CALIFORNIA OLIVE COMMITTEE

FINAL REPORT

Workgroup/Department: Olive / Plant Sciences, UC Davis

Project Years: 2016-2018

Project Title: Investigating Anti-Oxidant Amendments to Decrease the Leaf Abscission with Ethephon Applications:

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Cooperators: Dr. Richard Rosecrance: Professor, Chico State University; Mr. William H. Krueger: Farm Advisor Emeritus; Mr. Erick Nielsen: ENE Inc., pruning and harvesting designer, fabricator and contractor; Leigh Archer: Graduate Student, UC Davis.

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Problems and Significance:

Multiple studies, including a recent study in California (Burns et. al. 2008), have demonstrated that the concentration of Ethephon required to decrease olive fruit removal force to make mechanical harvesting with trunk shakers more efficient also results in unacceptable levels of leaf abscission.

At the 2016 International Society for Horticultural Science 8th International Olive Symposium in Split, Croatia a research group from Israel presented results examining the anatomical and molecular differences between fruit and leaf abscission in table olives. The following is from their abstract discussion:

"We found that the the typical anatomical characteristics of the abscission zones such as small cells with less pectin compared to the neighboring cells, exist in the leaf but not the fruit abscission zone. Screening the response of the cultivars in our olive germplasm collection reveals differences in the response of the abscission zones of the leaves and fruits as expressed in their anatomical characteristics. Transcriptomic analysis of the of the various abscission zones reveals induction of several hormones as well as cell wall degradation enzymes in the leaf and fruit abscission zones in response to exogenous ethylene. However, cellulase activation was found only in the leaf abscission zone. In addition, we found that reactive oxygen species mediated abscission in response to exogenous ethylene applications only in leaves. Thus, adding an antioxidant such as ascorbic or butyric acid to the abscission compound enhanced abscission of fruit but not leaves. Our findings suggest that advising growers to use an abscission agent

exclusively tailored to induce the abscission of fruit would greatly promote the mechanized harvest of table olives". (Goldental-Cohen et. al. 2016)

The major table cultivar in Israel is Manzanilla, which is also the major cultivar for the table olive industry in the United States. The specific treatment analyzed was 0.3% ascorbic acid. This was added to the standard Ethephon treatment to act as an antioxidant and reduce leaf abscission.

2016 Preliminary Trial: (October 15th - December 31st, 2016)

A preliminary application of 0.3% ascorbic acid was applied by Dr. Richard Rosecrance and William H. Krueger, Farm Advisor Emeritus in the Nickels Soils Laboratory moderate density olive block October 15th 2016. Effect on fruit pull force was evaluated on October 25th.

2017 Trial: (September 1st – December 31st, 2017)

2017 Experimental Procedures

Trial was conducted at the Nickels Soils Laboratory in Colusa County using table olives (cv. Manzanillo).

Experimental design was a randomized complete block. Each of four treatments were randomly assigned to an individual tree in each of 10 blocks.

Two weeks before harvest (September 29, 2017) the following treatments were applied at the 100 GPA rate to all 10 replicates:

1. 1500 PPM Ethephon + 0.25% surfactant
2. 1500 PPM Ethephon + 0.25% surfactant + 0.3% ascorbic acid
3. 0.3% ascorbic acid + 0.25% surfactant
4. A water control + 0.25% surfactant

Fruit detachment force was taken from the treated trees on 10 olives per tree from 3 different shoots. Pull force was determined using an Imada Force Gauge immobilized on a flat surface. These tests were performed 9/29, 10/4, 10/8, and 10/13.

Trees were harvested October 13, 2017 using a trunk shaker. At harvest trees were rated visually for leaf drop on a 0-3 scale; 0=none, 1 = mild , 2 = moderate, 3 = severe.

2018 Trial: (September 1st – December 31st, 2018)

2018 Experimental Procedures:

Trial was again conducted at the Nickels Soils Laboratory in Colusa County using table olives (cv. Manzanillo)

Experimental design was a randomized complete block. Each of four treatments were randomly assigned to an individual tree in each of 6 blocks. Different trees from the 2017 trial were selected.

One week before harvest (September 24, 2018) the following treatments were applied at the 100

GPA rate to all 10 replicates:

1. 1000 PPM Ethephon + 0.3% surfactant (Paraffin oil)
2. 1000 PPM Ethephon + 0.3% surfactant + 0.3% ascorbic acid + 4% MPK
3. 0.3% ascorbic acid + 4% MPK + 0.3% surfactant
4. A water control + 0.3% surfactant

Solutions were prepared just prior to application, treatments were sprayed before 11AM, and treatment mixtures were tested to maintain a pH range of 5.5-6.

Fruit detachment force was taken from the treated trees on 15 olives per tree from 3 different shoots. Pull force was determined using an Imada Force Gauge immobilized on a flat surface. These tests were performed prior to harvest on 9/23, 9/26, 9/30. Force was also tested one week after harvest on 10/8.

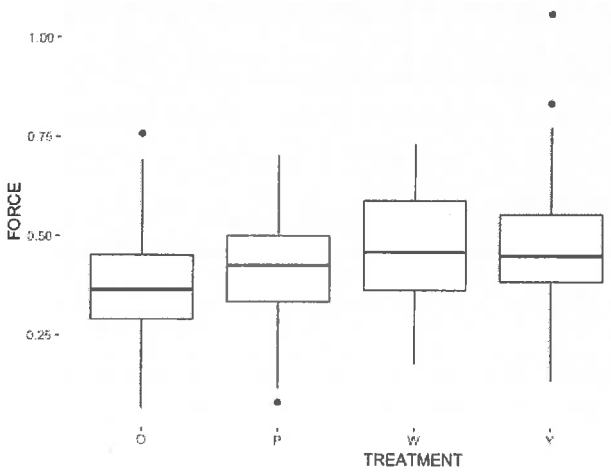
All treated trees were harvested using a trunk shaker on 10/1/2018. At harvest trees were rated visually for leaf drop on a 0-3 scale. 0=none, 1 = mild , 2 = moderate, 3 = severe.

Data from both years were analyzed using SAS and R software. Statistical analysis included an ANOVA with an LSD means separation for each factor.

Results and Discussion:

The 2017 trial was conducted using 1500ppm Ethephon in combination with .3% Ascorbic Acid (AA). The removal force of the fruit decreased after spray application in all treatments due to natural ripening. However, the detachment forces of both treatments receiving Ethephon were significantly lower (P<.01) than the control and AA only treatment (Figure 1.)

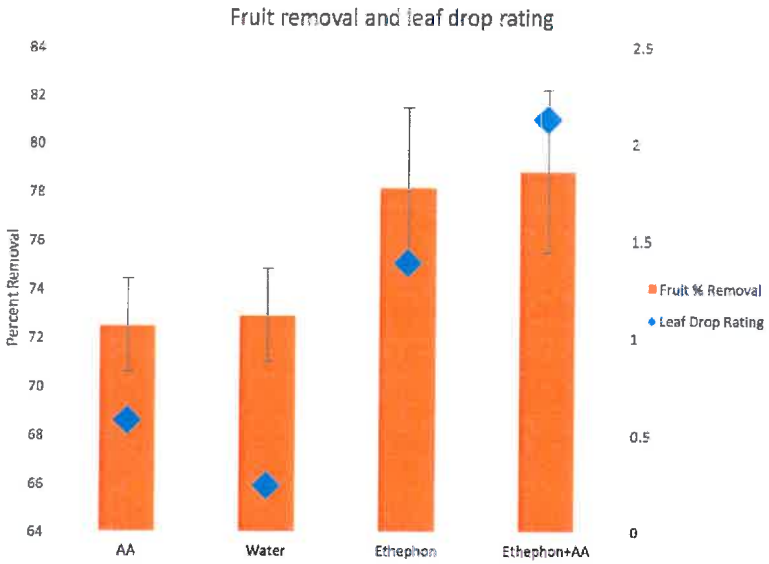
Figure 1: 2017 detachment force at harvest by treatment showing significant differences between treatments with Ethephon and treatments without Ethephon. O=Ethephon+AA, P=Ethephon, W=Control, Y=AA.



Fruit were sprayed two weeks before harvest and differences in fruit removal and leaf drop at

harvest were significant. Fruit removal and leaf drop were significantly higher in both treatments containing Ethephon, regardless of the use of AA (Figure 2.).

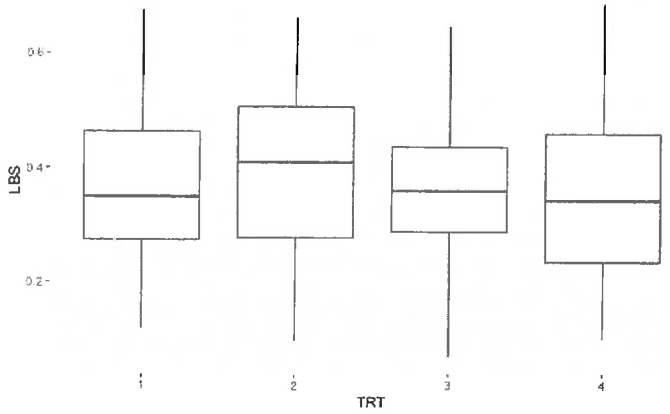
Figure 2: Percent fruit removal and leaf drop ratings at harvest for each treatment



The 2018 trial was modified to attempt to reduce leaf drop associated with the 1500ppm Ethephon treatment. The treatment was reduced to 1000ppm and the Ethephon was sprayed in combination with 4% monopotassium phosphate (MKP). Treatments were mixed immediately prior to spraying, applied in the morning, and pH was maintained near 6.0. The spray was applied only one week before harvest and the olives were sprayed when they were less physiologically mature than the previous year. This decision was made to reduce price per pound losses at processing facilities associated with overripe fruits.

Results from 2018 suggest that the spray application of Ethephon at 1000ppm was ineffective for enhancing ripening at the fruit maturation level used. There were no significant differences ($P>.05$) in removal force (Figure 3.), fruit removal, or leaf drop across all four treatments.

Figure 3. 2018 detachment force at harvest for all four treatments showing no significant differences



Detachment force testing was conducted one week after harvest (two weeks after spray application) in 2018 with no significant differences in treatments. The average pull force across all treatments was higher during the final testing date than during the test conducted at harvest, .380 lbs vs. .367 lbs respectively. We suggest that this is due to the removal of the fruits with lower detachment forces during trunk shaking.

While there is evidence to support the claim that Ethephon will enhance ripening and reduce detachment force of Manzanilla olives, we were unable to prove the efficacy of an addition of ascorbic acid to reduce unacceptable levels of leaf loss during and after harvest. We can also suggest that 1000ppm Ethephon was not effective at enhancing ripening of under-ripe fruits and consequently did not contribute to leaf loss.

Conclusion:

Results from the 2017 trial demonstrated that the application of Ethephon® decreased detachment force in Manzanilla olive fruits. However, the 1500ppm application concentration of Ethephon® resulted in unacceptable levels of leaf loss that were not reduced with the inclusion of an anti-oxidizing agent. The 2018 trial reduced the concentration of Ethephon® to 1000ppm. And treatments were applied when the fruits were less physiologically mature. Results showed no difference in detachment force related to Ethephon® or ascorbic acid. The uptake of Ethephon®, therefore, appears to be a function of fruit and fruit abscission zone maturity.

At this time we do not have the tools to detect when the olive fruit abscission zone is most receptive to reacting to exogenous ethylene applications. Nor, were we able to demonstrate significant evidence that the addition of an antioxidant would reduce leaf loss during or after harvest. Additional research that modifies Ethephon® concentrations, uses different cultivars, or applies treatments at varying physiological maturities may contribute to a better understanding of what combination of treatments will consistently decrease olive fruit detachment force and minimize leaf loss. However, at this time, our conclusion is that the concentrations of ethylene required to loosen Manzanillo table olives and improve trunk shaking mechanical harvesting efficiency also result in unacceptable levels of leaf loss the following winter season, compromising successful bloom and shoot growth the following season. We further suggest that

until new information on the mechanism of olive fruit and leaf abscission is available experimenting with spray applications is not productive.

We gratefully acknowledge the support of the California Olive Committee.

References:

Burns, J.K., L. Ferguson, K. Glozer, W.H. Krueger, and R.C., Rosecrance. 2008. Screening fruit loosening agents for black ripe processed table olives. HortScience 43(5):1449-1453.

Goldental-Cohen, S, I.B.Y. Mani, B. Avidan, S. Lavee, G. Ben-Ari. 2016. Anatomical and molecular differences between the olive fruit and leaf abscission zone enable development of a selective abscission compound. Abstract: Int. Soc. Of Hort. Sci.: 8th Int. Olive Symp. Oct. 10th – 14th 2016 Split, Croatia. P. 42.