Almond Stockpile Monitoring for Aflatoxin Potential 2011

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Introduction

The first objective of this project is to study the impacts of different tarp materials on stockpile conditions as related to food safety risk. The second objective is to develop methods of assessing nut moisture content before picking up the nuts. A third objective is to examine variability in nut drying on the orchard floor as it relates to position in the orchard and midday canopy light interception. The ultimate goal is to develop recommendations for stockpiling that minimize potential for growth of *Aspergillus* spp. (*A. flavus* and/or *A. parasiticus*) that result in aflatoxin contamination of nuts.

Almond stockpiles in Kern, San Joaquin and Glenn Counties were monitored following the 2007 and 2008 harvests and in Kern County in 2009-2011. Of particular note in the 2007/2008 season, stockpiling of nuts with a water activity notably above the recommended 0.65 - 0.70 resulted in significant mold growth near the pile surfaces. The two piles where this was observed had initial moisture contents of: 1) hulls 13.1% and kernels 5.2% (total fruit moisture content 9.2%); and 2) hulls 12.0% and kernels 7.3% (total fruit moisture content 9.7%). There was *Aspergillus* growth at the top and bottom edge of these stockpiles and analysis of one pile showed this was associated with aflatoxin production.

2011 Objectives

1. Investigate the impact of different tarp materials (clear and white/black) on stockpile conditions as they relate to aflatoxin potential
2. Develop methods to assess nut moisture before harvest
3. Investigate conditions affecting variability of nut drying on the orchard floor

Results

Objective 1 (Tarp investigations)- Results again suggest that fluctuations in temperature were again greatest under clear tarps, and significantly lower under white on black tarps (**Fig. 1**). Nuts under white on black tarps were slightly cooler than ambient temperature at midday and were significantly warmer than ambient temperatures at night (**Fig. 1**).

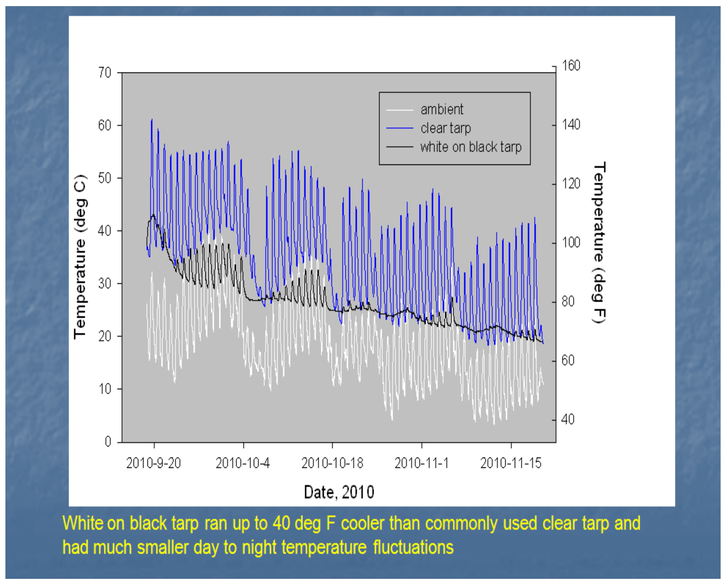

Fig. 1. Ambient temperature and temperatures at top of stockpiles covered with clear and white on black tarps from September to November 2010.

Moisture content in both the wet and dry stockpiles increased over the approximate six month storage period at all locations in the pile including the interior. This is an issue that should be considered in deciding the initial moisture content of stockpiles since ambient humidity conditions can lead to increasing moisture content over the winter storage period. **Photo 1** shows more extensive visible mold development in the clear versus white on black tarp covered stockpiles.

Table 1. Starting and ending moisture content in dry and wet stockpiles covered with either clear or white on black tarp. Samples taken from location labeled 3' down are from 3' down from the top/center of pile (indicated with arrows) are the most representative of conditions in the overall pile

Dry stockpile

	Location	Starting % moisture	Ending moisture	Change in % moisture	
clear	Top	4.9	31.6	+26.7	
	3' down	3.7	9.9	+6.2	←
	Side	4.3	6.3	+2.0	
White on black	Top	4.1	9.2	+5.0	
	3' down	5.2	7.2	+2.0	←
	Side	4.7	9.9	+5.2	

Wet stockpile

	Location	Starting % moisture	Ending moisture	Change in moisture	
clear	Top	7.8	27.7	+19.9	
	3' down	8.0	11.5	+3.5	←
	Side	7.5	8.1	+0.6	
White on black	Top	6.2	23.0	+16.8	
	3' down	7.1	10.9	+3.8	←
	Side	6.8	21.0	+14.2	

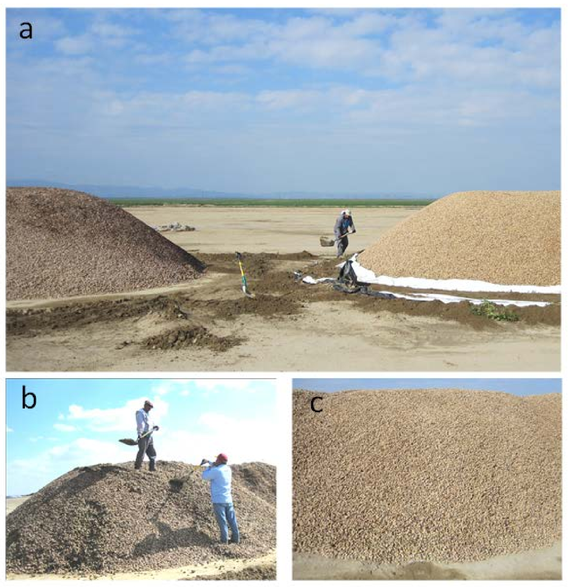

Photo 1. Photos taken of stockpiles from dry orchard on date of stockpile removal (Mar. 20, 2011). Stockpiles had been in place for approximately 6 months. View of (a) stockpile from orchard harvested under dry conditions that was covered with clear tarp with visible mold growth (left) and white on black tarp with no visible mold growth (right), (b) workers removing nuts with black mold growth from top of pile under clear tarp, and (c) generally clean nuts under white on black tarp.

Objective 2 (Develop methods to assess nut moisture before harvest)- Methodology was developed to take nuts from the orchard floor, place them in sealed plastic containers, and after allowing temperature to stabilize, read the relative humidity in the air space at the top of the container using a sensitive relative humidity/temperature probe (Rotronic HygroPalm 23 with HC2-C05 miniprobe).

The relative humidity in the air space of the container at temperature equilibrium is equal to the water activity which can be converted to a percent moisture using the data in **Fig. 2**.

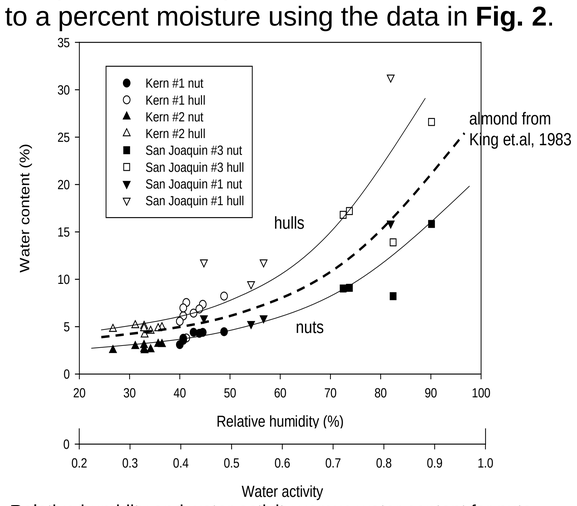

Fig. 2. Relative humidity and water activity versus water content for nuts (including shell) and hulls from the Kern and San Joaquin County stockpiles. Data include cv. Nonpareil from Kern County as well as stockpile #1 and stockpile #3 from San Joaquin County. Dashed line is the approximate curve for almonds (77 deg F) from King et. al, 1983.

This method can work well but it is important that nuts are allowed to equilibrate to a constant temperature (room temperature) before taking readings.This is the method used in **Fig. 3**.

Objective 3 (Investigate conditions affecting nut drying on the orchard floor)- The wettest nuts occurred in the middle of the tree row to the north of the tree trunk. As expected, the driest nuts came from the middle of the drive row. Difference in moisture content from the middle of the drive row to the area north of the trunk averaged about 2%. In a separate study, nuts dried in a windrow also varied with nuts from the bottom of the windrow averaging 2% higher moisture content than those from the top.

Photo 2. Sampling nuts from orchard floor for moisture content analysis. Nut samples were collected through the windrow from top to bottom.

In 2010 and 2011, nuts were sampled from a variety of areas from the least to most heavily canopied parts of 4 orchards that had previous been mapped with our Mule light bar mobile platform. Nuts varied in moisture content with those in the more heavily canopied orchards remaining significantly wetter at the time of harvest (**Fig. 3**).This suggests growers may need to more carefully monitor moisture content in heavily canopied orchards before harvest to assure they are adequately dry before picking them up.

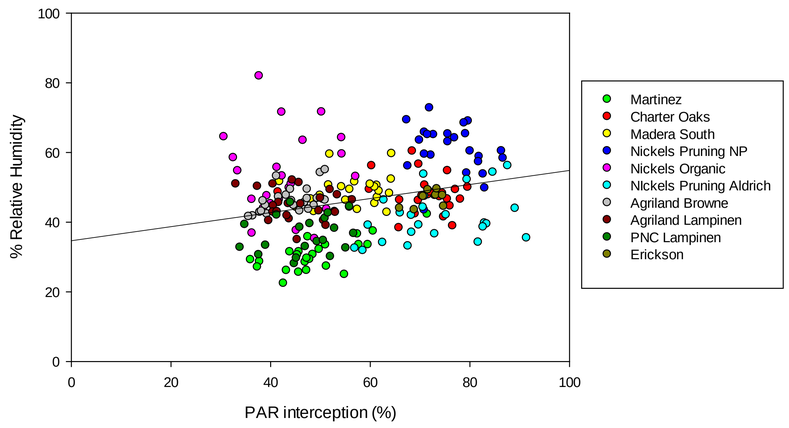

Fig. 3. Midday canopy PAR interception (as measured with mobile platform lightbar) versus sample percent relative humidity for 10 orchards in 2010 and 2011.

Conclusions

- Based on 2007-2011 data, stockpiling of high moisture content in-hull almonds can lead to problems with fungal growth
- White on black and white on white tarps appear to have lower daytime high temperatures and less day to night temperature fluctuations which should lead to decreased condensation problems on pile edges
- Moisture content in stockpiles can increase over the storage period due to ambient humidity conditions
- Substantial variation in moisture content of nuts can occur due to variation in orchard floor drying conditions related to tree canopy density.
- Windrowed nuts can also have substantial differences in moisture content from the top to the bottom of the windrow
- Samples should be taken from the extreme areas (most and least shaded parts of the orchard) where the wettest and driest nuts would likely be found to aid in determining appropriate harvest date.
- Nuts from orchards with higher midday canopy light interception should be carefully monitored to assure they are adequately dry before picking them up.

Reference

King, A.D.Jr., W.U. Halbrook, G. Fuller, and L.C. Whitehand. 1983. Almond nutmeat moisture and water activity and it influence on fungal flora and seed composition. J. Food Sci. 48: 615-617.