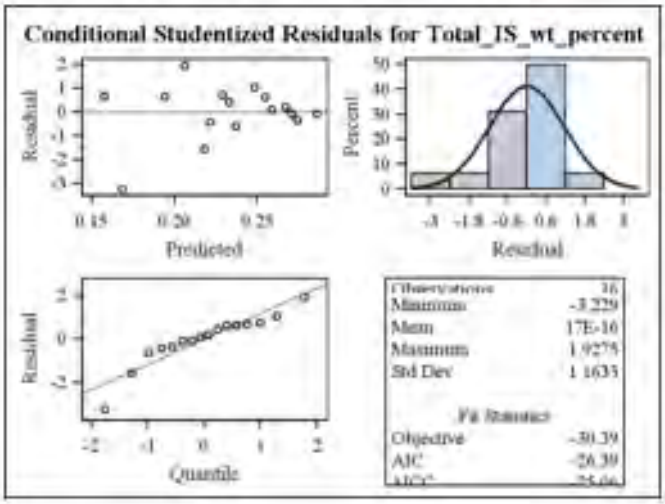
Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control		0.2441	0.02251	5.62	10.85	<.0001
TRT	Surround		0.2215	0.02251	5.62	9.84	<.0001
Irrigation		1 gph	0.2119	0.02251	5.62	9.42	0.0001
Irrigation		1/2 gph	0.2536	0.02251	5.62	11.27	<.0001
TRT*Irrigation	Control	1 gph	0.2423	0.02826	9.87	8.57	<.0001
TRT*Irrigation	Control	1/2 gph	0.2460	0.02826	9.87	8.70	<.0001
TRT*Irrigation	Surround	1 gph	0.1816	0.02826	9.87	6.43	<.0001
TRT*Irrigation	Surround	1/2 gph	0.2613	0.02826	9.87	9.25	<.0001

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		0.02263	0.02418	9	0.94	0.3736	Bonferroni
Irrigation		1 gph		1/2 gph	-0.04170	0.02418	9	-1.72	0.1187	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	-0.00371	0.03419	9	-0.11	0.9160	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.06062	0.03419	9	1.77	0.1100	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	-0.01907	0.03419	9	-0.56	0.5907	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	0.06434	0.03419	9	1.88	0.0926	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-0.01535	0.03419	9	-0.45	0.6640	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	-0.07969	0.03419	9	-2.33	0.0447	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.3736
Irrigation		1 gph		1/2 gph	0.1187
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1.0000

Year = 2009

Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.6599
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	0.5555
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.2682



Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
TRT	1	12	0.00	0.9873
Irrigation	1	12	5.11	0.0431
TRT*Irrigation	1	12	0.11	0.7514

Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT	Control		0.3762	0.007296	12	51.57	<0001
TRT	Surround		0.3761	0.007296	12	51.55	<0001
Irrigation		1 gph	0.3645	0.007296	12	49.96	<0001
Irrigation		1/2 gph	0.3878	0.007296	12	53.16	<0001

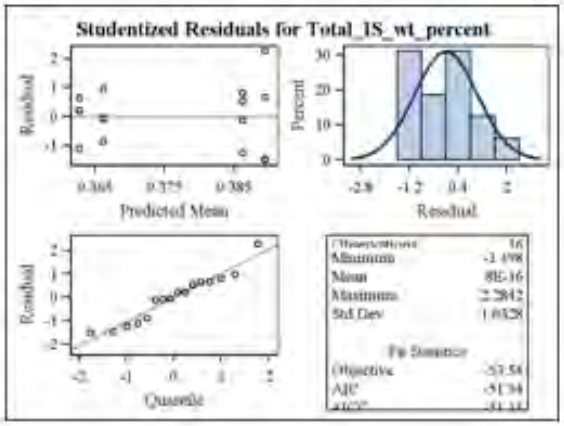
Year = 2010

Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT*Irrigation	Control	1 gph	0.3663	0.01032	12	35.50	<.0001
TRT*Irrigation	Control	1/2 gph	0.3862	0.01032	12	37.43	<.0001
TRT*Irrigation	Surround	1 gph	0.3627	0.01032	12	35.16	<.0001
TRT*Irrigation	Surround	1/2 gph	0.3894	0.01032	12	37.74	<.0001

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		0.000167	0.01032	12	0.02	0.9873	Bonferroni
Irrigation		1 gph		1/2 gph	-0.02333	0.01032	12	-2.26	0.0431	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	-0.01998	0.01459	12	-1.37	0.1959	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	0.003512	0.01459	12	0.24	0.8139	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	-0.02316	0.01459	12	-1.59	0.1384	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	0.02350	0.01459	12	1.61	0.1333	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-0.00318	0.01459	12	-0.22	0.8313	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	-0.02667	0.01459	12	-1.83	0.0925	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.9873
Irrigation		1 gph		1/2 gph	0.0431
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.8306
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	0.8000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.5551

Year = 2010



Year = 2009

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
TRT	1	9	6.35	0.0328
Irrigation	1	9	1.61	0.2368
TRT*Irrigation	1	9	1.39	0.2680

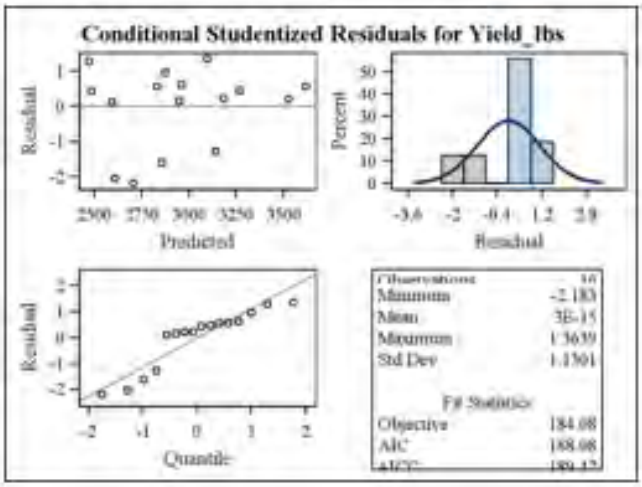
Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT	Control		2722.95	183.28	4.96	14.86	<.0001
TRT	Surround		3170.16	183.28	4.96	17.30	<.0001
Irrigation		1 gph	2834.05	183.28	4.96	15.46	<.0001
Irrigation		1/2 gph	3059.06	183.28	4.96	16.69	<.0001
TRT*Irrigation	Control	1 gph	2715.25	222.14	8.62	12.22	<.0001
TRT*Irrigation	Control	1/2 gph	2730.66	222.14	8.62	12.29	<.0001
TRT*Irrigation	Surround	1 gph	2952.84	222.14	8.62	13.29	<.0001
TRT*Irrigation	Surround	1/2 gph	3387.47	222.14	8.62	15.25	<.0001

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		-447.20	177.52	9	-2.52	0.0328	Bonferroni
Irrigation		1 gph		1/2 gph	-225.01	177.52	9	-1.27	0.2368	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	-15.4082	251.05	9	-0.06	0.9524	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	-237.60	251.05	9	-0.95	0.3686	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	-672.22	251.05	9	-2.68	0.0253	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-222.19	251.05	9	-0.89	0.3992	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	-656.81	251.05	9	-2.62	0.0280	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	-434.62	251.05	9	-1.73	0.1175	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.0328
Irrigation		1 gph		1/2 gph	0.2368
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1.0000

Year = 2009

Differences of Least Squares Means					
Effect	**TRT**	**Irrigation**	**_TRT**	**Irrigation**	**Adj P**
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	0.1518
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	0.1679
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.7047



Type 3 Tests of Fixed Effects				
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
TRT	1	12	0.27	0.6118
Irrigation	1	12	1.73	0.2134
TRT*Irrigation	1	12	1.10	0.3145

Least Squares Means							
Effect	**TRT**	**Irrigation**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
TRT	Control		6272.82	301.76	12	20.79	<.0001
TRT	Surround		6050.46	301.76	12	20.05	<.0001
Irrigation		1 gph	6442.00	301.76	12	21.35	<.0001
Irrigation		1/2 gph	5881.29	301.76	12	19.49	<.0001

Year = 2010

Least Squares Means							
Effect	TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|
TRT*Irrigation	Control	1 gph	6329.19	426.75	12	14.83	<.0001
TRT*Irrigation	Control	1/2 gph	6216.46	426.75	12	14.57	<.0001
TRT*Irrigation	Surround	1 gph	6554.80	426.75	12	15.36	<.0001
TRT*Irrigation	Surround	1/2 gph	5546.11	426.75	12	13.00	<.0001

Differences of Least Squares Means										
Effect	TRT	Irrigation	_TRT	Irrigation	Estimate	Standard Error	DF	t Value	Pr > |t|	Adjustment
TRT	Control		Surround		222.37	426.75	12	0.52	0.6118	Bonferroni
Irrigation		1 gph		1/2 gph	560.71	426.75	12	1.31	0.2134	Bonferroni
TRT*Irrigation	Control	1 gph	Control	1/2 gph	112.74	603.52	12	0.19	0.8549	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1 gph	-225.61	603.52	12	-0.37	0.7151	Bonferroni
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	783.08	603.52	12	1.30	0.2188	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	-338.35	603.52	12	-0.56	0.5854	Bonferroni
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	670.34	603.52	12	1.11	0.2884	Bonferroni
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	1008.69	603.52	12	1.67	0.1205	Bonferroni

Differences of Least Squares Means					
Effect	TRT	Irrigation	_TRT	Irrigation	Adj P
TRT	Control		Surround		0.6118
Irrigation		1 gph		1/2 gph	0.2134
TRT*Irrigation	Control	1 gph	Control	1/2 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1 gph	1.0000
TRT*Irrigation	Control	1/2 gph	Surround	1/2 gph	1.0000
TRT*Irrigation	Surround	1 gph	Surround	1/2 gph	0.7230

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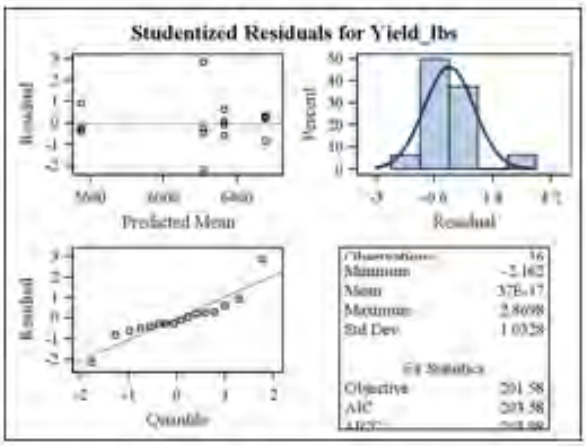
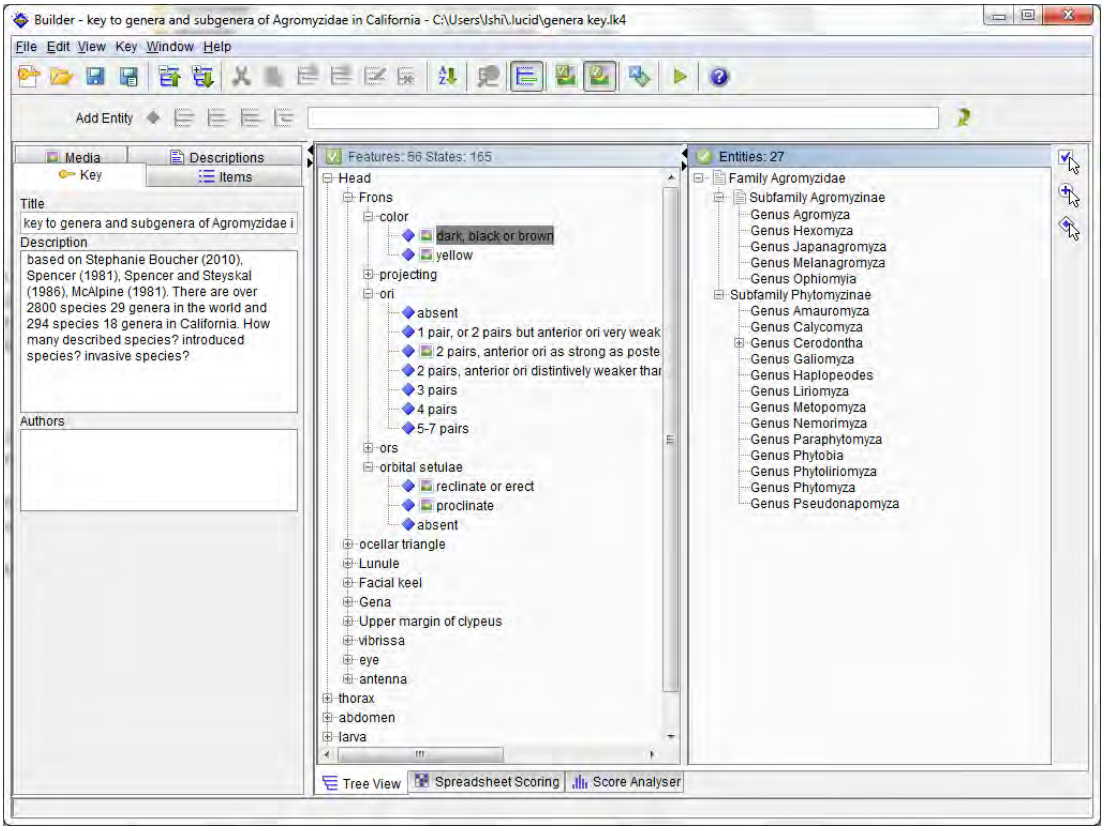
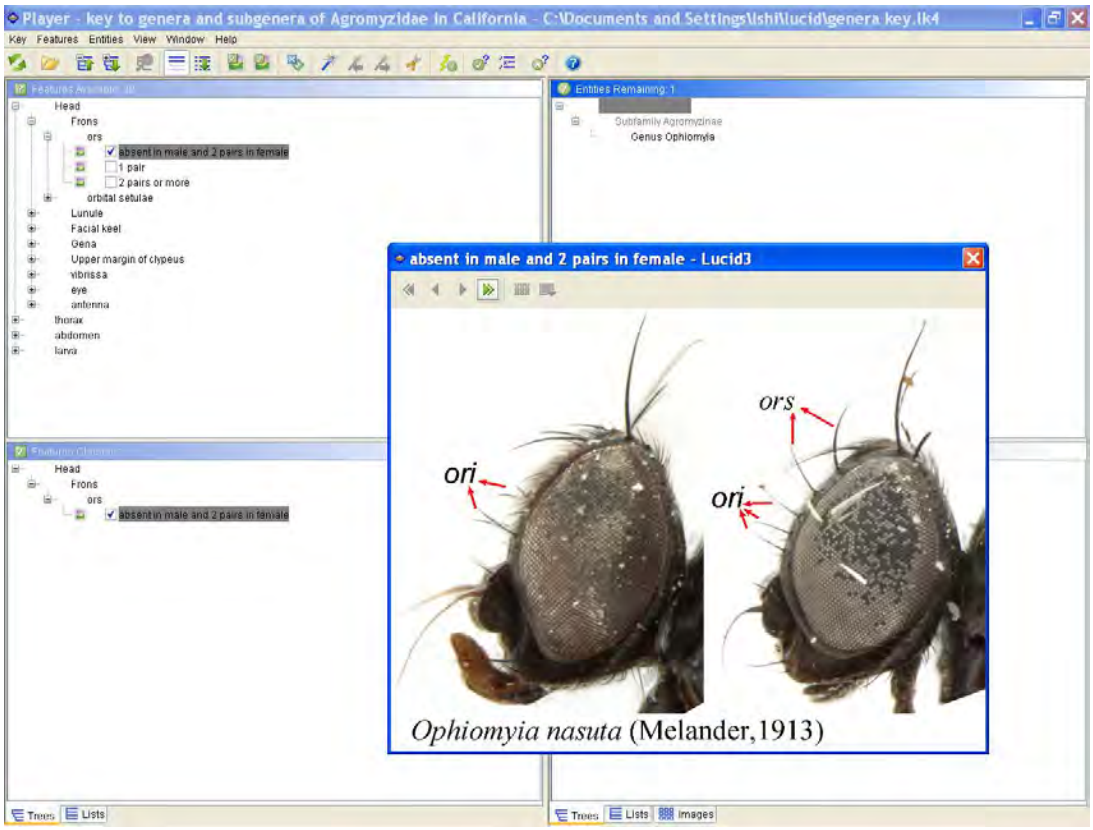
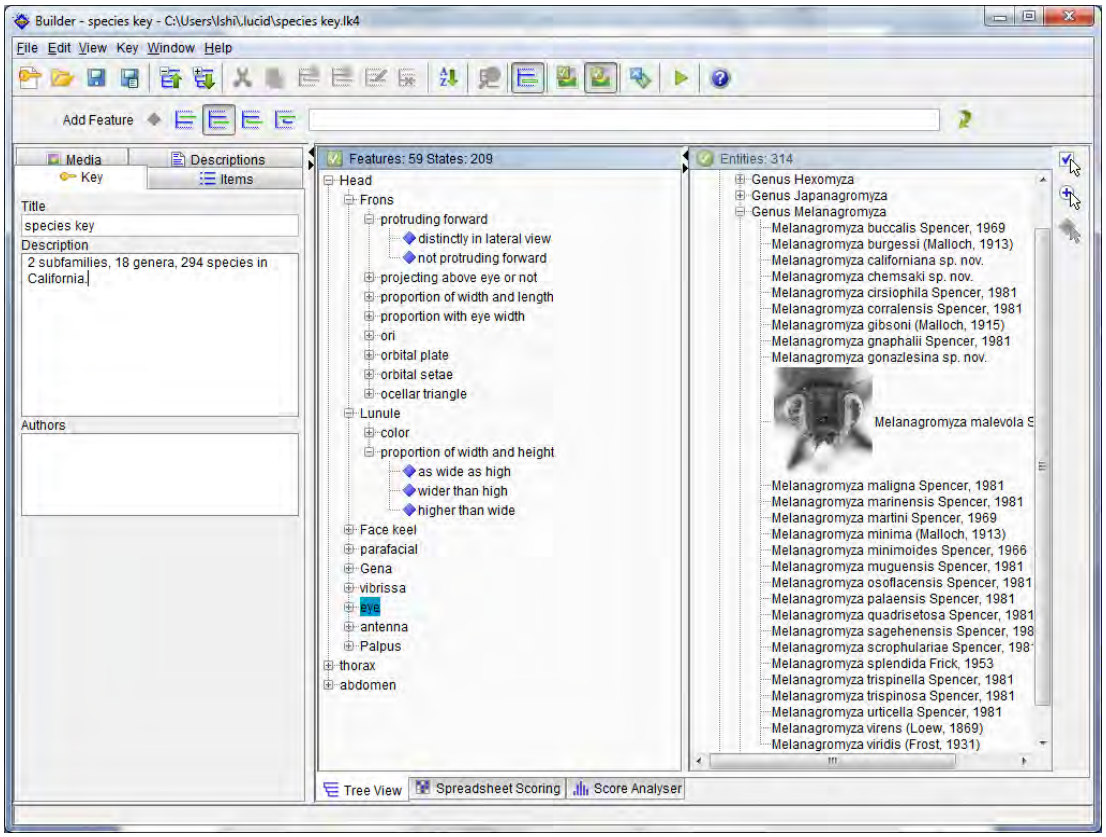


ADDITIONAL PAGES - SCREENSHOTS

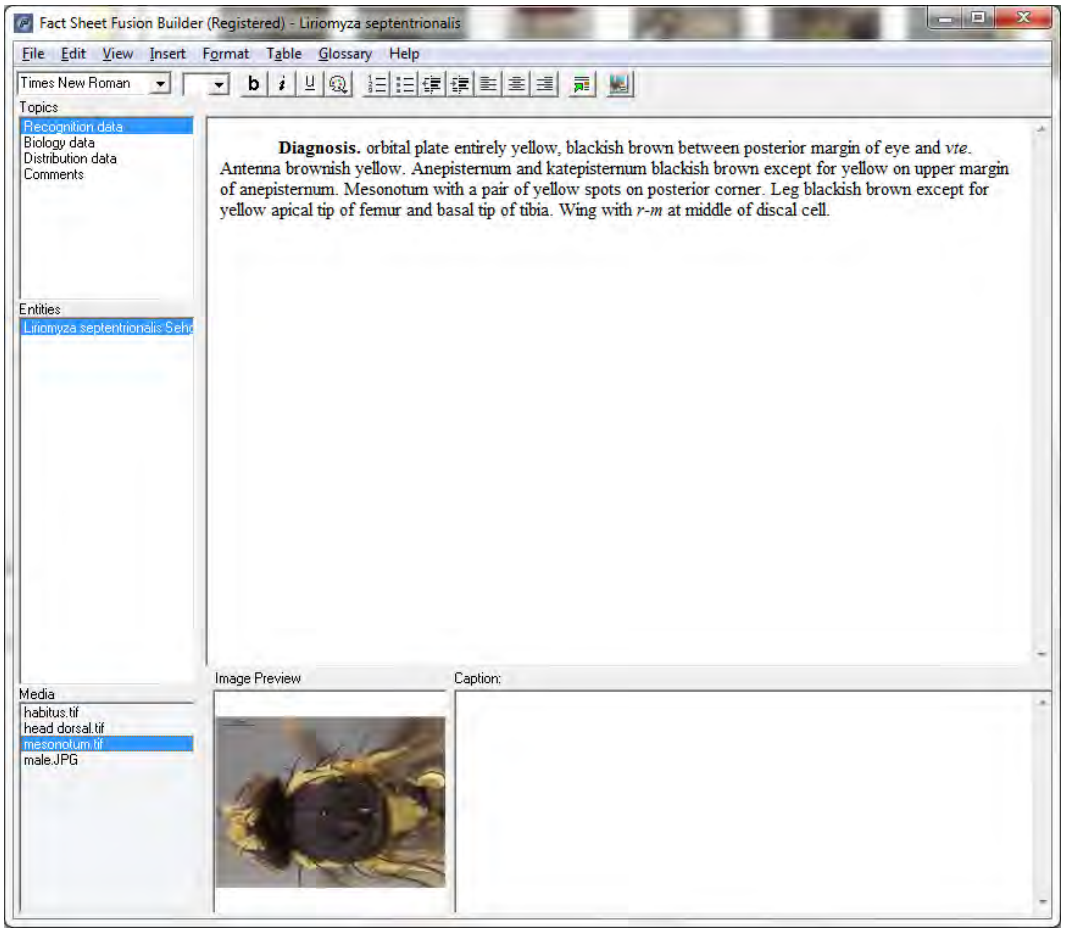
Lucid interactive identification tools:

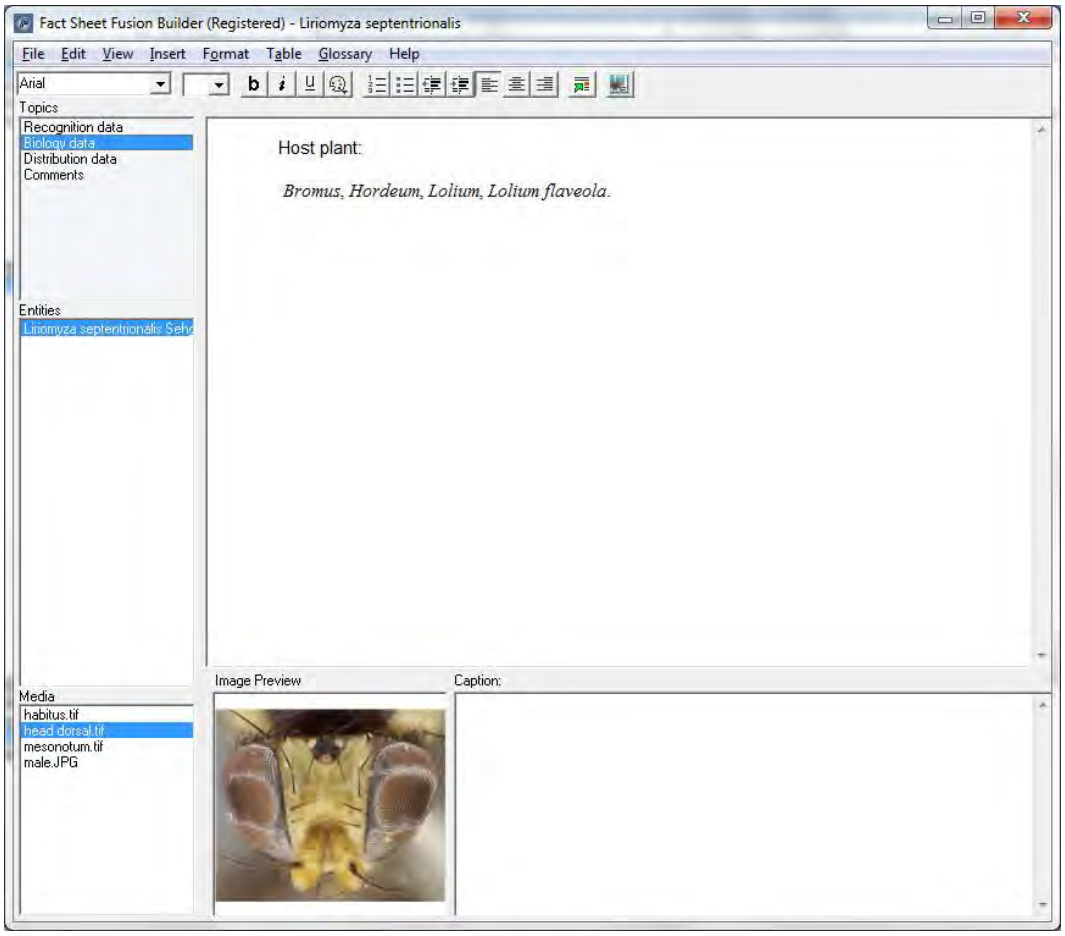




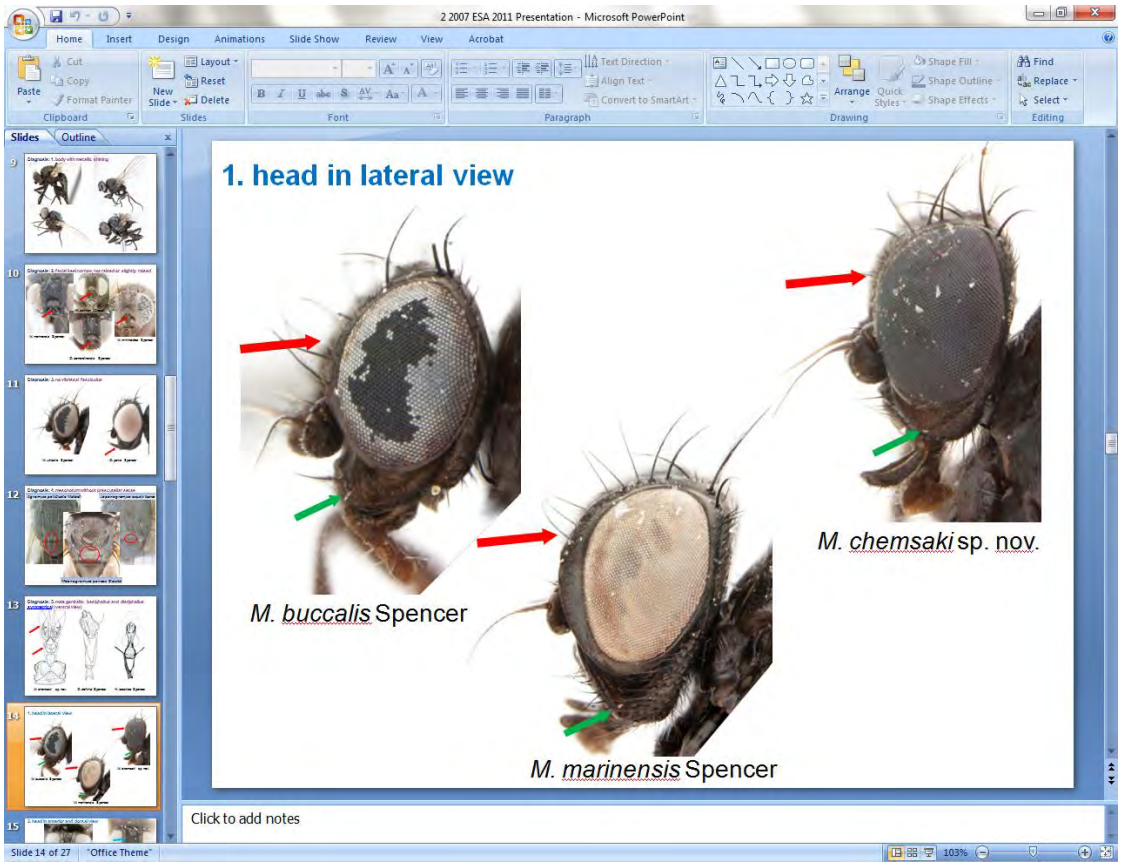


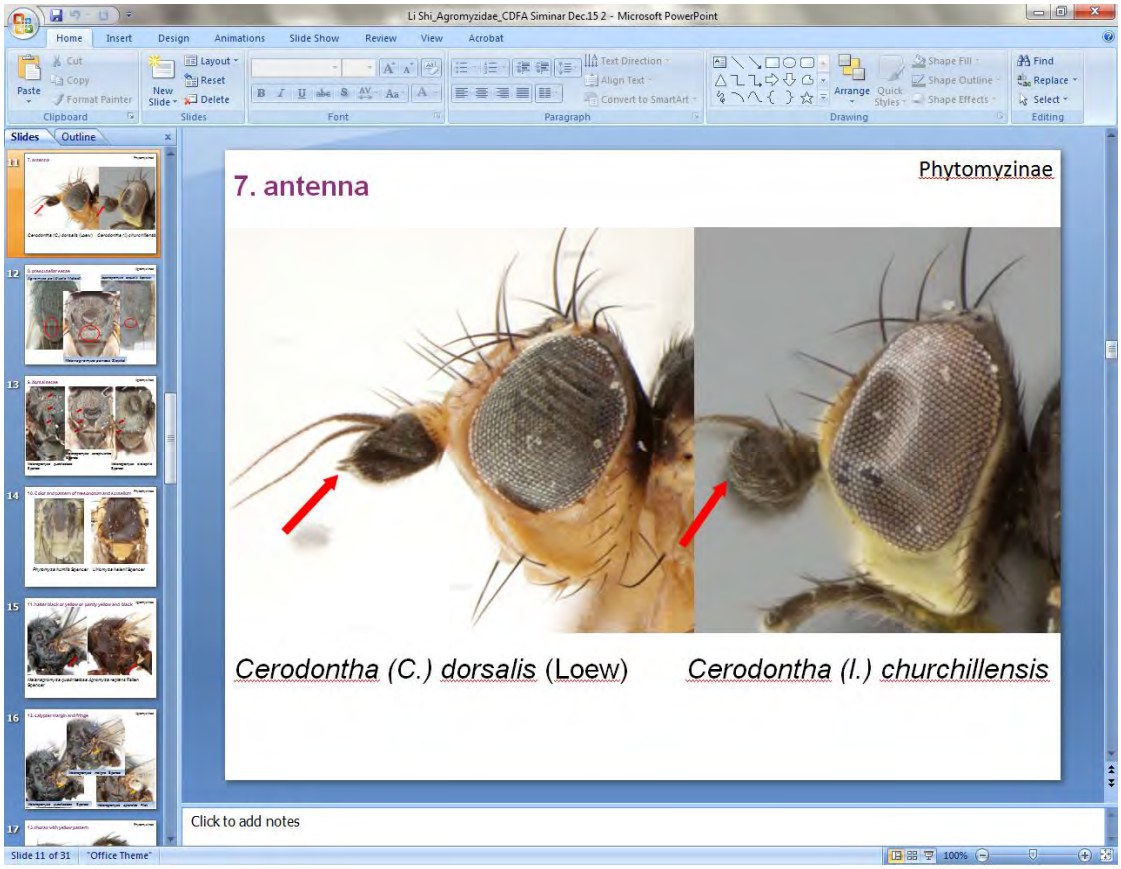
Fact Sheet Fusion development pages:

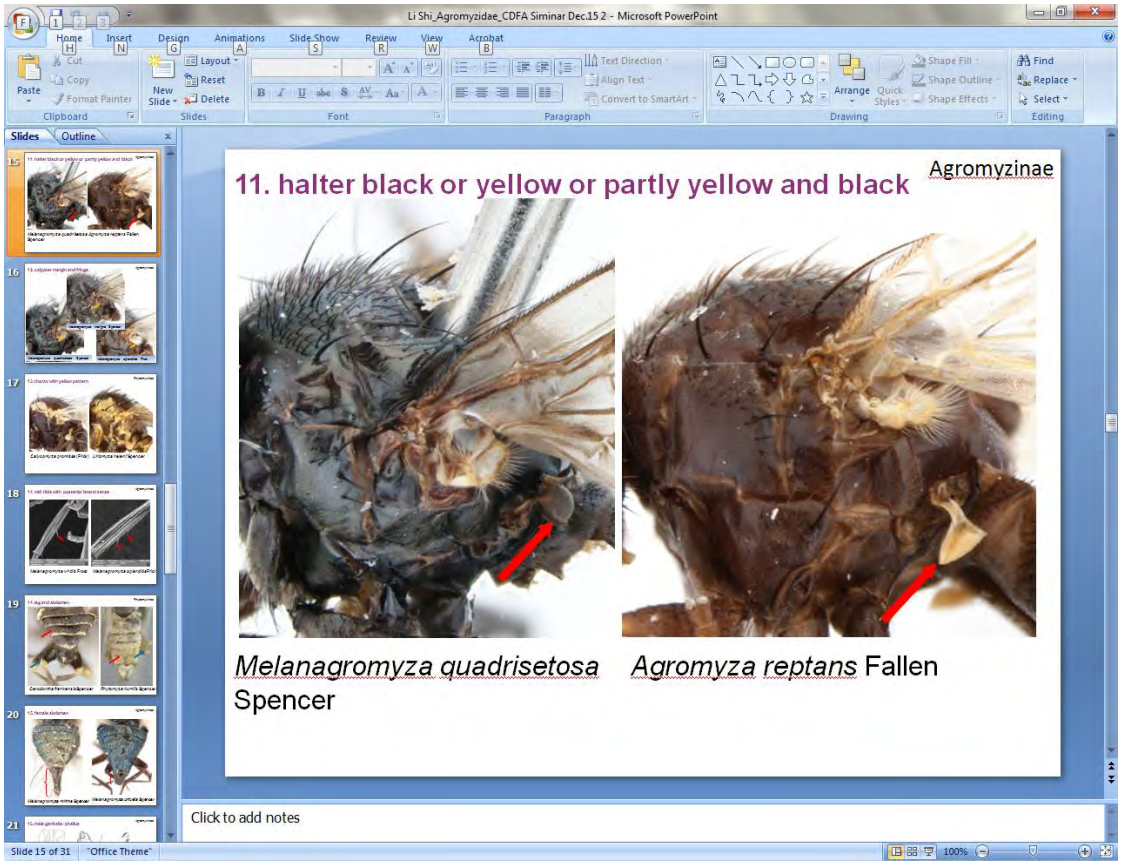




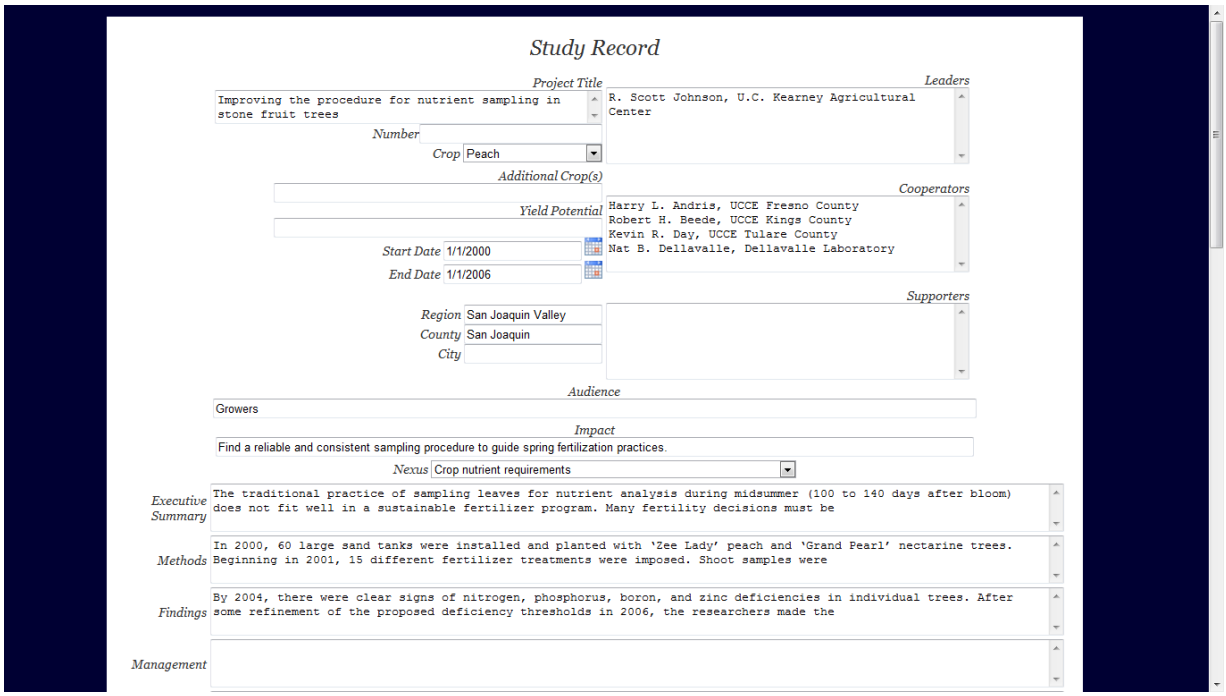
From presentations:




Li Shi_Agromyzidae_CDFA Siminar Dec.15 2 - Microsoft PowerPoint
7. antenna
Phytomyzinae
Cerodontha (C.) dorsalis (Loew)
Cerodontha (I.) churchillensis
Click to add notes
Slide 11 of 31
"Office Theme"


Li Shi_Agromyzidae_CDFA Siminar Dec.15 2 - Microsoft PowerPoint
11. halter black or yellow or partly yellow and black
Agromyzinae
Melanagromyza quadrisetosa Spencer
Agromyza reptans Fallen
Click to add notes
Slide 15 of 31
"Office Theme"

Example of database template (parent) for a peach crop.



Study Record

Project Title: Improving the procedure for nutrient sampling in stone fruit trees

Number:

Crop: Peach

Additional Crop(s):

Yield Potential:

Start Date: 1/1/2000

End Date: 1/1/2006

Region: San Joaquin Valley

County: San Joaquin

City:

Leaders: R. Scott Johnson, U.C. Kearney Agricultural Center

Cooperators: Harry L. Andris, UCCE Fresno County
Robert H. Beede, UCCE Kings County
Kevin R. Day, UCCE Tulare County
Nat B. Dellavalle, Dellavalle Laboratory

Supporters:

Audience: Growers

Impact: Find a reliable and consistent sampling procedure to guide spring fertilization practices.

Nexus: Crop nutrient requirements

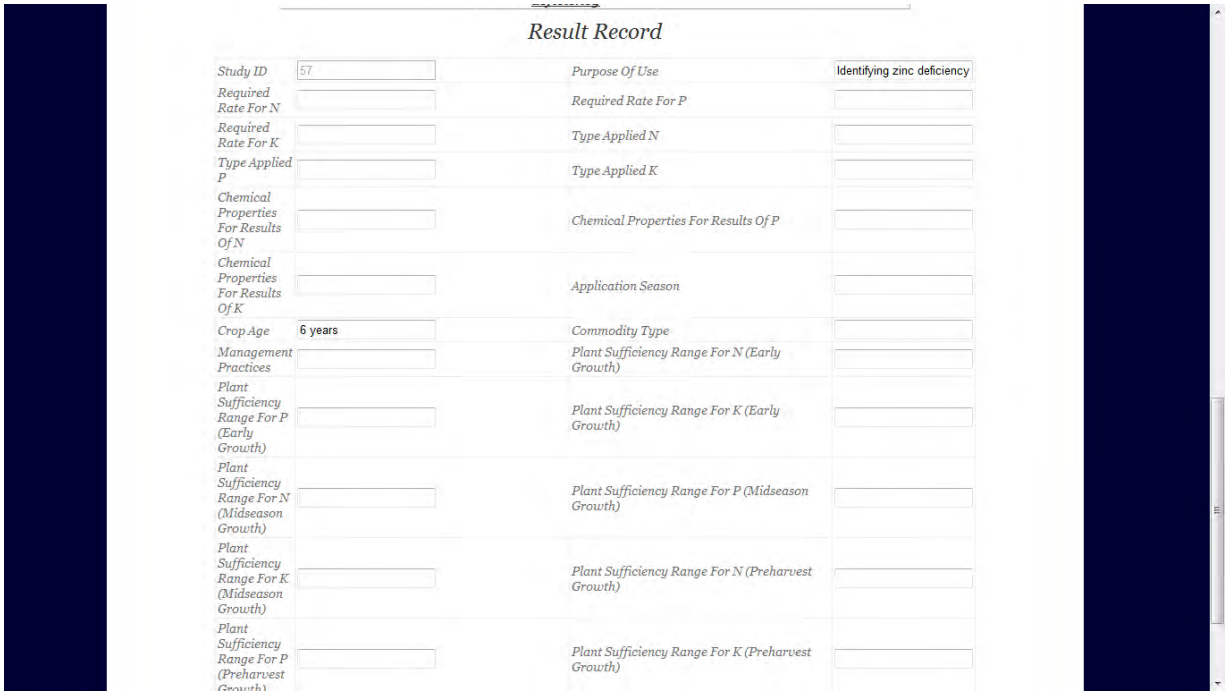
Executive Summary: The traditional practice of sampling leaves for nutrient analysis during midsummer (100 to 140 days after bloom) does not fit well in a sustainable fertilizer program. Many fertility decisions must be

Methods: In 2000, 60 large sand tanks were installed and planted with 'Zee Lady' peach and 'Grand Pearl' nectarine trees. Beginning in 2001, 15 different fertilizer treatments were imposed. Shoot samples were

Findings: By 2004, there were clear signs of nitrogen, phosphorus, boron, and zinc deficiencies in individual trees. After some refinement of the proposed deficiency thresholds in 2006, the researchers made the

Management:

Example of database template (child) showing data entry fields.



Result Record

Study ID	57	Purpose Of Use	Identifying zinc deficiency
Required Rate For N		Required Rate For P	
Required Rate For K		Type Applied N	
Type Applied P		Type Applied K	
Chemical Properties For Results Of N		Chemical Properties For Results Of P	
Chemical Properties For Results Of K		Application Season	
Crop Age	6 years	Commodity Type	
Management Practices		Plant Sufficiency Range For N (Early Growth)	
Plant Sufficiency Range For P (Early Growth)		Plant Sufficiency Range For K (Early Growth)	
Plant Sufficiency Range For N (Midseason Growth)		Plant Sufficiency Range For P (Midseason Growth)	
Plant Sufficiency Range For K (Midseason Growth)		Plant Sufficiency Range For N (Preharvest Growth)	
Plant Sufficiency Range For P (Preharvest Growth)		Plant Sufficiency Range For K (Preharvest Growth)	