Almond Stockpile Monitoring for Aflatoxin Potential 2012

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Introduction

The first objective of this project is to study the process of stockpiling including examining temperature and moisture conditions in stockpiled almonds in different production areas in California. A second goal is to determine the impact of different tarp materials on stockpile conditions. A third goal 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 2009-2012. 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.

2012 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 in 2012 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).

Objective 2 (Develop methods to assess nut moisture before harvest)- The relationship between relative humidity (and water activity) for in shell almond kernels plus hulls, hulls, and for in shell kernels is shown in Table 1. The green shaded area indicates moisture contents that are acceptable for stockpiling. Red shaded area indicates moisture contents that are too wet. The data in Table 1 was constructed from a regression across large sample sets from several years of stockpile results (not shown). However, it should be noted that the relationship between water content and water activity has been shown to vary depending on how wetting/drying cycles are produced. King et.al (1983) found that at a given water activity, the nut moisture content varied depending on the method of drying. This suggests that the most accurate measurement is water activity since it is directly related to microorganism growth potential.

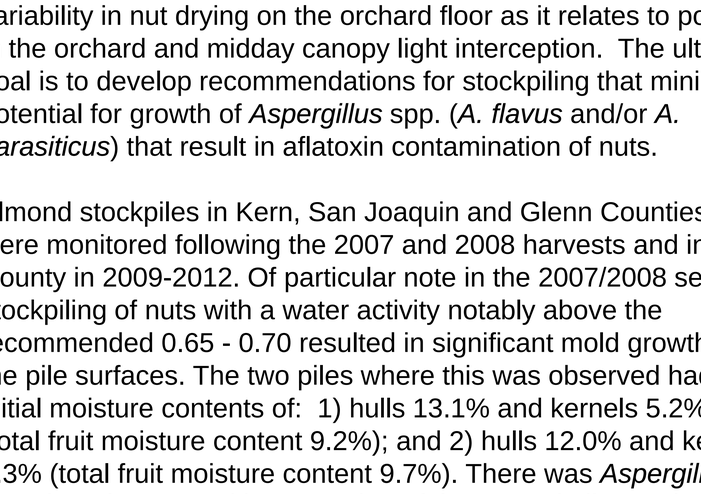

Fig. 1. Temperature (in degrees Celsius) near top of dry stockpile under two different types of plastic cover in Kern County in March 2012. High temperatures under different tarp materials of 30 degrees Celsius correspond to 86 degrees Fahrenheit.

		water content		
Relative humidity	Water activity	kernels+hulls	hulls	kernels
30	0.30	3.80	4.43	2.73
31	0.31	3.89	4.59	2.79
32	0.32	4.00	4.76	2.85
33	0.33	4.11	4.94	2.92
34	0.34	4.22	5.12	2.99
35	0.35	4.34	5.31	3.06
36	0.36	4.47	5.50	3.14
37	0.37	4.61	5.71	3.22
38	0.38	4.75	5.92	3.31
39	0.39	4.89	6.13	3.40
40	0.40	5.05	6.36	3.50
41	0.41	5.20	6.59	3.60
42	0.42	5.37	6.83	3.71
43	0.43	5.54	7.07	3.82
44	0.44	5.72	7.32	3.94
45	0.45	5.90	7.58	4.06
46	0.46	6.09	7.85	4.18
47	0.47	6.29	8.12	4.31
48	0.48	6.49	8.40	4.45
49	0.49	6.70	8.69	4.59
50	0.50	6.92	8.98	4.73
51	0.51	7.14	9.28	4.88
52	0.52	7.37	9.59	5.03
53	0.53	7.60	9.90	5.19
54	0.54	7.84	10.22	5.35
55	0.55	8.09	10.55	5.51
56	0.56	8.34	10.89	5.69
57	0.57	8.60	11.23	5.86
58	0.58	8.87	11.58	6.04
59	0.59	9.14	11.94	6.23
60	0.60	9.42	12.30	6.42
61	0.61	9.70	12.67	6.61
62	0.62	9.99	13.05	6.81
63	0.63	10.29	13.43	7.01
64	0.64	10.59	13.82	7.22
65	0.65	10.90	14.22	7.43
66	0.66	11.22	14.62	7.65
67	0.67	11.54	15.04	7.87
68	0.68	11.87	15.45	8.10
69	0.69	12.20	15.88	8.33
70	0.70	12.55	16.31	8.56
71	0.71	12.89	16.75	8.80
72	0.72	13.25	17.20	9.05
73	0.73	13.61	17.65	9.30
74	0.74	13.97	18.11	9.55
75	0.75	14.34	18.58	9.81
76	0.76	14.72	19.06	10.07
77	0.77	15.11	19.54	10.34
78	0.78	15.50	20.03	10.61
79	0.79	15.89	20.52	10.89
80	0.80	16.30	21.02	11.17
81	0.81	16.71	21.53	11.45
82	0.82	17.12	22.05	11.75
83	0.83	17.55	22.57	12.04
84	0.84	17.97	23.10	12.34
85	0.85	18.41	23.64	12.64
86	0.86	18.85	24.18	12.95
87	0.87	19.30	24.74	13.27
88	0.88	19.75	25.29	13.59
89	0.89	20.21	25.86	13.91
90	0.90	20.68	26.43	14.24
91	0.91	21.15	27.01	14.57
92	0.92	21.63	27.60	14.90
93	0.93	22.11	28.19	15.25
94	0.94	22.60	28.79	15.59
95	0.95	23.10	29.39	15.94
96	0.96	23.60	30.01	16.30
97	0.97	24.11	30.63	16.66
98	0.98	24.63	31.26	17.02
99	0.99	25.15	31.89	17.39
100	1.00	25.68	32.53	17.76

Table 1. Relationship between relative humidity (and water activity) for in shell kernels plus hulls, hulls, and in shell kernels. Green shaded area indicates moisture contents that are acceptable for stockpiling. Red shaded area indicates moisture contents that are too wet.

Objective 3 (Investigate conditions affecting nut drying on the orchard floor)- In 2012 a wetting study was conducted where simulated rain was applied to windrowed nuts at 0, 0.25, 0.50 and 0.75 inches in two positions, center of the drive row (sun) and under the tree (shade). Nuts were then sampled at 3 points - several hours, two days and 7 days after application. Samples were placed in sealed bottles and RH was measured using a Rotronic HygroPalm 23 with HC2-C05 miniprobe and then samples were dried to determine moisture content.

Fig. 2. Time lapse photos show the movement of the sun across the drive row between 6 AM and 4 PM.

The wetting study should show the reliability of using water activity versus drying of nut samples for making a decision as to when to pick up nuts after a rainfall event. Results from this study are currently being analyzed and will be presented in the annual report next year.

Conclusions

- 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.
- 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.

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.