

## **TITLE: TREE PLANTING SITE-SPECIFIC FUMIGANT APPLICATION TO CONTROL ALMOND REPLANT DISEASE**

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**SUMMARY:** The goal of this research was to use recent advances in the global positioning system and computer technology to apply just the right amount of fumigant (0.2 kg/tree) where it is most needed (i.e., in the neighborhood of each tree planting site) to decrease the incidence of replant disease. Upadhyaya et al. (2008) and Udompetaikul et al. (2008) have reported that tree planting-site-specific application of fumigants can lead to 58 to 76% reduction in fumigant cost and environmental load, compared to the conventional strip fumigation. This reduction in chemical application is not only beneficial to the environment, it can save a significant amount of money for the farmers. At a typical fumigant cost of approximately \$5/kg the savings would range from \$490 to \$640/ha. Thus it is clear that applying a small amount of soil fumigant to control replant disease makes environmental, ecological, and economical sense. In the first year of this study, we retrofitted a chemical applicator with a high-performance global positioning system receiver (accuracy in the range of 10 to 20 cm), an embedded controller to read GPS data and control a solenoid valve to implement tree-planting-site-specific fumigant application (Coates et al., 2007). Although the system appeared to work quite well, tests indicated that the RMS error in position location was 33.5 cm. Even at this level of accuracy the fumigant application rate could be reduced by about 50%. However, this design did not fully realize the accuracy level expected from the HPGPS unit (i.e., 10 to 20 cm RMS error). To address this limitation, following specific objectives were pursued for the 2007 planting season:

- a. Further improve the accuracy of the system by improving the hardware and software used in the first prototype developed by Coates et al. (2007),
- b. Conduct field tests to ascertain the accuracy and effectiveness of the site-specific fumigant applicator under actual orchard replanting conditions.

Figure 1 shows the schematic diagram of the newly developed system that was retrofitted on to a TriCal shank type fumigant applicator<sup>1</sup>. The system consists of a precision fumigant controller (PFC) which is connected to a HPGPS unit, an inclination sensor, a Pulse Width Modulation (PWM) unit and a Raven Flow controller<sup>1</sup>. The PWM unit controlled solenoid actuated nozzles that are located on the applicator shanks to apply desired amounts of fumigant. A tree gridding program that produced the coordinates of the tree planting sites based on the coordinates of the corner trees, row spacing, and tree spacing along the row was developed. Moreover, the gridding program allowed the trees to be planted in a

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<sup>1</sup> Mention of trade names does not constitute an endorsement of the product by the authors or the University of California.

rectangular or diagonal pattern. In addition, the applicator could also be operated in a “road test” mode during which PFC ignored the inclination sensor data and allowed to conduct position accuracy tests with shanks lifted up in the air. During operation, the GPS antenna was adjusted such that it was vertically above the fumigant discharge point on the center shank (i.e., no offset).

The results of the road tests conducted on the UC Davis campus indicated that the system accuracy was well within the HP GPS range (less than 15 cm) when appropriate look ahead values were used to turn the system “on” and “off.” The system was also tested in a field on the UC Davis campus using 30 grid points consisting of six rows spaced 15.2 m apart with five tree sites located 12.2 m apart along each row. These grid points along with the application zone length of 2.1 m were uploaded to the PFC. The RMS error (i.e., standard deviation) was in the range of 12 to 15 cm for all the tests. These error values are within the range (10 to 20cm) expected for the HPGPS system used. The application zone length was about 221 cm (i.e., a 3.8% error compared to the expected value of 213 cm). These results were thought to be acceptable for this system and the system was taken to three orchards in California – Arbuckle, Madera, and Parlier - to perform tree-planting-site specific fumigant application. The system worked quite well during the orchard tests in Arbuckle and Madera. There were some GPS signal quality issues in Parlier during the first day of test. However, the system performed fine on the following day. The final results of these tests will be known when the almond growth parameters will be measured in the coming years.

We are currently working on integrating the gridding program with the precision fumigant controller so that we can go to the field, mark the orchard corners, grid the field, and apply the fumigants where needed in just one step. We expect to include the test results of this new system during our presentation. Moreover, we are developing a photosynthetically active radiation (PAR) absorption measurement system that can assist in evaluating planting-site-specific fumigant treated trees versus those treated with conventional strip fumigation (Figure 2). Preliminary results obtained using this system will also be presented.

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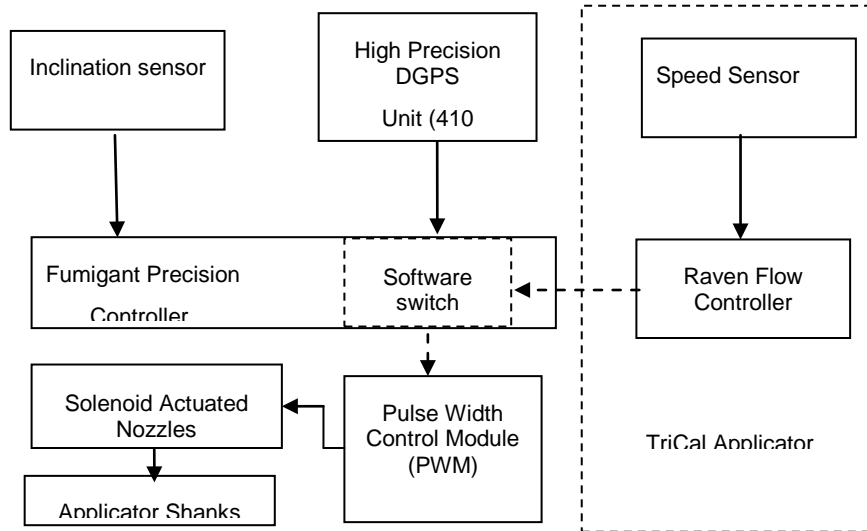


Figure 1. Schematic of the fine-tuned site-specific fumigant application system



Figure 2. A portable photosynthetically active radiation absorption measurement system under development at UC Davis.