Measurement and Reduction of In-Orchard Dust Generation from Harvesting

Project No.: **07-ENVIR4-Giles**

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Objectives:

The objectives addressed during this reporting period were:

1. Using gravimetric samplers, measure PM_{10} and TSP dust concentrations within orchards and within the discharge air from harvesters.
2. Investigate dust generation from harvesters using gravimetric and optical (opacity) methods and determine the degree of filtering provided by trees and foliage.
3. Provide cooperative measurements with other researchers during harvesting operations.

Interpretive Summary:

Previous work has established that an opacity monitoring system can be used to compare relative, visible dust intensity during nut handling operations. The measurement systems developed for this research have provided an efficient tool to assess field operating conditions and changes in management or cultural practices that can minimize dust intensity. Additionally, the tool provides results from tested conditions immediately, that is, during the actual test run.

Methods for assessing dust during agricultural operations can also be based on filter deposition measurements of airborne particulate matter and optical methods of measuring the “opacity” or visual obscuration of air. While there is debate over the absolute accuracy of some gravimetric sampling devices, the technique remains the most common method for airborne particulate measurements. Measurements from the 2006 season used a gravimetric sampler (MiniVol™ Portable Air Sampler, Airmetrics, Eugene, OR) during several field test runs. The device is used by researchers including the California Air Resources Board for PM_{10} and $PM_{2.5}$ measurements at high particulate

concentrations. When used to measure a single source of particulate, e.g., particulates from ag field work, the device can provide relative measurements.

While debate continues on urban vs. rural generated dust and regulatory methods, the opacity and gravimetric methods are useful for field-oriented research to guide grower practices and machinery development.

The goal of this project is to work with growers and equipment manufacturers in order to establish the effects of machinery and operating conditions on dust intensity, ultimately leading to methods for reducing dust intensity that can be adopted by growers in the relatively short term (1 – 3 years).

During the 2007 harvest season, a series of monitoring experiments were conducted in the Wasco area. These experiments were conducted and co-located with emission factor experiments conducted by ABC-funded researchers from the Texas A&M University. A standard, commercial harvester (Flory 850) was operated at 2 and 4 mph during experiments to determine the effect of ground speed on dust emission factors. Simultaneously with the emission factor experiments, four in-orchard air samplers (Mini-Vol™) were operated for the duration of the each test run. Two samplers were configured to sample PM_{10} (particles with diameter < 10 μm) and two samplers were configured to sample TSP (total dust). During the experiments one sampler exhibited intermittent failure; data from that sampler were recorded but not used. Observed results are summarized in Table 1. While these results are preliminary, they support the previous opacity findings that dust levels within the orchard are related to ground speed of the harvester, i.e., slower speeds produce less dust; the 2 mph operation produced 42% and 40% less PM_{10} and TSP, respectively, than the 4 mph operation. These results will be correlated with results from Texas A&M testing.

Table 1. Average filter deposition data from Wasco harvest tests coinciding with TA&MU measurements. PM_{10} and TSP samplers were set mid-location within the respective TA&MU testing block. Results in mg. Harvested land area was equal for each test; this allows direct comparisons and accounts for the harvest time difference that results from different ground speeds.

Harvester Speed	PM10	TSP
2 mph		
Average	0.322	0.980
Minimum	0.302	0.924
Maximum	0.354	1.035
4 mph		
Average	0.558	1.619
Minimum	0.330	1.338
Maximum	0.709	1.974

Data do not include suspect and damage filter mass deposition results.

Further experiments investigated the effects of harvester speed on opacity of the emitted air from the harvester and the benefit of orchard trees in attenuating the opacity (visible dust concentration) produced by the harvester. In these experiments, a trailer-mounted laser opacity instrument was positioned 1, 2, 3 and 4 rows over from the harvester discharge during the passage of the harvester past the instrument (Figure 1). Figures 2 and 3 show the instrument in the orchard rows during the approach of the harvester and during the time of interaction between the plume and the instrument. In addition to the opacity instrument, the gravimetric samplers were positioned at the bases of trees at 2, 3 and 4 rows over from the harvester as shown in Figure 1.

Figure 1. Sampling configuration for harvester air sampling. Set-up shown is for first replicate test; during subsequent test runs, the opacity monitor was moved, sequentially, to adjacent rows further from the harvester to sample 2, 3 and 4 rows over.

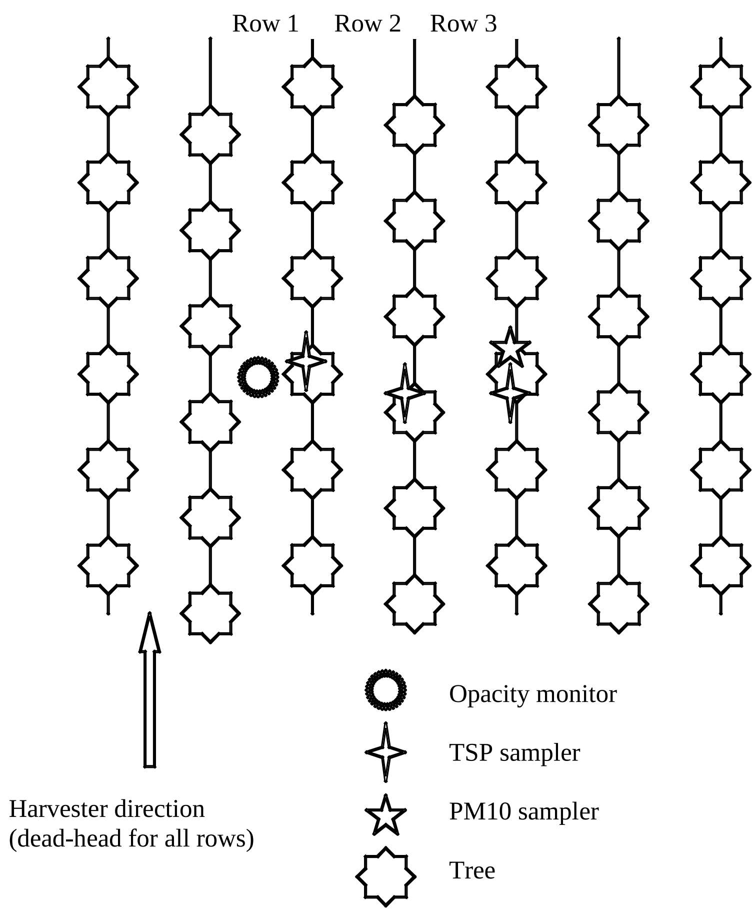

Fig 2. Approach of harvester to the laser-based opacity sampler. Harvester is in row to right of sampler.

Fig. 3. Harvester discharge plume being sampled by the instrument. Harvester is in row to the right of sampler.

While detailed analysis of the field data is still underway, the results show the benefit of distance and tree foliage in mitigating the airborne dust, both concentration and visual appearance, from the harvester outlet air. Figure 4 shows data from one block of the Wasco test orchard. Visible dust concentration in the harvester plume, measured as opacity, was reduced by over 75% within three tree rows.

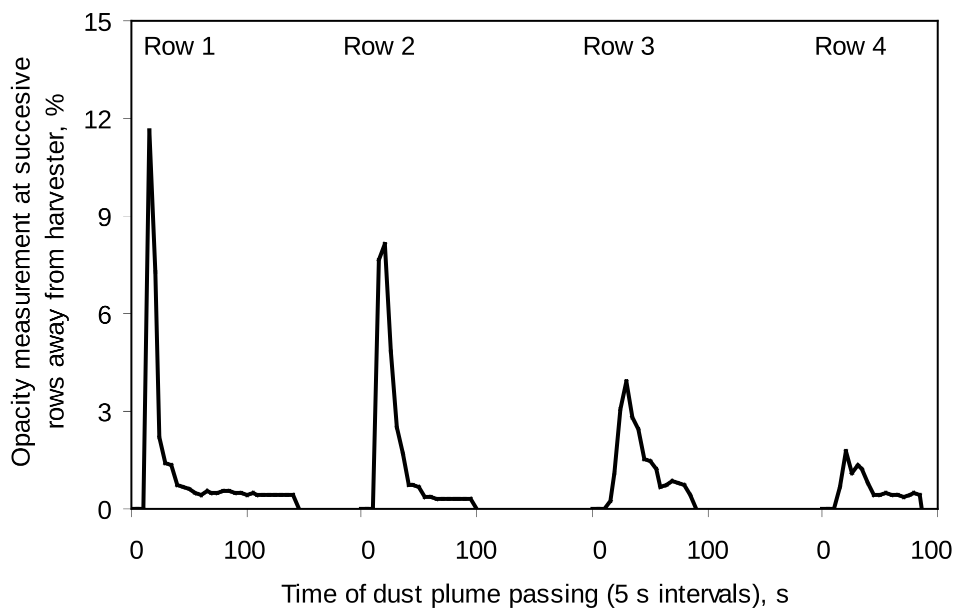

Figure 4. Opacity shown as average of 4 mph replicates from west block of Wasco orchard.

Overall, the field data collected during the 2007 season have confirmed the value of both reducing ground speed of harvesters and using the natural filtering benefits of orchard rows to reduce the amount and appearance of discharged dust near orchard boundaries, especially those near dust sensitive areas. By reducing ground speed of the equipment and driving harvesters in the direction so that the air discharge is directed inward to the orchard for the outermost 3 to 4 rows, the visible dust concentrations can be reduced by approximately 50 to 75% with only minor loss of harvest efficiency. Growers can use this good practice, supported by field results, immediately.

Recognition:

The Researchers would like to thank Mr. Gerry Rominger, Rominger Farms and Mr. Don Castle, Paramount Farming Company for their assistance and support allowing our harvester project to be tested in your orchards.