Measurement of Harvest Dust Generation

Project No.: **08-AIR1-Giles**
(Continuation of Project 07-ENVIR4-Giles)

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Objectives:

The project objectives reported here were to establish the effects of harvester fan speed on the intensity of the dust cloud produced during nut pick-up and the resulting effects on the cleanliness of the harvested material.

Interpretive Summary:

While the high air volume and velocity of the fans on standard nut harvesters are useful for separation of the nuts from orchard debris, the emitted air jet does produce significant amounts of visible dust. The smaller size fractions, namely, PM_{10} and $PM_{2.5}$, of this emitted dust are important for regulatory considerations about air quality while reducing the total dust emitted is a stewardship and environmental objective for the industry.

Previous seasons of work have determined that grower-controlled operational decisions and practices such as ground speed, sweeper settings and the direction of blower discharge can produce beneficial reductions in observed and measured dust intensity near the harvest operation. Experiments this year addressed the effects of a simple mechanical change to existing harvester operation, namely the reduction in fan rotational speed, on the dust produced within the orchard. The experiments also addressed any simultaneous changes in the cleanliness of the harvested product due to the reduction in separation (cleaning) air volume.

Experiments were conducted in a commercial almond orchard near Arbuckle, CA. The windrows were prepared using a standard sweeping practice for the local area and

grower. A standard harvester (Model 850, Flory Industries, Salida, CA) was operated at a constant ground speed of 3.2 mi/hr. Typically, the normal operating speed of the harvester fan is 1080 rpm (at a tractor PTO speed of 540 rpm). That typical speed, 1080 rpm, was tested along with experimental operational speeds of 910, 715 and 0 rpm. The slower fan speeds were achieved by replacement of the drive belts and sheaves. The 0 rpm (no fan) speed was achieved by disconnecting the drive shaft from the fan. During all tests, all other components (chains, etc.) on the harvester were operated at normal speeds (at 540 tractor PTO speed). Dust discharge was measured using opacity and gravimetric devices, and the windrow samples both before and after harvesting were collected to investigate the effects of fan speed on cleanliness of the harvested product. Post harvest samples were carefully collected into large bags as they fell from the discharge chain of the harvester. In addition, an opacity device, which uses laser light to measure the intensity of dust within the air, was located 1 row, 2 rows, and 3 rows away from the row being harvested. Moreover, gravimetric devices (filter-based air samplers) were located 1 row and 2 rows away from the row being harvested.

Visually, effects of fan speed on the observed dust were noticeable, especially at the 715 and 0 rpm settings (Figures 1-4). An additional observation, which has also been made in previous testing seasons, is that the air jet becomes dustier once it impacts the orchard floor and entrains dust from the floor. The effect of this is that the air leaving the fan outlet is sometimes less dusty than the air in motion one row over. This may suggest that orientation of the blower outlet may be another grower-controlled means to reduce dust, provided that dicharge of dust into the trees does not create other production problems.

Figure 1. 1080 rpm fan operation.

Figure 2. 910 rpm fan operation.

Figure 3. 715 rpm fan operation.

Figure 4. 0 rpm (no fan) operation.

The quantitative results are shown in Table 1. These results show that fan speed does have a significant effect on the duration of the dust cloud, the intensity (opacity) of the visible dust moving within the orchard and also on the mass of dust collected on air samplers. The effect of air jet impacting the orchard floor was also detected in the data as the second row over was the location of the greatest dust load in most experiments.

Table 1: Average results for gravimetric mass, peak opacity and time signature for dust discharge measurements as a function of fan speed.

	Time span (s)			Peak opacity (%)			TSP and PM10 mass (mg)		
Fan speed (rpm)	Row 1	Row 2	Row 3	Row 1	Row 2	Row 3	TSP Row 1	TSP Row 2	PM10 Row 3
1080	31.75	46.50	66.75	2.83	11.73	7.20	0.68	1.14	0.35
910	35.25	25.50	38.00	3.03	7.63	3.75	0.38	0.43	0.08
715	51.75	26.25	33.25	2.70	3.18	3.63	0.37	0.39	0.11
0	n/a	n/a	n/a	0.20	0.08	0.20	0.04	0.04	0.01

Operating the harvester with the fan disconnected resulted in a significant reduction in dust. Visually, there remained dust produced by the motion of the harvester through the orchard and the operation of the pick up and internal chains and handling of the windrow product. However, the experimental data indicate a virtually complete reduction in dust concentrations within the orchard air.

Obviously, these results must be placed in the context of the effects on the harvested material that is subsequently removed from the field. As of this writing (early October 2008), the windrow and harvested samples are being analyzed to measure the changes in the product as a function of fan speed. Visual observation and preliminary data do confirm that the product produced at low and zero fan speeds contained more debris. Detailed results will be available at the poster session at the 2008 Almond Board Conference.