Improving Particulate Matter (PM_{10} and $PM_{2.5}$) Emissions from Almond Sweeping and Harvesting Operations

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Objectives:

The objectives of this research are as follows:

(1) To determine differences, if any of the PM10 and PM2.5 emissions from reduced pass sweeping relative to traditional sweeping;
(2) To determine the PM_{10} and $PM_{2.5}$ emission factor for conditioning operations as a result of reducing the suction fan speed of the conditioner;
(3) To make an estimate of the product composition variations as a result of lower fan speed;
(4) To augment the current dataset of PM_{10} and $PM_{2.5}$ emission factors available to support revision of the current PM_{10} emission factors for harvest operations.

Interpretive Summary:

Field experiments were conducted to test the effect of reduced-pass sweeping as well as changes in the suction fan speed of an almond conditioner on PM_{10} and $PM_{2.5}$ emissions collected downwind from the almond orchard. A week of sampling was conducted for the 2009 harvesting season. Traditional and reduced-pass sweepers were tested as well as pickup machines utilizing the recommended setting of 1090 rpm (control) and reduced fan speed of 920 rpm (treatment). These were the same speeds

used by the UC Davis Group (Giles Group) during the summer of 2008 field testing to conclude that lower fan speed had lower PM emissions. We have utilized the same sampling sites as in previous years (Rominger Orchards) and made use of their sweeper and conditioner. The sampling locations and testing arrangements were coordinated through the Almond Board of California to ensure that PM_{10} and $PM_{2.5}$ are measured for the treatments enumerated above. In addition, tests were done to evaluate the nut product variations as a result of reduction in fan speed.

Upwind/downwind samplers were placed on orchard during sweeping and harvest operations and conducted in a manner similar to the tests performed in 2007 and 2008. Figure 1 shows a picture of the sweeper with sidekick and the location of the downwind samplers. Four (4) collocated low volume TSP and PM_{10} samplers were placed at the downwind edges of the orchard and one collocated sampler on the upwind location.

One to two hour tests were conducted to collect sufficient mass of PM on the filters so that accurate concentration and particle size distribution analyses may be performed. The samplers used for implementation in this protocol are the same low volume TSP and PM_{10} samplers used by Texas A&M University in previous studies and reported in several publications (Faulkner et al., 2009). A complete weather station was installed in order to effectively implement the EPA approved AERMOD dispersion modeling technique to report PM emission factors.

Figure 1. Photo showing sampler location and the sweeper used during the 2009 field sampling event.

For the sampling tests conducted in the summer of 2009, a total of 16 plots were harvested. Sixteen sampling tests were completed for the sweeping treatment: eight of these were using a standard sweeper and the other eight using a sweeper equipped with a side kick. There were 16 total tests for the conditioning operations: Eight tests were conducted using the recommended fan speed of 1090 rpm and the other eight tests used a lower fan speed of 920 rpm. Figure 2 shows the conditioning machine used during the tests.

Figure 2. The conditioner unit used to test the effect of various fan suction speed on PM emissions.

During the sampling, the time required to harvest each plot were recorded along with the GPS location of the area.

The particle size distributions of dust collected from almond harvesting operations are now being analyzed at Texas A&M University's Center for Agricultural Air Quality Engineering and Sciences (CAAQES). Fractionation of the nut product collected on the windrow is also being performed to determine the changes in product characteristics as a result of decreased fan suction speed.

In a study competed last year by the UC Davis group, they have concluded that the resulting gravimetric mass and dust intensity showed that decreasing suction fan speed can reduce the emissions of visible particle, TSP and PM10. In addition, the results from sieve analysis also illustrate significant effects on the characteristics of the nut product due to changes in suction fan speed. The operation at 920 rpm yields a substantial decrease in dust emissions and maintains similar characteristics of nut product to the maximum fan speed of 1080 pm (Giles, et al., 2008).

Our study will further investigate the above conclusions using the EPA approved dispersion modeling (AERMOD) technique and report actual PM_{10} and $PM_{2.5}$ emissions downwind from the orchard during harvest and report the PM emission factors as well. The results will be presented at the 2009 Almond Industry Conference in Modesto.

References:

1. Faulkner, W. B., L. B. Goodrich, V. S. V. Botlaguduru, S. C. Capareda and C. B. Parnell, Jr. 2009. Particulate Matter Emission Factors for Almond Harvest as a Function of Harvester Speed. J. Air & Waste Manage. Assoc. Volume 59 (943-949).
2. Giles, K., J. Thompson, D. Salzer and P. Ponpesh. 2008. The Effect of Suction Fan Speed of Nut Harvester on Dust Emission and Product Characteristics. Poster and paper presented at the 2008 Annual Almond Industry Conference held in Modesto, CA. Sponsored by the Almond Board of California.