FINAL PROJECT REPORT **YEAR**: 2 of 2
WTFRC Project Number: TR-07-703 (WSU # 13C-3643-5368)

Project Title: Expanding and Stabilizing WSU-decision aid system

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Total Project Request: Year 1: $80,965 **Year 2:** $79,960

Other funding Sources

Agency Name: Washington State Commission on Pesticide Registration
Amount awarded: $22,834
Notes: This supplements WTFRC funding for DAS.

Budget 1:
Organization: WSU **Contract Administrator:** ML Lou Bricker, Kevin Larson
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Item	Year 1: 2007	Year 2: 2008
Salaries[1]	58,093	57,297
Benefits[2]	20,372	20,063
Wages	0	0
Benefits	0	0
Equipment	0	0
Supplies[3]	2,000	2,080
Travel[4]	500	520
Miscellaneous	0	0
Total	$80,965	$79,960

Footnotes:
[1]Programmer 1 FTE, Web Programmer, 4 mo. 50% FTE, Callie Baker 16.7% FTE
[2]Programmer 35%, Web Programmer 36%, Callie Baker 34%.
[3]Cell phone charges are allowed
[4]Within State Travel

Objectives:

1. Stabilize and extend the current DAS program, including extensive documentation, help files, improving the overall interface, and better integration with AWN.
2. Improve the current disease models and add the model for shot-hole of stone fruit.
3. Develop organic control recommendations.
4. Once the program is stabilized, implement a bilingual interface for Spanish-speaking users.
5. Investigate methods to improve the codling moth model.

Significant Findings:

- Our short narrated video tutorials are nearing completion, with ten videos done and two left to finish.
- An on-line text tutorial has been finished and added to the help center.
- We have completed a stable, fast, and reliable iPhone version of DAS and are working on a blackberry version.
- The shot-hole model is online for our beta users and awaiting the final approval from Gary Grove before release to the general user base.
- Organic control measures have been completed and on-line for the last six months.
- A Spanish version of the recommendations is ready for beta testing; we are awaiting confirmation of our translation's accuracy from Leo Garcia and expect to have it on-line next spring.
- We are in the process of setting up a Spanish-speaking beta user group.

Significant Progress:

Objective 1. We have met all of the goals of this objective. Since the last progress report, new additions include:

Help Center. The help center has been the focus of our efforts since Dr. Chambers has taken over management of DAS in Sept 2009. She has currently finished ten narrated video tutorials that show users how to use the different features of DAS. The planned videos (italics with dot) and completed ones (black with check mark) are:

Getting Started

- *What is DAS?*
- *Introduction (main menu features)*
- ✓ User Login and Registration

Managing Weather Stations

- ✓ Setup a new weather station
- ✓ Edit and delete weather stations
- ✓ Add a custom weather station
- ✓ Import data to custom station
- ✓ .xls to .txt/.csv file conversion

Insect and Disease Models

- ✓ View model options
- ✓ Model output
- ✓ Spray Guide
- ✓ Historic Weather Data

We expect most of the planned videos to be finished by the presentation in early December. The spray guide video will likely have to be re-done as we are working to incorporate new features to help reduce spray effects on natural enemies and implement resistance management information (the video can't be made until those features are implemented). All videos will provide closed caption text as well as the audio explanations.

We have also completed the DAS text tutorial that users can access that has the same information as the videos. Further work will implement features to allow the users to follow the logic of why we are making particular recommendations at different times and to increase the integration with broader information on management and specific sections in the on-line *Orchard Pest Management*.

Mobile Web Browsers. Other progress on this objective has been the development of an iPhone version of DAS. This version is fast, reliable, and has no known issues. We have begun working on a blackberry version, but the quality of the display and browsers on many blackberries is poor and we may need to restrict it to only certain models. We will also begin working on a version for Android phones (Google's mobile phone OS) which use a high quality web browser similar to the iPhone.

Codling moth model changes. Next year we will finish the changes in our codling moth model to eliminate the resetting of degree-days (DD) after the first moth is predicted to occur. The use of "degree-days from biofix" causes large amounts of problems in programming, and logically no longer makes sense. This year, some users were looking at the DD accumulations and were confused because you would go from 175 to 0 degree days. The change will bring the model in line with all the other models where only DD since 1 January are used, and we will provide users information on DD with explanation such as 500 DD (=325 DD after biofix using old model); the following year the parenthesis will be eliminated. There will be help files available that show changes and explanations for why they were made.

Introductory page. Our programmer has developed routines that will allow us to automatically change the introductory page so that the information there is seasonally appropriate. We have also been working with the Pest Management Transition Program to develop the content for that page. We expect to have this finished and on-line before the start of the season.

Objective 2. The shot-hole model is on-line in the beta page and we are waiting for final approval from Gary Grove before opening the model to all users.

Objective 3. The organic control recommendations have been available for the last six months including the ability to switch back and forth between the different options. All objectives were met.

Objective 4. We have added the ability to translate DAS on the fly using the Google Translate option. However, because of some of the vagaries of that system, we have translated the conditions and management recommendations by hand. Leo Garcia (WVC) and Malaquias Flores (WSU small farms project) are currently reviewing our translations. We expect the Spanish translation to be on-line this spring. We have started the process of recruiting a Spanish-speaking beta group to help insure that the system is useful and contains features those users need. As mentioned above, our video help system is able to provide closed captions and we can implement Spanish translations of those as soon as we can get the scripts translated.

Objective 5. As mentioned in the last progress report, our data showed that the length of pre-chilling period larvae were held at did not significantly affect the emergence curve when done on either a calendar data basis or a DD basis for either males or females. However, surprisingly, the temperature that they were held at (before the cold period) made a significant difference in both the mean emergence period and the variability around that emergence period on both calendar date and DD scales. *That result was completely unexpected and not predictable from the literature data we reviewed*. Recall that the larvae enter diapause in the last instar larval stage, so that development after the chilling period should be similar and occur with a given mean and standard deviation of times. As all moths entering the chilling period were held the same time at the same temperatures both during

and after the chilling period, we would expect very little change in emergence period, because they are all overwintering in roughly the same physiological state.

Our data suggest that there is a sensitive period in the fifth instar that must occur within 7 days of the larvae molting to the fifth instar when the temperature affects the timing of emergence from diapause. We have collected more larvae this year from bands in the field and are re-running this experiment. However, we have changed the experiment to expose larvae to temperatures of 15, 20, 25, and 30°C in the pre-chilling period for a fixed period and then evaluate emergence patterns after chilling to determine if we can predict emergence variability by the holding temperatures. We have currently collected the larvae, exposed them to the different temperature regimes, and the larvae are now being transferred to the cold period. The larvae will be brought out of the cold sometime in January and we will have results sometime next spring.

We have also made great strides in improving the prediction of CM first emergence across the US. We initially found that emergence could be predicted using a combination of latitude and altitude. However, data this year showed that the latitude and altitude were really just expressing the amount of solar radiation. Our current models allow prediction of the average date of emergence based on heat units and accumulated solar radiation (Fig. 1). The solar radiation is important, because we found the bark temperature (CM overwinter under the bark) is up to 30°F higher during the winter compared to air temperature measurements (Fig. 2).

Overall Impact of this Project. WSU-DAS has improved significantly over the past two years and will likely continue to improve in the future. In 2008, we surveyed users and found that they managed 2,888 orchards (≈ 3,000 in industry) and 250,000 acres (≈ 225,000 bearing acres in the industry). The figures are higher than the industry estimates because they do not account for multiple people making recommendations on a single orchard. Regardless, WSU-DAS is used on a large portion of the industry. Users also estimated that the value of WSU-DAS was ≈ $17M/year. Our survey indicates that WSU–DAS has changed the information flow in the industry and for its full impact to be realized, the current educational process needs to be re-designed to emphasize portions of pest management that are not provided directly by DAS (e.g., sampling, model assumptions, life history and management of pests not predicted by DAS).

Fig. 1. Prediction of first moth emergence at 8 different sites across the US using degree-days and solar radiation.

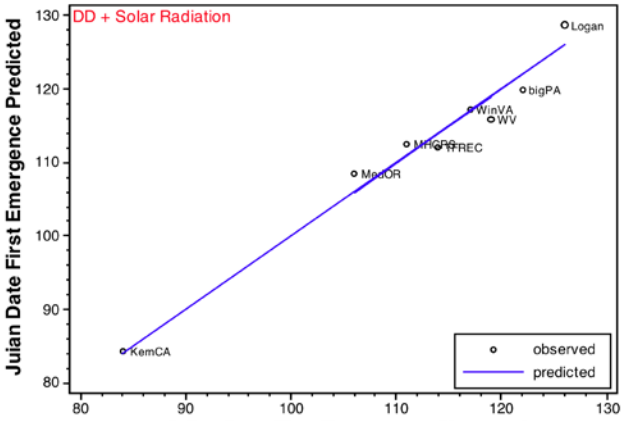
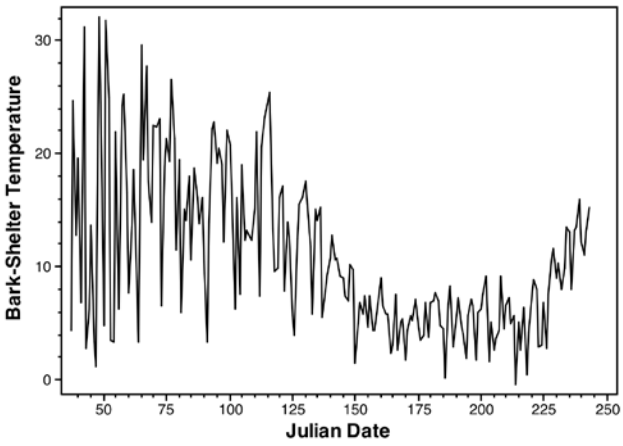


Fig. 2. Difference between bark temperature and air temperature at WSU-Sunrise from February through August 2009.



Executive Summary:

Significant Progress or Outcomes

- We have met all the objectives of our project during the past two years. DAS is now much more user friendly, has extensive documentation, help files, video help files, the ability to look back at past years data, and has been integrating AWN data in new and innovative ways. We have implemented a mobile version for the iphone and other smart phones will be added as time and hardware quality permits.
- Our changes to the system have also allowed us to enhance the educational experience of the users.
- We have made all changes suggested by Dr. Gary Grove and Tim Smith to the disease models and are awaiting the final approval from Dr. Grove to release the shot-hole model.
- Organic control recommendations were implemented this past season for all models.
- The Spanish language version is complete and we are waiting for the final approval for our translations from Leo Garcia and should have it on-line next spring.
- We are setting up a Spanish-speaking beta user group to help with implementation and features of the Spanish version of DAS.
- We have made several changes to the codling moth model, primarily eliminating biofix, better defining the factors influencing diapause and how that affects phenology. We are also currently finishing studies to determine if we can better predict emergence in the spring based on conditions when larvae enter diapause in the fall.
- Our user survey in 2008 showed that DAS was used for recommendations on the majority of the industry's orchards and acreage (≈2,880 orchards and 250,000 acres). Those values are high because we cannot correct for situations when multiple people are making recommendations for the same block; thus duplication of acreage and orchards are possible.
- The respondents indicated that they felt the value to the industry of DAS was roughly $17M/year.

Summary of finding and future directions

DAS is not strictly a research project where objectives are met and the project is done. It has a very important role in the future implementation of new strategies and technologies for pest management in tree fruits. For it to be successful, it must continue to evolve to add new features of use to the users. We expect to continue the current trend of adding new useful features and models, speeding access to time-critical information, and serving the needs of the user base.

The future directions for DAS can be broken into the scientific directions and those needed for long-term survival. In the area of science, we feel the primary needs are to evaluate how the AWN weather data reflects in-orchard conditions, the effects of new orchard architectures and overhead cooling on model accuracy, the importance of solar radiation on model predictions (see objective 5 of this report) and whether we can use the NOAA 1-day site specific forecasts as virtual weather stations. A proposal to evaluate these concerns will be forthcoming at the December meeting.

In terms of the long-term survival, that issue has not been resolved at this point. WSU administration has expressed no interest in supporting DAS, so it is likely that a number of different tactics will be needed for long-term survival. We are currently investigating subscriptions, sponsored advertising, and other ideas with industry input.