AREAWIDE PROGRAM FOR CONTROL OF NAVEL ORANGEWORM

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This area-wide project will implement an integrated pest management (IPM) program in the Central Valley of California to control navel orangeworm (NOW), *Amyelois transitella*, a primary pest of almonds and pistachios and a secondary pest of walnuts (although in some years it causes more damage than any other insect). The three crops comprise more than 445,000 hectares (almond 295,546, pistachio 61,943, and walnut 97,570) and there has been unprecedented expansion of almond and pistachio acreage in the last four years (30% for almond, 31% for pistachio) with substantial growth for walnut (17%). 2005 total farm gate value for the three was $3.46 billion (almond $2.34 billion, walnut $540 million, and pistachio $580 million). Damage by NOW can exceed 30% in almonds and 11% in pistachios, and infested nuts face an increased likelihood of mycotoxin (aflatoxins B1, B2, G1, G2) contamination, which is a serious food safety concern.

Navel orangeworm in almonds is managed by a combination of orchard sanitation, in-season chemical sprays, early harvest and post harvest fumigation. In pistachios, orchard sanitation has been adopted relatively recently and the emphasis has been on in-season sprays, early harvest and post harvest fumigation. A similar management program is used in walnuts, but NOW is controlled by managing pests and diseases that break the integrity of the walnut husk early in the season. The insecticides used in these crops are subject to continuous regulatory scrutiny due to changing pesticide, air and water quality standards and it is imperative that cultural and chemical control strategies are updated to ensure that economically sound management practices are available to meet the new food, air and water quality standards.

This Area-wide project will reduce NOW damage through adoption of control strategies consisting of cultural control, reduced risk insecticides, and nonchemical methods, primarily mating disruption, optimized for the different growing regions of the Central Valley. These strategies will be validated in representative counties in the north, middle and south valley. The reduced risk chemical approaches demonstrated will include integration of molt accelerating compounds into existing sanitation practices, as well as evaluating and incorporating other recently registered alternatives to organophosphate insecticides for in-season control. This project will reduce insecticide use and decrease the need to fumigate these commodities, by better integrating insecticide application timing with NOW biology, combined with mating disruption.

This focus on an IPM approach will include linking producer data on NOW damage and aflatoxin contamination within and between commodities and identifying high incidence areas to increase our understanding of their dynamics. Coordinating control measures in these three commodities as well as linking grower data will reduce NOW damage and reduce the use of in season sprays. Participants in this project are researchers from the USDA/ARS, University of California, University of California Cooperative Extension Service, and Paramount Farming Company. The three commodity boards have an essential advisory role in this project as well as the responsibility to disseminate our findings to their growers.

The cornerstone of NOW management in almonds is winter sanitation, and the current guidelines recommend a minimum threshold of 2 mummies per tree by February 1 (www.ipm.ucdavis.edu/PMG/f3300311.html). Adoption of this standard has reduced NOW damage to levels below 4 percent, but the recent increase in almond prices combined with the reduced tolerance for aflatoxins has changed acceptable NOW damage to ≤ 2 percent. In a recent 4-year collaborative study, 2003-2006, focusing on sanitation (Higee and Siegel, in press) the following associations were determined between NOW damage and the number of mummy nuts on the tree and on the ground. Based on inspection (Table 1) the threshold should be set below 0.7 mummies per tree and analysis employing the statistic Relative Risk indicates that a threshold as low as 0.2 mummies per tree is beneficial ($P < 0.0001$). This same study (Table 2) also revealed an association between the average number of ground mummies per tree and NOW damage. Analysis employing the statistic Relative Risk indicates that a threshold as low as 5 mummies on the ground per tree is beneficial ($0.01 > P > 0.005$). Finally, the effect of almond proximity to pistachios (center of almond block to margin of pistachio block, each block is 4.05 hectares) was evaluated using the statistic, Relative Risk. The analysis contrasted the frequency of blocks experiencing damage $\geq 2\%$ with the frequency of blocks experiencing damage below this threshold. Even at a three-mile separation from the pistachio margin, almond blocks that were less than 3 miles away were 46% more likely to experience damage $\geq 2\%$ than almond blocks that were more than 3 miles way from pistachios.

Table 1.
The relationship between average tree mummies per tree and NOW damage in Nonpareil almonds. A total of 1,920 blocks (4.05 hectares per block, 8 trees sampled per block) and 2,596,008 almonds were used.

Tree Mummies	NOW damage	SD	Blocks in Category
0	1.631%	1.945	605
0.01-0.49	1.218%	1.649	1,112
0.5-0.69	1.772%	2.249	71
0.7-0.79	2.321%	1.995	39
0.8-1.9	3.505%	3.005	65
≥ 2.0	8.325%	5.789	40

Table 2.
The relationship between average number of Ground Mummies per tree and NOW damage in Nonpareil almonds. A total of 1,920 blocks (4.05 hectares per block, 8 trees sampled per block) and 2,596,008 almonds were used.

Mummies	NOW damage	SD	Blocks in Category
0-4.9	1.393%	1.915	1,288
5.0-7.9	1.567%	2.094	296
8.0-8.9	1.715%	1.815	60
9.0-9.9	2.778%	3.489	46
≥ 10.0	2.715%	3.470	230

Table 3.
A total of 1,368 4.05-hectare blocks and 2,008,742 nuts were used.

Distance (kilometers) from almond center to pistachio margin	Relative Risk	Chi Square	Percent Class with damage ≥ 2%
0.42	2.21	30.64 P < 0.0001	61.3% (62 total)
0..83	2.09	55.08 P < 0.0001	53.8% (169 total)
1.67	2.62	139.95 P < 0.0001	51.5% (413 total)
2.5	3.08	143.35 P < 0.0001	43.9% (695 total)
3.3	2.95	92.83 P < 0.0001	37.9% (895 total)
4.2	1.98	24.60 P < 0.0001	32.3% (1,116 total)
5.0	1.46	4.11 0.05> P > 0.025	30.1% (1,252 total)