

THE IMPACTS OF WALNUT HUSK FLY INFESTATION ON WALNUT QUALITY: 2007-08 HARVEST SEASONS

William W. Coates

ABSTRACT

Walnut husk fly (WHF) can have serious impacts not only on the shell of walnuts but also on the quality of walnut kernels. This project compared matched samples from infested and un-infested nuts collected from the same trees. Four varieties were collected from two orchards in San Benito County over two years. In 2007, samples were collected from 'Hartley' and 'Chandler' in one site and 'Tulare' in a second site. For 'Chandler', nuts that were infested early and late in the season were also compared. In 2008, samples were collected from 'Payne' and 'Hartley' in one orchard site.

Samples were cracked and quality analyzed by Diamond Foods, Inc. Among the parameters evaluated were mean nut weight, % baby nuts, % medium nuts, % large sound nuts, % stained shells, % adhering hull, % external damage, % insect, % mold, % shrivel, % edible yield, color (extra light, light, light amber, amber), reflected light index (RLI) and relative value (RV). WHF damage resulted in reduced nut weights, % large sound nuts, % edible yield, extra light colored kernels, RLI and RV. WHF damage resulted in increases in % adhering hull, % external damage, % mold, and % amber and % light-amber colored kernels. Increases in % shrivel occurred in some but not all WHF-damaged samples. Late WHF damage resulted in reduced color but not in reduced % edible yield.

OBJECTIVES

1. The first objective of this project was to compare WHF infested and un-infested nuts from the same trees for differences in nut and kernel quality.
2. The second objective (2007) was to compare nuts infested with WHF early in the season versus those infested later in the season for differences in nut and kernel quality.

PROCEDURES

Samples were collected just prior to normal commercial harvest in commercial walnut orchards near Hollister, CA. These consisted of matched 1000 g samples of WHF-infested and un-infested nuts from the same trees. In 2007, the samples collected from location 1 were 'Hartley' and 'Chandler' and from location 2 the sample was from 'Tulare'. These were all typical severely damaged, early infested nuts. The damaged hulls were mostly dry, black and decayed with exit wounds and no live larvae present. A sample of nuts that were infested late in the season was also collected for 'Chandler' from location 1. These had hulls that were decayed with soft, moist black areas that often had live larvae present. In 2008, samples of 'Payne' and 'Chandler' were collected from location 1. These were all early-infested nuts.

Samples were collected in mesh bags and dried at 110 deg F in a drying oven. Loose adhering hull was removed. Dried samples were submitted to Diamond Foods, Inc. for cracking and analysis of quality.

RESULTS

The results for whole nut and external characteristics are shown in table 1. For all samples except 'Hartley' in 2008, mean nut weight decreased with WHF damage. There was a substantial increase in % baby and medium nuts in the 2007 'Chandler' samples but not for other varieties. The % large sound nuts varied from 64.8 to 100 % for un-infested nuts but from 0 to 4.4% for WHF-infested nuts. The % stained was substantial for 'Chandler' in 2007 and 'Hartley' in 2008. The % adhering hull varied from 0 to 2.9% for un-infested nuts and 3.6 to 91.1% for infested nuts. The % external damage was 0 to 2.9% for un-infested nuts and 17.9 to 100% for infested nuts.

The results for internal characteristics are shown in table 2. The % insect damage (mostly codling moth) was zero in most samples except 'Chandler' – early damage in 2007 with 0.7% and 'Hartley' – early damage in 2008 with 1.1% damage. The percent mold was zero in all un-infested samples but ranged from 4.1 to 32.8% in infested samples. Shivel was not a major factor in either year but infested samples of 'Tulare' – early infestation, 2007, 'Chandler' – early infestation, 2007 and 'Hartley' – early infestation, 2008 all had more shivel than the un-infested samples. The % edible yield was consistently higher in un-infested nuts than in early infested nuts with the difference varying from 5.9 to 11.0 %. There was a slight increase in % edible yield for late-infested 'Chandler' walnuts versus un-infested nuts. There were substantially more extra-light kernels and fewer amber kernels in the un-infested nuts. The RLI was higher for all un-infested samples.

The RV for all un-infested nuts was higher than matched infested samples. The actual numerical losses for RV were .256 for 'Hartley', .362 for 'Tulare' and .258 for 'Chandler' in 2007. Late damaged 'Chandler' nuts had a 0.078 RV loss. In 2008, RV numerical losses were 0.297 for 'Payne' and 0.275 for 'Hartley'.

DISCUSSION

WHF infestation can result in more than just stained shells and adhering kernel. This has been documented in previous research^{1,2,3}. Research results for 2007 and 2008 confirm that early WHF damage can adversely impact nut weight, nut size (% baby, % medium and % large sound nuts), % shell staining, % adhering hull, % external damage, % mold, % edible yield, color (% extra light, light, light amber, amber), RLI and RV.

Edible yield and RLI are the most important components of both RV and price. Percent losses in % edible yield for infested versus un-infested nuts in 2007 were 14.4 for 'Hartley', 20.4 for 'Tulare' and 11.5 for 'Chandler'. There was actually a 1.4% increase in edible yield for late-infested 'Chandler' walnuts versus un-infested samples. In 2008, percent losses in edible yield were 21.4 for 'Payne' and 16.0 for 'Hartley'. Edible yield is adversely impacted by early WHF damage.

Color as measured by the reflected light index is adversely impacted by WHF damage occurring early or late in the season. Losses in RLI occurred in all infested samples. In 2007, losses in RLI were 14.2% for 'Hartley', 15.6% for 'Hartley' and 15.1% for 'Chandler'. In late-infested 'Chandler' nuts, RLI dropped 8.8% versus un-infested nuts. In 2008, there was a 10.3% drop in RLI for 'Payne' and an 18.7% drop in 'Hartley' RLI.

The relative value of walnuts is adversely impacted by walnuts in proportion to its edible yield and RLI components. The RV was 26.5% less for infested 'Hartley' nuts in 2007, 33.0% less for infested 'Tulare' nuts in 2007, 24.9% less for infested 'Chandler' nuts in 2007, 29.5% less for infested 'Payne' nuts in 2008 and 31.6% less for infested 'Hartley' nuts in 2008 than for un-infested samples. The late-infested 'Chandler' sample in 2007 had a 7.5% RV loss. The mean RV loss for all early-infested samples was 29.1%. The % shrivel was increased in some WHF-damaged samples but only to a minor degree. The late-infested nuts were also adversely impacted for most factors except % shrivel and % edible yield.

ACKNOWLEDGEMENT

The assistance of Diamond Foods, Inc. in performing crackout analyses on all samples is gratefully acknowledged.

REFERENCES

1. Coates, William W. 2005. Walnut husk fly: varietal susceptibility and quality observations. Walnut Research Reports – 2004:179-181. Walnut Marketing Board, Sacramento, CA.
2. Coates, W. W. 2006. Walnut husk fly: varietal susceptibility and its impact on nut quality. Walnut Research Reports – 2005:157-160. Walnut Marketing Board, Sacramento, CA.
3. Coates, William W. 2007. Walnut variety quality evaluations in California's Central Coast region – 2006 and the impacts on nut quality of walnut husk fly infestation and organic versus conventional practices. Walnut Research Reports – 2007: 3- 9. Walnut Marketing Board, Sacramento, CA.

**TABLE 1: EXTERNAL CHARACTERISTICS OF WALNUTS WITH AND WITHOUT WHF DAMAGE
SAN BENITO COUNTY - 2007 AND 2008**

| YEAR | LOCATION | VARIETY | WHF DAMAGE | NUT WT | % BABY | % MEDIUM | % LG SND | % STAIN | % ADH HULL | % EXT DAM |
|------|----------|----------|------------|--------|--------|----------|----------|---------|------------|-----------|
| 2007 | 1 | Hartley | none | 11.11 | 4.4 | 11.1 | 87.3 | 0.0 | 0.0 | 0.0 |
| 2007 | 1 | Hartley | early | 10.42 | 3.1 | 6.3 | 0.0 | 0.0 | 90.6 | 90.6 |
| 2007 | 2 | Tulare | none | 13.00 | 0.0 | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 |
| 2007 | 2 | Tulare | early | 10.32 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| 2007 | 1 | Chandler | none | 9.62 | 8.7 | 26.9 | 64.8 | 0.0 | 2.9 | 2.9 |
| 2007 | 1 | Chandler | early | 7.46 | 33.6 | 48.5 | 0.0 | 12.7 | 5.2 | 17.9 |
| 2007 | 1 | Chandler | late | 9.09 | 10.0 | 47.3 | 0.0 | 39.1 | 3.6 | 42.7 |
| 2008 | 1 | Payne | none | 11.36 | 3.4 | 1.1 | 95.8 | 1.1 | 0.0 | 1.1 |
| 2008 | 1 | Payne | early | 11.14 | 1.1 | 0.0 | 4.4 | 3.3 | 91.1 | 94.4 |
| 2008 | 1 | Hartley | none | 11.38 | 5.7 | 2.3 | 93.7 | 0.0 | 0.0 | 0.0 |
| 2008 | 1 | Hartley | early | 11.39 | 5.7 | 1.1 | 1.0 | 35.2 | 56.8 | 92.0 |

WHF=walnut husk fly

WHF Damage= the amount and timing of WHF damage

NUT WEIGHT= the mean nut weight of individual kernels in grams

% BABY= percent baby size nuts

% MEDIUM=percent medium size nuts

%LG SND=percent large size nuts that are sound (free of defects)

%STAIN= percent of nuts where the shell is stained

%ADH HULL=percent adhering hull, where a portion of the hull is attached to the shell and cannot be easily removed

%EXT DAM=percent external damage, a summation of all external defects

**TABLE 2: INTERNAL CHARACTERISTICS OF WALNUTS WITH AND WITHOUT WHF DAMAGE
SAN BENITO COUNTY - 2007 AND 2008**

| YEAR | LOCATION | VARIETY | WHF DAM | %INSECT | %MOLD | %SHRIVEL | %ED YIELD | %EX LT | % LT | %LT AMB | %AMB | RLI | RV |
|------|----------|----------|---------|---------|-------|----------|-----------|--------|------|---------|------|------|--------|
| 2007 | 1 | Hartley | none | 0.0 | 0.0 | 0.0 | 45.9 | 73.6 | 23.5 | 2.8 | 0.0 | 57.9 | 0.9674 |
| 2007 | 1 | Hartley | early | 0.0 | 26.0 | 0.0 | 39.3 | 6.9 | 27.8 | 20.4 | 3.4 | 49.7 | 0.7110 |
| 2007 | 2 | Tulare | none | 0.0 | 0.0 | 0.0 | 54.0 | 73.2 | 21.8 | 5.0 | 0.0 | 55.9 | 1.0997 |
| 2007 | 2 | Tulare | early | 0.0 | 4.1 | 2.1 | 43.0 | 0.0 | 74.2 | 13.6 | 3.3 | 47.2 | 0.7380 |
| 2007 | 1 | Chandler | none | 0.0 | 0.0 | 1.0 | 51.3 | 70.4 | 19.6 | 9.5 | 0.0 | 55.6 | 1.0382 |
| 2007 | 1 | Chandler | early | 0.7 | 32.8 | 3.7 | 45.4 | 0.0 | 28.5 | 13.6 | 2.7 | 47.2 | 0.7800 |
| 2007 | 1 | Chandler | late | 0.0 | 26.4 | 0.9 | 52.0 | 10.6 | 17.8 | 21.9 | 6.8 | 50.7 | 0.9596 |
| 2008 | 1 | Payne | none | 0.0 | 0.0 | 0.0 | 50.1 | 75.6 | 18.4 | 6.0 | 0.0 | 55.2 | 1.0066 |
| 2008 | 1 | Payne | early | 0.0 | 20.0 | 0.0 | 39.4 | 20.5 | 61.8 | 12.4 | 5.3 | 49.5 | 0.7096 |
| 2008 | 1 | Hartley | none | 0.0 | 0.0 | 0.0 | 41.9 | 64.2 | 28.6 | 7.2 | 0.0 | 57.1 | 0.8700 |
| 2008 | 1 | Hartley | early | 1.1 | 10.2 | 1.1 | 35.2 | 5.1 | 51.0 | 39.9 | 4.0 | 46.4 | 0.5950 |

WHF=walnut husk fly

WHF DAM=amount and timing of WHF damage

% INSECT=percent of kernels with internal insect damage (mostly codling moth)

% mold=percent of kernels with visible mold

% shrivel=percent of kernels with shrivel

% ED YIELD=% edible kernel yield

%EX LT= percent extra-light color kernels

%LT=percent light color kernels

%LT AMB=percent light-amber color kernels

%AMB=percent amber color kernels

RLI=reflected light index (a measure of total color of a sample)

RV=relative value (a measure of comparative value of samples)